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# SCOPE OF USING DIFFERENT AGROWASTES AS RAW MATERIALS FOR PRODUCTION OF PULP AND PAPER

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**Abstract:**

The conventional raw materials like eucaliptus and bamboo for a major portion (about 75 %) of the fibre source, for pulp and paper production in India. The conventional raw materials both soft wood and hard wood for paper manufacture are in extremely short supply. Also to present the environmental pollution, there is demand for environmental preservation and stiff resistance against deforestation. On the contrary, the demand for fibrous raw materials for manufacture of pulp and paper is increasing rapidly day by day. The forest in India is unable to meet the demand of raw materials for manufacture of variuos types of pulp and paper products. Requirement of raw materials for pulp-paper in 1988-89 will be around 7.7 millions tonnes would reach an atronomical figure of 17 million tonnes by 2000 A.D. The country like India has to depend also on imports of paper, demanding precious foreign exchange. For instance, more than 2 lakh tonnes of newsprint is annually imported by spreading a valuable foreign exchange to the tune of rupees one hundred sixty crores. This valuable foreign currency can be saved if alternative agricultural crops and residues are expoilted for the production of newsprint.

India is an agricultural country, which produces several agrowaste raw materials, in abundance after the harvest of the crops. With new technologies developed at JTRL, many of these products can be utilised for the production of pulp, paper and baords, in place of conventional raw materials, which are alredy in short supply in the country. In this paper, the potentiality of different agrowastes for the industrial utilisation in the manufacture of pulp and paper products has been reviewed. It is strongly felt that there is an urgent need to pay more alteration for utilisation of vast amount of agricultural wastes including cotton stalk, jute and mesta stick as well as their whole plants, straws etc. which are readily available in the country without additional effort and are not exploited properly so far. It is not only solves disposal problems and ensures rich divident to the farmers, but also opens an in-exhaustible reservoir of natural resources for meeting various challenges facing the nation.

**Introduction**

The importance of paper as a tool for national growth needs no special emphasis. The per capita paper consumption in India is much less, compared to developed countries. Even to maintain the present level of consumption, it is imperative that paper industry must grow to meet the challenge from the increasing population and ancilliary industries required paper, paper board and other paper products. According to report to technology on group of the development council of paper, pulp and allied industries, if the population of India of 60.56 crores i 1976 increased to 94.58 crores by 2000 AD and per capita consumption rose from 2 kg in 1976 to 4.5 kg in 2000 A.D. Country should have at the turn of the installed capacity of 42.5 lakh tonnes as shown in Table-I. The National Commission on Agriculture has estimated a domestic consumption of various categories of paper and pulp for the year 1985 and 2000 AD, as given in Table II, which indicates the additional capacity that would be needed in future. The conventional raw materials like bamboo and soft wood for manufacture of pulp and paper are in short supply. Also to prevent the environmental pollution, there is demand for preservation of forest and natural greenary which restricted against deforestation by the Government.

On the contrary, the demand for fibrous raw material for manufacture of pulp and paper is increasing rapidly day by day. The existing forest resources in the country are not sufficient to meet the demand of raw materials for manufacture of pulp and paper products. The alternative way is to meet the partial demand by imports of paper, spending precious foreign exchange. In an agricultural country like India, it is essential that every possible efforts should be made to find ways for proper utilisation for vast amounts of agricultural waste products. It, not only solves, disposal problems and ensures rich dividends to the farmer, but also offers an in-

exhaustible reservoir of natural resources for meeting various challenges facing the nation. The agricultural wastes like jute, mesta sticks, cotton plant stalk, jute and mesta whole plant straws, bagasse and similar other products are the most promising and attractive ligno-cellulosic sources that can be suitably used for productions of different products. Details of surveys and tuilisations of various agricultural wastes available in India have been reported in earlier publications[1-2]. The manufacture of several products from different agrowaste, appears to be feasible both in small and large scale industries. The present paper presents a synoptic view various end uses of the different agro-industrial wastes and their role in the development of new industries and employment of rural populations.

**Utilization of Jute Stick for production of pulp and paper**

Jute stick, after the extraction of fibres from the plants is considered as an agricultural wastes. Hence, it deserves serious attention for its proper utilization. It is a fact that for every tonne of fibre produced from jute plant, about 2.5 tonnes of jute sticks are obtained.This by-product of jute cultivation in the country is available about - 4 million tonnes per year. the chemical composition of jute stick and fibre is given in Table - 3. Cellulose and hemicellulose content of jute stick has attracted the attention of the paper industry for use as substitute for conventional raw materials in jute growing are as. There is enough scope for its utilization for production of various grade of writing, printing speciality papers and newsprint by utilizing the jute stick pulp in different proportions with conventional pul even in existing paper mill. jute stock, has been successfully utilized for the production of good quality paper. Jute stick can be converted to a pulp by various methods, these are as under: a) Kraft process using mixture of sodium sulphide and caustic soda as cooking chemical at about 160°C-170°C for 3-4 hours, maintaining the total alkalinity at 15-18 % and sulphidity at 20-24 %. The results are given in Table 4-8. (b) Chemi-mechanical process (by cold soda and hot soda chemi-mechanical process).

It is an inexpensive process involving softening treatment of jute stick with caustic soda solution of low concentration at room temperature for about 2 days or at elevated temperature for about 2-3 hrs, followed by refining and beating to get the pulp. It was observed that with the increase of percentage of alkali the yield decreased and the breaking length and fold increased to a constant value. Economic fisibility of jute stick as raw material for manufacture of kraft paper and speciality paper has been studied in details at J.T.R.L. Similary mixing jute stick with other agricultural residues like rice straw jute root cuttings, cotton rangs cotton stalks etc. have shown promising results for production of better grade pulp & paper. Based on these technologies jute stick can be utilised in small units ie. 10-30 tonnes plants or in still smaller units for production og hand made paper in rural areas. The results are given in Table 9-10.

**Utilization of Jute Root cutting as raw material for production of pulp and paper.**[10]

Jute is an important cast crop grown to the tune of about 1.8 million tons every year. About 10-15 % of the crop contains hard barky roots at the bottom portion of the fibre knonen as jute root. It is an excellent raw material for making paper particularly of special grade. Extensive research at JTRL has shown that high yield soda chemi-mechanical pulp could be obtained from jute root cuttings by treatment with 10 % NaOH solution. The strength characteristic of the pulp had been found to be very satisfactory. Addition of Anthraquinone (0.05 %) during cooking of jute root cutting with caustic soda solution improved the breaking length, fold and tear factor. Karft pulping of jute root cutting gane good yield of bleachable grade pulp of very satisfactory strength characteristics. The results are given in Tables 11-13.

**Cotton plant stalk for production of pulp and paper** 11-17

Cotton plant is mainly cultivated for its fibre and as a fibre crop it occupies an unique position in the textile world. Total production of cotton plant stalk in the country is about 40 million tonnes per annum. In addition to other agricultural residues, cotton plant stalk is comparable to the most common species of hard woods with regard to fibrous structure and dimensions. Pulp and paper made from semi-chemical pulp produced from cotton plant stalk can be utilised for various and 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 pulp indicated 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 with other agricultural waste pulp or conventional pulp can be made for productions of different types and grades of products for specific and uses. Pulp and paper produced from cotton plant stalk will be economical that those produced from conventional raw materials, as this agrowastes is available in abundance at a very low price.

**Production of Newsprint from Mesta whole plant** 18-19

Mesta plant is widely cultivated in India in about 3 lakh hecteres and its fibre is utilized for various purposes including rope making. Its sticks are used as full 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 utilization 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. To meet this demand locally the pilot plant trial for production of newsprint from mesta whole plant, was taken up in collaboration with J.T.R.L., Calcutta and Central Pulp and Paper Research Institute, Dehra Dun and it has been found that whole mesta plant can be utilised for production suitable quality of newsprint. The newsprint produced in pilot plant trial from whole mesta plant compared well with there produced from conventional raw materials. It is further seen that the process of newsprint production from whole mesta 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 help to some large amount of valuable foreign exchange which is presently being spent on import of newsprint. The comparative properties of mesta newsprint with commercial newsprint samples from H.P. Kerala indicate almost similar properties. The economic 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 also fetch higher income to the farmer cultivating the mesta crop.

**Conclusions:**

Various possible ways for utilization of agrowastes have been described. Installation of even a few small scale industries mentioned in the above discussion in the rural sector could generate additional employment opportunities 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 degenred due to deforestation, it is high time to make the best use of the different agrowastes like jute and mesta whole plant etc. and other materials available in huge quantity in our country from annual crops, either alone or in admixture with other conventional raw materials.

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TABLE-I

GROWTH IN POPULATION UPTO 2000 A.D. AND PER CAPITA CONSUMPTION OF PAPER

| Year | Population | Capacity (in Lakh tonnes) | per Capita Consumption (in Kg) | Rates of Growth for the 15 years period (percentage) |
|---|---|---|---|---|
| 1976 | 60.56 | 11.3 | 2.0 | -- |
| 1981 | 66.82 | 16.8 | 2.5 | 7.0 |
| 1986 | 73.04 | 22.0 | 3.0 | 5.5 |
| 1991 | 80.12 | 28.0 | 3.5 | 5.0 |
| 1996 | 88.26 | 35.0 | 4.0 | 4.5 |
| 2000 | 94.56 | 42.5 | 4.5 | 4.0 |

TABLE-II

REQUIREMENT OF PAPER BY THE YEAR 2000 A.D.

| Sl. No. | Item | Average Esti-mated Consumption (in Tonnes) in The Year. 1985 | 2000 A.D. |
|---|---|---|---|
| 1. | Printing & Writing Paper | 1055 | 2726 |
| 2. | Newsprint | 417 | 1014,5 |
| 3. | Industrial Paper | 373,5 | 1023,5 |
| 4. | Paper Board | 464 | 859,5 |
| 5. | Rayon Grade Pulp | 2355,5 | 6899,5 |

TABLE-III

CHEMICAL COMPOSITION OF DIFFERENT RAW MATERIALS

| | Jute Stick | Cotton Stalk | Baga-sse | Jute Root cutt-ings | Hard Wood | Soft Wood |
|---|---|---|---|---|---|---|
| CELLULOSE | 40.8 | 40.6 | 54.5 | 60 | 40.43 | 40-43 |
| HEMI-CELLULOSE | 31.9 | 26 | 24.5 | 25 | 30-35 | 25-30 |
| LIGNIN | 23.5 | 19.4 | 20.0 | 11 | 20-25 | 25-30 |
| ASH | 0.8 | 3.0 | 1.17 | 1.16 | -- | -- |
| OTHERS | 3.0 | 11.0 | 0.33 | 2.84 | -- | -- |

TABLE-IV

USE OF DIFFERENT M.L. RATIO, YIELD PULP AND PROPERTIES OF PAPER

| Expt NO: | Material to Liquor ratio | Unbleached Pulp yield | Permanganate No. | Breaking length (m) | Fold |
|---|---|---|---|---|---|
| 1. | 1:5 | 43 | 15.9 | 5650 | 115 |
| 2. | 1:6 | 44 | 16.2 | 5720 | 150 |
| 3. | 1:7 | 47 | 18.5 | 5860 | 201 |
| 4. | 1:8 | 49.38 | 19.6 | 6210 | 245 |
| 5. | 1:9 | 56.21 | 20.2 | 7010 | 250 |
| 6. | 1:10 | 62.1 | 22.3 | 7902 | 261 |

Time — 3 Hrs. Sulfidity — 25%.
Percentage of Chemical - 25 % Max. Temp. - 170°C

TABLE-V

USE IN CHEMICAL CONC & YIELD OF PULP

| Expt NO. | % Chemical | yield | Permanganate no. | Breaking length (m) | Fold |
|---|---|---|---|---|---|
| 1. | 15 | 70.3 | 27.4 | 8000 | 203 |
| 2. | 17.5 | 54.5 | 19.2 | 7660 | 259 |
| 3. | 20 | 52.3 | 15.8 | 7540 | 256 |
| 4. | 25 | 48.7 | 15.1 | 6836 | 58 |
| 5. | 28 | 47.6 | 14.7 | 6550 | 12 |
| 6. | 30 | 46 | 13.1 | 3500 | 4 |

Time - 3 Hrs. Sulphidity-25 %
Lig. Ratio — 1:5, Max. Temp. - 170°C.

## TABLE-VI

### EFFECT OF PULPING TIME ON YIELD & PROPERTIES OF PULP

| Expt No. | Time at Max Temp. Hrs. | Unbleached Pulp Yield (%) | Permanganate No. | Breaking Length (m) |
|---|---|---|---|---|
| 1. | 1 | 62.64 | 20.1 | 5692 |
| 2. | 2 | 59.1 | 16.15 | 5950 |
| 3. | 3 | 52.3 | 15.8 | 7540 |
| 4. | 4 | 48.3 | 14.20 | 7560 |
| 5. | 5 | 46.2 | 13.40 | 6202 |

Sulphidity - 25 % Lig. Ratio - 1:5, Percentage of Chemical - 20 % Temp. 170°C.

## TBALE VII

### EFFECT OF TEMPERATURE ON DIGESTION, YIELD & PROPERTIES OF PULP.

| Expt No. | Temp. of digestion $^0C$ | Unbleached Pulp Yield (%) | Permanga-nate | Breaking Length (m) |
|---|---|---|---|---|
| 1. | 150 | 58.3 | 17.7 | 7344 |
| 2. | 160 | 54.2 | 16.2 | 7500 |
| 3. | 170 | 48.3 | 14.8 | 7560 |
| 4. | 180 | 44.2 | 13.0 | 7140 |

Time - 3/½ hrs., Sulphidity - 25% Lig Ratio - 1:5
Percentage of chemical - 20%

## TABLE-VIII

EFFECT OF SULFIDITY ON YIELD & VARIOUS PROPERTIES OF PULP

| Expt No. | Sulfidity | Unbleached Pulp Yield (%) | Permanganate No. | Breaking Length (m) | Fold |
|---|---|---|---|---|---|
| 1. | 10% | 46.2 | 20.68 | 4957 | 112 |
| 2. | 15% | 48.33 | 17.7 | 6444 | 203 |
| 3. | 20% | 48.6 | 16.28 | 7110 | 241 |
| 4. | 25% | 48.9 | 15.0 | 7550 | 260 |
| 5. | 30% | 49.4 | 21.58 | 6601 | 278 |

Percentage of Chemical - 20 %, Time — 3½ hrs. Lig. Ratio - 1:5, Max. Temp. — 170°C.

## TABLE IX

### PULPING CONDITIONS AND STRENGTH CHARACTERISTICS OF SODA CHEMICAL JUTE STICK PULP.

| Expt No. | Strength-of NaoH (%) | Liquor Ratio | Temp. of Digestion | Time of Cooking Cooking (Hrs.) | Yield (%) | Permaga-nate | Breaking Length (m) | Fold No. |
|---|---|---|---|---|---|---|---|---|
| 1. | 5 | 1:8 | 160° | 3 | 80 | -- | 3170 | 14 |
| 2. | 7.5 | 1:8 | 160° | 3 | 75 | -- | 3000 | -- |
| 3. | 10 | 1:8 | 160° | 3 | 67 | -- | 4160 | 55 |
| 4. | 20 | 1:8 | 160° | 3 | 44 | 17.1 | 4870 | 208 |
| | | | | | | | 4980 | 220 |

## TABLE X

PULPING CONDITIONS AND STRENGTH CHARACTERISTICS OF SODA CHEMI-MECHANICAL JUTE STICK PULP.

| Expt No. (%) | Strength of NaoH | Liquor Ratio | Soaking time hrs. | Temp of Soaking | Yield (%) | *Breaking length (m)* | *Fold No* |
|---|---|---|---|---|---|---|---|
| 1. | 5 | 1:10 | 72 | Room Temp. | 81 | *3200* | *14* |
| 2. | 7.5 | 1:10 | 72 | -do- | 78 | *3000* | -- |
| 3. | 10 | 1:10 | 72 | -do- | 76 | *4000* | *55* |
| 4. | 15 | 1:10 | 71 | -do- | 76 | *5000* | *150* |
| 5. | 20 | 1:10 | 72 | -do- | 76 | *5000* | *145* |

TABLE - XI
STRENGTH PROPERTIES OF SODA CHEMI-MECHANICAL JUTE ROOT CUTTING PULP BEATEN TO DIFFERENT DEGREES OF FREENESS

| Nature of pulp | °SR | Strength Naoh (%) | Liquor Ratio hours | Time of Soaking | Temp | Yield | B.L. (m) | T.P. | Fold No. |
|---|---|---|---|---|---|---|---|---|---|
| Soda Chemi-mechanical jute root cutting pulp (obtained by treatment with (10% NaoH) | 47 | 10 | 1:5 | 72 | Room temp. | 80.2 | 4426 | 195 | 211 |
| | 55 | 10 | 1:5 | 72 | -do- Room temp. | 80.2 | 5926 | 160 | 649 |
| | 60 | 10 | 1:5 | 72 | Room temp. | 80.2 | 7396 | 152 | 1079 |
| | 65 | 10 | 1:5 | 72 | | 802 | 6582 | 130 | 672 |

## TABLE - XII
### PULPING CONDITIONS AND STRENGTH CHARACTERISTICS OF CHEMI-MECHANCAL JUTE ROOT CUTTING PULP

| Method of pulping | Strength of NaoH (%) | Anthra quinone | Liquor Ration | Time of Soaking/ open Cooking hrs. | Temp. °C | Yield % | Breaking | Burst Factor | Tear Factor | Fold No |
|---|---|---|---|---|---|---|---|---|---|---|
| Soda chemi- | 5 | — | 1:5 | 72 | Room temp. | 86 | 6120 | 38 | 150 | 264 |
| mechani- | 10 | - | 1:5 | 72 | Room temp. | 80 | 7396 | 40 | 152 | 1079 |
| cal pulp- | 15 | — | 1:5 | 72 | Room temp. | 80 | 6365 | 33 | 171 | 581 |
| ing | 20 | — | 1:5 | 72 | Room temp. | 80 | 5420 | 31 | 178 | 375 |
| Hot Soda Chemi- | 10 | — | 1:10 | 4 | 95°C | 74 | 6345 | -- | 124 | 716 |
| mechanical | 15 | — | 1:10 | 4 | 95°C | 76 | 7623 | -- | 112 | 524 |
| pulping | 20 | — | 1:10 | 4 | 95°C | 73 | 63330 | — | 130 | 656 |
| Soda Anthra | 10 | 0.05 | 1:10 | 3 | 95°C | 75 | 7548 | — | 193 | 466 |
| quinon chemi- | 13 | 0.05 | 1:10 | 3 | 95°C | 74 | 9303 | -- | 166 | 949 |
| mechanical pulping | 20 | 0.05 | 1:10 | 3 | 95C | 73 | 8804 | -- | 139 | 614 |

## TABLE - XIII

### PULPING CONDITIONS AND STRENGTH CHARACTERISTICS OF JUTE ROOT CUTTING KRAFT PULP

| Method of pulping | Percent Chemical % | Sulphidity as Na2O% | Liquor Ratio | Temp. of cooking °C | Time of-Cooking | Yield % | B.L. (m) | T.F. | Permn No. | Fold No. |
|---|---|---|---|---|---|---|---|---|---|---|
| Kraft pulping | 11.6 | 3.9 | 1:5 | 160 | 3 | 62.2 | 8634 | 165 | 12 | 1350 |
| | 11.6 | 5.9 | 1:5 | 160 | 3 | 67 | 7456 | 180 | 12.5 | 1537 |
| | 11.6 | 7.9 | 1:5 | 160 | 3 | 60 | 6253 | 185 | 7.9 | 1489 |

## TABLE - XIV

### PROPERTIES OF PAPER FROM UNBLEACHED AND BLEACHED SEMICHEMICAL PULPS FROM COTTON STALKS

| Sl. No. | Properties | *A | | *B | | *C | |
|---|---|---|---|---|---|---|---|
| | | Unbleached | Bleached | Unbleached | Bleached | Unbleached | Bleached |
| 1. | Bulk density $cm^3/g$ | 2.20 | 1.72 | 2.10 | 1.66 | 1.90 | 1.71 |
| 2. | Breaking length 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 | 2.60 |
| 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 NaO%

B* = 10% NaoH as Na2O%

C* = 5% NaoH + 5% Na2So3 as Na2O

## TABLE - XV

COMPARATIVE PROPERTIES OF MESTA NEWSPRINT AND SAMPLE FROM HINDUSTHAN P. L.

| Sl. No. | Properties | Mesta sample | Mill sample |
|---|---|---|---|
| 1. | Grammage ($G/m^2$) | 50.8 | 51.5 |
| 2. | Thickness(Microus) | 100 | 100 |
| 3. | Apparent density ($g.m^3$) | 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 | 1.10/4.30 |
| 8. | Air Resistance (s/100 ml) | 13.5 | -- |
| 9. | Fold (MD/CD) | 17.7 | - |

## Optical brightness

| Sl. No. | Properties | Mesta sample | Mill sample |
|---|---|---|---|
| 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

| Sl. No. | Properties | Mesta sample | Mill sample |
|---|---|---|---|
| 13. | Print Surface Roughness (mm) (MD/CD-H-20) | 7.15/7.60 | 3.6/3.7 |
| 14. | Ink Demani (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 | - |