Production of pulp, paper and boards from agro wastes

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ABSTRACT

India is an agricultural country, which produces several agro-waste raw materials in abundance after the harvest of the crops. These products at present do not find proper use but these are worth for rupees several crores. With new technologies developed recently, these products can be utilized for the production of various grades of pulp, paper and boards, in place of conventional raw materials, which are in short supply in the country This paper reviews the potential of different agrowastes for the industrial utilization, such as in the manufacture of pulp, paper and boards. It is suguested that there is an urgent need to pay more serious attention for the utilization of such agricultural commodities including cotton stalk, cotton seed hull, jute and mesta sticks, straw etc. which are readily available in the country without additional efforts and are not exploited properly so far.

INTRODUCTION

The conventional raw materials like bamboo and soft wood for paper manufacture are in short supply due to the demand for environmental preservation and stiff resistance against deforestation by the Government. Moreover, the forests are shrinking day by day with respect to area as well as stocks due to growth of population increasing demand of wood etc. On the contrary, the demand for fibrous raw materials for manufacture of pulp and paper is increasing rapidly day by day. The existing forest resources in India are not in position to meet the increasing demand of raw materials for manufacture of various types of pulp and paper products. According to the latest estimate the demand for paper in 1988-89 will be around 4 million tonnes and for which around 7.7 millions of raw materials will be required. The countries like India has to depend also on imports of paper, demanding precious foreign exchange. For instance about 2 lakh tonnes of newsprint is annually imported spending a valuable foreign exchange to the tune of Rupees one hundred and sixty crores. This valuable foreign currency can be saved if alternative agricultural crops and residues are utilized for the production of newsprint. Recently technologies have been developed for production of newsprint. using agricultural residues such as, mesta whole plant, cotton plant stalk, jute stick and also cotton rags, waste paper etc.

According to the estimate of the Food and Agricultural Organisation (FAO). the annual requirement of Indian industries for wood is about 12 million tonnes, while supply is only 5.7 million tonnes. There is little doubt that by the end of this century, the position of supply of wood will be alarming not only within India but also for the whole world. Wood-based penel such as particle board has always been an important commodity. The most common type of board is made from wood chips obtained from forest thinnings and timber waste from peeler cores, shartings and mill waste. However, owing to the declining portential of forest, it may not be possible to meet the rapidly increasing needs for board in future. The situation has been further agravated by the rapid increase in the populations of the developing countries.

A Reuter survey on three continents found that governments are finally heeding the words of ecologists and acting to conserve the last remaining forests within

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their borders. But these steps may be too late or impossible to enforce: Tropical rain forests are vanishing at a rate of about 20 hectares a minute, the world wild life estimates.

In cost Rica, long praised for conservation efforts, the last remaining forests out side national parks are expected to fall to the lumberer's chair saw and the settler are by 1995. The falling of trees also hastens erosion and disrupts weather patterns. The consequence is both floods and draughts. Similar situation is likely to prevail through out the world. Though they still cover huge tracts of land in equatorial regions of Latin America, Africa and the vast Archipelago stretching from South East Asia to Australia, bit by bit, the forests are failing to settlers, loggers and urban sprawe.

Ivory coast one boasted 15 million hectares of forest but now only a 10th of that remains. Hard wood timber is the West African State's third largest export but officials say they may have to import it wlthin 10 years. In Brazil waves of settlers are on Amazon gold rash have fuelled the wholesale destruction of the world's largest remaining rain forest to the point that scientists now say it may be nearly wiped out in 15 years. Slash and burn deforestation sends about five million tonnes of carbon dioxide into the upper atmosphere a year. Scientists say the phenomenon already has begun and could drastically cut farm yields around the world as the earth becomes hotter and drier. Forests in India are dwindling in a smaller way the country has to face an alarming situation if specialprecaution is not taken to preserve the remaining forests.

In an agricultural county like India, it is essential that every possible effort should be made to find proper utilization for vast amounts of agricultural waste products. It not only solves disposal problem and ensums rich dividends to the farmers, but also opens an inexhaustible reservoir of natural resources for meeting various challenges facing the nation. The agricultural wastes like jute, ramie and mesta sticks, cotton plant stalk, cotton seed hull, straws, corn cabs and similar other products are the most promising and attractive lignocellulosic sources that can be suitablly used for production of different products. Details of surveys and utilizations of various agricultural wastes availale in India have been reported in earlier publications[2,3]. The manufacture of several products from different agro wastes, appears to be feasible both in small and large scale Industries. The present paper presents a synoptic view of various end uses of the different agro-industrial waste and their role in the development of new industries, preservation of forests and trees and employment of rural population.

UTILIZATION OF JUTE STICK FOR PRODUCTION OF PULP AND PAPER

Jute stick after the extruction of fiberes from the plants is considered as an agricultural waste and it deserves serious attention for its better utilization. It is a fact that for every ton of fibre produced from the jute plant, about 2.5 tonnes of jute sticks are obtained. This by-product of jute cultivation in the country is available about 3 million tonnes per year. The chemical composition of jute stick and fibre is given in Table–1. Cellulose and hemicellulose content of jute stick has attracted the attention of the paper industry for use as subsitute for bamboo and eucalyptus. Jute stick, has been successfully utilized for the production of good quality paper[4,5] There is enough scope for its utilization for production of various grades of writing, printing and speciality papers. Newsprint and speciality grade papers can be manufactured by utilising jute stick pulp in different proportions with conventional pulps even in existing and new paper making units.[6,7] Economic feasibility of jute stick as raw material for mannfacture of kraft paper and speciality paper has been studied in details in JTRL[8,9]. Similarly mixing jute stick with other agricultural residues have shown promising results for production of pulp and paper of various grades. Based on these technologies jute stick can be utilised in small units, i.e. 10-30 tonnes plants or in still smaller units for production of hand made paper in rural areas.

JUTE STICKS FOR BOARD PRODUCTION[11]

The possibility of using jute sticks for making boxboards, hard boards and particle boards has been exmined and results are encourging. The high proposity of sticks is worth taking into considiration for making acoustic and heat insulation boards. Particle board has also been made from jute stick chips in a hot process under suitable temperature and pressure, using thermosetting resins such as urea-formaldehyde, in presence of catalyst. Both Particle board and fibre boards can be used in a number of applications where they are superior to wood based board and at the same time cheaper. The physical property of wood board can not be adjusted

TABLE—1

Chemical composition of Different Raw Materials

%	Cotton seed hull	Jute Stick	Cotton Stalk	Bagasse	Hard wood	Soft wood
Cellulose	35—47	40·8	40.6	54·5	40—43	40—43
Hemicellulose	19—27	31 9	26	24·5	30—35	25—30
Lignin	15—20	23·5	19·4	20·0	20—25	25—30
Ash	2.0	0·8	3·0	1·17	—	—
Others	3.0	3 0	11 0	0·33	—	—

TABLB—II

Properties of Paper from Unbleached and Bleached Semi-Chemical Pulps

Sl. No.	Properties	A* Unbleached	A* Bleached	B* Unbleached	B* Bleached	C* Unbleached	C* Bleached
1.	Bulk density Cm^3/g	2.20	1.72	2.10	1.66	1.90	1.71
2.	Breaking length in Km	2.30	3.00	2.72	3.70	3.10	3.80
3.	Strength %	2.20	2.40	2.60	2.70	2.60	2.80
4.	Burst Factor	17.30	18.30	20.20	21.90	22.50	22.80
5.	Tear Factor	73.50	76.20	86,00	90.90	85.50	90.90
6.	Double Folds (MIT)	16	20	20	28	25	28
7.	Porosity (ML/MIN)	1300	400	1050	260	700	240
8.	Brightness	18.9	43.5	21.5	51.0	26.1	57.3

A*= 5% NaOH as Na_2O%
B*=10% NaOH as Na_2O%
C*= 5% NaOH+5% Na_2SO_3 as Na_2O%

TABLE—III

Characteristics of Particle Boards made from Cotton Plant Stalk

Sl.No.	Resin Content %	Density g/cc	Tensile Strength parallel to plane Kg/Cm^2	Modulus of rapture Kg/Cm^2
1.	3.7	0.57	5.8	15.5
2.	6.4	0.61	15.4	21.2
3.	12.2	0.67	22.8	35.0
4.	14.6	0.69	27.0	43.5
5.	20.8	0.72	27.3	66.7

TABLE—IV

Characteristics of Particle Boards made from Cottonseed hull

Rosin (%)	Moisture (%)	Density (gm/cm^3)	Tensile Strength Parallel with plane ($Kg\ cm^{-2}$)	Modulus of rapture ($Kg\ cm^{-3}$)
0	15	1.14	0.47	6.98
2	15	1.21	5.84	21.74
7	15	1 25	7.89	32.98
10	15	1.27	12.53	44 17
15	15	1 28	14.67	45.16
18	15	1.28	17.70	47.11

TABLE—V

Comperative properties of Mesta newsprint and sample from Hindustan P. L.

Sl. No.	Properties	Mesta Sample	Mill Sample
1.	Grammage (G/m^2)	50.8	51.5
2.	Thickness (microns)	100	100
3.	Apparent density (g/cm^3)	0.51	0.51
4.	Tensile Index (Nm/8) MD/CD	28.0/14.5	29.0/10.5
5.	Stretch % (MD/CD)'	1.3/2.6	1.1/1.4
6.	Burst Index (IC Pam^2/g) MD/CD	0 25	0.50
7.	Tear Index (MNm^2/g) MD/CD	6.20/7.10	3 10/4.30
8.	Air Resistance (S/100 ml)	13.5	—
9.	Fold (MD/CD)	17.7	—
	OPTICAL BRIGHTNESS		
10.	Brightness %	51.3	55 2
11.	Opacity %	90.8	95.3
12.	Sp. Scatt. Coefficient (m^2/Kg)	37 9	45.0
	PRINTING PROPERTIES		
13.	Print surfac Roughness (mm) MD/CD–H–20	7.15/7.60	3.6/3.7
14.	Ink Demand (Ink layer)	9.8	—
15.	Amount (ml)	1.25	—
16.	Print through (Macbeth Density)		
	S. No. 1 (53 GSM)	0.68	0.37
	S. No. 2 (59 GSM)	0.41	—

according to need, but boards made from jute stick can be tailor-made for various applications. Small scale industries can be set up in the jute growing regions, in rural areas, which will provide an opportunity for employment to poor farmers and this may enhance their income. The possible cost of jute stick particle board will be about Rs. 24/- per sq. mtr. (size:305 cm × 30.5 cm × 1.27 cm). While the cost of a similar type of conventional board is Rs. 89/- per sq. mtr.

COTTON PLANT STICK FOR PRODUCTION OF PULP AND PAPER

Cotton plant is mainly cultivated for its fibre as a fibrs crop, it occupies a unique position in the textile world. The other products of cotton plant after remaining cotton fibre are considered as agricultural waste[12],[13] and not much attention has been paid for the utiliuation of cotton plant stick, cotton seed hull, leaf etc. which are still mere wastes can be profitably used for industrial purposes[14].

Total production of cotton plant stick in the country is about 40 million tonnes per annum. In contrast to other agricultural residues, cotton plant stick is comparable to the most common species of hard woods with regard to fibrous structure and dimensions[14]. The chemical composition of different raw materials is given in Table—I. Pulp and paper made from semi-chemical pulp produced from cotton plant stalk can be utilized for various end uses. Moreover the paper products produced from cotton stalk will be much cheaper compared to the paper produced from the conventional raw material. The properties of paper from unbleached and bleached semi chemical pulps[15] indicate that good quality paper bleached as well as unbleached can be produced from agricultural waste products like cotton plant stalk. Moreover, blending of cotton plant stalk pulp with other agricultural waste pulp of conventional pulp can be made for production of different types and grades of products for specific end uses. Pulp and paper produced from cotton plant stalk will be economical than those produced from conventional raw materials, as this agrowaste is available in abundanbe at a very low price.

COTTON STALK FOR PRODUCTION OF BOARDS

Cotton plant stalk can be used as a raw material for preparing composite boards[16]. The stalk cut into small chips and mixed with natural or synthetic resins can be made into particle boards for different end uses. For preparation of boards from wood particles, several binding materials have been suggested[18-20]. The quality of boards depends on various factors such as pressure, temperature and particle size and the type of binder used. Attempts have also been made to prepare hard boards from cotton stalk by converting the material to fibrous state using steam under pressure. Some work has also been reported on hardenrng and fibre retardance of boards[22]. A simple process was developed for production of particle board from cotton stalk, commercially appropriate to rural conditions[17]. These boards have potential for use for interior decoration and partitioning. They can also be used in furniture making as table tops, drawer bottoms and several other components. Besides solving the waste disposal problem, it would open employment avenues in village and improve the economy of the farmers and will be substitute to the conventional material which will help in preservation of forests and greenery in the country.

COTTON SEED HULL FOR PRODUCTION OF BOARDS[23]

Among the cotton seed producing countries, India ranks fourth being next only to USSR, USA and China. The prodution of cotton seed is about 3 million tonnes from which about 1.2 million tonnes of cotton seed hull, on outer covering of the seed is available. A simple process for the production of particle board from cotton seed hull has been developed. The process is appropriate to rural conditions and does not require very expensive machinery boards make from hulls can be cut, nailed, painted and polished by conventional methods Many kinds of particle board might be made from cotton seed hulls and these could be used for ceiling and wall coverings, as decorative sheets and in furniture as table tops and drawers. Lower density particle boards can be used for insulating purposes and those of higher density for making various types of tools such as press tools, jigs, rubber press dies and drawing and piercing tools. The production cost of boards from cotton seed hull is cheaper than the conventional process of board making. The milling of hulls requires much less power compared with other hard woods because of the small particle size involved. The production of boards from hulls is a process, which could be exploited by farmer in cotton seed growing areas.

Flame retarding partiele board has also been made from cotton seed hull[24]. This type of board will prevent fire hazards in order to protect life and property if used on a large scale.

PRODUCTION OF NEWSPRINT FROM MESTA PLANTS

Mesta plant is widely cultivated in India in about 3 lakh hectares and its fibre is utilised for various purposes including rope making. Its sticks are used as fuel or some times burnt away. Due to coarseness of its fibre, it is not very useful as textile fibre. Efforts were made to study the utilizations of mesta whole plant for production of newsprint. Generally newsprint has been produced from soft wood pulp with long fibre to give better strength, surface brightness, opacity and other qualities required for newspaper production. Countries, like India has limited resources of soft wood, therefore large quantity of pulp and paper has to be imported from other countries by spending valuable foreign exchange. Annual requirement of newsprint in the country is about 4.5 lakh tonnes while its production in the country is around 2.5 lakh tonnes. About 2 lakh tonnes of newsprint is imported annually. Hence the work was taken up in collaboration with JTRL Calcutta with Central Pulp and Paper Research Institlte Dehradun and it has been found that whole mesta plant can be utilised for production of newsprint of suitable quality. The newsprint produced in pilot plant trial from whole mesta plant compared well with those produced from conventional raw materials. It is further seen that the process of newsprint production from mesta whole plant is simple and economical. The use of mesta whole plant for production of newsprint will help in meeting the requirement of newsprint in the country and also will have to save large amount of valuable foreign exchenge which is presently being spent on import of newsprint. The comparative properties of mesta newsprint with commerctal newsprint sample from H.P.L, Kerala indicates almost similar properties. The economics of the process also indicates that the cost of newsprint produced from mesta will be much lower than the paper produced from conventional product and it will fetch higher income to the farmers cultivating the mesta crop.

CONCLUSIONS

Various possible ways for utilizing agrowastes have been described. Installation of even a few of the small scale industries mentioned in the above discussion in the rural sector could generate additional employment opper tunities for the rural poor.

At present, when there is an acute shortage of conventional raw materials like wood for the industries making pulp and paper, board and the ecological balance is endangered due to deforestation, it is high time to make use of the different agrowastes like cotton plant stalk, jute & mesta sticks, bagasse, corn cobs etc. and similar various other materials available in huge quantity in our country especially from annual renewable crops.

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