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UNITED NATIONS
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# THE PAPER INDUSTRY IN INDIA

## - A SURVEY OF ITS DEVELOPMENT AND STATUS -

Prepared by the

Regional and Country Studies Branch

Studies and Research Division

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## FOREWORD

An extensive study of the Indian paper industry by Mr. Y.A. Rao, was presented at the UNIDO Seminar on Comparative Pulping Processes including the Monopulp Process, held in Bangkok, Thailand, 2-6 December 1985. India being one of the major paper producers among developing countries, it was felt that the Indian experience could be of great interest to those involved in paper manufacturing in other developing countries. It was therefore decided to make the paper available - in a revised form - to a wider audience. The present report thus forms part of the series of policy-oriented studies in support of policy-making in developing countries.

In the 1970's and 1980's, for more than a decade, Mr. Y.A. Rao was Director in the Ministry of Industry, Department of Industrial Development, Pulp and Paper, New Delhi. He therefore was in a position to prepare a very thorough and detailed report on the development of the pulp and paper industry in India. UNIDO is very thankful to Mr. Rao that he made his report available to UNIDO and thereby could be the basis for this UNIDO publication.

The report was prepared by staff of the Regional and Country Studies Branch, Studies and Research Division, Department for Project and Programme Development, with Paul Hesp as consultant, in co-operation with the Chemical Industries Branch, Department of Industrial Operations.

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## INTRODUCTION

The report covers various pertinent issues of the development of the paper industry in India, such as:

- choice of technologies;
- plant size and location;
- raw materials and energy;
- utilization of scattered agricultural resources and agricultural residues;
- paper production and the environment;
- prospects for cottage industries;
- effectiveness of pricing and taxation policies, government ownership;
- competitiveness vis-á-vis developed country products;
- R and D;
- domestic markets.

In most developing countries, as in the case of India, paper production is directed to the domestic market. Lately, however, some developing countries, like Brazil and Chile, which posses substantial forest reserves have been successful in penetrating the markets in developed countries. As major producers in the developed countries face raw material supply constraints, developing countries may find new opportunities to produce for export. Yet, as the report indicates, developing country producers encounter various difficulties in competing with developed country suppliers e.g. in the case of the Indian newsprint producers. There seem to be three fields with particularly good potentials: the production of pulp, of the less sophisticated types of industrial paper (for e.g. paper bags) and of special hand-made paper the artistic purposes.

Several issues observed in the development of the Indian paper industry may also be relevant for other developing countries:

(i) Raw materials for paper should ideally be long-fibred, to give sufficient strength. For climatological reasons, forests in developing countries mainly consist of a wide variety of hardwoods, which tend to have short fibres; the lack of uniformity moreover makes large-scale processing difficult. These problems have now to a large extent been overcome. In India, bamboo is widely used as a raw material, and in recent years bagasse, the fibrous residue left after sugar-cane crushing, has also become a major input. Waste paper, agricultural residues and a wide variety of grasses and other non-wood plants are also used.

(ii) In factory-scale production, both the preparation of pulp and the drying of paper sheets demand large amounts of energy. In developing countries like India, obsolescent, worn equipment with a low energy efficiency is often used. The huge amounts of capital needed to install completely new, efficient capacity however are not always available. In India, research has therefore focused on adapting existing plant through the introduction of energy-saving and energy-recycling methods. The application of such methods also has the advantage of making paper mills less dependent on outside energy sources, reducing infrastructural costs.

(iii) The choice of technology in developed countries is complicated by the fact that equipment makers generally construct custom-made plants for developed countries. Apart from necessitating very high capital outlays, most of the equipment can only produce economically for a substantial market (modern paper mills produce upward from 400 tonnes per day) and highly qualified personnel is needed both for supervision and maintenance. In the case of newsprint, needed daily in large, uniform quantities of low per unit weight, the need for large-scale, sophisticated production units is obvious. In the case of some types of cultural paper (e.g. writing and drawing paper) and industrial paper, simpler, smaller scale mills may be appropriate, and there may even be a niche for artisanal production.

India initially imported second-hand machinery as a low-cost, rapid way of increasing domestic paper production capacity, with mixed results. Drawbacks were relatively low efficiency, mismatching of machinery and unsuitability for domestic raw materials. On the other hand, there have been considerable foreign exchange savings, and while employment was created for untrained labour, scarce highly qualified labour was hardly needed. Meanwhile, the country has been building up a domestic paper-making equipment industry. Co-operation between developing countries building up their paper industry and suppliers of paper-making plant in newly industrializing countries deserves to be stimulated.

(iv) The size and location of mills are determined by a combination of the factors mentioned above (markets, raw materials including water, technology) and by the power and transport infrastructure available. Small mills have the advantage that they can be located in rural areas where scattered agricultural residues are available, without needing a complex and costly infrastructure. They can thus contribute to employment and income-generation in marginal areas; apart from this, the experience gained in simple manufacturing operations can be useful for further industrial development. Growth in the Indian small-scale (less than 25,000 tonnes per annum) sector has been much more rapid than in the large-scale sector; a more careful assessment of resources, available technologies and markets is needed, however, to guarantee the long-term viability of small mills.

(v) The industry's consumption of large amounts of wood, water and energy can have strongly negative environmental consequences. Disregard of forest depletion also threatens the industry's own existence, and water pollution causes direct damage to other economic activities (fishing, irrigated agriculture). As pointed out, large energy savings can result from upgrading equipment and recycling waste energy. Well-tested methods are available for water treatment, and measures to protect the environment and save energy represent only a fraction of the total capital outlay for a mill, especially when the long-term savings resulting from such equipment are taken into account. Wood replanting is a costly, long-term affair, and the Indian experience shows that careful planning is needed to ensure an continuous, long-term supply to mills. Maintaining forest cover however is essential, not only for the paper industry but also to prevent soil erosion and droughts.

(vi) R and D is needed to find solution to the specific problems of the paper industry in developing countries. The issues on which R and D in India focuses (unconventional raw materials, machinery and environment-related technical problems) should be of great interest to other paper producers. Co-operation between developing countries in R and D matters could solve the manpower and funding problems which often face R and D in these countries.

(vii) Government policies may take a several forms. In the absence of private enterprise, the Government may have to create public enterprises to ensure as domestic supply of essential types of paper - newsprint in India is one example. Apart from the savings of foreign exchange, the employment effects can be important, and the paper industry can help to create an industrial base in rural areas. Economic viability, although an essential criterion, is thus not the only factor to be taken into account when evaluating a country's (potential) paper industry.

Fiscal policies to support the industry can take the form of tax concessions etc., and of reduced import duties for inputs. These have certainly had a positive impact on the growth of the paper sector in India. The control of paper production, distribution and prices, motivated by a desire to ensure a sufficient, low-priced supply of this essential product, has generally not had the results desired. Improved marketing channels constitute a more effective way of ensuring a wider availability of paper.

Although developing countries have 50 per cent of the world's forest resources, they produced only 8.2 per cent of world output of paper and paper products in 1980; this share is expected to rise to 9.1 per cent by 1987 and should continue to increase in the future. By analysing the experience of one of their major paper producers, a clearer focus may be obtained on some of the issues which will play a role in the further growth of the paper industry in the developing countries.

## 1. GROWTH AND STRUCTURE OF THE INDIAN PAPER INDUSTRY

### 1.1. Growth of the industry

Although a number of paper mills were built during the colonial era, India had to rely to a large extent on paper imports at the time when the country became independent. At the beginning of the First Five Year Plan, in 1950, the country produced 116,000 tons of paper; imports were at 90,000 tons in 1951/52. Production expanded rapidly from the Second Plan (1955-1960) period onwards. By the early 1980's imports were down to 60,000 tons, and production was almost tenfold the 1950 level, largely covering a vastly increased domestic demand. Table 1 shows the development of paper manufacturing from 1950 to 1985.

Table 1. Capacity and production in tonnes

| Year | No. of Units | Capacity | Production | Capacity utilization (per cent) |
|---|---|---|---|---|
| 1950 | 17 | 137,000 | 116,000 | 84.7 |
| 1955 | 21 | 186,000 | 185,000 | 99.3 |
| 1960 | 25 | 400,000 | 345,000 | 86.3 |
| 1965 | 52 | 644,000 | 539,000 | 83.7 |
| 1970 | 57 | 768,000 | 758,000 | 98.7 |
| 1975 | 74 | 1,042,000 | 829,000 | 79.5 |
| 1980 | 123 | 1,538,000 | 1,112,000 | 72.3 |
| 1985 | 251 | 2,356,000 | 1,450,000 a/ | 61.5 |

a/ Estimated.

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

Declining capacity utilization has been and remains a major problem of the Indian paper industry. The figures in Table 1, which, admittedly, show performance only at five-year intervals, in fact indicate a continuous decline since the mid-50s, from 99.3 per cent to 61.5 per cent, with a temporary improvement in 1970, when mills were working at almost full capacity (98.7 per cent). In spite of the suboptimal utilization of plants, the building of new production units has always continued. During the 1980-85 period, three new integrated pulp and paper mills came on stream while the number of small mills almost doubled. Although capacity was thus increased by 65 per cent, capacity utilization dropped by 10.8 per cent. The contrasting tendencies of growing capacity and decreasing capacity utilization will be analyzed in section 1.2.

The Committee on Investments for the Paper Industry of the Development Council has calculated the financial requirements for an additional 1.2 million tonnes production capacity, to be installed by the year 2000. On the basis of a debt to equity ratio of 3:1 for large units and 2:1 for small units, total requirements would be Rs. 24,800 million, a large part of which would have to be mobilized by the private sector.

Modernization of the Indian paper industry is another major issue. The investment required for a 150 t.p.d. unit has been calculated at Rs. 325 million, which can pay itself off in approximately 8 years. The cost of modernization for a mill of this size is around Rs. 6,500 per annual tonne, as compared to Rs. 23,000 per annual tonne for a new mill. Modernization is therefore the most obvious way of improving the Indian paper industry's performance. Total cost would amount to Rs. 7,700 million, and the modernization programme ought to be completed by the early 1990's to prevent major disruptions in the production of paper.

## 1.2. Size and general operational characteristics of paper mills

Until the late 1950's, the average size of Indian paper mills was relatively small. The mills built during the Second Five Year Plan (1956-1961), however, were generally of a much larger size. The average size of a production unit increased from 8,870 tonnes in 1955 to 16,000 tonnes in 1960. During the 1960's and early 1970's most of the capacity added took the form of small units or expansion of existing units. Several large integrated mills came on stream during the late 1970's, but otherwise growth, apart from the expansion of existing capacity, has mainly been the result of creating new small plants (see Table 2). As a consequence, average plant size has declined considerably.

Table 2. Unit size and capacity growth in the paper industry, 1970-1985

| Year | 1970 | | 1975 | | 1980 | | 1985 | |
|---|---|---|---|---|---|---|---|---|
| Mill category | No. of units | Capacity (tonnes) | No. of units | Capacity (tonnes) | No. of units | Capacity (tonnes) | No. of units | Capacity (tonnes) |
| Large integrated mills (capacity 20,000 t.p.a.) | 13 | 571,000 | 16 | 775,160 | 21 | 1,043,960 | 23 | 1,140,860 |
| Small paper mills (capacity 20,000 t.p.a.) | 44 | 183,920 | 58 | 267,010 | 102 | 494,025 | 228 | 1,215,330 |
| Total | 57 | 767,920 | 74 | 1,042,170 | 123 | 1,538,165 | 251 | 2,356,190 |
| Average size (tonnes) | | 13,470 | | 14,090 | | 12,540 | | 9,310 |

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

Large mills

As of 1.1.1985, there were 23 large integrated pulp and paper mills with a total capacity of 1,140,860 tonnes (see Table 3). The large integrated mills category is characterized by strong public sector presence (see Section 1.3). Except for three units (Rohit Pulp and Paper, J.K. Straw Products, Bhopal and Laxmi Board and Paper Mills), all these mills are based on forest raw materials. Two of these mills have sister units of capacity below 20,000 tonnes per annum (t.p.a.). (Titaghur Paper Mills, Orissa and Ashok Paper Mills, Bihar), and a new unit (Century Pulp, Uttar Pradesh) of 20,000 t.p.a. capacity based on forest raw materials has been commissioned in 1984. Of these 23 mills, only 6 have a capacity in excess of 200 t.p.a., and therefore most of them may be regarded as falling short of internationally accepted standards of minimum economic size for integrated plants. Six of these mills were set up more than 50 years ago, and eleven more than 20 years ago, only five units having been set up after 1975. Some of these mills, particularly those in West Bengal, were set up in locations which could originally draw upon adequate raw material resources which have since been exhausted. The problems faced by the large mills, which account for nearly 70 per cent of total production, basically stem from their uneconomic size, obsolescent equipment and raw material shortages. The most recently commissioned large mill, the Nagaland Pulp and Paper Co., was operating at 11 per cent (and less) of its capacity in the early 1980's, as a consequence of inadequate infrastructural facilities and power generation problems.

The raw material base of the large integrated pulp and paper mills is provided by bamboo and mixed tropical hardwoods extracted from natural forests. Due to severe depletion of bamboo, increased use is made of hardwoods. Nevertheless, acute scarcity of raw material now occurs in West Bengal, Karnataka, Andhra Pradesh and Tamil Nadu and mills have been forced to shut down at times. As natural forests can no longer supply the paper mills, leave alone the projected new mills, efforts are made to establish pulpwood plantations (see Section 3.1). It takes approximately a decade, however, for a plantation to become productive. To bridge the gap and prevent further deterioration of natural forests, Government incentives have been provided for the use of alternative raw materials such as bagasse (see Section 3.2), and wood chips, pulp and waste paper can be imported duty-free.

The paper industry is an energy intensive industry. Large amounts of energy are needed both to operate machinery and to raise steam which is used in the drying process.[1/] The major energy source used in India is coal. An average paper mill requires 1.5 tonnes of coal to produce 1 tonne of paper. Most bulk transport takes place by rail, and the Indian railway system cannot meet the demand for transport capacity by the paper industry. Part of the coal therefore has to be transported by road, adding to energy costs, and even so there are bottlenecks in coal supply. The energy efficiency of Indian paper mills moverover is much lower than of mills in developed countries. As compared to the typical Scandinavian mill, even relatively modern mills consume 70 per cent more heat energy (and 7 per cent more additional electric power) to produce a tonne of paper, and the energy conversion systems are also less efficient. The situation is worse in the older mills with their obsolete boiler systems. Additionally, part of the coal used is low-grade, further reducing the efficiency of power and heat generating systems. Improving the

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1/ A short description of the paper-making process is given in the Appendix 1.

Table 3. Large integrated paper mills
Capacity (tonnes)

| Name and location of mill | 1970 | 1975 | 1980 | 1985 | Remarks |
|---|---|---|---|---|---|
| Titaghur Paper Mills I + II Kankinara and Titaghur, West Bengal | 54,000 | 65,000 | 75,000 | 75,000 | |
| Bengal Paper Mills Raniganj, West Bengal | 36,000 | 50,000 | 50,000 | 50,000 | |
| Star Paper Mill Saharanpur, Uttar Pradesh | 36,000 | 45,200 | 46,000 | 46,000 | |
| Rohtas Industries Ltd. Dalmianagar, Bihar | 60,000 | 60,000 | 60,000 | 60,000 | |
| Orient Paper Mills Brajrajnagar, Orissa | 70,000 | 76,000 | 76,000 | 76,000 | |
| Orient Paper Mills Amlai, Madhya Pradesh | 65,000 | 85,000 | 85,000 | 85,000 | |
| J.K. Straw Products Raigada, Orissa | 20,000 | 31,500 | 35,500 | 50,500 | |
| Ballarpur Industries (SG) Yamunanagar, Haryana | 40,000 | 46,000 | 51,000 | 51,000 | |
| Ballarpur Industries (B) Ballarshah, Maharashtra | 45,000 | 69,000 | 69,000 | 80,500 | |
| Sirpur Paper Mills Sirpur | 40,000 | 40,000 | 66,100 | 66,100 | |
| Andhra Pradesh Paper mills Andhra Pradesh | 36,000 | 60,000 | 75,000 | 75,000 | |
| West Coast Paper Mills Dandeli, Karnataka | 36,000 | 45,000 | 60,000 | 60,000 | |
| Seshasayee Paper and Boards Erode, Tamil Nadu | 33,000 | 35,000 | 50,000 | 55,000 | |
| India Paper Pulp Mills Naihati, West Bengal | - | 23,000 | 23,000 | 23,000 | Expansion from small category |
| Mysore Paper Mills Bhadravati, Karnataka | - | 24,000 | 24,000 | 37,000 | Expansion from small category |
| Laxmi Board and Paper Mills Kalyan, Maharashtra | - | 20,460 | 20,460 | 20,460 | Board mill based on agricultural residues and waste paper |

| Name and location of mill | 1970 | 1975 | 1980 | 1985 | Remarks |
|---|---|---|---|---|---|
| JK Straw Products Bhopal,Madhya Pradesh | - | - | 25,700 | 20,700 | Board mill based on agricultural residues and waste paper |
| Punalur Paper Mills Punalur, Kerala | - | - | 33,000 | 33,000 | Expansion from small category |
| Ashok Paper Mills, Jogighopa, Assam | - | - | 27,000 | 27,000 | New unit 1976 |
| Sri Rayalaseema Paper Mills Adoni, Andhra Pradesh | - | - | 42,000 | 42,000 | New unit 1979 |
| Bhadrachalam Paper Board Ltd. Bhadrachalam, Andhra Pradesh | - | - | 50,000 | 50,000 | New unit 1979 |
| Rohit Pulp and Paper Mills Udvada, Gujarat | - | - | - | 24,600 | Expansion from small category |
| Nagaland Pulp and Paper Co. Ltd., Tuli, Nagaland | - | - | - | 33,000 | New unit 1982 |

All these mills, except where otherwise indicated, are based on utilization of forest raw materials (bamboo, reeds and hardwoods).

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

efficiency of power and heat generation would reduce the bottlenecks in coal supply by reducing coal demand, and would also eliminate one reason for low capacity utilization. The subject of energy conservation is dealt with more extensively in Section 4.2.

Equipment problems are not restricted to power generation. The majority of large mills having been established decades ago, there is a widespread problem of plant obsolescence. Although the domestic industry can now produce a wide range of equipment for integrated pulp and paper plants, there are areas where design needs to be improved and others where imports have to be used which are not always adequately adapted to Indian operating conditions. Chapter 4 gives more information about the efforts to improve paper manufacturing technology. The present opinion is that, generally speaking, modernizing existing large mills is to be preferred to setting up completely new capacity: in the case of modernization, the investment per tonne per annum is only about one third of the investment for a new plant.

Due to the problems outlined above and to economic recession, the profitability of the paper industry declined during the early 1980's. Whereas for 16 major companies the gross return on capital was 9.3 per cent and the gross margin on net sales 11.1 per cent in 1982/83, the figures for 1983/84 were 6.0 per cent and 6.8 per cent, respectively. The net return on net worth was 8.1 per cent in 1982/83, whereas in 1983/84 there was a net loss of 0.3 per cent. Seven of the large integrated mills were closed throughout most of 1983, and four were only producing intermittently during 1984. One of the enterprises, the Ashok Paper Mills, has actually been closed since 1982.

Small paper mills

In India, small paper mills[1/] are defined as not being of the integrated mill type, having an installed capacity of not more than 26,400 t.p.a. or 80 tonnes per day (t.p.d.) and utilizing secondary raw materials, like waste paper and non-wood plant fibres such as cereal straw and bagasse. According to generally accepted standards, the minimum economic size of plants of this type is 10,000 t.p.a. A large number of Indian paper mills, however, have a much smaller capacity. Table 4 lists the small paper mills in the 10,000 + t.p.a. range.

Small paper mills serve important social and economic goals:

- they can utilize scattered agricultural residues and other raw materials which might otherwise be wasted;
- they relieve the pressure on forest resources;
- they help to disperse industrial development outside the large manufacturing centres.

The small mills need less skilled labour, management, investment, and infrastructual facilities; all of these tend to be scarce in a developing economy.

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1/ Not to be confused with small-scale paper mills, a term which in India is used to refer to the cottage-type paper industry only.

Table 4. Main units in the small paper mill category
Capacity (tonnes)

| Name and location of mill | 1970 | 1975 | 1980 | 1985 | Remarks |
|---|---|---|---|---|---|
| Titaghur Paper Mills<br>Chowdwar, Orissa | 12,000 | 18,000 | 18,000 | 18,000 | Forest raw material-based |
| Mandya National Paper Mills<br>Belagula, Karnataka | 10,800 | 10,800 | 10,800 | 16,500 | Bagasse based mill |
| Central Pulp Mills<br>Fort Songad, Gujarat | - | 16,500 | 16,500 | 16,500 | Forest raw material based pulp mill |
| Sun Paper Mills<br>Charanmahadevi, Tamil Nadu | - | 15,000 | 15,000 | 15,000 | Mechanical printing paper mill based on wood residue/waste paper |
| Tribeni Tissues Ltd.<br>Hooghly, West Bengal | - | - | 13,500 | 13,500 | Cigarette paper and specialties based on sun-hemp, jute sticks, imported pulp |
| Paper and Pulp Conversions<br>Khopali, Maharashtra | - | - | 12,000 | 20,000 | Board mill |
| Sengal Paper Mills<br>Dharuhera, Haryana | - | - | 15,000 | 15,000 | |
| Ellora Paper Mills, Tumser,<br>Maharashtra | - | - | 13,200 | 13,200 | |
| Ashok Paper Mills<br>Rameshwarnagar, Bihar | - | - | 13,500 | 13,500 | New unit 1976<br>Obtains bamboo pulp from sister unit in Assam |
| Padamjee Pulp and Papers Ltd.<br>Poona, Maharashtra | - | - | - | 11,000 | |
| Wood Papers Ltd.<br>Bilimora, Gujarat | - | - | - | 14,000 | |
| United Pulp and Paper Mills<br>Ropar, Punjab | - | - | - | 20,000 | |
| Zenith Papers Ltd.<br>Hoshiarpur, Punjab | - | - | - | 19,800 | |
| Century Pulp and Paper Mills<br>Nainital, Uttar Pradesh | - | - | - | 20,000 | New unit 1984<br>Forest raw material-based |
| Sri Lakshmi Saraswati Papers Ltd.<br>Nizamabad, Andhra Pradesh | - | - | - | 15,500 | New unit 1984 |
| Neptune Paper Mills<br>Midnapur, West Bengal | - | - | - | 16,500 | New unit 1984 |
| Brooke Bond India<br>Bilaspur, Madhya Pradesh | - | - | - | 15,500 | New unit 1984 |

Except where otherwise stated, all these mills are based on agricultural residues and waste paper.

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

In 1985, 228 small paper mills existed. These could be classified as follows:

- Units based on waste paper recycling (143 mills), with a capacity range from 500 t.p.a. to 5000 t.p.a. Generally such units are located near metropolitan centres which supply the waste paper, and they manufacture cheap grades of paper and board.
- Units based on waste paper and agro-residues (68 mills), with capacities of 5,001 - 10,000 t.p.a. Many of these were started as waste paper based units, but added pulping sections later. These units make writing and printing paper as well as kraft and corrugated paper.

- Units based primarily on agricultural residues (17 mills), with capacities of 10,001 - 25,000 t.p.a. These units often supplement agricultural residues with waste paper and market pulp and manufacture a wide range of paper and paper board.

Most of the small paper mills have been set up after 1970, with Government assistance, and the great majority of them is located in the rice/wheat belts (e.g. in the Ganges valley) or near sugar mills, where supplies of straw and bagasse are available.

Capacity utilization in the small units is generally even lower than in the large, integrated mills: the percentage is often less than 50. At present, 33 mills in this category are closed. The following factors have been identified as contributing to this situation:

- Installation of inferior and inadequate equipment, low quality of premises (a result of efforts to keep capital costs low);

- Lack of balance and standardization in unit equipment;

- High steam costs as a result of remote location (coal transport by road rather than rail) and low thermal efficiency of boilers;

- Inadequate power supply;

- Fluctuations in the availability and prices of raw materials;

- Management and skilled labour scarcity;

- Absence of technically and economically sound waste recovery systems, leading to pollution and waste of valuable materials;

- Time and cost overruns at the project implementation stage, resulting in higher financial burdens.

The presence of inferior equipment in the small mills is to a large extent a consequence of a Government policy to allow imports of cheap second-hand machinery with a capacity of up to 30 tonnes per day, to stimulate investment in the industry (see also Section 4.3). Apart from this, there has been a proliferation of very small mills with a 5-10 t.p.d. capacity, as mills of this size do not require a license. Such mills generally do not dispose of

the financial means and the know-how to produce efficiently - in marginal rural areas technicians, skilled labourers and managers who have been exposed to modern industrial developments are scarce.

Even the supply of raw materials is often a problem. Firstly, it tends to be irregular: bagasse, cereal straw, etc. are not produced round the year; therefore, the problem of handling and storage arises, and for small mills such costs are disproportionately high. Secondly, there are alternative, competing uses for the raw materials: waste paper is used for packaging in the toy industry and also increasingly in large paper mills which are short of forest raw materials. Agricultural waste is used for, a.o., heating and fertilizing purposes.

Improved waste recovery would do much to reduce the cost of chemicals used in the paper-making process, and to reduce the widespread pollution now caused by these. More details about ongoing attempts to solve the technical problems of small mills outlined above may be found in Chapter 4.

In spite of the disappointing performance of many small mills (which, a.o., is reflected in a widespread inability to service loans) their potential contribution to development (especially in rural areas) is significant. Moreover, considerable investments have been made in the small mills over the years. The efforts to improve their performance should therefore be stepped up. The following measures have been suggested in this context:

- Fiscal concessions in the form of increased excise duty relief. These concessions should relate to output rather than mill size, and the lowest output categories should be exempted from excise duty altogether;

- Ensuring sufficient power supply and allocating coal on a priority basis;

- Development (and subsidization) of chemical recovery systems for small paper mills;

- Simplification and standardization of equipment, particularly pulping equipment;

- Increased utilization of waste paper, with improved de-inking.

The handmade paper industry

Hand manufacturing of paper is a traditional industry in India, and has long been recognized as a contribuant to village development. Limited though its contribution to the branch as a whole is - it produces only 0.5 per cent of the total output of paper and paper board - it is an important source of employment in some rural areas, and the distinctive qualities of its products ensure a separate market niche. Low capital intensity, simple equipment and high labour intensity characterize the production process. A commercial-scale handmade paper unit can provide employment to as many as 100-120 persons, at an investment of only about Rs. 400,000; the wage component of the handmade products is 30-35 per cent. Table 5 provides some general figures on the industry:

Table 5. The handmade paper industry - some general data

| | 1980-81 (Actual) | 1981-82 (Actual) | 1982-83 (Provisional) | 1983-84 (Target) | 1984-85 (Target) |
|---|---|---|---|---|---|
| Output (tonnes) | 6,688 | 6,741 | 5,985 | 6,700 | 7,052 |
| Value (Rs. 10 million) | 3.57 | 4.05 | 4.00 | 4.72 | 5.59 |
| Sales (Rs. 10 million) | 3.58 | 4.12 | 4.10 | 5.19 | 6.15 |
| Employment (100,000) | | | | | |
| Full time | 0.05 | 0.05 | 0.05 | 0.07 | 0.08 |
| Part-time | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

The industry has the advantage of being able to use a wide variety of scattered raw materials which are often not rated as inputs for the paper industry (jute bags, tailor's cuttings, grasses). Even so, competition by large mills for these inputs has been growing. Output in the main consists of small batches of a variety of special quality papers (e.g. greeting cards, drawing paper) which can be sold as relatively high prices. Marketing of general grade paper (e.g. file covers, grey board) produced by the handmade paper industry has encountered serious difficulties.

The Khadi and Village Industries Commission (KVIC), established in 1957, has provided special assistance to the handmade paper industry. KVIC's development efforts have concentrated on:

- Improvement of production methods and technologies, introduction of modern tools and equipment, and supply of technical know-how, including product development;
- Diversification of production;
- Training of artisans and managerial personnel;
- Search for new raw materials.

As a result of KVIC's continuous R & D efforts, the handmade paper industry is almost on par with any other sophisticated small-scale industry.

KVIC's strategy for the Seventh Five Year Plan (1985/86 - 1989/90) includes:

- Clustering of handmade paper units which would then be supplied by a central pulping unit;

- Diffusion of handmade paper units in marginal areas (e.g. hill areas) where tree bark and other unconventional raw materials can be used to produce exclusive paper varieties;

- Encouragement of entrepreneurs (individuals, co-operatives or institutions) who wish to adopt intermediate technologies to expand production by providing support/advice in financial matters;

- Raising the value of production to Rs. 109 million and creating additional employment for over 8,000 persons.

Further stimuli to the industry could take the form of:

- Government purchase of and reservation schemes for special paper/board varieties to be used for e.g. passport covers and railway tickets;

- Excise duty exemption and subsidies for location in marginal areas;

- Ensuring raw material supplies, e.g. through (maintaining) export bans on cotton linter, cotton rags;

- Providing export incentives for handmade paper.

1.3 Public sector newsprint mills: plans, production, problems

Public sector mills are the only producers of the most common type of paper: newsprint. So far, private sector entrepreneurs have not been able to realize plans for newspaper mills. This is due to the following factors:

Shortage of raw materials

For newspaper production, soft coniferous wood is still the most convenient raw material. In India very little coniferous wood is available for the paper industry. Other raw materials, apart from being in short supply (hardwood, bamboo, reeds) do not lend themselves so well for newsprint manufacturing and need special pulping procedures. Nepa Mill newsprint, e.g., made of bamboo and salai (Boswellia serrata) has come in for much criticism because of its grammage, colour and price. Bagasse technology has only recently been perfected (see Section 3.2) and recycled paper is not available in sufficient quantities.

High capital cost

The scale of capital investment required for newsprint manufacturing is generally beyond the means of private sector entrepreneurs in India. The capital investment for the Government paper mill projects in Kerala and Mysore (see below) was nearly Rs. 20,000 per annual tonne.

Pricing (see also Section 5.2)

As a consequence of the scarcity of conventional resources for newsprint, necessitating costly innovations, and insufficient scale economies, the price of Indian newspaper is higher than of (better quality) imported newsprint. The price of imported newsprint, moreover, has shown a declining trend.

The Government of India has considered the gains from a domestic newsprint industry (savings of foreign exchange, independence of external sources, domestic multiplier effects) to be more important than the costs. To ensure a sufficient domestic supply of newsprint, the Central Government became involved in, or established several major newsprint mills.

The National Newsprint and Paper Mills Ltd. (Nepa)

The National Newsprint and Paper Mills Ltd. (Nepa), founded in 1947, was part-financed by public means from the start, through the State Government of Madhya Pradesh. The State Government also provided infrastructure. The demand on financial and managerial resources were too much of a strain for the private partners and soon the Central Government had to step in. Nepa became a public enterprise in 1958. The pattern of equity shareholding in 1983 was as follows: Central Government 78 per cent, Government of Madhya Pradesh 16 per cent, private shareholders 6 per cent. The mill was planned for paper and board production, but converted to newsprint production. The mill was slow to attain its targetted production, but by 1963 capacity was fully utilized, and it was decided to expand the mill by increasing the capacity of the existing paper machine, installing a new one with a capacity of 37,500 tonnes, expanding the pulping capacity (based on bamboo and a local hardwood, Boswellia serrata, or salai) and adding a new recovery plant to existing facilities. Expansion took far longer than expected, the new pulping plant only being installed in 1980, and the scheme revealed a number of deficiencies:

- production of the expanded groundwood pulp mill (designed for 90 t.p.d.) remained at approximately 60 t.p.d. (its pre-expansion capacity), mainly as a consequence of power shortages;

- production of the expanded chemical pulp mill, with a designed capacity of 90 t.p.d., did not exceed 70 t.p.d.;

- the new cold soda pulping plant, which was intended to produce 90 t.p.d., produced some 50 t.p.d.;

- as the pulping plants could not attain planned production levels, the expansion of the capacity of the existing paper machine was not carried out; production of both the existing and the new paper machine remained well below design levels.

In 1978, following a study by a Finnish consulting firm, the overall functioning of the mill and output quality improved. The main improvements were in power generation, production by the cold soda pulping plants, and the reduction of paper grammage (both high grammage, or weight, and colouring of Nepa newsprint have given rise to persistent criticism). Table 6 gives the 1965/66 - 1983/84 production figures for the Nepa mill.

Even the improvements of the late 1970's have failed to increase production to optimum levels: there is still an imbalance between pulping and paper making capacity, and there is a chronic power shortage. To overcome these constraints, a modernization programme is underway, with the following elements:

Table 6. Nepa mill paper production

| Year | Paper machine 1 (tonnes) | Paper machine 2 (tonnes) | Total (tonnes) |
|---|---|---|---|
| 1965-66 | 30,348 | - | 30,348 |
| 1966-67 | 29,506 | - | 29,506 |
| 1967-68 | 31,308 | - | 31,308 |
| 1968-69 | 30,512 | 50 | 30,562 |
| 1969-70 | 23,170 | 16,105 | 39,275 |
| 1970-71 | 12,470 | 24,800 | 37,270 |
| 1971-72 | 12,058 | 27,982 | 40,040 |
| 1972-73 | 11,918 | 28,853 | 40,771 |
| 1973-74 | 14,173 | 34,498 | 48,671 |
| 1974-75 | 19,245 | 34,759 | 54,004 |
| 1975-76 | 19,054 | 33,809 | 52,863 |
| 1976-77 | 22,890 | 34,800 | 57,690 |
| 1977-78 | 21,837 | 33,666 | 55,503 |
| 1978-79 | 17,778 | 30,187 | 47,965 |
| 1979-80 | 17,416 | 29,969 | 47,385 |
| 1980-81 | 18,561 | 32,722 | 51,283 |
| 1981-82 | ... | ... | 55,021 |
| 1982-83 | ... | ... | 57,310 |
| 1983-84 | ... | ... | 58,315 |
| 1984-85 | ... | ... | 64,900 |

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

- increasing the capacity of the two paper machines to 42,000 t.p.a. each;

- increasing the capacity of the chemical pulp, cold soda pulp and groundwood pulp plants to 30,000 t.p.a. and 27,000 t.p.a., respectively;

- increasing power generation from 5 MW to 15 MW;

- improving the performance of the utilities and service departments.

The Hindustan Paper Corporation

During the 1960's growth in the private paper industry was low, as a result of price controls, escalation of investment costs, and increasing scarcity of forest raw materials. The latter were still available in relative abundance in remote areas, such as the Himalayas, but these areas lacked a developed infrastructure. In order both to stimulate the economy of these marginal areas and to expand the domestic capacity for paper products, especially newsprint, the Central Government established the wholly Government-owned Hindustan Paper Corporation Ltd. (HPC) in 1970. HPC's authorized capital is Rs. 4,000 million; paid-up capital as on March 31, 1984, was Rs. 3,643 million. HPC operates three subsidiary companies:

- Hindustan Newsprint Ltd., Kerala State;
- Mandya National Paper Mills Ltd., Karnataka State;
- Nagaland Pulp and Paper Co. Ltd., Nagaland State.

The Karnataka State mill has been producing since 1962. Originally a private mill, it performed unsatisfactorily. To prevent closure, HPC took over the mill. Capacity utilization, however, has remained far below optinal levels (see Table 7). Reasons adduced for its low performance are: irregular supply of bagasse, power cuts and inefficient machinery. The mill was being modernized in 1985 to raise total capacity and remove operational bottlenecks.

The Kerala newsprint mill began commercial production in late 1982, after considerable delays resulting from industrial action, changes in plant design and layout and effluent treatment problems. The total costs of the project, Rs. 1,560 million were almost double the planned costs. Eucalyptus and reeds are used as raw materials. Performance so far has been disappointing (see Table 7); the main reasons are power shortages and production problems in the pulping plant.

The Nagaland mill, based on bamboo and reeds, commenced commercial production in July 1982. Capacity utilization has been exceptionally low (see Table 7). Inadequate boilers and the remoteness of the region are the main cause for the mill's low performance. Infrastructural facilities are inadequate, a suitable grade of coal is not available locally and there is a serious shortage of skilled manpower.

Construction of two new HPC mills in Assam, both with a capacity of 100,000 t.p.a. and utilizing bamboo as a raw material, was started in 1977. The Nowgong project should have been completed in 1980, the Cachar project in 1981. Largely due to a variety of infrastructure-related problems, of which the limited carrying capacity of the railways in the region is the most serious, completion of the projects has been delayed. The Nowgong project was expected to commence trial runs March 1985, and the completion schedule for the Cachar project was extended to March 1986. The capital cost for both projects was originally estimated at Rs. 2,282 million; present estimates are well over Rs. 5,000 million.

Under the Seventh Five Year Plan (1985/86-1990/91), HPC intends to initiate the construction of several new mills, mainly for the production of newsprint. A prefeasibility study has been made for an 80,000 t.p.a. bagasse and hardwood based paper and newsprint mill close to three sugar mills in Uttar Pradesh. Bagasse from the sugar mills would be supplied in exchange for steam supplied by the paper mill. In Bihar, location of a paper mill in the proximity of a number of sugar mills is being considered as well. The capacity of this mill would also be 80,000 t.p.a. Bagasse will be supplemented by bamboo and woods from forests in the State. Attention is being paid to good transport linkages and a reliable, sufficient supply of coal. A much more modest paper mill project (33,000 t.p.a.) has resulted from studies examining the paper manufacturing potential in Arunachal Pradesh. The advantages of the location chosen are the proximity to bamboo, hardwood, coal and other inputs.

A State Government mill, the Mysore Paper Mills of the Government of Karnataka, became a newsprint producer in 1981. The 75,000 t.p.a. eucalyptus and bamboo based project was initiated in the late 1970's, as an addition to the existing paper mill owned by the State Government. The newsprint mill produced 9280 tonnes in 1981/82 and 35,800 tonnes in 1982/83, 53,906 tonnes in

Table 7. Performance of the Hindustan Paper Corporation Mills

| Year | Karmataka mill | | | Kerala mill | | | Nagaland mill | | |
|---|---|---|---|---|---|---|---|---|---|
| | Production (tonnes) | Capacity utilization (per cent) | Net loss/ profit (Rs. million) | Production (tonnes) | per cent Capacity utilization | Net loss/ profit (Rs. million) | Production (tonnes) | Capacity utilization (per cent) | Net loss/ profit (Rs. million) |
| 1979/80 | 6,087 | 37 | -10.7 | - | - | - | - | - | |
| 1980/81 | 6,089 | 37 | -10.5 | - | - | - | - | - | |
| 1981/82 | 11,946 | 72 | 1.7 | - | - | - | - | - | - |
| 1982/83 | 9,231 | 56 | -30.1 | 15,478 | 19 | -46.2 | 1,527 | 6 | -86.4 |
| 1983/84 | 8,092 | 49 | -25.6 | 64,178 | 80 | -107.3 | 3,603 | 11 | -157.7 |
| 1984/85 | ... | ... | ... | 64,217 | 80 | ... | ... | ... | ... |

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

1982/84 and 71,430 tonnes in 1984/85. Finally, an undertaking of the State Government of Tamil Nadu, the Tamil Nadu Newsprint and Papers Ltd., was going through trial runs in late 1984 (see also Section 3.2). This mainly bagasse-based project has largely been financed by the World Bank (US$ equivalent of Rs. 1,100 million out of estimated total investment of Rs. 1,800 million). Bagasse is obtained from six sugar mills in the State. As in the Central Government (HPC) project in Uttar Pradesh (see above), the paper mill will supply steam to the sugar mills.

In recent years, private entrepreneurs have started to investigate the possibilities of producing newsprint from waste newsprint and waste paper. Eleven schemes with a total capacity of some 600,000 t.p.a. have been proposed. These mills would be located in ports, as imported used newsprint would be the major input. The good sales prospects on the internal market and the relatively low capital and energy costs would seem to make these projects attractive, but so far none of them have been implemented.

## 2. MARKETS AND SUPPLY

### 2.1. Demand on the internal market

Paper demand depends on a number of factors of which per capita income, educational levels and industrial development are the most important. A variety of projections for paper demand in India has been made over the years. As can be seen in Table 8, there have always been overestimations:

Table 8. Paper and newsprint: projected and actual consumption in selected years
(1000 tonnes)

| | Paper consumption | | Newsprint consumption | |
|---|---|---|---|---|
| Year | Projected | Actual | Projected | Actual |
| 1975 | | | 300 (NCAER) | 179 |
| 1975/76 | 1,028 (FAO)<br>1,039 (NCAER)<br>1,217 (MRCI) | 830 | | |
| 1980 | | | 500 (NCAER) | 336 |
| 1980/81 | 1,462 (NCAER)<br>1,217 (MRCI) | 1,171 | | |
| 1983/84 | 1,860 (TF)<br>1,662 (DC) | 1,178 | | |
| 1985 (est.) | | | 500 (PC) | 385 |

Abbreviations: NCAER - National Council of Applied Economic Research
MRCI - Market Research Corporation of India
TF - Task Force for Pulp, Paper and Allied Industries
DC - Development Council for Pulp, Paper and Allied Industries
PC - Planning Commission

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

The consistent overestimates would appear to be the consequence of assuming a continuous growth rate of per capita income and of literacy levels; neither has been realized. Nor does the negative influence of increasing paper prices on demand seem to have been taken into account. Finally, the introduction and spread of telecommunication systems appears to be the cause

of stagnating demand for certain types of paper by private enterprise and by Government institutions.

The most recent demand projection for the 1980-2000 period assume the following compound growth rates for paper and newsprint: 5.2 per cent for cultural paper (bookprint, writing paper, etc.), 5.4 per cent for industrial paper (board, insultation paper, etc.), 4 per cent for newsprint. Total demand by 2000 is expected to be 1.8 million tonnes for cultural paper, 1.25 million tonnes for industrial paper and 545,000 tonnes for newsprint.

## 2.2 Domestic production

India is now largely self-sufficient in the production of paper and paper board, imports being restricted to several special types of paper (see Section 2.3). The growth of paper and paper board production is shown in Table 9.

The domestic production of newsprint has in recent years led to a significant drop in newsprint imports, as Table 10 shows:

Table 9. Paper and paper board production: capacity and output targets and achievements, 1950-1980
(1000 tonnes)

| Plan period | Capacity | | Output | |
|---|---|---|---|---|
| | Target | Achievement | Target | Achievement |
| I Plan (1950-55) | 214 | 214 | 203 | 190 |
| II Plan (1956-61) | 457 | 430 | 356 | 350 |
| III Plan (1961-66) | 833 | 669 | 711 | 558 |
| Annual Plans (1967-69) | 750 | 730 | 635 | 658 |
| IV Plan (1967-74) | - | 992 | 850 | 825 |
| V Plan (1975-80) | 1,300 | 1,538 | 1,050 | 1,112 |

Source: Y.R. Rao, The paper industry in India - a survey of its development and status.

Assuming a realistic capacity utilization of 80 per cent, capacity requirements will be 680,000 tonnes by the year 2000, indicating that additional capacity to the extent of 415,000 tonnes will have to be set up in order to achieve self-sufficiency.

## 2.3. Imports and exports

In the early 1950's, paper imports supplied as much as 40 per cent of total consumption. As mentioned above, imports, reduced to only a fraction of domestic demand, are now limited to certain special products. The demand for these has been considered too limited to warrant domestic production, although recently some small units producing special paper products have become operational.

Table 10. Newsprint requirements, production and imports, 1979/80 - 1984/85 (tonnes)

| Year | Total requirements | Domestic | Imports |
|---|---|---|---|
| 1979-80 | 336,000 | 45,000 | 291,000 |
| 1980-81 | 370,000 | 50,000 | 320,000 |
| 1981-82 | 360,000 | 60,000 | 300,000 |
| 1982-83 | 360,000 | 150,000 | 210,000 |
| 1983-84 | 350,000 | 170,000 | 180,000 |
| 1984-85 | 385,000 | 200,000 | 185,000 |

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

The main varieties of paper and paperboard which are being imported are art paper, cheque paper, photobase paper, high strength kraft paper, special wrapping paper, filter paper, cable and condenser paper, tissue paper and special boards like electrical insulation and press board. The total quantity of paper and paperboard imported was to 16,000 to 25,000 t.p.a. during the 1970's. The new special product units, all of which (will) produce electrical insulation paper and board, are expected to reduce imports to about 10,000 tonnes.

Domestic suppliers were unable to meet the demand for writing paper and certain types of book print during the late 1970's and early 1980's. This led to a temporary duty-free import scheme for these products, handled by the State Trading Corporation; actual distribution was entrusted to HPC. The amounts imported were 66,000 tonnes in 1979/80, 60,000 tonnes in 1980/81 and 43,000 tonnes in 1981/82. The scheme was then discontinued, as domestic producers were once more able to supply the amounts required.

Table 10, above, indicates the magnitude of newsprint imports, still the most important category of paper imports. These imports are mainly supplied by Canada, the USSR and the Scandinavian countries. Imports from the region alo play a certain role: Bangladesh has provided up to 4 per cent of total Indian imports in recent years.

Exports of Indian paper are very limited: at present, total exports of paper and paperboard are only of the order of 2000 to 3000 tonnes, mostly to neighbouring countries. The export of writing and printing paper was banned till 1982-83, and thereafter, a ceiling of 10,000 tonnes was imposed on exports. This quota has not been fully utilized. Considering the domestic demand, the shortage of raw materials and the production costs which the domestic industry has to contend with, the potential for export growth is likely to remain very limited.

## 3. RAW MATERIALS

### 3.1. Forest raw materials

Natural forests cover a surface of about 72 million hectare (1980), or almost 22 per cent of the total land surface of India. The National Forest Policy aims at keeping 33 per cent under forest. Not only is the actual surface far less, but natural forests are rapidly being depleted: remote sensing surveys have indicated a reduction of the aggregate forest area by 16 per cent between 1972/75 and 1980/82. Table 11 gives a breakdown of the various natural forest categories.

There is still some potential for new projects using forest raw materials in the following regions:

(a) The Himalayas

The State Government of Himachal Pradesh has proposed setting up a kraft paper/corrugated box unit which would produce fruit packaging material substituting wooden boxes. The serious depletion of natural forests in the State demands that ecological considerations will have to play a major role in the planning process for this project. Coniferous forests in Sikkim have been considered as raw material suppliers for another project, but the type of tree which constitutes these forests does not appear to be suited. Moreover, there are serious infrastructural constraints in the area.

(b) The Northeastern Region

Forest raw materials are still relatively abundant in the Northeast. A pre-investment study has established that bamboo reserves are large enough to supply a 500 t.p.d. pulp mill in Tripura State. Several studies were made in other States, but very little progress seems to have been made with these projects. The remoteness of the area, the forest ownership question (here, forests are owned by villages rather than the State) and the lack of qualified personnel inhibit the development of the paper industry.

(c) Madhya Pradesh

Bastar District in the State of Madhya Pradesh possesses extensive bamboo/forest reserves. A 200 t.p.d. writing and printing paper mill, with additional 130 t.p.d. market pulp capacity was set up with UNDP/FAO assistance during the late 1970's. It has been estimated that the area could support an additional writing and printing paper mill (50,000-100,000 t.p.a. capacity), a 50,000 t.p.a. newsprint mill or a 40,000 t.p.a. rayon grade pulp mill. In the long run, part of the natural forest could be replaced by eucalyptus plantations.

Although there has been great pressure to further exploit these forests, the effects on the population of the area, whose socio-cultural and economic life is based on the forests, have been considered too damaging. The Bastar District case points out the need to conceive paper mill projects on a total base, that is, taking account of social and environmental aspects of development.

Table 11. Natural forest vegetation, 1980
(1000 hectares)

| Vegetation category | Productive forest land | | | | | Unproductive forest land | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Managed | Unmanaged | | Total 1+2+3 | Per cent of total forests | Unproductive forest | Fallow forest | Open forest | Scrub forest | Total 5+6+7+8 | Per cent of total forests | Total forest 4+9 |
| | | Undistributed | Logged | | | | | | | | | |
| | 1 | 2 | 3 | 4 | | 5 | 6 | 7 | 8 | 9 | | |
| Broad leaved | 29,440 | 4,885 | 4,033 | 38,358 | 53.2 | 7,686 | 8,176 | 5,393 | 5,378 | 26,633 | 37.0 | 64,991 |
| Bamboo | 640 | 559 | 168 | 1367 | 1.9 | 73 | 657 | - | - | 730 | 1.0 | 2,097 |
| Coniferous | 2,477 | 547 | 123 | 3147 | 4.4 | 1,210 | 637 | - | - | 1,847 | 2.5 | 4,994 |
| | 32,557 | 5,991 | 4,324 | 42,872 | 59.5 | 8,969 | 9,470 | 5,393 | 5,378 | 29,210 | 40.5 | 72,082 |

Source: FAO data base 1981.

(d) Andamans

The Andaman and Nicobar islands possess extensive forest reserves, but little fresh water. The islands could therefore only serve as raw material suppliers to mainland industries. In the early 1980's, an FAO/UNDP feasibility study for a mill based on Andaman raw materials was carried out. It established a.o. that forest regeneration on the islands is too slow to allow exploitation on a major scale. Environment-related issues will have to be studied more closely before any decision can be reached on the utilization of Andaman hardwoods.

The Indian paper industry mainly uses bamboo and mixed tropical hardwoods extracted from natural forests. The requirements and availability of forest raw material for the paper, board and newsprint industry up to the year 2000, calculated by the Development Council for Paper, Pulp and Allied Industries, are shown in Tables 12 and 13. These projections are based on the assumption that 30 per cent of total paper requirements would be met from production based on agricultural residues and recycled fibres, and 70 per cent from production based on forest raw materials. The demand projections are

Table 12. Forest raw material for paper and paper board production - projections
(million tonnes)

| Year | Total requirement of paper and paper board | Requirement of forest raw material a/ | Availability | Shortfall |
|---|---|---|---|---|
| 1986 | 1.76 | 3.45 | 2.85 | 0.60 |
| 1991 | 2.24 | 4.40 | 2.85 | 1.55 |
| 1996 | 2.80 | 5.50 | 2.85 | 2.65 |
| 2000 | 3.40 | 6.70 | 2.85 | 3.85 |

a/ 70 per cent of the 2.8 tonne raw material requirement per tonne of paper.
Source: Development Council for Paper, Pulp and Allied Industries.

Table 13. Forest raw material requirements for newsprint production - projections
(million tonnes)

| Year | Total requirement of paper and paper board | Requirement of forest raw material a/ | Availability | Shortfall |
|---|---|---|---|---|
| 1986 | 0.48 | 0.67 | 0.36 | 0.31 |
| 1991 | 0.62 | 0.87 | 0.36 | 0.51 |
| 1996 | 0.80 | 1.12 | 0.36 | 0.76 |
| 2000 | 1.03 | 1.45 | 0.36 | 1.09 |

a/ 70 per cent of the 2.0 tonne raw material requirement per tonne of newsprint.

Source: Development Council for Paper, Pulp and Allied Industries.

slightly different from those under Section 2.1, but the order of magnitude is the same.

It is obvious that shortages of forest raw materials will become critical in the near future. To circumvent the hardwood supply problems, a higher percentage of bamboo (60-70 per cent) is now used in the production of paper and newprint. But bamboo supplies also have their limits: consumption in Andhra Pradesh, Bihar, Tamil Nadu and West Bengal now exceeds the yield from State forests, and the same is true for hardwood consumption in Andhra Pradesh, Haryana, Karnataka and Kerala. Further large-scale exploitation of productive natural forests is unadvisable for ecological reasons, and the remoteness of the few forest areas which could yet be exploited precludes exploitation on an economically regarding scale.

To meet the growing demand of the paper industry (as well as other wood-based industries), a more rational development and utilization of forest resources is urgently needed. Closer co-operation between Government and private enterprise is also needed: whereas much of the area under forests is under Government control, most of the manufacturing enterprises using forest resources are privately owned, and investment decisions have aften been taken while a sustained, sufficient supply of raw materials was not ensured. The technical knowledge of Government forestry agencies and the management expertise of entrepreneurs should be combined to achieve an improved supply of forest raw materials to the manufacturing sector.

The solution to the problem of raw material supply will largely depend on the expansion and improvement of plantations. Large-scale plantations serving the manufacturing industry, primarily of eucalyptus, have been established from the 1960's onwards. These efforts have only been partially successful in solving the raw material problem in the paper industry because:

- the distribution of plantations is not related to the location of paper mills;
- there is a large, conpeting demand for their products;
- the yield of plantations has frequently been below expectations because of fires, disease and insufficient maintenance;
- there is a lack of adequate data on plantation areas, species grown, and yields.

The planning and management of plantations, in short, are in need of improvement. It should also be realized that underpricing of forest raw materials, which takes place occasionally to attract new manufacturing investment in a State, has the consequence of generating inadequate funds for plantation management and hence contributes to the deterioration of plantations.

The establishment of industrial plantations should follow certain general principles:

- suitable land should be available in proximity to paper mills;
- the area reserved for plantations should be sufficiently large to cover raw material needs of expanding mills;

- climatic and soil factors should be evaluated;

- species chosen should be adapted to local soil and climate;

- the effects of monocultures and/or of the introduction of exotics on the local ecosystem must be taken into account;

- special attention must be paid to the financial aspects of plantation projects: the amounts of capital needed are large, and gestation periods are long.

There would appear to be a sufficient area of land where new plantations could be established. Assuming that 10 per cent of the input would be from recycled fibre, 37,800 tonnes of air-dry bamboo and 88,2000 tonnes of air-dry debarked wood would be needed for a 50,000 t.p.a. paper mill. The (unirrigated) plantation areas required for such a mill would be 7,500 hectares for bamboo and 32,000 hectares for wood. This gives a total land requirement of 1.6-2.0 million hectares for the paper industry.

As Table 11 has shown, a substantial part of forest land (39.5 million hectares, altogether) is either unmanaged or unproductive. With proper cultivation and management methods these could probably provide the amount of bamboo and wood needed, but the question remains whether these lands are always conveniently located for the paper industry. There is a large surface of barren and uncultivable land (7.2 per cent and 41.1 per cent of total Indian land surface, respectively, in 1980). Part of the plantations might be established there. It should be borne in mind, however, that presently unused cultivable land is to a large extent needed for future agricultural purposes (part of it, in fact, is fallow land) and that barren and uncultivable land may either be inaccessible or the soil too deteriorated to serve any purpose.

So far, the establishment and management of pulpwood plantation has largely been a Government affair. The involvement of the private sector has been growing, however. The constitution of the National Wastelands Development Board was a first step towards creating suitable legislative and administrative measures encouraging more extensive private sector involvement. At present, the following types of ownership/management exist:

Plantations raised by Government agencies:

Most of the existing plantations in India have been developed by the Forest Departments of the State Governments. Massive programmes of afforestation were taken up on degraded lands, marginal lands, etc., mainly to meet fuelwood requirements of the local population. A number of State Governments have set up Forest Development Corporations with the specific objective of promoting production forestry. In so far as development of plantations in existing forest areas is concerned, the main effort would perhaps have to come from these Corporations.

Plantations raised by joint venture companies:

In recent years there have been proposals to promote joint ventures with participation of the paper mills and the State Governments. In West Bengal, Titaghur Paper Mills and the Government of West Bengal have formed a joint venture company with the objective of raising pulpwood plantations on 24,000 hectares in non-reserved forests and non-protected forests. In terms of the agreement between Titaghur Paper Mills and the State Government, the

land would be given on lease for raising pulpwood plantations, which would be created at the cost of the paper mill. When the plantations mature, the joint venture company and Titaghur Paper Mills would share the value of the wood. A joint venture company for raising pulpwood plantations over an area of 25,000 hectares has also been created by the National Newsprint and Paper Mills, Nepanagar, and the Forest Development Corporation of Madhya Pradesh State.

Plantations raised under farm forestry schemes:

Some paper mills have resorted to farm forestry schemes to supplement their raw materials. Sree Rayalaseema Paper Mills (SRPM), Andhra Pradesh, with an installed capacity of 42,000 tonnes, from the outset had difficulties in procuring its requirements of wood from the State Forest Development Corporation. Nor did the forest raw materials position permit any expansion of the mill. SRPM therefore decided to encourage extension forestry in private lands by providing incentives to farmers. The scheme devised by SPRM envisages raising plantations of fast growing pulpwood (Eucalyptus camaldulensis and Lucaena leucocephala) over 6,000 hectares of private land, cover a period of 12 years. A tripartite agreement has been entered into between SRPM, the farmers and a bank, under which the bank advances loans to the farms for raising the plantations and to cover his private consumption during that time. SRPM undertakes to buy the wood on maturity. The proceedings will be used to pay back the loans and interest to the bank and to cover the costs of seedlings and fertilizer provided to the farmers. The residual is paid to the farmers. The National Bank for Agriculture and Rural Development (NABARD) is the principal refinancing bank for this scheme.

Plantations raised by the paper mills:

The paper mills have urged the Central and State Governments to be allowed to establish their own plantations. The State Government of Karnataka has decided to entrust degraded forest lands to industries within the State for raising pulpwood plantations, on condition that the industries do so at their own cost and, at the time of harvesting, hand over to Government a part of the produce in lieu of land rent/Government royalty. An example of such an agreement is the long-term lease (in the first instance, a 40-year period has been agreed upon) of some 30,000 hectares to the Mysore Paper Mills.

## 3.2 Agricultural residues

The most important agricultural residues used in paper manufacturing are:
- cereal straw
- other non-wood crops fibres (jute, kenaf, cotton linter)
- grasses
- bagasse

Cereal straw

The by-products of the staple crops rice and wheat are at present mainly used as cattle fodder and for thatching. The yield of rice and wheat straw has been as follows:

Table 14. Cereal straw yields (million tonnes)

| | 1979/80 | 1980/81 | 1981/82 |
|---|---|---|---|
| Rice | 28.3 | 35.9 | 35.9 |
| Wheat | 39.7 | 45.3 | 47.2 |

Source: Based on studies by Punjab Agricultural University.

Note: The grain/straw ratio has been taken as 1:0.67 for rice and 1:1.25 for wheat.

On the basis of a Planning Commission's estimate of an annual 4-5 per cent growth rate in the production of principal food grains, 113.8 million tonnes of wheat straw and 86.4 million tonnes of rice straw could be available by the year 2000. It has been calculated that 25 per cent of straw, or some 50 million tonnes, would be available for manufacturing paper and board. This would be adequate to sustain a paper making capacity of 1.5 to 2 million tonnes around the turn of the century.

Two factors which are likely to reduce the actually available amount of straw are the spread of high-yield cereal varieties with short stems (and hence an unfavourable grain/straw ratio) and crop failures. An expansion of alternative uses of straw may also reduce the available quantities.

Straw being a bulky material, concentrating a sufficient supply near a mill may be costly. Small mills are therefore the most suitable straw-based paper producers. The production of rice and straw being distributed reasonably evenly over the country, it is possible to disperse mills and thus to contribute to a wider diffusion of industrial development. The mills tend to be concentrated in the densely populated major cereal producing areas (e.g. the Ganges valley, Gujarat); in some cases, overconcentration of mills has led to competition for raw materials among mills, pushing up prices and leaving some mills short of inputs.

The soda process, generally used for treating straw, gives a yield of about 35 per cent. The resultant pulp is a short-fibre, low-strength pulp. It has to be mixed with approximately 25 per cent long fibre pulp to produce an acceptable paper quality. At present, waste paper and domestic wood pulp are utilized for this purpose. The abolishment of customs duty on imported wood pulp would enable small mills to use this raw material source as well.

Other non-wood crops

Kenaf (Hibiscus cannabinus, Hibiscus sabdariffa) has generally been grown as a crop fibre for the manufacture of rope and twine. The bast fibre from the bark of this plant yields high quality pulp which can be utilised for the manufacture of paper. However, the bark constitutes only 20-25 per cent of the stem, and the rest of the stalk, consisting of very short fibres, is generally discarded. If the whole plant is used, the quality of pulp deteriorates. Research has pointed to the posibility of using the dissimilar components separately for the various paper-making purposes they serve best.

Kenaf is not yet used on a significant scale in India, but Ballarpur Industries Ltd. have promoted a joint venture at Bangpa-in, Thailand, based on kenaf cultivated in Northeast Thailand by small farmers. However, comparatively high costs of production and unfavourable market conditions have been reported. The Jute Technological Research Laboratories, Calcutta (JTRL) have carried out pulping experiments and developed several varieties of mechanical kenaf pulp suitable for newsprint. Pilot plant trials have been carried out in the Central Pulp and Paper Research Institute, Dehra Dun, and the results are encouraging. In the next phase, large scale trials are to be carried out. JTRL intends to make a complete technical-economic feasibility study on the use of the whole plant for newsprint production.

India being one of the largest producers of jute, there has been considerable interest in the use of jute as a raw material for the manufacture of paper. Jute sticks, for which there is little alternative use, could become an important input: even if only 20 per cent were collected, this would add up to 600,000 tonnes yearly. Research has been carried out by a.o. the Jute Technological Research Laboratories, Calcutta and the Cellulose and Paper Branch of the Forest Research Institute, Dehra Dun on the use of jute sticks for the manufacture of paper and newsprint. Jute sticks have also been used to manufacture cigarette paper.

The high cost of jute stick collection and transportation have so far inhibited its use on a significant scale. Further, jute sticks are available only on a seasonal basis (November to January) and are liable to rapid deterioration during storage. These factors preclude the utilization jute sticks as a major raw material for the manufacture of paper. Their potential, however, deserves greater attention.

Other non-wood crops, which are used on a modest scale, are cotton linter (utilized for special products such as filter paper, and to supplement other raw materials) and sun hemp (Grotalaria Juncea). The latter serves as green manure, fodder and raw material for cordage. Due to competition from synthetic fibres for cordage, the demand for sun hemp declined, but its utilization in the manufacture of a.o. cigarette tissue is on the increase.

Other crops which are of potential interest to the paper industry are Sesbania aculeata, a legume, which also serves as nitrogen-rich fertilizer and as cattle fodder. It is adaptable to a variety of growing conditions. Water hyacinth (Eichornia crassipes), a weed which grows in profusion in inland waterways and has to be removed to prevent clogging, has proved to be a good raw material, but as harvest and transport are very costly its use will presumably be restricted to small handmade paper mills.

Grasses

Although bamboo and reeds are strictly grasses, they are considered as forest raw materials in the paper industry. Other grasses which can be used for pulping are sabai grass (Eulalionsis binata) and elephant grass (Imperata cylindrica). Both are available in many regions in India and provide a reasonably good quality pulp. It is, however, difficult to obtain sufficient quantities as harvesting takes place by hand. Several mills use sabai grass and elephant grass to produce paper.

Bagasse

Bagasse, a by-product of the sugar industry, is the fibrous residue left after sugarcane is crushed for extraction of cane juice. Bagasse has become a major raw material for the manufacture of a wide variety of paper and paperboard.

India is the world's largest producer of sugarcane, but only 33 per cent of total production is processed in the large sugar mills, the suppliers of bagasse to the paper mills. The production of mill wet bagasse (moisture content about 50 per cent) is again approximately one-third of the sugarcane crushed, and the yield of paper from bagasse is about one-sixth. During the 1982/83 season, 26,45. thousand tonnes of wet bagasse were produced, which could theoretically yield some 4 million tonnes of paper. Almost the entire production of bagasse, however, has traditionally been used to fuel the sugar mills. As such, it is a readily available and cheap energy source for an industry with a strongly fluctuating (seasonal) production.

There is a supply of surplus bagasse which remains after the energy requirements of mills are fulfilled, and this surplus can be increased through improvement in processing and sugar mill operation. On the other hand, bagasse can be substituted by coal or fuel oil. Both methods have been employed to ensure a better supply of bagasse to paper mills. Sugar mills can increase the amount of surplus bagasse by:

- energy conservation methods (see also Section 4.2);
- partial drying of bagasse which is to be used as fuel;
- improved milling.

The exact amount of surplus bagasse gained in this way cannot be calculated with precision, much depending on the overall efficiency of the sugar mill in question. But is seems unlikely that surplus bagasse available for papermaking could be more than 10 per cent of the cane crushed. Taking an average sugar mill with a crushing capacity of 2,500 t.p.d., operating for a season of 150 days, the wet bagasse available on surplus basis would probably be 5 per cent of cane crushed, or 18,750 tonnes, equivalent to 8 t.p.d. of bagasse pulp. The use of surplus bagasse may therefore be confined to small paper mills of 30 to 50 t.p.d. capacity, which may have to procure supplies from more than one sugar mill.

Bagasse can only be acquired in large quantities if the entire bagasse production of one or more mills is replaced by another energy source. This would mean that the paper mill would undertake the responsibility of supplying steam and electric power to the sugar factory, which in return releases all its bagasse to the paper mill. Detailed investigations have been carried out in India on the subject, and the following conclusions have emerged:

- The only replacement fuel which can be considered at present is coal, as the cost of furnace oil is too high;

- The conversion of existing bagasse-fired boilers to coal-fired boilers would be too costly and time-consuming, and result in lowering of efficiency; it is therefore necessary to replace the bagasse-fired boilers of the sugar mill with new coal-fired boilers;

- The entire cost of replacing bagasse by coal would have to be borne by the paper mill.

Bagasse can be transported to the paper mills in a dried form (bales) or as wet loose bulk, the latter method being cheaper but more suited for short-distance transport. Where sugar and paper mills are located in close proximity, wet bagasse can be transported by conveyor belt.

As bagasse is a seasonal product, special storage facilties are needed at the paper mill. Wet bulk storage is cheapest and simplest, and is another argument in favour of location close to the sugar mills.

Pulping of bagasse is easy and yields are high, the lignin content of the raw material being low. Both chemical and semi-chemical processes are used. For newsprint production, wood pulp can be added. The recovery of chemicals from the black liquor residue left after pulping used to present problems, due to the short fibre length which gives the pulp poor drainage characteristics, the high silica content which causes scaling problems in the evaporator tubes, and the high viscosity of the black liquor. The problems, however, can now be considered overcome.

Until recently, only one bagasse-based mill existed in India. The excise duty exemption for mills utilizing 75 per cent bagasse in the furnish has encouraged a number of other small paper mills which were previously using cereal straws to switch over to bagasse. The demand for bagasse by a proliferation of very small paper mills has now led to a situation where larger mills which depend on surplus bagasse may face great difficulty in procuring their requirements of bagasse at a reasonable price.

The first large mill in India based on substitution of bagasse is the Tamil Nadu Newsprint and Papers Ltd. (TNPL), a State Government enterprise, with a capacity of 50,000 t.p.a. of newsprint and 40,000 t.p.a. of writing and printing papers. Bagasse for the mill will be secured from six sugar mills located in Tamil Nadu. TNPL will be supplied with bagasse in exchange for steam to be supplied by TNPL. The bagasse will be supplemented by eucalyptus wood pulp.

Recently, Mysore Paper Mills, Bhadravati, an existing paper mill of 37,000 t.p.a. capacity, based on forest raw materials, has set up a sugar mill with a 2,500 t.p.a. crushing capacity. All bagasse from the sugar mill is to be used to produce chemical pulp for the paper mill. The sugar mill's steam, power and water supply are linked with the paper plant's, with consequent economy in steam and power consumption.

Further major bagasse-based projects under consideration are:

- A newsprint project of 50,000 t.p.a. capacity in Maharashtra. (The State Industrial Investment Corporation of Maharashtra).

- A paper/newsprint project of 80,000 t.p.a. capacity in Uttar Pradesh. (Hindustan Paper Corporation Ltd.).

- A paper/newsprint project of 80,000 t.p.a. capacity in Bihar. (Hindustan Paper Corporation Ltd.).

In view of the necessity to conserve forest resources, bagasse utilization has been supported by a package of Central Government policy measures since 1979. These include:

- Encouragement to clusters of sugar factories to set up paper and/or newsprint plants;

- Financial support to the various methods outlined above which reduce the demand for bagasse as a sugar mill energy source;

- Excise duty exemption on paper made with at least 75 per cent bagasse, for an initial period of three years, with possible extensions;

- Priority to the movement of coal to sugar factories by railway.

Whether these measures will actually secure a sufficient long-term supply of bagasse remains to be seen. Bagasse is attracting attention as an energy source for power generation outside sugar mills as well. As with other agricultural resources, therefore, competition for the raw material must be taken into account when a paper mill's raw material base is chosen.

### 3.3 Waste paper

Waste paper has always been one of the principal raw materials for the manufacture of paper in India, particularly by small paper mills. There are a number of very small paper mills, with 5-10 t.p.d. capacity, which exclusively use waste paper, procured from nearby metropolitan areas. Larger mills of 30-75 t.p.d. capacity use waste paper in admixture with agricultural residues. A wide range of products such as second grade writing paper and boards, particularly duplex board, are produced from waste paper.

As recycling of waste paper contributes to the reduction of environmental pollution and of energy consumption, it deserves to be taken up on a larger scale. It has been observed that the recycling of waste paper by the Indian paper industry is very low since a large quantity of waste paper is diverted for packaging and other uses. As a consequence, only 15 to 20 per cent of all paper produced in India is available for recycling. The Sub-Committee of the Development Council for Paper, Pulp and Allied Industries has suggested that a target of 30 per cent of total paper production would be feasible.

The usual sources of waste paper are domestic refuse (newspapers and magazines), office refuse, particularly Government sources (paper and files) and industrial refuse (cartons and packaging material). The waste paper recovery system offers considerable scope for improvement, by adoption of more rational and scientific methods of collection and grading. Domestic supply is supplemented by imports, but imports of waste paper should be organised more effectively, so as to secure lower freight costs and long-term availability at advantageous prices. It has been suggested that small paper mills, in particular, could pool their requirements and resort to bulk imports. In order to encourage utilisation of imported waste paper, the Government has granted complete exemption of customs duty for specified categories of waste paper. Adoption of better methods of waste paper processing in the mills, such as de-inking, is also encouraged.

## 4. ENVIRONMENTAL AND TECHNOLOGICAL ISSUES

### 4.1 The paper industry and the environment

The paper industry has a major inpact on the environment, both from the point of view of raw material consumption and of pollution. In order to prevent a degradation of the environment which will be detrimental to long-term development, management of environmental problems must be an integral part of paper mill management from the planning stage onwards. Standards for pollution control have been laid down at the national and State levels. These should be continuously monitored and re-assessed in the light of experience gained in the paper industry.

In the absence of a well-planned system of industrial plantations, paper mills have exploited natural forests on a large scale. As pointed out in Section 3.1, natural forests now only cover 22 per cent of the total land surface of India, which is far below the 33 per cent norm of the National Forest Policy. Without sufficient tree cover, widespread soil erosion is likely to take place, especially in hill and mountain regions, reducing the available cultivable surface and increasing the danger of floods, landslides, etc. With an improved and expanded programme for industrial plantations (see Section 3.1) the paper industry could help to prevent further damage to the country's ecosystem. In calculating the availability of agricultural residues for paper production, it should be realized that long-term soil productivity (and hence the long-term availability of these residues) to an extent depends on recycling them as natural fertilizer.

The pollution caused by the paper industry may be classified as follows:

- Air pollution by raw material particles, toxic gasses and odour during the pulping stage;
- air pollution caused by energy generation;
- Water pollution caused by discharge of process water containing residues;
- Soil pollution by solid wastes, particularly lime sludge.

Air pollution

No exact measurements are available on the extent of air pollution caused by paper mills, but digester house operations (liquor preparation, cooking, chemical recovery) involve a discharge of particles, mercaptans, hydrogen sulfide and sulphur and nitrogen oxide. An energy-intensive activity such as pulp drying involves emission of particles and sulphur compounds, and so does captive power generation. Air pollution can be controlled by the following types of equipment:

Cyclones: collectors in which the carrier gas follows a helical path, and the inertia of the particles carries them to the walls from which they drop to collect at the bottom. The clean gas is exhausted through the top. The cyclone collector is simple and reliable with low initial cost and easy maintenance.

Dynamic precipitators: in these the centrifugal force of the fan pushes dust particles to the tips of the blades from where they are drawn off in concentrated steam.

Electrostatic precipitators: very efficien collectors, which operate on the basis of electrostatic attraction, and can be used for dry particles or fumes, as well as mists.

Fume incinerators: utilised for the collection and oxidation of gases. Direct flame incineration is used when the waste materials can be burned when mixed with air. If the gas stream does not contain enough combustibles to support a flame, gas burners are used.

This equipment is not generally used in the Indian paper industry; practically no control systems exists for gaseous emissions, except for those which are part of power plant systems.

Water pollution

The manufacture of paper requires a large volume of water (300-425$m^3$/tonne). Most of the large integrated pulp and paper mills in India are therefore located near rivers which provide water and receive waste water. The process water discharged from paper mills contains bark, wood debris, fibres and lignin and their decomposition products; clays and other minerals, resins, phenolics, starches, unsaturated fatty terpenes, metal oxides and other suspended solids. The toxic pollutants have an adverse effect on fish, aquatic fauna and flora, and on human health. Suspended solids also affect aquatic life through anaerobic decomposition. Turbidity and colouring also reduce the quality of river water.

Pollution raises the Biological Oxygen Demand (BOD). This is the amount of oxygen required to biologically oxidize the water contaminants to harmless carbon dioxide, and is thus a measure of organic matter in water. Related to BOD, and often measured instead, is Chemical Oxygen Demand (COD) which is a measure of the amount of oxygen required to chemically oxidize the contaminants to carbon dioxide. Many substances used in paper manufacturing cannot be neutralized biologically, and therefore have to be oxidized chemically. COD is therefore higher than BOD. It is estimated that India's large paper mills discharge 1.11 x $10^6 m^3$ of waste water per day having 477, 186, and 790 tonnes of suspended solids, BOD and COD respectively, while the small paper mills discharge 0.3 x $10^6 m^3$ of waste water per day, with 469, 210 and 779 tonnes of suspended solids, BOD and COD respectively. Although the small paper mills have only 30 per cent of the total installed capacity, their pollution is almost equal to that of the large paper mills, because they lack chemical recovery systems and other waste water treatment facilities. Of the large mills, five reportedly meet the full set of required standards.

A combination of the following methods is commonly employed to control water pollution:

- Pretreatment: coarse solids are removed by screening. Excessive acid or alkaline content can also be neutralized at this stage;

- Primary treatment: suspended solids are removed from waste water by using settling basins;

- Secondary treatment: at this stage, dissolved organic matter is reduced by biological treatment. This may take place in oxidation ponds, aerated lagoons which use a mechanical device to increase the oxygen supply in the water or anaercbic lagoons which use methane bacteria. Micro-organisms are also used. These separate organic matter from water, after which the sludge can be removed.

Tertiary treatment, in which water is recycled through methods such as filtration, chemical oxidation, electrodialysis and reverse osmosis, is not generally employed in Indian paper mills. It is however an important method to reduce the intake of water, and it contributes to savings. Finally, properly treated waste water can be used for irrigation purposes.

Solid waste

About 4 per cent of the wood processed by paper mills remains in the form of dust, rejects and grits. In addition, about 550 kilogrammes of dry lime sludge remains after the production of a tonne of paper which is disposed of along with waste water or dumped on fallow land. The possibility of obtaining low-grade lime from lime sludge, or partial substitution of limestone in cement by lime sludge, deserves more attention. Similarly, the sludge residue left after clarification of paper machine effluent can be utilized for the manufacture of cheap grades of paper and board. Solid wood residuals and sludge from pulp mill effluent could be utilized as a manure or fuel. More research is required in these areas.

4.2 Research and development

The main issues in research and development in the paper industry are:

- Idenfication of non-conventional raw materials and their development;
- Development of process know-how for the utilization of various raw materials;
- Improving technology to optimize production and reduce costs;
- Development and up-dating of design engineering for pulp and paper machinery;
- Solutions to problems of effluent disposal.

Following a description of the institutional infrastructure for R and D in the Indian paper industry, a brief survey of selected R and D projects and issues is given.

Institutions

Before the mid-1970's, the only significant agencies involved in pulp and paper research were the Cellulose and Paper Branch, Forest Research Institute (FRI), Dehra Dun, and the Institute of Paper Technology (IPT), Saharanpur. The former was engaged in testing the pulping characteristics of wood, and carried out experiments up to the pilot plant stage. Laboratory equipment however was outdated and the pilot plant did not have adequate facilities. The Saharanpur institute did limited research on process technologies, but it could not fulfill its main task, training personnel for the paper industry, as it lacked pilot plant equipment.

In the context of a 1975 UNDP/FAO project, "Exploration and Identification of Alternative Raw Materials", the facilities of both FRI and IPT were upgraded.

UNDP financed the foreign exchange component of the expenditure which covered imported equipment, fees of foreign experts and fellowships to train

mill engineers, paper technicians and research institute staff. The Government of India counterpart expenditure covered the cost of domestic equipment, civil works and salaries of local staff. Two pilot plants (a thermo-mechanical pulping plant and a chemi-mechanical pulping plant) and sophisticated laboratory equipment were provided to the research institutes. The project prompted the Indian Government to set up a specialized, autonomous research institute for paper and pulp. This institute would combine the resources of FRI and IPT. Membership of the institute was to be open to all entities engaged, or interested in the manufacture of paper.

The management of the institute would be in the hands of a governing council with respresentatives of the various Government research agencies, with a president appointed by the Central Government. To provide financial support for R and D, a tax would be levied on the production of paper. The administration of funds and the approval and financial support of R and D projects would be undertaken by a committee of direction set up by the Ministry of Industry, and consisting of government and industry representatives and prominent scientists. Headquarters would be at Saharanpur.

The Central Pulp and Paper Research Institute (CPPRI) was established in 1980. Its objectives are:

- to promote research and scientific work connected with the pulp and paper industries;
- to establish and maintain laboratories, pilot plants and workshops for pulp and paper research and to conduct experiments;
- to publish periodicals on these activities;
- to encourage discoveries and acquire patent improvements;
- to assist research work of any society or institute connected with the pulp and paper industries.

CPPRI has the following sections:

- Chemical pulping and bleaching
- Pulp evaluation
- Paper and board testing
- Instrumental and chemical analysis
- Microscopy
- Chemical recovery
- Environmental pollution abatement
- Conservation of utilities
- Equipment design and standardisation
- Pilot plants and process analysis equipment
- Training
- Library and information
- Technical services

The following research areas have been given priority:
- improved utilization of indigenous resources;
- improved productivity;
- equipment standardization and design;
- optimization and conservation of utilities;
- manpower training;
- reduction of pollution;
- technical services.

Some of the research projects taken up on the basis of these priority areas are improved pulping of domestic raw materials, pulping of mixed agricultural residues and chemical recovery systems for small mills. Research has been programmed on, a.o., improved stock preparation, low-cost pollution control and energy conservation. CPPRI intends to expand its facilities with a composite paper and coating pilot plant and to improve its laboratory facilities.

Selected R and D projects and issues

Plantation research

The Eucalyptus Fungus Investigation Unit (EFIU), established under the Kerala Newsprint Project of the Hindustan Paper Corporation, has carried out highly useful research both in disease control and development of better yielding and more appropriate pulpwood species. Future research on plantations should include the following objectives:

- Establishing wood requirements of the (future) paper industry to formulate adequate plantation extension programmes;

- Surveying the availability of land for plantations, and estimating the investment requirements for new plantations;

- Formulating a sylvicultural research programme;

- Improving the network of research facilities.

Pulping

Given the shortage of raw materials, the development of high-yield pulping processes for indigenous fibre resources is extremely important. The Central Pulp and Paper Research Institute has carried out pilot plant trials for high yield pulping. The alkaline sulphite anthraquinone pulping process developed recently is also considered to have potential for application in India.

There is considerable interest in scaled-down or simpler methods of pulping for the smaller Indian paper mills. Sulphur-free pulping, which would permit considerable simplification of the heat and chemical recovery systems, now appears both economically and technically feasible for small units. Recently developed mechanical and chemi-mechanical pulping processes may also prove suitable for production of cultural papers. So far as non-wood raw materials are concerned, UNIDO has suggested that using hypochlorite in chest bleaching could simplify the bleaching sequence and replace expensive chlorine dioxide bleaching. The soda process has proved to be successful for cereal straws due to its simplicity, low cost and sulphur-free cooking. The siropulper process for non-wood furnishes, a further development of soda pulping, also deserves to be evaluated for utilization by small mills.

Chemical recovery

Chemical recovery plant equipment for paper mills with capacities below 50 t.p.d. is not available. Conventional chemical recovery from alkaline pulping liquors is not applicable to mills producing less than 30 t.p.d. pulp from agricultural residues. The main reasons are the high investment costs in relation to capacity and the shortage of skilled personnel needed to run sophisticated equipment.

As a result, expensive chemicals are discharged as waste and increase pollution. As the number of small paper mills based on agricultural residues is likely to increase substantially, these problems may become more serious.

A proposal has been made for UNIDO assistance to establish a pilot plant project in a typical Indian pulp/paper mill using non-wood fibres to demonstrate and evaluate different fibre and chemical recovery processes which, if successful, could be recommended to other pulp and paper mills.

Desilication of bamboo black liquor

The main raw material used for pulping in India and many other developing countries is bamboo, which contains an appreciable amount of silica. Most of the silica is dissolved during cooking and causes the following problems at subsequent stages of processing:

- Scale formation in evaporation tubes;
- Hard smelt deposit on furnace walls of recovery boilers;
- Slow settling rate of recaustisized white liquor;
- Unsuitability of lime sludge for lime mud reburning.

As a result, overall economic performance and recovery operations are affected. The more stringent environmental regulations which may be expected in the near future will also make it more difficult to dispose of lime sludge

A pilot plant project for black liquor desilication, utilising the carbonation process, is being undertaken at the Central Pulp Mill Ltd., Gujarat, with the assistance of UNIDO. The mill only uses bamboo and produces 120 tonnes of bamboo pulp per day. The carbonation process involves precipitation of silica from black liquor by passage of flue gas and subsequent selective separation of the liquor so that the desilicated black liquor can be burnt in a conventional recovery boiler system or a roaster-smelter system. The end product is a lime sludge with a low silica content from which lime can be extracted. The pilot plant will also be used to process black liquor from nearby mills using agricultural residues.

Fibre fractionation

Agricultural fibrous material and grass materials like bamboo contain varying percentages of long and short fibres. The fibre length distribution in bamboo is from 0.4 to 4.2 mm with an average fibre length of 2.4 mm. About 10 to 15 per cent of the bamboo fibres have a fibre length comparable with soft wood fibres.

Stock screening machines are now on the market which can separate long and short fibre fractions. Application of this technology to bamboo pulp could produce two different fibre fractions which, when separated, could help to produce high-tear packaging papers in developing countries. The long fibre fraction of bamboo pulp could act as a softwood fibre substitute.

A test of the new screening technology is now being undertaken with UNIDO assistance at the National Newsprint and Paper Mills, Nepanagar, Madhya Pradesh. The test data and technological know-how collected in the pilot plant will be made available to developing countries.

Energy conservation

The paper industry is an energy-intensive industry: it ranks next to the basic metals branch in energy consumption. The estimated total energy requirement of the paper industry, based on seventy percent capacity utilisation, was 2.39 million tonnes coal equivalent and 1356 kwh electricity in March 1982. The projected energy consumption of the paper industry by the year 2000 is estimated to be about 5.4 million tonnes of coal equivalent and 3186 million kwh of electric energy.

The Indian paper industry is dependent on external fuel sources for 70 per cent, which is very high as compared to mills in developed countries. Fuel costs are approximately 15 to 20 per cent of the total cost of production, partly as a consequence of the fact that expensive (fossil) energy resources are used to meet low-grade energy requirements (process heat). Energy requirements and the cost of energy therefore have a great influence on the viability of the industry. Although energy efficiency was found to be better in mills where purchased energy was costly, energy efficiency of typical Indian paper mills is much lower than in mills in the developed countries. Even a relatively modern mill in India consumes 70 per cent more heat energy and 7 per cent more electric energy to produce one tonne of paper than a typical Scandinavian mill. The overall operating efficiency of energy conversion systems (fuel to steam and power) is also very low in Indian mills, being only about 58 per cent as compared to 76 per cent for a typical Scandinavian mill. This is mainly due to technological obsolesence. Inter-mill comparison again shows a wide variation in energy consumption: the total purchased energy costs per tonne of paper varies from Rs. 343 to Rs. 1182.

There is scope for energy conservation in the following elements of the production process:

Steam generation

Heat energy requirements account for 85 per cent of the total energy requirement of a paper mill, and practically the entire purchased fuel is consumed in the boilers for generation of steam. Therefore, improvement of energy conservation efficiency of boilers deserves the highest priority. The present low efficiency levels are due to unsuitable grades of coal, inadequate coal handling and preparation systems, design limitations, lack of proper instrumentation, and poor maintenance. Better methods of coal handling and preparation, blending, improvement of combustion control systems and better heat recovery are some of the steps suggested for increasing efficiency of boilers, keeping in view the fact that replacement by new high-efficiency boilers would not be financially viable, due to the high capital costs, and long gestation period.

Co-generation

The paper industry is an industry which is well-suited to co-generation of power. Process temperatures are much lower than those occurring in steam generation, and the difference can be used to generate captive energy.

There are several obstacles to co-generation. First, most of the paper mills in India operate captive power generation in isolation from

the power supply through the grid. Variations in demand are therefore not absorbed smoothly. Second, the low conversion efficiencies of generation plants cause considerable energy losses. Third, although co-generation systems have been adopted by many mills they are not properly selected, designed and operated. To ensure improved co-generation, it would be necessary to generate steam at the highest possible pressure and temperature, extract steam at as low pressure as possible, and ensure parallel operation with the grid.

High-pressure boilers with better co-generation potential should be adopted more widely, but their cost may prove prohibitive for many plants.

Pulping and bleaching

In the average Indian mill, the digester house, in which the raw materials are cooked, consumes about 20 per cent of total mill heat energy requirements and 4 per cent of total power requirements. The net energy input of the digester house has been calculated at 1.42 million kcal/tonne of pulp as against 0.57 million kcal/tonne in a typical Swedish kraft mill.

The introduction of more energy-efficient digesters (continuous digesters) would be a solution were it not that the conversion would be very expensive and that suitable continuous digesters for the small mills are not generally available. Also, these digesters cannot very well handle the varied raw material furnish generally utilized in India.

The solution would appear to be an improvement of digesters through better operating conditions, improvements of insulation, installation of heat exchangers, condensate recovery, blow heat recovery systems, better instrumentation and control, proper scheduling of digester operations etc.

The washing and bleaching of pulp involves the handling of enormous quantities of liquid, calling for high capacity pumps and hydraulic systems, which consume about 15 per cent of the total power input of the mill. There is potential scope for energy conservation through improvements of the hydraulic systems and operational procedures of Indian paper mills.

Chemical recovery

As part of the chemical recovery process, energy is released which meets about 30 per cent of the energy requirements of the large mills. As has been indicated before, small mills do not yet possess chemical recovery systems, and thus, apart from chemicals, a considerable amount of energy is wasted.

The viability of energy conversion systems which are part of chemical recovery systems depends on the efficiency of the latter. Recovery boiler operations can be improved considerably with installation of efficient process control systems, control of input steams and optimization of boiler clearing systems. Most Indian paper mills have direct contact evaporators in which heat transfer is inefficient. New evaporation systems now being introduced are expected to improve the performance of evaporators.

Paper machines and stock preparation

Machine house operations (including stock preparation, when pulp is refined) can consume some 35 per cent of the total energy input of a large mill.

The specific energy consumption of paper machines varies with capacity and age. Most of the existing paper machines and associated equipment were designed at a time when there was no energy consciousness, and the machines have moreover deteriorated over the years. Reconditioning and renovation of paper machines is being considered for a number of mills and should not only take into account capacity increase but also reduction of energy consumption.

Stock preparation by itself consumes about 20 per cent of total power utilised in large integrated paper mills. Process modifications such as higher refining consistencies and use of more efficient refining systems are some of the areas which could reduce power consumption.

Other energy-conservation areas

Energy consumption can be further reduced by recycling water (see Section 4.1), thus lowering the energy requirements of pumping systems and reducing the heat waste in effluents. Wood, agricultural residues and sludge from effluent treatment plants can be used as fuel, reducing the demand for external energy sources. Improved conveyor systems, hydraulic systems, etc., and the introduction of systematic energy audits can also contribute to energy savings.

## 4.3 Equipment

The establishment of adequate capacity for paper production and the achievement of self-sufficiency have been assigned a high priority in the industrial development policy and plans of India. However, conventional technology based on abundant wood resources, and the scale accepted as economic for production in developed countries, are not immediately relevant to the needs and problems of countries in India.

The variety and often limited availability of raw materials, the specific role of the paper industry in overall development planning and the specific conditions of the country require that technology as well as size are adapted to domestic conditions.

Indigenous industry has developed to the extent that it can now undertake the manufacture and supply of almost the entire range of equipment for integrated pulp and paper mills including pulping plants, stock preparation equipment, paper machines, steam and power generation equipment and chemical recovery equipment. Only part of the finishing house equipment (slitter rewinders, cutters, etc.) has to be imported. The major manufacturers collaborate with reputed international suppliers, and have gained adequate experience in the design, fabrication, supply, erection and commissioning of pulp and paper mill equipment.

Although much of the plant and machinery can be produced domestically, there is a need for greater technical sophistication. Specific equipment types which need further development are smaller size continuous digestors, falling film evaporators, twin wire former paper machines, drum chippers and

quality control equipment for paper machines. There is also a need for energy saving devices. The development of indigenous capability for rebuilding and modernizing existing pulp and paper machinery, incorporating contemporary technology, also deserves attention.

Second-hand paper machinery

As mentioned in Section 1.2, the adoption of a strategy to achieve a rapid growth of small-mill capacity at low cost led to imports of second-hand machinery from the mid-1970's onwards. Import permits were made available for equipment up to 30 t.p.d. and a technical life of at least 10 years. Applicants were not to be affiliated to large industrial or commercial groups, and should preferably be located in peripheral areas. Production plans had to be submitted, and the (foreign exchange) cost of the plant had to be considerably lower than that of a domestically produced plant.

By 1980, 44 licenses had been issued, of which 15 had not resulted in the installation of new plans yet. By 1981, it was considered that enough additional capacity had been created and as moreover the domestic industry was now in a position to offer a wider range of equipment, the scheme was discontinued.

The use of second-hand paper machinery has aroused a great deal of controversy. The disadvantages may be summed up as follows:

- Use of outdated technology;
- Operational problems due to higher maintenance requirements and lack of spare parts;
- A tendency, in some cases, to effect false economies by opting for very old machines;
- Second hand equipment, designed for utilization of conventional soft-wood raw material in developed countries, may be unsuitable for local secondary raw materials;
- Problems arising out of mismatching of equipment.

The general poor performance of small paper mills has often been attributed to failure of the second-hand paper machinery. However, there are still arguments in favour of second-hand machinery:

- The fast-changing technologies in developed countries reduce the supply of appropriately-sized, relatively simple machinery which can be used in a developing country;
- The most modern machinery requires highly trained personnel which is in short supply, especially in the peripheral areas where many of the smaller mills are located;
- The capital requirements of sophisticated small machinery are often disproportionately high.

## 5. GOVERNMENT POLICIES AND THE PAPER INDUSTRY

The 1956 Industrial Policy Resolution, which was the basis of the Government's approach to industrialization, foresaw that the development of the paper industry would mainly be left to the private sector, with Government support for certain parts of the private industry.

The capital-intensive nature of the large mills, and the importance which the Indian Government attaches to the role of the paper industry in its import substitution policies have led to intensive involvement of both national and State Governments (see Section 1.3 for public sector mills). To encourage more private investment in the industry, the Government has provided several forms of support. Government involvement also takes the form of pricing and distribution policies, a consequence of shortfalls in supply and price differentials between domestic and imported paper. Both support and control measures will be described below.

### 5.1 Licensing and support measures

#### Licensing

Licensing of paper mills has been simplified over the years. As of 1985, no license is required for the manufacture of writing, printing and wrapping paper on the basis of agricultural residues, registration with the Ministry of Industry being sufficient. There are, however, restrictions for non-licensed mills with regard to location in urban areas, foreign exchange requirements and ownership (foreign companies and large industrial enterprises are not exempt from licensing). Also, a number of paper products have been reserved for the small-scale sector, defined as mills having less than Rs. 2 million in fixed assets.

#### Fiscal incentives

Apart from general fiscal concessions such as tax relief and incentives for enterprises locating in peripheral areas, a number of special concessions are available to the paper industry to make investment more attractive and profitable:

Excise duty relief

In response to serious difficulties caused by a.o. the rising cost of inputs, the basic excise duty on printing, writing and kraft paper was reduced in 1984/85. Table 15 gives an overview of the excise duty rates in recent years.

Mills using at least 50 per cent unconventional raw materials (i.e. raw materials other than bamboo, hard- and softwoods, reeds or rags) are eligible for even lower duties, and special rates are available for small mills in this category (see Table 16). The concessional rates do not apply to certain high-value specially papers (e.g. cigarette tissue, coated and greaseproof paper).

Complete excise duty exemption is available for paper containing not less than 75 per cent by weight of bagasse pulp. New intergrated pulp plants are entitled to a 50 per cent excise duty reduction over a period of five years, with a maximum equal to 30 per cent of the value of fixed assets. High-value special papers are exluded. Exemptions are

Table 15. Basic excise duty-rates, 1983/84 - 1985/86
(Rs./mt)

| | 1983/84 | 1984/85 | 1985/86 |
|---|---|---|---|
| | 10 per cent ad valorem plus: | 10 per cent ad valorem plus: | 10 per cent ad valorem plus: |
| Writing and printing paper | 1,430 | 1,005 | 1,205 |
| Kraft paper | 1,810 | 1,385 | 1,585 |

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

Table 16. Special excise duty rates - 1984/85
(Rs./mt)

| | Writing and printing paper | Kraft paper | Paper board |
|---|---|---|---|
| Basic excise duty[a/] (cf. Table 15) | 1,805 | 2,085 | 2,510 |
| Excise duty for mills[b/] using 50 per cent (or more) unconventional raw materials | 1,205 | 1,390 | 1,415 |
| Ditto for small mills, and production range: | | | |
| Up to 3,000 tonnes | 275 | 275 | 560 |
| 3,001 - 7,500 tonnes | 550 | 550 | 900 |
| 7,501 - 16,500 tonnes | 730 | 730 | 1,120 |
| 16,501 - 24,000 tonnes | 950 | 1,200 | 1,415 b/ |

a/ Including 10 per cent ad valorem duty, assuming the following ex-mill rates:
Writing and printing paper: Rs. 8,000/tonne
Kraft paper: Rs. 7,000/tonne
Paper board: Rs. 7,000/tonne

b/ 7 per cent ad valorem duty (based on rates under a/) plus surcharge.

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

also available for newsprint, hand-made paper, white printing paper supplied to the educational sector and several other types of paper and board.

Customs duty relief

The basic customs duty rates for paper and material for the paper industry as indicated in the 1962 Customs Act are 100 per cent for the final products, and for waste paper and board used as inputs, and 40 per cent for pulp and machinery. In recent years, however, almost all types of raw material have been exempted from customs duty; only certain types of waste paper are excluded from the assignment. The customs duty on paper making equipment has been reduced to 30 per cent. From 1981 onwards, customs duty was levied on imported newsprint. Initially, a 15 per cent tariff applied; this was changed to Rs. 825/tonne in 1982 and reduced to Rs. 550/tonne in 1984. Papers with a circulation up to 15,000 copies pay no customs duty. A reduced tariff is to newspapers with a circulation of 15,000 - 50,000.

Suggestions for further support

To ensure viability and a reasonable rate of return on investment in new and modernized mills, the following additional support measures have been suggested:

Infrastructural support

This would include adequate coal supply, improved rail transport and incentives for captive power generation.

Financial and fiscal support

Special financial and fiscal facilities should be made available for new mills and for renovation of mills. Existing excise duty concessions (see above) e.g. could be increased to a maximum of 40 per cent of fixed assets instead of 30 per cent and payments could be deferred. Low-interest long-term loans could be made available for new plants and for reservation purposes. Depreciation allowances could be raised. Prices for raw materials from Government forest reserves and plantations could be reduced.

Technological support

The present research programme (see Section 4.2) could be expanded. Development of appropriate technology should focus more strongly on handling and storage, pulping, desilication and chemical recovery systems for plants, using agricultural residues. In the interest of more rapid modernization and performance improvement, import regulations with regard to foreign equipment could be eased.

## 5.2. Pricing, production and distribution control

Paper being an essential commodity which has generally been in short supply in India, the Government has complemented its policies to expand domestic paper production by pricing, production and distribution controls. For several years, restrictions on paper consumption existed as well; these were, however, abandoned in 1981.

## Pricing control

### Newsprint

Although there is no formal statutory control of the price of newsprint, price fixing is subject to consultations with and approval by the Ministry of Industry. As both newsprint mills and newsprint distribution are Government-controlled, there exists a de facto control of sales prices.

Table 17 shows the trend in newsprint prices. NEPA was long the only producer of newsprint in the country. The price of its product has long been kept on a very low level, and revisions of the sales prices were only made after elaborate, time-consuming scrutiny of input costs. The mill thus incurred serious losses. In 1981, a different system of price calculation and fixing was introduced. The sales price was now calculated on the basis of parity with imported newsprint, taking account of the higher grammage of the domestic product[1/]. As long as this formula was applied, no Government approval was needed for price changes.

The frequent changes in the price of newsprint which were a consequence of this price fixing method led to complaints by the newspaper industry and a reintroduction of the system of consultations with the Government, while the import parity formula was retained.

With the commencement of commercial production by two new newsprint mills in 1982, the pricing policy underwent further change. The production costs of both the Mysore Paper Mills (MPM) and the Hindustan Newsprint Ltd (HNL) were higher than those of the existing NEPA mill. The reasons were cost overruns during the implementation stage, the adoption of chemical and chemi-mechanical pulping processes for unconventional raw materials (both less efficient and more expensive) and imports of pulp to conserve energy, the mills suffering from power shortages. The sales price of MPM and HNL newsprint was consequently fixed at an appreciably higher level (see Table 17). To an extent, the lower grammage justified the prices charged.

The pricing system of newsprint is a complicated issue. The import parity concept, although having the advantage of being more flexible and testing the competitiveness of the domestic industry by exposing it to price trends on international markets, has met with opposition. Low prices in the international market have had a depressing effect on the rise of the sales price of NEPA newsprint after the system was adopted. Had the old method of calculating production costs been retained, the price would have been higher. Price fluctuations for newsprint are also a disadvantage for newspaper publishers. Howeve, if one reverts to a price system based on production costs, care must be taken that reasonable efficiency norms are applied, and that costs are not inflated by overcapitalization and undue delays in project

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1/ An example:
Sales price of imported newsprint, April 1981: Rs. 4,780/tonne
Weight of imported newsprint: 51g/m$^2$
Weight of NEPA newsprint: 57g/m$^2$
Sales price of NEPA newsprint, April 1981: Rs. 4,780 x $\frac{51}{57}$
= Rs. 4,277/tonne

Table 17. Paper prices, Rs/tonne[a/]

| Year | Ex-mill selling prices | | | | | Imported newsprint |
|---|---|---|---|---|---|---|
| | | | Newsprint | | | |
| | Creamwove | White printing | NEPA 56g/m² | MPM 52g/m² | HNL 52g/m² | Ex-godown prices |
| 1977 | 4,000 | ... | 2,700 | - | - | ... |
| 1978 | 4,700 | ... | 2,700 | - | - | ... |
| 1979 | 5,300 | 3,000 | 3,200 | - | - | ... |
| 1980 | 5,310 | 3,500 | 3,682 | - | - | 4,488 |
| 1981 | 6,700 | 4,200 | 4,700 | - | - | 5,255 |
| 1982 | 6,600 | 4,200 | 5,200 | 7,200 | 7,000 | 6,030 |
| 1983 | 6,650 | 5,400 | 5,600 | 7,200 | 7,000 | 5,760 |
| 1984 | 7,500 | 6,400 | 6,000 | 8,000 | 8,000 | 6,630 |
| 1985 | 8,060 | ... | 6,000 | 8,000 | 8,000 | 6,540 b/ |

a/ Interim price changes occurred in a number of years. In these cases, the price prevailing over the longest period over the year has been selected.

b/ High-sea sales price plus customs duty.

Source: Y.A. Rao, The paper industry in India - a survey of its development and status.

Note: NEPA = National Newspaper Mills
MPM = Mysore Paper Mills
HNL = Hindustan Newsprint Ltd.

implementation. It should also be realized that the sales price must be sufficiently high to allow the accumulation of funds for replacement and expansion.

The disappointing financial performance of the domestic newsprint mills and the declining trend in international newsprint prices have led to the suggestion that a pooled price for newsprint could be established. By raising the sales price of cheap, imported newsprint, funds could be created to compensate domestic producers for the losses sustained by charging a price comparable to the import price for their product.

Other types of paper

Since the mid-1970's, only prices of white printing paper (which usually serve as a basis for establishing prices of other paper types) have been continuously subject to control. Attempts to improve the availability of paper by introducing stricter price controls under the 1979 Paper (Control) Order led to protests from the paper manufacturers and to production and supply disruptions. The price of white printing paper variety was then

revised upwards, and price controls on other types of paper were largely abolished.

The sharp increase in prices during recent years (cf. Table 17) is a result of a variety of factors, among them increasing input costs and insufficient supply. The trend was interrupted in 1982, when inports depressed sales prices. Prices charged by the producers of the standard paper varieties mentioned in Table 17 tend to be comparable. Small production batches of special varieties, however, show considerable price variations, and many paper manufacturers have increased their profits by changing their product mix to include more high-value paper types.

Production control

Explicit production control measures have never been applied to the newsprint industry, for the simple reason that newsprint mills are all Government-owned, and very few in number. Newsprint production can, therefore, be "internally" controlled.

In the paper and paper board industry the situation is more complicated. The declining production of paper for cultural purposes (especially white printing paper) during the early 1970's, when domestic supply diminished by almost 50 per cent, led to the introduction of production control in 1974.

Following discussions between representatives of the paper industry and Government, the industry accepted to take the following steps:

- To revert to the pattern of production of 1968-69, particularly in respect of commonly used writing and printing papers, in order to correct imbalances in the availability of cultural varieties of paper vis-a-vis industrial varieties of paper;

- To make available a quantity of 2,000,000 tonnes per year of white printing paper to meet educational needs;

- To supply white printing paper at a concessional rate of Rs. 2,750/tonne.

As the situation did not show much improvement, a Paper (Control of Production) Order was issued later during the year, stipulating a minimum monthly production share of 57 per cent for six varieties of cultural paper, mainly white printing and cream laid/wove paper. Mills with insufficient capacity for these varieties or producing less than 20 tonnes of paper and paperboard per day were exempted. White printing paper (the major category) was to be produced according to certain specifications.

The supply position rapidly improved, and by 1975 there was overproduction of certain varieties. Production control was then modified to include only white printing and cream laid/wove paper (30 and 15 per cent of production, respectively). Exemption henceforth included mills up to 25 t.p.d. capacity. By 1977, however, paper for cultural purposes was in short supply again, one of the reasons, according to the industry, being the low price of white printing paper (still Rs. 2,750/tonne), which was far below production costs.

The paper prices were raised, but otherwise the Government reacted by tightening production controls in 1978. The obligatory share of cultural paper in total production was raised to 53 per cent. Mills with less than 30 t.p.d. capacity, or predominantly utilizing unconventional raw materials, were exempted, as were mills commissioned after 1.1.1976 (for a period of five years). Mills facing serious financial problems could also be exempted. These regulations applied until 1983, when they were considerably relaxed at the demand of the paper industry. Compulsory production quotas for new units were phased to enable them to adjust production. Exemptions now apply to all mills with a capacity of up to 24,000 t.p.d., the percentage of white printing paper to be produced has been reduced, and account is taken of the technical problems a mill may face in producing white printing paper.

Evaluation of price and production controls

The application of statutory orders relating to production and price control has been very difficult. Despite modification of the Orders, and repeated revision of the price of white printing paper, production and price control has continued to be plagued by a variety of problems. Although the paper industry had agreed in 1974 to supply 200,000 tonnes of "concessional" paper yearly, the average supply of white printing paper has in practice been only a little over 100,000 tonnes. The paper mills had initially taken advantage of the possibility of setting off the supply of other varieties of paper against the production of white printing paper, and once this system was discontinued, the reluctance to produce white printing paper to the extent required became more marked. A number of factors have contributed to this situation:

Financial difficulties

Raw material problems, modernisation requirements, interest burdens, etc., have seriously undermined the profitability of many mills and increased their reluctance to supply white printing paper at low prices.

Price differential between controlled and free market varieties

There is a wide differential between the price of concessional white printing paper (Rs. 6,400/tonne ex-mill + 5 per cent excise duty = Rs. 6,720/tonne) and the equivalent market variety (Rs. 8,000/tonne ex-mill + Rs. 2,000/tonne excise duty + Rs. 1,000/- dealers' margin = Rs. 11,000/tonne). This leads to leakage of paper to the open market.

Price fixing problems

The revision of the price of white printing paper is a time-consuming procedure. Frequent revisions lead to a tendency on the part of the mills to accumulate backlogs and delay supplies so that they have the advantage of the higher price.

Variations in product mix and production conditions

Unlike e.g. cement factories, which produce a uniform product, the paper mills manufacture a large variety of paper and paper board. The equipment is different from mill to mill, and royalty rates for raw materials, power tariffs and local conditions also vary. A uniform production pattern therefore does not exist, and uniform price may be to the disadvantage of a number of mills.

In view of these problems, it has been suggested that the present Control Orders should be substituted by the levy of an "educational cess" on the production of paper and paper board. The proceeds of the cess could feed a special fund which can directly subsidize exercise books/text books. The advantages of such a scheme would be that mills are free to produce and sell the paper varieties which are best suited to their condition and that the burden of supplying cheap paper for educational purposes is spread more evenly over the industry.

Distribution of paper and newsprint

Newsprint

The Newsprint Control Order, 1962 promulgated under the Essential Commodities Act, regulates the acquisition, sale and consumption of newsprint, imported as well as indigenous. The Registrar of Newspapers for India (RNI) of the Ministry of Information and Broadcasting administers the provisions of the Order, and acts as the centralised distribution agency, which issues quarterly allocations to the newsprint consumers, in accordance with pre-determined quotas based on the Newsprint Allocation Policy announced for each year. The Newsprint Advisory Committee (NAC) oversees the implementation of the policy. An ad hoc sub-committee of the NAC has been constituted to advise the Government on the requirements, production and import of newsprint. This sub-committee includes representatives of the newspapers and of the Government bodies involved. Such newsprint imports as are considered necessary by the committee are channelled through the State Trading Corporation of India (STC).

Newspapers with an allocation of less than 300 tonnes have a choice between domestic and imported newsprint. For larger newspapers, allocation ratios for domestic and imported newsprint are established every year, depending on expected supply. As an example, the total 1984/85 newsprint requirement in this category was estimated at 385,000 tonnes, of which 200,000 tonnes were expected to be met from domestic sources. The allocation ratios making up a newspaper's entitlement were as follows:

21 per cent from Nepa Mills;
21 per cent from Mysore Paper Mills;
23 per cent from Hindustan Paper Mills Ltd.;
35 per cent from imports (at least 25 per cent of which would consist of STC buffer stocks).

Paper

White printing paper being in short supply (see above), and an essential input for Government, educational and general cultural publications, its distribution has long been subject to Government control. In accordance with the Paper (Production Control) Order, and taking account of estimated demand and production potential, paper mills are allocated a share of production every quarter. State Governments are notified of these allocations and are responsible for notifying (potential) users of white printing paper in the educational and cultural field. Allocations to producers and users are then made at the State level. The Hindustan Paper Corporation (HPC) allocates the producer shares. It is attempted to cover the requirements of each State by local production.

The size of the wholesale/retailer network and the many varieties of paper and paper products, together with the imbalance between supply and demand, create a situation where the distribution of the allocated quantities leaves much to be desired. Although a voluntary "Code of Conduct" has been adopted in 1974, the distribution system is far too complex to allow strict control. Raising prices of paper types after a brand name change (but without a quality improvement) and demanding illegal supplementary payments are not uncommon.To raise prices, artificial shortages are created as well, by witholding stocks (mills have reduced output for a similar effect).

There have also been difficulties over the allocation of scarce white printing paper between Government offices and printing presses on the one hand and the educational/cultural sector on the other. The Directorate General of Supply and Disposals (DGSD) used to negotiate supply quotas with the industries, after which individual mills were allocated a share in the tonnage to be supplied. Apart from white printing paper, DGSD also ordered special varieties, the production of which competed with the compulsory production of white printing paper. The price of the latter being fixed, there was considerable upward pressure on the price of the former. This resulted in permission to set off 80 per cent of the special paper varieties production against the white printing paper production share. The overall result was an increasing competition for scarce white printing paper with the educational sector, whose demand moreover was growing. In 1978, it was therefore decided to give strict priority to the demands of the educational sector; DGSD's requirements henceforth had to be covered through commercial channels.

The only solution to the distribution problems is to increase production and improve marketing networks. Several recent developments may contribute to improved distribution: HPC has developed a consumer-oriented distribution system which is expected to capture a major share of the market and thus to help stabilize it, and many of the small paper mills have resorted to direct sales to the consumers.

## APPENDIX 1: THE PAPER MAKING PROCESS

The manufacture of paper involves the following stages:

### 1. Pulping

After wood is debarked and cut into chips, the cellulose fibres in the raw material are separated from the non-cellulosic element, lignin, which binds the fibres together. This can be done mechanically, by grinding, or chemically under high temperature and pressure (digestion). A combination of these processes can also be used. The less lignin remains and the less damage is done to the cellulose fibres, the better the quality of pulp Good quality pulp is expensive because of the costly chemical procedure needed to remove lignin and because of the lower raw material/output ratio.

Through washing, dissolved lignin and chemicals are removed; screening then removes any remaining lumps of fibre. The pulp slurry which emerges from this process can be bleached (depending on the degree of whiteness desired in the end product) and is then concentrated for storage.

### 2. Stock preparation

Pulp is either provided by the paper mill's own pulp mill or bought from a supplier. In the latter case it generally arrives in dried form and has to go through a slushing step. The pulp slurry is diluted and undergoes a beating operation to open the cellulose fibres, which facilitates bonding and thus produces more tear-resistant paper. After refining which removes any remaining lumps, the different types of pulp and the admixtures required for the production of a specific type of paper are blended.

### 3. Paper milling

At the "wet end" of the paper machine, the head box ensures a continuous, uniform flow of stock which then passes over a wire mesh through which water is drained. The next step consists of pressing the pulp between felt cylinders which squeeze out the remaining water. At the "dry end" of the machine, the paper (which now has acquired sheet form) is dried by circulating it around steam-heated cyliners. The final stages are calendering, when the sheets are pressed between cylinders giving them a uniform thickness and surface finish, and slitting-rewinding, when paper produced by the machine is cut and rewound to produce manageable reels of paper.

### Manufacture of hand-made paper

The hand-made paper industry generally utilises vegetable textile fibre derived from rags, gunny bags, cotton linters and other waste material. The pulping is carried out by boiling with a mild solution of soda ash, followed by bleaching and washing. Sheets are formed by dipping moulds in the pulp suspension, and then draining the water, leaving a deposit of pulp on the wire. The sheets are pressed, and lifted by hand for drying. It is the action of lifting by hand which largely gives hand-made paper its special qualities. Particularly in India there is a strong ideological bias attached to this aspect, and attempts to mechanize the lifting and drying of hand-made paper sheets have been resisted.

Hand-made paper has a characteristic random fibre formation, high average strength and a carefully prepared surface. Because of the high cellulose content and the restricted chemical treatment, permanence and durability are very good, and hand-made paper is therefore used for special purposes (e.g. for legal documents and artistic work).

## APPENDIX 2: NOTE ON THE HISTORY OF PAPER MAKING IN INDIA

Paper was possibly invented in India independently from Egypt. There is archeological evidence that paper was used in India in the fourth century BC. The Indian hand-made paper industry can thus look back on a very long tradition. Modern paper making was introduced during the nineteenth century. The industry was firmly established through the construction of paper mills at Lucknow, Titaghur, Poona and Raniganj during the 1879-1889 period, and these mills are still in operation. The industry's natural resource base was considerably expanded when bamboo began to be utilized as a raw material in the early decades of the twentieth century. It also received considerable boosts from policies protecting the domestic market and from the need to rely on expanded domestic production during the two World Wars. By 1950, when India launched its first Five-Year Plan, there were 17 paper-making units with a capacity of 137,000 tonnes, mainly of common varieties of paper and paper board. The expansion of the industry in the course of the Five-Year Plans is described in Chapter 1.

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