Cellulosic Raw Materials For Indian Paper Industry and Technological Options

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INTRODUCTION :

Paper is an essential component of a modern society. Paper consumption for any country closely follow the growth economics of that country. As a component of peoples consumption, paper contributes about one percent to the annual value of world economic activity - gross domestic product (GDP). For developing countries the consumption of paper per unit of income has increased over the years. In some of poor countries particularly those which have rural economy as their mainstay the consumption of paper is low.

India has over 26% of the world's population but consumes only 1% of the world's paper and paper board. However, with the liberalisation of market economy it is expected that both domestic and export market may see a growth rate of over 5%. As India enters the world consumer market the demand will be high for paper and paper boards, particularly the packaging grades, fine paper and other cultural varieties. The actual paper production which was 2.8 million tonnes in 1995-96 is expected to reach 3.4 million tonnes by the year 2000 and 5.0 million by 2010.

To meet the projected demand of paper, board and newsprint. India as a role model will be looking for utilising forest base materials, agro-residues, waste paper and imported market pulp for meeting its requirement of paper industry. In the present paper we havediscussed the future demand of paper, board and newsprint, availability of raw materials particularly forest based and agro-residues (bagasse and straws), problems involved and technological options vis a vis role of Central Pulp & Paper Resreach Institute in upgrading paper making potential of non-woods.

DEMAND PROJECTION FOR PAPER, BOARD AND NEWSPRINT:

Future demand for paper, paper board and newsprint till 2010 have been studied by a number of agencies. Purpose of these studies is to arrive at some sort of demand requirements, so that measures can be adopted by the paper industry in case of any eventuality. The task of projecting the demand requirements is complex because of the fact that it does not follow a set pattern, but it is governed by a number of external factors, which change at an acceleration. Such factors may include world economy, national economy and policy, development in communications, unforseen changes in technology, and depletion of raw material, inputs etc. Based on a study conducted by Development Council in 1990 the future demand till 2010 is shown in Fig. 1.

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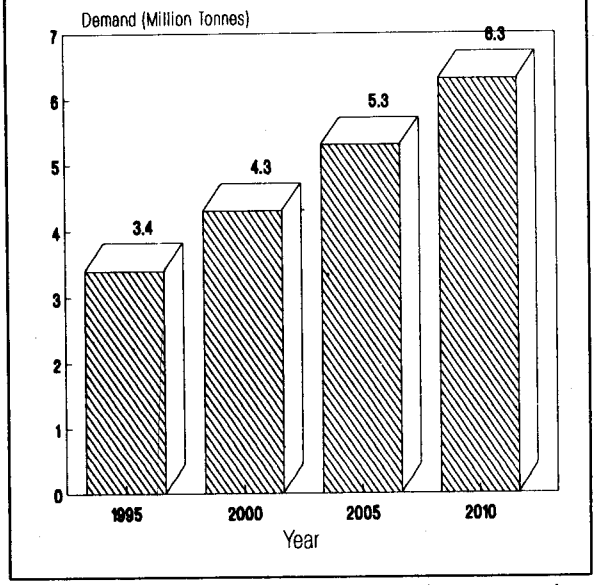
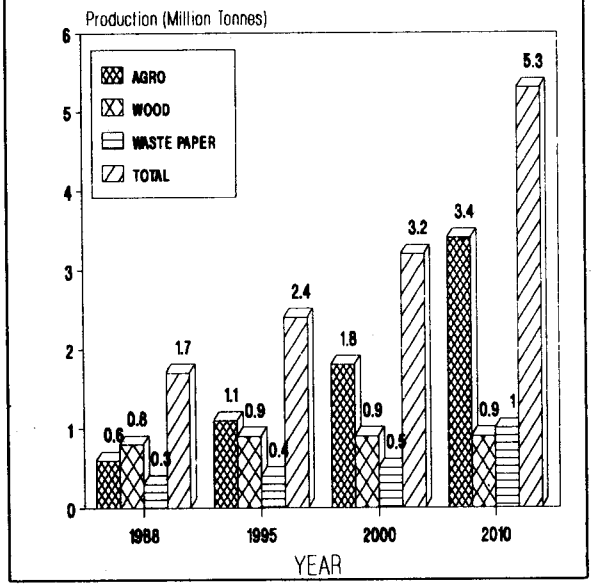
Fig.1. **Projected demand of Paper, Paper board & Newsprint**



To meet the present level of per capita consumption and the projected level of 4.1 million tonnes by year 2000 the paper industry must grow. Grow it must, but where is the raw material for it ? Before we examine the raw materials scene, let us examine the percent share of paper produced from different raw materials and there likely requirements in future.

Fig. 2 compares paper produced from forest wood, agro-residues and waste paper and possible paper production from these raw materials till the year 2010. Comparsion of Fig. 1 and Fig. 2 would reveal that there exists a large gap between the demand projection and the estimated production.

Fig.2. **Paper production & estimated projection**

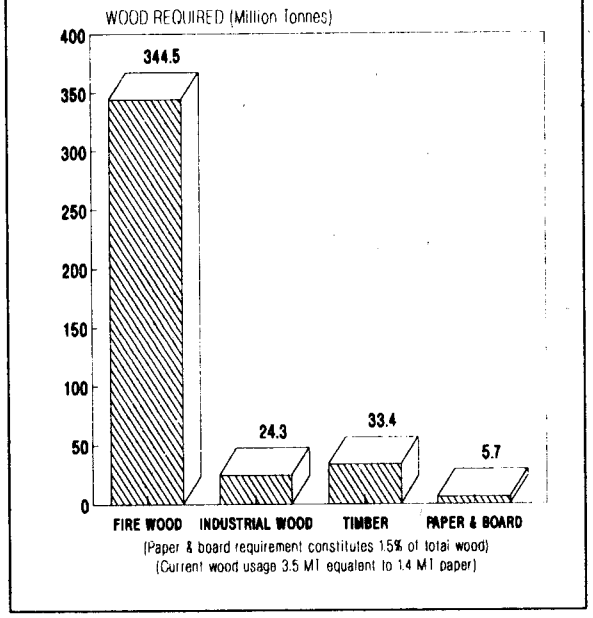


RAW MATERIALS

FOREST BASED MATERIALS :

Recorded forest area in our country is estimated at 75 million hectares and of this nearly 37million hectares is degraded forest. The growing stock of our forests at 65 m^3/ha is very low compared to world average of 110 m^3/ha. India is loosing forest cover at the rate of 1.3 million tonne/ha/year to meet requirements of fuel wood, wood industry, timber and paper industry. Our rate of deforestation is very high and mean annual increament is half the world average. Wood requirment for 2010 for the paper industry projected by FAO is shown in Fig. 3. Requirment of wood for paper industry has been projected at 5.7 million tonnes(being I.5 % of the total wood).

Fig.3 **Projected requirement of the wood for different uses**



NATIONAL FOREST POLICY FOR FOREST BASED INDUSTRIES :

Some of the main consideration governing the establishment of forest based industries and supply of raw materials to them is as follows.

- As far as possible, a forest based industry should raise the raw materials needed for meeting its own requirements.

- No forest based enterprise, except that at the village or cottage level should be permitted in future unless it has been first cleared after a careful scrutiny with regard to assured availability of raw material.

- Natural forest serve as a gene pool resource and help to maintain local ecological balance. Such forests will not therefore be made available to industries for undertaking plantation and for any other activities.

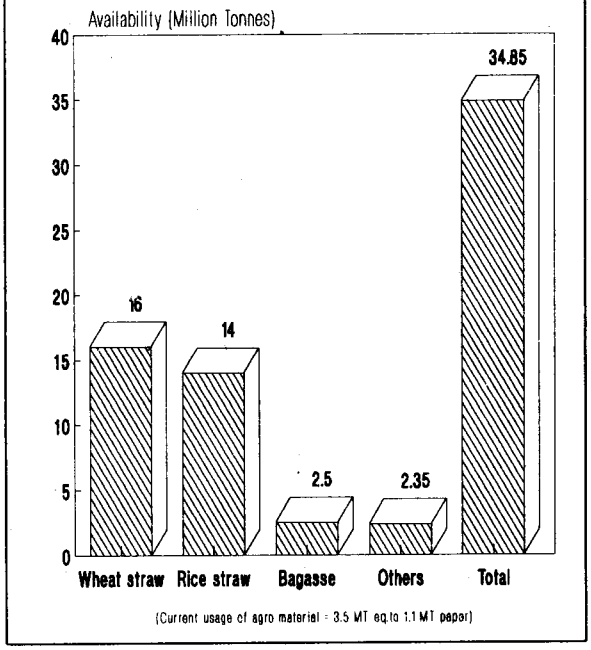
- The practice of supply of forest product at economical price should cease. Industry should be encouraged to use alternate raw materials. Import of wood and wood products should be liberalised.

It is clear from the National Forest Policy that no forest wood supply would be forthcoming for paper industry in the future. The current utilisation of wood and bamboo by the paper industry is about 3.5 million tonnes, which is eqivalent to produce 1.2 million tonne of pulp and newsprint only. In the future when demand increases, the raw materials requirement can not be sustained from forest based materials and the paper industry shall have to generate their own woody raw materials resources keeping in view the **National Forest Policy** and have to increase the usage of agricultural residues mainly bagasse, straws and other agro-based annual plant like mesta kenaf and jute etc. for its survival. **National Forest Policy** has forced the paper mills to look for alternate solutions. With improved methods of social forestry, tissue culture and genetic improvement in tree species, some of the forest based mills like **APPM, SPM, MPM, ITC** have under taken ambitious plantation programmes.

AGRICULTURAL BASED RAW MATERIALS :

The use of agricultural based raw materials will rise in the future. Agro based paper mills will improve their share in the total production from the present level of 40% to 50% and above, by year 2000. The potential availability of agricultural based raw materials by 2000 is estimated at about 35 million tonnes as shown in Fig. 4. Presently only about 3.5 million tonnes of the agro-based raw materials is being consumed by our small paper industry.

Fig.4. **Availability of Agro residues**



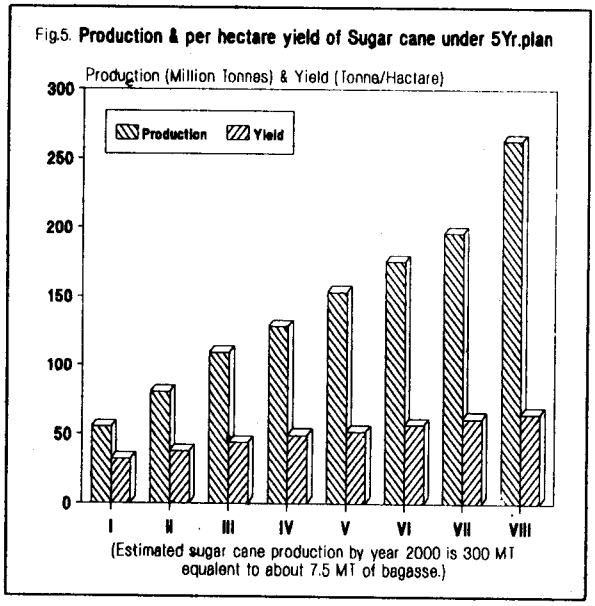
India is the highest producer of sugar cane in the world, yet the average size of sugar factories continues to be small.The capacity of sugar factories varies from 400 TCD (Tonnes crushing per day) to 5000 TCD. Depending upon cane potential, and technology upgradation, there is a trend towards expansion to higher crushing capacities of 5000 TCDand above.

The working group on sugar industry constituted by **Planning Commission** to formulate projections for sugar production for 8th five year plan estimated the production of 12.1 million tonnes of sugar in 1990-91 as against these estimates the actual production was 13.4 million tonnes. **Govt of India** has already sanctioned liscenced capacity of 18.1 million tonnes by the end of 8th five year plan.

Sugar cane production trends under different five year plan is shown in Fig. 5, and it is expected that total cane production by year 2000 will be 350 million tonnes. Based on the current level of fuel usage, it is observed that present availability of bagasse is about 2.5million tonnes and this is expected to be 7.5 million tonnes by year 2000. However a modern factory adopting best techniques of steam automation etc. we can expect upto 20-25 million tonnes of bagasse.

Similarly the situation with straws is such that large quantities are produced in India, however due to lack of coordination in handling, transportation, storage and other technology problem, the paper industry has not been able to make full use of this potential raw material.

Fig.5. **Production & per hectare yield of Sugar cane under 5Yr.plan**



(Estimated sugar cane production by year 2000 is 300 MT equalent to about 7.5 MT of bagasse.)

SPECIAL PROBLEMS :

As a raw material for papermaking non-wood fibres are generally short, slender and accompanied by high percentage of non-wood fibrous elements. In some species the fibre length and width are only one fourth and the non-fibrous cell content is about 20 times greater than that of softwood. Technically they can replace hardwood chemical pulps in some writing and printing papers, but have no unique characteristic that would allow them to sell at a premium above hardwood pulps.

Some of the specific problems associated with their use are:

- Supply is seasonal and subject to local conditions.
- Bulky in nature.
- Handling, stroage and transportation. costs are high.
- Pulp is heterogenous in nature and have low fibre content.
- Difficulties in brownstock washing, slow drainage and poor runnability.
- High silica content and problem related to chemical recovery.
- Low papermaking potential as compared to wood fibre.
- Higher brightness can be achieved but at reduced strength.

Low optical properties of bagasse chemical pulps (i.e. opacity).

With above mentioned problems and weak points non-wood pulps were not considered suitable for strength critical grade papers. However with newer technologies and developments both abroad and in India it has now become possible to increase there use and produce good grades of paper. We can learn from these technology developments for an effective utilization of bagasse and straws by Indian Paper Industry.

TECHNOLOGY OPTIONS :

In the development of technologies for papermaking from non-wood, most of the developments have been for bagasse. These efforts have resulted in greatly improved methods of classification, storage, preservation, depithing, pulping and bleaching of bagasse to produce different varieties of paper, board and newsprint. Some of these technologies can be applied to other non-woods as well.

Discussed below are some of the technology options and the efforts that the Central Pulp and Paper Research Institute has made in improving the papermaking qualities of non-wood.

NEW DEVELOPMENTS IN COLLECTION, HANDLING BAILING AND STORAGE :

The key to more wide spread use of bagasse and straws appears to be the adoption of advanced methods of collecting, handling, baling, storage, transport, bale breaking and chopping developed in the USA. These systems results in high density round or rectangular bales weighing as much as 700 Kgs. and when combined with mechanical handling and loading, they can be transported economically. With better collection and storage methods it has been shown that chopped straw can be stored by wet bulk storage system used for bagasse. Such systems are already working in the USA.

DEVELOPMENT IN WET BULK STORAGE :

a) A number of methods for storage of bagasse has been proposed over the years. It has been observed by Cellotex Corporation that two extreme condition result in excellent preservation of bagasse.

- Drying the bagasse to moisture content lower than 20 % and stop all fermentation.
- Wetting the bagasse to 80 % moisture or above to control fermentation and stop all reactions.

b) Ritter Biological pre-treatment : This method is now being used in new bagasse pulp and paper mills. It is one of the best methods for bulk storage of bagasse using Ritter Biological Pre-Treatment Process.

c)Bagatex-20 Process : This method offers good promise for excellent preservation of bagasse and also its brightness. It is a unique process for rapid drying of bagasse in large 600 Kgs. bales from 50 % to 20 % moisture content within 20 days, by adding biochemical catalyst. The catalyst accelerates and controls the microbiological fermentation of residual sugar no external fuel is required. The bales can then be stored for over 2 years without deterioation.

UPGRADING RAW MATERIAL QUALITY:

BAGASSE :

Bagasse should be depithed for pulp production. The pith is not a fibre element. It comprises of the parenchyma tissue, which contains sucrose juice. Presence of pith will introduce negative effect like high consumption of chemicals (20 times its weight) and high mineral content will interfere in bleaching, chemical recovery, drainage and life of refiners.

Over the years paper industry has seen gradual improvements in highly efficient centrifugal type depithers, for both moist and wet depithing. For high quality chemical or mechanical pulp in addition to efficient moist depithing, which is usually carried at sugar mills with moist pith returned to the sugar mill for fuel value, it is also necessary to wash depithed bagasse thoroughly and to carry out a wet washing step just before pulping.

PARTICLE SIZE DISTRIBUTION :

When bagasse leaves the sugar mill it is very heterogenous with particle size distribution ranging between 1 to 35 mm and average size being 15 mm. The particle size distribution will depend mainly on the sugar extraction machinery process and cane variety. The particle size distribution is very important for bagasse pulping. Often we can foresee following problems

Low efficiency in depithing of bagasse and high losses.

Difficulties in mixing bagasse with water and pumping for industrial operations.

Decrease in average fibre length of bagasse fibres.

Difficulties in chemical impregnation.

A recommended particle size distribution according to Cuba-9 experience to produce quality grade paper is as follows

A. Retained on
   Mesh 1.0 : 1 - 3 %
   Mesh 2.5 : 30 - 40 %
   Mesh 10 : 15 - 25 %
   Mesh 16 : 25 - 35 %
B. Passing
   Mesh 16 : 10 - 15 %

It has been a practice that bagasse containing more than 15% of passing 16 mesh is often rejected.

STRAWS :

Just as we do debarking of trees and depithing of bagasse to improve raw material quality. similarly we need pre-treatment methods for removing leaf , sheath, dust and undesirable non-fibrous material from straws. One of the option available is wet cleaning of raw material using water. In some cases mild alkali is also used. In such cases huge quantities of water are needed which would increase the effluent load.

CPPRI had conducted successful trials to upgrade the quality of straws using the Disc milling treatment. Effect of dise milling treatment on ash, alkali charge and kappa number is shown in Figs. 6 & 7. Results indicated that there is :

considerable improvement in the quality of the raw material.

undesirable silica and non-fibrous material is effectively removed.

marked saving in chemical consumption during pulping and bleaching with out adversly affecting the strength properties.

Fig.6. **Upgrading of Raw Material Quality**
(Ash Values of Different Fractions)

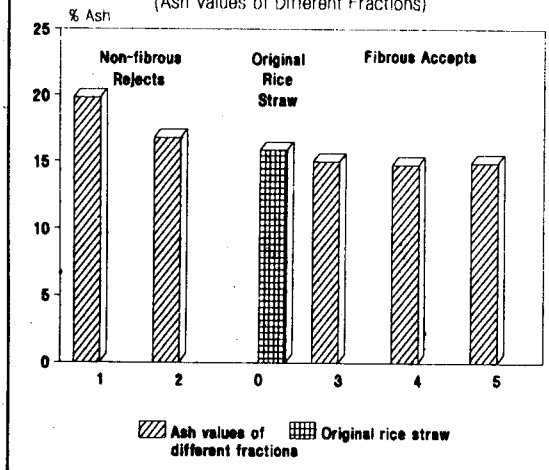
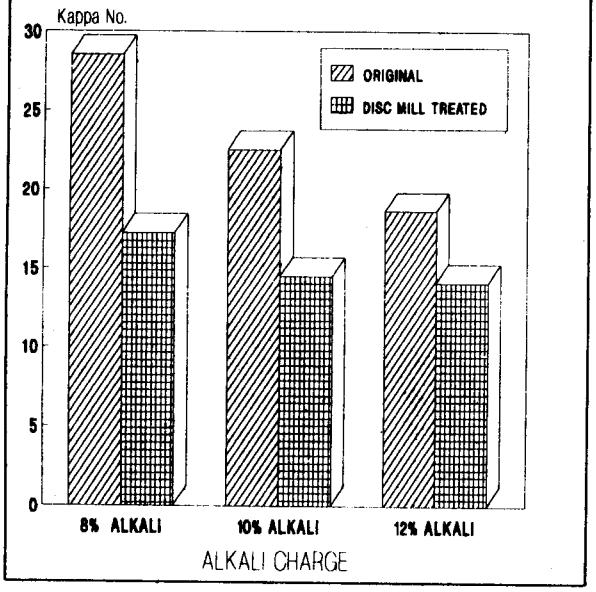


Fig.7. **Effect of alkali charge on kappa no.**



ADVANCED TECHNOLOGY FOR BAGASSE PULPING AND OTHER NON-WOOD PLANTS :

All the initial efforts on development of pulping procedures have been concentrated on bagasse and later applied to straws. For example wet cleaning of straw was developed from procedures of wet depithing. The rapid continuous horizontal tube digester has been highly successful for straws and bagasse. The cooking time is 10-15 minutes for bagasse and straws as compared to 6-7 hrs. cycle in batch cooking,washing.

VAPOUR PHASE PULPING :

The process developed at CPPRI indicates that vapour phase pulping of agro-residues by keeping the bath ratio 1 : 3.5 instead of 1 : 5 results in substantial reduction in steam consumption with black liquor of higher concentration thereby requiring less steam during evaporation. the results at pilot scale trials are promising

Particulars	Liquid Phase	Vapour Phase
Steam consumption t/t od pulp	4.8	1.7
Bath ratio	1 : 5	1 : 3.5
Black liquor solid, w/w ,%	9.6	18.4
Black liquor, m/t pulp	15.5	7.3

UREA PULPING :

Nitrogen based fertilizer was tried for pulping experiments with a view that the spent liquor generated in the pulping can be used in the agricultural fields. Unbleached pulp of ~36 K.No could be produced from rice straw by cooking rice
straw with 8% Urea at 150°C for 1 hr. followed by refining in a disc refiner at clearance 0.25 mm. Physical strength properties of the pulp produced from urea were found comparable (Burst factor +20) with the rice straw soda pulp by using 4% sodium hydroxide, so over all cost of chemical in urea pulping was half to that in soda pulping,for this unbleached grade paper in addition to the utilization of soda free spent liquor for irrigation purpose.

Rice straw pulp was found to have exceptionally high scattering coefficient and it can be used to improve the otherwise poor opacity of bagasse chemical pulps.

WASHING OF AGRO-RESIDUES PULP :

Rotary drum vacuum filter are basically designed for bamboo/wood pulps don 't serve the purpose of washing agro pulps. Loading of pulp is less, break and pickup are more, washing is difficult, dilution factor is high, output consistency, washing efficiency and productivity is low.

CPPRI installed and conducted brown stock washing trials on double wire belt washer for the first time in India using pulp produced from agro-residues. It consists of two converging wires forming a wedge section for multistage counter current washing and 3 nip press for final dewatering. Feed is at 1.5 % and outlet consistency is 30-40 % irrespective of pulp type. All short coming of rotary drum vacuum filter are overcome in double wire belt washer. Washing efficiency is upto 95 % and about 85 % TDS are removed in wedge zone. Demonstration of this unit has been given to representatives from industry from time to time.

DESILICATION OF RICE STRAW BLACK LIQUOR :

The process developed by CPPRI incorporates slow and stepwise reduction of black liquor pH using CO_2 rich flue gas in submerse bubble reactor. This results in selective precipitate of silica. The institute has conducted extensive studies on desilication of black liquor and installed at HNL, Kerala, based on eta reed and bamboo black liquor. Similar studies have been conducted for rice straw based mill in Central India. Results indicated that over 90% desilication can be achieved with remarkable improvements in liquor properties with respect to its rheological and combustion behaviour.

THERMAL TREATMENT OF BLACK LIQUOR:

Bagasse spent pulping liquor due to its diverse chemical nature is difficult to concentrate in the evaporator beyond 50% solids because of high viscosity. Thus to support combustion and to prevent explosion hazards, supplementary fuel is required. Detailed studies conducted by CPPRI have shown that the reduction in viscosity can be achieved by thermal treatment of black liquor. The semi- concentrated black liquor is subjected to thermal treatment at temperature higher than normal pulping temperature (180-190°C). The thermally treated black liquor is further concentrated to 60-62 % and fired in the recovery furnace.

CONCLUDING REMARKS :

With the liberalisation of market economy it is expected that both domestic and export market may see a growth rate ofover 5% . As India enters world consumer market the demand will be high for paper particularly packaging grades. To meet the projected requirment of raw materials the paper industy will have to rely on fibre resources other than forest based. Agro-residues hold promise as they are available in large quantities. However, because of some weak points and problems associated with their use they were not considered suitable for making fine and strength critical grade papers. Technology developments both abroad and in India have taken place which have helped in upgrading papermaking potential of agro-residues, and it is expected that with these developments Indian Paper Industy will be able to make better grades of paper from them and meet its requirements for the future.