

FOREST RAW MATERIALS
FOR
PULP, PAPER AND NEWSPRINT



सत्यमेव जयते

COMMITTEE ON NATURAL RESOURCES,
PLANNING COMMISSION, NEW DELHI
SEPTEMBER, 1965

STUDY ON
FOREST RAW MATERIALS
FOR
PULP, PAPER AND NEWSPRINT

E R R A T A

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FOREWORD

The demand for paper newsprint is steadily rising. Concerted efforts are therefore needed to fill the widening gap between the raw materials available from the forests and their requirements in subsequent years. A Working Group of Committee on Natural Resources of the Planning Commission was set up to undertake a study on the subject. It has made some practical recommendations for meeting the future demand of raw materials for Pulp, Paper and Newsprint. I sincerely hope that these recommendations will be implemented by the State Governments during the successive Plans.

M. S. THACKER
Member
(*Natural Resources*)

NEW DELHI,
September 17, 1965

CONTENTS

	Page
Preface	(iii)
I. Introductory	1
II. Trends and Prospects	3
III. Forest Raw Materials	8
IV. Pulpwood Requirements and Plantation Programme	15
V. Pulpwood Plantation Research	20
VI. Economics of Plantations	25
VII. Present Processes and Recent Technological Developments	31
VIII. Summary and Recommendations	37

Annexures

I. Possibility of Erecting Large Mills in the Public Sector	41
II. Mills in Production on 15-5-1965 and Their Expansions Licensed	43
III. Research Centres Proposed for Trials of Pulpwood Species	52
IV. Fibrous Raw Material for the Indian Pulp, Paper and Board Industries	53
V. Industry Oriented Plantations	57

PREFACE

Consumption of paper and newsprint is regarded as a good index of the development of a country. Judged by this standard, India is far behind: its *per capita* consumption of paper is only 1.4 kg. as compared to 7 kg. in UAR, 16 in USSR, 57 in Japan, 106 in UK and as much as 205 in USA. This low consumption is also the result of non-availability of adequate cellulosic raw materials and to some extent due to the difficulty of obtaining foreign exchange. The country has made some progress in the production of paper and newsprint after independence. Even so nearly 75 per cent of the newsprint worth over Rs. 6 crores is being imported. The demand for paper and paper products is rising rapidly and is expected to be as much as six fold of the present consumption in 1980. Manufacture of paper requires a certain percentage of long-fibre to give it strength. So far the only long-fibre forest material used has been bamboo. The available bamboos have more or less been booked except for those available in the forests which have not yet been opened up. The present off-take of 0.7 million tonne of bamboos by the paper industry may eventually rise to about 2.5 million tonnes. Even when all of this is utilised most rationally to produce paper, the total production will be only 2.5 million tonnes as against the anticipated requirements of nearly 4 million tonnes by 1980.

A Working Group of the Committee on Natural Resources of the Planning Commission was set up in December, 1964, to undertake a quick survey of the forest resources in the already exploited forests; to estimate the present availability and future requirements of forest raw materials for pulp, paper and newsprint and later for other forest based industries; and to recommend sites where plantations of suitable fast growing pulpwood species should be raised to meet the requirements of the existing paper mills and of new mills to be set up hereafter; as also the extent of these plantations, the species that should be used, the agency which should undertake this work and the funds that will be required during the Fourth and subsequent plans. The Working Group consisted of the following:—

Chairman

Shri A. B. Guha, Adviser (Resources), Planning Commission, New Delhi.

Members

2. Shri Hari Singh, Inspector General of Forests, Ministry of Food and Agriculture, New Delhi.
3. Shri T. N. Srivastava, President, Forest Research Institute and Colleges, Dehra Dun.
4. Shri R. S. Singh, Chief (Agriculture) Planning Commission New Delhi.
5. Shri N. Narsimhan, Development Officer (Paper), D.G.T.D., Ministry of Industry & Supply, New Delhi.
6. Shri G. S. Matharu, Development Officer (Timber), D.G.T.D., Ministry of Industry & Supply, New Delhi.
7. Shri M. Satyapal, Director (Chemicals), Planning Commission, New Delhi.

Member Secretary

8. Shri K. P. Sagreiya, Senior Specialist (Forest Resources), Planning Commission, New Delhi.

The present study incorporates information made available to the Working Group by:—

1. The Directorate General of Technical Development (Paper Directorate), Ministry of Industry & Supply;
2. The Forest Research Institute, Dehra Dun, (Ministry of Food & Agriculture);
3. Heads of the Forest Departments of the States and the Union Territories; and
4. The representatives of the Paper Industry

The Working Group has suggested the following measures to meet the shortage:

1. Creation of bamboo plantations in suitable areas;
2. Opening up of the coniferous forests in the higher Himalayas by the introduction of up-to-date logging methods, as conifers are the most suitable pulpwood;
3. Creating large scale industry-oriented plantations of Eucalyptus and other fast growing species.

It is hoped that the Forest Departments of the States will take adequate steps to create the requisite quantities of raw materials and then to utilise them rationally so that the progressively increasing demand of paper is met indigenously in future.

I take this opportunity to thank all the members of the Working Group for the cooperation given. Special thanks are due to Shri K. P. Sagreiya, the representatives of the Paper Industry and the Heads of Forest Departments of the States/Union Territories for all the help given by them. Thanks are also due to Shri I. M. Qureshi, Director, Forestry Research and Dr. S.R.D. Guha, Officer-in-Charge, Cellulose and Paper Branch, F.R.I., Dehra Dun for detailed information furnished by them and to Shri K. G. Bhatia, Research Officer (Forest Resources) for assisting in the compilation of this Report.

A. B. GUHA
Adviser (Resources)

NEW DELHI,

September 16, 1965.



A Bamboo Plantation

CHAPTER I

INTRODUCTORY

Sometime ago, the Indian Investment Centre appointed a Committee on Raw Materials for Chemicals and Processing. This Committee in its report in March, 1963, recommended the constitution of a National Board for Cellulosic Raw Materials with the following terms of reference :

- (a) to examine measures, including adoption of new silvicultural techniques, for increasing the forest resources of the country;
- (b) to advise the Central and State Governments on policies pertaining to scientific development of forest resources with particular reference to cellulosic materials. This may include policies for charging royalty as well as conditions and duration of leases to be given to paper and pulp mills;
- (c) to recommend special measures necessary for the cultivation of cellulosic raw materials required for the production of dissolving grade pulp;
- (d) to devise plans for integrated working of saw mills, joinery mills and pulp mills in order to ensure maximum utilisation of the cellulosic materials;
- (e) to examine measures to conserve bagasse to use it as industrial raw material providing modern and efficient steam raising equipment to sugar factories; and
- (f) to take all other steps, including arrangements for training programmes, surveys and adoption of modern methods for regular supply of timber.

The question of establishing this Board was deferred pending finalisation of a project for the survey of forest resources which the Ministry of Food & Agriculture has taken up with United Nations Special Fund Assistance. The Plan of Operation of the project, *Pre-investment Study of Forest Resources*, was signed on 1st February, 1965. The purpose of this project is to assist the Government of India in the development of the country's forest resources and associated forest industries to increase wood production to fill the widening gap between domestic production and local demand, especially in the field of plup and paper. To this end, the project is oriented towards planning the expansion of the existing and the development of new forest industries based on the available resources or on industrial plantations created and to be created hereafter in selected areas. In the next 3½ years, this study is expected to cover an area of

29,785 sq. km. (11,500 sq. miles) which is about 4 per cent of the total forest area of the country. The study will be confined to the following forest areas:

- (i) the Himalayan Coniferous Forests of Punjab, Uttar Pradesh and Himachal Pradesh 6,475 sq. km. (2,500 sq. miles) in the North;
- (ii) the Moist Deciduous Forests of Dandakaranya comprising parts of Madhya Pradesh, Orissa, Andhra Pradesh and Maharashtra 18,648 sq. km. (7,200 sq. miles) in the Centre; and
- (iii) the Evergreen Forests of Kerala and Mysore 4,662 sq. km. (1,800 sq. miles) in the Western Coast.

All these areas carry valuable forests which have not yet been fully surveyed or exploited for want of adequate logging and transport facilities. To arrive at an accurate assessment of physical availabilities of raw material, modern methods of forest inventory are to be employed. These will include aerial photography-cum-photo-interpretation, mapping and statistical analysis of field data using recently developed techniques. To carry out the field work of forest inventory, training courses are to be organised.

As the opening up of the hitherto unworked forests will take time and as it is becoming increasingly difficult to meet the progressively increasing demand for suitable pulping material from the forests already under working, it will be necessary to create large scale plantations of suitable fast growing species. (Some large scale plantations already created by the States of Mysore, Uttar Pradesh and Himachal Pradesh were visited by some members of the Working Group).

Besides this, on the decision already taken in the Planning Commission to put up two large pulp mills and one newsprint mill in the public sector, the Ministry of Industry & Supply appointed a two-men team consisting of Shri K. P. Sagreiya, Senior Specialist (Forest Resources), Planning Commission, and Shri Kan. D. Mariwalla, Chief Planning Engineer, T.C.B. of the National Industrial Development Corporation to examine the extent information regarding the availability of forest raw materials and to make suitable recommendations. Accordingly the team examined the availability in Assam, Madhya Pradesh and in the tri-junction of Kerala, Mysore and Madras States. A summary of the findings is given in Annexure I.

CHAPTER II

TRENDS AND PROSPECTS

Consumption and Demand

After the country became independent, the consumption of paper and newsprint has steadily increased as a result of rise in the living standard of the people. But even so, the present *per capita* consumption is the lowest amongst the comparable countries of the world as will be seen from Table 1.

TABLE 1

Annual per capita Consumption of Paper and Paper Products (1962)

Country	Per capita consump- tion (kg.)	Population (million)
United States	205	186
United Kingdom	106	53
West Germany	84	56
Japan	57	95
U.S.S.R.	16	223
U.A.R.	7	26
China (Mainland)	2.6	669
Ceylon	2.5	10
Pakistan	1.6	96
INDIA*	1.4	470
WORLD	26.7	3,060

*1964 figures

The demand for various types of paper and paper boards in India is estimated to be: printing and writing paper 65 per cent; packing and wrapping paper 16 per cent; paper boards 16 per cent; speciality paper 3 per cent. This proportion is not likely to change during the Fourth Plan period.

The consumption of (a) Paper and Paper Boards and (b) Newsprint in India is shown in Table 2.

TABLE 2

Production, Imports and Consumption *(a) Paper and Paper Boards*

(Thousand tonnes)

Year (1)	Production (2)	Imports (3)	Consumption (4)
1947-48	93.7	6.0	161.6
1948-49	98.2	82.9	181.1
1949-50	104.4	69.6	174.0
1950-51	107.6	34.2	141.8

TABLE 2—contd

Year (1)						Production (2)	Imports (3)	Consumption (4)
1951-52	..	..	..	..	..	135.6	32.4	168.0
1952-53	..	..	..	..	..	136.8	39.2	176.0
1953-54	..	..	..	..	..	137.3	41.7	179.0
1954-55	..	..	..	..	..	169.1	37.9	207.0
1955-56	..	..	..	..	..	187.0	50.0	237.0
1956-57	..	..	..	..	..	197.0	45.0	242.0
1957-58	..	..	..	..	..	219.0	41.5	260.5
1958-59	..	..	..	..	..	261.0	15.0	276.0
1959-60	..	..	..	..	..	32.0	18.0	330.0
1960-61	..	..	..	..	..	343.2	22.8	366.0
1961-62	..	..	..	..	..	367.5	21.5	389.0
1962-63	..	..	..	..	..	387.6	23.4	411.0
1963-64	..	..	..	..	..	464.6	29.0	493.6
1964-65	..	..	..	..	..	493.0	25.0	518.0
1965-66*	..	..	..	..	..	520.0	20.0	540.0

*Estimated

(b) Newsprint

(thousand tonnes)

Year						Production	Imports	Consumption
1948-49	..	..	..	..	..	..	43.9	43.9
1949-50	..	..	..	..	..	..	44.7	44.7
1950-51	..	..	..	..	..	..	75.2	75.2
1951-52	..	..	..	..	..	..	50.5	50.5
1952-53	..	..	..	..	..	..	54.3	54.3
1953-54	..	..	..	..	..	..	70.8	70.8
1954-55	..	..	..	..	..	..	79.0	79.0
1955-56	..	..	..	..	..	3.6	74.7	78.3
1956-57	..	..	..	..	..	13.6	62.8	76.4
1957-58	..	..	..	..	..	14.2	63.7	77.9
1958-59	..	..	..	..	..	21.9	57.5	79.4
1959-60	..	..	..	..	..	22.4	74.5	96.9
1960-61	..	..	..	..	..	22.9	75.5	98.4
1961-62	..	..	..	..	..	25.2	93.6	118.8
1962-63	..	..	..	..	..	26.6	99.2	125.8
1963-64	..	..	..	..	..	30.4	94.8	125.2
1964-65*	..	..	..	..	..	30.0	95.5	125.5

Source—Directorate General of Technical Development (Paper Directorate).

*Estimated.

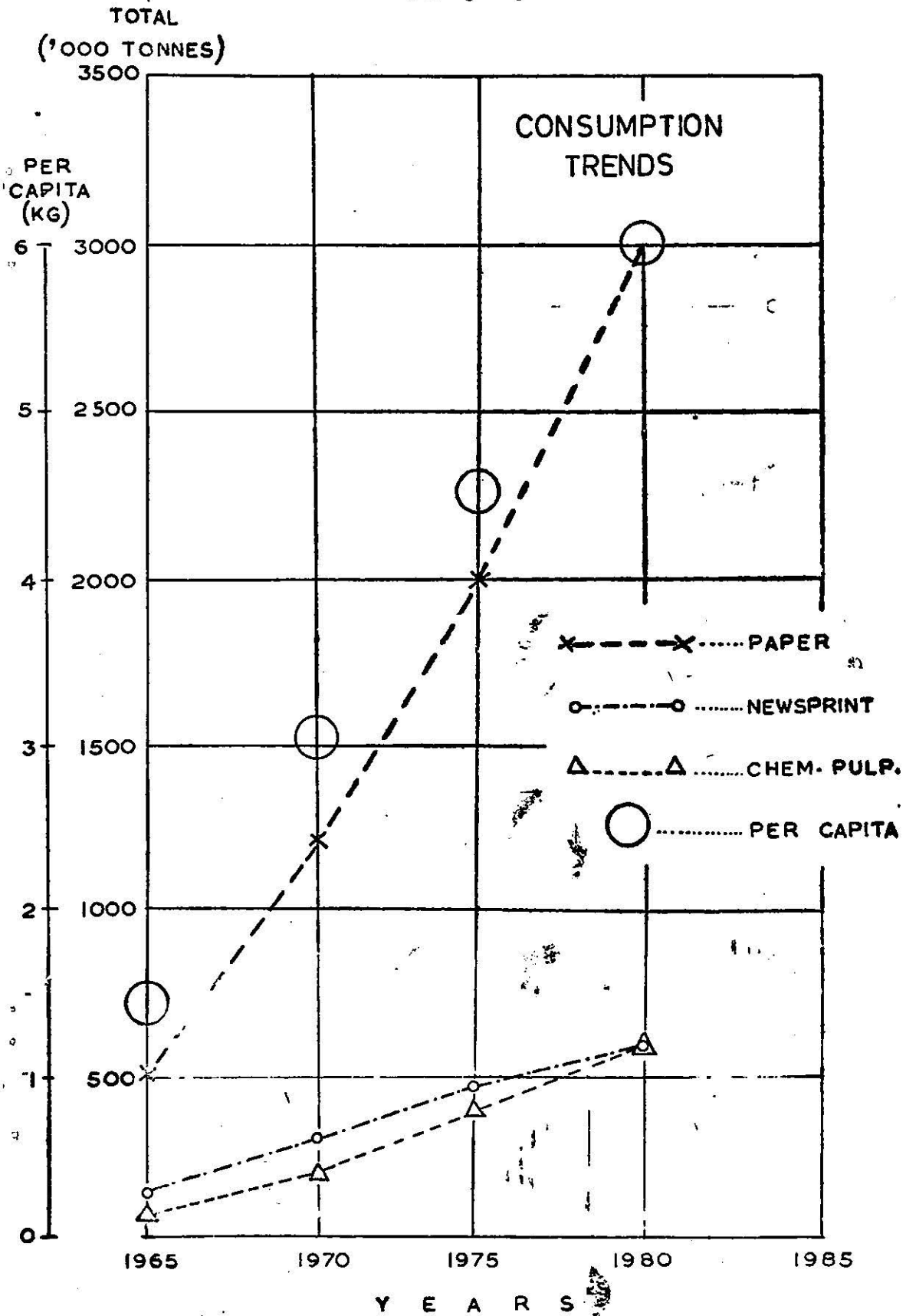


FIG. 1.

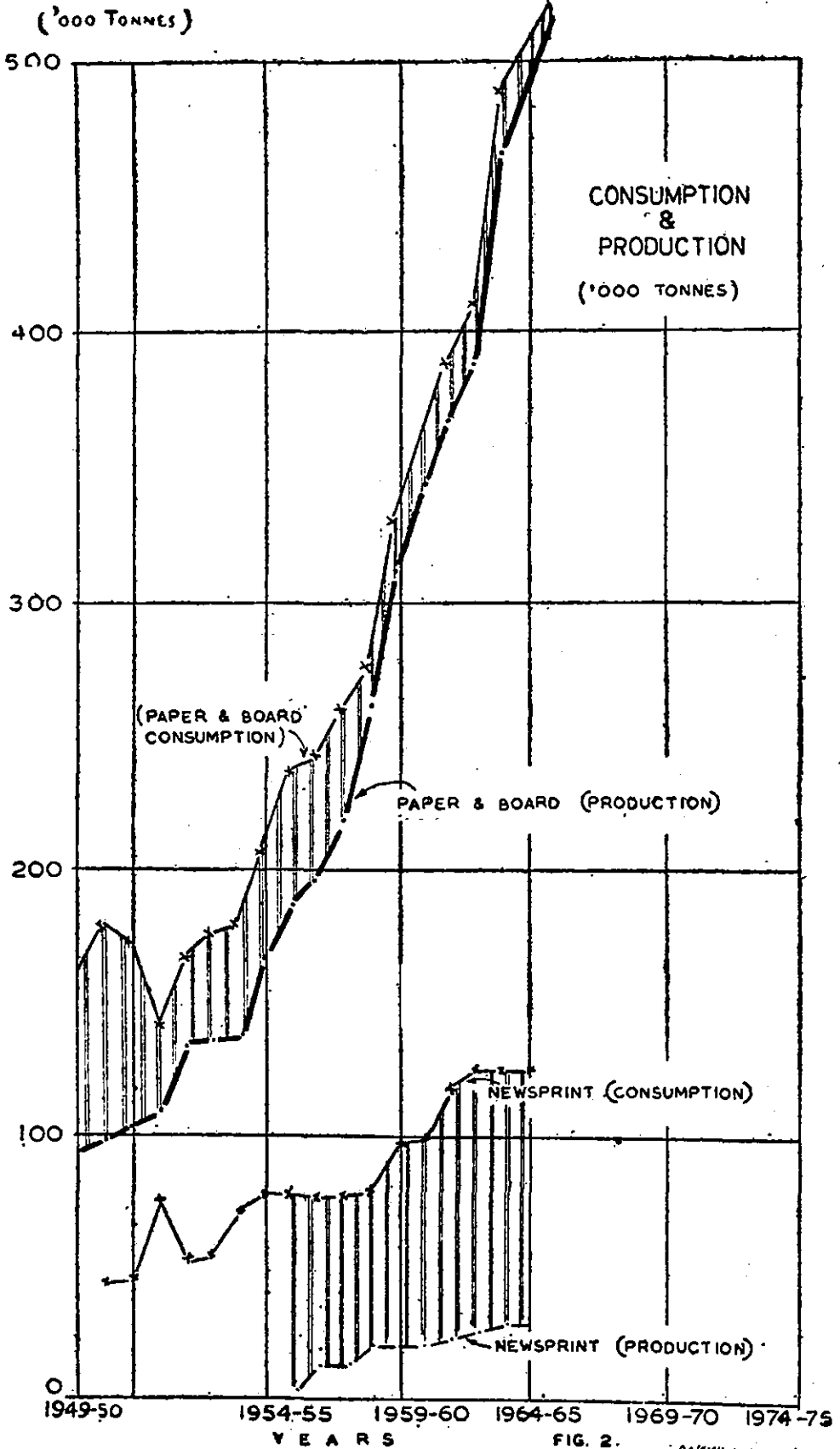


FIG. 2.

The consumption is far below what is considered reasonable in the present stage of development of the country: a consumption of 4 kg. *per capita* would be the barest minimum. By 1980-81, the reasonable consumption is estimated to be about 6 kg. *per capita*. As by this time the population would have increased to about 700 million, the total requirements will mount up to 4.2 million tonnes as against the present consumption of only 0.7 million tonnes, namely nearly six-fold. The trend of future demand is exhibited in Table 3.

TABLE 3
Consumption and Estimated Demand of Paper, etc.

(Thousand tonnes)

Type	Consumption (1963-64)	Estimate of future demand		
		1970-71	1975-76	1980-81
1. Paper and Paper Boards	493.6	1,200	2,000	3,000
2. Newsprint	125.2	300	450	600
3. Chemical Pulp	75.4	200	400	600
Total	694.2	1,700	2,850	4,200
Population (Million)	470	560	630	695
Per capita consumption (kg.)	1.4	3.0	4.5	6.0

Production Trends

(a) *Paper and Paper Boards*—The production of paper and paper boards in 1956 and 1962 in certain countries was as shown in Table 4.

TABLE 4
Production of Paper and Paper Boards

Country	1956	1962 (^{'000} tonnes)	Population (million)
U.S.A.	31,428	37,580	186
Canada	8,504	8,783	19
Japan	2,830	6,252	95
U.K.	3,618	4,425	53
U.S.S.R.	2,839	4,035	223
West Germany	2,955	3,978	56
India	197	388	470
Pakistan	33	108	96

*1964 figure.

On 15th May 1965, there were 53 Paper and Board mills in production in India with a capacity of 6,43,870 tonnes and with a licensed expansion of 2,29,516 tonnes. Besides this, 10 new large units have been licensed or approved with a total capacity of 2,44,200 tonnes (Annexure II).

The Statewise existing capacity and licensed expansion of mills already in production and the capacity licensed for new units is shown in Table 5.

TABLE 5

Statewise Existing Licensed Production Capacity for Paper and Paper Boards as on 15-5-1965

(tonnes)

States	Mills in Production		New Units
	Existing capacity	Expansion licensed	Capacity licensed
Andhra Pradesh	43,000	42,900	..
Bihar	63,000	37,500	15,000
Gujarat	18,390	6,600	..
Kerala	11,640	..	3,000
Madhya Pradesh	57,200	..	..
Madras	26,000	..	9,000
Maharashtra	71,610	19,580	79,200
Mysore	66,640	35,800	33,000
Orissa	102,000	37,600	..
Punjab	45,760	11,740	30,000
Uttar Pradesh	34,200	3,800	48,000
West Bengal	102,430	4,996	..
Total	643,870	227,516	244,200

The production for the year ending 31st March, 1964, was 4,93,000 tonnes. It may be expected that during 1965-66 the total production of paper and paper boards might be around 520,000 tonnes as against the target production of 7,00,000 tonnes for the Third Plan.

The progress in the implementation of licensed schemes continues to be unsatisfactory mainly due to inadequacy of cellulosic raw material and as finances are not readily forthcoming. It is expected that during the next 3 to 4 years, except the Ashoka Paper Mills, Bihar, and a few small units practically no new units are likely to come into operation. In the case of existing paper mills as a result of the balancing equipment programme which was mooted in 1963-64 some additional capacity might be expected.

A statement showing the capacity likely to materialise during the first 3 years of the Fourth Plan period is given in Table 6.

TABLE 6

Estimated level of Production Capacity for Paper and Paper Boards during the first 3 years of the Fourth Plan

Year	Estimated Production	
	Capacity (tonnes/yr.)	
1965-66	660,000	
1966-67	692,620	
1967-68	749,916	
1968-69	819,716	

Thus at the present rate of progress the capacity of the industry could at best be about 820,000 tonnes by 1968-69. Unless concerted efforts are made right from now it may not be possible to achieve the target envisaged for the Fourth Plan.

(b) *Newsprint*—In the Third Plan, the target capacity of 150,000 tonnes per year of newsprint was fixed to meet the anticipated consumption of about 120,000 tonnes by 1965-66. The figure was fixed keeping in view the restrictive policy adopted by Government for the consumption of newsprint, as its import requires foreign exchange. If all curbs on consumption are removed, the free demand would be much larger. It is estimated that by 1970-71 this might well be of the order of 300,000 tonnes. Therefore, the target capacity by the end of the Fourth Plan will have to be fixed at about 330,000 tonnes per year.

At present the National Newsprint and Paper Mills Ltd. (Nepa Mills) is the only unit in the country producing newsprint. This is made from a furnish containing 60 per cent mechanical pulp from salai wood and 40 per cent chemical pulp from bamboo. The rated capacity of this mill is 30,000 tonnes per year which has just been reached. Expansion of the Nepa Mills from 30,000 to 75,000 tonnes has already been licensed and orders for plant and machinery have been placed. The expanded capacity of this unit is expected to become available in 1967-68. Other schemes have not made any appreciable headway. Of the three new schemes licensed for making newsprint, only two are likely to materialise by the middle of the Fourth Plan with a capacity of only 90,000 tonnes i.e. in all 165,000 tonnes against the anticipated demand of 300,000 tonnes.

(c) *Pulp*—In the Third Plan, no target was fixed separately for the production of paper-grade pulp*. For the rayon-grade pulp a target capacity of 100,000 tonnes was fixed. Seven schemes with a total capacity of 276,000 tonnes of rayon-grade pulp and one scheme with a capacity of 22,500 tonnes of paper grade pulp were licensed. In the case of rayon-grade pulp most of the licenses granted have been revoked. The only scheme which is still valid is that of M/s. South India Viscose Ltd., Coimbatore, for the manufacture of 21,000 tonnes/year of rayon-grade pulp from Eucalyptus. M/s. Manjushree Industries, who hold a licence for rayon-grade pulp in Assam, now propose to take up manufacture of paper-grade pulp with a larger capacity. The Gwalior Rayons in their Kerala Pulp-plant, with a capacity of 54,000 tonnes of rayon-grade pulp, has gone into production, utilising bamboo as the raw material. Such pulp could also be made from short fibred material. The question of this unit producing larger quantities of paper-grade pulp from bamboo is under examination.

By 1970-71 a capacity of 130,000 tonnes of paper-grade pulp may be expected.

*All large paper mills in the country were integrated units converting the entire pulp produced by them into paper in their mills.

CHAPTER III

FOREST RAW MATERIALS

The main constituent of paper is cellulose fibre obtained from plants. In 1958-59, the latest year for which figures are readily available, the paper industry in India consumed various cellulosic raw materials in the proportion: bamboo 70 per cent; sabai grass 9 per cent; waste paper and agricultural waste 8 per cent; imported pulp 5 per cent; bagasse 3 per cent; salai wood 4 per cent; coniferous wood 1 per cent.

This study deals only with raw materials obtainable from forests namely, bamboo, sabai grass and various woods. At present the main long fibred raw materials used are bamboos (fibre length 2 to 4 mm.) and to a lesser extent sabai grass (fibre length 1.5 to 3 mm.) and some coniferous woods (fibre length 3 to 5 mm.).

The main bamboo used so far is *Dendrocalamus strictus* *Bambusa arundinacea* is now being used by the paper mills in the South; for instance, the West Coast Paper Mills are using gregariously flowered and dead bamboos for the last three or four years. The other species of bamboo which occurs in large quantities, mostly in the Cachar District of Assam, and is found suitable for making paper is Muli (*Melocanna bambusoides*).

In the early stages of paper industry development, sabai grass (*Eulaliopsis binata*) constituted more than 50 per cent of the raw material used mainly because of its special fibre characteristics, lower consumption of processing chemicals, durability and strength. It is eminently suitable for the manufacture of high class book and printing paper. But because of collection difficulties, unsteady supplies and higher cost, increasing quantities of bamboo have been used instead, and now as much as 70 per cent of the total forest raw materials used is bamboo. Sabai grass from the lower Himalayas is now mainly being used by three mills one each in Punjab, U.P. and West Bengal.

Besides this, small quantities of coniferous woods mostly twisted chir pine, kail pine and waste firewood are also being utilised by one or two mills in the North because of its long fibre.

Of the short-fibred raw materials, salai wood (*Boswellia serrata*) with a fibre length of less than 1 mm., found in the dry deciduous forests, has been used for making mechanical pulp since 1955 by the Nepa mills in admixture with chemical pulp from bamboos to make newsprint. One or two other mills are also known to have used various proportions of salai and other hardwoods with bamboos to make chemical pulp at a lesser cost.

Utilisation of hardwoods has been adopted in a big way in the western countries as also in Japan where as much as 65 per cent of the production of pulp and paper is now based on hardwoods. Pulping methods have been specifically developed for utilisation of low grade hardwoods. Miscellaneous hardwood species widely occur in the Indian forests and it may be possible to successfully utilise them. Although attempts are being made in India to use mixed hardwoods,

the technology of pulping of these hardwoods has not yet been fully developed. Some mills in India have been able to use upto 30 per cent of mixed hardwood pulp in admixture with bamboo pulp in making various grades of papers. Even here considerable technical difficulties have been encountered both in pulping as well as in the bleaching of the pulp. While the techniques used for pulping temperate hardwoods could be adapted for pulping of mixed tropical hardwoods, considerable amount of technical work will have to be done in India to develop suitable processes. When such processes have been developed it will be necessary to ascertain the total availability of such woods for the industry, as large quantities are likely to be available in certain forests such as (i) the tropical evergreen forests of the west coast (ii) the moist deciduous forests of Dandakaranya and (iii) the extensive forest of Assam

AVAILABILITY

Exact figures of the present consumption of various forest raw materials by the industry and their source are not readily forthcoming nor have any reliable estimates been made of their total availability from the forests. At the meeting of the Raw Material Sub-Committee of the Development Council for Pulp, Paper and Allied Industries held in June, 1965, it was decided that data regarding the actual off take of bamboo and other cellulosic raw materials by the pulp and paper industry during 1964-65 from various forest divisions (whether by direct lease or through contractor purchase) as well as the consumption of fibrous raw materials other than bamboo should be collected quickly. These data, when available, will be found very useful in deciding to what extent and where pulpwood plantations should be created.

The present position regarding availability of bamboo, conifers and grasses, utilisable in the paper industry, is summarised below:

(a) *Bamboo*

Bamboo has been the major source of raw material for the paper industry in India. In general, most of the bamboo from accessible forests, surplus to domestic and other non-industrial demand, is already being collected and utilised by the industry. Some surplus bamboo is however still available in the worked forests of Madhya Pradesh, Assam, Dandakaranya and the Western Cost. Besides this, some of the remote forests, which have not yet been exploited, also contain bamboos.

As mentioned above exact information regarding the total availability of bamboos in different regions is lacking. It will be very desirable to ascertain this by a systematic survey in the interest of industrial development. In the absence of such data, an attempt has been made to determine the approximate availability from figures supplied by the States or the industry. The statewise position is as follows:

Andhra Pradesh—The State has reported a bamboo bearing area of 19,790 sq. km. with an annual availability of 2.55 lakh tonnes of bamboos; 1.8 lakh tonnes being removed for industrial use, 0.77 lakh tonnes for agricultural and commercial uses.

Assam—Bamboos (mainly muli) occur over at least 10,000 sq. km. The annual potential availability is reported to be:—

- (i) *Cachar—Mizo Zone*—Over 10 lakh tonnes* (mainly muli bamboo).
- (ii) *Central Assam Zone*—1.3 lakh tonnes bamboo and 0.83 lakh tonnes reeds.
- (iii) *Lower Assam Zone*—0.43 lakh tonnes bamboo.
- (iv) *Upper Assam Zone*—0.36 lakh tonnes bamboo.

The total present industrial off-take is only about 60,000 tonnes mainly removed by certain mills of West Bengal.

Bihar—The state has a bamboo bearing area of 5,294 sq. km. with annual production of 1.70 lakh tonnes against the estimated sustained availability of 2.0 lakh tonnes. Industrial off-take for the paper industry has been reported at 1,38,778 tonnes and removals for agricultural and commercial purposes at 30,173 and 1,893 tonnes annually.

Gujarat—Gujarat has reported a bamboo bearing area of 1,936 sq. km. On an average 11,500 tonnes are consumed locally and a minimum of 35,000 tonnes are likely to be available for industrial use from the forests of Dangs, Surat, Bulsar and Rajpipla.

Kerala—Kerala has reported 631 sq. km. of bamboo bearing forests with an annual sustained production of 1.08 lakh tonnes of bamboos; the present off-take is 50,000 tonnes for industrial use and about 4,360 tonnes for agricultural and commercial uses.

Madhya Pradesh—Madhya Pradesh has reported a bamboo bearing area of 14,846 sq. km. with an annual estimated potential availability of about 8 lakh tonnes; the present off-take is 1.28 lakh tonnes for industrial use and 2.83 lakh tonnes for agricultural or commercial uses.

Madras—Madras has reported bamboo bearing forests over an area of 5,388 sq. km. with 64,220 tonnes (air dry) of stock standing in the forests. The present off-take is 43,190 tonnes for industrial use; 12,250 tonnes for commercial use and 316 tonnes for agricultural use.

Maharashtra—The state has reported 8,500 sq. km. of bamboo bearing area with an annual production of 2.5 lakh tonnes and a potential of 3.0 lakh tonnes; the present off-take is 1.4 lakh tonnes for industrial use; 0.85 lakh tonnes for commercial use; and 0.29 lakh tonnes for agricultural use.

Mysore—The state has reported a bamboo bearing area of 6,000 sq. km. with an annual potential production of nearly 4.75 lakh tonnes. The surplus has already been booked for mills to be put up hereafter.

Orissa—The state has reported bamboo bearing forests over 10,500 sq. km. with a potential production of 5.39 lakh tonnes. The present industrial off-take is 2.42 lakh tonnes, besides 20,000 tonnes are being utilised for agricultural and commercial purposes.

Punjab—It is reported that about 9,000 tonnes are being supplied annually to M/s Shree Gopal Paper Mills. Besides this, the State has no surplus bamboo for the paper industry.

*Estimate based on a systematic survey.

Uttar Pradesh—The State has reported a bamboo bearing area of 4,000 sq. km. with annual availability of 41,000 tonnes. Of this 29,400 tonnes are being removed for agricultural or commercial use leaving about 12,000 tonnes of hitherto unutilised bamboos for industrial use.

West Bengal—The State has reported an area of only 164 sq. km. under bamboo, with an annual yield of 8,000 tonnes. Of this about 4,000 tonnes are being utilised.

Himachal Pradesh—Himachal Pradesh has reported a bamboo area of 104 sq. km. with an annual yield of about 3,000 tonnes.

Tripura—Tripura has 2,849 sq. km. of bamboo bearing forests with an approximate estimated availability of about 2,15,000 tonnes.

NEFA—NEFA has 7,770 sq. km. of bamboo bearing forests along the foot hills with estimated annual permissible cut of 200,000 tonnes of bamboos.

Manipur—Manipur has reported bamboo bearing forests over 2,500 sq. km.

The sub-joined Table gives at a glance the bamboo potential and the surplus for the various States and the Union Territories.

TABLE 7

Potential and Surplus Availability of Bamboo in the States

State/U.T.	Bamboo area (sq. km.)	Potential availability* (lakh tonnes)	Surplus** (lakh tonnes)
(1)	(2)	(3)	(4)
Andhra Pradesh	19,790	2.55	..
Assam	10,000	12.10	11.50
Bihar	5,294	2.00	0.29
Gujarat	1,936	0.46	..
J. & K. .. .. .	..	Negligible	..
Kerala	631	1.08	0.54
Madhya Pradesh	14,846	8.00	3.90
Madras	5,388	N.A.	N.A.
Maharashtra	8,500	3.00	0.46
Mysore	6,000	4.75	..
Orissa	10,500	4.39	2.77
Punjab	N.A.	0.09	..
Uttar Pradesh	4,000	0.41	0.12
West Bengal	164	0.08	0.04
Himachal Pradesh	104	0.03	..
Tripura	2,849	2.15	..
NEFA	7,770	2.00	2.00
Manipur	2,500	N.A.	N.A.
Total	100,272	40.09	23.77

N.A.—Not available.

*The estimated maximum sustained yield.

**Col. 3 less present off-take for agricultural, commercial and industrial uses.

On working out the overall potential production per hectare from the figures given in the Table it will be seen that against the average of 0.40 tonnes/ha. the potentiality varies from 166 (Kerala), 1.25

(A.P.), 1.20 (Assam) at one extreme to only 0.10 (U.P.), 0.12 (Madras), 0.25 (Gujarat) at the other.

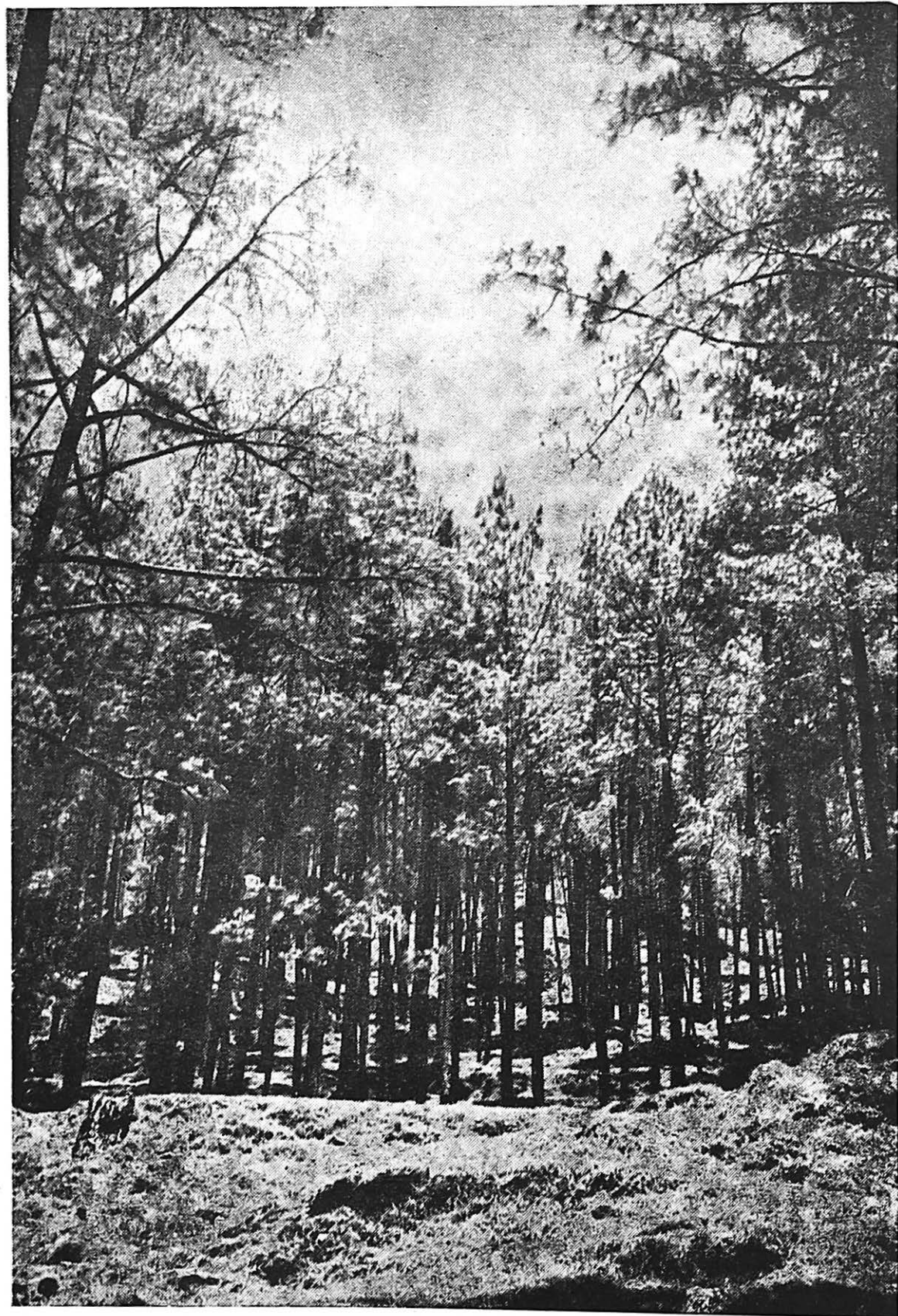
Such wide variation can hardly be attributed to climate and soil alone. It is obviously also due to the size of culms, density of clumps and personal bias. It cannot therefore be too strongly emphasized that an all-India systematic survey is immediately called for to determine the bamboo potential.

It will thus be seen that if the bamboo bearing forests are properly tended and the inaccessible areas are opened up an additional quantity of nearly 24 lakh tonnes of bamboos are likely to be available. Assuming that out of this only 18 lakh tonnes will be available to the paper industry, the total availability of bamboos to the paper industry would increase to $7+18=25$ lakh tonnes. If this quantity is rationally utilised by mixing with the maximum quantities of hardwoods say 70 per cent, bamboos and suitable hardwoods from forests would be sufficient to produce 27 lakh tonnes (or say 25 lakh tonnes) of paper. Hence the importance of conserving the present bamboo resources for the paper industry and utilising them most rationally and creating large scale plantations of short fibred fast growing species such as Eucalyptus, Poplars etc.

(b) Coniferous Woods

Coniferous woods are excellent raw material for paper manufacture since they have a long fibre. Conifers occur over only 3 per cent of the forests of India. Pines (chir and kail in the North and Khasi in Assam) occur in lower regions and fir and spruce in the upper reaches of the Himalayas. So far, these forests have been only partially exploited mainly for want of developed communications and introduction of modern logging techniques. Some twisted chir pine wood has been utilised by certain paper mills (other trees fetch a high price as timber). Also it has not been possible to utilise to any significant extent fir and spruce for paper manufacture because so far this wood is being extracted in the form of sleepers or sawn baulks leaving the slash unutilised in the forest. If and when these forest areas are provided with better facilities for extraction and their exploitation made economically feasible so that logs could be brought down to saw mills in the plains, large quantities of slash would be available for utilisation by the paper industry. The exact quantities and the cost at which coniferous wood will be available to the paper industry has yet to be determined. It will mainly depend upon the intensity of management of these forests. Some tentative estimates have been made by the States. These are given below:—

Himachal Pradesh—H.P. has an area of 644 sq. km. under chir pine; 600 sq. km. under kail; 528 sq. km. under deodar and 831 sq. km. under fir. Total stock standing of all coniferous woods is estimated at nearly 400 lakh tonnes with a computed annual increment of about 4.6 lakh tonnes. There is no paper mill in Himachal Pradesh. Small quantities of coniferous wood not utilisable as timber are however sold by contractors to certain paper mills. The Government of Himachal Pradesh is trying to estimate the availability of pulp-wood from its forests by a detailed aerial survey. In the meantime modern logging equipment for exploiting its more difficult forest areas in the Pabbar Valley Division has been installed.



Chir (Pine, Roselaghii) forest in Garhwal (U.P.)

Jammu and Kashmir—The total area of coniferous forests is reported to be 7,492 sq. km. Forests are being worked under the selection system removing trees over 12" diameter and sawing them in the forest leaving the slash in the forest. The total annual availability in the forest is reported to be 5.97 lakh tonnes. How much of this could be made available to the paper industry has yet to be estimated. One estimate is as follows:

Jammu Province—54 lakhs cft. per year (pine and deodar 42 per cent, fir and spruce 58 per cent) to 100 lakh cft. after 12-year and to 126 lakh cft. after 20 years.

Kashmir Province—60 lakh cft. per year (pine and deodar 42 per cent, fir and spruce 58 per cent) increasing to 75 lakh cft. after 12 years and 90 lakh cft. after 20 years.

These raw materials have been considered adequate to feed a 200 tonnes/day capacity paper and newsprint mill in Jammu and 100 tonnes/day capacity rayon cord pulp mill in Kashmir.

Punjab—Punjab has reported an estimated annual production of about 1.1 lakh tonnes of fir and spruce. As against the present removals of about 5,000 tonnes by the paper mills, with improved communications and mechanisation of logging it should be possible to obtain as much as 10,000 tonnes.

An aerial survey of the fir and spruce forests of the Kulu and Seraj Divisions has already been completed. This has shown that on an average about 5.8 million cft. or about 87,000 tonnes (at 66.6 cft=1 tonne) of timber in logs will be annually available. When this is sawn, slash would be available for making paper or newsprint. The State Government has recently announced putting up of a 100 tonnes/day newsprint mill at Nangal, utilising pulpwood available from these forests.

Uttar Pradesh—Total area of coniferous forests under the Forest Department is about 17,360 sq. km. of which 3,090 sq. km. are under fir and spruce. The total stock standing over the entire coniferous forests has been estimated at 2,08,23,230 tonnes with an annual increment of 5,22,910 tonnes. Total annual removals for all coniferous woods amount to 1,74,100 tonnes of which annual removals for agricultural uses is estimated at about 17,500 tonnes and for commercial and industrial uses is 1,39,100 tonnes.

At present only chir pine to the extent of 38,000 tonnes obtained from twisted trees, slash from main felling coupes and thinning yield from converted crops, is being extracted by the Star Paper Mills, Saharanpur for manufacture of quality Kraft Paper.

The annual availability of coniferous pulpwood for industrial use in this State from forests under the control of the Forest Department has been estimated as under:

Tehri Circle—Fir and spruce pulpwood=50,000 tonnes (slash).
—Chir pulpwood=40,000 tonnes (slash and thinning).

Kumaon Circle—Chir pulpwood=38,000 tonnes (twisted chir, slash and thinning).

This yield has already been committed to the Star Paper Mills at Saharanpur and other projected paper and rayon-grade pulp

mills, proposed to be set up. The yield from Tehri Circle is contingent upon proper development of road communications and mechanisation of logging operations.

West Bengal—West Bengal has reported an area of 16.4 sq. km. under *Cryptomeria japonica* a very fast growing exotic conifer. Total standing stock in the forest is estimated at 40,800 tonnes with computed annual increment of 4,000 tonnes. About 80 hectares are being planted annually with this species.

(c) Grasses

As mentioned earlier, sabai grass (*Eulaliopsis binata*) is of significant importance. The Bengal Paper Mills, the Shree Gopal Paper Mills and the Star Paper Mills are utilising this raw material to the extent of 18,000, 30,000 and 15,000 tonnes annually. This includes about 10,000 tonnes being supplied to the Shree Gopal Paper Mills from Nepal. A number of other grasses have also been tested by the Forest Research Institute, Dehra Dun and found suitable for paper manufacture (vide *Indian Forester* July, 1965, pp. 505—529).

CHAPTER IV

PULPWOOD REQUIREMENTS AND PLANTATION PROGRAMME

In view of the rapidly rising demand for paper and paper products, it is unlikely that the production from the natural forests even after they are fully tapped will be able to meet the requirements of the mills. Anticipating this, the Forest Departments of States have already started creating plantations of fast growing species, particularly Eucalyptus a short fibred wood and of bamboos and conifers which have a long fibre. This will reduce the dependence of the industry on conventional raw materials specially when technological advances make it possible to increase the proportion of short fibred pulp in the furnish to a still greater extent. Production of adequate raw materials is of special significance to minimise the drain of foreign exchange on import of pulp. Thus the ultimate problem remains to make available to the industry adequate quantities of suitable pulping material on a sustained basis. A number of Eucalyptus species have been tried. The so called Eucalyptus 'hybrid'* from Mysore which has the advantage of growing satisfactorily in a variety of climates and soils, and is fairly fast growing is being extensively planted. It is expected to yield 70 to 100 tonnes of air-dry wood per hectare in 10 to 15 years depending on the site-quality. The wood which has a short fibre is generally believed to be quite suitable for pulping. It would be desirable to create large scale industry-oriented plantations of this species to get the maximum quantity of wood at the minimum cost for meeting the demand of the industry.

No special efforts were made in the First and the Second Plans to augment production of pulpwood. In the Third Plan a provision of Rs. 275 lakhs has been made for planting 55,000 ha. with various fast growing species (mostly short-fibre) and it is anticipated that the physical target achieved would be over 60,000 ha. These plantations will begin to yield from 1,973 and it may be assumed that the average annual cut of pulpwood will be from an area of 5,000 ha.** The plantation will again yield pulpwood from coppice regrowth from 1,983 to 1,987.

Attention of the Working Group has also been drawn to the planning shortage of forest raw materials particularly long fibre material—and the serious setback that the paper industry will receive if suitable steps are not taken to ensure sustained supplies to the requisite extent.

ESTIMATED PULPWOOD REQUIREMENTS FROM 1965-66 TO 1980-81

The total cellulosic raw materials of all categories (yielding both long and short fibre), that will be required to realise the targets given in Table 3 earlier, is shown in Table 8. In arriving at these figures, it has been assumed that the minimum quantity i.e., 30 per cent of long-fibre material, which is in short supply, would be used

* Since identified as *E. tereticomis*.

** As all plantations are not fully stocked or of uniform quality.

to get acceptable grade of paper and newsprint, so that with the available limited resources of long fibre material the maximum production is achieved:

TABLE 8

Estimated Annual Pulpwood Requirements

(Million tonnes)

Pulpwood Requirements for	1965-66		1970-71		1975-76		1980-81	
	LF*	SF*	LF	SF	LF	SF	LF	SF
1. Paper & Paper Board	0.70	1.40	1.20	2.40	2.0	4.00	3.00	6.00
2. Newsprint ..	0.16	0.32	0.30	0.60	0.45	0.90	0.60	1.20
3. Chemical Pulp ..	..	0.24	..	0.80	..	1.60	..	2.40
Total ..	0.86	1.96	1.50	3.80	2.45	6.50	3.60	9.60

*LF Long fibred pulpwood.

SF Short fibred pulpwood.

Paper and Paper Boards—Although it is unlikely that the mills will be able to switch over to paper made with only 30 per cent long fibre bamboo pulp immediately at the beginning of the Fourth Plan, it has been assumed that this will be possible by the end of the plan (1970-71). It may be safely assumed that as a result of utilising the surplus bamboos from the forests already under working, and working some of the hitherto inaccessible forests, the industry will be able to procure 1.5 million tonnes of long fibre raw material by 1970-71.

Newsprint—The consumption of newsprint by the end of the Fourth Plan (1970-71) may be taken as 300,000 tonnes.

The Nepa Mills are expected to produce on an average 65,000 tonnes per year against their licensed expansion of 75,000 tonnes. The two other licensed mills with a total capacity of 120,000 tonnes may be expected to produce another 100,000 tonnes. The production will still fall short of requirements by about 135,000 tonnes. Efforts will need to be made to bridge this gap to the extent possible by making newsprint from bagasse utilising the latest technique, or by importing long fibre chemical pulp to be used in admixture with bagasse or short-fibred wood. The total availability of bagasse in the country is estimated at 3 million tonnes and there should be no difficulty in getting the requisite quantity for the paper industry. In case this consummation is not realised some newsprint will have to be imported.

Chemical Pulp—It is estimated that by the end of the Fourth Plan (1970-71) the production of rayon grade pulp will rise to 200,000 tonnes. For this 800,000 tonnes of short fibre wood will be needed. Eucalyptus wood will not be available to the full extent and consequently bamboos, which are being used for the purpose at present, will continue to be so used till the Kerala plantations of *E. grandis* mature.



Eucalyptus plantation (1 year old)

PROPOSED PLANTATION PROGRAMME

To meet the future requirements of the paper industry as far as practicable the following programme of industry-oriented plantations was suggested for the Fourth Plan at a total cost of Rs. 51.56 crores at an inter-departmental meeting held in the Planning Commission on 12th April, 1965. This meeting was also attended by Heads of the Forest Departments of States/Union Territories and representatives of the Paper Industry. Since then the proposed targets for the Fourth Plan have been revised to Eucalyptus 60,000 ha. and bamboos 20,000 ha. per year at a total cost of Rs. 30 crores and it is assumed that at least to the same extent in subsequent plans.

These plantations will have to be so located that the existing mills which are likely to experience difficulty in the future will be able to get the plantation wood most conveniently. Similarly, the plantations will have to be located near the probable sites of new mills.

After this programme has been fully implemented, the existing and the proposed plantations will give pulpwood to the extent indicated in Table 9.

TABLE 9

Yield from Plantations proposed in the Third, Fourth and Fifth Plans

(^{000 tonnes})

Plan	Year	III Plan Plantations		IV & V Plan Plantations		Total	
		*Bam-boo (3,000 ha/yr)	†Euca-lyptus (5,000 ha/yr)	*Bam-boo (20,000 ha/yr)	†Euca-lyptus (60,000 ha/yr)	Bamboo	Eucalyptus and other fast growing pulp-wood species
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
III	1961						
	1962						
	1963						
	1964						
	1965						
IV	1966	..				..
	1967	..				..
	1968	30				30	} av. 18
	1969	30				30	
	1970	30				30	
	1971	30				30	
V	1972	60	..	..		60	} av. 75
	1973	30	350	..		30	
	1974	30	350	..		30	} av. 210
	1975	30	350	200		230	
VI	1976	60	350	200	..	260	} av. 350
	1977	30	350	200	4200	230	
	1978	30	..	200	4200	230	} av. 325
	1979	30	..	400	4200	430	
	1980	60	..	400	4200	460	

TABLE 9—*contd.*

1	2	3	4	5	6	7	8
VII	1981	30	..	400	4200	430	} av. 4410
	1982	30	..	400	4200	430	
	1983	30	350	600	4200	630	
	1984	60	350	600	4200	660	
	1985	30	350	600	4200	630	
	1986	30	350	600	4200	630	
	1987	30	350	800	8400	830	

*Each plantation has been assumed to yield 10 tonnes/ha of bamboos in the 8th, 12th, 16th, etc. years.

†Each plantation has been assumed to yield every 10th year 70 tonnes/ha pulpwood and 30 tonnes/ha fuelwood.

ANTICIPATED OVERALL AVAILABILITY

It has been assumed that—

- (i) the bamboo forests already being tapped by the mills will be properly managed to maximise production;
- (ii) additional bamboo areas from hitherto un-exploited forests will be available to the industry;
- (iii) the process would have been so modified that the minimum quantity of long fibre (30 per cent) would be utilised to make acceptable grades of paper and newsprint; and
- (iv) the plantation programme proposed will be fully implemented.

The yield from the existing forests and the plantations proposed from year to year is set out in the sub-joined Table 10.

TABLE 10

Annual Requirements and Availability of Pulpwood

(Million tonnes)

	1965-66		1970-71		1975-76		1980-81	
	LF	SF	LF	SF	LF	SF	LF	SF
1. Annual requirements of Pulpwood	0.86	1.96	1.50	3.80	2.45	6.50	3.60	9.60
2. Availability								
(a) Long fibre								
(i) Bamboo from natural forests	1.00	..	1.50	..	2.00	..	2.50	..
(ii) from plantations	..	..	0.03	..	0.23	..	0.46	..
(b) Short fibre								
(i) Pulpwood from fast growing plantations	..	..	..	..	..	0.35	..	4.20
Total	..	1.00	..	1.53	..	2.23	0.35	2.96
Shortage	..	..	1.96	..	3.80	0.22	6.15	0.64

Long fibre pulpwood

By the end of the Third Plan (1965-66) the estimated target production of 0.7 million tonnes of paper and paper boards can be reached only if the production capacity of the industry could be sufficiently increased as also *the available long, fibre is most economically utilised* by mixing with it short fibre pulp from hardwoods or bagasse to the maximum extent. In so far as target production of 0.16 million tonnes of newsprint is concerned, the installed capacity is unlikely to increase beyond 0.03 million tonnes as the new units and expansions licensed have not come up so far. For reaching the target of 0.06 million tonnes of rayon grade pulp, adequate quantities of raw materials are available.

In 1975 the shortfall will be nominal (22,000 tonnes). In 1980, however, only an extra 64,000 tonnes of fibre will be needed. It may be possible to meet this small deficit by increased yield from bamboo forests and by harnessing Himalayan conifers, failing which craft pulp will have to be imported.

Short fibre pulpwood

The analysis shows that towards the end of the Third Plan (1965-66) there will be a shortage of 1.96 million tonnes of short fibre. This figure, however, has been arrived at on the assumption that newsprint production would increase to 0.16 million tonnes and that of paper to 0.7 million tonnes. This is unlikely as newsprint production will not be above 30,000 tonnes and paper and paper boards 0.52 million tonnes, and therefore, the actual shortage will be much less, which could be made good by utilisation of bagasse or hardwoods.

By 1970-71, however, as the pulpwood plantations would still not be in full bearing, the shortage will mount up to 3.8 million tonnes. As against this, 2.0 million tonnes of bagasse and 0.4 million tonnes of miscellaneous fibres may be expected to be available. Beyond this, reliance will have to be placed on mixed hardwoods.

By 1975-76, contemplated shortage will be as much as 6.15 million tonnes. As against this 2.5 million tonnes of bagasse and 0.7 million tonnes of miscellaneous fibres may be expected to be available. This will still leave a gap of nearly 3.0 million tonnes. Efforts will have to be made to devise processes under which mixed hardwoods could be utilised to the maximum extent.

By 1980-81, the shortage will be of the order of 5.40 million tonnes against which it may be expected that 3.5 million tonnes of bagasse and 1.0 million tonnes of miscellaneous fibres will be obtainable. This will leave a gap of 0.9 million tonnes. In other words the position would improve appreciably.

CHAPTER V

PULPWOOD PLANTATION RESEARCH

The need for having extensive industry-oriented pulpwood plantations is obvious considering the acute shortage of raw material from the natural forests. As coniferous woods* which are the conventional material for making paper and newsprint were not readily available in the country, after intensive research it was established that paper could also be made from bamboos which occur in large quantities in the Indian forests. Bamboos however are also in great demand for agricultural and commercial purposes. Almost all bamboos in accessible forests, which are surplus to agricultural and commercial needs have been utilised for making paper. Nearly 700,000 tonnes of bamboos are being thus utilised. If and when all the inaccessible forests have been opened up it may be possible to get at the outside 2.5 million tonnes of bamboos for the paper industry, say by 1980.

At present most mills make paper from 100 per cent bamboo. Research has, however, shown that if the process is suitably modified, acceptable paper can be made at an economic cost using only 30 per cent bamboo chemical pulp in admixture with 70 per cent of short fibre pulp. If and when this becomes feasible the available 2.5 million tonnes of bamboo together with short fibre pulpwood to the requisite extent could produce 2.5 million tonnes of paper.

Bamboo, however, has shorter fibre (1—3 mm.) as compared to conifers (3—5 mm.). Only 20 per cent of chemical pulp from coniferous wood in admixture with mechanical pulp from the same wood or chemical pulp from short fibred hardwoods can give acceptable paper. Although definite commercial trials have not been made with Indian conifers, it is generally held that the pines and fir, which are available in large quantities, and spruce, of which few trees occur as also deodar will be quite suitable. It would therefore be desirable to create plantations of these species, particularly in the Himalayan region where bamboos do not occur. In so far as fir is concerned, as no economically feasible method of naturally regenerating the species in the Punjab forests has yet been found, it would be necessary to evolve a suitable technique.

In so far as short fibred forest raw material is concerned, certain species occurring naturally have been found to be quite suitable, for instance salai is being actually used by the Nepa Mills and experiments at the FRI, Dehra Dun have shown that the species given in Annexure IV are also suitable and some of them have proved even better. But almost all the indigenous suitable species occur sporadically in the forests along with less suitable species and are very slow growing. Therefore, it is very desirable to create plantations of suitable fast growing pulpwood species, both exotic and indigenous. Hence the need for immediately taking up following in-

*Only 3% of the Indian forests carry conifers and they mostly lie in the high Himalayas from where it has not yet been possible to tap wood economically for use in the paper industry.

vestigations by the Forest Research Institute, Dehra Dun in collaboration with the State Forest Departments:

- (1) determination of the most suitable pulpwood species for various localities particularly those which have a long fibre;
- (2) working out the economically most feasible techniques for raising large scale plantations of these species and tending them; and
- (3) studying the economics of the pulpwood plantations.

In so far as determination of the most suitable pulpwood species for various localities is concerned it would be desirable to raise trial plantations of various species, exotic and indigenous, which *prima facie* are considered suitable and are fairly fast growing.

Of the indigenous species fir, spruce, pine and bamboo are long fibred and among short fibred cadamb, safed siris, bakain, gamari, toon, champa and maharukh may be mentioned. Exotics that deserve trials are:

Long fibred—*Cryptomeria japonica* *Pinus merkusii*; *Pinus radiata*.

Short fibred—*Broussonetia papyrifera*; Wattles (*Acacia dealbata*, *A. decurens*, *A. mollissima* and *A. auriculiformis*). Eucalyptus species particularly, *Eucalyptus camaldulenis*, *E. tereticornis*, *E. citriodora*, *E. globulus*, *E. robusta*, *E. rostrata*, *E. botryoides*, *Albizia falcata*, *Enterolobium saman*, *Pinus patula* and Poplars.

It would be desirable that instead of making plantations of all these species indiscriminately a few *prima facie* most suitable species for particular localities are selected pending detailed nursery and plantation trials, and standard technique is followed for raising nursery stock and for planting and tending.

The Forest Research Institute has already initiated a research project, covering the entire range of climate and soil conditions for trials with exotic species. As regards the determination of the techniques of plantation and tending, after the suitability of particular species has been established this work could be taken up immediately by the Central Silviculturist in collaboration with the State Silviculturist and the Plant Introduction Officer at the Forest Research Institute. Besides this, special study will have to be made of the various plantations raised to determine the best initial spacings and the rotation at which the mean annual volume increment culminates as also the economics of raising such plantations on a large scale.

Present experience concerning introduction of exotic species and the scope of taking up such trials on a larger scale is summarised in the following paragraphs.

Earlier trials with exotics in India

Trials with several exotics in India are almost over a century old; they were mostly made on a very small scale in research stations and research gardens. Extension on a large scale has been

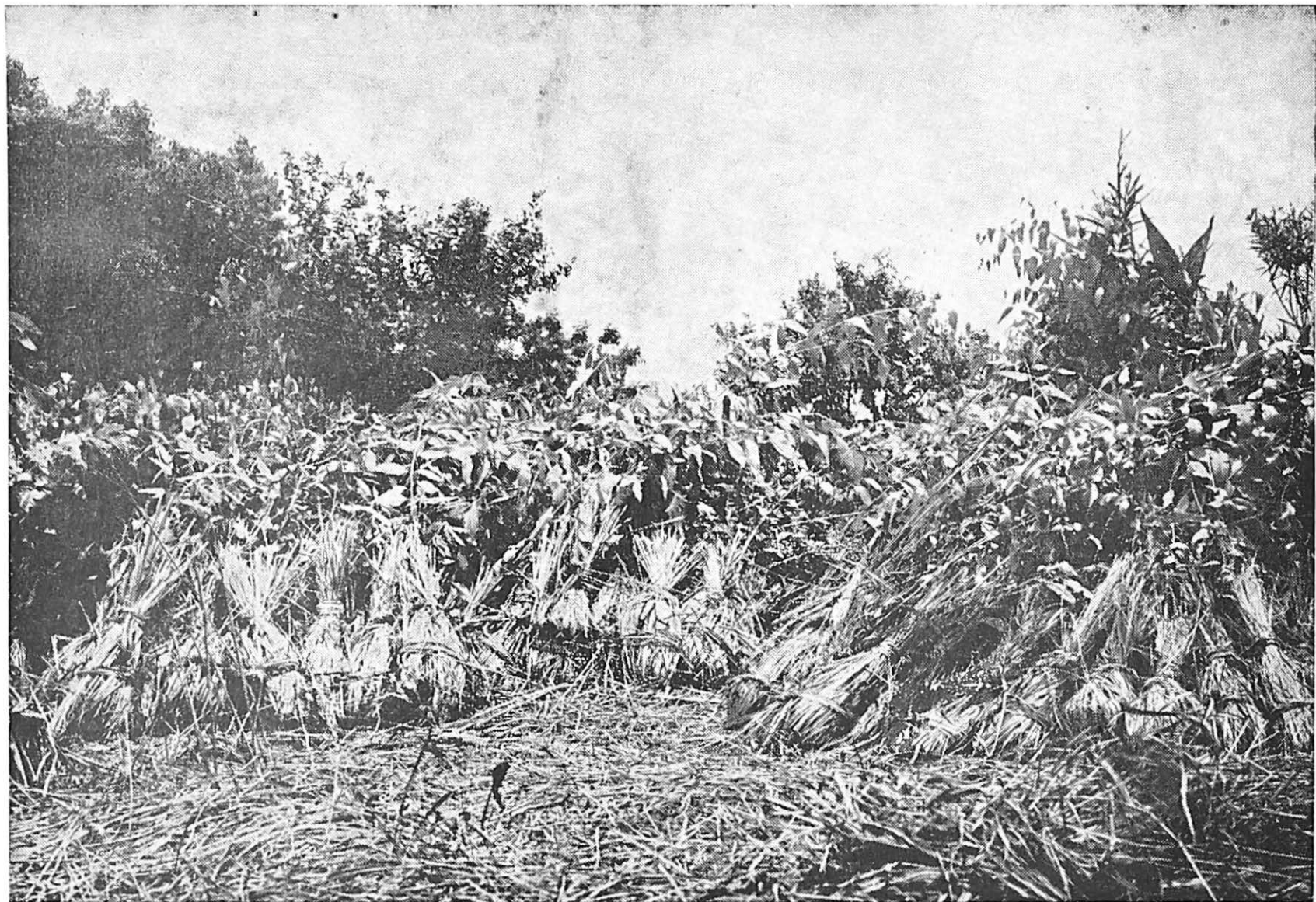
limited to a few species only. *Cryptomeria japonica* was first introduced in Darjeeling hills as early as 1884 at elevations varying between 3,000'—7,000'. It grows much faster than the indigenous pine, *pinus khasya* in the Assam Hills. Similarly *Eucalyptus globulus*, together with many other species of Eucalyptus, was introduced in the Nilgiris in Madras State as far back as 1843 and now this species covers vast areas, and provides the much needed firewood in the locality. Recently this species has been tested and found suitable for making rayon grade pulp. The Madras Forest Department has entered into a lease with a factory for the purpose. *Acacia mollissima*, *A. dealbata* and *A. decurrens*, were introduced in the Nilgiris in 1932 for the production of tannin from their bark and have been extensively grown. Many species of Eucalyptus were also introduced in Mysore State from 1937 onwards particularly from species originally growing in Nandi hills including, *Eucalyptus tereticornis*, *E. camaldulensis*, *E. citriodora*, *E. globulus*, *E. robusta*, *E. tessellaris*, *E. intermedia*, *E. botryoides* etc. In fact *Eucalyptus tereticornis* is now growing well in many States under a variety of climatic conditions. Other exotics usable as pulpwood which have been introduced in India and have been found to grow well are *Albizia falcata* (Assam), *Broussonetia papyrifera* (Bengal, Maharashtra, Mysore, Madras, U.P.), *Enterolobium saman* (Mysore, Maharashtra, Bengal), *Leucaena glauca* (Assam, H.P., Madras, Maharashtra, Mysore and U.P.), *Pinus carabeae* (Assam), *P. patula* (Bengal, Bihar, Punjab, Dehra Dun), *Robinia pseudacacia* (Bihar, Jammu and Kashmir, H.P.).

Some exotics which have come into prominence recently are *Eucalyptus grandis* (Kerala), *E. saligna* (Bengal), *E. deglupta*, *E. papuans*, *E. camaldulensis* syn. *E. rostrata* (Punjab), *E. tereticornis* (Mysore, Madras, U.P., A.P., Bihar etc.), *E. tessellaris*, *Pinus radiata*, *P. patula*, *P. caribaea*, *P. merkusii*, *P. hondurensis* and many species and hybrids of Poplars. There are many other species which have been tried or are being tried on an experimental scale. Field trials are however, yet to be made for conclusive results. Indeed trials with exotics in the past were more for academic investigations than for commercial exploitation as the demand for indigenous raw material has not outstripped the supplies. It is only recently that large scale plantations of exotics are being taken up in various States for meeting the requirements of forest industries. Unlike past trials, future experimental work must be on a systematic basis and with definite objectives.

Selection of species and localities

There is vast scope for raising plantations of some of the fast growing broad-leaved and coniferous species which have been already tried on a limited scale or which hold promise of introduction in suitable localities. The choice is governed by:

- (1) suitability of the wood for pulping,
- (2) superior rate of growth and per hectare yield as compared to indigenous species,
- (3) climatic and edaphic factors prevailing in the locality and selection of seeds from proper provenances,



Euclayptus transplants ready for dispatch to plantation site.

(4) ease of cultivation, establishment, and management.

Other important considerations include qualities like immunity from insect pests and fungal diseases, resistance to wind damage, and other local factors.

The climatic and edaphic conditions mostly govern the success of any species in a given area. With this is closely connected the origin of seed and the selection of correct provenance. The choice of a proper geographical ecotype is essential for the success of an introduced species. Many wide-ranging species contain enough genetic variability within the species to enable selection and adaptation to a particular set of conditions, which fact needs to be fully made use of in making a choice. Species which thrive in winter rainfall conditions in their native lands cannot easily adapt themselves in summer rainfall areas, unless, the imbalance is counteracted by other helpful factors. Under edaphic factors, drainage, soil morphology and the fertility status are of great importance. However, there is usually a certain amount of plasticity exhibited by a majority of exotic species and that is one of the reasons why some of the exotics have done better in new habitats than in their native lands, such as *Cryptomeria japonica* in West Bengal. Therefore, species trials have to be done not only in areas which are theoretically as homo-climatic as the native locale but also in areas with marginal climatic types in order to cover the entire potential of adaptability of any exotic. The Forest Research Institute has accordingly selected about 28 centres for trials of exotics in India covering all the major climatic and edaphic types.

The stations selected for species trials are given in Annexure III together with the climatic data. It should not be easy to conduct species trials systematically. The trials will be under the supervision of the State Silviculturists working in collaboration with the Central Silviculturist. Efforts to obtain seeds of promising exotic species are being made by the Ministry of Food and Agriculture. Adequate allocations of foreign exchange will be necessary for the purpose.

In case of some of the indigenous species like *Duabanga sonneratioides*, *Cedrela toona*, *Artocarpus chaplasha*, *Gmelina arborea* *Michelia champaca*, the mean annual increment per hectare is fairly high. For example, *Gmelina arborea* gives a mean annual increment of 22.96 cubic metres at the age of 6, *Cedrela toona* gives 18.53 at the age of 5, *Michelia champaca* 18.25 at the age of 78. Some of these figures compare well with the rate of growth of exotics i.e., *Eucalyptus globulus* which gives 23.8 cubic metres at the age of 5, *Pinus patula* 34.93 at the age of 30 and *Pinus radiata* 35.20 at the age of 34. Therefore, it is equally important to do systematic trials with some of the fast growing indigenous species also.

An expected mean annual increment of 150 cu. ft. per acre per annum (=10 cu. m. per ha. per annum) is adopted as the criterion for a 'fast growing' species.

SPECIES FOUND CHEMICALLY SUITABLE

A list of species tested by the Cellulose and Paper Branch, F.R.I. for pulp production is given in Annexure IV.

Programme of Work

Any trials with exotics include two stages. First is the *elimination* stage in which a number of exotics or allied forms, eco-types

etc., are tried on a very small scale, say with even 10—25 plants of each species in each locality and observations for about 2-3 years are necessary to eliminate unsuitable ones or to confirm the promising species. The second is the *performance* stage in which larger field trials, statistically designed, are conducted and observations recorded for a longer period, say about 5—10 years or at least 1/3 or 1/2 the rotation age, taking 8—15 years as the range of rotation for fast-grown pulp woods. This period will also give an indication of the proper spacing for various species and the rate of growth for each locality.

Standardization of Nursery and Plantation techniques with due regard to insect pests and fungal diseases

Simultaneously with the performance trials, the nursery and plantation techniques should be perfected and steps taken to put the species on a commercial scale. In doing so, at least 4-5 species should be selected instead of one or 2 so that in case of mishaps or any other natural calamities to which a particular species may be susceptible, the remaining species will come handy for meeting the supplies. The nursery and plantation work should record the cost of each operation and the estimates of intermediate and final yield so that the economics of particular plantation can be studied.

Role of macro and micro-nutrients

Both macro and micro-nutrients play an important role in the growth of exotics. In parts of Australia, addition of phosphorus has increased the growth of *Pinus radiata*. Similarly, in parts of Great Britain, addition of nitrogen has increased the growth of *Picea sitchensis*. Potassium deficiency has been the cause of yellow tip disease in Scots pine (*Pinus sylvestris*) and Corsican pine (*Pinus nigra* var. *corsican*) in young plantations on potassium deficiency heath podzols.

Boron deficiency has been attributed to be the cause of die-back and discoloration of leaves in many *Eucalyptus* (*E. grandis*, *E. torellians*, *E. albs*, *E. tareticornis*) and also conifers (*Pinus caribaea*, *P. ellittii*, *P. patula*, *iciophylla*, *P. douglasiana*) in Northern Rhodesia (*vide* Empire Forestry Review, pp. 118 to 126, Vol. 41(2), No. 108, June 1962). The role played by micro-elements like zinc, copper, magnesium, manganese, sulphur, in correcting deficiencies and accelerating growth are too well-known to mention.

Treatment and Management of Pulpwood Plantations

Tending of pulpwood plantations to achieve the maximum mean annual increment is of great importance as this will help in shortening the rotation and making the plantations profitable. Initial spacing and the thinning regime suitable for maximum production in the shortest time will have to be worked out after proper field

CHAPTER VI ECONOMICS OF PLANTATIONS

INTRODUCTION

Of the total expenses on production of paper or newsprint the cost on cellulosic raw material is a major item. It is therefore very necessary to see that this is kept at the minimum. This cost consists of (i) the expenditure on transport and (ii) the cost on the production of wood including the grower's profit. In so far as the former is concerned, to reduce it, the mills should be located as near the forests as possible and these should be made accessible by good road, rail or water communications. As regards the latter, bamboos, the most important forest raw material, grow naturally in certain forests and therefore a nominal royalty is being charged to encourage the industry or may be because no expenses were incurred on producing the bamboos. Indeed in certain forests it is a weed interfering with the development of timber trees. But, now that pulpwood is being grown in plantations the grower expects to get a fair return on his investment namely, rent on the land and a reasonable interest on the expenses incurred in the formation of the plantation, its annual maintenance and on harvesting the wood, otherwise he would prefer to invest his money in other ventures. Hence the need for studying the economics of pulpwood plantations.

So far this aspect of forestry has not received adequate attention. But now that large areas of forests are being utilised to grow pulpwood it would be necessary to determine the most economical technique for creating such plantations, the best initial spacing and the rotation that would give the maximum mean annual volume increment. Therefore, the syllabus of the Indian Forest College should include the subject of Forest Economics, and the Forest Research Institute should conduct research to determine the financial rotation and the most economic technique. It would be advisable to depute some officers to foreign institutions where such work is receiving close attention.

In the following paragraphs an attempt has been made to work out the economics of Bamboo and Eucalyptus plantations using more or less a hypothetical set of figures of yield, costs, etc.

Economics of Bamboo Plantations

The royalty paid by Paper Mills, is by no means the fair price that the Forest Department should get. It is far below the commercial rate. It will therefore be misleading to use the royalty as the basis for determining what should constitute *reasonable* market rate or *fair price* if bamboos are grown in plantations.

The delivered cost of bamboos at the mill is as much as (or even more than) Rs. 100 per tonne, which obviously the mills can afford to pay even when the prices of paper are fixed. Of this, the cost of felling and carting to road side is about Rs. 30 per tonne. It is thus obvious that the lower the costs on transport, handling etc. the higher the royalty a mill could pay. Therefore, when bamboo

Similarly discounting all future receipts to the beginning of the first year these will be

(i) 10 tonnes at Rs. R/tonne in years 8, r+8, 2r+8, etc.

i.e. say

$$Y_8 = 10 R \frac{1 \cdot 0p^{r-8}}{1 \cdot 0p^r - 1}$$

in the same way

$$Y_{18} = 10 R \frac{1 \cdot 0p^{r-18}}{1 \cdot 0p^r - 1}$$

$$Y_{28} = 10 R \frac{1 \cdot 0p^{r-28}}{1 \cdot 0p^r - 1}$$

etc.....

$$Y_{38} = 10 R \frac{1 \cdot 0p^{r-38}}{1 \cdot 0p^r - 1}$$

and

(ii) the value of 15 tonnes at Rs. R per tonne in years r, 2r, 3r, etc.

i. e. $Y_{3r} = 10 R \frac{1}{1 \cdot 0p^{r-1}}$

Substituting 32 for r and x for 1.0p the total receipts, say B, will be

$$R \left\{ \frac{10(x^{24} + x^{20} + x^4) + 15}{x^{32} - 1} \right\}$$

$$\text{or } R \left\{ \frac{10x^4(x^{24} - 1)}{(x^4 - 1)(x^{32} - 1)} + \frac{15}{x^{32} - 1} \right\} = B$$

From these the Land Expectation Value (Sc=B-A) may be worked out for typical values of C, e & R.

The values of various fractions involving the powers of x in the expression for B-A, where p=3, 4, 5, 6 or 8 per cent are indicated in the subjoined Table 11.

TABLE 11

Fraction	Value where x=				
	1.03	1.04	1.05	1.06	1.08
$\frac{x^{32}}{x^{32}-1}$	1.63	1.40	1.27	1.18	1.08
$\frac{1}{(x-1)}$	33.3	25.0	20.0	16.67	12.5
$10 \frac{x^4(x^{24}-1)}{(x^4-1)(x^{32}-1)}$	58.45	42.63	32.95	26.61	18.42
$\frac{15}{(x^{32}-1)}$	9.48	5.4	3.95	2.72	1.46

Examples

Case I—C=Rs. 750, e=Rs. 10 and R=Rs. 30.

TABLE 12

(Rupees per hectare)

				3%	4%	5%	6%	8%
Receipts	..	..	(B)	2037.9	1457.1	1107.0	879.9	596.4
Costs								
C	..	..	..	1222.5	1050.0	952.5	885.0	810.0
e	..	..	..	333.3	250.0	200.0	166.7	125.0
Total (A)	..		..	1555.8	1300.0	1152.5	1051.7	935.0
S=(B-A)	..		..	482.1	157.1	-45.5	-171.8	-338.6

Case II—C=Rs. 750, e=Rs. 10 and R=Rs. 25.

TABLE 13

(Rupees per hectare)

				3%	4%	5%	6%	8%
Receipts	..	..	(B)	1698.3	1204.2	922.5	733.3	497.0
Costs								
C	..	..	..	1222.5	1050.0	952.5	885.0	810.0
e	..	..	..	333.3	250.0	200.0	166.7	125.0
Total (A)	..		..	1555.8	1300.0	1152.5	1051.7	935.0
S=(B-A)	..		..	142.5	-95.0	-230.0	-31.4	-438.0

Case III—C=Rs. 500, e=Rs. and R=Rs. 20.

TABLE 14

(Rupees per hectare)

				3%	4%	5%	6%	8%
Receipts	..	..	(B)	1358.6	971.4	738.0	580.6	397.6
Costs								
C	..	..	..	815.0	700.0	635.0	590.0	545.0
e	..	..	..	333.3	250.0	200.0	166.0	125.0
Total (A)	..		..	1148.3	950.0	835.0	756.7	670.0
S=(B-A)	..		..	210.3	21.4	97.0	-176.1	-272.0

Assuming that the Land Expectation Value is zero, the financial yield in Case I is 4.7%. However, if a subsidy of Rs. 45.5 per hectare is given, the financial yield will be 5%. In other words, with some financial help from Government derelict areas could be planted up at a cost of Rs. 750 per hectare to yield 5% interest if bamboo fetches Rs. 30 per tonne.

If the royalty on bamboo is only Rs. 25 per tonne but the cost of formation of plantation is still Rs. 750 per hectare (Case II) the financial yield will be only 3.5% which is low considering the present

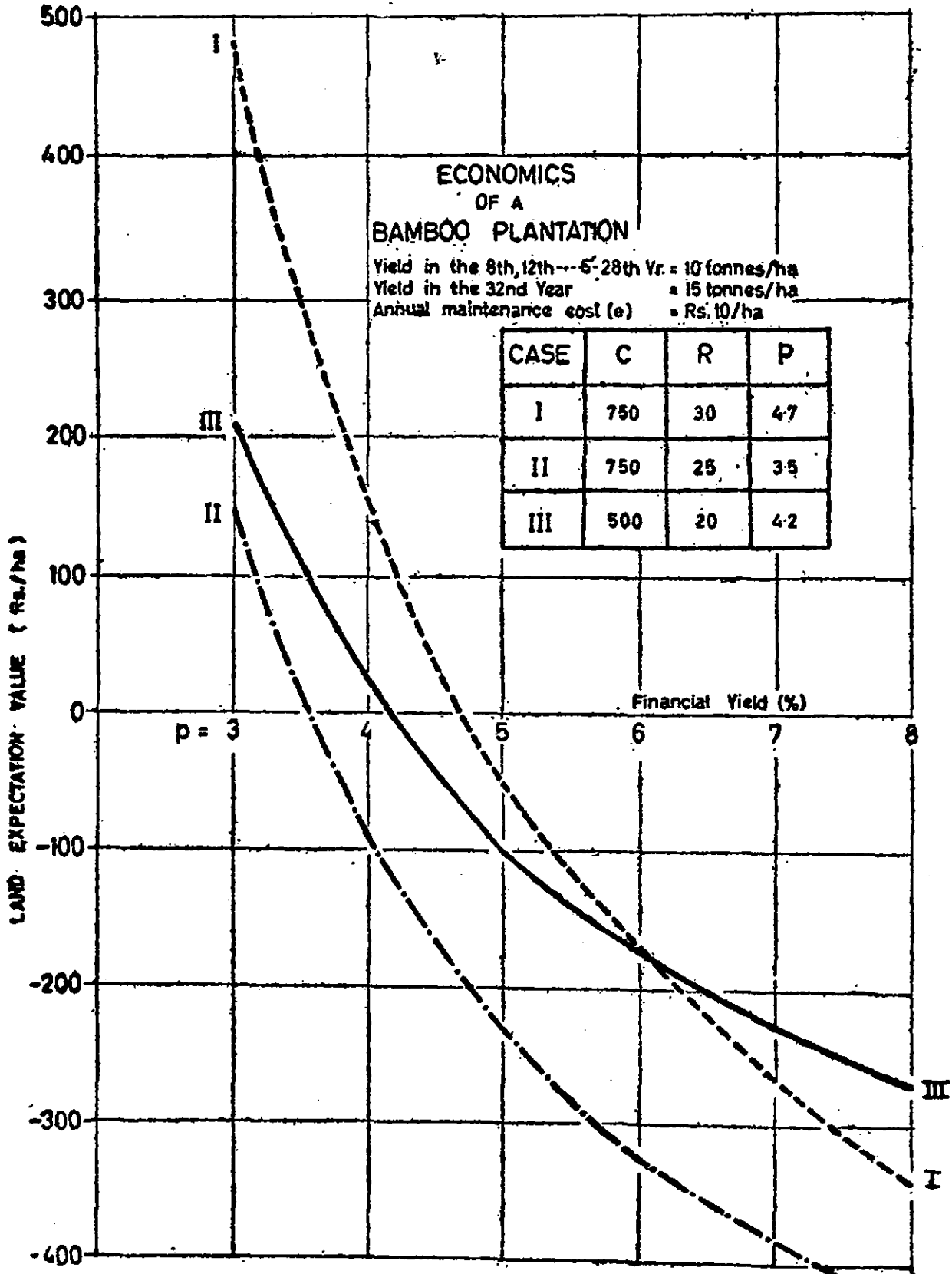


FIG. 3

bank rate. In case III if the cost of planting is only Rs. 500/ha. and a royalty of Rs. 20 is obtainable the financial yield will be 4.2%.

Figure 3 shows the trend of the curves obtained by plotting the values of (S) against the rate % (p).

Cost of Production of Pulpwood Grown in Plantations:

The simplest method of arriving at the minimum rate of royalty chargeable for pulpwood grown in plantations will be to carry forward at compound interest, all costs incurred on creating the plantation and on its tending till it is ready for felling and then working out the cost per tonne of wood obtained. Let the cost of formation be rupees 'C' per hectare and the annual cost of maintenance together with the rental charged on land be rupees 'e' per hectare, and let 'p' be the yearly rate of compound interest payable on the loan raised for meeting the expenses till the plantation is ready for harvesting in 'r' years. Carrying all expenses to the time of harvesting and writing x for 1.0p.

(a) the capitalised value of C at the end of

$$r \text{ years} = *Cx^r$$

(b) the capitalised value of all expenses incurred annually at the rate of Rs. 'e' per hectare

$$e + ex + ex^2 \dots \dots \dots + ex^{r-1}$$

$$= e \frac{(x^r - 1)}{(x - 1)}$$

(It has been assumed that money was borrowed for meeting this expense at the end of each year).

Therefore, the capitalized value of total costs will be:

$$Cx^r + e \frac{(x^r - 1)}{(x - 1)}$$

Assuming that in r years total yield obtained is (Y) tonnes per hectare, the cost of production per tonne of this pulpwood will be:

$$\frac{Cx^r + e \frac{(x^r - 1)}{(x - 1)}}{Y} = R$$

Thus, if p=4, 5, 6, 8 and 10, the values of the coefficients of C and e in the formula when r=10 will be—

TABLE 15

Coefficient	Value when p=				
	4%	5%	6%	8%	10%
$x^{10}-1$	12.0	12.6	13.2	14.5	15.9
$\frac{x-1}{x^{10}}$	1.480	1.629	1.791	2.159	2.594

*Re. 1 at compound interest p per cent per year becomes 1. 0pⁿ in a years or say xⁿ.

Therefore, the cost of production, when $C=Rs. 750$, $r=10$ years, $Y=70$ tonnes/ha. and $e=Rs. 25$, $Rs. 40$ or $Rs. 50$ at the various rate per cents will be as shown below:

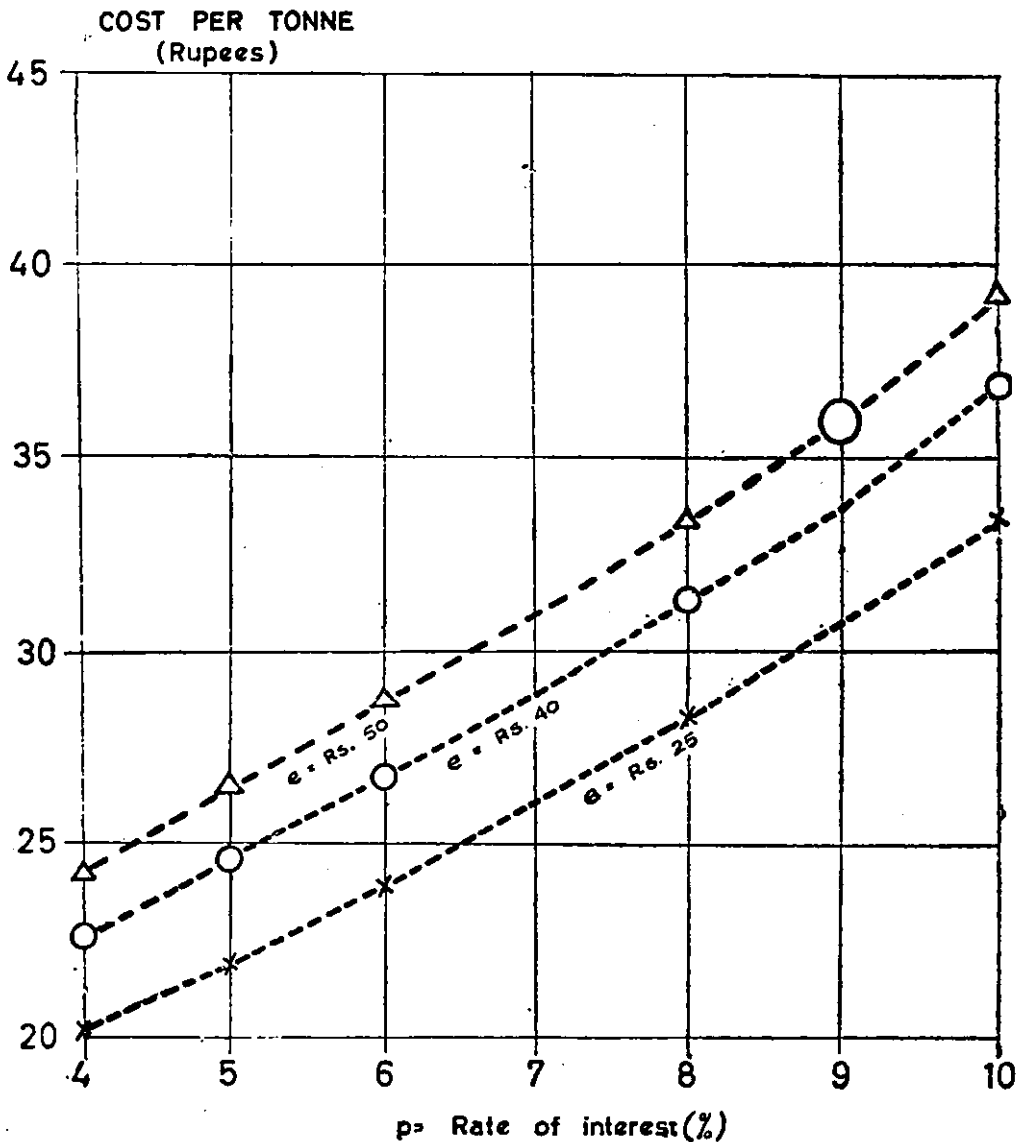
TABLE 16

e in Rupees	Cost in Rupees per tonne when $C=Rs. 750$ and $p=$				
	4%	5%	6%	8%	10%
25	20.14	21.95	23.90	28.31	33.48
40	22.71	24.65	26.73	31.42	36.88
50	24.43	26.45	28.62	33.49	39.16

The trend of curves obtained by plotting the cost of production per tonne (R) against the rate per cent (p) is shown in Fig 4 for three values of 'e' viz. Rs. 25, Rs. 40 and Rs. 50. From these curves the cost per tonne for any rate per cent between 4 and 10 may be read off. Thus if the rate is 9% and $e=Rs. 50$, the cost of production of pulpwood will be Rs. 36.00.

PULPWOOD PRODUCTION COST

e (Rupees)	Cost in Rupees per tonne when C= Rs 750 and p =				
	4%	5%	6%	8%	10%
25	20.14	21.95	23.90	28.31	33.48
40	22.71	24.65	26.73	31.42	36.88
50	24.43	26.45	28.62	33.49	39.16



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FIG. 4

CHAPTER VII

PRESENT PROCESSES AND RECENT TECHNOLOGICAL DEVELOPMENTS

The use of raw materials for paper making has increased in recent years and the same is expected to continue. The various paper making materials in India are wood, cotton and linen rags, bagasse, bamboo, sabai grass, agricultural waste such as cereal straws and fibres, and waste paper. Here only the raw materials obtainable from forests viz. coniferous and broad leaved woods, bamboos and grasses; as also bagasse which is likely to be available in large quantity have been considered.

The main source of cellulosic fibre for making paper is wood. It consists of approximately 50 per cent cellulose, 30 per cent lignin and the remainder hemicelluloses, pentosans and sugars. Lignin serves as a binder to hold the fibres together. It has to be removed to secure separation of these fibres if a product approaching pure cellulose is to be obtained. A number of processes have been evolved. It is also possible to produce pulp without removing the lignin. The various means of producing pulp, are briefly described below:

Mechanical Pulp

This is obtained by grinding pulpwood. Groundwood differs from chemical pulp in that it contains most of the lignin and the fibres are not fully disintegrated. If cheap power is available it is advantageous to make groundwood pulp because the yield* is almost double of pulp obtained by chemical digestion and it has a good printability. Its drawback is that it is affected in colour, strength and durability on exposure and the paper is weak.

The most suitable woods for grinding are conifers, but poplars in USA and Canada and Eucalyptus in Australia are also being so used extensively. In India *Salai* is being used by the Nepa Mills.

Recent trend is to do pitless grinding. After debarking, the wood is chipped and screened and then steamed and 'fiberised' in discrefiners. This process is considered suitable for hardwoods.

Cold Soda Process

This is a semi-chemical process developed in USA and is now being used to produce coarse pulps and is particularly suitable for hardwoods. The chips are treated with sodium hydroxide solution and the softened material is fiberised in disc mills. This process can also be operated on a continuous basis. Pressure impregnation is used to speed up penetration. This process is cheaper than mechanical grinding as the cost on chemicals is more than off-set by lesser energy consumption: The main disadvantage is lower brightness and lesser opacity.

*Yield 87—97%, Power 1100—2,000 kwh/ton; water requirement 10—50m/ton.

The operating data for broadleaved species when used to obtain newsprint grade pulp are

Yield 80—90%

Na OH 65—85 kg/ton of pulp

Chlorine 100 kg/ton of pulp

or

Peroxide 30 kg/ton of pulp

or

Hydrosulphite 5 kg/ton of pulp

Power 700—1200 kwh/ton

Water requirement 50—125 m³/ton

Mechano-chemical Process

This is based on simultaneous chemical and mechanical disintegration of the material, usually straw or grass. The material is treated with the chemical in a Vortex pulper. The operating data for straw and bagasse for making board grade and bleached grade pulp is as under:

TABLE 17

	Bagasse (depithed)		Straw	
	Board grade	Bleached	Board grade	Bleached
Caustic soda Kg/ton of pulp..	65—80	200—220	85—100	145—200
Lime Kg/ton of pulp .. ..	..	20—40	Alternate 140	20—40
Chlorine Kg/ton of pulp .. ..	..	90—140	..	90—140
Yield	70	43—50	65	48—50
Steam tons/ton	2—3	3—4	2—3	3—4
Power Kwh/ton	250—300	450—550	250—300	450—350
Water requirement m ³ /ton	75—150	200—350	75—150	200—350

Asplund Process

The Asplund process is a continuous pulping process by which green moist wood chips are defibrated at high temperature (160°—180°C) in the presence of steam. Pressure, temperature and time of steaming are critical factors which affect the yield and character of the fibre. This pulp is used for making wallboards or hardboards. The steam consumption averages 600—800 kg/ton of moisture free wood and power consumption varies from 160—200 kwh/ton. The yield is 80—90 per cent and water requirement is 50—125 m³/ton.

Lime Process

Lime has been used for the production of strawboard pulps, low quality wrapping paper, packing paper and corrugating medium. The advantages are its low solubility, which makes it possible to maintain a uniform cooking concentration in a saturated solution and its low cost. Lime can be used as the sole cooking agent or a small amount of sodium hydroxide, sodium sulphate or sodium carbonate may be

used in combination with lime. Usually 6—12 per cent lime as CaO on the weight of the straw are used for cooking. The other requirements are the same as those under mechano-chemical process.

Neutral Sulphite Semi Chemical (NSSC) Process

Semichemical pulping is a two stage process involving chemical treatment of wood chips to obtain softening and partial removal of the ligno-cellulose bonding material followed by mechanical refining to complete the fibre separation. Impetus has been given to this process in recent years because higher yields of usable pulp can be obtained from the hardwoods than could be obtained by conventional process. Both batch as well as continuous processes can be used.

In the batch process the pulp is produced by using either spherical rotary digesters or stationary vertical digesters. At the end of the cook the digester is blown usually under full pressure to a hot chip bin from which the chips are fed to the refiner. There are many continuous processes adaptable to semi chemical pulping like Kamyr, Pandia Defibrator, Sprout Waldren refiner continuous digester, Baurite pulping system, condii system etc.

The continuous pulping process not only offers the usual benefits of uninterrupted operation but has a further advantage of furnishing the softened chips to the refiner at elevated temperature. Other advantages are, the economy of space, uniform boiler load, and the fact that pulp rather than chips, is blown to the blow tank, thus facilitating handling and washing. It is more rapid than the batch process.

The pulping agent is a solution of sodium sulphite containing sufficient buffer like sodium carbonate to keep the pH around 7 during cooking. This process has the advantages of producing light coloured pulps, high yields for a given degree of delignification, high strength and no offensive odour. The economy of wood and chemical consumption plus the wide applicability to different wood species has made this a very popular process. The NSSC Process produces pulps which make more rigid papers than the usual alkaline pulps.

The operating data for the production of NSSC pulps from broad-leaved woods, straw and bagasse (depithed) are given below on the basis of per metric ton of slush pulp 90 per cent dry.

TABLE 18

	Broad leaved woods		Straw	Bagasse (depithed)	
	Un-bleached	Bleached	Board grade	Bleached	
Caustic soda kg/ton of pulp	90—130	200—280	60—120	140—220	
Lime .. .. .	..	20—40	..	10—30	
Sulphur	25—40	45—70	15—40	45—70	
Chlorine .. .. .	..	130—200	..	59—100	
Steam tons/ton	2.0	3.5	1.5	3.0	
Power Kwh/ton	600—800	600—800	200—300	350—450	
Water requirement m ³ /ton	50—150	200—350	50—150	200—350	

In India this process is not being used at the present moment. It deserves to be tried for hardwoods.

Alkaline Pulping Processes

The two principal alkaline processes are *soda* and the *sulphate*. In both sodium hydroxide is the major cooking chemical and in the sulphate process sodium sulphide is also present.

The sulphate process is used to produce pulps which vary from dark-coloured to soft easy bleaching pulps. The kraft process is a variation of the regular sulphate process in which the pulp is intentionally undercooked to produce pulps of exceptional strength. The sulphate process is superior to the soda process in pulp yield, pulp quality and cost of production.

The main advantages of sulphate process are:—(i) maximum flexibility with regard to species, (ii) short cooking time, (iii) pulp can be bleached to high brightness levels (iv) no pitch problems, (v) high pulp strength (vi) valuable bye-products produced in the form of tall oil and turpentine, and (vii) recovery of spent liquor is easy.

Alkaline pulping is carried out in welded steel digesters usually without lining. The digesters may be heated with either direct or indirect steam. In some cases an outside liquor circulating system is used. The newer sulphate mills have positive circulation and indirect heating of the liquor using heat exchangers made from stainless steel. The advantages of forced circulation and indirect heating are lower steam cost, lower liquor volumes and greater uniformity of cooking.

The operating data for the production of alkaline pulps (sulphate) from conifer and broadleaved woods and bamboos are given below on the basis of per metric ton of slush pulp, 90 per cent dry:—

TABLE 19

Sulphate

	Conifers		Broadleaved wood		Bamboo	
	Un-bleached	Bleached	Un-bleached	Bleached	Un-bleached	Bleached
Caustic soda kg/ton of pulp	..	30—40	..	30—40	..	20
Salt Cake kg/ton of pulp	70—160	80—170	65—150	70—160	90	120
Lime kg/ton of pulp	..	25—35	..	15—25	200	250
Lime stone kg/ton of pulp	10—45	10—50	10—45	10—45	..	..
Chlorine kg/ton of pulp	..	60—100	..	50—80	..	70
Yield %	..	45—50	..	50—55	40—50	36—42
*Steam tons/ton	..	0—0.5	..	0—0.5	1.2	3.0
Power kmh/ton	..	250—400	..	400—550	275—550	400—550
Water m ³ /ton	..	75—300	..	250—500	75—300	250—500

*It is assumed that the heat recovery, 4.5 tons of steam/ton of pulp, from liquor, barking and chipping waste is obtained.

Water Prehydrolysis—Alkaline Process

This method of pulping is adopted for the production of pulps suitable for cellulose derivatives. In the preparation of such pulps the function of the cooking liquors, bleaching agents and purification processes is to obtain cellulose of very high alpha cellulose content

and of uniform quality. Lignin should be completely removed from the dissolving pulp and amount of hemicellulose content should be as low as possible. The hemicelluloses are degraded by hydrolysis at a faster rate than cellulose and are soluble in alkalies. This hydrolysis is carried out by the natural acids liberated from the plant when it is treated with water at high temperature. The water prehydrolysis is carried out at a temperature of 153° to 186°C for 1 to 4 hours. The amount of water used is generally 3 to 5 times the amount of wood. The action of water under these conditions of treatment is primarily that of hydrolytic degradation. This treatment is highly effective in the removal of hemicelluloses. Water at such high temperatures has a plasticizing action on wood which favours the separation of the fibres. Due to these reactions it becomes possible to carry out the subsequent cooking process under milder conditions. Prehydrolysis also helps in the removal of non-cellulosic matter soluble in other. This is followed by alkaline pulping using 17—26 per cent chemicals for a period of 2—6 hours at temperatures of 153°—175°C.

By striking the right balance between the acid and the alkaline treatments during the pulping of wood, bleaching of the pulp and refining the pulp, pulps in maximum yields and of exacting specifications can be obtained.

The operating data is similar to that of alkaline pulping.

Bagasse

A recent technological development in the paper industry which is worth mentioning is the manufacture of paper from bagasse. Recently in view of the shortage of raw material from forests, attention has been focussed on the possibilities of utilising the vast potentialities offered by this cellulosic raw material. In tropical countries like India, where sugarcane is available in plenty and there is shortage of wood pulp, bagasse has assumed considerable importance as a raw material for paper. There are various methods of preparing pulp from bagasse. For the manufacture of coarse boards the treatment is mechanical and in this process the whole stalk is used. Where superior types of papers are to be produced, a more elaborate procedure is followed. In this case, the pith is separated from the fibre. For cooking the depithed bagasse nearly all the conventional processes e.g. soda, sulphate, neutral sulphite, semi-chemical as well as new methods are used. There have been and still are a number of so called proprietary processes for pulping bagasse. Mention may be made of the De La Roza process, Celdecor Pomilio process, mechano-chemical process. The A. Z. process, which has been devised by Aschaffener, Zellstoffwerk of Germany, was recommended for setting up a newsprint factory at Shakkarnagar in Andhra Pradesh. This process employs sodium sulphate with sodium carbonate and by-carbonate as cooking chemicals. Recently some doubts have been expressed on the feasibility of running 100 per cent bagasse paper on very high speed newsprint machines. Also the process requires the use of sulphur in which India is deficient. The method seems to be uneconomical and this is one of the reasons why the venture of Shakkarnagar newsprint factory did not prove successful and had to be dropped.

Recently Dr. D. S. Cusi, President, Cia Industrial De San Cristobal, Mexico, who is a distinguished worker in the field of cellulose

chemistry and specially in the use of bagasse fibre for the manufacture of pulp and paper has evolved a new process known after him as Cusi process for pulping bagasse. The pulping process developed by Dr. Cusi is considered an advancement over all other processes so far developed as it enables achieving a higher yield of pulp at low cost due to lower chemicals, steam and power consumption. It is claimed that by Dr. Cusi's process, it would be possible to manufacture newsprint of comparable standard to that currently made from groundwood and chemical pulp mixture. If this could be done, the present pattern of paper exports/imports in such areas of the world as Egypt, India, South-East Asia, Central and South America would change drastically, because at present in all these countries newsprint production lags behind the consumption and in comparison with other paper or other products, newsprint is the major item in cost and volume.

At the invitation of the Government of India Dr. Cusi recently visited India to advise the Government on the possibilities of utilising bagasse resources of the country for the manufacture of pulp & paper adopting the process which has been developed by him. Dr. Cusi visited a number of important sugar producing centres in U.P., Maharashtra and Andhra Pradesh. On the basis of the position obtaining in India Dr. Cusi *inter alia* has recommended the possibilities of establishment of the following projects in the country:

- (a) An integrated bagasse based pulp and paper mill with a capacity of 100 to 120 tonnes per day for the manufacture of medium grades of printing and writing papers with a brightness of 70—75°GE.
- (b) A 300 tonnes per day bagasse based pulp plant at a suitable site in the country.

CHAPTER VIII
SUMMARY AND RECOMMENDATIONS

SUMMARY

The *per capita* consumption of paper and newsprint which is regarded as a good index of progress is less than 1½ kg. in India whereas it is 7 kg. in UAR, 16 in USSR, 57 in Japan, 106 in UK and as much as 285 in USA. Reasons for this low consumption are the non-availability of suitable cellulosic raw material at a reasonable cost and the restrictions on import. The pulp and paper industry has however made spectacular progress after independence, to meet the rapidly rising demand for writing and printing paper and newsprint and of late for packaging. The production has spurted from less than 100,000 tonnes in 1947 to nearly 500,000 tonnes in 1964. But even so the import of newsprint has risen from 43,900 tonnes to 95,500 tonnes as there is only one newsprint mill—the Nepa—with a capacity of only 30,000 tonnes. (Its capacity is proposed to be increased to 75,000 tonnes in the Fourth Plant.)

The reasonable future demand for paper, newsprint and pulp is estimated to be as under:

						(Lakh tonnes)		
						1970	1975	1980
Paper	..	.	..	..	..	12	20	30
Newsprint	..	..	..	..	..	3	4.5	6
Chemical pulp*	..	..	..	..	..	2	4	6
Total						17	28.5	42
<i>Per capita (kg.)</i>						3.0	4.5	6.0

To achieve these targets, utilising the long and short fibre most economically, the industry will need cellulosic raw materials to the following extent.

						(Lakh tonnes)		
						1970	1975	1980
Long fibre (bamboo and conifers)	..	..	..	..	..	15.0	24.5	36.0
Short fibre (hardwoods, bagasse, etc.)	..	..	..	..	..	38.0	65.0	96.0

*Chiefly rayon grade pulp.

This study concerns only cellulosic raw materials obtainable from the forests, mainly bamboos and conifers (long fibre) and eucalyptus (short fibre). The present off-take from the forests of long fibre pulpwood (almost exclusively bamboos) is less than 10 lakh tonnes and short fibre pulpwood (salai used by the Nepa Mills) nearly 0.32 lakh tonne. The availability of bamboos is likely to rise to 15, 20 and 25 lakh tonnes in 1970, 1975 and 1980. The shortfall will have to be

made good by tapping the hitherto unexploited coniferous forests in the Himalayas and, in the long run, by creating plantations of bamboos and suitable fast growing indigenous as well as exotic long fibred woods in the plains.

As regards increased requirements of short fibre pulpwood, the indigenous mixed hardwoods obtainable from the forests are not favoured by the industry. The Forest Departments are, therefore, creating plantations of fast growing pulpwood species mainly eucalyptus. The Working Group has accordingly suggested the extent of industry-oriented plantations of various species that need to be created in the Fourth and the Fifth Plan as also the funds that will be required and the agency that should create these plantations.

The present study emphasizes the need for undertaking forest research to determine the most suitable pulpwood species, for various locations, and the best technique for raising such plantations most economically on a large scale. It also suggests the need for appropriately modifying the present pulp and paper making processes including installations of latest equipments to most rationally utilise the available resources.

RECOMMENDATIONS

The Working Group recommends as under :

Serial No.	Recommendations	Agency to take action
1	Some of the forests under working still contain so far unutilised bamboo in the remote areas particularly in Madhya Pradesh, Assam, N.E.F.A. and Tripura. These should be utilised to manufacture long fibre pulp in public sector mills which could then be utilised by mills making short fibre pulp to make acceptable quality of paper/newsprint.	(1) Ministry of Food and Agriculture and the Forest Research Institute, Dehra Dun. (2) D.G.T.D. (Ministry of Industry and Supply). (3) State Governments of Assam and Madhya Pradesh.
2	The present estimates of the availability of bamboos for industrial utilisation are at best intelligent guesses. These should be checked by systematic sampling of the forests with the help of the Forest Research Institute, Dehra Dun.	(1) Forest Research Institute, Dehra Dun. (2) Government of all the States/Union Territories.
3	Survey of the coniferous forest of U.P. and the hard wood forests of Dandakaranaya (parts of M. P. Orissa, Andhra Pradesh and Maharashtra) and the West Coast (Mysore and Kerala) being conducted with U.N. Special Fund Assistance by the Ministry of Food and Agriculture should be expedited to determine their potentialities for the paper industry.	Ministry of Food and Agriculture.
4	Now that it has been demonstrated that a certain proportion of mixed hardwoods can be used in admixture with long fibre pulp for making paper, the extent to which these are available on a sustained basis and at an economic cost should be ascertained by a quick survey in specified areas near the existing mills and where new mills are likely to come up.	(1) Ministry of Food and Agriculture. (2) Government of all the State Union Territories.
5	In the coniferous forests of J. & K., Punjab, U.P., H.P., West Bengal and Assam, which have so far not been tapped by the paper industry, the latest logging and transportation methods should be introduced to make it possible to exploit them for meeting the requirements of the paper industry.	State Governments of Jammu & Kashmir; Punjab; Himachal Pradesh; Uttar Pradesh; West Bengal and Assam.

Serial No.	Recommendations	Agency to take action
6	With a view to make long fibre pulpwood available to an increasing extent in the plains of India, plantations of bamboo and suitable conifers should be made as far as possible near the existing mills and where new mills are likely to come up. Similarly, to make available large quantities of short fibre pulpwood, at the minimum cost, extensive plantations of suitable fast growing woods, particularly, eucalyptus should be made in appropriate places. During the Fourth and the Fifth Plan period plantations should be made to the following extent under a Centrally Sponsored Scheme, at an overall cost not exceeding Rs. 750 per hectare.	(1) Ministry of Food & Agriculture. (2) Governments of all the States/ Union territories.

		Extent (Hectares)	Cost (Rs. crores)
<i>IV. Plan</i>			
Long fibre woods	.. ..	1,00,000	7.50
Short fibre woods	.. ..	3,00,000	22.50
Total	.. ..		<u>30.00</u>

V. Plan

At least to the same extent as in the Fourth Plan.

- | | | |
|----|--|---|
| 7 | The location of plantations should be finalised by the State Government concerned in consultation with the Ministry of Food & Agriculture and the Ministry of Industry and Supply. | (1) Heads of Forest Department of the States and Union Territories;

(2) Ministry of Food and Agriculture;

(3) D.G.T.D. (Ministry of Industry & Supply). |
| 8 | The agency which will create and tend the plantations will be the Forest Departments of the State/ Union Territory concerned. The Paper Mills may however create plantation on private lands. | (1) Ministry of Food & Agriculture.

(2) Governments of all the States/ Union Territories. |
| 9 | Ordinarily bamboo forests should be given out to paper mills on fairly long leases so that they may so work them as to get the highest sustained yield. The lease should permit periodical revision of the rate of royalty payable. | Government of all the States/ Union Territories. |
| 10 | The royalty on bamboo, wood or other raw material removed from Government forests should be so fixed that there is fair margin of profit to the Forest Department after making full allowance for the expenses on growing it (or replacing it) including development, overheads and reasonable rental on land. | Governments of all the States/ Union Territories. |
| 11 | In view of the acute shortage of long fibre pulpwood and as it would take several years to increase the availability and as modern research has shown that by suitably modifying the process acceptable paper or newsprint can be made by increasing the proportion of short fibre pulp in the furnish, it is recommended that the minimum quantity of long fibre pulp should be used. | D.G.T.D. (Ministry of Industry and Supply). |

Serial No.	Recommendations	Agency to take action
12	The Forest Research Institute, in collaboration with the Forest Departments of the States/Union Territories concerned should immediately start trials to find out the most suitable long and short-fibre pulpwood species that should be grown in particular localities and the most economical and feasible technique for creating large scale plantations of these species.	(1) Forest Research Institute' Dehra Dun. (2) Governments of all the States/Union Territories.
13	In the Fourth Plan adequate provision of foreign exchange be made for import of seeds of <i>prima facie</i> suitable exotic species for trials and for creating plantations.	Ministry of Food and Agriculture.
14	The Forest Research Institute should immediately take up a research scheme to study the economics of pulpwood plantations. This subject should also be included in the syllabus of the Indian Forest College and if necessary, a few officers sent out to study the subject in foreign countries/Universities.	Ministry of Food and Agriculture and Forest Research Institute and Colleges, Dehra Dun.
15	The Forest Research Institute should undertake research on a priority basis to find out the most suitable process for pulping mixed hardwood species. In order to obtain the maximum yield of pulp at the minimum cost it should try the semi-chemical pulping process. Any extra equipment necessary for this should be procured.	Ministry of Food and Agriculture and the Forest Research Institute, Dehra Dun.
16	The present pulp and paper making processes need to be appropriately modified to most rationally utilise the available cellulosic raw materials. This may also necessitate installation of some additional equipment involving foreign exchange.	D.G.T.D. (Ministry of Industry and Supply).
17	After the recommended programme of Industry oriented plantations has been launched it would be desirable to continuously evaluate the progress made, particularly, the quantities of pulpwood likely to be made available and the cost incurred.	The Working Group and Governments of all the States and the Union Territories.

ANNEXURE I

Possibility of Erecting Large Mills in the Public Sector

To find out if any mills could be put up in the country to produce long fibre pulp which could then be utilised for mixing with pulp of short-fibre obtained from hardwoods or bagasse to increase the production of paper or newsprint, an enquiry was made from the States. The information furnished and the possibilities of putting up such mills is summarised below:—

Assam—This State has extensive forests of Muli (*Melocarna bambusoides*) bamboo which has been proved to be very suitable for making long fibre pulp. The total availability has been estimated and is given in the following Table. The figures for the Cachar and Mizo district forests have been determined by systematic sampling.

TABLE

Zone	Division and district	Bamboo area (ha.)	Total growing stock	Sustained annual yield (lakh tonnes)	Surplus
1	2	3	4	5	6
Southern	1. Cachar	57,920	11.50	2.75	} 10.0
	2. Mizo	1,42,400	29.60	7.40	
Central	3. Mikir & N.C. Hills	27,960	3.08	0.78	} 1.3
	4. Nowgong	31,320	3.05	0.62	
Lower Assam	5. Kamrup	3,920	0.53	0.13	} 0.4
	6. Garo Hills	10,880	1.25	0.28	
	7. K. & J. Hills	6,560	0.78	0.18	
Upper Assam	8. Lakhimpur	9,000	1.30	0.36	} 0.04
	9. Sibsagar	4,800	0.65	0.15	
	Total	2,94,760	51.74	12.65	12.1
	10. Darang				} No surplus bamboos available.
	11. Goalpara				

On the basis of these figures and local enquiries concerning other particulars, it can be said that *prima facie* there is a good case for setting up in the public sector a 300 tonne day pulp at Badarpur where adequate quantities of Muli bamboo will be available on a sustained basis at an average cost (excluding royalty) not exceeding Rs. 75 per tonne air-dried.

Madhya Pradesh—The following statement gives the availability of bamboos that could be economically tapped for the production of pulp by a mill located in the Raipur-Bilaspur area.

Division	Bamboos available per year
	tonnes
S. Mandla	10,000
Balaghat	83,000
Raipur	16,000
Durg	17,000
Bilaspur	26,000
North Bilaspur	4,000
Raigarh	36,000
South Sarguja	7,000
Korea	77,000
Kanker	27,000
Total ..	303,000

Even assuming that the entire estimated quantity of bamboos is not available, as bamboos have flowered over certain areas, there is likely to be no difficulty in feeding, on a sustained basis, a pulp-mill of 200 to 300 tonnes daily capacity.

Mysore, Madras and Kerala—The possibility of putting up a large pulp-mill or a newsprint mill somewhere near the trijunction of the three states to tap their bamboo resources was examined. It was found that sufficient quantities of bamboos at a reasonable cost will not be available on a sustained basis for putting up any long fibre mill in the public sector in this area. However, if plantations of *Eucalyptus* continue to be made on a large scale, it should be possible to meet the requirements of a 300 tonne per day short fibre pulp mill in the area.

ANNEXURE II

STATEMENT I

Mills in production (as on 15-5-1965) and their substantial expansion licenced

(i) Paper & Paper Mills

State	Name & address of the mills	Location	Existing Capacity (Tonnes/yr)	Expansion Licensed (Tonnes/yr)
1	2	3	4	5
West Bengal	✓ 1. M/s. Titaghur Paper Mills Co. Ltd., Chartered Bank Bldg., Calcutta	Titaghur (I) Kankinara (II)	50,000	10,590*
	2. M/s. India Paper Pulp Co. Ltd., 8, Clive Row, Calcutta	Naihati	17,500	8,000*
	3. M/s. Tribani Tissues Pvt. Ltd., 24-B, Park Street, Calcutta	Chandrahati	5,050	2,400
	4. M/s. Bengal Paper Mills Ltd., 14, Netaji Subhas Road, Calcutta Hooghly	Raniganj	36,000	21,000
	5. M/s. Western Indian Match Co. Ltd., Indian Mercantile Chambers, Nicol Road, Ballard Estate, Bombay	Alambazar Calcutta	6,000	..
	6. Shree Gopinath Paper Mills, 7 Bhawani Dutta Lane, Calcutta 7	Baranagore	1,080	..
	7. M/s. Eastend Paper Industries Ltd., 32-A, Brabourne Road, Calcutta	Bansbaria	3,000	..
	8. M/s. Priti Paper Board Mills (P) Ltd., 22, Burro Shibola, Main Road, Calcutta 38	Sheoraphnli	1,800	..
Uttar Pradesh	.. 9. M/s. Star Paper Mills Ltd., Bahoria Palace, Saharanpur (27, Brabourne Road, Calcutta)	Saharanpur	30,000	13,800*
	10. M/s. Upper India Couper Paper Mills Co. Ltd., Lucknow	Lucknow	4,200	..
Bihar	.. 11. M/s. Rohtas Industries Ltd., Dalmianagar (Bihar)	Dalmianagar	60,000	37,500
	12. M/s. Thakur Paper Mills Ltd., Samastipur (Darbhanga)	Jitwarpur	3,000	..
Orissa	13. M/s. Orient Paper Mills Ltd., Brajrajnagar (Dt. Sambalpur), 15, India Exchange Place, Calcutta 1	Brajrajnagar	70,000	11,600
	14. M/s. Titaghur Paper Mills Co. Ltd., No. III Mill, Chowdwar	Chowdwar	12,000	6,000
	15. M/s. Straw Products Ltd., 11, Rabinra Sarani, Calcutta 1	Singhpur Road Bayagada.	20,000	..
Punjab	.. 16. M/s. Shree Gopal Paper Mills Ltd., Yamunanagar (Thapar House, 25, Brabourne Road, Calcutta)	Yamunanagar	60,000	7,000*
	17. M/s. Murari Paper Mills (Bharat Carbon & Ribbon Mfg. Co. Ltd.), N-75, Cannaught Circus, New Delhi	Faridabad	1,200	..
	18. M/s. Delhi Pulp Industries, 16/25, Katra Baryan, Fatehpuri, Delhi	Faridabad	3,000	1,500*
	19. M/s. Rajendra Paper Mills, 51, New Industrial Township, Faridabad	Faridabad	1,560	2,240*

*Approved schemes for speeding up by provision of balancing equipment.

ANNEXURE II—contd.

1	2	3	4	5
Madhya Pradesh	20. M/s. Alok Paper Industries, 11, Prince Yashwant Road, Indore City ..	Indore	1,200	..
	21. M/s. Straw Products Ltd., Chola Road, Bhopal ..	Bhopal	8,000	..
	22. M/s. Orient Paper Mills Ltd., 15, India Exchange Place, Calcutta ..	Amlai (Sahdol)	48,000	..
Gujarat	23. M/s. Gujarat Paper Mills Ltd., 653, Shakar Bazar, Ahmedabad ..	Barejadi	6,000	3,600
	24. M/s. Rohit Pulp & Paper Mills Ltd., Hassan Chambers, Parsee Bazar Street, Bombay ..	Pardi	4,500	3,000
	25. M/s. Jayant Paper Mills Ltd., People's Bldgs., Sir P. M. Road, Bombay ..	Utran	5,000	..
	26. M/s. Stadfast Paper Mills, Meadows House, Meadows Street, Bombay 1 ..	Dungra P.O. Vapi	450	..
	27. M/s. Parekh Paper Mills, Gondal (Saurashtra) ..	Gondal	1,000	..
	28. M/s. Speciality Papers Ltd., P. O. Udvada (Distt. Surat) ..	Udvada	1,440	..
Maharashtra	29. M/s. Deccan Paper Mills Co. Ltd. Commonwealth Buildings, Laxmi Road, Poona ..	Hadapsar	3,600	..
	30. M/s. D. Pudumjee Paper Mills Ltd., 32-H, North Lamington Road, Bombay ..	Bombay	1,800	..
	31. M/s. Paper & Pulp Conversions Ltd., 376, Shukrawar Peth, Poona 2 ..	Khopoli	7,500	4,000
	32. M/s. Pudamjee Paper Mills Pvt. Ltd., 60, Forbes Street, Bombay ..	Khopoli	3,300	3,900 1,480
	33. M/s. Ballarpur Paper & Straw Board Mills Ltd., Thaper House, 25, Brsbourne Road, Calcutta ..	Ballarpur (Ballarshah).	33,000	7,500
	34. M/s. Providence Paper Mills, New Standard Engg. Compound Ghodbunder Bd., Santa Cruz, Bombay ..	Santa Cruz	510	..
	35. M/s. Kondivita Paper & Board Mills P. Ltd. 54, Sutar Chawl, Bombay ..	Kondivita	900	..
	36. M/s. Premier Paper Mills Ltd., Jogeshwari Estate, Ghodbunder Road, Jogeshwari, Bombay 60 ..	Jogeshwari	2,100	..
	37. M/s. Oriental Timber Tradin Corporation (P) Ltd., 59, Apollo g Street, Bombay ..	Kalyan Thana Distt.	1,500	..
	38. M/s. Ajanta Paper & General Products (Pvt.) Ltd., Vadavali, P.O. Taluka, Kalyan, Bombay ..	Vadavali	1,800	..
	39. M/s. Paper Products Ltd., Dinshaw Vaccha Road, Vaswani Mansion, Bombay 1 ..	Boha (Kolaba Dt.)	4,800	1,200 1,500
	40. M/s. Vidharbha Paper Mills Ltd., Dugade Mansion, Sitabuldi, Nagpur ..	Kamptee	1,500	..
	41. M/s. Bombay Paper Mfg. Co., 109, Shaikh Memon St., Bombay ..	Kalyan	900	..
42. M/s. Afsons Industrial Corporation (P) Ltd., 18, Princess Street, Bombay ..	Waarangao	2,400	..	

(Approved for Glassine Grease proof)

ANNEXURE II—contd

1	2	3	4	5
Andhra Pradesh ..	43. M/s. Sirpur Paper Mills Ltd., Sirpur Kaghaznagar, 15, India Exchange Place, Calcutta	Sirpur-Kaghaznagar	40,000	11,400 16,500
	44. M/s. Andhra Pradesh Pulp & Paper Mills, Rajahmundry	Rajahmundry	3,000	15,000
Mysore ..	45. M/s. Mysore Paper Ltd., Bhadravati ..	Bhadravati	9,000	10,000
	46. M/s. West Coast Paper Mills Ltd., Shreeniwas House, Waudby Road, Fort, Bombay	Dandeli	33,000	15,000
	47. M/s. South India Paper Mills (P) Ltd., Chickayana, Chaitra, P.O. Nanjangud, Mysore	Nanjangud	3,000	..
	48. M/s. Mandya National Paper Mills Ltd., 14, Palace Road, P.B. No. 66, Bangalore 1	Balagula	10,800	10,800
	49. M/s. Senapathy Whitely (P) Ltd., 14, Tannery Road, Bangalore	Ramanagaram	840	..
Kerala	50. M/s. Punalur Paper Mills Ltd., Punalur (Travancore)	Punalur	11,640	..
Madras	51. M/s. Seethasayee Paper & Board Ltd., R. S. P.O. Cauvery (Salem Distt), Madras	Cauvery	20,000	..
	52. M/s. Sun Paper Mills Co. Ltd., P.B. No. 2, Cheranmahadevi, Tirunelveli Distt. Madras	Ariyanayakipuram	3,000	..
	53. M/s. Amravathi Srivenkatesa Paper Mills (P) Ltd., P.O. Udmalpet, Madras	Amravathi Nagar	3,000	..
		Total	643,870	227,516

(ii) Newsprint

M. P.	1. M/s. National Newsprint & Paper Mills Ltd., Napanagar	Napanagar	30,000	45,000
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(iii) Pulp

Kerala	1. M/s. Gwalior Rayon Silk Mfg. (Wvg). Co. Ltd., P.B. No. 37, Kozhikode ..	Mavoor	54,000	..
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(iv) Straw Board & Mill Board

U. P.	1. M/s. Meerut Straw Board Mills, P.B. No. 2, Meerut	Meerut	9,000	..
	2. M/s. The Straw Board Mfg. Co. Ltd., Saharanpur	Saharanpur	5,400	7,000
	3. M/s. Swatantra Bharat Paper Mills Ltd., 23, Chawri Bazar, Delhi	Naharnagar	1,500	..
	4. M/s. Bharat Straw Board & Paper Mills (P) Ltd., 13, Sheocharan Lal Road, Allahabad	Naini (Allahabad)	1,000	..
	5. M/s. Beopar Sahayak (P) Ltd., 58/2, Birhana Road, Kanpur	Kanpur	600	..
West Bengal	6. M/s. Pioneer Paper & Pulp Ltd., 24, Netaji Subhas Road, Calcutta	19, Dum Dum Road	1,200	..
	7. M/s. Himalaya Paper & Board Mills Ltd., 29, Seven Tanks Land, Ghughudanga, Calcutta	Ghughudanga	2,000	2,10

ANNEXURE II—contd.

1	2	3	4	5
West Bengal—contd.	8. M/s. Union Paper & Board Mills Ltd., 18, Netsaji Subhas Road, Calcutta ..	59, Kalicharan Ghosh Road, Sinthi.	5,000	..
	9. M/s. Swastik Board & Paper Mills Ltd., 51, Stephen House, 4, Dalhousie Sq., East, Calcutta	Belur	2,500	..
	10. M/s. Bharat Board Mills Ltd., 32, Ezra Street, Calcutta	Dum Dum Calcutta	1,200	..
	11. M/s. Eastern Paper Mills Ltd., 2, Dekshindari Road, South Dum Dum, Calcutta	Dum Dum	1,000	3,000
	2. M/s. Asiatic Board Mills Ltd., 29-B, Beer Para Land, Calcutta	Calcutta	600	..
	3. M/s. Priti Paper Board Mills (P) Ltd., 22, Burro Shibtoia Main Road, Calcutta	Alipore Sadar	600	..
Punjab	14. M/s. Delhi Board Mills, Ohawri Bazar, Delhi 6	Faridabad	600	..
	5. M/s. Chandigarh Paper Board Mills Pvt. Ltd., 26, Industrial Area, Chandigarh	Chandigarh	2,500	..
Maharashtra	16. M/s. Western India Paper & Board Mills (P) Ltd., Vikhroli, P.O. Bhandum, Bombay 40	Vikhroli	4,000	..
	17. M/s. Bharat Straw Board Mfg. Co., 12, Noble Chamber, Bombay	Goregaon	1,800	..
	18. M/s. Bombay Board & Paper Mills Ltd., Hamam House, Hamam Street, Fort, Bombay	Bombay	2,000	..
	19. M/s. Kondivitta Paper & Board Mills (P) Ltd., 54, Sutar Chawl, Bombay ..	Kondivitta	1,500	..
Gujarat	20. M/s. Arvind Board & Paper Products Ltd., Bilimora	Bilimora	12,000	..
	21. M/s. N.S.P. Straw Paper Products (P) Ltd., P.O. Digendranagar, Via Bilimora	Digendranagar	3,000	..
	22. M/s. Dhann Straw Board Works (P) Ltd., Plot No. 215, Off Gandel Road, Bombay 16	Dahanu Road*	600	..
	23. M/s. Saurashtra Paper & Board Mills, Pattani Bldg., Off Jubilee Gardens, Rajkot	Navgaon	1,800	..
	24. M/s. Baroda Board & Paper Mills Ltd., Fanibundra Bldgs., P. O. Railway- pura, Ahmedabad	Kathwada via Naroda Distt.	900	..
	25. M/s. Bharat Board Factory, Juni Mills, Nadiad	Nadiad	900	..
	26. M/s. Jai Bharat Paper & Board Mills, Para Bazar, Rajkot	Rajkot	200	..
	27. M/s. Indian Ginning and Pressing Co. Pvt. Ltd., Naroda Road, Ahmedabad 2	Ramol	1,500	..
	28. M/s. Shri Ambica Paper & Board Mills, Matar, Distt. Kaira	Matar	600	..
M. P.	29. M/s. Straw Products Ltd., Chola Road, Bhopal	Bhopal	6,800	..
	30. M/s. Ratlam Straw Board Mills, Ltd., Ratlam	Ratlam	7,500	..
Rajasthan	31. M/s. Kotah Straw Board Ltd., Kotah	Kotah	4,500	..
Mysore	32. M/s. Tungabhadra Pulp & Board Mills Ltd., 111, Mahatma Gandhi Road, Fort, Bombay 1	Munirabad	3,000	2,000
		Total	87,400	21,100

STATEMENT II
New Units Licensed/Approved
(i) Paper Mills (Large)

State	Name and address of the mills	Location	Capacity (Tonnes/yr)
1	2	3	4
Mysore	*1. M/s. Krishna Flour Mills, (Kasturi Paper Mills), Old Tharagupet, P. B. No. 515, Bangalore	Ghataprabha Belgaum District	21,000
	*2. M/s. Gopalan & Co., Shri Krishna Building, Avenue Road, Bangalore.	Kampli	12,000
Bihar	*3. M/s. Ashok Paper Mills Ltd., 2, Brabourne Road, Calcutta.	Darbhanga	15,000
Madras	*4. M/s. Papanasam Paper Mills, Ltd., Palayam House, Tallakulam, Madurai (Madras).	Papanasam	9,000
U. P.	*5. M/s. The Northern India Paper Mills, Meerut City.	Meerut	27,000
	*6. Uttar Pradesh Pulp & Paper Mills (Sir Shadi Lal Sugar and General Mills), Mansurpur.	Jansath Distt. Muzaffarnagar.	21,000
Maharashtra	*7. M/s. Shri Sohan Lal (Godavari Paper Mills, Ltd.), Golf Link Road, Delhi 6.	Rohuri	42,000
	*8. M/s. K. L. Gupta, & Co. 214, Marine Drive, Bombay (Shrirampur Pulp & Paper Mills, Ltd.).	Nasik Ahmednagar	37,000
Punjab ..	*9. M/s. Bedi & Co. (P) Ltd., 14, Palace Road, Bangalore 1. (Panipat Scheme/The Panipat Paper Mills Ltd.)	Panipat	30,000
Kerala ..	10. M/s. Packaging Paper Corp. Ltd., Post Box No. 134, K. K. Road, Kottayam.	Angamali Ernakulam ..	30,000 Flutting Media and Liner Paper
			244,300

The following schemes have been approved in principal and letters of intent issued:

State	Name and address of the mills	Location	Capacity (Tonnes/yr)
1	2	3	4
Andhra	*1. M/s. B. Hanumantha Rao, Mutyala Gardens, Hyderguda, Hyderabad 1.	Shakkar Nagar (Bhodan)	30,000
Mysore	2. M/s. Minute Enterprises, 63, Madhav Nagar, High Ground, Bangalore.	Shimoga (Near Tungu Dam).	30,000 (Cheap printing paper).
	3. M/s. Malnad Pulp Product Ltd., Upendra Bang, Udipi (S. India).	Udipi	18,000
Maharashtra	*4. M/s. Bharat Cooperative Paper Mills Ltd., Sangli (Distt. Sangli)	Sangli	36,000 (Cheap printing paper).
Madras	5. M/s. K. P. Kandaswamy M.A., 2-16, Mount Road, Madras.	Southern region	35,000 (Cheap printing paper).
Orissa	6. M/S. N. K. Karr & Co., 8/2, Heating Street, 3rd Floor, Calcutta.	Orissa State	25,000

*These units are bagasse based units.

ANNEXURE II—contd

(ii) Paper Mills (Small)

State	Name and address of the mills	Location	Capacity (Tonnes/yr.)	Types of Paper
1	2	3	4	5
Bengal	1. M/s Babria Bros. (P) Ltd., 36, Brabourne Road Calcutta.	Calcutta	900	Kraft Liner & Straw Paper.
	2. M/s. Card Board Box Mg. Co., 38, Colootola Street, Calcutta.	24 Parganas Calcutta.	3,000	Kraft Liner & Straw Paper.
Bihar	3. M/s. Bhagwan Devi Paper Mills, 33, Netsaji Subhas Road, 2nd Floor, Calcutta.	Dumraon Calcutta.	1,800	P. & W.
U. P.	4. M/s. Vindhya Paper Mills, 34, Aminabad Park, Luck- now (J. N. Singh & Co.).	Magarwara Distt. Unnao	1,500	Immitation Art Paper.
	5. M/s. Jugmandar Shital Praahad Jain, Sadar Bazar, Meerut.	Hastinapur Town- ship.	3,000	P. & W.
Rajasthan	6. M/s. Aravali Paper Mills Ltd., Shoji Ram Bhawan, Mirza Ismail Road, Jaipur.	Abu Road,	3,000	P. & W.
M.P.	7. M/s. G. S. Mandidip Paper Mills (P) Ltd., Sehore.	Sehore (Mandidip)	3,000	P. & W.
	8. M/s. Straw Products Ltd., Chola Road, Bhopal.	Bhopal ..	3,600	P. & W.
Maharashtra	9. M/s. Kalyan Pulp & Paper Mills (P) Ltd., 610, Raviwar Peth, Poona.	Thana ..	3,000	P. & W.
	10. M/s. India Rotoprints Cone and Tube Paper Mfg. Co., Santacruz, Bombay.	Pimpri ..	3,600	Base paper for textile cones.
	11. M/s. Niagara (Overseas) (P) Ltd., 165, Lower Chitpore Road, Calcutta.	Near Kalyan	1,500	Cable Insulative paper.
	12. M/s. Papehemi Corp. Ltd., 72, Advent, 12-A, Korshore Road, Bombay 1.	Thana ..	3,000	P. & W.
	13. M/s. Western India Paper and Board Mills Ltd., Vikhroli, P.O. Bhandup, Bombay 40.	Vikhroli ..	1,800	(N.A.)
	14. M/s. Shri Nagin M. Poojara Ambika Paper Mills (P) Ltd., 34, Panch Sheela, Bombay.	Bhiwandi	3,000	P. & W.
Gujarat	15. M/s. Bharati Pulp & Paper Products, 507, Outside Panch- kuwa Gate, Ahmedabad 2.	Ahmedabad	1,560	P. & W.
	16. M/s. Bansilal H. Shah, Associated Pulp & Paper Mills Ltd., 948, Rajamehta's Street, Ahmedabad.	Ahmedabad	4,800	Waxing, linoxating and sensitized base paper.
Mysore	17. M/s. Karnatak Paper Mills Ltd. (Paranjpa Shah & Co.), Kelgeri, Dharwar (S. Ry.).	Dharwar	1,500	P. & W.
Madras	18. M/s. Somasundram Paper Mills Ltd., Spencers Build- ings, No. 153, Mount Road, Madras 2.	Nambivayal Distt. Tanjore.	3,000	P. & W.
	19. M/s. Shri S. Rajagopalan (Bhanu Paper Mills), 'Saraba Vilas', 32, West Chitamani, Tiruchirappalli-2.	Pottavathalai	3,000	P. & W.
Kerala	20. M/s. Shri Joseph K. Thomas, Kottukapalli, Palai.	Palai ..	3,000	Grease-proof and glassina.

ANNEXURE II—contd.

1	2	3	4	5	
Kerala—contd.	21. M/s. Gwalior Rayon Silk Mfg. (Wvg.) Co. Ltd., P.O. Box No. 37, Kozhikode.	Kozhikode	..	2,700 Brown paper.	wrapping
	22. M/s. Adhi Lakshmi Paper & Boards Ltd., Peri Swamy Road, B.S. (Puram) Coimbatore.	Palghat ..	..	3,000 P. & W.	
	23. M/s. T.R.S. Ramanatha Iyer & Bros., Bankers, Coimbatore.	Palghat ..	..	3,000 P. & W.	
	24. M/s. T.S. Menon, Devi Vilas, Palghat, Kerala.	Palghat	..	3,000 P. & W.	
Andhra ..	25. M/s. Shri Raja Rajeshwari Paper Mills Ltd., Kavvali, West Godavari Distt., Andhra Pradesh.	Nuzvidi (Rly. Station).	(Rly.	900 P. & W.	
		Total	..	65,160	

(iii) Pulp

(a) Paper Grade Pulp from Bamboo

State	Name and address of mills	Location	Capacity (Tonnes/yr)
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Gujarat ..	1. M/s. Central Pulp Mills Ltd., 376, Shukarwar Peth, Poona.	Danga	..	22,500
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(b) Dissolving Pulp from Bamboo/Hardwoods

Assam ..	1. M/s. Manjushree Industries Ltd., 15, India Exchange Place, Calcutta.	Cachar	..	54,000
Madras ..	2. M/s. South India Viscose Ltd., Shanmuga Mansion, Race Course, Coimbatore.	Siramughai	..	21,600
		Total	..	75,600

(iv) Newsprint

U.P. ..	1. M/s. Birla Gwalions (P) Ltd., USO Bank Buildings, Parliament Street, New Delhi.	Muradabad	..	60,000*
Punjab ..	2. M/s. Shree Gopal Paper Mills, 25, Brabourne Road, Calcutta.	Kangra	..	60,000
		Total	..	90,000

(v) Straw & Mill Boards

Andhra ..	1. M/s. Sri Venkateswara Paper & Straw Board Mills, Tirupathi, Chittoor Distt.	Tirupathi	..	3,000
	2. M/s. Aruno General Industries Ltd., 15, India Exchange Place, Calcutta.	Bezwad	..	3,000
Bihar ..	3. M/s. Sarasgi Paper Mills, Dinajpur Road, P.O. Kishanganj, Distt. Furnea, Bihar.	Kishanganj	..	1,200
Gujarat ..	4. M/s. Simplex Board Products, Taloda Road, P.O. Box No. 18, Nandurbar.	Nandurbar	..	2,200
	5. M/s. Deah Bandhu Paper and Boards Mills, Dungri, Tehsil Bulsar, Distt. Surat.	Dungri	..	1,800
	6. M/s. Metro Wood & Engg. Works (P) Ltd., Opp. Ice Factory, Ashram Road, Naurangpura, Ahmedabad 5.	Kalol	..	2,400

*50 per cent. of the capacity will be for ordinary printing paper.

ANNEXURE II—contd

State	Name and address of mills	Location	Capacity (Tonnes/yr)
Maharashtra	7. M/s. Bharat Straw Board Mfg. Co., 12, Noble Chambers, Parsee Bazar Street, Fort, Bombay.	Goregaon Distt. Thana	4,800
	8. M/s. Solid Containers, Sir P.M. Road, Fort, Bombay.	Kalyan	7,500 (Solic fibre contain er Board).
U.P.	9. M/s. Vam Straw Board Pvt. Ltd., More Ganj, Saharanpur.	Tapri	7,500
	10. M/s. Upper India Couper Paper Mills Co. Ltd., Nishat Ganj, Lucknow.	Lucknow	1,500
Punjab	11. M/s. The Yamuna Syndicate Ltd., Yamuna Nagar Rly. Station, Jagadhari (N. Rly.).	Yamunanagar	3,000
Madras	12. M/s. Tamilnad Cardboards and Paper Mills Ltd., 34, Kumaran Road, Tirupur.	Bhavanisagar	3,000
	13. M/s. Shri P. Jagathesan, Ram Prakash Ltd., Peria Swamy Road, Coimbatore.	Thanjavur	3,000
	14. M/s. K.V. Press, 11, Officers Lane, Vellore (South India).	Vellore	3,000
M.P.	15. M/s. Madhya Pradesh Board & Paper Mills, Vidiasha (M.P.).	Vidiasha	2,880
West Bengal	16. M/s. Maruti Paper & Board Mills, 32, Seth Jannalal Bazaz Street, Calcutta 7.	Calcutta	3,600
Totl			50,500

STATEMENT III

Converted Paper Products

(i) Existing Units (as on 15-5-1965)

State	Name and address of mills	Location	Products manufactured
Maharashtra	1. M/s. Paper Products Ltd., Vaswani Mansion, Dinsha Wacha Road, Bombay.	Thana	Paper/film foil based industrial Packaging materials.
	2. M/s. Warden & Co. Pvt. Ltd., 62, Dr. Anand Rao Nair Road, Bombay.	Bombay	Do.
	3. M/s. Jayant Paper Box Factory, 30, Western India House, Fort, Bombay.	Bombay	Corrugated Paper and Boards and containers.
	4. M/s. Borwell India(P) Ltd., 54-A, Kurla Road, Andheri, Bombay 58.	Chakala Village Andheri.	Do.
	5. M/s. Amartara Industries, Thackersey House, Ballard Estate, Graham Road, Fort, Bombay.	Powari	Cellulose Adhesive tapes.
	6. M/s. Johnson & Johnson of India Pvt. Ltd., 30, Forjet Street, Bombay.	Bombay	Do.
	7. M/s. Popular Paper Converters, 138, C. Vakola, Santa Cruz, Bombay 35.	Bombay	Gated Paper Metallic, Embossed Laminates, Films and Industrial transfers.
West Bengal	8. M/s. Harbans Lal Malhotra & Sons Pvt. Ltd., 18, Neta Subhas Road, Calcutta.	Howrah	Waxed Paper.
	9. M/s. Diamond Products Ltd., 4, Olive Row, Calcutta.	Calcutta	Paper/Film/Foil based Industrial packaging material and water-proof paper.
	10. M/s. Rollspint Co. Pvt. Ltd., 6, Chowringhee, Calcutta 13.	Calcutta	Do.

ANNEXURE II—contd.

State	Name and address of mills	Location	Products manufactured
	11. M/s. Card Board Box Mfg. Co., 38, Colootola Street, Calcutta 7.	Calcutta	.. Corrugated Paper boards and containers.
	12. M/s. Dalhousie Jute Co. Ltd., Chartered Bank Buildings, Calcutta 1.	Baidyabati Distt. Hooghly.	Water proof paper.
Punjab	.. 13. M/s. Sehgal Puri Pvt. Ltd., Desh Bandhu Gupta Road, Paharganj, New Delhi.	Faridabad (Mathura Road).	Industrial Packaging.
Madras	.. 14. M/s. Lakshmi Paper Industries 126, First Agraharam, Salem (S. India).	Salem	.. Industrial Packaging. 1,500 tonnes/yr. coated paper.
West Bengal and Bombay.	15. M/s. Metal Box Co. of India Ltd., 59-C, Chowringhee, Calcutta.	Calcutta/Bombay	Composite containers.
Gujarat	.. 16. M/s. Chatrapati Associates, 6, Noble Chambers, Parsee Bazar Street, Bombay.	Baroda	.. Metalised Paper/films.

(ii) New units licensed/approved

Punjab	.. 1. M/s. Bermans Paper Mills Ltd., 1-A, Link Road, Jangpura Ex- tension, New Delhi 14.	Gurgaon	.. Coated Paper.
Maharashtra	.. 2. M/s. Sun Coated Paper Co., Janam Bhoomi Chambers, Fort Street, Ballard Estate, Bombay.	Kurla ..	.. Coated Paper.
	3. M/s. Metal Box Co. (India) Ltd., 59-C, Chowringhee, Calcutta.	Bombay	.. Paper/Board based Industrial packaging materials.

*Specially Assisted Units not Licensed under the Industries (D & R.) Act.**(i) Carbon Paper, Typewriter Ribbon & Duplicating Stencil Manufacturers*

State	Name and address of the mills	Location
Maharashtra	.. 1. M/s. Kores (India) Ltd., Plot No. 10, Off Haines Road, Worli, Bombay.	Bombay.
	2. M/s. Killick Carbonium Ltd., Killick House, Home Street, Bombay.	Bombay.
	3. M/s. R.V. Joglekar, 102, Hindu Colony Dadar, Bombay 14.	Poona (Duplicating Stencils).
Bengal	.. 4. M/s. Remington Band of India Ltd., 3, Council Street, Calcutta.	Calcutta.
	5. M/s. Gestetner Duplicators (P) Ltd., 9-A, Esplanade East, Calcutta.	Calcutta (Duplicating Stencils).
	6. M/s. Bharat Carbon & Ribon Mfg. Co. Ltd., N-75, Cannaught Circus, New Delhi.	Faridabad Calcutta.
Punjab	.. 7. M/s. Bharat Carbon & Ribon Mfg. Co. Ltd., N-75, Cannaught Circus, New Delhi.	Faridabad.
Mysore	.. 8. M/s. Khoday Carbon & Ribon & Allied Industries, 55, Santhuspeth, Bangalore 2.	Bangalore.
	9. M/s. Carbonink Products Pollachi Road, Podanur.	Podanur.

(ii) Fibre Drumse

Maharashtra	.. 1. M/s. ATE Private Ltd., 43, Forbes Street, Fort, Bombay 1.	Bombay.
	2. M/s. Warden & Co., 62, Dr. Anand Rao, Nair Road, Bombay.	Bombay.

ANNEXURE III

Research Centres Proposed for Trials of Pulpwood Species

Centre	State	Latitude	Longitude	Elevation (feet)	Temperature in centigrades			Annual Rainfall (mm.)	Drought period	Potential productivity as per Paterson
					Maximum	Minimum	Average			
1	2	3	4	5	6	7	8	9	10	11
1. Bapatla	Andhra Pradesh ..	15° 54'	80° 28'	..	..	..	..	901.9	December—April	800
2. Sahibnagar (Bhadraohalam)	Andhra Pradesh ..	17° 15' (17° 40')	80° 30' (80° 15')	..	32.2 (35.9)	20.0 (22.5)	26.1 (28.2)	737 (1053.1)	November—March	350
3. Digboi	Assam .. ..	..	..	..	28.0	18.5	23.3	2559.9	November—March	3,000
4. Gaya	Bihar	24° 45'	84° 57'	365	32.1	20.1	26.1	1184.9	January—June	40
5. Ahwa	Gujarat	20° 45'	73° 41'	496	31.7	20.0	25.6	1779.9	October—May	700
6. Srinagar	Jammu & Kashmir	34° 05'	74° 50'	5,205	19.5	7.2	13.4	658.9	September—December	200
7. Ladakh (LEH) ..	Jammu & Kashmir	34° 09'	77° 34'	11,529	12.3	-1.4	5.5	92.6	October—December	0
8. Kodanad	Kerala	11° 30'	76° 55'	250	32.2	22.5	27.8	1509.2	December—April	800
9. Chinglepet	Madras	12° 42'	79° 58'	20—30	32.2	32.3	27.8	1213.0	January—June	1,200
10. Ootacamund ..	Madras	11° 24'	76° 44'	7,364	19.3	9.2	14.3	1376.2	December—April	2,500
11. Jabalpur	Madhya Pradesh ..	25° 10'	71° 57'	1,289	32.1	18.3	25.2	1830.7	October—May	450
12. Shivpuri	Madhya Pradesh ..	25° 25'	77° 39'	..	..	..	..	861.7	October—May	200
13. Agumbi	Mysore .. ..	..	..	2,200	36	12	24	8275.7	December—February	5,000
14. Dandeli	Mysore .. ..	..	..	..	..	..	..	..	..	..
15. Bangalore	Mysore	12° 58'	77° 35'	3,021	28.8	18.4	23.6	888.9	November—April	900
16. Chanda	Maharashtra	19° 57'	79° 18'	634	33.4	20.8	27.1	1267.4	October—May	450
17. Poona	Maharashtra	18° 32'	73° 51'	1,834	32.0	18.2	25.1	661.3	October—May	600
18. Angul	Orissa	20° 50'	85° 06'	455	32.5	21.5	27.0	1205.5	November—May	500
19. Manali	Punjab	32°	77°	6,200	15.6	4.4	10.0	1270	November	..
20. Spiti	Punjab .. ..	..	..	..	..	..	..	..	..	300
21. Simla	Himachal Pradesh	31° 06'	77° 10'	7,224	17.1	10.1	13.6	1542.2	October—May	1,000
22. Jodhpur	Rajasthan	26° 18'	73° 01'	786	33.6	19.8	26.7	366.0	September—June	100
23. Jaipur	Rajasthan	26° 55'	76° 50'	1,431	31.7	18.4	55.1	597.9	October—June	200
24. Ranikhet	Uttar Pradesh	29° 38'	79° 26'	..	..	..	..	1202.9	October—May	1,000
25. Mathura	Uttar Pradesh	27° 30'	77° 41'	..	..	..	..	544.3	October—June	..
26. Sonarda	West Bengal	25°	83°	7,300	..	..	..	3202	January—March	1,000
27. Port Blair	Andamans	11° 40'	92° 43'	26	29.6	23.5	26.5	2994.5	January—April	5,000

ANNEXURE IV

Fibrous Raw material for the Indian Pulp, Paper and Board Industries

Serial No.	Name of Species	Average Fibre Dimensions		Proximate Chemical Analysis				Method of Pulping	Yield of Pulp	Product for which the pulp is suitable	Reference
		Fibre Dia. meter	Fibre Length mm.	Ash %	Cellulose %	Lignin %	Pentosans %				
1	2	3	4	5	6	7	8	9	10	11	12
	Bamboo—										
1	<i>Bambusa arundinacea</i> Wild	..	2.73	3.26	57.56	30.00	19.62	Sulphate	39.0 (B)	Writing and printing paper.	Indian Forest Bulletin No. 129 (1942).
2	<i>Dendrocalamus strictus</i> Nees (Male bamboo).	..	3.08	2.10	80.80	32.20	19.56	Sulphate	40.1 (B)	Writing and printing paper.	Indian Forest Bulletin No. 127 and 129 (1942).
								Sulphate	47.2 (B)	Grease proof paper	Research and Industry, 3, 9 (1958).
								Water prehydrolysis Sulphate.	27.3 (B)	Cellulose derivative	Indian Pulp and Paper, 13, 8 (1958).
								Mechanical	.. ..	Newsprint, cheap paper and board.	Indian Forest Bulletin No. 108 (1942).
								Mechanical	.. ..	Pressed board ..	Indian Pulp and Paper, 15, 3 (1960).
								Sulphate	.. ..	Wrapping paper ..	Indian Forest Bulletin No. 196 (1955).
								N.S.S.C.	.. 68.0 (U)	Writing, printing and wrapping paper.	Research and Industry, 6, 2 (1961).
								Water prehydrolysis Sulphate	44.0 (B) 26.0 (B)	Viscose rayon ..	Indian Pulp and Paper, 15, 11 (1961).
3	<i>Melocanna bambusoides</i> Trin. apud Spreng. (Muli bamboo).		2.72	1.87	62.25	24.13	16.73	Sulphate	.. 41.8 (B)	Writing and printing paper.	Indian Forest Bulletin No. 129 (1942).
								Water prehydrolysis sulphate.	32.2 (B)	Rayon ..	Cellulose Research Symposium II-1958, Pp. 113-118, Published by C. S. I. R., New Delhi.

ANNEXURE IV—contd.

1	2	3	4	5	6	7	8	9	10	11	12
4	<i>Ochlandra travancorica</i> Benth	..	4.03	2.60	61.67	26.91	17.84	Sulphate	.. 45.8 (B)	Writing and printing paper.	Indian Forest Bulletin No. 129 (1942).
								Water prehydrolysis sulphate.	32.0 (B)	Rayon ..	Indian Pulp and Paper, 16, 5 (1961).
5	<i>Oxytenanthera nigrociliata</i> Munro.	..	3.55	1.95	66.72	27.09	17.41	Sulphate	42.2 (B)	Writing and printing Paper.	Indian Forest Bulletin No. 129 (1942).
Grasses and Reeds											
1	<i>Eulaliopsis binata</i> (Retz.) O.E. Hubbard.	9	2.08	6.00	54.50	22.00	23.9	Soda	.. 43.2 (B)	Do.	Indian Forester, 86, 7 (1960).
2	<i>Phragmites karka</i> (Retz.) Trin. ex Stand.	11	1.20	3.09	55.23	25.70	22.40	Soda	.. 41.0	Do.	Indian Forester, 78, 3 (1952).
3	<i>Saccharum bengalense</i> Retz. Syn. <i>Saccharum munja</i> Proxb. (Munj grass).	15	2.06	2.30	58.20	20.50	23.70	Soda	.. 46.7 (B)	Do.	Indian Forester, 85, 4 (1959).
Wood—											
1	<i>Abies spectabilis</i> (D. Don.) Spach (High Level fir).	28	3.64	0.4	59.6	29.2	9.7	Sulphate	.. 68.9 (B)	Do.	The Paper Salesman, 1, 8 (1960).
2	<i>Acacia decurrens</i> (Wendl.) Wild (Green wattle).	14	0.86	0.86	63.1	21.2	19.3	Sulphate	.. 53.0 (B)	Do.	Indian Forest Bulletin No. 174 (1953).
								Soda Sulphate	.. 75.2 (U)	Wrapping paper ..	Indian Forest Bulletin No. 195 (1954).
								Water prehydrolysis Sulphate	35.6 (B)	Viscose rayon ..	Cellulose Research Symposium II, C. S. I.R. (1958).
								Mechanical	.. ..	Newsprint ..	Indian Forest Bulletin No. 21 (1957).
3	<i>Anthocephalus cadamba</i> Migt. (Kadam).	28	1.21	1.27	59.88	23.09	15.58	Sulphate	.. 47.9 (B)	Writing and printing paper.	Paper Salesman, 7, 1 (1961).
								Sulphate	.. 52.2 (U)	Wrapping paper ..	Paper Salesman, 7, 7 (1961).
								Mechanical	.. ..	Newsprint ..	Indian Pulp and Paper 17, 9 (1963).
								Cold Caustic Soda	.. 86.8 (U)	Newsprint and cheap grade paper.	Indian Pulp and Paper, 19, 4 (1964).
									82.0 (B)		
4	<i>Borwellia serrata</i> Roxb. (Salai)	24	0.88	1.80	50.76	27.30	13.0	Sulphate	.. 41.9 (B)	Writing and printing paper	Indian Forest Bulletin No. 158 (1952).
								Mechanical	.. 85.2 (U)	Newsprint ..	Indian Forest Bulletin No. 108 (1941).

ANNEXURE IV—contd.

1	2	3	4	5	6	7	8	9	10	11	12
5	<i>Brussonetia papyrifera</i> Vent (Paper-Mulberry).	30	0.82	1.08	59.18	23.26	16.43	Sulphate ..	48.3 (B)	Writing and printing paper.	Indian Forest Bulletin No. 156 (1952).
								Mechanical ..	..	Newsprint ..	Indian Forest Bulletin No. 143 (1950).
								Cold caustic soda ..	84.3 (U)	Newsprint ..	Research and Industry, 5, 11 (1950).
6	<i>Casuarina equisetifolia</i> Forst. (Horseshoe Beefwood).	11	1.08	0.90	56.70	23.20	19.20	Sulphate ..	50.3 (B)	Writing and Printing paper.	Indian Forester, 87, 5 (1963).
7	<i>Cryptomeria japonica</i> D. Don (Japanese Cedar).	38	2.18	..	..	..	..	Sulphate ..	50.3 (B)	Writing and Printing paper.	Indian Forest Bulletin No. 214 (1956).
8	<i>Eucalyptus citriflora</i> Hook. (Lemon Eucalypt, Lemongum).	14	1.03	1.45	57.90	22.99	16.75	Sulphate ..	42.0 (B)	Do.	Indian Forester 87, 12 (1961).
9	<i>Eucalyptus gibbulus</i> Labill (Tasmanian Bluegum).	14	1.11	0.5	60.95	20.27	15.52	Sulphate ..	52.8 (B)	Writing and printing paper.	Indian Forest Bulletin No. 196 (1956).
								Mechanical ..	..	Newsprint ..	Indian Forest Bulletin No. 217 (1957).
								Soda ..	..	Wrapping paper ..	Indian Forest Bulletin No. 204 (1956).
								Sulphate ..	59.1 (U)	Do.	Indian Forest Bulletin No. 211 (1956).
								Cold caustic ..	82.9 (U)	Cheap grade writing and printing paper	Indian Forest Bulletin No. 218 (1958).
								Soda ..	80.8 (B)	Viscose rayon ..	Research and Industry, 3, 9 (1958).
10	<i>Eucalyptus grandis</i> Hill ex Maiden (Toolur Eucalypt).	14	0.82	0.39	65.50	21.90	11.70	Sulphate ..	50.0 (B)	Grease proof paper	Research and Industry, 3, 10 (1958).
								Water pre-hydrolysis sulphate ..	32.8 (B)	Braille paper	Indian Pulp and Paper, 19, 3 (1964).
								..	..	Viscose rayon ..	Indian Pulp and Paper, 18, 3 (1963).
							
11	<i>Gmelina arborea</i> Roxb. (Gamari)	24	0.80	0.80	56.00	30.00	12.70	Sulphate ..	48.8 (U)	Wrapping paper ..	Research and Industry, 6, 8 (1961).
								..	..	Writing and printing paper.	..
12	<i>Kydia calycina</i> Roxb.	30	1.20	1.40	53.60	20.20	14.80	Sulphate ..	47.6 (B)	Writing and printing paper.	Indian Pulp and Paper, 18, 8 (1964).
								Mechanical	Newsprint ..	Indian Forest Bulletin No. 108 (1941).

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ANNEXURE IV—contd.

1	2	3	4	5	6	7	8	9	10	11	12	
13	<i>Lannea coromandelica</i> (Houtt) Merr. Syn. <i>Lanhea grandis</i> (Donnat.) Engl. (Jhingan).	24	1.01	1.60	53.37	24.11	14.40	Sulphate	46.2 (B)	Writing and printing paper.	Indian Forest Bulletin No. 152 (1951).
14	<i>Mallotus philippensis</i> (Lam.) (Muell.-Arg. (Kamla).	12	0.78	3.00	54.80	26.40	14.10	Sulphate ..	..	28.7 (B)	Do.	Indian Pulp and paper, 19, 2 (1954)
15	<i>Picea smithiana</i> (Wall) Boiss, (Himalayan Spruce) Syn. <i>Picea morinda</i> Link.	..	..	..	..	..	..	Mechanical	..	..	Newsprint	.. Indian Forest Bulletin No. 108 (1941).
16	<i>Pinus roxburghii</i> Sargent Syn. <i>Pinus longifolia</i> Roxb. (Chir Pine) twisted grain.	52	3.60	.25	53.46	28.56	7.23	Sulphate ..	..	39.2 (B)	Writing and printing paper.	Indian Pulp and Paper, 17, 3 (1953).
								Mechanical	..	..	Newsprint	.. Indian Forest Bulletin No. 108 (1941).
17	Mixture of hardwoods	..	..	..	..	..	..	Sulphate ..	..	53.9 (U)	Wrapping paper	.. Indian Forest Bulletin No. 197 (1955).
	(i) <i>Diospyros melanoxylon</i> , <i>Pterocarpus marsupium</i> , <i>Oleistanhus collinus</i> , <i>Dalbergia latifolia</i> , <i>Butea superba</i> , <i>Ougeinia dalbergioides</i> , <i>Terminalia chebula</i> , <i>Tectona grandis</i> , <i>Terminalia tomentosa</i> and <i>Schleichera trifuga</i>.	..	..	..	..	..	..	Sulphate ..	..	49.0 (U)	Wrapping paper	.. Indian Forester, 87, 3 (1951).
	(ii) <i>Terminalia chebula</i> , <i>Schleichera oleosa</i> —Same as <i>S. trifuga</i>.	..	..	..	..	..	..	Sulphate ..	..	44.1 (U)	Wrapping paper	.. Indian Forester, 90, 11 (1954).
	<i>Ougeinia Oojeinensis</i> —same as <i>O. dalbergioides</i> , <i>Terminalia tomentosa</i> , <i>Tectona grandis</i>	43.1 (B)	Writing and printing paper.	

U = unbleached pulp yield.

B = bleached pulp yield.

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50

Industry Oriented Plantations

Name of the State	Possible location of plantations	Mills to be catered to	Species suggested
1	2	3	4
1. West Bengal	Northern parts of Bengal such as Malda, Haldibari, Siliguri, Cooch Behar, etc	1. Titaghur Paper Mill 2. Bengal Paper Mill 3. India Paper Pulp Co. 4. WIMCO.	<i>Eucalyptus Pinus longifolia and Pinusradiata</i>
2. Uttar Pradesh	Hardwar, Rishikesh, Tons Chakrata, Tarai Almora.	1. Star Paper Mills, Saharanpur 2. New Pulp and Paper Mills to be located in suitable area for drawing timber from these areas.	Do. Do.
3. Punjab	Beas, Sutlej and Jumuna Valleys and Bhakra-Nangal area.	1. Shree Gopal Paper Mills ..	Do.
4. Himachal Pradesh	Paonta	1. To meet the demand of a possible new unit to be located. The assessment of the existing resources and the net extend of plantation should be made.	Do.
5. Orissa	Sampalpur .. Koraput .. Kalahandi, etc. .. Govindpur .. Rayagada .. Kalkan Gaon ..	1. Orient Paper Mills 2. Straw Products, Rayagada 3. Titagur Paper Mill Chowduar.	<i>Eucalyptus & Bomboo.</i>
6. Madhya Pradesh	Old Vindhya Pradesh area consisting of Rewa, Sidhi, Sahadol, Umaris, Panna and Chhatarpur. Bilaspur, Korea and Durg Balaghat Seoni Mandla Raipur Bastar Kanker Nimar Hoshangabad .. Betul Harda Khandwa East & West	1. Orient Paper Mills, Amali 2. A new mill in Bilaspur area 3. A new mill in Bastar 4. The Nepa Mills, Neapanagar.	Do.
7. Maharashtra	Chanda Jalgaon Amraoti	1. Ballarpur Paper Mills .. 2. The new Mill to be suitably located in Jalgaon Amrawati area (after reserving Salai in this region for supply of Nepa Mills).	<i>Eucalyptus & Bomboo.</i>
8. Andhra Pradesh	Asifabad Adilabad Mancheril Nirmal Paloncha West Godavari ..	1. Sirpur Paper Mills .. 2. Andhra Pradesh Pulp and Paper Mills.	Do.

ANNEXURE V—contd.

1	2	3	4
9. Mysore	.. Kanara North, east and west Hassan, Dharwar Sagar Shimoga Chikmagalur Bhadravati Coorg Mysore Kollegal Bandipur	1. West Coast Paper Mills, Dandeli. 2. Mysore Paper Mills, Bhadravati. 3. Mandya National Paper Mills Balagula. 4. New paper Mill in North Kanara. 5. New paper mill in South Kanara. 6. A new paper mill in Najangud area.	Eucalyptus and Bamboo ^a
10. Madras	.. Nilgiri District Mudumalai Cuddalore Mettur Dam area Kodaikanal Annamalai Palni	1. Seehsayee Paper Mills 2. Two new paper mills to draw raw material from the other areas.	Do.
11. Kerala	.. Gudalore Nilambur The area surrounding Periar in the Old Travancore State area adjacent to Moonnar.	1. Gwalior Rayon (Wood Pulp Division) Kozhikode. 2. Punalur Paper Mill 3. The new paper mills to be suitably located.	Eucalyptus, bamboo and tropical pine like <i>Pinus merkusii</i> .

Price: Inland Rs. 3.75 P.—Foreign 8sh. 9d. or 1 \$ 35 cents.