Grading of Hardwoods for Pulping (as Illustrated) for Bastar Forests

V.K. SETH
And
B.C. KHARBANDA

The need to evolve grading procedures for hardwood pulping material was stressed at a conference held at Dehra Dun in 1971. In the present work the idea on grading hardwoods for pulping, (as illustrated for the forest of Bastar for which a good deal of information is available) has been discussed.
At least 50 percent of the net available volume per hectare of the growing stock in Sal, Teak and miscellaneous strata can be taken as better grades of pulpwood. Similar studies can be undertaken for different regions of the country and a national system of grading can be evolved. The effect of intensification of management, reduction of rotations and raising of fast-growing plantations of pulpwood species on the production of better grades of pulpwood has also been examined.

Introduction

In 1935–36, the consumption of paper and board in the country was 123,000 tonnes[1], which rose to 722,000 tonnes in 1969–70. According to estimates[2], bamboo supply for expanding paper and pulp industry will fall short to a considerable extent. Also dependence on bamboo is very risky[3] due to gregarious flowering of the species, which may seriously affect supplies periodically.

Based on various tests and experiments done in other countries and in India, Seth [4, 5, 6, 7] has pointed out that hardwoods have come to stay as an important source of raw-material for the Indian pulp and paper industry. The Indian paper mills are using today a number of hardwoods, mostly in mixtures.[8] In tropical hardwood forests of the country a wide variety of species are growing and extraction of one or a group of species may not be economical. Recent researches in India and abroad have given very encouraging indications of pulping mixed hardwoods. In the beginning some doubts were raised that cooking of mixed hardwoods may not be satisfactory, but the doubts have been falsified and in a mixed cook each species consume only the amount of chemicals necessary for dissolving the incrustants and a mix of a large number of hardwoods can be cooked together.

Need of Grading wood

A grading of the felled material will separate the fuelwood from the pulpwood in the forest which would otherwise have been transported to the paper mill, causing unnecessary expenditure to the mill and a scarcity of fuelwood to the local population. In evaluating the suitability of various hardwoods for pulping two main factors should be considered[9], namely (a) the economy of pulp production and, (b) the quality of pulp produced. The "Economy" will inter alia include factors like price and pulpwood quality, severity of cooking, pulping efficiency, bleach ability and pulp yield. The "quality of pulp production" will include factors like wood species, cooking process, drying and special treatment, if any. Based on these factors hardwoods can be graded as excellent, good, fair, poor and very poor (ibid).

Batchelor *et al*[10] have assessed a forest for pulping on the basis of species wood type and for the particular grade of paper to be produced. Clark and Bagby[11] have followed the method of assigning various factors like potential availability, chemical composition, fibre length, pulp yield and individual assessment, to determine the suitability of the raw material for pulping. In India, the individual paper mills lay down their specifications[12] while calling tenders for supply or while negotiating deal with the state Forest Departments. The Forest Departments negotiate the deal with respect to species and the quantity required, without any regard to the ultimate grades of pulpwood required at the mill site. The industry has to pay for the wood outside the grade and to carry all wood in whatever from the local extraction methods permit. It is not fair to force on the industry any wood species which are not suitable for pulping and a time has come to evolve a pattern of grading to be followed in the forests. In fact a recommendation was made a conference held at Dehradun in 1971 to evolve a suitable procedure for grading hardwoods.[13]

PRESENT PRACTICE IN OTHER COUNTRIES AND SUGGESTED GRADING OF PULP WOOD

Present practices with regard to grading of pulpwood in countries like U.S.A., Australia and Canada are based upon:

(i) **Species** with respect to their suitability as raw material for pulping,
(ii) **Quality** of the logs or billets, and
(iii) Dimensions of the billets.

Keeping in view the above points, the following grading is suggested as a model, based on the inventory

V. K. SETH, Senior Photointerpretation & Mapping Officer,
B. C. KHARBANDA, Industrial Economist, Preinvestment Survey of Forest Resources, New Delhi.

TABLE I

SHOWING FREQUENCY OF DISTRIBUTION BY VOLUME

S. No.	Name of Species	Percentage of volume composition	Remarks
1	2	3	4
1.	*Terminalia tomentose*	13.2	Timber spp. part vol. to be treated as pulpwood
2.	*Shorea robusta*	11.6	—do—
3.	*Anogeissus latifolia*	11.0	—do—
4.	*Diospyros melanoxylon*	8.1	Larger sizes not suitable for pulpwood.
5.	*Cleistanthus collinus*	6.0	Entire vol. pulpwood
6.	*Teotona grandis*	4.9	Timber spp. only part vol. to be treated as pulpwood.
7.	*Pterocarpus marsupium*	4.8	—do—
8.	*Madhuca latifolia*	4.6	Not suitable for pulpwood.
9.	*Lagerstroemia parviflora*	3.0	Entire volume pulpwood.
10.	*Boswellia serrata*	3.0	—do—
11.	*Xylia xylocaroa*	2.9	—do—
12.	*Buchanania lanzan*	1.8	—do—
13.	*Lannea grandis*	1.6	—do—
14.	*Syzigium cummunii*	1.5	—do—
15.	*Terminalia chebula*	1.5	—do—
	Total:	79.5%	

TABLE II

SHOWING GRADING OF WOOD ACCORDING TO PULPING PERFORMANCE

GRADE ONE			GRADE TWO			GRADE THREE		
S.No.	Species	% Vol.	S.No.	Species	% Vol.	S.No.	Species	% Vol.
1.	*Shorea rubusta*	4.0	1.	*Terminalia tomentose*	7.6	1.	*Diospyros melanoxylon (larger size)*	3.8
2.	*Anogeissus*	8.4	2.	*Cleistanthus collinus*	3.4	2.	*Madhuca Latifolia*	5.8
3.	*Diospyros melanoxylon*	4.2	3.	*Syzigium cumunii*	1.7	3.	*Xylia xylocarpa*	2.8
4.	*Pterocarous marsupium*	2.7	4.	*Terminalia chebula*	1.4	4.	*Schlichera trijuga*	1.4
5.	*Tectona grandis*	0.4	5.	*Delbergia latifolia*	0.2	5.	*Others*	4.0
6.	*Boswellia serrata*	2.9	6.	*Ougeninia dalbergioides*	0.2			
7.	*Lagerstroemia*	2.8	7.	*Others*	6.3			
8.	*Buchanania Lanzan*	1.7						
9.	*Lannea grandis*	1.6						
10.	*Dalbergia paniculata*	1.2						
11.	*Emblica officinalis*	1.1						
12.	*Schrebera swieteniodes*	1.1						
13.	*Adina cordifolia*	0.5						
14.	*Stephegvne parviflora*	0.4						
15.	*Salmalia malabaricum*	0.4						
16.	*Garuga pinnata*	0.6						
17.	*Zizyphus xylopyra*	0.5						
18.	*Bridelia retusa*	0.4						
19.	*Mangifera indica*	0.4						
20.	*Chloroxylon swietenia*	0.3						
21.	*Albizzia spp.*	0.3						
22.	*Bauchanania spp.*	0.3						
23.	*Butea monospera*	0.1						
24.	*Kydia calycina*	0.1						
	Total:	36.4		Total:	20.8		Total:	17.8

results of the Preinvestment Survey of Forest Resources Organization for the Bastar forests. These are in all nearly 100 different species in the Sal forests of Bastar. In the survey, the frequency distribution of species both by volume and stems per hectare has been worked out. Nearly 80% of the volume was found to be made up by fifteen species. The details are given in table I.

The remaining 20% by volume is made up by fifteen other species of which the following size (i) Tactona grandis (ii) Shorea robusta (iii) Pterocarpus marsupium (iv) Diospyros melanoxylon (v) Anogeissus latifolia (vi) Terminalia tomentosa alongwith two other species namely Adina cordifolia and Ougeinia delbergoides are used as timber.

From the study of utilization assortment carried out in the Bastar Sal forests it was found out that of the total wood available the following classification can be made:

	Per cent by volume
(i) Plywood material	2
(ii) Saw milling material	23
(iii) Pulpwood and fuelwood	75

The "pulpwood and fuelwood" category includes poles (to the extent of 15% of this category) for which there is no demand at present in the locality. If and when demand for poles arises, a deduction from total pulpwood and fuelwood will have to be made. The 75% (by volume) of pulpwood and fuelwood available in Baster, the grading can be made as under:

Grading by species: On the basis of pulping performance the pulpwood can be graded as one, two or three, as shown in table II. Species under group three are unsuitable for pulping.

Woods under grades one and two are suitable for pulping. They are therefore subgraded by size as follows:

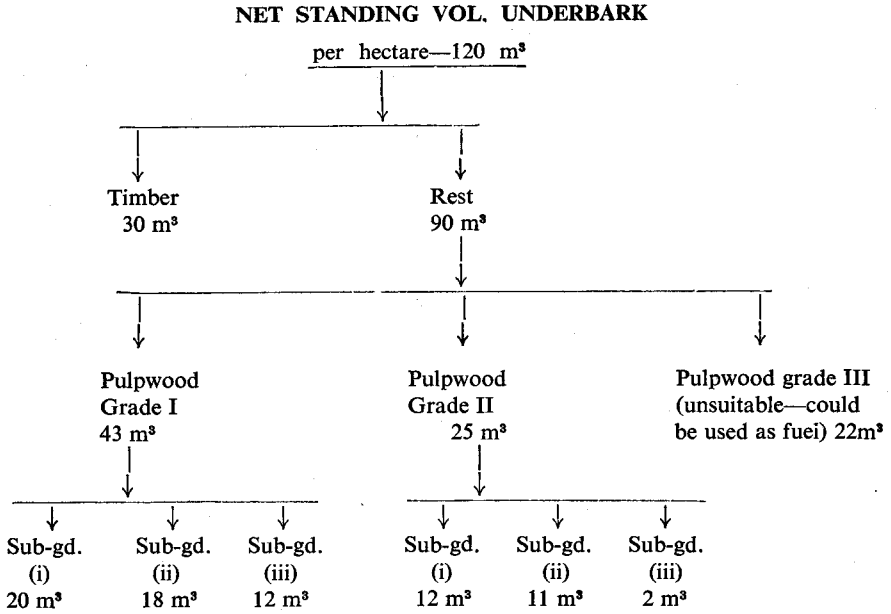
Sub-grade	(i)	Diameter from	5 to 20 cm.
,,	(ii)	,, ,,	20 to 40 cm. and
,,	(iii)	,, ,,	over 40 cm.

The pulp and paper industry prefers straight and uniform sized billet to produce chips of uniform size with minimum wastage and chipping problems. The ideal size of the billet is 2 metres by 20 cm. in diameter. The billets should be straight and free from defects. Billets with larger size will have to be sawn to the required size before fed into the chipper. This means extra cost and wastage of material. Besides size and straightness, the roundness of the billets is of considerable importance. The net available volume (75%) of pulpwood and fuelwood in the Sal stratum of Bastar forest varies in diameter from 60 cm. to 5 cm.

Analysis on the basis of diameters class distribution the volume of wood will roughly resolve in 20%, 40% and 40% proportion in the three diameter classes (c. f. Table III). Applying this proportion to the distribution of volumes of individual species by diameter classes gives the following break-up.

		% by volume
Grade one		36
Sub-grade	(i)	17
,, ,,	(ii)	15
,, ,,	(iii)	4
Grade two		21
Sub-grade	(i)	10
,, ,,	(ii)	9
,, ,,	(iii)	2
Grade three (Unsuitable for pulping)		18

Applying the above break-up to the Bastar Sal forest containing an average of 120 m³ hectare, the assortment of pulpwood and fuelwood will resolve as follows:



The summation of (i) and (ii) of grade one and (i) and (ii) of grade two, which represent good pulpwood comes to 51% of the total volume. The same percentage will apply to teak and miscellaneous forests.

The procedures evolved (as envisaged in the present work) namely to grade pulpwood first by species and then sub-grading by size on the basis of technological evidence and actual inventories of forest resources can be used for appraising pulpwood and evolving a rational system of calculating royalties for supplying the same to the industry. The central Indian dry deciduous and moist deciduous forests have a more or less similar floristic composition and the percentages of grades and sub-grades worked out in this paper can be applied as a rough guide for making estimates. A useful method has been outlined for linking pulpwood estimation with inventories of forest resources.

A good deal of data on forest resources for Chanda district in Maharastra, East Godavari Catchment of Andhra Pradesh, forests of Keral (detailed study necessary) and for coniferous resources in North India has been collected. Similar grading can be worked out for these. If and when this is done for different types of forests in the country, a comprehensive national methodology for grading of pulp-wood can be evolved. The importance and urgency of the work need no overemphasis.

Sliding Royalty Scale For Graded Pulpwood.

If the pulp and paper industry accept pulpwood grading by species and size, it should be prepared to pay enhanced royalty to cover expenses of grading. The increased rate of royalty will not put any burden on the industry, as it would be amply compensated by increased pulp yield per unit weight of the material, improved pulp quality, economy in chemical consumption and less mill problems. A rational and sliding scale of royalty for pulpwood supply need be worked out.

The idea is illustrated by an example below:

On assuming a royalty for ungraded pulpwood at a flat rate of Rs. 10/- per m³, the rate of the out-turn of

90m³ per hectare of pulpwood and fuelwood (from Sal forest stratum of Bastar) the royalty will be Rs. 900/- per hectare. The extra expenses on grading of pulpwood would amount to Rs. 360/- per hectare at nearly Rs. 4/- per m³ (estimated). Thus, if grading is done, then the forest department should be able to get from the pulp and paper industry an amount of Rs. 1260/- (i.e. Rs. 900 × Rs. 360). For this purpose a rational and sliding scale of royalty for graded pulpwood could be as shown below:

GRADE I			
Sub-grade (i)	20 m³ @ Rs. 22/- per m³	=	Rs. 440
,, ,, (ii)	18 m³ @ Rs. 16/- per m³	=	Rs. 288
,, ,, (iii)	5 m³ @ Rs. 12/- per m³	=	Rs. 60
GRADE II			
Sub-grade (i)	12 m³ @ Rs. 16/- per m³	=	Rs. 192
,, ,, (ii)	11 m³ @ Rs. 12/- per m³	=	Rs. 132
GRADE III			
Which may be used by the pulp and paper industry or sold as fuelwood.	22 m³ @ Rs. 7/- per m³	=	Rs. 154
Total:	90 m³	=	Rs. 1266

Analysis of Inventory Results of Bastar Forests:

Due to absence of scientific managements the forests (in Bastar) may have developed abnormalities and deficiencies. These defects will be removed when forests are worked scientifically and normally working is attained. The productivity will increase substantially and the stand and stock situation would also undergo a significant change for the better. The forests in the Bastar Sal stratum fall under All India Site Quality Class II. As per inventory results[14] the forests carry an average of 279 stems per hectare and a volume of 120m³ per hectare of stem timber under bark. This volume could be considered as net available volume after accounting for cull and felling and conversion losses, because the percentage of branchwood volume had been found almost equal to these. The break-up of stand and volume information by diameter classes is as shown in the table III.

If three diameter classes are adopted, i.e. upto 20 cm. 20–40 cm., and over 40 cm., the distribution of average volume per hectare in round figures would be:

Upto 20 cm. diameter	20 m³	17%
20-40 cm. diameter	45 m³	37%
Over 40 cm. diameter	55 m³	46%
Total	120 m³	100%

The normal growing stock of stem timber volume of a Sal forest per hectare for rotations of 100, 125 and 150 years for Site Quality II is[15]:

Years	*Volume in m³/ha*
100	115 m³
125	150 m³
150	175 m³

The above figures indicate that if the Sal forests of Bastar are managed intensively and scientifically to attain normalcy, there would be a considerable scope for increasing yields per hectare (to the tune of 25% over and above the present figure, if a rotation of 125 years is considered).

As for the teak and better quality miscellaneous strata, the average number of stems per hectare is 258 and the average volume per hectare is 80 m³. If these forests too are managed intensively and scientifically to attain normalcy, there would be a considerable scope for increasing yields per hectare (to the tune of 38% over and above the present figure, if a rotation of 80 years is considered). The volume per hectare for a normal Teak forest of IInd Quality is indicated to be about 110 m³.

The potential annual yield from the forests of Bastar district based on present inventory figures have been shown to be 3.14 million m³ [16]. By taking into consideration the above indications of stepped-up yields through better management aimed at the attainment of normalcy, the potential annual yield could be increased by nearly 1 million m³.

The number of stems per hectare by diameter classes for the Sal forests of Bastar has been indicated in the attached figure. For comparison the corresponding number of stems for a normal forest having a rotation of 100 and 125 years has also been shown. It becomes clear that in the Bastar forests there are a few abnormalities in the growing stock, i.e.,

(a) there is an accumulation of trees in the diameter class above 60 cm.
(b) there is a deficiency of trees in the diameter class from 30 cm. to 60 cm, and
(c) there is also an accumulation of stems below 20 cm. diameter.

These abnormalities in the crop could be attributed to the absence of proper and scientific management.

IMPLICATIONS OF INTENSIFICATION OF MANAGEMENT AND REDUCTION OF ROTATIONS

TABLE III

DIAMETER CLASS

Item	Over 10-20 cm.	Over 20-30 cm.	Over 30-40 cm.	Over 40-50 cm.	Over 50-60 cm.	Over 60 cm.	Total
No. of trees per hectare	199	43	19	8	3	7	279
Vol. in m³ per hectare.	20.20	26.82	17.79	12.97	8.69	33.53	120.00

FOR PRODUCTION OF BETTER GRADES OF PULPWOOD

The objectives of growing wood as timber are quite different from those of growing it as pulpwood. Technological evidence points that younger wood of homogeneous size is preferred as pulpwood. There is thus a need of segregating pulpwood areas from timber areas and the adoption of smaller rotations for the management of pulpwood forests.

Adoption of smaller rotations for pulpwood will result in the production of wood of smaller sizes to suit better the pulp and paper industry. The break-up of pulpwood yield by grades would automatically increase in favour of the better grades and this would mean higher returns per unit area by way of pulpwood royalties.

For a Sal forest of IInd Quality adoption of a rotation of 70 years as against one of 140 years would give the same production in two cycles of 70 years each as a single yield for a rotation of 140 years. An optimum range of rotations need be worked out on the basis of technological indications and sound silvicultural principles to work out such a way that there is no drop in the productivity of the forest. Reduction of rotations is justified from economic considerations too. The present worth of material sold in the 140th year would be very much less than the present worth of two yields (one in the 70th year and the other in the 140th year). The crux of forest management for pulpwood supply would lie in determining the optimum rotations for different crops on the basis of technological, economic and silvicultural considerations.

Intensification of management and reduction of rotation would also facilitate mechanization of pulpwood supply operations and also lead to a considerable saving in transportation cost of pulpwood to mill sites, because of the stepped up yields per hectare and the consequent concentration and shrinking of supply areas.

PLANTATIONS OF FAST GROWING SPECIES FOR PRODUCTION OF OPTIMUM GRADES OF PULPWOOD

The best arrangement for the pulp and paper industry would be regarding the supply of homogeneous and almost uniform-sized raw material of a single proven and acceptable species, such as some species of Eucalyptus or tropical pines. Plantations of these species, for the pulp and paper industry would have the merit of:

(a) Providing concentrated supplies of raw material at pre-determined spots, close to the mill sites;
(b) Resulting in considerable saving in the handling and transportation of raw material;
(c) Providing raw material within short rotations of 10 to 30 years;
(d) Making it possible to mechanize operations and apply the ideas of irrigation and fertilizing etc.

Raising industrial plantations of fast growing species for the pulp and paper industry from the point of grading would mean the production of pulpwood of grade I(i). The activity will cost roughly Rs. 1500/- per hectare and judging from the angle of provision of best quality pulpwood and considerable economy in handling and transportation, the pulp and paper industry should be able to either (1) handle the activity itself or (2) pay a reasonable royalty for pulpwood supply from plantations to cover the cost of raising them and looking after them.

The total yield per hectare from plantations of Eucalypts or tropical pines would depend on the localities where they are raised and on the species chosen. However, even allowing for a conservative estimate of total yield of 100m³ per hectare 10 years of *Eucalyptus tereticornis* plantation, the yield from such plantations should be worth (at the rate of grade I (i) pulpwood considered earlier)—100 m³ @ Rs 22 per m³ = Rs. 2200/- per hectare, which would cover the cost of formation and also provide for a reasonable margin of profit too.

Conclusion

1. The supply of pulpwood to the expanding pulp and paper industries in the country in the coming years will assume increasing importance and constitute an important source of earning for the forestry sector.

2. Due to technological advances the use of hardwoods is likely to increase rapidly in future.

3. It is necessary to evolve procedures for grading pulpwood on the basis of species and sizes.

4. All woods are not suitable as pulpwood and it would be a disservice to the pulp and paper industry if the forestry sector insists that all wood irrespective of suitability be used by industry as pulpwood.

5. There is a keen demand for fuelwood in many forests of the country. It is desireable that wood be graded separately into "pulpwood" and "fuelwood."

6. The need for grading pulpwood on the basis of frequency of occurrence morphological and anatomical characteristics and technological performances would soon be felt in India and the rational approach would be to integrate this work with forest inventories and to so design the collection of data in the field as to facilitate automatic processing on computers. For this purpose the first requirement would be to stratify forest areas by broad types, volume classes and species composition.

7. The arrangement of supply to

the pulp and paper industry should be:—

(a) exploitation of forest areas for pulpwood supply in combination with timber exploitation on long rotations;

(b) intensification of management, reduction of rotation and segregation of pulpwood supply areas from timber production areas, and

8. The pattern of pulpwood production in Bastar district would be:—

(a) 60 m^3 per hectare in Sal stratum and 40 m^3 per hectare in the Teak and Miscellaneous strata in a rotation period of 120 years and 80 years respectively;

(b) 80 m^3 per hectare for Sal stratum and 60 m^3 per hectare for Teak and Miscellaneous strata for a rotation period of 70 years and 40 years respectively; and

(c) 100 m^3 per hectare for *Eucalyptus tereticornis* for a rotation period of 10 years.

The areas of annual cut for the above yield patterns for a pulp and paper mill of 100,000 tonnes per year capacity (using 40% hardwoods, i.e., 150,000 m^3) would be:—

(a) 2,500 hectares for Sal stratum and 3,750 hectares for Teak and Miscellaneous strata;

(b) 1,900 hectares for Sal stratum and 2,500 hectares for Teak and Miscellaneous strata; and

(c) 1,500 hectares for *Eucalyptus tereticornis* plantation.

REFERENCE

1. Sharma L.C. Role of Forests in India for supply of Raw Material for Paper Economy During the Decade Ending 1980-81. "IPPTA Vol. VIII No. 1—1971.

2. Planning Commission. Study on Forest Raw Materials for Pulp, Paper and Newsprint—Committee on Natural Resources, New Delhi, Sept., 1965.

3. F.A.O. FAO of United Nations. Preinvestment Survey of Forest Resources India—Report on Project Results—Conclusions and Recommendations (Rome—1970).

4. Guha S.R.D. et al. Pilot Plant Production of Wrapping and Printing Papers from a Mixture of Hardwoods. Indian Forester—November 1964.

5. Guha S.R.D. et. al. Production of Writing and Printing Papers from a Mixture of Nagaland Hardwoods. Indian Forester—October, 1965.

6. Guha S.R.D. Summary of investigations on the Suitability of Indigenous Broad Leaved Woods for Production of Sulphate Pulp for Writing amd Printing Paper Carried on, at the F.R.I., Dehra Dun. Proc. Symp.—Utilization of Hardwoods for Pulp and Paper 1968.

7. Seth V.K. The Promise and Problems of Indian Hardwoods as a Source of Raw Material for the Pulp and Paper Industry. IPPTA Vol. VIII—No. 2 1971.

8. Bhargava K.S. Utilization of Mixed Hardwoods at the Bengal Paper Mills —Proc. Symp. Utilization of Hardwoods for Pulp and Paper 1968.

9. Makio Isoda, Yoshika Nomura. Evaluation of Woods Produced in Foreign Countries for their use as Pulpwood, IPPTA. Souvenir International seminar, New Delhi—1969.

10. Batchelor et al. The Assessment of a Forest for Pulping. Pt. II Appita. 24.4. January, 1971.

11. Clark T.F. et al. Kenaf and Other Non Wood Species for Paper Making IPPTA. Vol. VII No. G.N. 1970.

12. Bhargava R.P. Experience on Utilization of Mixed Hardwoods for Kraft Manufacture at Star Paper Mills Ltd., Saharanpur. Proc. Symp.—Utilization of Hardwoods for Pulp and Paper—1968.

13. Recommendation. No. 8 Conference on Utilization of Hardwoods for pulping, Dehra Dun, April 1971.

14. Preinvestment Survey of Forest Resources. Forestry and Industrial Development Opportunities in Bastar. (Un-Published).

15. Director of Forest Education. Growth and Yield Statistics of Common Indian Timber Species (plains Region) Vol. II, 1970.

16. Seth V.K. et. al. Feasibility Study for a Paper Mill in Bastar Region of Madhya Pradesh, IPPTA. Vol. VII No. 3. 1971.