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NEWSPRINT FROM BAGASSE: PAST AND POSSIBLE FUTURE ACTION 1/

by
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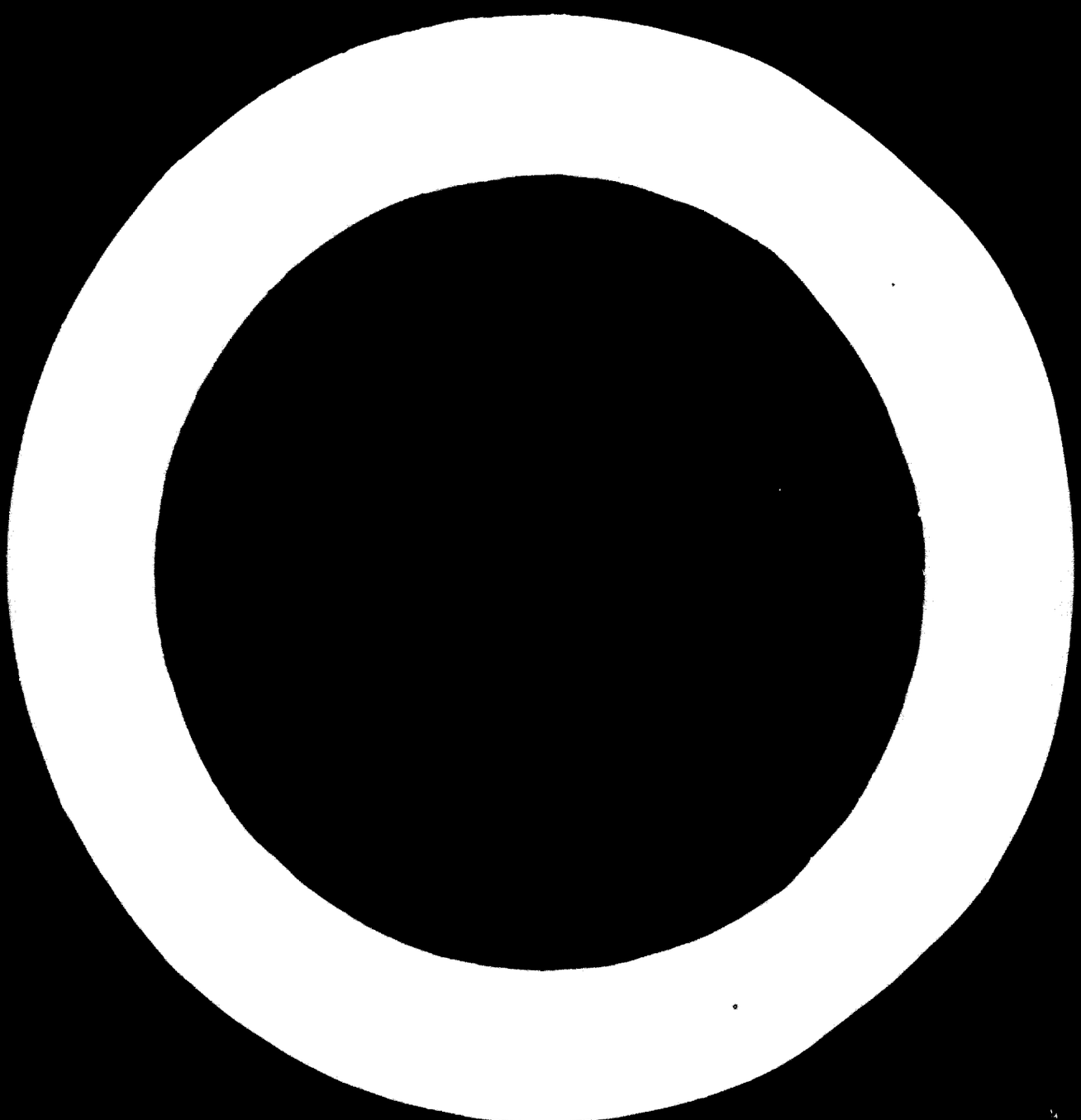

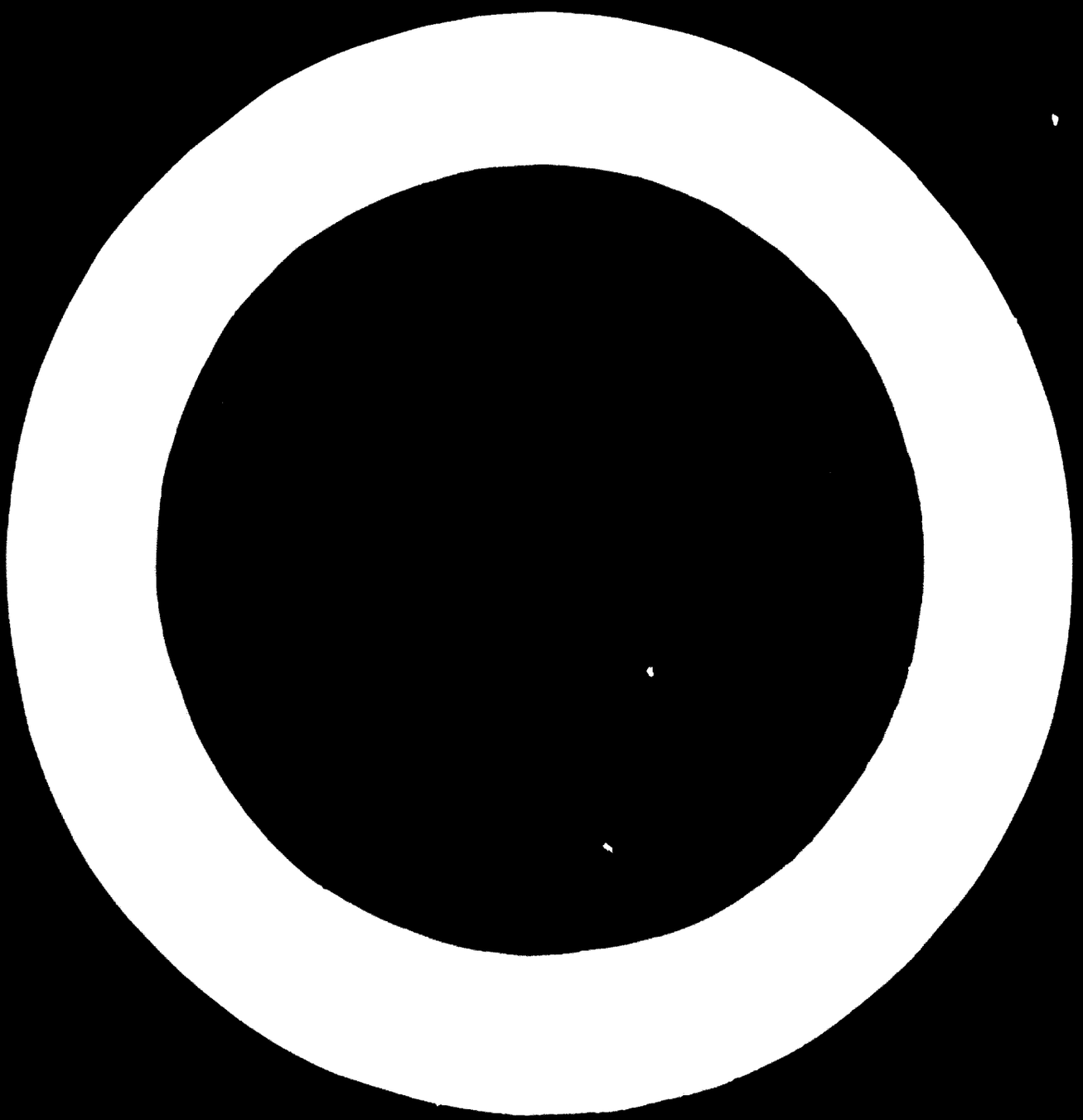

I. INTRODUCTION

Most of the newsprint used in the world at the present time consists of about 80 percent groundwood pulp derived from softwoods, with the remainder consisting of chemical pulp, also derived mainly from softwoods.

Spurred by the continually growing shortage of softwood timber, great strides have been made in recent years in developing technologies for utilization of hardwoods in the manufacture of newsprint and also bagasse which is a by-product of the sugar cane industry. While a considerable amount of technical information on the use of hardwood exists today, its acceptance as a quality chemical pulp is reducing its availability for newsprint manufacture.

Although the possibility of using bagasse pulp in the manufacture of newsprint has been demonstrated through laboratory and semi-commercial trials, the economic justification for extensive use of bagasse pulps in this field has yet to be established.

II. PURPOSE OF THE WORK

The purpose of this work is to present the bagasse newsprint techno-economic approach taken by the Research Group of the Paper Division of W. R. Grace & Co. and marketed by Process Evaluation and Development Corporation (PEADCO), a wholly-owned Grace subsidiary.

For a better and more comprehensive understanding of the bagasse newsprint process presented here, a recapitulation of the known bagasse newsprint pulping methods is included. To date none of these processes is in commercial operation or production.

An economic profile study of the PEADCO Process is included in the present paper based on the data collected in commercial trials for newsprint conducted by PEADCO and assuming the installation of one bagasse newsprint mill in the area of Veracruz, Mexico.

III. BAGASSE AS A RAW MATERIAL FOR NEWSPRINT

Sugar cane--Saccharum Officinarum--is a typical grass grown in most of the tropical and sub-tropical countries. Bagasse is the fibrous portion of sugar cane left over after the extraction of the sucrose containing juice. The physical characteristics of the material make it suitable for the manufacture of certain commercial products. Bagasse is also attractive as a potential

for newsprint paper because of its worldwide large-scale availability. Many of the problems associated with harvest and collection of annual plants have been solved in delivery of the sugar cane to the sugar central.

Because bagasse is the normal fuel for sugar mill boilers, the heat load of the mill governs the extent to which bagasse might be released for pulping. The presence and cost of alternate fuels as well as boiler efficiency plus the pith (fraction of bagasse not suited for paper making) being returned to the boiler, gives a good economical incentive for the utilization of bagasse in newsprint paper.

The map, Figure 1, shows the free-world area (other than U.S.A.) where bagasse fiber is being produced in sufficient amounts for possible bagasse pulp and bagasse newsprint operations.

IV. INTERPRETIVE VIEW OF TODAY'S KNOWN NEWSPRINT PULPING PROCESSES

A review was made of all pertinent literature and discussions held with knowledgeable people about existing bagasse newsprint technologies. A summary of this review follows:

a) Mechanical Process

Crown-Zellerbach Mechanical Process

This is the result of interesting research work conducted by Crown-Zellerbach at their Central Research Laboratory. The overall objective was to produce as many grades of paper as possible from a pure bagasse pulp furnish including newsprint paper.

In 1960, Crown-Zellerbach Corporation became interested in the use of sugar cane bagasse as a potential raw material for papermaking, and a joint development program was initiated with the Hawaiian Sugar Planters Association to determine which grades of paper could be produced from the bagasse in the Hawaiian Islands.

The Crown-Zellerbach approach for newsprint papermaking was simple: To apply the best of the wood processes. Crown-Zellerbach realized ground bagasse pulp offered excellent opacity properties. If it could be produced with economic power usage a furnish of fifty to sixty percent ground bagasse and forty to fifty percent bleached kraft wood pulp would yield a good newsprint with qualities falling within commercial specifications. A pilot plant was built in Camas, Washington in which Crown-Zellerbach developed a process for grinding bagasse at reasonable costs and power consumption. Laboratory and commercial paper machine runs were made. Table I shows the results of these trials.

b) Chemical Processes

Bagasse Newsprint Using a Chemical Pulp - De la Roza Process

During past years, experiments were carried out in the field of newsprint manufacture using a chemically cooked bagasse pulp. In Cuba experiments were carried out by De la Roza using whole bagasse chemical pulp. This process was investigated by the United States Bureau of Standards at the request of the House of Representatives. The Department of Commerce Report, dated October 1, 1952, suggested the De la Roza process was good for newsprint manufacture. Table II shows the newsprint characteristics prepared by De la Roza compared with mean values for three commercial newsprints.

Ayotla-Tuxtepec Mexico Trials

The chemical pulp obtained by the Ayotla process was semi-bleached with sodium hypochlorite to a brightness of 60 and blended with fresh mechanical pulp in a blend of 40% bagasse pulp and 60% mechanical wood pine pulp. The paper was manufactured in April 1961 at a speed of 1250 ft/min in an open draw newsprint machine. Paper obtained was utilized for an edition of "Ultimas Noticias de Excelsior" on April 18, 1961. Table III shows the properties of the 40-60% blend compared to other commercial newsprint papers.

The Simon-Cusi Newsprint Process

This process is based on the relative resistance of lignified central vascular fibers and vascular fiber bundles in the rind structure of bagasse. A mild caustic soda digestion followed by a fiber classification yields two types of fibers that are separated and nominated "A" and "B". "A" is the more digested fibers from the central portion of the stalk and "B" is the resistant rind fibers that remain almost intact or raw. The fraction "B" is heavily refined until it becomes pulp; fractions "A" and "B" are blended again, screened, centrifugated and semibleached to a brightness of 60° G.E.

Commercial trials have been conducted in the San Cristobal mill in Mexico; in Texas-U.S.A.; and in Canada. Table IV shows properties of Simon-Cusi newsprint paper compared with other papers.

c) Thermomechanical Process

Thermomechanical Pulping - Asplund Defibrator Newsprint

The Research Group of Asplund Aktiebolag, Sweden, conducted some work related to pulping bagasse for newsprint utilization. Basically it consists in steaming the fiber at 2 Kg/cm^2 pressure and 130°C and blowing it through a refiner. Freeness after third stage of refining is 230 ml. CSF. Pulp is screened on a 0.15 mm.

screen where 5% is separated as rejects. The accepted stock is centricleaned in one stage in a Radiclone at 0.5% consistency where 10% of ingoing pulp is rejected. Freeness of the accepted pulp is in the range of 120 ml. CSF. Data from refining and paper testing appear in Table V.

DISCUSSION ON THE NEWSPRINT PROCESSES DESCRIBED

Bagasse newsprint production has been attempted, making use somewhat of the classical pulping technology as applied in groundwood, thermomechanical, chemical and semichemical pulping. Unfortunately, full consideration was not given to the nature of the raw material. This is especially so with respect to the lignin-hemicellulose distribution and the difference of structure and morphology of the bagasse fiber bundles as compared to wood. A further interesting factor was the coloring of the lignin-hemicellulose groups under temperature and pressure and the need to semibleach the pulps in all cases, which has contributed to lowering yields, lowering opacity and increasing total pulp and newsprint paper costs.

The above results are not a surprise to us in view of our growing knowledge of the structure, morphology, chemical composition and properties of bagasse. Generally speaking, the most

logical approaches are those directed towards mechanical or thermo-mechanical pulping of bagasse fiber. However, consideration must be given to the fiber structure, lignin-hemicellulose bonding groups and their coloring.

Any approach through the classical mild cook, full cook or semichemical method will yield a pulp that will require semibleaching. As a consequence, the opacity property will be lowered, and thus require at the paper stage, the utilization of fillers to restore the opacity. Yields of such pulps are always low compared with those obtained by mechanical or thermomechanical grinding. Total cost of such newsprint papers is high and product quality is low.

V. PEADCO NEWSPRINT PROCESS

The newsprint approach taken by the Research Group of the Paper Division of W. R. Grace & Co. is based on the PEADCO Process modified by the introduction of a prehydrolysis stage, plus brightness control by means of sodium silicate as an oxidizing agent.

Process Description

The exhausted cane that comes from the sugar mill contains by weight approximately 2-3 percent sucrose and 48-52 percent water.

The bagasse is weighed continuously and conducted to the fiber preparation area where the pith fraction is removed. The depithers, which are known as PEADCO depithers are designed for two-stage depithing of the bagasse fiber. The first stage of depithing known as moist depithing is conducted at the sugar mill site, where separated pith is immediately returned to the sugar mill boilers for its disposal. The moist centrifugal PEADCO depither is based on the principle of fibers centrifugation where density variation of the fibers is a key factor. The fractions are separated by the rolling and rubbing action of the fibers on each other and pith is forced through the perforated basket by the centrifugal forces applied. The PEADCO depither is covered by U.S. Patent No. 3,537,152 of March 1970.

For most efficient overall operation of a pulp and paper mill, it is preferable to install wet depithing equipment directly after the initial moist depithing stage. Wet depithing operation as a secondary stage gives a high purity clean fiber, reducing the chemicals requirements at cooking stage.

However, wet depithing may be used as the primary and only stage of depithing or as a secondary stage for upgrading the fiber fraction accepted from the moist depithing. In either event, the selection of the depithing, moist-wet or only wet, will depend entirely of the newsprint mill design and in either event, the

resulting fiber is substantially pith-free and has relatively low solubles content.

The accepted clean fiber free of pith and solubles is treated in a continuous pressurized digester at 125 psig pressure and 347°F temperature minimum to a prehydrolysis stage at a pH of 4.5. Following the prehydrolysis stage, two percent sodium bisulfite and one percent sodium silicate are added to the fiber in bone dry basis. The pH of the fiber is then raised to 8.0 approximately and the cooking reaction is extended for another 10 minutes to a total 17 minutes cooking time. The reaction is conducted in vapor-phase conditions at same temperature and pressure of the digester (125 psig pressure and 347°F temperature).

From the digester, the pulp at high consistency is blown through a refiner where the fibers are freed from the bundles. The defibration when conducted at temperatures over 295°F produces pulps of high properties and low fines. The explanation is based on the thermoplastic properties of lignin. When heat is applied the lignin gets soft and fibers can be released from bundles without reducing the length of such fibers.

At the digester discharge and before and after the refiner, spent liquor is added to the pulp to decrease the degree of steam flash phenomenon. At the blow tank discharge consistency is regulated at approximately 15% and high density refiners are used

throughout for a complete defibration of the pulp.

Pulp is then screened and centrifugated in an inclosed screening system using centrisorters, Bird screens in a two-stage screening and three-stage Bauer 606 cleaners.

Accepted pulp is washed by a conventional vacuum cylinder washer. One-stage washing is normally enough considering that the amount of chemicals used are mainly for brightening the pulp and not for lignin extraction.

Lignin color groups that normally under high temperature become darker are oxidized and prevented from coloring by the sodium silicate which imparts a whitish color to the pulp. Brightness of the finished pulp under the above described process approximates 55° G.E. and yield is approximately 85% from bagasse fiber. Table VI shows the results of paper produced with the above described pulping process.

The newsprint pulp and paper process described and the technical data given in Table VI are the summation of the experimental trials described in our report to the TAPPI Nonwood Plant Fibers Committee Meeting in New Orleans, Louisiana on November 2, 1970.

On Figure 2, yields of newsprint pulp are shown in detail.

VI. ECONOMIC CONSIDERATIONS

While the technological feasibility of successfully manufacturing newsprint from bagasse has been established on a laboratory, pilot and commercial scale, the economic practicability of using bagasse as a newsprint material must be reviewed taking into consideration the following factors:

1) Cost of obtaining bagasse clean fiber at a given project.
2) Quantity of bagasse in the given area of the project.
3) Chemicals availability and prices. Chemicals in our process will be only sodium bisulfite manufactured (2% based on fiber input) from sulphur and sodium carbonate; and the sodium silicate (1% based on fiber input).
4) What the overall production costs are to make newsprint from bagasse in comparison with those for standard newsprint at high speed machines.

An estimation of the cost of newsprint manufacture is presented on Schedule A based on the PEADCO Process described in Section V and a pre-selected site in the area of Veracruz, Mexico where information of raw materials availability, prices and human resources are fully available to us. In arriving to the cost figures, i.e.,

operating materials and supplies, general and administrative expenses, etc., the operating data and experience of the pulp and paper mills around the world using the PEAD^O Process were drawn upon for guidance.

Design capacity of the mill has been settled in 330 metric tons bone dry per day. Operating days 330 per year and a furnish of 90% bagasse thermomechanical pulp and 10% long fiber wood pulp.

VII. DISCUSSION

After careful pilot plant research work and commercial trials evaluation on the development of the newsprint from bagasse, we believe that bagasse is a good raw material for the production of newsprint paper; and that if properly treated, a bright (55-60° GE brightness) mechanical type of pulp can be obtained at an attractive cost as shown in Chapter VI.

Research work is continuing on newsprint from bagasse. There is a positive and definite indication that yields can be raised to 90% plus from bagasse fiber. It is possible that the only chemical used will be 1% sodium silicate based on bagasse fiber B.D. Physical properties of this pulp are acceptable and its opacity and brightness fall into the limits of the regular newsprint

standards. Given these circumstances, we are scheduling a final commercial trial in our Trupal-Peru paper mill. High density refining and screening will be incorporated at the mill so a full production run of the mechanical pulp from bagasse with all the properties of commercial groundwood for newsprint can be made.

VIII. ACKNOWLEDGMENTS

The author is indebted to Sociedad Paramonga Ltda. by making their facilities in Peru available to the Paper Division Research Group of W. R. Grace & Co. in the development of this process; to Papelera Nacional S.A., San Carlos-Ecuador at whose plant we have conducted the commercial trials for pulping. Our special thanks to Beloit Corporation, Beloit-Wisconsin for making available their experimental twin wire former machine; to the Institute of Paper Chemistry, Appleton-Wisconsin for their continuous collaboration; and to Defibrator AB, Sweden and Crown-Zellerbach Corporation, Camas-Washington for the valuable assistance from their technical staffs.

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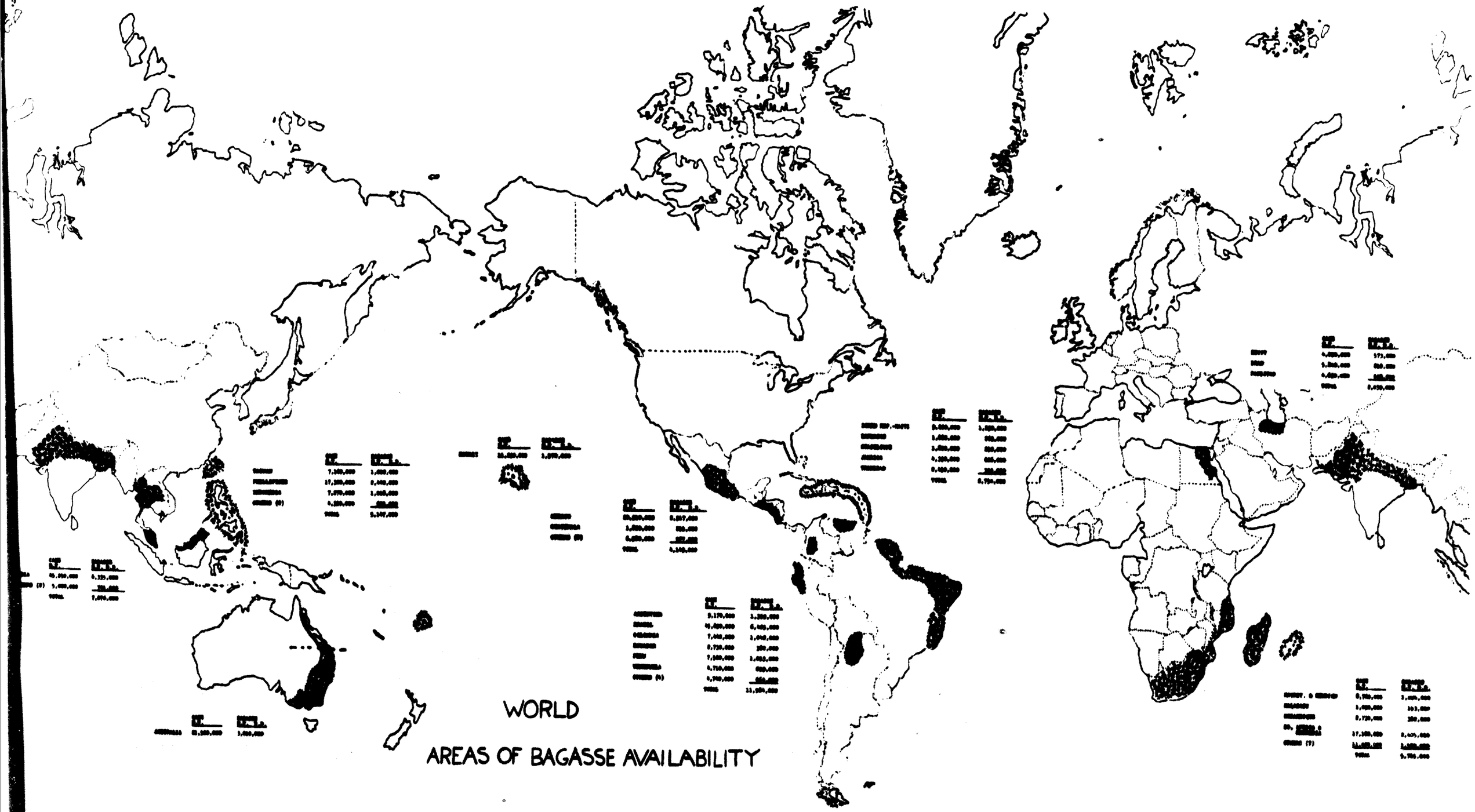
FIGURE 1



WORLD

AREAS OF BAGASSE AVAILABILITY

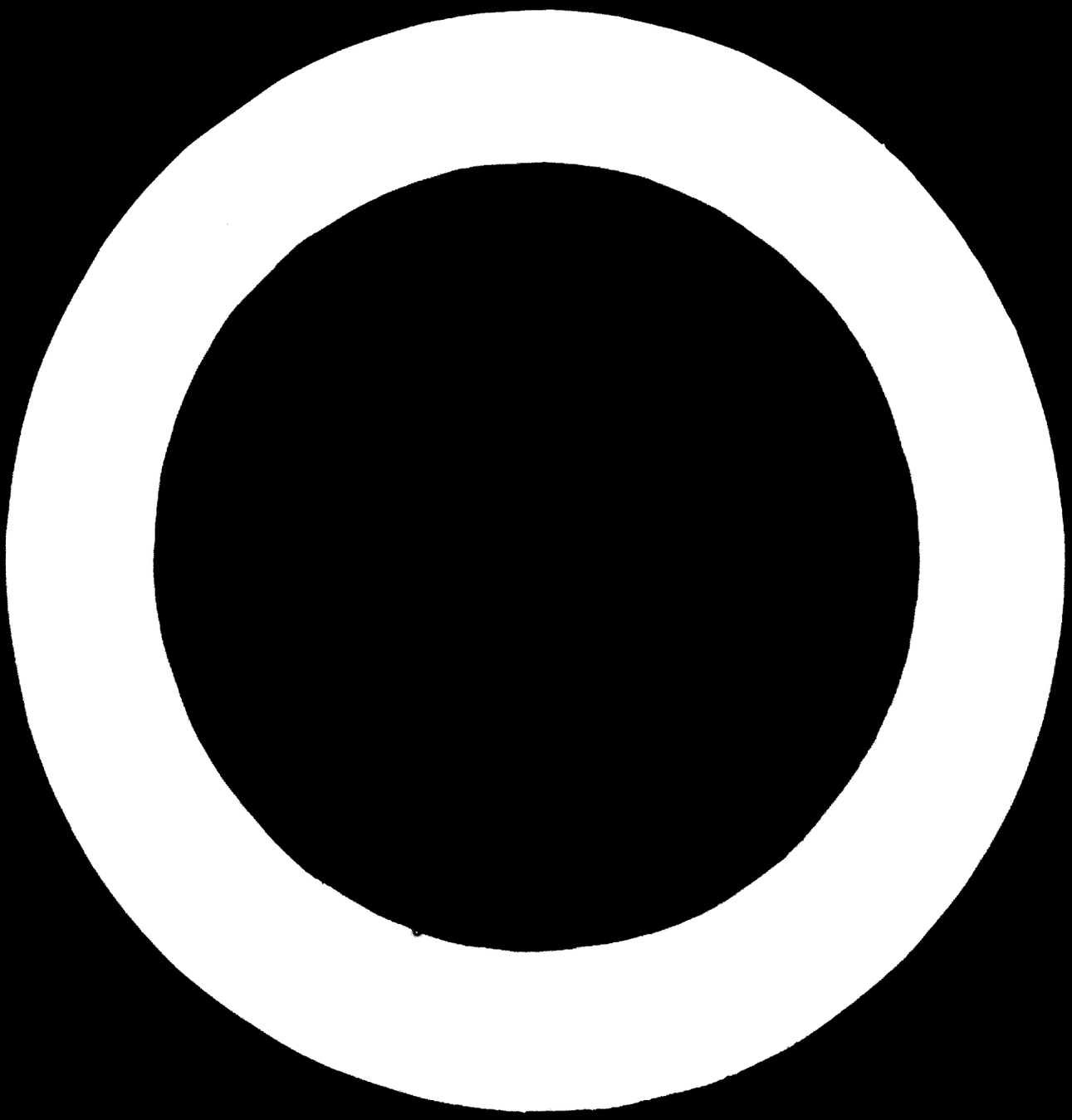


FIGURE 2

BAGASSE NEWSPRINT YIELDS

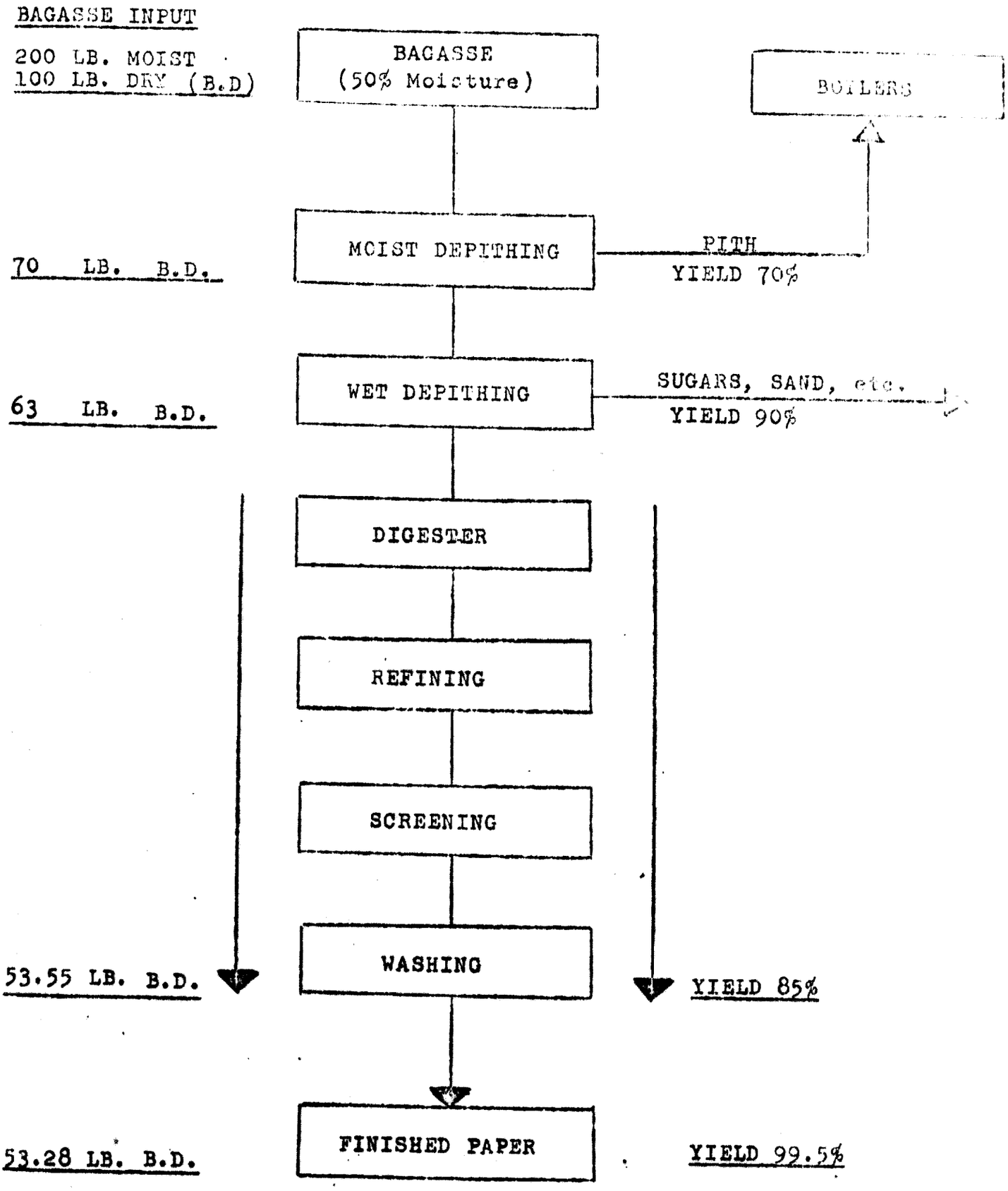


TABLE I

TRIAL 2
Ground Bagasse, Kraft Bagasse Newsprint
1960

	Trial A	Trial B	Commercial 3
Basis weight, lbs. 24 x 36 - 500 ream	31.5	31.8	32.1
Bulk, factor	94	125	105
Mullen, %	30	25	29
Tear, gms. WMD	21	24	20
CMD	23	29	28
Tensile, lb/½-inch, WMD	5.6	5.0	5.0
Opacity, %	82	87	88
Brightness, G.E.	51	52	56

Source: Crown-Zellerbach Corp., Camas-Washington

TABLE II

SOME CHARACTERISTICS OF BAGASSE NEWSPRINT PREPARED BY THE DE LA ROZA PROCESS AT THE UNITED STATES BUREAU OF STANDARDS COMPARED WITH MEAN VALUES FOR THREE COMMERCIAL NEWSPRINTS

	De la Roza Bagasse	Commercial, Wood, Mean of 3
Basis weight:		
24 x 36 - 500, lb	35.8	38.3
25 x 40 - 500, lb	41.4	33.1
Caliper, in/1,000	3.2	3.5
Burst, points	11.0	7.0
Folds, double:		
Machine direction	13	4
Cross direction	7	1
Tensile strength per 15-mm strip, Schopper:		
Machine direction	3.9	2.3
Cross direction	2.1	1.2
Tearing strength, Elmendorf:		
Machine direction	29	19
Cross direction	43	23
Smoothness, Bekk, sec.	15	62
Ash, ovendry basis, %	13.2	0.25
Opacity, %	92	90

Source: Subcommittee 5 of the Committee on the Judiciary, House of Representatives, "Study of Newsprint Expansion," p. 52, 1952.

TABLE III

COMPARISON OF NEWSPRINT PAPERS MADE OF WOOD PULP ALONE, AND BLENDS OF WOOD PULP AND SUGAR CANE BAGASSE

		Perkins	Anglo	Canadian	Tuxtepec 60	Tuxtepec 61	40/60 Bagasse
Basis Weight (g/m^2)		54.0	58.5	52.0	57.0	52.0	52.0
Caliper (0.001^2)		3.4	3.0	3.2	3.5	3.3	3.1
Porosity (Sec/100 ml)		14	33	85	57	64	25
Opacity (%)		91.0	90.5	90.0	94.0	95.0	91.0
Brightness (GE)		60	56	57	54	54	60
Burst ($lb.\ in.^2$)		9.0	9.0	9.2	8.5	9.2	11.5
Burst Factor		11.7	12.1	12.4	10.3	12.4	14.5
Tensile (Kg.)	MD	2,300	2,850	2,950	2,600	2,600	2,500
	CD	1,100	1,200	1,300	1,550	1,550	1,500
Tensile factor	MD	2,850	3,630	3,780	3,040	3,400	3,500
	CD	1,360	1,530	1,662	1,818	2,000	1,730
Tear	MD	34.6	26.6	26.6	26.6	34.6	26.6
	CD	45.3	34.6	34.6	32.0	45.5	29.4
Tear factor	MD	64.2	50.7	51.2	46.6	66.5	51.0
	CD	83.9	66.0	67.5	56.0	87.0	58.0

Source: Reprint from Proceedings of the Eleventh Congress of the I.S.S.C.T., Mauritius 1962, p. 1209.

TABLE IV

COMPARISON OF NEWSPRINTS FROM VARIOUS SOURCES

Properties	Wood			Bagasse
	Canadian	Chilean	Tuxtepec	1st Experimental Run at S.Cristobal
Basic Weight, g/m^2	52.9	52.2	53.8	51.3
Humidity, %	7.7	7.6	6.3	5.9
Thickness, mm	8.4	9.2	8.6	8.5
Spec. Volume, cc/g	1.72	1.9	1.7	1.75
Porosity, sec/100 ml	44	35	53	49
Opacity, %	92.5	88.7	93.1	74.5
Brightness, °GE	58	56.5	52.3	62.0
Burst, lb/in^2	11.5	10.9	10.5	17.2
Burst, factor	15.4	14.7	13.8	23.5
Tensile, Kg	3.55	3.05	3.72	3.82
Breaking Length, m	4500	3900	4600	4950
Tear, g/cm	27.5	34.9	23.5	35.8
Tear, factor	32.2	66.6	43.8	69.8
Bending, D.D.	246	417	307	540

Source: Dr. D. S. Cusi, "Technical and Economic Factors to be Considered in the Production of Bagasse Newsprint", paper presented at ATCP, 1962.

TABLE V

THERMOMECHANICAL PULP FROM BAGASSE

Defibration

Preheating time	min	:	4
Steam pressure	kg/cm^2	:	2
Steam temperature	°C	:	130
Disc type		:	5821 Cr
Disc clearance	mm	:	0.35

Refining

Raffinator type ROP, screw feeding, discs type 5821 Cr

Sample			:	E_1	E_2	E_3	E_4
Refining stage			:	1	2	3	Pulp E_3
Refining consistency		%	:	22	20	19	screened &
Disc clearance		mm	:	0.30	0.23	0.20	centri-
Pulp freeness without latency	CSF	ml	:	400	290	230	cleaned

Screening and Centricleaning

Total amount of reject	%	:	15
Freeness of accept	CSF ml	:	120

Paper Testing

Sheet weight	g/m^2	:	97.0	104.7
Bulk	cm^3/g	:	2.47	2.10
Burst factor		:	7	15
Breaking length	m	:	1720	3070
Elongation	%	:	1.8	2.6
Tear factor, APPITA-Elmendorf		:	31	42
Folding, Kohler-Molin, load 200g		:	40	400

Source: Defibrator AB, Sweden

TABLE VI

PHYSICAL PROPERTIES - DRY PAPER
BAGASSE NEWSPRINT

Number		1	2	3	4	5
Finish, %		100% Bagasse	90% Bagasse 10% Kraft	100% Bagasse 5% Clay	90% Bagasse 10% Kraft + 5% Clay	80% Regular Canadian Newsprint and 20% Ground Softwood Semibl. Pulp
Basis weight, gm/m^2		51.8	52.0	52.0	52.0	52.0
Tear, gm/cm	MD	36.0	40.0	35.0	37.0	38.0
	CD	38.0	40.0	36.0	38.0	34.6
Tensile, Kg	MD	3.08	3.60	3.00	3.45	3.55
	CD	2.10	2.10	2.00	3.00	3.03
Burst, lb/in^2		10.3	12.0	10.0	11.5	12.4
Porosity, sec/100 ml.		49	46	50	48	44
Brightness, °G.E.		55	56.5	55	56.5	58
Opacity, %		88	87	90	89	92.5

Source: Sociedad Paramonga Ltda., Paramonga-Peru. Newsprint trial runs. 1971

SCHEDULE A

BAGASSE NEWSPRINT PROJECT
PRODUCT COSTS

	330 Operating Days (109,000 B.D. Metric Tons)		
	U.S. $	% of Total Cost	Cost per Ton
DIRECT MATERIALS			
Furnish	$ 3,560,000	48.3 %	$ 32.66
Broke (Credit)	(261,600)	(3.6)	(2.40)
TOTAL (See Sched. B-C)	$ 3,298,400	44.7 %	$ 30.26
OPERATING MATERIALS AND SUPPLIES			
Gas	$ 440,000	6.0 %	$ 4.04
Wires and Felts	305,200	4.1	2.80
General Operating Supplies	300,000	4.1	2.75
Maintenance	150,000	2.0	1.38
Water Treatment	300,000	4.1	2.75
TOTAL	$ 1,495,200	20.3 %	$ 13.72
PAYROLL COST (INCLUDING BENEFITS)			
Workers	$ 304,600	4.1 %	$ 2.79
Employees	422,800	5.8	3.88
TOTAL (See Sched. D)	$ 727,400	9.9 %	$ 6.67
DEPRECIATION (See Sched. E)	$ 1,218,000	16.5 %	$ 11.18
GENERAL & ADMINISTRATIVE EXPENSES			
Administrative	$ 109,000	1.5 %	$ 1.00
Insurance	179,000	2.4	1.64
TOTAL	$ 288,000	3.9 %	$ 2.64
ROYALTIES	$ 350,000	4.7 %	$ 3.21
TOTAL MANUFACTURING COSTS E.O.M.	$ 7,377,000	100.0 %	$ 67.68

SCHEDULE B

BAGASSE NEWSPRINT PROJECT
COST OF DIRECT MATERIALS

	% on Bagasse Fiber B.D.	Metric Tons	Amount
Bagasse Fiber	100 %	117,474	$ 422,906
Semibleached Pulp 65° GE brightness		11,095	2,690,759
Sodium Bisulphite	2	2,349	352,350
Sodium Silicate	1	1,175	94,000
Sub-Total			$ 3,560,015
Less: Broke		4,360	261,600
TOTAL DIRECT MATERIALS			$ 3,298,415

SCHEDULE C

BAGASSE NEWSPRINT PROJECT
FIBER ASSUMPTIONS

	%	Metric Tons
ANNUAL PRODUCTION	100 %	109,000
Add:		
Broke	4	4,360
Total Production		113,360
Less:		
Moisture	8	9,069
Net Furnish		104,291
Add:		
Losses in Production	6	6,657
Gross Furnish		110,948
RAW MATERIALS		
Bagasse Pulp	90	99,853
Semibleached Pulp - 65° G.E. brightness	10	11,095
	100 %	110,948
BAGASSE PULP REQUIRED		
Pulp Required		99,853
Yield		85%
Bagasse Fiber B.D.		117,474

SCHEDULE D

BAGASSE NEWSPRINT PROJECT
MANNING TABLE

	Workers		Employees	
	Number	Amount	Number	Amount
Depithing and Yard	24	$ 71,525		
Pulp Mill	15	55,407		
Paper Machine	15	71,525		
Warehouse & Shipping	8	30,558		
Maintenance	15	75,555		
Engineering			6	$ 60,822
Laboratory & Technical Control			12	58,765
Operating			18	152,117
Administrative			19	151,104
TOTAL (including Social Benefits)	77	$ 304,570	55	$ 422,808

SUMMARY

Number of Workers and Employees	132
Wages and Salaries	$ 632,503
Social Benefits	94,875
Total	$ 727,378

SCHEDULE E

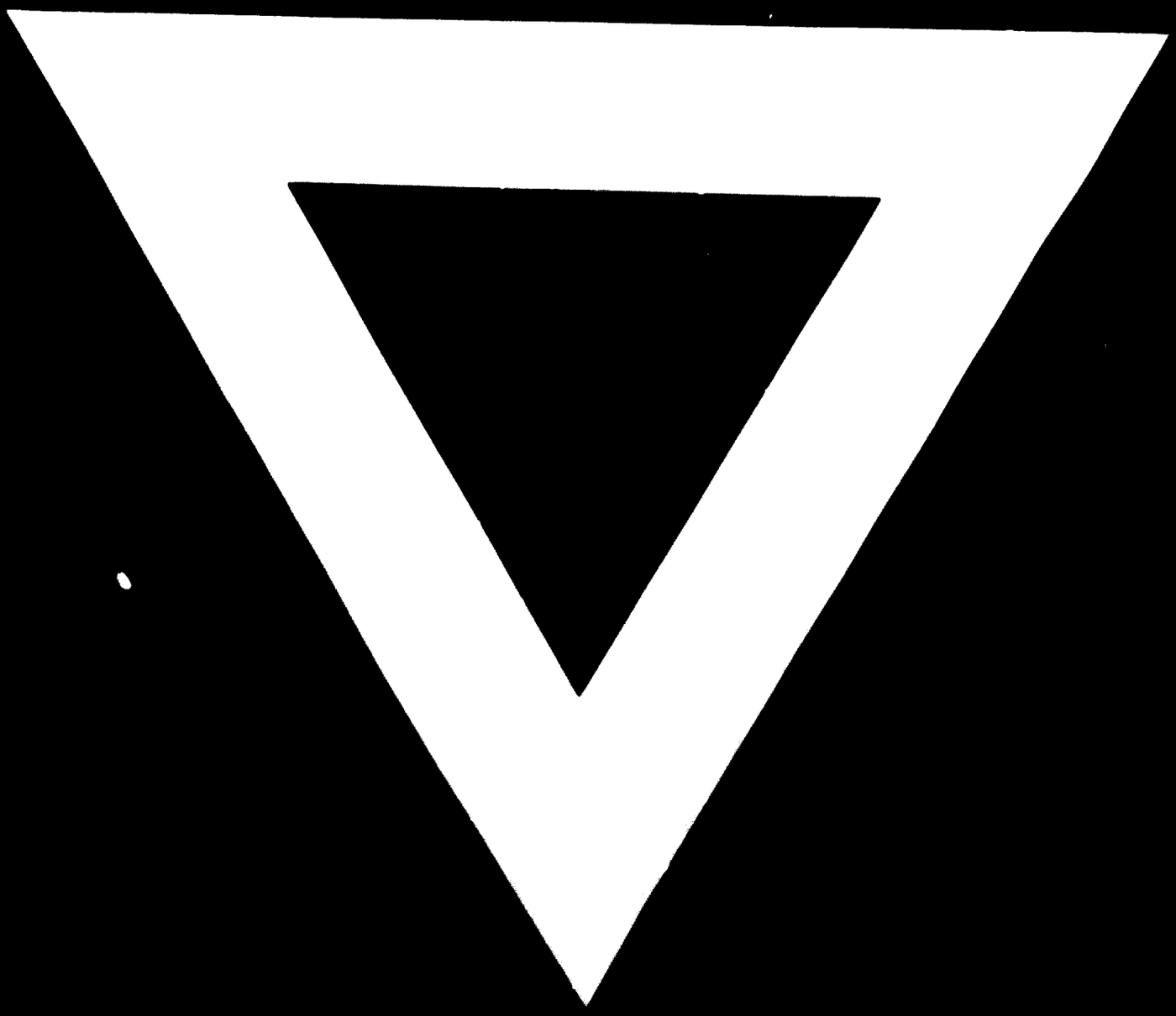
BAGASSE NEWSPRINT PROJECT
DEPRECIATION

GROSS FIXED ASSETS

Pulp Plant	$ 7,110,000
Paper Machine & Roll Wrapping	17,250,000
TOTAL	$ 24,360,000

ANNUAL DEPRECIATION

Rate	5 %
Amount	$ 1,218,000



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