

# Whole Jute—A Promising Raw Material for Indian pulp and paper Industry

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## ABSTRACT

Jute is an annual plant widely cultivated in Eastern and Central part of India. The main users of the jute plants in the country are the gunny bag industries, using only the bast portion for the gunny bags, leaving behind the jute sticks as a waste. Due to growing demand of the synthetic bags in the country, the jute industry is at the dying stage. For the survival of jute cultivation in the country the need to find out alternate use of jute plant is of utmost importance. Paper industries on the other hand (mills with the recovery unit), are facing shortage of conventional raw material like bamboo & hardwoods. Studies revealed that a bleachable grade kraft pulp of Kappa no around 22 could be produced by using 17 percent  $\text{Na}_2\text{O}$ . Pulp obtained showed very good bleaching response and could be bleached by  $\text{C}_6\text{E}_2\text{H}$ , to 76% ISO brightness. Bleached pulp strength properties were found much more superior than that of eucalyptus and bagasse pulps. Pulp is not only suitable for different grade of paper but can also be used as a reinforcing pulp to replace the use of long fibre bamboo and imported soft wood pulp. The farmers can earn (per tonne of whole jute) more than their earning by selling jute fibre and jute sticks separately and can have wider scope for jute cultivation.

## Introduction

### Scenario of Indian Paper Industry :

There are three types of mills existing in the country. Large mills, based on forest raw materials having complete chemical recovery system. Medium size mills, mostly based on the agricultural residues like bagasse straws etc, some of them also have recovery unit. Small size mills, mainly based on agricultural residues and waste paper are without chemical recovery. The large and medium size mills with complete recovery unit are very limited in number i.e. about 30 mills while there are more than 300 small paper mills in the country. Today, total production of the paper and board in the country is around 2.5 million tonnes per year, out of this about 60% is produced by large and medium size paper mills and rest by the small paper mills.

### Raw material situation :

Fast depletion of the natural forest in the country

has resulted in acute shortage of forest based raw materials for the paper industry. Efforts were made for the plantation of fast growing trees like eucalyptus, but the supply of wood is not sufficient to meet out the growing demand of the paper industry. Because of this short supply of eucalyptus and bamboo, the agricultural residues have gained importance. Wheat straw, rice straw and other grasses are being used since long but the bagasse which is a waste obtained after extraction of sugar juice is gaining importance day by day. Wheat straw is not available in plenty because, it is a regular cattle feed and rice straw is not a suitable raw material for large and medium paper mills because of the presence of very high silica content in the raw material (6 to 24%) which poses serious problem in the recovery unit. Bagasse is a suitable raw material for mills with recovery and also for small paper mills without recovery unit. Though it is a good

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raw material for the production of pulp but it poses a lot of difficulty in handling like storage and depithing. Pulp produced showed poor drainage, opacity and strength properties. Due to its bulky nature, it requires high raw material to liquor ratio in cooking which results in low black liquor solids (6-7%) and presence of higher silica (2-4%) in the bagasse, results in the generation of silica rich black liquor. Both of these factors poses problem in the efficient functioning of the recovery system.

To meet out growing demand of the papermaking raw materials specially for the medium and large paper mills with conventional recovery units, there are possibilities for utilizing agro based agricultural plants like kenaf, mesta and jute plants etc. Jute is a seasonal agricultural produce of tropical countries with abundant rainfall. India, Bangladesh, Malaysia, Thailand etc are the principal jute producing countries. India contributes about 2/5 of the total world jute production. Main jute producing states in India are Assam, Bihar, Orissa and West Bengal. West Bengal contributes to a maximum amount. On maturity, jute plant grows to a height of 1.5-2.5 meters, having an average yield of around 1.6 MT/hectares in India. At present, 8.5 lakh hectares of land is under jute cultivation in our country as indicated in Table-1.

Table-1

Jute Cultivation Area in Different States of India

State	Jute Cultivation Area in Hectares (1991-92)
Assam	97,700
Bihar	129,300
Meghalaya	5,000
Nagaland	200
Orissa	37,700
Tripura	2,100
Uttar Pradesh	600
West Bengal	573,400
<b>TOTAL =</b>	<b>846,000</b>

SOURCE : Agricultural Situation in India, April 1992  
Ministry of Food and Agriculture, Government of India

Most useful portion of the jute plant is the bast fibre. It contributes about 1/3 rd of the whole jute plant and the rest is the core material commonly called as jute sticks. The bast fibre is separated from the jute plant by retting process and is utilized mainly for the production of gunny bags, used for packing of food grains, cement and many other materials. This gunny bag industry was the major consumer of the jute fibres in the jute producing states. However, with the introduction of synthetic fibres like plastic, polythene etc. the gunny bags are being replaced with bags of synthetic fibres because of their better durability and less cost compared to the gunny bags made up of jute fibres.

With the decline in the market of jute fibre due to the decline in demand of gunny bags, need is felt to find alternative use of jute plant in order to support jute growers as well as save the dying jute industry of the country.

Paper industry is an area where there is a wide scope for utilizing whole jute plant as a papermaking raw material. Lot of research work have been carried out on utilisation of whole mesta and kenaf for papermaking and their suitability established for different grades of paper (1,2). Very little work have been done to establish the suitability of whole jute plant as a papermaking raw material over the other raw materials. Jute bast portion is already in use in paper industry as a raw material for speciality papers, but in very little quantity. Efforts are also made to use the waste of jute plant after extraction of jute fibre (jute sticks) for the production of various grade papers (3,4,5).

Studies are under taken to utilize whole jute plant for kraft pulping and to compare the suitability of whole jute pulp over the pulps obtained from other paper making raw materials like bagasse and eucalyptus.

## EXPERIMENTAL

### Raw Material Preparation :

Whole jute plants collected from West Bengal region were taken for laboratory studies. Air dried plants were chopped manually to obtain chips of 1" size with bast portion intact and the chips representing whole jute.

### Pulping :

Pulping was carried out in a series digester consisting of six bombs each of 2.5 ltrs. capacity, rotating in an electrically heated polyethylene glycol bath. Washing of the pulp was carried out with cold water. After thorough washing, the pulp was screened in laboratory Sarla Screen by using mesh of 0.25 mm slot width. Kappa number of the pulp was determined as per the standard procedure.

### Bleaching :

Pulp was bleached by CEH bleaching sequence under normal bleaching conditions as indicated below by using bleaching dosage optimised on small scale to achieve a brightness target of 76% ISO.

### Conditions for different stages of Bleaching :

	Chlorination	Alkali Extraction	Hypochlorite
Consistency, %	3	8	8
Temperature, °C	30	60	40
Time, min.	40	60	120

Intrinsic viscosity of bleached pulp was carried out in CED solution according to SCAN-C-15.62 Method.

Black liquor analysis was carried out according to TAPPI Method T-625-ts-64.

### Pulp Evaluation :

Beating of pulp was carried out in PFI mill under standard conditions as per ISO DP 5264. Testing of sheet strength and optical properties were carried out as per ISO & SCAN standards given in manual of Laboratory Research Method (6).

## RESULTS AND DISCUSSION

Table 2 indicates the results of proximate analysis of whole jute, eucalyptus and bagasse. Whole jute contains higher holocellulose (75.3%) as compared to eucalyptus (67%), bagasse (69%). Like in bagasse, lignin content in the whole jute is less (23.2%) as against 28% in eucalyptus. Like eucalyptus, whole jute contains less silica (0.2%) compared to bagasse (1.5%). This low silica content is good indication for efficient working of recovery unit.

Table 3 indicate the results of pulping of whole jute, bagasse and eucalyptus. By using 17% chemical as Na<sub>2</sub>O, a reject free pulp of Kappa no. 21.2 and pulp yield 50.2% could be obtained. Though, it consumes little higher cooking chemical than the eucalyptus but it does not effect much as 90% of the chemical is recoverable in the recovery unit. Moreover the pulp yield i. e. 50.2% is quite higher compared to eucalyptus pulp yield (44.3%).

Table 4 indicate the results of bleaching of whole jute, eucalyptus and bagasse pulp. Bleaching response of whole jute pulp is very good like that of eucalyptus and bagasse. Whole jute pulp could be bleached to 76 ± 2% brightness by a simple C-E-H sequence using C<sub>6</sub>E<sub>2</sub>H<sub>1</sub>. Whole jute bleached pulp showed higher intrinsic viscosity compared to eucalyptus and bagasse pulps.

Table 5 shows the physical strength properties of the unbleached and bleached pulps of whole jute, eucalyptus and bagasse at different stages of beating. These properties for unbleached and bleached pulps are also depicted in Figs. 1 & 2 respectively. It is quite evident that all the properties like tensile index, tear index and burst index of the jute pulp are higher than that of eucalyptus and bagasse pulps, tear/tensile ratio was also higher compared to that of eucalyptus and bagasse pulp at all the stages of beating. A comparison of the strength properties at a particular Freeness value (at 300 ml CSF) as indicated in Figs. showed, very high strength properties of whole jute pulp compared to eucalyptus and bagasse pulps.

All the above informations indicate that whole jute is a good raw material for making pulp superior than the eucalyptus and bagasse pulps. For most grades of paper there is no necessity for blending long fibre bamboo or imported softwood pulp. Moreover jute pulp can also be utilised as a reinforcing pulp for other hardwood and bagasse pulps.

Table 6 indicates the cost evaluation of the whole jute plant (per tonne), the farmers are getting at present.

**TABLE—2**  
**Physical Data And The Results Of Proximate Analysis Of Different Papermaking Raw Materials.**

BULK DENSITY Kgs/m <sup>3</sup>		WHOLE JUTE 130	EUCALYPTUS 200	BAGASSE DEPITHED 60—70
S.No.	Proximate Analysis	Whole Jute	Eucalyptus	Bagasse (Depithed)
1.	Ash	1.2	0.50	1.8
2.	Silica	0.24	0.20	1.5
3.	Solubility In:			
a.	Hot Water	3.7	2.5	4.0
b.	Alcohol Benzene	2.40	2.0	2.8
c.	N/10 NaOH	28.5	17.0	30.3
4.	Holocellulose	75.3	67.0	69.0
5.	Klason Lignin	23.2	28.0	23.4

Results Expressed AS % ON O.D. Raw material and Corrected For ASH.

**TABLE—3**  
**Results of Pulping of Whole Jute And Other Raw Materials**

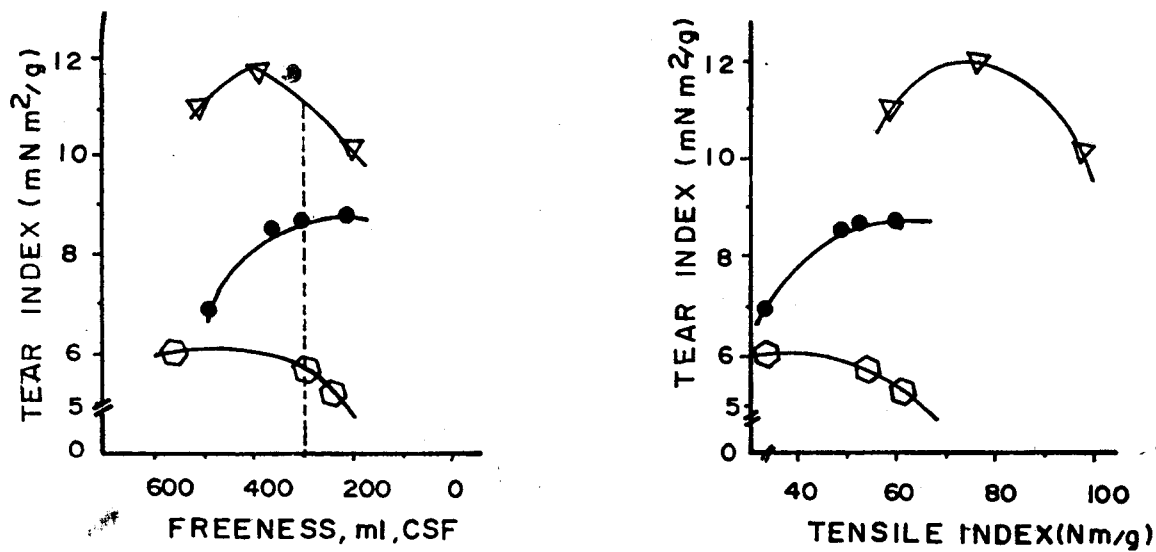
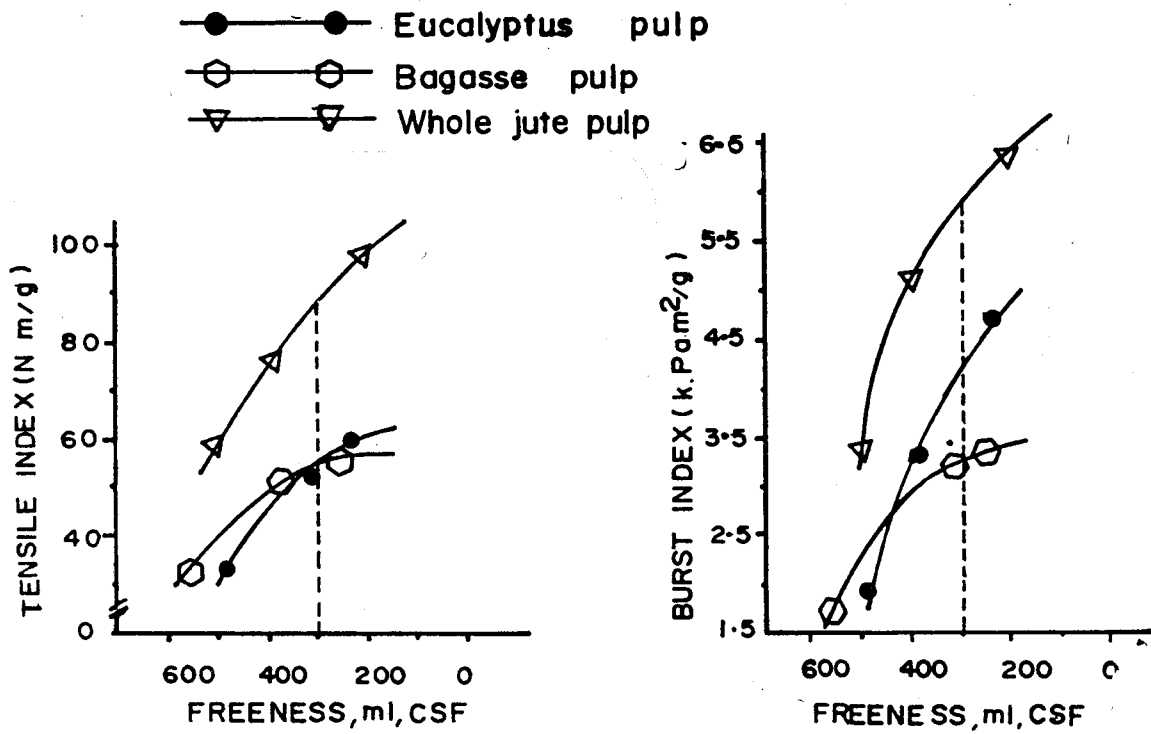
S.N.	PARTICULARS	WHOLE JUTE	BAGASSE	EUCALYPTUS
1.	Cooking Chemical As Na <sub>2</sub> O	17	11	16
2.	Bath Ratio	1:4	1:4	1:3
3.	Sulfidity of Cooking Liquor, %	20	20	25
4.	Cooking Temp., °C	165	168	165
5.	Cooking Time, min	90	60	90
6.	Unscreened Pulp Yield, %	50.2	62.2	44.3
7.	Screened Rejects %	NIL	1.4	0.1
8.	Kappa No. of Unbleached Pulp	21.2	22	27
9.	Black Liquor Analysis			
i)	pH	10.7	10.0	11.2
ii)	Total Solids W/W, %	15.0	11.3	19.5
iii)	Residual Active Alkali As Na <sub>2</sub> O g/l	2.32	1.36	6.64
iv)	Residual Active Alkali As Na <sub>2</sub> O g/l (at 200 gpl Total Solids.)	3.93	2.32	5.53

**TABLE—4**  
**Bleaching Response Of Whole Jute, Bagasse And Eucalyptus Pulp**

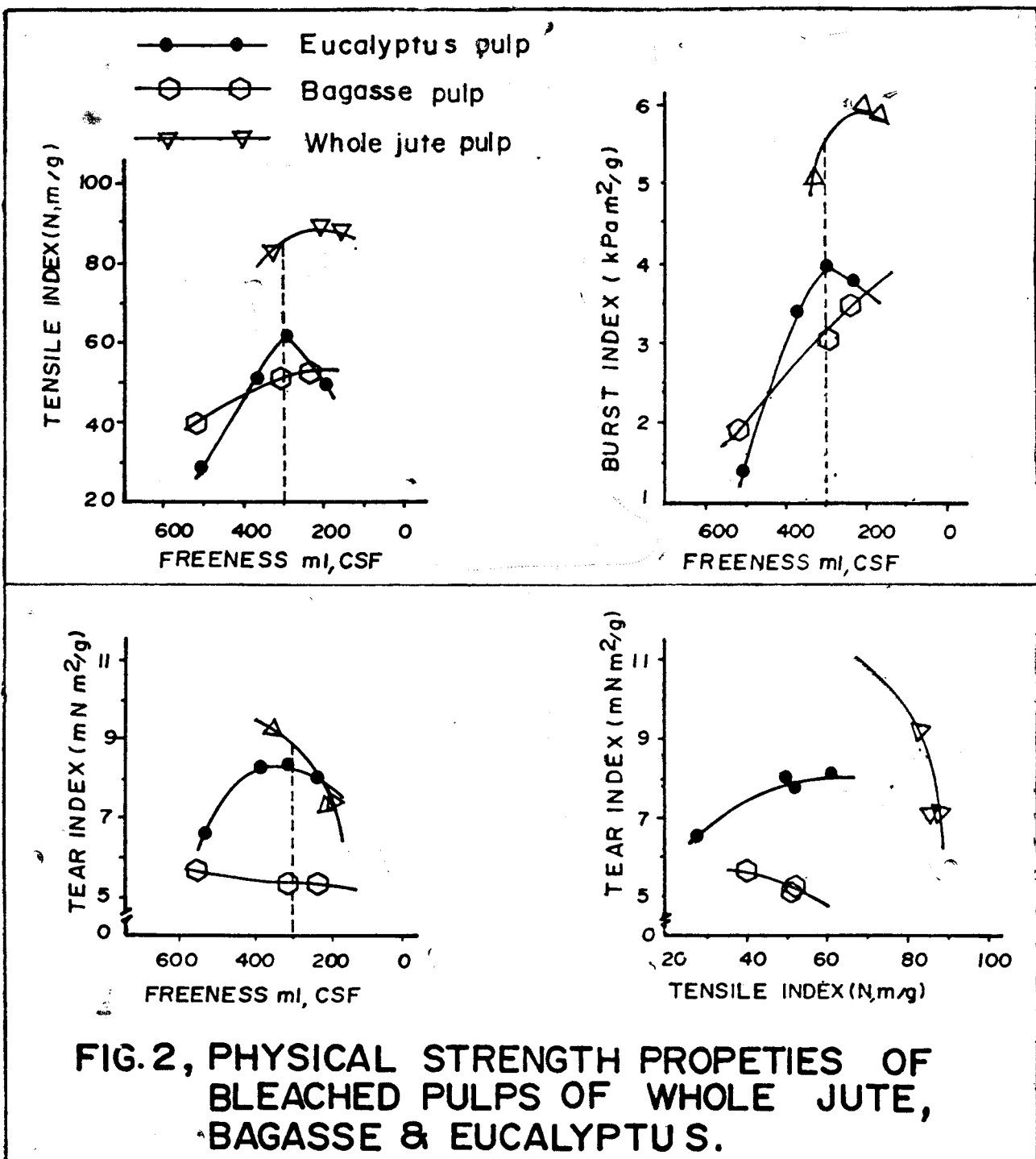
	WHOLE JUTE	BAGASSE	EUCALYPTUS
Kappa No. Of Unbld. Pulp	21.6	22	27
Bleaching Sequence	CEH	CEH	CEHH
1. Chlorination			
Cholorine Applied/ Consumed, %	5.0/4.9	4.5/4.3	6.0/5.2
2. Alkali Extraction (NaOH applied, %)	2.0	2.0	1.25
pH initial/final	11.5/11.1	10.6/10.5	11 0/10.7
3. Hypo Stages			
Hypo Chlorine Applied/ Consumed	1.0/1.0	2.0/1.9	1.5/1.1+1/0.4
Buffer Used As NaOH	0.2	0.5	0.6+0.2
4. Shrinkage (Yield Loss During Bleaching) % on Unbleached pulp	4.8	6.2	5.1
5. Total Chlorine Applied/Consumed, %	6/5.9	6.5/6.2	8.5/6.7
6. Total Sodium Hydroxide Used, %	2.2	2.5	2.0
7. Brightness of Pulp % ISO	77.0	77.8	78.1
8. Intrinsic Viscosity of Pulp cm <sup>3</sup> /g	630	542	570
9. Opacity, %	81	76	85

**TABLE—5**  
**Physical Strength Properties of Ubleached and Bleached Pulp of Whole Jute Bagasse and Eucalyptus**

Particulars	PFI	Freeness	Drainage	Apparent	Burst	Tensile	Tear	Fold	Bendtsen
	(rev.)	ml. C.S.F.	Time S	Density g/cm <sup>3</sup>	Index KPam <sup>2</sup> /g	Index Nm/g	Index mNm <sup>2</sup> /g	Kohler Molin (log)	porosity ml/min.
Whole Jute	0	500	5.4	0.65	3.40	59.0	11.0	1.68	635
	500	400	5.08	0.69	5.15	76.0	12.0	2.79	200
	1000	210	16.3	0.76	6.35	97.0	10.2	2.96	30
Whole Jute Bleached	500	330	12.09	0.73	5.10	82.5	9.20	2.58	351
	1500	200	23.90	0.79	6.00	89.0	7.20	2.74	20
	2000	176	24.10	0.84	5.90	87.0	7.25	2.71	10
Bagasse Unbleached	0	560	4.3	0.68	1.60	32.5	6.0	0.95	1480
	500	305	7.4	0.75	3.20	54.0	5.8	1.80	120
	750	255	9.4	0.70	3.30	55.5	5.4	1.78	53
Bagasse Bleached	0	525	4.8	0.75	1.90	39.0	5.60	1.28	570
	250	300	8.0	0.78	3.05	51.0	5.30	1.62	70
	500	235	11.8	0.81	3.50	51.5	5.25	1.91	25
Eucalyptus Unbleached	0	485	4.85	0.59	1.90	33.0	6.90	1.00	—
	1000	370	5.50	0.68	3.30	50.0	8.60	1.82	—
	2000	305	6.80	0.71	4.10	52.5	8.70	2.10	—
	4000	235	8.85	0.74	4.70	59.5	8.80	2.42	—
Eucalyptus Bleached	0	505	4.05	0.56	1.40	27.5	6.50	0.81	—
	2000	365	6.30	0.69	3.45	50.0	8.20	1.82	—
	4000	295	6.68	0.76	4.00	61.5	8.25	2.10	—
	6000	230	12.95	0.79	3.80	52.5	7.95	2.49	—



**FIG.1, PHYSICAL STRENGTH PROPERTIES OF UNBLEACHED KRAFT PULPS OF WHOLE JUTE, BAGASSE & EUCALYPTUS.**



**FIG. 2, PHYSICAL STRENGTH PROPERTIES OF BLEACHED PULPS OF WHOLE JUTE, BAGASSE & EUCALYPTUS.**

**TABLE—6**  
**Cost Evaluation of whole jute (per tonne), presently the growers are getting.**

	% of Whole Jute	Cost/Ton (Rs)	Value/T of whole jute (Rs)
Bast portion, valuable fibre of the jute plant (suitable for gunny bags Industry).	30	5000/-	1500/-
Jute Sticks, waste of jute plant (used as fuel)	70	300/-	210/₹

On the basis of table 6 we can assume that the farmers are earnings around Rs. 1700/- per ton of the crop which is possible only after lot of labour input for separating the jute bast from jute plant. If the farmers sell their whole jute plant to paper industry at around Rs. 1500/- per ton they can earn better in addition to the wider scope for survival of jute plantation.

### Conclusions

1. Limited demand of jute bast fibres for the gunny bag industry due to increased use of synthetic fibre have resulted in the need to find alternative use of jute plant for the survival of jute industry in the country.
2. Paper industry is one area where the whole jute plant can be used to supplement the growing demand and limited supply of the forest based raw materials for the Indian paper industry.
3. Whole jute plant have an advantage that it does not require any pretreatment step as depithing in case of bagasse.
4. Whole jute plant contains higher holocellulose compared to eucalyptus and bagasse. Like in bagasse, lignin content in whole jute is lower than eucalyptus.

5. Like eucalyptus, the whole jute contains less silica which is a positive indication for efficient working of the recovery unit.
6. By using 17% Na<sub>2</sub>O at 165° C for 90 min. bleachable grade kraft pulp at yield 50% can be prepared.
7. Strength properties of the whole jute unbleached pulp are very much superior to the pulps of conventionally used raw materials like bagasse and eucalyptus.
8. Bleaching response of the whole jute plant chemical pulp is very good, similar to bagasse and eucalyptus pulps. Pulp of around Kappa No. 22 could easily be bleached by CEH sequence to 76% ISO brightness.
9. All the physical strength properties of bleached chemical pulp of whole jute are much superior than that of the bleached chemical pulps of bagasse and eucalyptus.
10. The bleached chemical pulp of whole jute is very good for making different grade of papers. It can also be used as a reinforcing pulp to replace long fiber bamboo pulp and imported softwood pulp for various grades of papers.
11. If the whole jute plant be supplied to the paper industry as a raw material, the farmers can earn almost the same money with less labour input as they are getting by selling bast fibre and jute sticks separately. Moreover there will be lot of avenues, of extending the possibility of growing jute plantation.

### Acknowledgement :

Authors acknowledge the services rendered by Shri K.S Moorthy, Dr. Y V. Sood and other supporting staff of Central Pulp and Paper Research Institute.



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