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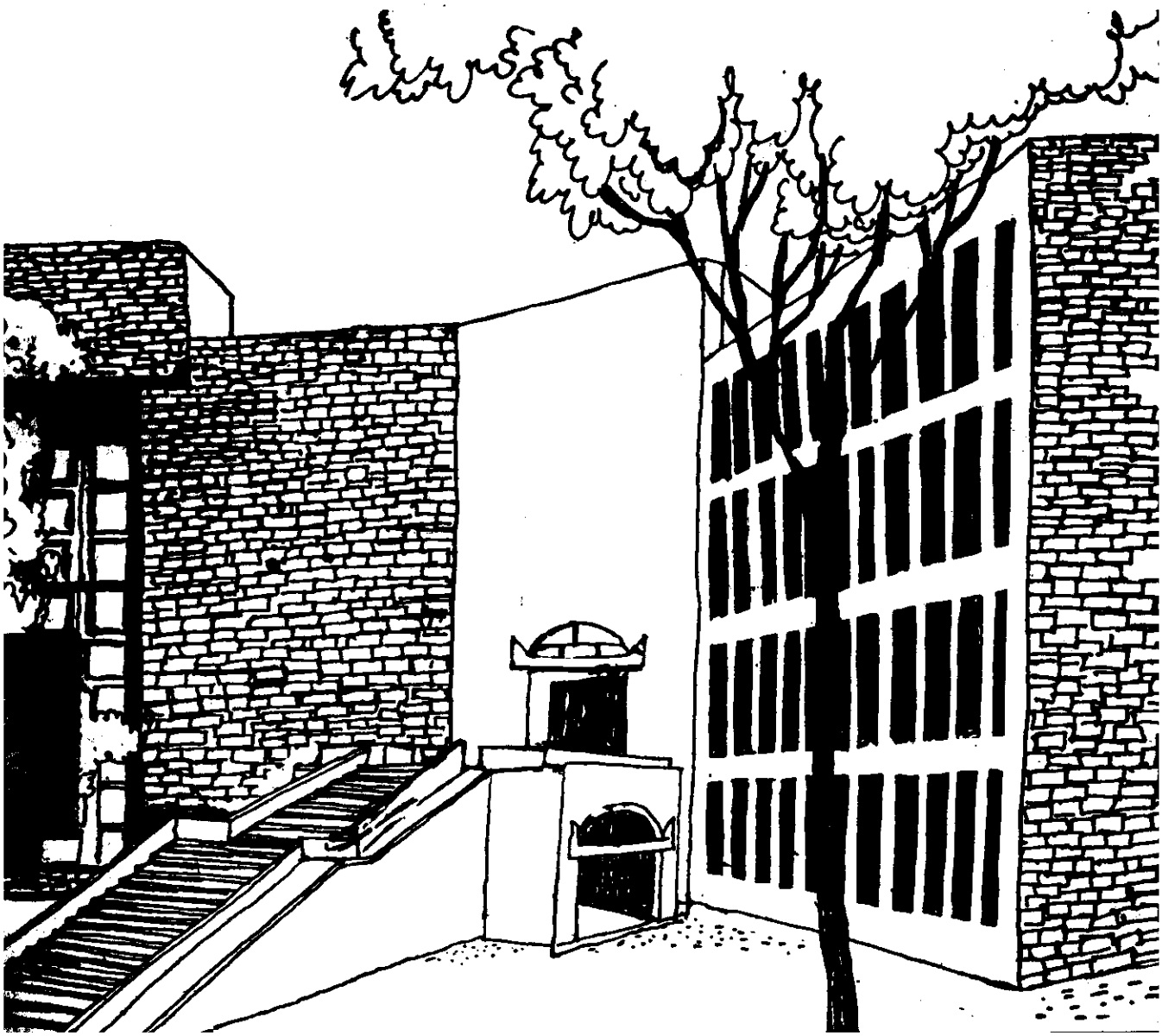

DEMAND-SUPPLY MANAGEMENT OF FOREST BASED CELLULOSIC RAW MATERIALS FOR THE PAPER INDUSTRY IN INDIA

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1. The Setting and Objectives

Nearly 23 per cent of India's total geographical area is classified as forests, but the forestry sector's contribution to the Gross Domestic Product has been less than two per cent. That has been attributed to a number of factors including under pricing of forest outputs used as raw materials by the manufacturing sector, rights and privileges of the local people, inefficient harvesting technology, poor stocking, and inadequate policy support.

At the same time, numerous policy statements have emphasized that forests in the country should meet the community's basic requirements (not necessarily demand) for fuelwood, industrial raw materials, amelioration of climate and maintenance of environmental quality, regulation of water flows, soil conservation, etc. It can even be argued that the long gestation period of most tree crops, the vast expanse of forests, and the synergy effects of the quality and extent of vegetation are some of the important reasons for state ownership and management of forest land.

This study deals with demand-supply management of forest based cellulosic raw materials for production of cultural and industrial papers in India. The focus is on bamboo and mixed woods which have been and continue to be the most important basic inputs for the industry.

The subject is of importance as annual production of paper and paperboards in the country has increased from just aout 0.1 million tonnes in 1950 to 1.5 million tonnes in 1985 and may increase further by 4.0 per cent a year by AD 2000, competing demands on forest produce in general and bamboo and hardwoods in particular have been rising while natural forest wealth has been dwindling, and there has been an unprecedented spurt of thoughts pertaining to conflicts between objectives of environmental quality and enhanced outputs of tangible goods.

For the supply of bamboo and mixed woods, the state governments and the pulp and paper manufacturing companies have been entering and continue to enter into formal and informal agreements. The agreements specify the royalty rates per tonne of bamboo and mixed woods, the extent of periodic revision in royalty rates, procedures for weighment of the materials, duration of supply of agreed quantities of the materials, etc.

A review of the agreements in three states of the Indian Union showed that the produce from natural forests has been treated as an almost free good and the revenues from royalties were construed as net surpluses. The state governments have also been offering numerous financial concessions and other facilities to the forest based industries with the presumptions that enhanced opportunities for gainful employment would keep the local people away from destructive practices vis-a-vis the forests, and the incremental revenues from a broadened tax base could be ploughed back to enhance the productivity of forest land [Sicom, 1970]. But these have rarely been valid or practiced.

Moreover, the agreements in the initial stages of development of the industry, were stipulated to be valid for 30-40 years, and their renewal for similar periods (not period) was provided for in some cases. The agreement periods were, however, reduced to around 20 years towards the middle of 1960s, and to 10 years in the late 1970s. Perceptions of absolute scarcity of forest produce appear to be the main reason for such changes, but these perceptions could have been avoided with the desired and deserved level/type of efforts at enhanced outputs per unit of forest land.

Similarly, at least some FDs in the 1930s commited themselves to lease out additional forest areas if those earmarked did not generate the required quantities or even the desired quality of bamboo. Though such commitments have not been made in the recent past, yet little attempts have been made to systematically assess and enhance the productive potentials of the leased and other forest areas.

There are significant differences in the methods and basis of weighing the produce: actual weighment at the factory gates, actual weighment in the forest depots, different running lengths per tonne of bamboo, different number of bamboos per tonne, and different volumes per tonne of bamboo and mixed woods. Even where bamboo is actually weighed, the bases of weights have varied: air dry weight with around 10 per cent moisture, sun dry weight requiring lapse of specified periods after harvesting, and weight with full moisture. There have been continuous battles of words on this issue.

One of the consequences has been non-availability of accurate data on outputs of scarce goods with multiple values. Another, and more serious consequence has been, an environment of mistrust and confusion whereby unconscious and/or conscious attempts have been made at evading the issues. This is evidenced by suggestions or arguments that

- Pulpwood growing forest areas should be leased for long periods on the lines of leases of bamboo growing areas [Mehta, 1981, p.56].

- Industry's requirements for pulpwood should not be compared with alternative uses as each tonne of the material used for paper manufacturing creates 7.7 mandays of work against nothing in case of its use as fuelwood, and for each tonne of paper the industry pays at least Rs.2,700 by way of excise duties and other taxes [Raina, 1982b, p.17].

- If the industry agrees to pay a fair price of cellulosic materials, management of pulpwood forests can be separated from timber growing activity [Seth, 1982b, p.91].

Without any comments on their validity or logic, these arguments could suffice to show the need for further studies to

i) assess the demand for and potential supply of forest based cellulosic raw materials for the paper and paperboards industry in India in the foreseeable future, say, by AD 2000

ii) assess the logic and feasibility of the various bases that have been suggested for pricing the cellulosic raw materials of forest origin, and

iii) objectively select a basis for a long term pricing policy of forest outputs used as raw materials by the pulp and paper industry.

This paper deals with the first of these aspects. The other two have been discussed in an accompanying study.

Newsprint industry has not been covered. It, of course, competes with writing and printing papers and paperboards for cellulosic raw materials. But demand for newsprint has been somewhat independent of or only indirectly related to the demand for paper; most of the total newsprint consumption in India is accounted for by those sections of the urban population which are relatively better off in terms of per capita incomes, educational levels, etc.; and the price elasticity of demand for newsprint has been low.

2. Paper Industry's Future Demand for Forest Outputs

An assessment of the industry's demand for and supply of forest based cellulosic materials has to be one of the basic considerations for evaluating the alternatives for enhancing their supplies. These, in turn, should serve as a basis for their long term pricing and, if necessary, demand management policies.

Demand for these goods would be derived from demand for paper and paperboards estimates of which by AD 2000 have varied from 3.25 million tonnes to 4.40 million tonnes. A review of the literature, however, showed that the demand for paper and paperboards in India over the last three and a half decades has been substantially overestimated [Gupta, 1986b]. Based on this review, qualititative observations on the markets for these goods, and discussions with knowledgeable people; it has been estimated that the demand in the foreseeable future may rise by 3.5 per cent a year. This means that without imports[1/] and without any attempts at demand management, the

1. Comparative advantages of importing paper and/or ready pulp have not been assessed as the policies favour enhanced indigenous production.

markets for paper and paperboards in the country should be in equilibrium with a gradual rise in production to 2.5 million tonnes by AD 2000. But, in view of the current installed capacity at 3.0 million tonnes, production capacity in the pipeline, recent policy interventions to encourage the consumption of paper and paperboards, and possibility of some exports; we chose to work with a growth in demand at the rate of 4.0 per cent a year. This entails a production of 2.7 million tonnes by the turn of the century [Gupta, 1986b].

Though this study focusses on bamboo and hardwoods, yet these alone need not, in fact would not, support the total production of paper and paperboards. A few general observations would, therefore, be in order.

1. Natural forests also generate pulpable grasses and reeds. One thought has been that these materials cannot gain importance because of their seasonal availability and low productivity per unit of land [Raina, 1982b, p.7]. The contrary should be true if i) there are acute shortages of pulpable materials, and ii) the forestry system gears up to augment their supplies through improved management practices including harvesting and baling. These could also reduce the costs per unit. Moreover, systematic cultivation of species such as sabai grass (Eulopsis binata) is a financially viable and complimentary measure to soil conservation in hilly areas. Such considerations could justify policy interventions to encourage the industry to use more of these materials.

A basic approach of the study, however, has been to err on the higher side of demand for bamboo and hardwoods. It has, therefore, been assumed that grasses and reeds may make only a marginal contribution to the total supply of cellulosic materials in India by the turn of this century.

2. Coniferous woods, commonly known as softwoods, are the most appropriate materials for pulping and form the mainstay of the industry in many countries. Estimates of forest land covered by softwood tree species in India range around 6 per cent of the total [Tiwari, ND, 1982, p.11]. These forests are confined to the high Himalayan region where a major portion may have to be conserved for protective and other reasons.

Moreover, harvesting and transportation costs of the exploitable portion are generally prohibitive for pulping, and the material has a much higher value as sawn timber. At the same time, manmade plantations of tropical pines in the plains have met with several constraints. Softwoods have, therefore, not been considered as a source of cellulosic materials.

3. Fiscal concessions have been extended to production of paper grade pulp with a minimum 50 per cent content of unconventional raw materials: straw, bagasse, jute and hemp waste, gunny bags; and a substantial number of small scale paper mills have also been based on these. But issues such as i) opportunity costs of these materials; and ii) problems of logistics including their handling, transportation, and storage have not been adequately studied.

Once again, in line with the philosophy to err on the positive side of demand for bamboo and hardwoods, it has been assumed that agricultural and agro-industrial residues may also not make a substantial contribution towards the total supply of cellulosic materials to the pulp and paper industry in India by AD 2000.

4. In spite of the facts that i) a substantial portion of used paper in India is reused for packaging, particularly in retail trade; and ii) with perhaps a single exception, the pulp making units cannot handle printed waste paper for want of deinking facilities; an estimated 20 per cent of the total production is currently recycled. The world average is around 40 per cent [DCPPI, 1983, p.71. The process offers some basic advantages: low energy consumption, negligible pollution costs. Printing presses, offices, educational institutions, are the main source of supply such that it can be gathered at low cost.

It has, thus, been estimated that at least 35 per cent of the total production of paper and paperboards in India can be available for recyclying. Since waste paper yields 0.75 per cent pulp, this source can support the production of at least o.70 million tonnes of paper and paperboards by the year AD 2000.

This discussion should suffice to show that of the total estimated production of paper and paperboards by the turn of the century, at least 1.0 million tonnes would be based on grasses, reeds, agricultural and agro-industrial residues, waste paper, etc., and bamboo and hardwoods would have to support a maximum of 1.7 million tonnes of the industry's outputs.

There is almost a unanimity of thought that the mix of bamboo and hardwoods in the total of these two materials would be 40:60 by the turn of the century. With the chemical pulp process, 2.5 and 2.7 tonnes of bamboo and hardwoods, respectively, are required per tonne of final outputs. This means that by the year AD 2000 the industry's demand for bamboo and mixed woods should be a maximum of 1.70 and 2.70 million tonnes, respectively. The input levels would be significantly lower with other pulping processes such as mechanical or chemo-mechanical, but these have not been considered in conformity with the stated desire to work with higher side of the demand for the conventional sources of cellulose.

3. Prospects of Enhanced Supplies of Bamboo and Mixed Woods

Available data show that over 45 million hectares of forests in India are being harnessed and another 16 million hectares have that potential. However, in spite of favourable natural factors for tree growth, the mean annual increment of forests in India has been estimated at 0.5 m^3 per hectare [2/] against 2.6 m^3 in Asia, 2.5 m^3 in Europe, 2.3 m^3 in USA, 1.9 m^3 in USSR, and 2.1 m^3 for the world. Similarly,the growing stock in India's forests is estimated at 25 m^3 per hectare against the world average of 200 m^3 per hectare [Tiwari (N.D), 1982, p.10]. Poor stocking of a substantial portion of the forest land and ruthless exploitation with inefficient technology are some of the main reasons for the low growth-low output situation. Estimates of potential productivity vary between 1.8 m^3 and 3.4 m^3 per hectare per year [Raina, 1982b, p.7].

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2. Based on a 40:60 ratio, this comprises 0.2m^3 timber and 0.3m^3 mixed woods per hectare.

The importance of harnessing the potential productivity has been recognized. A brief meditational exercise on the reasons for low productivity could suffice to show that, with modest but sustained efforts, at least 1.2 m^3 per hectare or two-thirds of the lowest of the estimated potential average output can be harnessed from 50 million hectares of India's forest land within 10-15 years. That would mean a total output of 60 million m^3 of timber and fuelwood.

Afforestation and reforestation of the currently unproductive but potentially productive forest land may necessitate the choice in favour of some fast growing tree species. As a result, the mix of output between timber and fuelwood may change from the current 40:60 to 35:65 or, safer still, to 33:67. In spite of this, both timber and fuelwood/pulpwood outputs can substantially increase: the latter from the current level at around 30 million m^3 to at least 40 million m^3 a year.

The estimated demand for mixed woods by the industry at 2.70 million tonnes or 2.17 million m^3 would be less than seven per cent of the technically and managerially feasible potential output. The picture would look substantially better with success of the programmes/projects aimed at afforesting revenue wastelands, low productivity community lands, rail and roadsides, canal banks, etc. Though the forestry system can absorb as much capital as may be available during the next 15-20 years, yet the ensuing discussion assumes that most of the measures to enhance productivity of the land resource need not necessarily be capital and technically trained manpower intensive. For ease of presentation, bamboo and hardwoods have been discussed separately.

3.1 Prospects for Enhanced Bamboo Production/Supply

Currently bamboo meets around 60 per cent of the requirements of cellulosic materials for the industry which consumes an estimated 1.7 million tonnes a year. Though its proportionate contribution has declined over time, yet it is the single most important source of cellulose. In view of the continual reduction in its proportion in the furnace and the estimated demand by the turn of the century at 1.7 million tonnes = the current consumption, a discussion on the prospects for enhanced bamboo output may not appear relevant to this study. On the contrary, an objective identification of the need for demand management necessitates an understanding of the technically, financially, and managerially feasible potential output of this good.

Besides earlier observations regarding the terms of lease of natural bamboo areas to the industry, a perusal of the widely varying estimates of i) natural bamboo growing areas, ii) yield per hectare, and iii) total annual output [Bachkheti, 1982, p.29; Biswas, 1982b, pp.134-136; Ghosh, 1980, p.7; Vermah and Pant, 1981, p.466] would suffice to show that the resource has not been adequately managed. We have, however, chosen to work with the generally accepted estimates of output at 3.0 million tonnes a year and the natural bamboo growing areas at 6.5 million hectares.

Currently around 1.3 million tonnes of bamboo should be available for all users other than the industry. The tension-ridden situation can be adequately eased if about 3.0 million tonnes can be available for the non-industrial uses. This calls for total annual output at

around 5.0 million tonnes. The required action may be grouped into three categories: i) better management of natural bamboo growing areas, ii) raising manmade plantations of bamboo, and iii) inducing individual land owners to cultivate bamboo to meet their requirements and also for the market.

3.1.1 Feasibility of Opening Additional Areas

A conservative estimate of potential annual output of bamoo in India has been around 5.0 million tonnes. Harnessing the whole of the current potential may, however, not be easy or even feasible. On the other hand, the potential can even be enhanced.

One thought has been that provision of approach roads and bridges to open unharvested but harvestable areas can enhance annual output by at least 0.75 million tonnes. Data to assess the harnessable potential from the financial, managerial, and environmental angles were not available. Two questions can still be raised and debated.

1. Should a natural resource be allowed to remain dormant for want of infrastructural facilities? The answer would depend on the relative costs and returns, but an assessment of the expected returns must also account for i) retardation in future growth due to congestion and decay, ii) deterioration in the productivity of comparatively accessible areas due to further enhancement in pressures, and iii) multiple benefits of infrastructural development. With these, the investment would most likely be viable.

2. Should the investment be made and managed by the forestry system or the user industry? Arguments for or against entrusting the task to any one of them can be made. The governments in their capacity

as owners of the forest land have, at least till the recent past, looked at it as a source of net revenues.[3/] On the other hand, at least in some cases, it has been accepted since long that the industry must invest in infrastructural development. To facilitate this, the royalty rates of bamboo harvested from relatively inaccessible areas have been significantly lower compared with the rates of the produce from accessible areas.

Data on the extent of industry's investments on such works have not been available. It has, however, been said that the observed yield of interior forest areas tied to the old leases is substantially lower than the potential, and the resources remain grossly underutilized because the lessees have contributed only marginally to their infrastructural development [Sowani, 1982a, p.39].

This thought is supported by at least one set of observations. A state government has considered it appropriate to do away with the distinction between accessible and inaccessible forest areas after supplying bamboo to a paper making company for over 30 years, but the latter have argued for continuation of the distinction. Their reasoning is that i) harvesting and extraction costs from the inaccessible areas are substantially higher, and/or ii) the investments made in opening the inaccessible areas have not been recovered. Data to assess the reasoning have not been available.

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3. The need for enhanced investments in forests appears to have been recognized. For instance, Andhra Pradesh Government has thought of a forest development fund. In Maharashtra, a forest development tax has been operative for over 4 years. But, impacts of such measures on management of the resources remain to be studied.

3.1.2 Improved Silvicultural and Biological Management

Besides inadequate infrastructure, appropriate silvicultural and biological management have also been wanting. Changes in the desired direction could consist of a number of steps.

1. A sizeable number of the knowledgeable and concerned people appeared to agree that i) bamboo should not continue to be classified as a minor forest product (MFP); and ii) silvicultural practices including determination of optimum harvesting cycles, and intensity and methods of harvesting different bamboo species in relation to the rest of the forest crops can be improved.

2. Measures consisting of gap filling, soil working, moisture conservation through trenching and mounding, use of chemical fertilizers, etc. appear to hold the key to improved resource management. Experiments on these lines in bamboo areas leased to a paper mills exhibited increase in new bamboo shoots by an average of 54 per cent, and considerable general improvement in the crop condition [Chugh, 1982, p.65]. Conservative assumptions that i) such steps can enhance yields of the denser bamboo areas by 30 per cent, and ii) 5.0 million hectares of such areas with current maximum average yield of 1.5 tonnes per hectare can be treated over a period of 4 years; lead to an estimated incremental out-turn of bamboo at 2.25 million tonnes within 8 years [Ibid, p.67].

The industry appears ready to undertake the task but would like the administrative arrangements, particularly with respect to royalty of additional outputs, to be finalized in advance. One state

government moved in this direction in 1983 but their scheme could hardly be characterised as practicable [Gupta, 1986a]. Efforts by an industrial unit in another state had improved the density of bamboo clumps per hectare and production per clump [Sowani, 1982b, p.57]. Replicability of such experiences with or without modifications must be systematically assessed. Alternatively, the FDs must undertake time-bound projects.

3. Genetic engineering can accelerate the growth rate and reduce the gestation cycle. Bamboo was crossed with sugarcane many years ago with the objective of producing an annual bamboo crop, but the work has not been carried further either by the Indian Agricultural Research Institute, research stations of the Indian Council of Agricultural Research, the Forest Research Institutes, or the paper industry [Swaminathan, 1982, p.17]. In general, very little research towards genetic improvements in bamboo has been carried out. The main reason has been low propensity to wait for the results which, in turn, could be attributed to the current environment and culture of the industrial, administrative, policy making, and the professional circles.

This discussion must suffice to say that bamboo output in India can be enhanced by at least 3.0 millions tonnes a year within the next 8-10 years by concentrated action to provide the necessary infrastructure, and improve the silvicultural and biological management. These steps are technically and financially feasible, and should obviate the need for conscious measures at demand management.

It should not, however, mean that i) technical, financial and managerial feasibilities of raising manmade plantations of bamboo; and ii) the prospects of encouraging individual farmers to raise the crop at least along the corners and bunds of cultivated fields need not be assessed.

Estimated yields from bamboo plantations vary between 7 and 15 tonnes per year with varying rotations and agro-climatic conditions [Vermah and Pant, 1981,p.467; DCPPI, 1983, p.16]. The activity should be financially viable in most situations. There is, however, considerable difference of opinion regarding managerial feasibility mainly due to biotic interference. Moreover, capital and trained manpower requirements per unit of land would be substantially higher compared with the measures for enhanced productivity of natural forests.

Financial, economic, and managerial feasibilities of private plantations of bamboo could be beyond doubt. The activity may also not occupy prime cultivated land. It has been estimatead that over 2.5 million hectares of land is available only along farm boundaries. Substantial benefits for the land owners as well as the economy can emerge even if 20 per cent of it is used for bamboo cultivation.

3.2 Prospects of Enhanced Production of Hardwoods

It has been noted that mixed woods can and would play a relatively more important role amongst the cellulosic materials in the forseeable future. This can be further facilitated through a number of measures to enhance production and supplies.

1. Hardwood resources are not evenly distributed. Mother pulp mills can be installed where the materials are in surplus and other natural inputs such as water are available. Similarly, marginal technological changes such as use of mini chippers can be induced to enhance the financial feasibility of using the smaller pieces of wood left behind in the forests. These steps would also enhance productivity per unit of forest land.

2. Waste in harvesting is estimated at over 40 per cent in the hills and 20 per cent in the plains [Thapar, 1982, p.25]. This can be substabtially reduced through improvements in the related technology and practices. In general, none of the felled materials should be left behind in forests unless required for silvicultural and biological reasons. Some unconventional steps may also be taken. For instance, destumping in the mixed forest areas clearfelled for manmade plantations should be a cost effective measure. One must, of course, think of environmental impacts. Discussions with knowledgeable people indicated that environmental considerations of monoculture would usually not vary without and with destumping the natural crops, and the latter could even enhance the growth of plantation crops. Similarly, effluent water discharged by industries may be usable to enhance biomass production per unit of tree lands.

3. A simple augur method of placing gypsum in pits for tree planting in saline and alkaline soils has reportedly been developed. This obviates the need to spread gypsum over the whole of such areas [Swaminathan, 1982, p.16]. This, if feasible, can substantially

reduce the costs and enhance the speed of covering the vast extent of wastelands in and outside the regular forest areas.

4. Eucalyptus wood is a prominent place as a pulpable material in many countries. It is a fast growing and high yielding species. Yield per hectare per annum with 10 year rotations could be as high as 30 tonnes [Anon, 1965, p.63]. Some eucalyptus species possess desirable properties for pulping: light coloured wood, low density, low percentage of extractines, etc. During the last two decades or so, large scale eucalyptus plantations have been raised in most parts of the country. Capital requirements of the crop are substantially lower compared with the broad leaved species. It may also not necessarily be raised as blocks of the single species as in the case of highly commercial plantations. Whole tree pulping should also not be necessary. In fact, use of a good portion of the main trunk as timber may be financially more viable and socially more acceptable.

5. Vertical integration of some of the wood production and processing functions should be managerially feasible and financially viable. A portion of the timber logs sold at forest depots could, for instance, be converted into finished consumer goods: doors, windows, furnitures, and fixtures. The FDs and FDCs have a distinct advantage in such activities. The consumers would also benefit especially in terms of assurance regarding the quality and the species of wood used [Maslekar, 1980, p.191]. The activity would, of course, have to be undertaken on a reasonably large scale to reduce overhead costs and generate a critical minimum quantity of the material for pulping from specified locations.

6. The term 'plantations' ned not be interpreted in the limited sense of placing nursery raised seedlings in manmade pits and/or on mounds. Considerations to cover the nakedness of land at a fast speed, and with minimal capital and trained manpower could show the importance of harnessing the established root stock. Hardy species such as Acacia arabica (Desi Babool), and Prosopis juliflora (Vilayati Babool) could be relatively more relevant for managing the wastelands in and outside of the regular forests. Natural growth of Vilayati Babool can be periodically thinned to encourage speedy growth into trees of one or two straight stems per plant. The weaned materials can be used as fuel. In general, tree species which occur naturally in most degraded areas, and/or can be raised by direct sowing, and possess good coppicing power, could result in highest biomass production per unit of land, capital, trained manpower, and time.

It would be of interest to note that i) Acacia Arabica is one of the hardwood species used by at least one integrated pulp and paper mill in the organized sector in conjunction with eucalyptus, and ii) young Prosopis juliflora wood has been assessed as one of the prime grade pulping materials [Misra, 1973 and 1978].

4. Summary and Some Policy Issues

A mixture of conventional and unconventional measures which can substantially enhance the outputs of timber, mixed woods, and bamboo within the next 8-10 years have been discussed. Most of the chosen measures need not be capital and trained manpower intensive. More importantly, contrary to the common thinking, the conflict between

fuelwood and pulpwood should be eliminated. It has been reasoned that without the wood would not have found a market even as fuel without and the enhanced industrial use, and the latter has not only enhanced its market price and societal value but has also encouraged plantations of short rotation tree species [GOI, 1972, p.16]. The current tensions amongst the foresters, the administrators, the industry, and the policy makers can be dispensed with; and there should be no need for any conscious efforts at demand management in the foreseeable future.

It can also be reasoned that meeting the industry's demand for woody materials through enhanced productivity of the forest land and other wastelands would be one of the most practicable and cost effective ways to manage and improve upon the quality of biophysical environment. But, if all concerned are not willing and able to face the challenges and cease the opportunities, some unconventional alternatives may have to be chosen.

One of the thoughts has been to raise plantations to meet the raw materials requirements of specific industrial units. Based on studies conducted by the NCA and the Forest Resources Survey of India, one estimate has been that 150,000 hectares of optimally stocked forest land can perpetually feed a 300 tonnes per day (say 100,000 tonnes per annum) capacity paper mill [Raina, 1982b, p.17]. This is a liberal estimate as it implies an average annual output of only 1.7 to 1.75 tonnes per hectare per year. But even this means that 2.4 million hectares or 3.0 per cent of the total forest area,

or 4.0 per cent of the currently managed and potentially manageable forest area can meet the paper industry's total demand for pulpwoods by the turn of the century.

Assuming a yield from industrial plantations at 10 m^3 or eight tonnes per year, another estimate of land required to feed paper mills with capacity at 400 tonnes per day or 130,000 tonnes per annum has been 70,000 hectares [Agarwala, 1982, p.46]. The arithmetic has not been understandable. With the output level at eight tonnes per hectare per year, the total area reuired to meet the paper and paperboards industry's demand for mixed wood by the turn of the century should be 0.55 million hectares or less than one per cent of the productive forest area in the country.

These differences in land requirements for industrial plantations should serve to emphasize at least three important but connected issues. First, the yield levels would vary amongst agro-climatic conditions and tree species chosen for the purpose and would, therefore, have to be worked out for individual paper mills. Second, manmade plantations need not be raised to feed all the existing and up coming pulp and paper making units. Third, as already discussed, all of the outputs from the industrial plantations need not, or even should not, be used for pulping. The manner in which timber and poles are marketed/processed would have definite bearing not only on land requirements for raising industrial plantations but also on pricing the materials used for pulping.

A somewhat different but important issue would be whether industrial plantations should be raised only on forest land. It has, for instance, been estimated that two rows of trees on both sides of one running km of a road or rail track would equal one hectare of plantations. The length of the country's road and rail tracks is over two millon km. If 25 to 30 per cent of the road and rail-road sides can be stocked with 3-4 rows of trees during the next 5 years or so, the industry's demand for wood by the turn of the century can be fully met from this source alone. Enhancement in quality of the biophysical environment would be an added benefit. There can be more of such examples to once again emphasize that enhanced demand for industrial raw materials can enhance the feasibility of speedier coverage of the wastelands.

Who should take up the activity? The pulp and paper industry has been keen to raise <u>captive</u> plantations. Their reasoning is that such plantations would provide a sustained and cost effective solution to the problem [Biswas, 1982a amd 1982b; Dhanuka, 1973]. The prevailing socio-political dynamics have not favoured this reasoning. The main issue relates to changes in land mangement (not ownership) policies. If, however, the forestry system and other developmental departments/agencies cannot come together to systematically formulate and implement feasible time-bound projects and programmes to raise the productivity of the land resource under their control and management, feasibilities of leasing a portion of the forest and other common property waste land to the industrial units to raise bamboo and tree crops must be examined with enhanced objectivity.

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