Scope And Economic Viability of Pulp Wood Plantations In India

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ABSTRACT

The development of paper industry depends on the availability of cellulosic raw material on sustained basis. The demand of the paper and paper board is increasing steadily with the increase in the population, literacy rate, and economic development, the cellulosic raw material from waste paper and Agro based bagasse is constrained due to their competing alternate uses. Under the prevailing conditions the use of hard wood as a raw material for paper making is a viable solution. Hard woods from the natural forests can not be thought off since the natural forests are in threat and needs to be protected from further exploitation. Hence, development of captive pulpwood plantation will be the most viable alternative source of cellulosic raw material for paper industry. The pulpwood plantations could be developed profitably with the use of improved genetic planting material matching to the site conditions with appropriate silvicultural package of practices. Experience and economics of MPM Captive pulpwood plantations are here under discussed.

CELLULOSIC RAW MATERIAL SCENARIO IN INDIA

During the early stages when the domestic paper and pulp production was small, Sabai grass (Eulaliopsis binata) provided the required raw material for paper production. As the paper industry developed, once abundantly available Bamboo in the natural forests formed the major source of raw material. Increase in the demand of bamboo for domestic consumption viz., cottage industry, small timber, etc., coupled with gregarious flowering, with poor regeneration made bamboo a scarce commodity. Hence, paper industries developed the technology by blending bamboo with hardwoods for paper and pulp production.

Bagasse, an agro-based raw material is also used in addition to other conventional raw material sources like Bamboo, sabai grass for paper & pulp production. The availability of bagasse fluctuates with economies of cane cultivation, sugar industry and also depends on the climatic conditions. Further, sugar industry uses bagasse as cheap substitute for coal for burning in the boilers. Hence, it can not be reliable source.

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The other option left with, is hardwood as a source of raw material. The increasing demand for fibrous raw material and the improvement in pulping technology led to the use of hardwood as basic reliable source of raw material for paper & pulp production. But, natural forests are always on threat and shrinking alarmingly, further exploitation of natural forests for pulpwood cannot be advocated. Under these circumstances, development of pulpwood plantations on degraded forest lands and other cultivable waste lands which are hitherto barren, nonproductive and uneconomical causing ecological concern is the positive line of approach both from industrial & national interest.

The per capita consumption of paper in India is meagre 3.2 kgs as against Asian average of 18 kgs. The projected demand of paper and pulp in India is estimated to be 3.4 million tonnes and that of news print 1.03 million tonnes by the turn of the century. The production, consumption & shortfall of newsprint and paper-board during 1996 and estimated requirement, availability & shortfall of Forest based raw material, assuming 65% of the Indian paper & pulp industries are forest based (Promod Jain 1997) is given below.

	Production	Consumption	Short fall	Forest R/M requirement	Availability	Shortfall
News print	365	714	349	928	360	568
P & W	1310	1285	25	2338		
Packaging P & B	1370	1375	5	2500	2850	2219
Other P & B	124	127	3	231		
Total	**3169**	**3501**	**332**	**5997**	**3210**	**2787**

Source : Paper makers 1997 and Development council for paper, pulp and allied industries. Report of Raw material committee (YA Rao, 1989) Figures converted into 1000's)

Note: . It is assumed that 2.8 ADT of Forest based raw material is required to manufacture 1 tonne of paper and 2.00 ADT of Forest based raw material for 1 tonne of Newsprint.

The gap between demand and supply is wide and continues to grow wider as the per capita paper consumption of paper increases. there is an urgent need to develop raw material reserves to narrow down the demand and supply gap. Forest based raw material is renewable, cost effective source with positive socio-ecological impact, is the most amenable solution to the crisis.

ROLE OF PULP WOOD PLANTATIONS IN THE PROSPERITY OF PAPER INDUSTRY

Raw material shortage is the major constraint in the growth and development of the paper industry. The development of the captive pulpwood plantation with desired species is essential for development of paper industry in India. The plantations provide the required pulpwood at reasonable cost on sustained basis. The development of captive plantations depends on the following factors.

LAND AVAILABILITY

Land is the most important factor for the establishment and development of pulpwood plantations. The land available should have all the characteristics which support the tree growth. The forest degraded lands once with abundance of vegetation; due to over exploitation and unscientific management parctices over a period of time, denuded the forests resulting in degraded lands. Such lands posses all the required characteristics for tree growth and are the best suited for plantation development. Similarly, there are large chunks of culturable waste lands which can readily support tree cropping and best suited for afforestation programme.

FINANCIAL ASSISTANCE

The second major factor after land availability is the finance for execution of plantation programme. Huge investment is required for the establishment and maintenance of pulpwood plantation. But, the forestry projects have a long gestation period to realise their investments and hence financial institutions are sceptic about the returns from pulpwood plantation.

CHOICE OF SPECIES

The success of the Captive plantation programme depends upon the right choice of species used for plantation development. The criteria for the choice of species depends on the following.

Suitability to Land

The chosen species should match to the land available for plantation development. Edapho-climatic factors viz., Soil, rainfall, and temperature play a major role in the tree growth and development. Early performance of a species should not be taken as a right criteria for selection of a species and it needs careful monitoring of the rate of growth till the rotation period. In MPM plantation sites, Acacia holosericea a drought hardy species showed better survival percentage and growth performance in the beginning but grew as a shrub and did not attain tree form at all. Eucalyptus grandis showed poor survival percentage and high mortlity. Another species, Pinus pinaster survived for first two years and completely dired up in the third year. Where as Acacia auriculiformis, pinus caribaea, Eucalyptus pellita and E. urophylla in high rainfall zone and E. camaldulensis in low rainfall zone are found to be well adapted to the wide range of edapho-climatic conditions within their respective rainfall zones. Hence, it is necessary to conduct extensive research in species and provenance trials before introducing high yielding indegenous and exotics for captive plantation development.

Productivity of Pulpwood Plantations

The productivity of the pulpwood plantations is another important and critical factor, because on this the investments and prosperity of the paper industry

	Species	Age in years	Volume (M^3)	MAI (M^3)
1.	Acacia auriculiformis local seed source	8	128.8	16.1
2.	Acacia auriculiformis Prov. Morehead R.	8	292.2	37.4
3.	Acacia auriculiformis Prov. auriculiformis	5	83.6	17.3
4.	Acacia auriculiformis Prov. Balamukh	6	132.6	24.1
5.	Acacia Hybrid clonal plot	4	130.4	32.6
6.	Eucalytus Hybrid	8	38.4	4.8
7.	E. camaldulensis Prov. Emu creek petford	8	72.0	9.0
8.	E. tereticornis	8	83.7	10.5
9.	E. pellita	5	152.4	31.4
10.	E. urophylla	5	113.0	23.5
11.	Pinus caribaea var. Hon. Honduran sources	12	164.4	13.7
12.	Pinus caribaea var. Hon. CSO 4H	9	311.8	34.6
13.	Pinus caribaea Var. Hon. CSS 13H	9	303.5	33.7

hangs delicately. The productivity of the plantation invariably affected due to the use of wrong choice of species, poor genetic planting material and Eucalyptus hybrid plantations showed lot of variation in stand growth affecting the productivity significantly where as E. Camaldulensis stand in dry zone and E. pellita stand in wet zone showed uniform stand growth. The pinhole damage to Acacia mangium and Acacia crassicarpa rendered the wood spongy and light in nature affecting the productivity and quality. Whereas Acacia auriculiformis and Acacia hybrid showed great resistance to borer damage on the same site. Use of disease resistence and genetically superior planting material ensures higher productivity of plantations. The productivity of genetically superior sources in comparison to local seed sources in MPM research plots is given below.

The productivity of the plantation also depends on the soil preparation, cultivation technique and optimum planting density. In MPM, Planting density (plants per Hactare) adopted for different species is as follows.

1. Eucalyptus camaldulensis	2500
2. Acacia Species	2300
3. Eucalyptus pellita/E. urophylla	2300
4. Acacia hybrid clones	1800
5. Pinus species	1800

After analysing the growth performance and

Lab cold soda pulping and pulp characteristics

Species	Caustic consumption %	Unbleached pulp yield %	Unbleached Pulp brigtness %	H_2O_2 consumption %	Bleached pulp brigthness %	Bleached Pulp phy. str. Burst factor	Bleached Pulp ppts. at 200 ml. CSF Breaking length (m)	Bleached Pulp ppts. at 200 ml. CSF Tear factor
E. cloeziana	9.6	84.6	44.8	1.50	63.9	10.2	1820	26.8
E. grandis	11.0	83.8	36.7	1.50	60.3	19.8	3760	39.0
E. hybrid	8.5	82.6	35.3	2.00	57.0	14.5	2830	28.1
A. fraxinifolious	10.6	80.4	45.7	1.50	60.1	25.8	5060	49.8
A. auriculiformis	9.6	85.3	40.5	1.25	57.0	18.8	4010	40.2
A. crassicarpa	8.6	80.1	31.5	3.00	57.5	12.2	2900	29.1
A. hybrid (5 years old)	8.1	85.1	39.8	1.50	55.4	18.5	3740	38.0

Lab kraft pulping and pulp characteristics

Species	Active Alkali (As Na_2O) %	Kappa No.	Yield %	Unbleached brightness %	Total Bleach Consumption %	Bleached brightness %	Bleached Pulp phy. str. Burst factor	Bleached Pulp ppts. at 300 ml. CSF Breaking length(m)	Bleached Pulp ppts. at 300 ml. CSF Tear factor
E. cloeziana	17	22	46	23	7	77	29	4900	68
E. grandis	15	23	47	27	7	80	51	7600	80
E. hybrid	15	23	46	25	7	78	43	6800	72
A. fraxinifolious	13	22	48	36	5	78	53	7620	62
A. auriculiformis	14	23	45	30	10	83	46	7250	61
A. crassicarpa	15	24	46	17	12	78	42	6450	61
P. caribaea	21	23	45	23	8	78	41	6000	84

growth trends of different species, the rotation period is fixed for maximum productivity. The rotation period for species of Acacia and Eucalyptus is fixed at 8 years and Pinus species is at 12 years. The growth trend and productivity of Acacia hybrid clonal plot is under study. If the growth trends of parent hybrid trees reflected in the clonal plots developed through vegetative means, the productivity of these plantations will be much higher. The analysis of pulping characteristics of Acacia hybrid at 4th & 5th year has showed pulping qualities comparable to the 8 year old Acacia auriculiformis. These results may pave for possible reduction in rotation period atleast by two years.

Pulping Characteristics of Pulpwood Species

The species chosen should suit the pulping technology of the paper industry. It should be economical for processing with less comsumption of chemical, high pulp yield with better fibre quality and strength properties. The pulping characteristics analysed in MPM (R&D) for different pulpwood species is given in the tables namely for lab. cold sods pulping and lab. kraft pulping.

The pulp characteristics analysed in MPM-R & D Laboratory indicates that the pulp properties of Acrocarpus fraxinifolious are good in both cold soda and kraft processes and the chemical consumption is less. Where as Acacia crassicarpa and Eucalyptus cloeziana has poor pulping properties and requires higher chemical dosage in pulping. Eucalyptus grandis and Acacia auriculiformis has good pulping properties with normal chemical requirements in both cold soda and kraft pulping process. Acacia auriculiformis gives 2-4% higher pulp yield, better runnability on machine and better strength properties when compared to Eucalyptus hybrid. Five year old Acacia hybrid samples showed better pulp properties with normal chemical requirements in cold soda pulping process. The kraft pulp properties of Pinus caribaea are good with better resistence though the chemical requirement is high.

ACHIEVEMENTS AND ECONOMIC VIABILITY OF MPM CAPTIVE PLANTATION

The Mysore Paper Mills Limited (MPM), Bhadravati was established in the year 1936. The present installed capacity after final expansion is to produce 30000 TPA of cultural paper and 75000 TPA of Newsprint. The basic raw material required for paper making is of two types.

(a) Long fibre & (b) Short fibre.

Bamboo and Pinus are the source of long fibre and Eucalyptus, Acacia and Casuarina are the source of short fibre. The total annual requirement of pulp wood is 182400 ADT (Air dried tonne) of short fibre and 57600 ADT of long fibre. The Karnataka govt. allocated 3000 Ha. of forest degraded lands and C & D lands for the development of captive pulpwood plantations by MPM to meet its increase demand of pulpwood on sustained basis.

The MPM forest wing took up captive plantation programme in two phases. For raising captive plantation during first phase MPM made a tie up arrangement with overseas development administration (ODA), London U.K. for financial and technical assistance. Pulpwood plantations over an extent of 17215 Ha. were developed during the period from 1981 at a total cost of Rs. 21.618 crores. The technical assistance was provided by Oxford Forestry Institute

Expected annual yield of pulpwood from plantations. (ADT)

Sl. No.	species	Extent	productivity MAI (M^3/Ha.)	total pulpwood productivity	Mean annual pulpwood yield
1.	E. hybrid	4584	4.8	114600	14325
2.	E. camaldu.	2571	9.0	118266	14783
3.	A. auri.	15573	16.0	1245840	155730
4.	Pinus spp.	6715	13.7	631210	52601
5.	Res. Plots	-	-	-	-
	Total	**30000**			**237439**

Note : The yield from research plots is not taken into consideration as some of the plots are to be conserved as gene conservation stands, seed stands and seedling seed orchards, clonal seed orchards and clonal multiplication areas.

and Institute of Hydrology, Wallingford, U.k.

During the second Phase, M/s Common wealth Development Corporation (CDC), London. U.K. provided the financial assistance to a tune of Rs. 55.5 crores for pulpwood plantation development and to an extent of 14742 Ha. of captive plantations developed from 1991 to 1996.

The MPM captive plantation sites identified and divided into two zones based on the MAR (mean annual rainfall). Areas with more than 1000 mm MAR is grouped under Zone A (wet zone) and areas with less than 1000 mm MAR are grouped under Zone B (Dry zone).

Careful planning is done as to how much area is to be under each species so that MPM could get the required forest raw material on sustained basis at reasonable cost. The species wise area envisaged and their expected productivity is given in the table below.

With the completion of development of pulpwood plantations over about 30000 ha. the hardwood (short fibre) and pine wood (long fibre) production from the above plantation will be sustainable at 184838 and 52601 ADT. respectively. MPM will be self sufficient in its forest raw material requirement once the harvest starts from combined Phase I and Phase II plantations. Species wise plantation development in Phase I and Phase II period is given in the table below.

Extraction of Phase I plantations of Acacia and Eucalyptus has commenced in the year 1991-92 on completion of 8 years. Annually about 1 lakh Tonnes

Summary of phase I Captive pulpwood plantations. (Ha)

Species	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
E. Hybrid	192.00	560.04	699.70	833.80	1277.00	1566.00	827.00	327.00	454.00	6736.54
E. Cam.	-	-	-	15.00	28.80	25.00	94.00	370.30	255.00	788.10
Acacia	32.80	373.16	478.88	1043.00	1143.00	1209.00	1363.00	629.00	1154.00	7425.84
Pinus	-	-	20.00	9.00	33.00	75.00	34.00	696.00	10.00	887.00
Casuarina	-	-	151.00	276.00	220.00	568.00	372.00	-	-	1387.00
Total	224.80	933.20	1349.58	1976.80	2701.80	3443.50	2690.00	2022.30	1873.00	17214.98

Summary of phase II Captive plantations. (Ha)

Species	1990	1991	1992	1993	1994	1995	1996	1997	Total
Acacia New	966.00	611.05	1071.55	1904.50	2142.50	1829.14	1544.00	895.50	10964.24
RPA	-	33.00	702.25	146.00	128.50	500.41	1033.00	569.30	3115.46
Total	960.00	644.05	177.80	2050.50	2271.00	2329.55	2577.00	1464.80	14079.70
Pine New	-	229.50	17.00	25.00	38.00	-	-	1.50	311.00
RPA	-	80.50	171.00	830.00	1173.00	993.5	554.25	384.50	4186.70
Total	-	310.00	188.00	855.00	1211.00	993.45	554.25	3896.00	4497.70
Eucalyptus									
New	848.00	802.00	474.00	295.00	222.00	120.00	250.60	414.50	3426.10
RPA	-	-	100.00	341.55	359.25	278.50	310.65	189.80	1578.75
Total	848.00	802.00	574.00	636.55	581.25	398.50	561.25	604.30	5005.35
Grand Total	1814.00	1756.05	2538.80	3541.55	4063.25	3721.50	3692.50	2455.10	23582.75

Cost Benefit analysis of MPM captive Plantation

Year of Pltn.	Extent (Ha)	Total Expedr. Rs. in lakh	Yr. of Harvest	Qty recd. (MT)	Cost per tonne Rs.	Value as per bal. Rs. in lakhs	Market value (Apprx.) Rs. in laksh	Benefit to MPM Rs. in lakh
1981	224.80	37.61						
1982	933.20	83.41						
1983	1349.58	95.17	91-92	91360	237	306.95	650.48	343.53
1984	1976.80	236.68	92-93	90165	262	294.49	723.12	428.63
1985	2701.80	251.68	93-94	125513	201	415.81	850.98	435.17
1986	3443.50	17.84	94-95	127999	248	1336.40	1407.99	71.59
1987	2690.00	312.50	95-96	133238	235	1411.31	1493.60	82.29
1988	2022.30	354.96	96-97	88644	400	867.27	1183.40	316.13
1989	1873.00	299.57	97-98	91987	326	445.00	1310.81	865.81
Total	**17214.98**	**1989.42**		**748906**	**5077.23**	**7620.38**	**25443.15**	

of debarked pulpwood is being obtained from the MPM captive source. The cost benefit analysis of MPM captive plantation shows that development of captive plantation is a profitable venture. The details are as follows.

The cost of the wood produced as worked out by the cost accountant with reference to the cost of production and pulp yield obtained during 1997-98 is Rs. 326.00 per ADT excluding extraction and transportation cost. Assuming an average cost of extraction and transportation at Rs. 300 to 400 per MT, the landed cost per MT of wood from captive source worked out to be Rs. 626 to 726 depending on the lead as against Rs. 1400/MT from private source. Thus, pulpwood plantations have provided economic supply of quality pulpwood on sustained basis.

DISCUSSIONS

The availability of forest raw material, which is in short supply and in-adequate to sustain even the existing level of production is expected to be critical (Y.A. Rao 1989). Alternate source of agro-based fibrous raw material, bagasse prefered as a source of energy in sugar mill in place of unreliable, cost prohibitive coal. Hence, it's availability for paper and pulp production cannot be relied upon. The availability of secondary fibre source i.e., waste paper for paper industry is constrained due to its competing end uses, poor organised waste paper recovery systems and inferior grade of waste paper (Arun G Bijur 1997). Under the existing scenario, the forest based raw material appears to be more reliable and best alternative source of raw material available on sustained basis. The selection of planting site and right choice of species with fast growth rate and high productivity will make the plantation programme economically viable. The chosen species not only has to perform better in the plantation sites but also given better pulp yield, quality fibre and posses good strength properties. The mismatch between the pulpwood productivity in the plantation site and pulping qualities may lead to greater disappointments. In MPM, Eucalyptus cloeziana and Acacia crassicarpa has shown better pulpwood productivity in plantation but have poor pulp yield and quality. On the contrast, Eucalyptus grandis has a better pulping characteristics but is not preferred for plantation development because of it's high mortality rate. Acacia mangium and Acrocarpus fraxinifolious has satisfactory to best pulping characteristics but not a viable species for pulpwood plantations as Acacia mangium needs deep fertile soil and vulnerable for pinhole damage while Acrocarpus is vulnerable for pest damages in the initial years of plantation development. So, choice of species plays a critical role in plantation development. In MPM the plantation programme is reviewed annually and redefined to maintain the adequate standards for improvement of productivity and reduction of plantation cost. The MPM research is oriented towards optimum pulpwood production has led to the introduction of high yielding Euc. camaldulensis into plantation scale in dry zone replacing the traditional Euc. hybrid there by increasing the productivity from 25 MT to 45 MT per hectare on rotation . The local seed sources of Acacia auriculiformis which has a MAI of 16 to 20 M^3 /Ha. is in the process of replacement with high yielding Provenances like

Balamukh (PNG), Springvale and Morehead R (QLD) which has a MAI of 21 to 35 M^3 / Ha.

The development of captive pulpwood plantation with these improved sources increase the pulpwood productivity atleast by 25 to 30%. The performance of Acacia hybrid clonal plantations is highly encouraging and at the end 4th year a productivity of 32 M^3 is recorded. Expecting the similar growth trend to continue till rotation period, it is presumed to yield a MAI of 45 M^3 /ha. Pinus caribaea is suitable replacement for bamboo as a ong fibre source has shown tremendous adoptation to MPM captive plantation sites. The Honduran seed sources showed a MAI of 13.7 M^3 /ha at the end of 12 year whereas improved genetic sources CSS 13H and CSO 4H from Australia has shown the productivity of 34 M3/Ha at the 9th year itself. Thus, there is every possibility of increasing the productivity of captive plantations with right choice of species and advance suitable planting technology. The increase in productivity will decrease the cost of pulpwood significantly. These plantations also play significant role in Socio-economic upliftment of the rural communities by generating mass employment and providing basic forest based needs viz., fuel wood, leaves for fodder and mulch etc., Further, the plantations play a significant role in the improvement of the ecological conditions and helps in conservation of soil and water.

CONCLUSION

The Socio-economic development increases the per capita consumption of paper in future. The gap between demand and supply will be stretched wider. The growing demand of cellulosic raw material for pulp and paper industry cannot be met any more with conventional sources i.e., Sabai grass and bamboo. The agro-based bagasse and waste paper has better alternative use, former for generating energy and the latter for packing and wrapping purposes. Banning of use of plastic a non-bio-degradable material for packing increase the demand of waste paper for paper cover and packaging substantially. The only economically viable eco-friendly source of raw material available for paper industry is through pulpwood plantations. Pulpwood plantations helps in converting the uneconomical waste lands into productive and economical one and recreate the ecosystem. pulpwood plantations generate mass employment and provide basic needs of fuel wood, mulching material to the rural communities. Hence, plantation development helps in progress and prosperity of paper industries on one hand and helps in Socio-economic and ecological development of the Indian Society.