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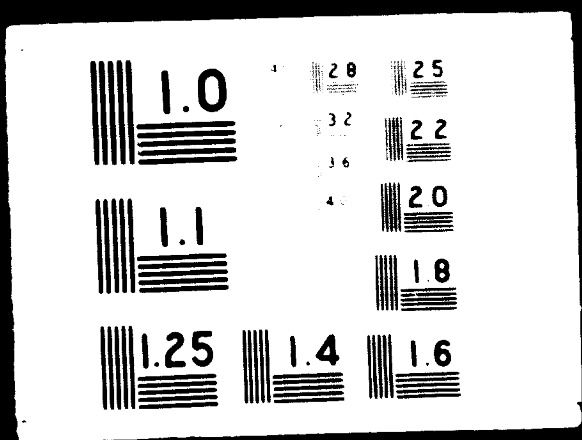

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NEWSPRINT FROM BAGASSE 1/

by
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UAR

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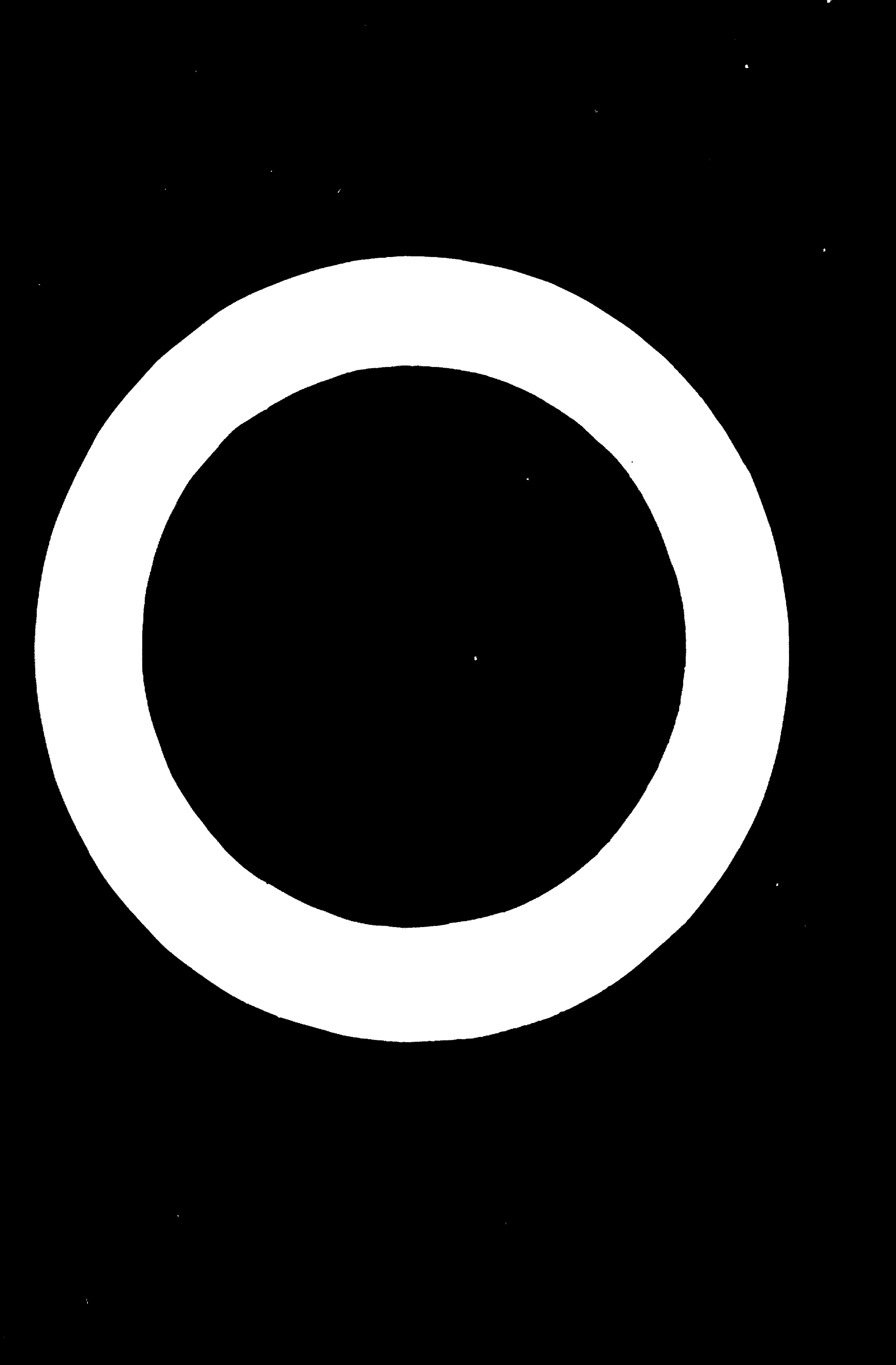

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SUMMARY

The role of newsprint in modern society is evaluated. Figures for its production and consumption in developing countries are given and compared with the figures pertaining to the highly developed countries.

The term "bagasse newsprint" is discussed. The studies carried out by committees entrusted by the United Nations Conferences in Tokyo 1960 and Cairo 1965 with covering this field are mentioned. Specifications of bagasse newsprint as suggested by these committees are recorded.

Bagasse as a paper making raw material is dealt with both technologically and economically with the purpose of throwing some light on the feasibility of its choice as a potential raw material for newsprint in preference to other agricultural residues.

The chemical composition and morphological nature of bagasse are described to furnish a background for discussing its use as a paper making raw material. The best technological procedures for treating bagasse to produce pulp, whether chemical, semi-chemical or mechanical, are described.

In addition and also as a background to the processing of bagasse in the pulp mill, a description is given of the various methods in use at present for depithing and pulping bagasse.

The main question of producing bagasse newsprint is dealt with. It is emphasized that bagasse newsprint per se is not being produced at present anywhere on a commercial basis. However, mill scale trial runs as well as pilot plant tests have been carried out in various parts of the world by different pioneering companies. These companies were testing their conceptions of how to produce a grade of bagasse pulp suitable for making newsprint, whether 100% bagasse or mixed with other fibres.

These conceptions are discussed in detail and as many as possible of the results of these runs are recorded, whether published or obtained by the writer as a witness to these tests.

Some light is thrown on the economical aspects of bagasse newsprint manufacture. Based on a call for tenders in Egypt

in 1965, figures are quoted as an approximate indication of the estimated capital investment and cost of production.

Conclusions are drawn from the previous data as to the present situation with regard to bagasse newsprint and suggestions are presented for future research and development.

I. Introduction

Newsprint is a commodity of special importance today because of its use in journalism and publishing, whose role in modern national and international societies cannot be overemphasized. With the evergrowing need for more information, the volume of consumption of newsprint is expected to grow at a proportional rate. The present world annual consumption is estimated at over 19 million tons.

An analysis of world production and consumption reveals some facts which are worth considering. The highly industrialised countries (mainly Europe, North America and Australia) produce at present about 18,500,000 tons per year, i.e. 97.6% of the world production of newsprint, while the production of the developing countries stands at a modest 448,000 tons per year, i.e. 2.4%.

Moreover, the highly industrialised countries have a per capita consumption of 15.7 kgs. of newsprint, while the developing countries' per capita consumption is only 0.8 kgs.

The strikingly low volume of consumption and production in the developing countries can be attributed partly to the obvious handicaps which confront these countries during the early stages of industrialisation.

However, in the particular case of newsprint another factor comes to the fore. At present newsprint is produced from long-fibre, coniferous woods, which grow in the cold parts of the world, mainly northern Europe and the North American continent. In other words, almost all the developing countries lack the basic raw material for producing this grade of paper. Therefore if a newsprint mill were to be established in such a country, it would depend wholly on an imported raw material, which in turn would render the industry uneconomical.

Although very promising technological advances have been made towards producing other grades of paper, such as writing and printing paper, tissues, wrapping paper, etc., from many raw materials other than wood, no comparable advance has been made so far in the case of newsprint.

For this reason, a good deal of attention has been given in the last decade or two to developing new techniques for producing newsprint from non-woody raw materials which are available in the developing countries.

The achievement of this goal will certainly have very significant consequences, not only in enabling the developing countries to produce all or part of their needs of newsprint locally. It will also tap a large potential market for newsprint in these countries, which so far has been unexploited because of a general lack of hard currency necessary to import more than the basic requirements of newsprint.

Moreover, it is my opinion that the consequences of newsprint being available from local sources in the developing countries will also have repercussions on the sociological, educational and political patterns in these countries.

Perhaps this introduction puts the topic "Newsprint from Bagasse" or any other similar raw material in the right perspective.

II. <u>What is Newsprint and What is Bagasse Newsprint?</u>

In 1960 a FAO conference held in Tokyo defined newsprint in the following way:

> "The term newsprint will be used without any restrictions as to fibre composition, thickness, ash content, degree of sizing or finish. It will then apply to any kind of paper capable of being run through modern printing press and of producing an acceptable sheet of printed newsprint at a reasonable cost."

This definition reflects the desire of the members to break away from any rigid restrictions which may limit the use of the word newsprint to a sheet of paper that complies with one set of specifications.

Again in 1965 an ECA/BTAO/FAO conference held in Cairo discussed the subject of newsprint from bagasse, reaching the following understanding:

"From the standpoint of the newsprint user, the important qualities required are: 1) runnability, 2) opacity and, of course 3) low cost."

In general, it was agreed to adhere to the following minimum characteristics:

Tear CMD	24 gr.
Opacity	86
Brightness	50% (MgO = 100%)
Basis weight	32 lbs./500x24"x36" or 52 gms/m^2

It was also noted by the working group in the conference that considerable quantities of newsprint were produced and internationally traded which, while falling somewhat short of the above minima, were fully accepted by the consumers, since they did possess the required runnability and opacity.

The above figures are intended to be minimum guide values and not rigid specifications; in other words, some of these characteristics (such as basis weight) can be overlooked, provided the paper retains the other minimum guide values.

The working group also agreed on the following principles with respect to the composition of bagasse newsprint:

"(a) It should contain the maximum amount of bagasse which is technically feasible and economically justified (irrespective of the method of its production); this may be as high as 65% or more;

(b) The most economic sheet-forming materials derived from bagasse should be used as the basic ingredient;

(c) No limitations should be established as to the use of additives, fillers, sizes or other materials which may be necessary and economic to reach the minimum guide values noted above."

It is evident from these two statements that there is no rigid definition for newsprint. The main requirement in any sheet of newsprint is to be suitable for running in a modern printing machine and to produce an adequate newspaper.

Perhaps the most important issue the two conferences agreed upon is the fact that the furnish used in manufacturing newsprint is immaterial as long as the quality meets the required specifications.

The standard furnish used at present by almost all paper mills is a mixture of 15 to 25% of long-fibred pulp made from soft woods, either by the sulphite or the Kraft process, while the balance of the furnish is groundwood, also produced by grinding soft woods in most cases.

The use of groundwood in this high percentage has the following results:

a) It imparts qualities to the paper produced which render it more suited to use as newsprint, such as opacity, bulk and absorbency.

b) It lowers the cost of production of the paper produced appreciably, since it is the cheapest quality of pulp produced. It is made by grinding wood without any addition of chemicals. The yield of pulp is in the range of 90-95% of the original wood, as compared to about 50% in the case of chemical pulp.

Technologically, should a similar quality of paper be produced from a different furnish, using raw materials other than wood, there is no reason whatever not to call it newsprint.

III. Why Bagasse?

As mentioned before, there has been a good deal of interest lately in exploring the possibilities of producing newsprint from raw materials other than wood.

Most of this work has been done on bagasse. It certainly seems that bagasse has been the choice of interested parties from among the potential cellulosic raw materials available.

This choice should not be taken for granted. It seems to me that this choice was based on both technological and economical considerations.

A. Technological Considerations

When bagasse is compared to other woody and non-woody paper-making raw materials it shows certain qualities which may explain the reasons for its choice. The following table gives a comparison between these raw materials as far as the characteristics of the fibres are concerned.

TABLE I: PHYSICAL CHARACTERISTICS OF VARIOUS FIBRES

Raw Material	Length in μ			Diameter in μ			Ratio
	Ave.	Max.	Min.	Ave.	Max.	Min.	
Agricultural Residues:							
Sugar cane bagasse	1700	2800	800	20	34.1	10.2	85:1
Wheat & rye straws	1480	3120	680	13.3	23.8	6.8	111:1
Rice straw	1450	3480	650	8.5	13.5	5.1	170:1
Soft Woods:							
Red spruce	2700	-	-	32	-	-	85:1
Jack pine	3000	-	-	40	-	-	75:1
Aspen	1000	-	-	26	-	-	38:1
Hard Woods:							
Red gum	1600	-	-	32	-	-	50:1

It appears from this table that bagasse fibres are equivalent in length to those of hard woods and compare favourably with them as far as the fibre length to diameter ratio is concerned. This ratio is important since it is an indicator of fibre bonding capacity.

On the other hand bagasse fibre is appreciable inferior to soft wood fibres in length, but has a better fibre length to diameter ratio.

When bagasse fibre is compared to other agricultural residues, it is clear that it is superior to them as far as fibre length is concerned. Moreover, a good part of bagasse fibres are rind fibres, which are characterized by comparatively thick and strong cell walls. The significance of this fact will be discussed at length later in this report.

Since most of the processes suggested for manufacturing newsprint from bagasse entail grinding in one way or another, as will be described later, and since the resulting pulp is to be run on fast paper machines, the strength of the original fibres and their resistance to mechanical action become of paramount importance.

Perhaps this is one of the reasons why bagasse has been given more consideration as a potential raw material for manufacturing newsprint than other agricultural residues which may also be available.

It is worth mentioning here that non-woody paper-making raw materials other than bagasse can eventually become the subject of development and research work for the purpose of producing pulp suitable for incorporation in the manufacture of newsprint.

B. Economical Considerations

Perhaps these considerations give an explanation of why bagasse has so far attracted more attention as a potential raw material suited for manufacturing newsprint than other agricultural residues.

1. Bagasse is a by-product of the sugar industry. After the cane has gone through the sugar mill crushers, bagasse (sugar cane refuse) is collected. Consequently, unlike other agricultural residues, bagasse collection presents no problem. In the case of straw, for example, its collection from over a large area, baling and transportation can be quite difficult.

2. Since bagasse is used at the sugar mill as a fuel in the steam raising boilers, its value in the mill is calculated according to its calorific value as compared to that of fuel oil. The calorific value of bagasse is approximately 7,000 BTU/lb. and that of fuel oil is 18,200 BTU/lb. Accordingly, it is generally accepted that 3 tons of O.D. bagasse can replace one ton of fuel oil. This fact helps to stabilize the price of bagasse, while in the case of straw or other similar raw materials, the price may fluctuate depending on many factors.

Moreover, many sugar mills have a surplus of bagasse which in many cases is wasted. The utilization of this surplus would be a net gain.

IV. The Nature of Bagasse

When evaluating the possibility of producing bagasse newsprint, it would be wrong to go into the subject without a knowledge of the specific nature of this raw material chemically and morphologically. It is also necessary to discuss the technological aspects of pulping it.

A. Chemical Composition of Bagasse

The chemical composition of bagasse varies to some extent according to its origin, variety and conditions under which it is grown. Chemically speaking, it resembles other agricultural residues and differs from coniferous and deciduous woods.

The following table gives the chemical composition of some varieties of bagasse, that of some of the other agricultural residues, as well as some species of wood.

TABLE II. CHEMICAL COMPOSITION OF VARIOUS PAPER-MAKING RAW MATERIALS

Material	Ash %	Lignin %	Pentosans %	Extractives in: Hot Water %	Alcohol Benzine %	1% NaOH %	Cross & Bevan Cellulose %
a. Bagasse:							
1-Louisiana whole bagasse	2.9	21.3	29.4	4.0	1.7	32.9	58.4
2-Florida whole bagasse	1.0	18.2	26.6	15.1	7.0	40.7	48.0
3-Hawaiian whole bagasse	5.4	21.3	27.7	5.7	3.2	33.9	50.2
4-Philippine whole bagasse	2.3	22.3	31.8	2.8	3.0	31.3	56.8
5-Egyptian whole bagasse	1.9	23.29	29.1	-	1.9	-	-
b. Straws:							
1-Wheat straw	7.4	18.4	26.7	18.2	4.3	48.0	46.8
2-Rice straw	17.5	12.5	24.0	13.9	4.6	50.0	47.3
3-Barley straw	6.4	14.5	24.7	16.1	4.7	47.0	47.4
c. Coniferous woods:							
1-Spruce	-	27.8	12.1	2.1	2.3	11.6	60.6
2-Pine	0.3	29.9	14.0	3.1	4.2	13.9	58.3
3-Hemlock	-	31.2	8.7	4.0	4.1	14.0	58.3
d. Broadleaf woods:							
1-Aspen	0.3	23.4	22.1	3.3	1.3	20.4	64.6
2-Birch	0.3	26.8	26.5	2.1	3.2	17.3	60.4
3-Red gum	-	21.4	20.7	2.5	2.0	12.0	60.5

From this table it may be seen that bagasse has the following main characteristics when compared with straws, coniferous and broadleaf woods:

a) Bagasse has a low ash content as compared to straws. This fact is of special importance since it renders the incorporation of a recovery plant possible. In many countries where the price of chemicals is high their recovery is quite advantageous.

b) The Cross and Bevan cellulose in bagasse is comparable to that of wood and higher than that of straws.

c) The pentosan content of bagasse is higher than in straws and woods. This fact is important since the high pentosan content affects the opacity of the pulp. The influence of this on manufacturing newsprint will be dealt with later.

d) The lignin content in bagasse is higher than in straws and lower than in both kinds of woods. This naturally reflects on the bleachability of bagasse pulp.

B. Morphological Nature of Bagasse

Without understanding clearly the nature of bagasse as a plant, the structure of its cells, and the different components of its fibres, it is quite difficult to understand the technological aspects of producing bagasse pulp. Consequently, a brief description of bagasse is given here:

Bagasse is a heterogeneous raw material. Generally speaking it is composed of two main cellular constituents,

a) the fibrous part, which is composed of the thick-walled long rind fibres and fibro-vascular bundles, and

b) the non-fibrous part, or pith, which is derived from the thin-walled cells of the ground tissues or parenchyma of the stalk.

The thick-walled long rind fibres give the stalk its rigidity while the pith fraction stores the juice in the sugar cane. Both fractions of bagasse are so intimately mingled in the plant that a complete separation of one from the other is impossible. Although there is no exact way of measuring the pith fraction, it is agreed that this fraction constitutes 35 to 45% of the whole bagasse, depending on the variety of the cane stalk.

In addition to these two main fractions of bagasse, there are a multiplicity of cells of different shapes and sizes. Some of these cells exist in the outer layer of the stalk, like epidermis; the majority exist in the fibro-vascular fibrous bundles.

These two fractions of bagasse, i.e. rind fibres and pith, differ essentially in their physical properties and in their behaviour in the pulping processes.

As a paper-making raw material, pith has a low felting power on account of its nature. If left in the pulp it decreases the rate of drainage and the strength properties. Moreover, due to the much larger surface area of the pith which is exposed to the chemicals in the pulping process, it consumes much more of these chemicals than the rind fibres do. Consequently, it is imperative that this undesirable fraction of bagasse should be removed prior to pulping.

From a purely chemical viewpoint there are differences between both fractions of bagasse, as illustrated in the following analysis of one variety.

TABLE III. ANALYSIS OF BAGASSE, PITH AND FIBRE

Material	Ash	Lignin	Pentosans	Alpha Cellulose Corrected	Extraction Alcohol Benzine	Extraction Hot Water
	%	%	%	%	%	%
Whole Bagasse	1.65	21.6	27.1	38.7	3.5	2.6
Pith	2.00	21.5	28.7	35.3	2.5	1.6
Fibre	0.63	22.0	27.7	42.5	1.6	0.43

It is evident that pith contains more ash and less alpha cellulose than fibre.

Moreover, because of the different nature of the two components of bagasse they behave differently when they undergo crushing in the sugar mill and are stored until they reach the pulp mill.

1. Effect of Crushing

Since the pith cells store most of the juice in the cane stalk, the sugar mill crushers rupture these cells to extract the juice. This causes considerable damage to pith cells. On the other hand, fibres, not containing juice, suffer much less damage.

2. Effect of Storage

Most sugar mills operate during only part of the year; hence bagasse earmarked for pulping is baled and stored for use later.

As bagasse leaves the sugar mill, it contains a small amount of sugar (3-5%) and its moisture content is somewhere around 45-50%.

Since most sugar cane producing countries lie in subtropic or tropic regions, bagasse in storage is exposed to quite high air temperatures.

On account of these factors, bagasse during storage undergoes

a) a complex chemical attack by bacteria and fungi,

b) a biochemical process whereby the residual sugars ferment into alcohol and are then oxidised to organic acids.

As a result of these complex chemical and biochemical reactions the bagasse fibres are damaged to varying degrees. These reactions proceed until the moisture content of the stored bagasse is reduced to such a level that they come to a stop. The way in which the bagasse is stored plays an important role in this.

V. The Technology of Processing Bagasse

The production of chemical and semichemical bagasse pulp has been developed over the last few decades. It is now considered a well-established industry. Many mills all over the world produce bagasse pulp successfully and economically. It is incorporated in various percentages in the furnishes of many grades of papers, such as writing and printing paper, tissues, fluting, etc.

The use of bagasse pulp per se is not the subject of this report, although it furnishes the background for the historical development which has led to the present increasing interest in using a high percentage of bagasse pulp in newsprint.

Some of the basic industrial techniques already developed, such as depithing, will undoubtedly be used in producing bagasse pulp especially prepared to meet the requirements of a pulp suited for use in manufacturing newsprint.

For this reason, it is important to record in this report a short description of the techniques used by bagasse pulp makers today.

A. Bagasse Baling and Storage

It has been mentioned above that the proper storing of bagasse has an important bearing on the preservation of its fibres during storage. Bagasse is usually baled as it comes out of the sugar mill. A part of the bagasse may be sent directly to the pulp mill if it is located on or close to the sugar mill site. Bagasse not immediately required by the pulp mill is baled and stored, since most sugar mills run only 3-5 months a year, while the pulp mill runs the whole year.

The type of bale depends largely on the type of equipment used and local conditions. Usually the density of the bales is around 0.3-0.4, although even higher densities have been reached by using special balers.

Bagasse bales are stacked in piles in the storage yard and the bales are handled by conveyors and stackers or manually, depending on local conditions.

The arrangement of the bagasse stacks should be studied thoroughly. This arrangement should allow for ventilation to utilize the heat generated by the exothermic fermentation of sugars in bagasse to dry up the whole mass of the pile and stop the detrimental effect of bacteria, fungi and organic acids.

If this is done properly, the losses in the weight of bagasse during storage can be limited to 5-10%, while improper storage can cause considerably higher losses.

Recently it has become a common practice to carry out partial depithing of bagasse before baling. This is advantageous, since the separated pith can be used as fuel during the sugar season.

Another completely different conception of storage has been advocated comparatively recently, that is, bulk storage. The advocates of this process claim certain advantages from its use and a description of the process will be given when discussing depithing.

B. <u>Depithing</u>

It is evident from the brief description of the constituents of bagasse that the pith fraction has little or no paper-making value. Consequently, it has become a standard procedure to separate the pith from the bagasse prior to its treatment for producing pulp.

In the inner structure of bagasse, the pith adheres to the outside of the fibro-vascular bundles. By virtue of this fact, if bagasse is subjected to vigorous mechanical action like hammering or rubbing, the pith is lossened from the fibres and can be separated by screening, a process termed "depithing."

Depithing can be accomplished by many methods. The degree of separation varies widely according to the quality of pulp required.

Although there is no accurate way of measuring the percentage of pith in bagasse, yet it can safely be estimated at between 35-45%, as mentioned before. As much as 60% of the pith contained in bagasse or as little as 10% may be separated according to the method used. The separated fraction is not actually all pith, but contains small parts of fibres broken due to mechanical action as well as leaves, soil, and other constituents of bagasse.

1. Moist Depithing

The simplest method of depithing is to screen the moist bagasse (50% moisture content) as it leaves the sugar mill. Inclined vibrating screens may be used for this purpose. About one quarter of the pith is separated by this method and is sent to the sugar mill boiler. This percentage depends, naturally, on the size of the perforations of the screen plate.

Other types of rotary screens are also used, such as cylindrical rotary screens.

Several developments have been introduced in moist depithing and screening. In a paper mill designed by W. R. Grace at Paramonga in Peru, after the above-mentioned preliminary step, the bagasse is subjected to a strong mechanical action in a hammer mill to break down the particles and loosen the pith further. The bagasse is then screened again. This method is reported to be used also in other South American mills, such as Moron in Venezuela and Arecibo in Puerto Rico. A good separation efficiency is reported by some of these mills. As much as 45% of the original weight of the whole bagasse is said to have been separated. Since this process is usually carried out at the sugar mill, it allows for the separated pith to be sent back to the boilers to be used as fuel. The depithed bagasse is baled and sent to the pulp mill.

This method involves a considerable amount of conveying of the bagasse through the two stages. To avoid this drawback some methods have been developed which succeed in combining both the beating in a hammermill and screening in one machine to cut down on operating costs. Examples of this are the Rietz and Horkel mills.

Both mills are similar in their main features. The mill is a vertical hammermill where the moist bagasse is fed into the upper part of the rotor and passes through a screen-lined cylinder in which the rotor is operating. Bagasse is subjected to the strong mechanical action of the hammers. The pith is set loose and passes through the holes of the screen, whereas the fibre fraction falls down to the bottom. The Rietz mill uses fixed hammers, while the Horkel mill uses swinging hammers.

These two mills find wide use; the percentage of pith separated is reported to be in the range of 27% of the weight of the original bagasse.

2. <u>Wet Depithing</u>

Some methods have been developed to separate pith from bagasse in the wet state. Aronovsky and Lathrop developed a method of this nature in the U. S. A.; Krauss Maffei of West Germany developed another similar method.

The method involves the use of bale breakers if dry baled bagasse is the raw material. The opened bales are dumped in a pulper along with enough water to bring the consistency down to about 3% in the pulper. The bagasse particles are exposed in the pulper to very strong rubbing against one another. In this way the pith is separated from the fibre. The mixture of water and bagasse is then screened in a rotary screen, where the pith is carried through the screen wire, while the fibre drops at the end of the screen into a screw press to squeeze water out of it.

This method of depithing involves the use of more equipment and consequently a higher investment, but it has the advantages of efficient depithing and removal of a good deal of dirt and water-soluble material from the bagasse. The main advantage of this process in comparison with other systems lies in the fact that none of the depithing stages involves any drastic mechanical action on the bagasse fibres. It therefore avoids breaking the fibres to fines and thus reduces losses of good fibres.

In Egypt in 1966 the writer witnessed a mill scale run carried out on such a wet depithing system, where whole bagasse was dumped in the pulper and the screen. The test was also observed by several experts from different concerns interested.

Some of the results are recorded here:

Percentage of pith in whole bagasse to whole bagasse by weight	30.9%
Losses in depithing	18-23%
Percentage of pith in the depithed bagasse by weight	18%
Efficiency of system for removing pith	about 60%

It should be mentioned that the bagasse used for this run was not put through any primary depithing in the sugar mill. Better results could be expected if this depithing run were preceded by a moist depithing stage.

3. The Ritter Process

This process, in fact, covers both storing and depithing of bagasse.

It involves storing bagasse in bulk. Whole or partly depithed bagasse is conveyed from the sugar mill to an elevated channel where it is mixed with a special biological culture liquor and then flushed to a large slab of concrete which forms the storage area. The bagasse is removed from the storage area either manually or mechanically using heavy earthmoving equipment. The pith is loosened by the action of the biological liquor during the storage period and can easily be separated from the fibre during the dewatering process or by means of wet depithing.

The Ritter process is used in conjunction with other depithing systems to attain a high efficiency of depithing. This process is said to have several advantages, mainly in reducing the cost of labour needed for handling bagasse, baling wire, minimising the fire hazard and dust problems. It also preserves the bagasse during storage and effects a prehydrolysis which helps in producing a better pulp.

C. Bagasse Pulping

Like other agricultural residues, bagasse can be pulped into chemical or semichemical pulps by almost any of the traditional cooking methods, such as alkaline pulping, neutral sulphite and bisulphite pulping, caustic chlorine pulping, etc.

A variety of pulping equipment can be used in the case of bagasse. Rotary or tumbling digesters can be used as well as more modern continuous pulping equipment manufactured by several machine builders, such as Pandia, Kamyr, Bauer, etc.

It is generally agreed that alkaline pulping is more suited for pulping bagasse. The following table illustrates some results of pulping depithed Hawaiian bagasse by alkaline and sulphite methods at optimum conditions.

TABLE IV. COMPARISON OF TWO METHODS OF PULPING BAGASSE

	Method of Cooking	
	Alkaline	Neutral sulphite
Cooking Conditions:		
Time, min.	5	75
% chemical added	12% Na_2O	12% Na_2SO_3 + 3% NaOH
Temp., °F.	340	340
Liquor:solid ratio	3½:1	6:1
% Screened yield	60	63
Burst factor	55	51
Tear factor	71	66
Breaking length	9000	9300
MIT fold	1000	600
Schopper Riegler CSF	200	200
Brightness	40	48
Permanganate number	7-9	11

When comparing these two most common pulping processes, it becomes apparent that both the soda and Kraft processes have considerable advantages. Although the neutral sulphite process is capable of yielding 3% more pulp and is 8 points brighter than that produced by the alkaline process, these advantages are more than offset by the disadvantages of longer cooking times and higher chemical costs in the case of the neutral sulphite process.

D. Bleaching Bagasse Pulp

Bagasse pulps are easily bleached by usual bleaching methods. The normal 3-stage bleaching system, chlorination-caustic extraction-hypochlorite, yields a brightness of up to 85% at a comparatively low usage of chemicals and little loss in physical properties.

A higher brightness pulp of up to 90% can be produced by the use of chlorine dioxide without any appreciable loss in physical properties.

VI. Concepts of Producing Bagasse Newsprint

In spite of the fact that bagasse has been used successfully in varying percentages for producing several grades of paper and paperboard, it has not been used as yet commercially for the production of newsprint.

It is also true that bagasse chemical pulp has been incorporated in newsprint furnishes in some countries, but this cannot be defined as bagasse newsprint, since it does not meet the prerequisites of newsprint agreed upon internationally, as previously discussed in this report.

The use of bagasse chemical pulp is by no means the answer to the problem many of the developing countries are facing, on account of its high cost and unsuitable properties. Developing countries want to produce newsprint which is comparable in cost and quality to standard newsprint as produced today from wood, by using a locally available raw material (bagasse) in as high a percentage as is technologically feasible.

Several research institutions, whether belonging to large pulp and paper companies or governmental, have attempted to find the answer to the problem. Many of these efforts were based on original concepts and went as far as producing limited quantities of bagasse newsprint on commercial machines. However, it can be said without any doubt that none have really reached the stage of gaining experience based on continuous commercial operation, where practical difficulties, minor or major, expected or completely unexpected, are discovered and solved.

It is the purpose of this report to describe as fully as possible these different concepts. The evaluation and recommendations will be stated after the description is given.

Generally speaking, the various techniques which have already been utilized in manufacturing newsprint from bagasse fall into two major categories:

a) Mechanical processes.

b) A combination of chemical and mechanical processes.

A. Mechanical Processes

1. The Crown-Zellerbach Process

This process was developed at the research centre and pilot plant of the Crown Zellerbach Company at Camas, Oregon. The work was done in conjunction with the Hawaiian Sugar Planters Association, who are naturally interested in the utilization of bagasse.

The writer witnessed a demonstration of the process in Camas, using a large quantity of Egyptian bagasse. Commercial size equipment was used all through the run. A description of this run is given here:

a. Ground bagasse manufacturing

(1) The whole bagasse was broken up in a continuous hydrapulper at 6% consistency. Bagasse slush overflowed onto a conveyor with a perforated trough to drain the water and bring the dry content to about 20%. Bagasse was then fed into a Rietz depithing machine. Depithed bagasse was stored for future use.

(2) The most important feature of this process is grinding the depithed bagasse. Depithed bagasse at about 24% dry content is fed into a screw conveyor which in turn feeds a constant flow to the hopper of a double disc Bauer refiner. Water is added to bring the consistency down to 6-7%.

The resulting ground bagasse is stored in a chest at about 4% consistency.

From this chest ground bagasse is pumped to a thickener and a screw press to bring the dry content up to about 30%. At this consistency the ground bagasse is fed onto a screw conveyor, and drops into the hopper of a single disc Sprout Waldron refiner. At this stage water is added to bring the consistency down to 5-6%. The resulting twice-ground bagasse is again diluted to 4% and stored. It is described at this stage as "secondary fibres."

(3) The secondary fibres are pumped to a one-stage centrifugal cleaner at a consistency of 0.5% to separate heavy materials and unbroken particles.

About 11% of the original weight of the secondary fibres were separated as rejects. However, should a multi-stage centrifugal system be used, a lower percentage of rejects would be expected to be separated.

The screened secondary fibres were run over a decker and stored.

(4) Ground bagasse was then bleached with sodium hydrosulphite to a brightness of 60-65% GE.

It may be interesting at this point to give some of the results and figures obtained during this run.

Weight of fraction separated during depithing on basis of whole bagasse, %	27%
Consistency at primary refining	6.75%
Consistency at secondary refining	5.5%
Initial freeness after primary refining CF	550
Initial " " secondary " CF	404
Freeness of screened ground bagasse	340

b. <u>Paper machine run</u>

The resulting ground bagasse and long-fibred semi-bleached Kraft pulp in the ratio of 70-30% respectively were run on a pilot plant scale paper machine with the purpose of producing newsprint.

It would not be justifiable to draw any final conclusions from the results of such a run with regard to the runnability of this furnish on high-speed commercial size newsprint machines. However, it may be safe to make some preliminary deductions with regard to the general quality of the paper.

The pilot plant machine had the following specifications:

Wire width	26"
Wire length	24"
Number of presses	2
Number of suction boxes	6

The running conditions were as follows:

Furnish	70% ground bagasse at 350 CS 30% semibleached Kraft pulp at 457 CSF
Consistency at head box	0.5%
Speed of machine	105 inches/min.
Dry content after presses	35%
Steam pressure in drying cylinders	35 lbs/in^2

The specifications of the resulting newsprint were as follows:

Basis weight	52 gm/m^2
Burst	19
Tear g/sheet M.D	22.6
C.D	27.2
Tensile lb/½ inch M.D	3.6
C.D	2.1
Opacity %	90.3

At the FAO Conference in Cairo, the Crown Zellerbach Co. also reported the results of another similar run they carried out in 1962. No mention was made of the type of machine used. The figures quoted were:

Basis weight		52 g/m^2
Bulk factor		108
Mullen Burst %		26
Tear gm	MD	30
	CD	40
Tensile lb/½ inch	MD	5.8
Opacity		90
Brightness %		50
Furnish		ground bagasse and softwood Kraft

The general properties of the newsprint produced in this test seemed to be acceptable. The physical properties were up to the standards set by the FAO Conference. Moreover, a quantity of the paper produced was printed and it was reported that it ran without difficulties. No details of this printing run are available to the writer.

Crown Zellerbach Co. believe that their process is especially suited for newsprint, since the ground bagasse produced by their process is a very good opacifying agent and if about 30% of long fibres are added to the furnish it will add enough strength to the web to enable running this furnish on a high-speed newsprint machine without any unusual difficulties.

2. <u>The Karlstads Process</u>

This process is quite similar to the Crown Zellerbach process with one main difference. The Karlstads Process does not include any depithing of the bagasse and produces ground bagasse containing almost all the pith.

a. <u>Ground bagasse preparation</u>

(1) Whole bagasse is slushed in a pulper, then dewatered to about 20% dry content. In this stage some pith is separated.

(2) Bagasse is then run through a set of three single-disc defibrator refiners.

(3) The resulting ground bagasse is screened on a Johnson vibratory screen, then on a Cowan rotary screen. Accepts are thickened and stored.

(4) A final refining stage follows, using the same equipment as in the first refining stage, but fitting the refiners with different type discs.

(5) The ground bagasse thus obtained is bleached by the hydrosulphite process. The bleached pulp is further screened in two stages in hydrocyclones,

The following results were obtained in a run carried out on a quantity of 6 tons of Egyptian bagasse:

Consistency at first stage refining	12%
Final freeness of pulp CSF	700
Consistency at final stage refining	12%
Final freeness CSF	300
Final freeness after screening CSF	140-170

b. <u>Newsprint manufacture</u>

Karlstads also recommend a furnish of 70% ground bagasse and 30% long-fibred pulp for producing newsprint.

Two runs were made and the paper produced was tested for printability.

One newsprint run was made at a comparatively low speed at the Central Laboratory of the Swedish Paper Industry. The other run was made on the KMW (Karlstads Mekaniska Werkstad) experimental machine, but at a much higher speed. They also tested a similar furnish, but containing bagasse chemical sulphate pulp, on a laboratory scale.

The following data were recorded during these tests:

	At PCL	At KMW
Furnish	70% mechanical bagasse 30% semibleached sulphate pulp	61% mechanical bagasse 26% semibleached sulphate pulp 13% unbleached sulphite pulp
Paper machine speed, m/min.	75	400
Head box consistency %	0.38	0.35
Head box freeness CSF	75-80	75-80
Basis weight of paper gm/m²	52-54	48-52
Burst factor	9-10	7-8
Tear factor MD	46	60
CD	52	70
Breaking length in MD	3100	2000
CD	1500	1300
Opacity % GE	97	-

on the machines are appreciably affected by the percentage of long-fibred semibleached Kraft pulp. They quote the experience of some large newsprint producers, where the paper machines could only be run at 1750 ft/min. when 15% of the long-fibred fraction is incorporated in the furnish. Raising this speed to 2000 ft/min. requires the use of 20% long-fibred fraction in the furnish. Speeds in the order of 2500 ft/min. can be reached by increasing this percentage to 30%.

Consequently they have suggested that a very mild cook of bagasse should precede the grinding action. Probably the Cusi process is the leading exemplar of this school of thought.

1. <u>The Cusi Process</u>

a. <u>Pulp preparation</u>

The process suggested involves the production of chemimechanical pulp by the following method.

(1) Whole bagasse is depithed in two stages: in the moist state at the sugar mill by screening, and then wet-depithed at the pulp mill using the Horkel system. This step is very much like similar steps in other processes.

(2) The depithed bagasse undergoes a mild cook in a batch digester under the following cooking conditions:

Time to maximum temperature	20 min.
Time at maximum temperature	0 min.
Maximum temperature	133°C.
NaOH added on basis of O.D. bagasse 9%	

In other words, the digester contents are blown to the blow tank the moment the required temperature is reached. Naturally the residual alkali in the resulting pulp is high. About 65-70% of the added cooking chemical is consumed.

(3) The pulp is fed into especially designed screens to classify the pulp according to fibre length. The longer fibred fraction is termed "B" fibre to differentiate it from "A" fibre, which apparently consists of shorter fibres.

"B" fibre is washed from black liquor and fed into a disc refiner at 16% consistency to convert it into chemimechanical pulp. This pulp is diluted and screened on a Jonssen Lindgren screen. The accepts are pumped to a storage chest.

In an experiment on Egyptian bagasse carried out in Mexico the following results were obtained:

(a) The "B" fibre and chemimechanical pulp were classified on a Twing-Albert Classifier to show the effect of the disc refiner.

		"B" Fibre	Chemimechanical pulp
Retained on mesh	14	61.54%	6.12%
	30	10.96	19.17
	50	4.65	16.43
	100	9.20	25.69
Through mesh	100	13.45	24.59
Permanganate Number		20.5	28.9

(b) The physical properties of the chemimechanical pulp were reported at 540 CSF (23° SR) as:

Breaking length m.	5,100
Burst factor	21.1
Tear factor	60.32
Opacity	83.0
Brightness	32.0

(4) Bleaching. At this stage the "A" fibre separated at the classification step was remixed with the chemimechanical pulp at the ratio of 20 to 80% respectively. The mixture was screened and pumped to the bleaching department. The screenings separated at this stage were high, in the neighbourhood of 18%.

A 2-stage hypochlorite bleaching system was used and a brightness of 60% GE was reached. The bleached pulp was screened in a 2-stage centricleaner system. Some laboratory tests made at the time showed that the use of peroxide for bleaching would have improved the opacity of the bleached pulp but this was only applied in the last stage before baling without any further washing, due to certain practical difficulties.

The following data were obtained during this run:

Bleaching Conditions	After First Stage	After Second Stage
Consistency	3.96%	6.94%
Retention time	120 min.	300 min.
Temperature	35-40°C.	35-40°C.
Permanganate number	16.7	12.5
Freeness CSF	465	445
pH	8.5	8.4
Brightness GE	34.5	55.5

The physical properties of this unbleached and semibleached pulp are listed below at 200 CSF (51 SR):

	Bleached	Unbleached
Beating time to reach 200 CSF	20 min.	15 min.
Basis weight of sheet gm/m^2	56.8	60
Breaking length m	6575	6620
Tear factor	38.15	36
Burst factor	-	36.0
Opacity	71	[illegible]
Brightness	60.5	44

b. Newsprint manufacturing

The chemimechanical semibleached pulp was blended with long-fibred Kraft pulp and unbleached ground wood to investigate the running conditions on the machine and the properties of the newsprint produced, as will be described later. For this purpose a commercial newsprint machine was used. The first run was made with the following furnish:

Run 1

70% chemimechanical bagasse pulp

20% unbleached ground wood

10% semibleached Kraft pulp (long-fibred)

The second run was made with this furnish:

Run 2

80% chemimechanical bagasse pulp

20% unbleached ground wood

In both furnishes, china clay (about 7%), rosin size, alum and dye stuff were added.

It was reported by observers that no appreciable difference in machine performance was noticed between the two runs.

In both runs the stock was refined on the standard equipment in the mill.

Speeds of 150-160 m/min. were reached and the machine performance was satisfactory. Two factors affected the machine run. Firstly, the chemimechanical pulp contained shives which caused more web breaks on the machine than usually encountered. Secondly, the machine itself had some shortcomings, mainly a limited drying capacity and long open draws between the first and second presses and the dry end.

Some of the operating conditions are listed below:

Head box consistency	.65-.75%
Moisture content after couch	75%
Moisture content after presses	69%

The properties of the newsprint produced were tested and compared with some imported qualities of newsprint. The following table gives the data obtained from the tests.

The newsprint produced was tested for printability on a printing press at a speed of 40,000 copies per hour and ran satisfactorily.

TABLE VI COMPARISON OF BAGASSE NEWSPRINT WITH NEWSPRINT

	Bagasse Newsprint Run 1	Bagasse Newsprint Run 2	Canadian Newsprint used locally
Basis weight gm/m^2	51	52	53
Breaking length (Kms) MD	3.62	3.52	4.64
CD	2.72	2.96	2.25
Tear gms MD	21	16	20
CD	22	20	29
Folding endurance MD	4	5	14
CD	2	2	3
Burst Kg/cm^2	0.65	-0.60	0.84
Ash %	7.57	6.60	0.30
Brightness GE	62	59	55
Opacity	89	90	95
Porosity, sec.	70	75	-

2. The A-Z Process

This process has been developed by the Aschaffenburger Zellstoffwerke in West Germany. It is based on using bagasse pulp only for producing newsprint, without the addition of any other fibre.

This bagasse pulp is produced by the neutral sulphite hydrolysing process. The resulting pulp has a comparatively high brightness and no further bleaching is required.

Aschaffenburger Zellstoffwerke have carried out a large scale test on the basis of this conception. However, the writer could not obtain any details of the technological features of the process.

The properties of the 100% bagasse newsprint produced were reported to be as follows:

Basis weight gm/m^2		51
Brightness		56
Breaking length	MD m	3530
	CD m	2090
Fold endurance	MD	11
	CD	7
Tear resistance	MD	34
	CD	34
Burst strength kg/cm^2		0.41

3. <u>The Asplund Defibrator Process</u>

This process was developed by Asplund Aktiebolag of Sweden. It is based on steaming bagasse fibres at a pressure of 2 kg/m^2 and 130°C., then blowing the mass into a refiner. The pulp is screened in a 2-stage system. Freeness of the screened pulp is reported to be 120 ml CSF.

4. <u>The Grace Peadco Process</u>

The process has been developed by the research group of W. R. Grace & Co. and is based on the prehydrolysis of completely depithed bagasse during the initial stage of digestion. This is carried out in a continuous digester at 347°F. at a pH of 5.5, using residual acid groups in the bagasse and removing a part of the xylosans.

This acid treatment opens the bagasse fibres and permits more efficient cooking. The lignin groups are oxidized by adding sodium silicate, which gives a whitish color to the pulp. The cooking chemical used in the digester is 2% sodium sulphite.

The pulp yield is reported to be about 80% and the developers hope to exceed that by introducing further changes in the equipment used.

The properties of the pulp produced by this process at 212 CSF are reported to be:

Time to reach 212 CSF, min.	25
Basis weight	62.4
Mullen factor	36.4
Tensile m	7610
Tear factor	35.5
Folding factor	3.2
Opacity % Photovolt	90
Porosity sec/100 ml	higher than 1200
Brightness % Photovolt	46

Newsprint runs were made using this pulp with a furnish of

80% bagasse pulp
10% ground wood
10% long fibres

The speed of the machine during the run was reported to be 2500 ft/min.

Some physical properties of some runs of newsprint made by the same company are reported as:

Furnish	85% bagasse
	15% Kraft
Basis weight gm/m^2	52
Caliper, microns	112
Tensile lb/in MD	19.16
CD	9.16
Tear gm MD	34
CD	37
Porosity sec/100 ml	31
B & L Opacity	84.0

VII. Economical Aspects of Manufacturing Bagasse Newsprint

The manufacture of bagasse newsprint is obviously not merely a pure technological problem to be solved. The economical aspects are in the end the deciding factor. Any new process which stands any chance of gaining commercial application has to be technically sound and at the same time economically feasible.

It is true enough that in many developing countries industries do not necessarily produce at internationally competitive prices, since hard currency saving is a target these countries may sacrifice to attain. However, there are limits to the extent to which these countries could go to make such savings.

Consequently, it is prudent to dwell briefly on the economical aspects of bagasse newsprint production.

Standard newsprint is normally produced from a furnish of about 80% ground wood and 20% semibleached chemical long-fibred pulp. The function of the long-fibred fraction is to impart strength properties to the sheet so that it may be run on high speed newsprint machines as well as enabling the finished newsprint on high speed printing presses. The function of the ground wood is to reduce the cost of the finished paper, as well as to impart desirable qualities to the paper, mainly opacity, bulk and ink absorbency.

Chemical bagasse pulp may replace all or part of the long fibred pulp in the newsprint furnish. However, since bagasse pulp is basically short-fibred, the percentage of the chemical pulp fraction in the furnish has to be increased to compensate for the difference in strength properties as compared to long-fibred chemical pulp made from, say, spruce.

The percentage of bagasse chemical pulp in such cases is estimated to be in the neighbourhood of 40-50% instead of the usual 20% of long-fibred chemical pulp. This furnish, 40-50% chemical bagasse pulp and 50-60% ground wood, is appreciably more expensive than the standard furnish.

Nevertheless, this furnish or similar furnishes are reported to have been used in some mills, but most of them failed to continue due to the high cost of production. Very few mills still use a similar furnish. They sell their production at considerably higher prices than world prices. The local economic circumstances in the countries where these mills operate justify the additional cost. By and large these exceptional cases should not be taken as the rule.

From the foregoing considerations, it appears that any project for building a bagasse newsprint industry should be based on producing bagasse pulp by mechanical or chemimechanical methods at a low cost, comparable to ground wood, yet still meeting all the technical requirements necessary for producing an acceptable quality of newsprint.

A project on these lines was contemplated in Egypt in the middle 60's. Several offers were made which covered most of the processes known then. Although the project has not been executed yet, the economical studies carried out at the time reveal many facts which may be of interest. Naturally, the price of equipment varied according to the supplier, and the cost of production also fluctuated according to the process recommended, but this is to be expected. The prices quoted here are based on prices current in 1965.

The mill as envisaged comprised the following:

- A paper mill capable of producing 100,000 tons/year of newsprint and magazine paper
- A corresponding bagasse pulp mill, whether mechanical or chemimechanical
- A 50,000 tons/year pulp mill for bagasse chemical bleached pulp for the domestic market, with a recovery system

- An electrolytic plant to produce about 5-6,000 tons/year of caustic soda and the corresponding quantity of chlorine
- Power station, water plant and all other utilities with adequate capacity to service the mill

On this basis the FOB prices quoted for all the machinery and equipment required ranged between 15 and 14.5 million pounds sterling. The prices included all the engineering costs as well as the royalties on the use of the process which some of the potential suppliers demanded.

A further study was made by the Egyptian authorities, based on the prices quoted in the best offer, to calculate the expected cost of production. Naturally the then current prices of raw materials were used for calculation.

Accordingly, the cost of production of a ton of newsprint was estimated at about 75 pounds sterling. This estimation was based on the assumption that the mill would be running at a good efficiency rate and at maximum production. Obviously these favourable conditions should not be expected during the initial stages of production.

At that time, the cost of importing newsprint was around 70 pounds sterling per ton, about 5 pounds sterling <u>lower</u> than the estimated cost of producing it locally. This obviously would not necessarily hold true in all cases since it depends on local conditions and prevailing prices.

VIII. <u>General Conclusions</u>

Certain conclusions can logically be drawn from the above survey of the subject of bagasse newsprint. I would like to summarize them as follows:

A. No mill at present is producing bagasse newsprint in the true sense of the word. There have been, however, many attempts to prove the worth of certain suggested processes by carrying out short commercial runs or pilot plant scale trials.

B. The question of producing bagasse newsprint is one of the most pressing for the developing countries. Their needs for newsprint are mounting every year and they have to import these requirements, which represents a burden on their balance of payments and resources of foreign currencies.

C. The subject of bagasse newsprint is gaining increasing interest from specialized firms and research centres, but in my opinion a great deal of development work has still to be directed to exploring the possibilities of bagasse as a suitable raw material for making newsprint.

Unluckily, most of the research and development work in the highly industrialized countries is concentrated on wood, the common paper making raw material used in these countries. On the other hand, most of the developing countries interested in bagasse lack adequate research and development facilities.

Consequently, most of the research work now being done is carried out by machinery manufacturers, who are naturally hesitant to earmark the large funds necessary for such an undertaking unless they are fairly confident of enough volume of sales to cover their expenses.

D. The two main conceptions of producing bagasse pulp suited for newsprint are:

1. mechanical bagasse pulp
2. chemimechanical bagasse pulp

In my opinion, both conceptions may be right. Mechanical bagasse pulp seems to lack the physical properties needed, mainly wet strength. This may be a drawback when the pulp is run on high speed newsprint machines. On the other hand, it enjoys certain advantages, such as excellent opacifying properties, good bulk and ink absorbency.

Chemimechanical pulp appears to lack in opacity and ink absorbency properties, but these drawbacks can be compensated for by using fillers of adequate nature and in percentages which will not impair physical properties. The pulp seems to have good physical properties and can be run at higher speeds on newsprint machines.

Nevertheless, other conceptions such as the comparatively recent Peadco process are worth considering, especially since they are still new and are being developed further at present.

E. Most of the development work so far has been in the direction of the technology of pulping bagasse. Very little if any development work has been directed toward adapting paper making machinery to the nature of bagasse pulp.

It may have been noticed in the course of this report that almost all the pilot plant and commercial runs were made on standard paper machines, originally designed to cope with the different nature of standard newsprint furnish.

It is my opinion that exploring this side of the problem should go hand in hand with the present trend of development. As it stands now, efforts are being expended to produce bagasse pulp suitable for running on standard newsprint machines, a task which may prove to be difficult. A new paper machine especially designed to cope with the properties of bagasse pulp may be the solution needed.

F. So far, it seems that at best bagasse newsprint will be more expensive than standard newsprint produced from wood, at least during the first stages of operation.

This situation must be realized by the interested developing countries. Their main gain would be in foreign currency saving. I believe, however, that further development of both process and machinery will eventually bring the cost down substantially.

G. In view of all the foregoing discussion of bagasse newsprint, I should like to recommend that, because of the difficulty encountered in investing enough funds to finance the research and development necessary for such an undertaking, it may be advisable for the countries interested to pool their efforts and funds for this purpose. This can be done either as a joint effort by these countries, or under the auspices of one of the United Nations agencies. The importance of the issue cannot be overestimated.

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