Fibrous-raw-material shortage— A challenge to Indian technologists

N.D. MISRA

Indian Paper Industry today produces nearly 0.8 million tonnes of paper and board; and for this it consumes nearly 1.5 million tonnes of bamboo and about 1 million tonnes of hardwoods. By 1980, the Industry has to expand three times atleast, to produce 3.0 million tonnes of paper and board, for which about 2 million tonnes of bamboo, 4 million tonnes of hardwoods and about 1 million tonnes of long-fibred woods will be needed. Agricultural crops like bagasse, kenaf, jute sticks and sesbania are very bulky and prove uneconomical in batch-digester of system of cooking, which most of the Indian paper mills have today. As such, hardwoods are the only sources of raw material for future expansion of Indian Paper Industry.

Tropical hardwoods grow mixed in hundreds of species, each different from the other in its pulping and paper-making properties. A rational method of grading hardwoods for their degree of suitability for producing bleacheable grade pulp chemical is required to be evolved, which could help the Industry to sort out hardwoods in the order of degree of their suitability for making chemical grade pulp. Author has suggested as empirical method based on the experience gained with certain hardwoods in their pulping and paper-making properties. Factors like ease in chipping, chemical consumption, yield, bulk-factor, machine runnability, strength properties and fibre-characteristics are the variables taken as gradients to evaluate the degree of suitability of a specie.

Concept of Mixed-Cooking is bombarded by the theory of 'Peeling action of alkali' over cellulose fibre at temperatures of cooking. It is unscientific and not recommended.

Forest strategy for growing man-made forests to met the Industry demand by 1980 is called for. Suggestion is made how to arrange funds for this purpose. Reducing raw materials wastage in forests and mill yards, due to attack of teermites, white ants and borer by use of suitable insecticides in forests is suggested. This could minimise the present 10% wastage by rotting, and thereby nearly 50,000 M.T. of paper-making fibre could be recovered every year. Suggestion is also given to build stacking platforms out of a mixture of coal-cinder and lime waste or soda recovery sludge—filter waste sludge. In this white ants do not breed. Both coal-cinder and lime waste or sludge are waste products of pulp mill and hence very economical.

Indian Paper Industry, today, is at the cross-roads of expansion and quality production. Future demands of paper, news print and board for expanding economy of the nation, call for extension expansion of the Industry on more than three times of its present size within the next decade. Continued rise in standards of living and education, expansion of packaging and paper conversion industry and diversified use of paper and paper-products for cultural and industrial purposes, have brought about new dimensions of quality. We are face today with the problem of improving quality of paper and board on one hand, and increase production more than three times on the other hand, with whatever raw material is indigenously available. Our choice is very much limited. Long-fibred raw material is very scarce. Short-fibred raw material is available in plenty, both from forests and farms. To produce durable and strong paper form tropical hardwoods, bagasse, jute sticks, etc. needs extensive technological improvements over the existing pulp and paper making equipment, and process operation. It is a challenge our Scientists, Technologists and Engineers have to take up with determination and devotion, to save the Nation from fast approaching paper famine.

Dr. N.D. Misra, M. Sc., Ph.D. (Chemical Engineering) Technical Superintendent, The Sirpur Paper Mills Limited, Sirpur-Kaghaznagar (A.P.).

FIBROUS-RAW MATERIAL AVAILABILITY - PRESENT AND FUTURE

From the present 0.781 million tonnes of paper and board per year, the production is to increase to nearly 3.0 million tonnes a year by 1980. For this we will need nearly 2.0 million tonnes of bamboo, 4.0 million tonnes of hardwoods and about a million tonnes of long fibred woods every year. Although nearly 4.0 million tonnes of bamboo grows in India, yet only 1.5 million tonnes is yearly extracted, because most of the bamboo forests are in inaccessible regions of Assam, Nefa, Nagaland and Bastar region of Madhya Pradesh Long-fibred woods like spruce and pipe are difficult to extract from the rugged Himalayan region economically, although they grow in plenty there. Bagasse being a source of fuel to our old-designed sugar industry, is not possible to be released to paper industry for some time to come. Jute - sticks, another short-fibred raw material available in plenty, needs specially designed stock preparation and paper-making equipment. Unless we have such modified machines, use of jute sticks on large scale for paper-making cannot be possible. Ultimately, the only hope of immediate future availability of fibre for pulp and paper is from the hardwood forests.

Out of a total growing stock of 2500 million m³ of hardwoods, nearly 50 million m³ are annually available for exploitation, out of which nearly 18 million m³ are extracted for fuel wood, timber and industrial consumption.

Sesbania and Kenaf are also a potential source of pater-making fibre, but their bulky nature proves uneconomical in batch-digester system of pulping, Bulky materials like bagasse, jute-sticks, grasses, sesbania, kenaf and cotton stalk can be economically cooked in continuous digesters, but nct in batch digesters. Unless we go for continouous digesters to cook such bulky raw-material, it will be difficult to achieve economy and improvement in quality of paper made from these raw materials.

INDIAN HARDWOODS :

Tropical forests of India abound with hundreds of species of hardwoods each dirrerent from the other in its chemical and physical properties and paper-making qualities. They grow mixed wildly. Out of so many species, there are only a score of species which are really good in their quality for making bleachable grade chemical pulp, and economical in pulping. But to extract them selectively is a problem.

To solve the present glut of raw material shortage and increase the use of more hardwoods in paper making, Indian Technologists, forest Management and Engineers have to boldly find out new technics of utilising available hardwoods in a rationalistic way. It is necessary that unscientific decisions and hurried planning do not jeopardise the National economcy. To aviod such a situation, it is necessary to extensively study the pulping properties of different hardwood species, and from the knowledge gained, they be graded for making different varieties of pulp for different purposes.

BROAD BASIS OF GRADING HARDWOODS FOR PAPER AND BOARD MANUFACTURE:

It is needless to say that paper and board are not manufactured by one system of pulping. For different qualities of paper and board, different systems of pulping, like sulphate process, bisulphite process, cold-soda process, chemiground pulping process, etc. are adopted to get desired quality and economy. For each process, quality of wood need not be same. Indian Hardwoods can also be graded according to the process of manufacture adopted by different mills for making different varieties of paper and board. In India, generally following three types of pulps are made.

1) Bleachable grade chemical pulp for cultural papers and board:
2) Semi-chemical pulp for board filler, fluted board, wrapping paper, etc. and
3) Ground-wood pulp for industrial paper, etc.

Next to quality of pulp, comes the economy of the process. Suitability of a hardwood for a particular process of pulping depends on following important factors.

(i) easy chipping, (ii) low chemical cousumption, (iii) reasonably economic yield, (iv) economic bulk factor in case of batch-cooking, (v) machine runnability, and (vi) satisfactory quality of end product.

If a suitable technic of grading hardwoods on above lines is evolved, it will help both the forest management and the Industry to avail right type of wood for right type of manufacturing process.

Woods, having deep coloured hard-wood difficult to bleach are not suitable for chemical grade pulp. Very hard woods prove very uneconomical in chipping, and cannot be accepted for pulping on large scale. Too bulky woods give lower production in batch digesters and upset economy of pulping. Woods having high alkali demand beyond a reasonable limit cannot be acceptable to an industry — since that increases the cost of production. Some woods, having too much making different varieties of paper resins cause serious troubles in machine operation adversely affecting the production and wire life.

In view of the observations made above, and experience gained

(1,2,6) in chemical grade pulping of some 18 species of hardwoods from Andhra Pradesh forests, this Author has tried to develop a tentative method of grading hardwoods for chemical grade pulping purposes. Factors of gradation have been drawn from the experience in general made with the quality of paper and board made for cultural use in the country. This method, as described and illustrated below, gives a fairly good basis of grading hardwoods according to their suitability for making bleachable variety of pulp, which most of the paper mills in India produce.

A tentative method of grading Hardwoods for Bleached Pulp

In this method pulping characteristics and fibre-characteristics of each wood specie are ennumerated in 9 constants, called suitability factors, as given in Table No. 1 below. Each of these nine constants is given four gradients, viz, I Grade, III Grade and IV Grade, representing First Preference, Second Preference; Last Choice and No-Choice respectively, and allotted numerical points as 100, 50, 25 and 12.5 in same order. Some suitability factors have more than one constant, e.g. (6) yield being subdivided into (a) Unbleached, and (b) bleached; (8) Fibre-characteristics in three constants of (a) % retention over 40 mesh, (b) % pass through 80 mesh, and (c) slanderness ratio; and (9) strength properties having 4 constants of (a) breaking length, (b) burstfactor, (c) Double Folds; and (d) % stretch. These sub-constants are allotted with equal fractions of the total number given to each, except in case of main factor No. 3, where the slanderness ratio is allotted 50% of the numbers allotted to the main factor and the rest 50% are subdivided equally for fibre classification constants.This has been illsutrated in Table No. 3.

TABLE No. 1

Tentative Gradation of Hardwoods for their suitability for making bleachable grade pulp

Sl. No.	Suitability Factory	Grade—I First Preference	Grade— II Second Preference	Grade—III Last Choice	Grade—IV No Choice	Remarks
1	2	3	4	5	6	7
1.	Chipping Quality	Normal	Normal	Hard	Very hard	—
2.	Bulk-density (b.d.)	200 Kg/m^4 ($\pm$30)	170 Kg/m^3	150 Kg/m^3	120 Kg/m^3	This applies in case of batch digesters.
3.	Alkali demand (as Na_2O TAA % on chips)	16.0 or less	18.0 ($\pm$2)	20.0	22.0	—
4.	Rejection of knots (% on chips)	1% or less	1—2%	2—4%	4.0%	Mainly as knots, uncooked and half cooked stuff.
5.	Permanganate No.	18.0 ($\pm$2) or less	22.0 ($\pm$2)	24—30	30.0	—
6.	Yield (% on chips)					
	(a) Unbleached	Above 44.0	42 ($\pm$2)	37 ($\pm$3)	30 ($\pm$3)	Yield of washed screened pulp
	(b) Bleached	Above 40.0	37 ($\pm$2)	30 ($\pm$4)	25	Yield of washed pulp of average brightness 75°GE
7.	Bleachability of Pulp	Easy	Easy	Bleachable with no unbld shives	Partially bleachable with unbld.	By conventional CEH or CEHH system.
8.	Fibre Characteristics:					
	(a) Fibre Classification					
	(i) +40 mesh	40.0	25.0—40.0	15—25	15.0	All unbeaten fibres
	(ii) —80 mesh	30.0	30—35	35—40	40.0	
	(iii) Slandarness Ratio L/D	100	50—100	30—50	30.0	of unbld. unbeaten fibre.
9.	Strength Properties: (unbld.)					
	(a) Breaking Length (m)	5000	3500—5000	2000—3500	2000	
	(b) Burst Factor	25	20—25	15—20	15	Standard hand sheets as per Tappi Std.
	(c) Double Folds	25	20—25	10—20	10	
	(d) % stretch	2.5	1.5—2.5	1—1.5	1.0	

TABLE

Pulping characteristics of some Andhra Pradesh

S. No.	Name of wood (with local name)	Chipping		Bulk Density Kg/m (b.d.)	Alkali demand %NaO TAA on chips	Knots Rejection % on chips	For manganate Number	%Yield on b.d.o. Unbld.
		Very Hard	Normal					
1	2	3	4	5	6	7	8	9
1.	Dandro claums strictus (Bamboo)	—	—	225	15.0	1.5	18.5	41.0
2.	Acacia sundra (Catechou)	—	—	—	20	1.3	18.3	44.6
3.	Anogissus latifolio (Tirman)	—	—	263.5	20	1.0	20.0	42
4.	Doswellis serrata (Anduk)	—	—	223.4	17	1.4	21.0	41.5
5.	Batea frondosa (Plas)	—	—	153.6	18	0.4	19.0	34.3
6.	Chloroxylon swetania(Bilugn)	—	—	225.3	16	1.0	19.0	40.9
7.	Cleistanthus collinus (Nalla Kodsa)	—	—	250.0	20	0.4	25.7	37.8
8.	Dalbergia panniculata (Cidar)	—	—	—	20	0.1	18	48.4
9.	Eucalyptus hybrid	—	—	255.4	14	0.6	18.1	47.8
10.	Garuga pinnata (Garugu)	—	—	270	16	2.2	17.3	42.4
11.	Gmelina arbora (Gummidi Teak)	—	—	190.6	18	1.6	17.4	45.5
12.	Lagerstromia parviflora (Chinnagi)	—	—	—	20	8.2	47.8	36.8
13.	Lannea grandis (Dumpidi)	—	—	185.3	16	NIL	20.3	47.5
14.	Prerocarpus marsupium (Bija Sal)	—	—	211.3	18	0.6	19.5	45.4
15.	Starculia urens (Tapsi)	—	—	149	16	0.7	17.8	43.0
16.	Terminalia balerica (Bahera)	—	—	195.3	20	1.5	20.5	43.8
17.	Yerminalia ptomentosa (Bajjain)	—	—	230	20	0,5	30	35.9
18.	Diospyros malanoxylon (Tendu)	—	—	—	—	—	—	—
19.	Nadhuca latifolia (Mowha)	Too hard	—	—	—	—	—	—

No. 2

Hardwoods (1.8.6) (including bamboo)

Bld.	Bleacha-bility CEHH/ CEH	Fibre classification 40 mesh	—90 mesh	Slanderness Ratio L/D (of the un-bleached fibre)	Strength properties of unbld. sheets B.L. (m)	B.F.	No. of D.F	% stretch	Remarks
10	11	12	13	14	15	16	17	18	19
36.1	Easy	60	31	190	6346	43.8	75	3.1	—
—	Difficulty	14.5	43.4	—	—	—	—	—	Unbld. shiver left
36.3	Easy	41.6	26.7	127	4923	30	61	2.2	—
36.5	,,	15	44	46	4800	20.8	8.5	1.8	—
25.4	,,	63.4	27.4	125	4103	24.6	12.0	2.15	—
25.4	,,	63.4	27.4	125	4103	24.6	12.0	2.15	—
44.6	,,	41.3	20.5	56.3	5699	48.0	80	3.15	—
30.2	Difficult	60	25	78	3602	15.0	12	2.15	Unbld Shives left
40.4	Easy	10.0	41.0	—	3070	15.7	5.5	—	—
44.4	,,	8.6	50.4	45.8	5699	43.5	56	2.3	—
39.4	,,	35	18.0	63	7311	50	536	1.35	—
39.7	,,	10	25	64.2	5161	22.5	45	1.95	—
—	Very Difficult	—	—	—	3384	15	10	1.53	—
38	Easy	8	24	73.7	7103	55.7	560	2.5	—
39.5	,,	—	38.8	38.8	5381	32.5	31.5	2.5	—
34.6	,,	61	26	174	6111	41.6	299	2.35	—
96.7	,,	62	32	111	4371	24.5	35	2.3	—
30.7	,,	39.0	24	126	3666	21.6	15	2.3	—
	Impossible to bleach bleack hard-wood.								
—	—	—	—	—	—	—	—	—	—

Accordingly, if each wood in the above table is given the gradation points, as suggested, we get the following results.

TABLE 3

	Name of Wood		No. of Gradation points achieved
(1)	Chloroxylon swetannia (Bilugu)	..	837.5
(2)	Eucalyptus hybrid	..	806.0
(3)	Dandrocalamus (Mrictus Bamboo)	..	787.5
(4)	Anogissus latifolia (Tirman)	..	765.0
(5)	Lannea gradis (Dumpidi)	..	765.5
(6)	Sterculia urens (Papsi)	..	762.5
(7)	Pterocarpus marsupuim (Bija Sal)	..	734.0
(8)	Garuga pinnata (Garugu)	..	718.0
(9)	Gmelina arborea (Gummidi Teak)	..	703.0
(10)	Terminalia balerca (Bahera)	..	662.5
(11)	Boswellia serrata (Salai)	..	571.5
(12)	Butea fronduse (Palas)	..	562.5
(13)	Dalbergia panniculata (Cidar)	..	546.0
(14)	Terminalia tomentosa (Sajjain)	..	456.0
(15)	Cleistanthus callinus (Nalla Kodsa)	..	437.0
(16)	Acacia sundre (Catechon)	..	237.5
(17)	Lagerstromia paruflora (Chinnagi)	..	224.0
(18)	Diaspyrox malanoxylon (Tendu)	..	Not workable.
(19)	Madhuca latifolia (Mowha)	..	

In above table, we get a very clear demarcation of points gained by woods including bamboo, from serial No. 1 to 9, which have achieved total marks of 703 to 837.5.

The second group, consisting woods from Serial No. 10 to 14 has achieved marks from 546 to 662.5.

The third group, consisting of woods from Serial No. 14 to 19 are all such woods, which are absolutely unsuitable for making bleachable grade pulp by sulphate process.

One exception in Group No. 2, is the Salai Wood, which has got lower marks — indicating its proximity to Bahera and Palas woods in its properties and suitability for making bleachable grade pulp. Reasons of this still need further confirmation with more experimental data. Woods belonging to Second Group are such which due to one reason or the other fall in second choice.

However, as has already been told earlier, this system of Gradation is only tentative, and needs more extensive observations with more woods to decide its real utility.

Concept of Mixed-Wood Cooking

Action of alkali on cellulose fibre during the cooking process, i.e. "Peeling action" (3) is against the concept of mixed cooking. It is not correct to say (4) that "in a mixed cook, each species consumes only the amount of chemicals necessary for dissolving its incrustation, and that a mix of several hardwoods can, therefore, be successfully cooked together". Such a reaction is scientifically untrue, since the peeling-action starts above 110°C, and temperatures employed usually to cook hardwoods is always 145° C, or above. If hardwoods of mixed species are cooked together, loss of cellulosic fibre due to peeling action and hence the yield is bound to suffer adversely. To achieve best economy in pulping, mixed cooking can never be recommended.

Forest Strategy and Planned Aforestation

According to Seth and Kharbanda (5), to meet paper industry's requirements, it would be necessary to dedicate one million hectares of land for bamboo plantations, and another million hectares for pulpwood (including soft and hardwoods). To bring up these plantations, funds to the tune of Rs. 2500 million will be required. This means that, to bring up man-made forests, to meet future requirements of Paper Industry, quite a substantial fund will be required, and all this has to be generated within the country in a short period of 3-4 years. According to this, if Rs. 600 million are raised every year towards planned aforestation programme as suggested, we may hope to get all required raw materials for envisaged expansion of paper industry by 1980. It quick growing species, like eucalyptus, casurina, bamboo, sesbania, tropical pines are grown, we may well hope the success in starting big-sized paper mills in the coming decade in India.

The problem is of raising required funds for planned aforestation. For this purpose, the Government, the Industry and the Financing Institutions have to make joint ventures on similar lines, as in case of floating heavy industries. Forest Management should seriously take up this proposal, and raise funds by disposing off all available surplus of hardwoods in open world market on reasonable cost. This could help in quick clearance of present mixed hardwoods forests to give place for man-made forests. Mixed hardwoods do not respond favourablyto chemical grade pulping by sulphate ocess, but they may be quite suitable for making chemi-mechanical and semi-chemical grades of pulp for fluted-medium, packaging board and wrapper, which most of the advanced countries of the world consume in large quantities. Central Forestry Board and Indian Forestry Commission can play their important role in this respect.

Storage Losses of Bamboo and Hardwoods

It is estimated that due to attach of termites, white ants and borer nearly 10% of the extracted raw material is lost while in storage in forest depots and mill yards. This amounts to nearly 1,50,000 M.T. of bamboo lost every year, which could well feed a 200 tonnes paper mill. Loss in hard-woods is additional. Such a colossal loss of fibrous raw material, particularly when we are short of it, should be minimised if not alltogether stopped. This can be achieved by scientific methods of stacking and storing bamboo, hardwoods and other similar raw material.

Hardwoods are more prone to termite and white ants effects and their preservation will need greater attention with their increased consumption.

It is found that treating bamboo stacks or hardwoods stocks with spray-type insecticides in storage yards, does not prove much affective. Since the termites and borers once entered inside the bamboo or wood log do not come in contact with the chemical. Fumigation proves practically impossible and too costly since for this purpose, the stacks are to be covered with leak-proof tarpaulins. The only alternative is to treat the standing plantations with insecticides sprays, and to treat stacking grounds with suitable chemicals to kill white ants and check their future growth. For treating standing plantations in forests with suitable insecticides, commercially feasible and economical methods for our country have yet to be developed.

For building white-ant free stacking platforms, it has been found tat a mixture of coal cinder and waste lime power from limekilns or lime-sludge from Soda Recovery Lime Filters, proves a very useful material to construct anti-white ants platforms. All these materials are industrial wastes and can be well utilised.

CONCLUSIONS

Above discussions may be concluded in brief as follows :

(1) Indian Paper Industry has to expand more than three times of its present size by 1980 to meet the growing demand of cultural and industrial paper and board ;

(2) For envisaged expansion we will require nearly 2.0 million tonnes of bamboo, 4.0 million tonnes of hardwoods, and 1.0 million tonnes of long fibred raw material ;

(3) Indian hardwoods grow mixed in forests, and each specie differs from the other in its pulping and paper-making properties ;

(4) In view of their diverse properties, hardwoods need gradation for their suitability for (i) chemical grade bleachable pulp ; (ii) semi-chemical pulp ; and (iii) groundwood pulp ;

(5) While deciding the suitability of hardwoods species for different pulping systems, gradation factors like pulping economy, chemical demand, yield, fibre dimensions, strength properties, machine runnability, content of fines etc. need to be taken into consideration ;

(6) A system of gradation of hardwoods for their suitability for making bleachable grade pulp, has been tentatively suggested by the Author. Pulping properties like alkali demand, yield, permanganate number, bleachability, strength properties, slanderness ratio of fibre, and economy factors like bulk-density, knots-rejection, fibre classication, etc. have been taken as 9 gradation factors in all, and they are distributed in 4 gradients representing 4 grades accord-

ing to the order of suitability of the wood. By allotting numerical points in gesmetric progression, starting 100 with Grade I, the last Grade IV gets 12.5 points.

When these points are enumerated for different factors of each species, the total number of points gained by it, decided the position of the wood for its suitability for making bleachable pulp.

By this method a fairly dependable classification of hardwoods, out of the 18 tried by Author, could be drawn out.

(7) Mixed cooking of hardwoods is unscientific, and is not supported by the "theory of peeling action of alkali in cellulosic fibres". Such a cooking causes higher chemical consumption, lower yield, and heterogenius pulp properties ;

(8) A national forest strategy of planned afforestation is called for, so that the present glut in utilising presently available hardwoods is removed; and way is paved for organised plantations of bamboo and hardwoods for future industrial expansion ;

(9) To make place to new man-made forests, it is necessary to clear out certain forest areas of mixed hard-wood forests. Such hardwoods should be chipped, mixed and disposed off in open world market, where it could find use in making semi-chemical pulps. It is not desirable that the Indian Paper Industry is forced to accept such woods, since they do not have facilities of usefully pulping mixed hardwoods;

(10) Economic and effective methods of treating bamboo and hardwoods with insecticides are yet to be developed. Use of presently available insecticides over stacked bamboo and wood does not prove commercially economical and effective. Spraying of standing plantation suitable insecticides is suggested ;

Constructing stacking platforms out of coal cinder, waste lime powder and lter sludge is recommended, since white ants do not grow or live in this composition.

Acknowledgment :—Author is highly thankful to the Vice-President and Works Manager of Sirpur Paper Mills Ltd. for permitting this paper to be presented in this conference.

REFERENCES

1. Misra N.D. "Chemical Grade Pulp from some more Hardwood from Andhra Pradesh".
2. Misra N.D. "Chemical Grade Pulp from some more Hardwoods from Andhra Pradeseh". (Private Communication—Pending Publication).
3. Rydholm S.A. "Pulping Processes" (1965) pp. 307. Interscience Publishers, New York.
4. Seth V.K. Kharbanda "Ideas on Grading Hardwoods for Pulping as Illustrated for the Forests of Bastar".
5. Seth V,K. Kharbanda B.C. "Integrated Planning and Financing of Man-made Forests for the Pulp and Paper Industry".
6. Misra N.D. Rao A.V. "Pulping Characteristic of Anduk wood (Beswellia Serrata Roxbi) grown in A.P."—INDIAN PULP & PAPER, XXIII, No. 12 June 1969.