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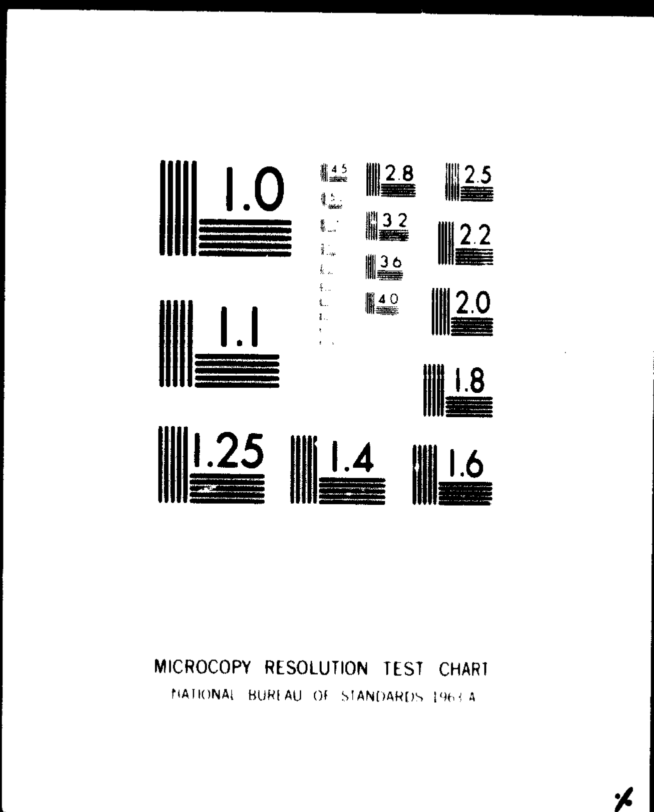
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REPORT P2368/2
5 DECEMBER 1969

UNITED NATIONS

NEW YORK U.S.A.

UTILIZATION OF BAGASSE

UTILIZATION OF BAGASSE IN MAURITIUS

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SUMMARY

1. This report presents the results of the second part of a study concerned with the utilization of bagasse and covers an assessment of the potential for using the bagasse available in Mauritius.

2. The cane sugar industry in Mauritius is expected to grow only slightly in future and the annual output of raw sugar is forecast to increase from the present level of about 600,000 metric tons to 660,000 and 690,000 metric tons by 1975 and 1980 respectively.

3. The total quantity of bagasse available is forecast to be about 770,000 metric tons on a dry fibre basis in 1975. Of this quantity 647,000 metric tons could be used by the sugar factories as fuel and the remainder, 123,000 metric tons, would be surplus.

4. Bagasse normally used as fuel could be replaced by fuel oil and would have a value of about US$ 8.80 per metric ton of dry fibre plus transportation charges and any charges required to modify the power boilers of the sugar factories to permit the use of oil. Surplus bagasse would have no value other than the cost of transporting it to the use point.

5. Domestic markets for paper and paperboard products in Mauritius have been reviewed and have been forecast to be only about 4,000 metric tons of a wide variety of both cultural and industrial grades of these products by 1980. The requirement is considered to be both too small and too diverse to be supplied by domestic production facilities.

6. Domestic markets for building board products that could replace a portion of existing imports have been forecast to be 3,800 metric tons by 1975. In addition, about 1,800 metric tons of building board could be marketed as building components for use in conjunction with cement block in construction of housing.

7. Export markets for both pulp and building board products might be developed in East Africa or in Europe.

8. Based on the availability of bagasse and other raw materials and on the markets available in both the domestic and export fields, three cases have been considered. These cases are concerned with establishing a pulp mill and/or building board plant of a size that would use only the bagasse that is surplus to the fuel requirements of the sugar factories.

9. The cases evaluated are as follows:

Case	Product	Capacity	Market Area
1.	Bleached Pulp	33,000 ADMTPA*	East Africa
2.	Building Board	11,200 BDMTPA	Mauritius and East Africa
3.	Combination of Cases 1 and 2		

10. Gross returns, before depreciation, interest charges and taxes, for the three cases have been estimated to be as follows:

Case 1 - 14%
Case 2 - 16%
Case 3 - 16%

11. The gross returns are not considered to be sufficiently high to be of interest for private investment, but the installation of these facilities might enhance the overall economy of Mauritius in that the balance in foreign trade might be improved and employment on a year round basis would be created.

*ADMTPA - Air dry metric tons per annum. For this and other abbreviations see Appendix 1

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INTRODUCTION

The United Nations, on behalf of the United Nations Industrial Development Organization, has authorized Sandwell and Company Limited to undertake a study of the utilization of bagasse. This study was initiated by a request from the Government of Mauritius for assistance in developing means of utilizing this by-product from the manufacture of cane sugar. The study has been carried out in two parts. The first part provides an evaluation of the technology available and in use at the present time, for the utilization of bagasse. The second part of the study provides a description of the cane sugar industry in Mauritius together with assessment of how the various means of utilizing bagasse can be applied to the bagasse produced there. The results are presented in two reports which cover the two aspects of the study separately.

THE ISLAND OF MAURITIUS

Mauritius, an independent member of the British Commonwealth, is a sub-tropical island located in the Indian Ocean approximately 1,500 miles off the east coast of South Africa. The island is volcanic in origin and is mountainous over much of its area. Maximum length of the island is 40 miles and its width approaches 30 miles. Total land area is 720 square miles. A location map is included in Appendix 5.

The estimated population of Mauritius in 1968 was 790,000 but the people are concentrated in a number of small cities. Port Louis is the largest city and is the capital, commercial centre and only port of the island. The other cities are located on a central plateau and provide the preferred residential areas of the island with the residents commuting to Port Louis. The population is divided as follows:

Hindu	52%
Muslim	17%
Chinese	3%
Others	28%

The "Others" includes some Europeans plus many other groups. The annual population growth has been high even though there has been a net emigration for the past several years. Consequently, the single biggest problem that the island has to solve is increasing unemployment.

The island was a Crown Colony of the United Kingdom until 1968 when independence was granted and it became a full member of the British Commonwealth. Although it had been a Crown Colony since 1810, French is still the principle language in use throughout the island. It was a French colony during the 1700's. Road signs and government publications are provided in English only and debate in the Legislative Assembly is bilingual. However, the majority of the population does not speak English.

The economy of Mauritius is based primarily on the cultivation of sugar cane and the manufacture of raw sugar. In 1967 approximately half of the total land area of the island was planted in sugar cane. Attempts to diversify the economy are being made and this program has been intensified substantially since the island became independent. Tea has been cultivated effectively for several years and the cultivation of other foods such as rice and fruit is being initiated. Raising beef and dairy cattle is also under evaluation. A definite effort is being directed to make the island more self sufficient in its food supply than it has been in the past.

Other industry in Mauritius is on a small scale but is quite varied. Industrial alcohol is produced by several of the sugar factories and this is converted to spirits, primarily a type of rum, by a government agency. Processing equipment for the sugar industry, including press rolls and evaporator vessels can be manufactured locally. Bus bodies and metal doors and frames can also be made and major repairs to marine vessels up to 300 feet in length can be handled. The island has a small concrete industry manufacturing block and pipe. Salt is produced locally from sea water. Certain other industries also exist.

CANE SUGAR INDUSTRY IN MAURITIUS

Growth of Sugar Production

Production and export of sugar provides essentially all of the income for Mauritius. The cultivation of cane is carried out by individual sugar estates, by independent growers and by tenant planters. There are at present twenty two sugar factories in operation. A small factory was closed down at the end of 1968 and it is probable that other small factories will be closed over the next several years. The trend is to concentrate the total production into a smaller number of relatively large units.

The average annual production of raw sugar for the past several years has been around 600,000 metric tons as shown in Table 1.

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Table 1 - Annual Production of Sugar in Mauritius

Year	Raw Sugar MT
1958	525,800
1959	580,400
1960	235,800
1961	553,300
1962	532,800
1963	685,600
1964	519,000
1965	664,400
1966	561,800
1967	638,300
1968	596,500

Annual production levels have fluctuated considerably but this is normal for this industry and is caused primarily by climatic variations. High production levels have been realized during seasons when the rainfall is high, especially during the early part of the season, whereas the lowest levels have resulted from cyclone damage to the crop. The average annual growth in production has been only about one percent a year as determined from the above figures, and also as indicated from the land area harvested and yield data during the same period.

It is considered by officials of the Mauritius Chamber of Agriculture and of the Mauritius Sugar Industry Research Institute (MSIRI) that the area now under cultivation, approximately 200,000 acres, will be maintained but will not be enlarged over at least the next six years. However, a small average growth in the annual production of sugar is forecast. This will be achieved by improving the yield of sugar per acre which is expected to result from the development and use of better varietal strains of cane. This improvement in yield is expected to increase the present average yield of 3.50 metric tons per acre by about 0.02 metric tons per year. Based on this forecast the annual increase in the production of raw sugar will average about one percent and the production in 1970, 1975 and 1980 will be 630,000, 660,000 and 690,000 metric tons, respectively. However, annual fluctuations in production levels can be expected from climatic variations as has been the case in the past.

Cultivation of Sugar Cane

The cultivation of cane is distributed over the whole island and the sugar factories are similarly distributed. However, because of the overall size of the island the average distance from outlying sugar factories to those that are centrally located and relatively close to Port Louis would be less than 25 miles.

In the cultivation of cane, planting is carried out during April and May and the first crop is harvested in 12-13 months for short season varieties and in

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16-18 months for other varieties. After the first cutting subsequent harvests are obtained on approximately a 12-month cycle. An average of 8 harvests (ratoons) are obtained after the initial cutting, consequently 9 crops are obtained from each planting. The crop yield decreases with each successive ratoon. For the period 1962-1966 the average annual yield of virgin cane was 85.0 metric tons per hectare and by the 6th ratoon the yield had dropped to 68.0 metric tons per hectare. The number of ratoons varies widely and depends on such factors as cane variety, soil conditions, climatic conditions and the attitude of the planter.

Although there is heavy rainfall in most sections of the island essentially all cane fields are interlaced with irrigation ditches which are used during dry periods. Along the south west coast a small area receives much less rainfall and regular overhead irrigation of the fields is carried out.

Harvesting Sugar Cane

In Mauritius, sugar cane reaches maturity between July and the end of October so harvesting is carried out during the period July to December. Prior to cutting the cane, workers go through the fields and strip off and collect the lower leaves that have already dried out. These leaves are used locally as thatch for roofs. The cane is then cut manually and the green leaves and tops are stripped from the stalks. These cane tops and leaves are left in the fields and are cleaned up by local farmers who use them as food for dairy cattle.

A small portion of the cane, about 10 percent is burned prior to harvest to remove the leaves and tops. This procedure is followed only in the coastal region where overhead irrigation is used. Prior to harvest the irrigation water is stopped, the leaves and tops dry out and can be burned. The cane stalks are then cut manually.

Production of Sugar

Full length cane (about two meters long) is trucked to the sugar factories of which there will be twenty two in operation for the 1969 season. Annual output from the individual factories ranges from a low of only 13,400 metric tons to 73,400 metric tons of raw sugar. Two factories produce white sugar but all others produce only raw sugar. Most factories are independently owned as part of a sugar estate that will have a certain acreage of sugar fields. The remaining cane required will be purchased from independent planters. The crushing season for each factory varies from about 102 to 149 days. The factories are operated six days a week. Crushing capacities vary from 60 to 275 metric tons per hour of cane.

On arrival at the factory the cane is prepared with conventional rotary knives. This cane is then fed directly to the crushers. In Mauritius the factories use an average of 6 three-roll crushers to extract the sugar juice from the cane. Maceration water is added to the last crushing unit and this is used countercurrently at each crushing stage until it is mixed with the virgin juice from the first crusher. Pressure on the crushing rolls of each successive unit is increased to provide maximum extraction of the sugar - containing juice from the cane.

The mixed raw juice is first clarified to remove fine dirt and fibre extracted from the cane. After removal of residual sugars the filter muds are returned to the sugar fields for disposal. The clarified juice is concentrated in several stages and, after seeding, the raw sugar crystallizes from the syrup. The residual molasses contains some sugar. At present it is all exported for use as cattle feed. The prospect of using more of this molasses domestically is now being assessed by an FAO team studying beef and milk production on the island.

Several factories use the molasses for the production of industrial alcohol. The quality of this alcohol is stated to be very high compared with that produced in the beighbouring sugar producing areas of Reunion and South Africa. This industrial alcohol is sold to an agency of the government which compounds it to potable spirits, primarily a type of rum, for sale to the public. Most of this is sold domestically as its quality is considered to be below that of rums produced in other areas. A recent change in the liquor control laws in Mauritius will permit the inclusion of larger amounts of impurities in the liquor produced and hence will allow the use of more flavour. It is expected that the production of good quality rums will now be possible. It has also been demonstrated by at least one factory that gin can be produced from this industrial alcohol that would meet the rigid specifications required by the producers of the standard, brand name gins. The former controls were legislated to curtail illicit production of liquor.

The cane residue, bagasse, is removed from the process at the last stage of the cane crushers. Simply for convenience the bagasse is baled and is moved to the power house area of the factory for use as fuel in the power boilers. Although the baling of bagasse to facilitate handling within the factory is not a common practice in most sugar producing areas, it was reported that essentially all mills on the island had adopted this procedure. As will be discussed later, the sugar factories do not require all of the bagasse produced as fuel. The surplus is burned until a better means of disposing of it can be established.

The composition of the bagasse varies depending on both the extraction efficiency of the factory and also on the cleanliness of the cane when it is brought to the factory. Data for 1967 from the various sugar factories indicate the following ranges in the composition of bagasse as shown in Table 2.

Table 2 - Composition of Bagasse from Mauritius Sugar Factories

Item	Range %	Overall Average %
Moisture	45.4-41.1	48.6
Fibre (all fibrous material)	46.20-52.07	48.85

As noted in Table 2, in 1967 the fibre content of the bagasse varied from 46-52 percent but averaged 49 percent. This value is a measure of all fibrous material in the bagasse and includes both true fibre and pith. It is thus the substance that would be fed to the depithers in preparation for use as the raw material in the production of pulp or board products. The moisture content of the bagasse from the different factories varies over a similar range to that of the fibre content but, on the average is 48.5 percent. The remaining solid substances in the bagasse, the residual sugars, other solubles plus dirt, thus must comprise about 2.5 percent of the whole green bagasse. These sugars will be converted to acidic materials during storage or will be largely removed by depithing so that their initial content is of relatively minor importance except to establish a heat value for the bagasse. The component that is of major interest to a user is the fibre content. The moisture and other components are simply impurities.

Marketing of Sugar

All sugar produced in Mauritius, except the small amount (24,000 metric tons) of white sugar required for domestic consumption, is exported as raw sugar. Of the nearly 580,000 metric tons of raw sugar exported in 1968 about 420,000 metric tons was sold to the United Kingdom. The next largest customers were Canada and the United States with about 140,000 and 16,000 metric tons respectively.

Shipments of sugar to the United Kingdom are made under terms of the Commonwealth Sugar Agreement (C.S.A.), those to the United States and Canada are at special rates related to the World Sugar Price and other sales are at the World Sugar Price.

The Commonwealth Sugar Agreement is one of several agreements that control the international price of sugar. Of the approximately 68,000,000 tons of sugar produced from sugar cane and sugar beet throughout the world in 1968 about 44,000,000 tons was used within the producing countries. Consequently only about 24,000,000 tons was exported by sugar producing countries. Of this quantity, various sugar agreements, the C.S.A., the U.S. Sugar Agreement, the Russian Sugar Agreement and several other smaller agreements, controlled the marketing of approximately 15,000,000 tons. The remainder, some 9,000,000 tons annually was free-traded on world markets at the World Sugar Price. This price can fluctuate widely as it must reflect economic and production factors associated with the total production of sugar throughout the world.

The terms of the C.S.A. are reviewed every three years and a six year cancellation period is required to terminate the agreement. The price for sugar is negotiated for a three year period at these tri-annual meetings. As the latest negotiations were held in late 1968 and were ratified only early this year the future production of sugar in Mauritius is assured for nine years and the price at which the major portion of the output can be sold over the next three years has been established.

Because the C.S.A. controls the sales and price of only about two-thirds of the output of sugar from Mauritius the profitability of the overall operation is dependent to a large extent on World Sugar Prices. This price has been depressed for several years, approximately £10 per long ton below the level set by the C.S.A. of about £47 per long ton of raw sugar. The profitability of the sugar industry in Mauritius is therefore not considered to be at an acceptable level at the present time.

Marketing of sugar from the individual sugar factories is handled by a central agency, the Mauritius Sugar Syndicate. This agency buys all the sugar from each factory at the same price and exports it to various world markets.

Shipping of Sugar

Practically all of the sugar produced in Mauritius is shipped in bulk. There are no deep water docking facilities on the island and all products must be transported to and from ocean going vessels by lighter. Bulk handling facilities have been developed for only fuel oil and cement. The latter is unloaded from the vessels by suction using a pipeline extending to deepwater from the storage silos on shore. Port Louis has the only harbour facilities on the island that can handle deep sea vessels and all products shipped to and from the island are handled through this port.

For handling sugar the procedure is as follows. The factory fills the sugar into jute - aloe fibre bags. These bags are manufactured locally from aloe fibre, grown and produced on the island, and from imported jute fibre. These bags of sugar, each having a capacity of 50 kilograms, are transported by truck to Port Louis, a distance averaging about 25 miles from all the sugar factories. The sugar is deposited at one of two sugar warehouses from where it is taken to the vessel by lighter. The bags of sugar, after being loaded into the vessel are emptied into bulk holds. The bags are returned for re-use and up to ten trips per bag can be obtained. The bags are then exported to the Far East where they are used in a less critical service.

Essentially all truck transport on the island is handled by one firm which maintains a large fleet of trucks for transporting sugar from the factories to Port Louis. As this operation is carried out only during the crushing season, the trucks are idle for approximately half of each year.

AVAILABILITY AND VALUE OF BAGASSE

Without Fuel Replacement

In Report P2368/1 the amount of bagasse that would be available for use from any cane sugar producing operation is described as being dependent on a number of factors. These include the variety of cane, the fuel requirements of the sugar factories and the value of alternative fuels. As the amount of bagasse available can be increased several times if alternative fuels are used by the sugar factories, the situation that would exist with or without fuel replacement must be discussed separately. The latter approach will be assessed first.

In Mauritius, the fibre content of the cane relative to the sucrose content and sugar recovery is shown in Table 3.

Table 3 - Sugar and Fibre Content as Percent of Cane in Mauritius

Year	Average Sucrose Content	Average Commercial Sugar Recovered	Average Dry Fibre Content
1965	12.5	11.1	12.9
1966	13.2	11.6	13.5
1967	12.5	11.0	13.1
1968	13.1	11.6	13.5
Average		11.3	13.2

From these data it may be seen that the ratio of dry bagasse fibre to commercial sugar recovered has averaged 1.17 for the period 1965 to 1968. Based on data for 1967 the average fibre content of green bagasse is 49 percent and the moisture content is 48.5 percent.

At the present time the sugar factories in Mauritius use green bagasse as fuel. However, as only raw sugar is produced the total amount of bagasse from the cane is not required for fuel. The average steam requirement of a sugar factory producing raw sugar varies from a minimum of 400 kilograms to a maximum of 700 kilograms per metric ton of cane processed depending largely on the type of processing equipment in the factory and on the type and condition of its power boilers. Based on calculations carried out by several individuals in Mauritius it has been estimated that the average steam requirement for all mills in Mauritius is about 500 kg/MT of cane.

Based on an average moisture content of 48.5 percent the heating value of green bagasse is 1,300 kcal/kg*. As the heat required to produce steam at 150 to 300 psia averages 570 kcal/kg the amount of steam that can be produced is about 2.27 kg/kg of green bagasse. One ton of cane, requiring 500 kg of steam would thus require 220 kg of green bagasse. As the average fibre content of cane and bagasse in Mauritius is 13.2 and 49 percent, respectively the amount of green bagasse available would be 269 kg/MT of cane processed. Surplus green bagasse would thus be 49 kg per ton of cane with a fibre content of 24 kg. This would represent a surplus of 18.3 percent. However, as some mechanical losses would occur the amount of usable surplus would be of the order of 16 percent of the total bagasse produced.

From the recent and forecast sugar production data given in Table 1 and its associated discussion, the quantities of bagasse that would be available in Mauritius and those that would be surplus to that required for fuel are shown in Table 4.

*See Report P2368/1 for elaboration of this calculation.

Table 4 - Availability of Surplus Bagasse in Mauritius

Year	Sugar Production 1,000MT	Dry Bagasse Fibre Total 1,000MT	Dry Bagasse Fibre Surplus 1,000MT	Green Bagasse Total 1,000MT	Green Bagasse Surplus 1,000MT
1965	664	772	123	1,575	252
1966	562	652	104	1,330	213
1967	638	763	122	1,558	249
1968	596	697	111	1,422	228
1970	630	735	118	1,500	240
1975	660	770	123	1,570	250
1980	690	805	129	1,640	260

For Table 4, the amounts of fibre and green bagasse have been estimated from the actual and projected data for sugar production by use of the percentage values shown in Tables 2 and 3. From this table it may be seen that by 1975, 123,000 MT of surplus fibre (dry basis) would be available from all sugar factories in Mauritius for use as a raw material. This amount is similar to the surplus in 1967.

A major drawback to the utilization of this surplus material is that it is produced at 22 different locations on the island. The estimated distribution is shown in Table 5 for the year 1967. A similar distribution would be expected for 1975 except that one less sugar factory would be in operation but its production would be taken up by neighboring factories.

Table 5 - Distribution of Sugar and Bagasse Production in Mauritius Based on Data for 1967

Factory	Cane Crushed 1,000 MT	Dry Fibre Content %	Dry Fibre Content 1,000 BDMT	Surplus Dry Fibre[1] 1,000 BDMT
Medine	430.7	13.67	58.9	9.4
Solitude	223.6	13.54	30.3	4.8
Beau Plan	192.8	14.13	27.2	4.3
The Mount	212.0	13.23	28.1	4.5
Belle Vue	302.5	13.79	28.1	6.7
St. Antoine	256.6	14.34	36.8	5.9
Mon Loisir	281.9	13.84	39.0	6.2
Constance	285.1	14.58	41.6	6.7
F.U.E.L.	677.0	12.71	86.0	13.8
Beau Champ	319.2	12.62	40.3	6.5
Ferney	134.7	14.12	19.0	3.0
Riche en Eau	228.1	14.18	32.3	5.2
Mon Tresor	237.6	12.79	30.4	4.9
Savannah	259.3	12.69	32.9	5.3
Rose Belle	225.3	11.93	26.9	4.3
Britannia[2]	171.8	12.55	21.6	3.5
Benares	124.0	13.26	16.4	2.6
Union St. Aubin	185.6	12.12	22.5	3.6
St. Felix	131.4	14.11	18.5	3.0
Bel Ombre	190.3	13.52	26.4	4.2
Reunion	213.7	12.20	26.1	4.2
Highlands	192.6	11.23	21.6	3.5
Mon Desert	337.7	11.52	38.9	6.2
Total	5,814.5	13.13	763.4	122.3

The two largest sugar factories, F.U.E.L. and Medine, would have only 13,800 BDMT and 9,400 BDMT of bagasse fibre available as surplus, respectively. The amount from F.U.E.L. is sufficient to supply a particleboard plant having an output of about 50 tons per day. To supply a larger operation bagasse would need to be collected from several factories and be transported to a central location, preferably adjacent to one of the larger sugar factories.

As the bagasse would have to be depithed before use for the production of either pulp or board, the depithing operation and the disposal of pith could present problems. All sources of surplus bagasse are relatively small, as shown in Table 5, and it is considered that the establishment of depithing stations at each source would be prohibitive both in capital outlay and operating cost. Effective utilization of this material would thus require the collection of green whole bagasse from a number of sources and its transportation to a

1. Based on 16 percent of total fibre content
2. This factory was closed after the 1968 crushing season

central point of use. A single depithing station could thus be established and operated as the bagasse is received. Pith could either be returned to the source of the bagasse, shipped to the local sugar factory for use as fuel, or might eventually be used for cattle fodder.

A pulp mill or board plant could thus be located adjacent to one of the larger sugar factories, Medine or F.U.E.L. The operation could utilize all of the surplus bagasse available from the local factory plus surplus bagasse from a number of neighboring factories. If it is assumed that the pith obtained from the total quantity of bagasse processed can be used by the local factory as fuel then this pith could release to the process an equal weight of the whole bagasse normally required for fuel.

From the data given in Tables 4 and 5 it is seen that the quantity of surplus whole bagasse that is forecast to be available in 1975 is about 123,000 bone-dry metric tons. The amount of pith that would be obtained from this bagasse is approximately 43,000 bone-dry metric tons, based on a normal depithing operation whereby 35 percent of the bagasse is separated as pith. As this pith could release an equal weight of whole bagasse, the total quantity of bagasse that would be available for use as a raw material, without requiring the purchase of alternative fuels, is about 166,000 bone-dry metric tons. If the pith could not be used as a fuel this quantity would be reduced to 123,000 bone-dry metric tons. It is estimated that the total quantity on this basis would be sufficient raw material to supply a 150 TPD pulp mill and a 50 TPD board plant.

The surplus bagasse has no real value as it is now burned for disposal and the cost of using this material would be essentially the transportation charge. A transportation system has already been established on the island for shipping sugar. This system has previously trucked baled bagasse, which was destined for export, and should be capable of transporting bagasse to a central converting point. The maximum transportation charge to haul bagasse to Medine or F.U.E.L. from almost anywhere on the island has been estimated to be Rs 41 (US$7.35) per bone-dry metric ton based on baling costs and the trucking rate for baled bagasse.

With Fuel Replacement

If the sugar factories use alternative fuels to replace bagasse for steam generation the total amount of bagasse available would simply be 1.17 times the output of raw sugar with the weight of bagasse expressed on the basis of contained fibrous material (fibre plus pith). From Table 4 it was seen that the total bagasse available in Mauritius in 1975 would be 770,000 BDMT. As this bagasse would contain about 35 percent pith and an overall yield for a bleached pulp would be about 43 percent from the depithed fibre the output of bleached pulp could be as high as 215,000 BDMTPA or 650 BDMTPD. The extent to which bagasse might be replaced by alternative fuels would be dependent simply on the relative value of bagasse as fuel.

Mauritius has no local source of fuel. Coal is available from South Africa and fuel oil from the Middle East. Although specific duties are normally levied against imported fuels it is understood that the Government of Mauritius would waive the imposition of duties in this situation as is the usual practice to promote the development of new industry within the country. The calorific values and the available heats in steam for the different fuels are as shown in Table 6.

Table 6 - Calorific Value and Available Heat in Steam of Bagasse and Various Fuels

Fuel	Gross Calorific Value kcal/kg	Boiler Efficiency %	Available Heat in Steam kcal/kg of fuel
Bagasse (48.5% Moisture)	2,400	54-59	1,300
Fuel Oil (Bunker C)	10,000	80-85	8,200
South African Coal	6,700	76	5,100

A comparison of these data indicates that one ton of fuel oil will replace approximately 6 tons of green bagasse or one ton of South African coal will replace about 4 tons of green bagasse.

The CIF price of coal is Rs 130 per metric ton. Unloading and delivery charges would add Rs 18.50 so that the delivered price in Mauritius would be Rs 148.50 (US$26.70) on a duty-free basis. The relative value of green bagasse would thus be Rs 37.10, and on the basis of contained fibrous material, Rs 75.80 (US$13.60) per metric ton.

For Bunker C fuel oil the CIF price is approximately Rs 112 (US$20.10) per metric ton and unloading and delivery charges are Rs 32 (US$5.80). The delivered price of duty-free oil is thus Rs 144 (US$25.90) per metric ton. The equivalent value of green bagasse would be Rs 24 (US$4.30) or Rs 49 (US$8.80) per metric ton on the basis of bone-dry fibre content. Consequently, fuel oil would be the cheaper of the two alternative fuels in Mauritius to replace bagasse used in the power boilers of a sugar factory.

A pulp mill or board plant could be located adjacent to one of the larger sugar factories, for example the one at F.U.E.L. All of the bagasse normally required as fuel by this factory could be used as the raw material and would be purchased at the cost of US$8.80 as developed above. The small quantity of bagasse that is surplus to the fuel requirements would also be available for use but would be assumed to have no value. If the total amount of bagasse available from this factory is not sufficient to supply the requirements then an additional quantity would have to be obtained from other factories. This material could either be surplus bagasse or it could be the total amount available whereby fuel oil would have to be used for its replacement. The cost of bagasse obtained from these other factories would be only the transportation charge in the former case or the transportation charge plus the fuel replacement value in the latter.

If bagasse is used on a fuel replacement basis, there would also be a charge associated with the modification of the power boilers at the sugar factories to permit the use of oil. This could be minor in amount or it could require complete replacement of the boilers depending on their present type and condition. The cost of this modification would have to be borne directly by the bagasse user or alternatively the price of bagasse could be adjusted to recover the cost plus a reasonable return on the required capital over a period of several years.

From the foregoing considerations the transportation charges,from the preceding section, are about US$1.45 less per bone-dry metric ton of bagasse than the direct fuel replacement value. Consequently, it would be economically more attractive to collect and use surplus bagasse from all the sugar factories than to use all of the bagasse produced at one or two locations and pay fuel replacement value for it.

DOMESTIC MARKETS

General

Markets in Mauritius for products that could be based on bagasse as the raw material have been divided into three main categories, these include paper products, board products and miscellaneous materials. A brief discussion of each category follows.

Paper Products

Mauritius imports all of its requirements of paper products. The quantities are small but there is a large variety of grades imported. Because there have never been any paper products produced on the island it has been possible to import in the small quantities required a very diverse array of products. It would thus be difficult to satisfy this market because of its size and also because of the high quality standards that have developed through the use of only imported goods.

The imports of cultural paper products since 1956 are listed in Table 7. As noted, the total of these imports in 1967 was only 1,800 metric tons but this quantity is distributed among five different grades of product. An estimate of the amount of bagasse pulp that could be utilized in the manufacture of these different grades is provided in Table 8. The degree to which bagasse pulp could be used has been based on present commercial practice in the various areas of the world where bagasse pulp is produced as has been discussed in Report P2368/1. This estimate is thus based on the assumption that bagasse pulps can constitute up to 90 percent of printing, writing and stationery papers, 85 percent of exercise book paper and 25 percent of other articles of pulp.

The growth in this potential outlet for bagasse pulp has been at the rate of nearly 10 percent a year. This rate would not be expected to continue but future growth of at least 7.5 percent is forecast. At this rate of growth the future demand for a bagasse pulp that could be utilized in the manufacture of cultural papers would amount to a requirement of 1,400 metric tons by 1975 and 2,000 metric tons by 1980 as shown in Figure 2, Appendix 5. The type of pulp required to supply this market would be a fully bleached pulp of the highest quality that could be produced from bagasse.

Table 7 - Imports of Cultural Paper Products into Mauritius
Metric Tons per Year

Year	Newsprint	Printing and Writing Rolls or Sheets	Paper Stationery Packaged	Exercise Books	Articles made of Pulp	Total
1956	238.5	188.7	44.7	210.7	43.3	725.9
1957	294.8	187.0	32.0	213.7	62.4	789.9
1958	334.6	210.9	27.2	179.9	68.3	820.9
1959	338.2	301.6	28.1	134.8	58.7	861.4
1960	341.9	357.4	24.3	130.4	91.4	945.4
1961	431.6	283.1	37.2	173.7	108.7	1,034.3
1962	393.5	281.2	-	169.9	100.1	944.7
1963	472.1	284.2	44.9	112.0	175.1	1,088.3
1964	535.3	379.2	94.5	33.3	194.9	1,237.2
1965	697.2	418.9	49.8	60.0	230.3	1,456.2
1966	625.0	441.4	53.6	127.7	218.1	1,465.8
1967	556.5	779.1	89.8	90.6	284.3	1,800.3

Table 8 - Potential Bagasse Pulp Content in Cultural Paper Products
Metric Tons per Year

Year	News-Print	Printing & Writing	Paper Stationery	Exercise Books	Articles of Pulp	Total
Bagasse Pulp Content	Nil	90%	90%	85%	25%	
1957	-	168.3	28.8	181.6	15.6	394.3
1958	-	189.8	24.5	152.9	17.1	384.3
1959	-	271.4	25.3	114.6	14.7	426.0
1960	-	321.7	21.9	110.8	22.9	477.3
1961	-	254.8	33.5	147.6	27.2	463.1
1962	-	253.1	-	144.4	25.0	422.5
1963	-	255.8	40.4	95.2	43.8	435.2
1964	-	341.3	85.1	28.3	48.7	503.4
1965	-	377.0	44.8	51.0	57.6	530.4
1966	-	397.3	48.2	108.5	54.4	608.5
1967	-	701.2	80.8	77.0	71.1	930.1

The imports of industrial paper products are of comparable quantity to those of cultural papers but tend to be even more varied. The statistics for the period 1957-1967 are shown in Table 9 and the potential for utilizing bagasse pulp in these products is shown in Table 10. As industrial papers have, in general, higher strength requirements than the fine papers the percentage of bagasse pulp that could be incorporated into the furnish for these grades is generally less. Consequently, the potential outlet for bagasse pulp in 1967 in papers of this

Table 9 - Imports of Industrial Paper Products into Mauritius
Metric Tons per Year

Year	Packing & Wrapping	Paperboard & Building Papers: No Coating	Bitumen Coating	Other Coating	Misc	Paper Bags	Cement Bags	Total
1957	26.7	26.5	42.7	21.9	85.3	168.0	-	371.1
1958	20.6	35.8	56.0	5.6	114.8	275.2	-	508.0
1959	30.2	34.6	58.5	93.3	86.8	370.6	-	674.0
1960	40.3	33.1	60.0	98.9	54.2	376.8	-	663.3
1961	46.8	50.5	53.5	80.6	53.1	536.4	-	820.9
1962	48.6	56.1	42.7	22.0	56.4	376.3	-	602.1
1963	56.8	121.0	12.0	60.5	102.0	378.6	51.4	782.3
1964	80.7	133.3	108.4	76.2	90.2	295.7	268.8	1,053.3
1965	47.6	321.7	24.3	140.3	25.5	252.8	612.1	1,424.3
1966	75.2	243.2	21.7	97.4	18.3	198.7	444.1	1,098.6
1967	63.3	168.4	6.7	116.9	23.2	307.9	403.4	1,089.8

Table 10 - Potential Bagasse Pulp Content in Industrial Paper Products
Metric Tons per Year

Year	Packing & Wrapping	Paperboard & Building Papers: No Coating	Bitumen Coating	Other Coating	Misc.	Paper Bags	Cement Bags	Total
Bagasse Pulp Content	70%	75%	75%	75%	75%	55%	55%	
1957	18.7	19.9	32.0	16.4	62.5	92.4	-	241.9
1958	14.4	26.9	42.0	4.2	86.1	151.4	-	320.8
1959	21.1	26.0	43.9	70.0	65.1	203.8	-	429.9
1960	28.2	24.8	45.0	74.2	40.7	207.2	-	420.1
1961	32.8	37.9	40.1	60.5	39.8	295.0	-	506.1
1962	34.0	42.1	32.0	16.5	42.3	207.0	-	373.9
1963	39.8	90.8	9.0	45.4	76.5	208.2	28.3	498.0
1964	56.5	100.0	81.3	57.2	67.7	162.6	147.8	673.1
1965	33.3	241.3	18.2	105.2	19.1	139.0	336.7	892.8
1966	52.6	182.4	16.3	73.1	13.7	109.3	224.3	671.7
1967	44.3	126.3	5.0	87.7	17.4	169.3	221.9	671.9

type would be less than 700 metric tons. Growth in this field has averaged nearly 11 percent during the period. As a future growth of at least 8 percent might be expected, the forecast potential for bagasse pulp would be 1,500 and 2,200 metric tons by 1975 and 1980 respectively as shown in Figure 3, Appendix 5. The grades of pulp required for this outlet would be primarily unbleached pulps of medium yield so strength would be at its maximum level.

From the above estimates, the total requirements of bagasse pulp for potential use in domestic markets are shown in Table 1.

Table 11 - Potential Demand for Bagasse Pulps in Mauritius

Outlet	Metric Tons 1975	1980
Cultural Papers	1,400	2,000
Industrial Papers	1,500	2,200
Total	2,900	4,200

Even by 1980 a domestic requirement of only about 4,000 metric tons of bagasse pulp might be developed and this would have to be distributed among many different grades of paper and paperboard products. A wide variety of long fibre pulps would have to be imported for blending with this pulp.

It is judged that to be economic a pulp and paper industry to serve the domestic market in Mauritius would require

1. A total market size of about 20-30,000 TPA.

2. A limited number of products in order to achieve a reasonable level of efficiency.

Neither of these conditions is satisfied by present or future markets in Mauritius and thus there would appear to be no opportunity to develop a pulp and paper industry to serve domestic markets.

Building Board Products

As discussed in Report P2368/1, bagasse has been used effectively in several countries as the raw material for the manufacture of various types of building boards. Processes and equipment are now available that permit the production in a single installation of a variety of boards that can range in density from about 300 kg/m^3 to 1,000 kg/m^3. Thus bagasse-based products can be used to replace hardboard, particleboard and light weight fibre board as used for acoustic tile.

In addition to the direct replacement of the standard building boards it would also be possible to use the bagasse-based board to an increasing extent in outlets that at present require all-wood plywood and solid wood. Wood veneer and vinyl laminates on a base of hardboard or particleboard are being used extensively as wall panelling. The use of particleboard for furniture construction has increased steadily since its introduction in the mid-1950's.

A field that has been attracting an increasing amount of interest is the production of pre-fabricated housing components based on the use of a medium density particleboard. Model houses have been constructed for which all structural units and wall surfaces are composed of a bagasse-based particleboard. Factories to produce pre-fabricated wall sections from bagasse particleboard are being planned for Hawaii, Taiwan and at a more preliminary stage for

Reunion. In these factories it is planned that complete wall sections, for both interior and exterior walls would be produced from particleboard.

In Mauritius, housing has been based either on cement block or wood frame construction with interior partitions being built up on a wood frame. Wood frame housing provides less resistance to cyclone damage to which Mauritius is subjected on a fairly regular basis, and thus the local government has been promoting the use of cement block which is also manufactured locally. It is unlikely that a change in this approach which would permit the use of particleboard for exterior applications would be either desirable or feasible. However, particleboard could be used effectively for both partitions and interior panelling on exterior walls. Assuming that only five hundred housing units were constructed each year with bagasse-based particleboard used as described, the requirement would be of the order of 1,800 metric tons annually.

Imports of sawn lumber, plywood, various types of board and of tea chests (or components) into Mauritius over the period 1957 to 1968 are listed in Table 12.

Table 12 - Imports of Various Building Products into Mauritius

Year	Lumber	Plywood	Fibreboard	Particle Board	Building Board	Panels for Tea Chests: Assembled	Parts	Total
	$1,000m^3$	$1,000m^3$	$1,000m^3$	MT	MT	$1,000m^2$	$1,000m^2$	$1,000m^2$
1957	16.8	54.8	326.6	213.8	72.8	7.2	20.6	27.8
1958	12.2	51.9	299.6	19.7	174.9	16.3	17.7	31.0
1959	17.8	91.5	166.4	168.2	466.5	3.6	7.1	10.7
1960	18.0	115.3	12.0	48.5	1,191.3	15.2	11.2	26.4
1961	16.8	148.2	31.7	13.7	1,054.1	25.2	9.8	35.0
1962	12.9	116.9	6.7	15.1	858.2	12.7	0.6	13.3
1963	11.0	158.7	2.0	29.9	684.7	17.7	2.0	19.7
1964	12.7	168.4	3.5	62.2	713.1	29.7	22.1	51.8
1965	9.9	236.2	1.0	58.1	628.5	81.3	20.2	101.5
1966	9.0	208.5	4.3	132.2	592.1	2.5	8.8	11.3
1967	10.8	307.0	4.1	316.4	491.3	30.8	32.2	63.0
1968	7.3	268.7	5.5	32.5	339.1			

Based on the growth in the use of particleboard in the manufacture of furniture, door frames and faces and of decorative panelling when laminated with wood or vinyl veneers it is considered that about 20 percent of the sawn lumber and 50 percent of plywood that is now imported could be replaced with particleboard. All imports of such items as fibreboard, particleboard and building board (hardboard) could be replaced by a locally made product as essentially the same grades could be produced. For tea chests, there has been increasing consideration given to the use of various types of hardwood to replace the plywood normally used. This approach is gaining acceptance and it is considered that all the requirements for the shipment of tea from Mauritius could be supplied by a board produced locally from bagasse. Based on these levels of replacement the potential market in Mauritius for various types of particleboard are listed in Table 13.

Table 13 - Replacement of Various Building Products & Particleboard
Metric Tons per Year

Year	Sawn Lumber	Plywood	Fibreboard	Particle-Board	Building Board	Tea Chest Panels	Total
Replacement	20%	50%	100%	100%	100%	100%	
1957	2,016	164	1,568	214	73	167	4,202
1958	1,464	156	1,438	20	175	204	3,457
1959	2,136	275	799	168	467	64	3,909
1960	2,160	346	58	49	1,191	158	3,962
1961	2,016	445	152	14	1,054	210	3,891
1962	1,548	351	32	15	858	80	2,884
1963	1,320	476	10	30	685	118	2,639
1964	1,524	505	17	62	713	311	3,132
1965	1,188	709	5	58	629	609	3,198
1966	1,080	626	21	132	592	68	2,519
1967	1,296	921	20	316	491	378	3,422

As noted in Table 13, growth in the demand for particleboard has been very erratic during the period from 1957 to 1967 and a major reduction in the demand occurred after 1961. Growth since then has been only about 2 percent a year. If this growth continues the demand by 1975 and 1980 will be 3,800 and 4,300 metric tons respectively as shown in Figure 4, Appendix 5. As mentioned earlier there is an additional potential requirement of 1,800 metric tons by 1975 for the fabrication of housing components. Total domestic demand for all types of board could thus be about 5,600 metric tons by 1975.

The potential distribution of board that could be marketed in 1975 in Mauritius based on the data in Table 13 is estimated to be as shown in Table 14.

Table 14 - Estimated Distribution of Board Products - 1975

Board Thickness	Density	Total Area	Weight
mm	kg/m^2	$1,000\ m^2/A$	BDMTPA
19	12.4	145	1,780
13	5.2	60	320
13	8.5	175	1,500
8	6.0	230	1,400
6	5.4	110	600
Total		720	5,600

Miscellaneous Products

Several products other than those destined for use in the manufacture of paper or board can also be produced from bagasse. The list includes; briquettes for fuel, methane, furfural, cattle feed from pith, as well as a number of others.

Briquettes have been produced in a number of countries but generally the operation has not been considered to be very successful. In Mauritius, these briquettes would replace imported coal. The demand for coal has decreased steadily from about 19,000 metric tons in 1956 to less than 1,000 metric tons in 1967. Methane could be collected from the fermentation of bagasse. The reported yield is low as fermentation is seldom complete and the gas is impure and would require extensive purification before it could be handled effectively. Consequently, the size of the operation would have to be very large so that unit prices could be reduced to a level that would permit use of the gas as a replacement for electric power in lighting and heating, or as a replacement for gasoline as a tractor fuel. Although this outlet has not been studied in any detail it would appear that the prospect is low.

Furfural can be produced effectively from either whole bagasse or pith. The amount of product that can be recovered is 5-9 percent of the dry weight of raw material. Furfural is now produced in relatively large plants using corn cobs or bagasse as the raw materials. Markets exist primarily in the United States, Europe and Japan although the oil refineries of the Near East have a small demand. As existing production is from large operations the unit manufacturing cost is relatively low and hence the world market price is about U.S. $0.12 per pound. There is no domestic demand for this chemical and it is not considered that a plant of competitive size could be built in Mauritius.

Pith can be used effectively in admixture with molasses and protein as a food supplement for beef and dairy cattle. The dairy herd on the island numbers about 25,000 head but is considered to be undernourished as present feed consists primarily of coarse grass cuttings and cane tops and leaves, during the crushing season. The prospect of improving the quality of these dairy cattle and also of establishing a herd of about 15,000 beef cattle is the subject of a study now underway by a team from the Food and Agriculture Organization of the United Nations. It is the opinion of this team that pith from bagasse can be assimilated satisfactorily by ruminants, whereas whole bagasse cannot, and consequently pith could be an effective carrier for molasses and protein in a feed supplement. Molasses is readily available in Mauritius and protein should be available from local fishing operations. At the present time, very little molasses is used locally as a cattle food; it is essentially all exported for this purpose to the United States and Europe. The amount of food supplement that could be used effectively is about 5 kilogram per head per day for both the dairy and beef cattle. This supplement could contain about 25 percent bagasse pith so that in total about 15,000 metric tons, dry weight, of pith could be utilized annually for this purpose. Its use might be contingent upon the establishment of a pulp or board operation which would provide the means of producing the pith.

EXPORT MARKETS

General

Based on recent statistics, Mauritius imports goods primarily from the United Kingdom, South Africa, Australia, Burma, Western Germany and France. In 1967 these countries provided over half of the island's imports. Exports were principally to the United Kingdom, the United States and Canada and these three markets accounted for over 90 percent of the island's export of sugar, molasses and tea. In general, the overall trade pattern is not in balance as imports usually exceed exports by a few percent, except in those years in which there is a good sugar crop. Additional export potential for Mauritius is thus highly desirable. From the point of view of trade balance, it is not considered to be important with which countries this trade is developed.

Mauritius, for the past several years has had favourable trade balances with both the United States and especially the United Kingdom so imports from other countries can be purchased with either of these currencies. However, increased exports to both France and Western Germany would be beneficial to offset major imports from these countries. Of the other countries listed above, from which Mauritius obtains its imports, the United Kingdom is considered to be the only export market for either pulp or particleboard. The other countries are net exporters of these or competitive materials.

East African Pulp Markets

Mauritius, being close geographically to the countries of East Africa, is often associated with these countries for trade considerations. The Economic Commission for Africa of the United Nations recently undertook a study on the "Forest Industries Development in Eastern Africa" (E/CN.14/INR/80, 10 August 1965) and developed forecasts for the various types of forest products. It was forecast that total annual requirements for paper and paperboard would increase from 90,600 metric tons in 1960 to 198,000, 226,000 or 264,000 metric tons by 1975 as the low, medium and high estimates, respectively. Printing and writing papers would increase from 19,500 to 46,000, 52,000 or 62,000 metric tons on the same basis. By plotting these estimates with actual demand statistics as presented in various Review Issues of the journal Pulp and Paper International as shown in Figure 5, Appendix 5, the growth in demand for paper and paperboard is shown to follow very closely the high forecast prepared for the ECA study. The demand by 1975 should thus be 264,000 metric tons for all paper and paperboard products of which 62,000 metric tons will be printing and writing papers. Most of the requirement in 1960 was centred in the countries of Kenya and Rhodesia. Growth since then has been greatest in these two countries and also in Tanzania and Zambia.

Production facilities in all countries included in this East African Bloc accounted for only 4,000 tons of pulp, primarily mechanical pulp, and 20,500 tons of paper and board in 1965. By 1968 this capacity had been increased to only 7,800 tons of pulp and 32,000 tons of paper and board. However, the installation of a number of major mills has been under study for several years. Of these, one at Broderick Falls in Kenya has been under study for the longest period of time but still cannot be classified as a definite project. The most likely capacity for this mill is now considered to be about 40,000 tons a year of pulp from pine and cypress. Other prospects include mills in Malawi and Tanzania but these are speculative and could not be operational prior to 1975 at the earliest.

A bleached bagasse pulp that might be produced in Mauritius, could be used in one of the major countries of East Africa for the production of printing and writing papers. The demand by 1975 for this grade of paper is forecast to be 62,000 metric tons. As such papers can contain up to 90 percent bagasse pulp the potential demand for this type of pulp in East Africa could be as high as 56,000 metric tons. Thus, a mill in Mauritius, with a capacity of 100 tons a day could supply about 60 percent of this potential demand.

East African Particleboard Markets

In the ECA report mentioned above, the demand for wood-based panels (plywood) is estimated to increase from 43,700 cubic meters to 161,000 cubic meters by 1975 if the high estimate, as was applicable for paper and board, is used. As with paper products, the major demand will be in the countries of Kenya, Rhodesia, Tanzania and Zambia. After deducting the local demand in Mauritius of about 5,000 cubic meters, the net required in 1975 would be about 156,000 cubic meters. The future availability of peeler logs in the area is not considered to be sufficient to supply this demand and in the ECA report it is recommended that the use of other indigenous species should be developed. An alternative would be to increase the use of particleboard as core stock which could be veneered with wood, a trend which is increasing throughout the world.

A plant to produce particleboard could be constructed in Mauritius of a size comparable to that of several recent installations in other countries, about 45 BDMTPD. Half the annual output or 5,600 tons could be sold in domestic markets as discussed earlier. The remainder might be exported to East Africa where the amount, 5,600 BDMTPA would represent less than 6 percent of the forecast requirement for plywood in 1975.

European Pulp Markets

A bleached bagasse pulp would be expected to be competitive with a bleached hardwood pulp in many applications. The forecast demand for such pulps in Western Europe except the Nordic Countries has recently been studied by Sandwell. It has been forecast that the trade in both long and short fibre bleached sulphate pulp in the 1966 to 1980 period would be as shown in Table 15.

Table 15 - Trade in Bleached Sulphate Pulp 1966 to 1980 Western Europe except Nordic Countries - 1,000 ADMT

Year	Production	Imports	Exports	Demand
1966	477	2,411	170	2,688
1970	620	3,100	220	3,500
1975	870	4,280	250	4,900
1980	1,190	6,020	310	6,900

From the data in Table 15 it may be seen that the additional imports of bleached sulphate pulp over the 1970 level, which would be required by 1975 are approximately 1,200,000 metric tons. Of this demand, about 500,000 metric tons would be for short fibred pulp based on projected trends for the utilization of different fibres. Most of this requirement would have to be

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supplied from non-European sources as the Nordic Countries are not expected to be able to supply more than a small portion. An opportunity for introducing bagasse pulp to replace hardwood pulp in this market would therefore appear to exist. Bagasse pulp is not used at the present time in Europe and its acceptability in this market would have to be established.

European Particleboard Markets

In Europe the consumption of plywood has exceeded production for a number of years and in 1960-61 the figures were 2,900,000 and 2,598,000 cubic meters, respectively. Forecasts based on recent growth data indicate that the demand by 1975 will be about 6,400,000 cubic meters of wood-based panels which would require approximately 14,000,000 cubic meters of roundwood. Europe depends on the importation of logs to supply its plywood operation and as demand increases the availability of raw materials is expected to become a major problem. Sandwell considers that an appreciable portion of the future requirement will be supplied by such materials as particleboard and hardboard. A very conservative estimate is that 10 percent of this forecast growth will be supplied by a medium density (650 kg/m^3) particleboard which would create a demand for this type of board of 230,000 metric tons by 1975. Growth in other fields such as pre-fabricated housing components would also be expected to increase the demand for particleboard with much of this growth developing at the expense of such materials as plasterboard. Some potential therefore exists of supplying a small quantity of particleboard to Europe from a plant in Mauritius.

SELLING PRICES OF PULP AND BUILDING BOARD PRODUCTS

Pulp

Based on the data developed in the foregoing sections of this report the logical market areas to which a pulp mill in Mauritius could ship bleached bagasse pulp are East Africa and Europe. As the pulp that could be produced is considered to be similar in characteristics to a hardwood pulp its price should also be similar. However, as bagasse pulp has not as yet been handled as a market pulp in either of these areas Sandwell considers that an average discount of U.S.$5 per short ton would be required. Based on present prices in these market areas the approximate mill prices that should be realized are shown in Table 16.

Table 16 - Mill Net Prices of Bagasse Pulp in East Africa and Europe

Item	East Africa /MT	East Africa /MT	Europe /MT	Europe /MT
CIF Price Bleached Hardwood Pulp	US$149.00	Rs 828	US$140.00	Rs 778
- Less Discount	5.50	31	5.50	31
- Insurance	0.50	3	0.50	3
C&F Price	143.00	794	134.00	774
- Less Loading	2.25	13	2.25	13
- Ocean Freight	9.00	50	12.00	65
- Discharging	2.75	15	2.75	15
FAS Price	129.00	716	117.00	651
- Less Agents Commission	2.25	13	2.25	13
- Local Freight	1.75	10	1.75	10
Mill Net Price	US$125.00	Rs 693	US$113.00	Rs 628

Recent news releases forecast that world market prices are likely to be increased within the next two to three years by approximately 12 percent. If these increases are realized the corresponding mill net prices based on the above estimates would be approximately US$143 and US$130 (Rs 794 and Rs 722) for pulps shipped to East Africa and Europe respectively.

Building Board

As shown earlier in Table 14 the domestic market in Mauritius is forecast to require about 5,600 metric tons of various grades of board products. Based on existing selling prices in Mauritius for similar or competitive products the total sales value of these board products is estimated to be as shown in Table 17. Also included in this table is the value of a similar quantity of board (5,600 metric tons) that is forecast to be salable in export markets in East Africa. The unit value of this material on the dock and ready for export is estimated to be the existing FAS price of similar material that is now being imported into Mauritius less local loading charges.

Table 17 - Sales Value of Building Board Products

Board Thickness mm	Weight MT	Total Area m^2/A	Unit Value Rs/m^2	Total Value Rs/A
Domestic Sales				
19	1,780	145,000	10.75	Rs 1,559,000
13	1,820	235,000	14.00	3,350,000
8	1,400	230,000	4.30	989,000
6	600	110,000	2.15	237,000
Total Domestic	5,600	720,000		Rs 6,135,000
Export Sales				
19	5,600	450,000	7.60	Rs 3,420,000
Total Sales	11,200	1,170,000	8.17	Rs 9,555,000

From the sales values of the board products given in Table 17 the approximate mill net price can be estimated as shown in Table 18.

Table 18 - Mill Net Price of Building Board

Item	Unit Amount Rs/MT	Annual Amount Rs/A
Domestic Material		
- Total Sales Value	1,096	Rs 6,135,000
- Less Retail Mark-Up	329	1,840,000
- Less Local Freight	9	50,000
- Mill Net Price	758	Rs 4,245,000
Export Sales		
- Total Sales Value FAS	610	Rs 3,420,000
- Less Agents Commission	30	170,000
- Less Local Freight	9	50,000
- Mill Net Price	571	Rs 3,200,000
Total Sales		
- Mill Net Price	Rs 665 US$120	Rs 7,445,000 US$1,340,000

AVAILABILITY OF RAW MATERIALS AND LABOUR

Bagasse

The availability of bagasse has been discussed in an earlier section of this report.

Chemicals

The primary chemicals required for the production of bleached pulp from bagasse are caustic soda, chlorine and burned lime. For particleboard the major raw material is urea-formaldehyde resin.

Neither caustic soda nor chlorine is available in Mauritius. They could not be imported in the quantities required at reasonable cost and thus would have to be manufactured. Salt, the required raw material is now produced locally in small quantity; about 4,000 metric tons annually, from sea water by solar evaporation. The owner of the major salt plant on the island considers that an expansion to supply the required amount of salt could be provided without difficulty.

Burned lime is available in Mauritius. Minor items such as graphite and sulphuric acid, required for the chloralkali plant, would have to be imported. Resin required for the manufacture of particleboard would have to be imported.

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Fuels

As discussed in a preceding section, there are no sources of fuel in Mauritius. Coal could be obtained from South Africa and fuel oil (Bunker C) from the Middle East. Based on the heat value of these fuels, oil would be cheaper.

Electric Power

Electric power is produced in Mauritius by hydro installations, and by diesel generating and thermal stations. Ten of the sugar factories have incorporated power generation with their steam plants and about 16 percent of the island's total power requirement is obtained from this source. Power from the sugar factories is available only during the crushing season of about 5 months each year. A small amount of power, about 1,500 kW, could be supplied from existing or committed installations which would probably be sufficient to supply the power requirement of a particleboard plant but not of a pulp mill.

Water

Because of its size Mauritius has no major rivers and only a few lakes which are used as reservoirs for domestic service. There are six locations where the firm flow of available water is in excess of 20,000 cubic meters per day. As the average requirement of water for the manufacture of bleached pulp is about 150 cubic meters per metric ton of product the mill sizes that could be supplied are listed in Table 19.

Table 19 - Water Supply in Mauritius

Location	Water Available m^3/D	Size of Mill at 150 m^3/ADMT ADMTPD
Beau Champ	110,000	700
Savannah	18,000	120
Union St. Aubin	18,000	120
St. Felix	18,000	120
F.U.E.L.	25,000	160
Medine	25,000	160

Each of these locations is at a sugar factory and the last two are at the largest and second largest factories on the island. The Beau Champ location which has a sugar factory of less than half the size of F.U.E.L. as the potential source of bagasse, is about 5 miles farther from Port Louis but is near the coast.

The water available at both the F.U.E.L. and Medine locations is now used for irrigation and would be released to a pulp mill on the basis that the mill effluent would be processed to the extent required to permit its use for this purpose. Recent research studies have indicated that pulp mill effluents, after primary treatment, could be used for irrigating certain crops including corn but sugar cane was not tested. No commercial application of this approach

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is known and the possibility of using the effluent in this way would have to be investigated thoroughly. The alternative site, Beau Champ, is the only location on the island which has ample water that is not required for irrigation purposes but less bagasse could be obtained from the local factory.

Labour

There is a surplus of labour in Mauritius and a growing problem on the island is unemployment. Consequently, the supply of labour should present no problems other than training. As the sugar factories have provided basic training in operator skills and the Government is sponsoring technical schools it is considered that essentially only the specific training pertinent to the operation of a pulp mill or a building board plant would be required. For supervision, training would also be essential and Sandwell considers that an overseas management team of experienced personnel would have to be provided on a permanent basis. This team would be required largely to assure that product quality is maintained at a high level in order to establish and retain export markets.

GOVERNMENT ASSISTANCE AND SOURCES OF CAPITAL

Government Assistance

Over the past several years the Government of Mauritius has been increasing its efforts to encourage the establishment of new industry on the island and hence to diversify the economy. However, it is not the Government's policy to impose any limit on the production of sugar as this industry is recognized as the continuing backbone of the island's economy. The effort has been directed largely towards the development of new industries which would be compatible with existing industry. Because of the increasing unemployment problem in Mauritius those industries that are labour-intensive have been favoured. The Government's assistance program includes the following items:

1. Income tax allowances and holidays
2. Customs tariff concessions.
3. Technical training.
4. Capital loans

Recent amendments in the Income Tax Law were enacted to provide greater inducement to prospective industrial development. The main provision includes favourable initial allowances and tax holidays. An industry may claim against assessable income an initial depreciation allowance of 40 percent on equipment and 20 percent on structures.

Two alternative types of tax holiday were introduced for industries qualifying for a Development Certificate. These alternatives are

a. A tax holiday of eight years with normal depreciation allowances but no initial allowance or

b. A tax holiday of five years with the initial depreciation allowance on capital expenditure becoming deductible the first year after the tax holiday.

Furthermore, dividends received from any new industry with a Development Certificate are exempt from income tax during the first five years of the tax holiday period. Additional incentives are provided to encourage the investment of revenues from industrial operations in further development enterprises.

As a corollary to the Income Tax Law, the Government has revised the customs tariff. The broad objectives are to reduce the rates of import duties on raw materials and semi-processed products that might profitably be used in local manufacture and to provide rebates of import duties and drawbacks for selected industries that qualify for Development Certificates. Consequently, complete exemption of custom duties can be granted to those industries that are classified as development enterprises.

The Government is establishing a Trade Training Centre and a number of vocational training centres have been opened in various centres on the island.

The Government of Mauritius also provides direct financial assistance in the form of long term loans to cover capital expenditures. The Development Bank of Mauritius has been established recently to adminster these loans.

Sources of Capital

There are two main sources of capital in Mauritius on which new industry can draw. As mentioned above the Government of Mauritius through the Development Bank will make direct loans to cover a portion of the capital requirements of a new industry. The second source includes the industrial and commercial establishments on the island.

The Development Bank of Mauritius was established in 1964 to provide capital assistance to small industries wishing to establish production facilities on the island. The Bank has been a party to essentially all new projects that have been assessed by the Government for allocation of Development Certificates. As most of these projects have been relatively small the size of the loans provided by the Bank has usually been under Rs 3 million (U.S.$550,000). Interest rates are normally 6.5 percent but under certain special circumstances the rate can be as low as 4.5 percent.

The Bank will invest in larger projects but as the funds available to it amount to about Rs 25 million (U.S.$4.5 million) there is a reluctance to invest too great a portion of the total money available in any single project. The general policy of the Development Bank may be expressed as being to provide backing to local enterprises and if the local business community is willing to invest money in a new venture then the Bank will assist by providing a portion of the required capital.

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The sugar industry in Mauritius would be considered to be a logical source of new capital for an industrial venture based on the utilization of bagasse. The factory owners would be interested provided, of course, a reasonable rate of return could be assured. However, the extent of this participation would be a direct reflection of the current profitability of the sugar industry and hence the size of its cash reserves. The world market prices have been low for a number of years and consequently the profitability of the industry has also been low. It was reported that the build-up of cash reserves has been unsatisfactory and that certain major expenditures for modernization by some of the sugar factories have had to be deferred. However, several years of good world sugar prices would be expected to remedy this situation and it is understoon that these prices have recovered well over the past two years and further improvement is forecast.

The commercial houses in Mauritius, including the importers, have been an important source of new capital. At the present time, two of the largest importing firms are independently assessing the prospect of building small particleboard plants, each having a capacity of about 15 tons per day. Proposals have been submitted to the Government for Development Certificates and to the Development Bank for financial assistance.

The Government of Mauritius could become a source of capital by direct investment in a project that can be demonstrated to provide major advantages to the economy of the country as a whole. This approach would not be favoured if capital can be obtained from private sources.

For large amounts of capital, such as would be required to establish a pulp mill, the major portion would have to come from foreign investors.

DESCRIPTION OF MILLS

General

Two alternatives exist for utilizing the bagasse produced as a by-product of the cane sugar industry in Mauritius. Either the total quantity of bagasse produced, or that quantity which is surplus to the fuel requirements of the sugar factories could be used.

Use of the total quantity of whole bagasse produced, which is forecast to be 770,000 metric tons, dry basis in 1975 would permit the installation of a large pulp mill having a capacity of about 650 tons per day or of a large combined pulp and building board mill of equivalent size. Because of limited water resources on the island there is only one location, Beau Champ, where such a mill could be sited. Whole bagasse would be obtained from all of the sugar factories at a cost of about U.S.$16.15 per metric ton of dry whole bagasse which amounts to its fuel replacement value plus the average transportation charges. Also, the power boilers at each sugar factory would have to be modified to permit the use of fuel oil at the expense of the new mill. Output from the mill would have to be marketed in both East Africa and Europe as the forecast markets in East Africa would not be of sufficient size to absorb the quantity of short fibre pulp that would be produced. At the present time, bagasse pulps are not handled in export markets except for small quantities that are shipped from Taiwan to Japan and other neighboring countries. No bagasse pulp is used in Europe and it is considered that extensive tests would likely be required to develop markets for the large quantity of pulp that would be available. The mill would be about three times the size of the largest existing bagasse mill. Sandwell considers that the economic advantages of size could be largely offset by the higher raw material costs and increased marketing expenses.

The alternative approach would be to establish a pulp mill and/or building board plant of a size that could be based on the use of only the bagasse that is surplus to the fuel requirements of the sugar factories. This surplus bagasse would have no value. Three sites, adjacent to sugar factories, have sufficient water to be considered. At one site the amount of surplus bagasse available from the local factory would be sufficient to supply approximately half of the mill's requirements. The remainder would be obtained at only the cost of transporting it to the use point, about U.S.$7.35 per metric ton of dry whole bagasse. Pith could be used as fuel by the local factory in a mixture with whole bagasse so that no modification of its power boilers would be required. Markets for the pulp could be developed in East Africa or, if desired, in Europe. The building board plant could be sized so that about half of the output is required to supply domestic markets and the remainder could be exported to East Africa. The sizes of the pulp mill and building board plant would be comparable to those of many existing installations which use bagasse as raw material.

Based on the foregoing considerations the following cases would appear to be of interest and warrant consideration.

a. Establish a pulp manufacturing facility with a capacity of 100 ADMTPD of bleached pulp. All the output from this mill would be exported and Sandwell considers that the logical market area is East Africa but Europe could also be supplied if further study indicated this to be of interest.

b. Establish a building board manufacturing facility with a capacity of 45 BDMTPD of a variety of board products. By 1975 half of the output would be required to supply the domestic market and half of the output would be exported. As for the export of pulp, the most logical market area is East Africa.

c. As there is sufficient surplus bagasse available to support both the above facilities an integrated operation could be established. Such an operation would have several advantages resulting from the use of common bagasse preparation and storage facilities plus common maintenance, administrative and warehousing services.

As noted, there are three locations with sufficient water to support a pulp mill of the size considered. These are at the F.U.E.L., Medine and Beau Champ sugar factories. At the first two locations the mill effluent would have to be processed so that it could be used for irrigation of cane. Beau Champ is on the coast and more water is available than at the other two locations.

Effluent treatment would not be necessary but much less bagasse would be available from the local sugar factory.

The cases defined above would be based on the use of only that bagasse which is surplus to the sugar factories fuel requirements. Additional whole bagasse from the local sugar factory would be processed but this would be replaced by the pith removed from all the bagasse handled. The F.U.E.L. factory would have sufficient surplus bagasse to supply the requirements of the proposed particleboard plant, provided the pith is returned for use as fuel. For the other cases or for the other locations bagasse would have to be obtained from a number of sugar factories. Because transportation of bagasse is a major cost item the F.U.E.L. location has a minor cost advantage over either Medine or Beau Champ and the calculations for the different cases have been prepared on this basis. However, a more detailed examination of these sites could indicate a preference for one of the other locations.

Case 1 - Pulp Mill

The proposed pulp mill would have a nominal capacity of 100 ADMTPD of bleached bagasse pulp and would be operated three shifts per day for an average of 330 days a year. It would be located adjacent to the F.U.E.L. sugar factory and would obtain its requirements of bagasse from this factory plus other factories as required. The bagasse would contain an average of 49 percent fibrous material and 48.5 percent moisture with the remainder consisting of soluble sugars and extraneous material.

Bagasse would be obtained in bulk from F.U.E.L. and would be brought to the depithing station by conveyor belt. Bagasse from other factories would be brought by truck. When received at the station all bagasse would be depithed in a single stage of depithing to remove about 35 percent of the dry weight of fibrous material. Depithing would be carried out at the moisture content of the material as received. Pith would be sent to the F.U.E.L. factory and would be mixed with whole bagasse for use as fuel. As the ratio of whole bagasse to pith is estimated to be 1:1.5 it is believed, that this mixture can be used in the existing power boilers at the F.U.E.L. factory without alteration to the boilers. The bagasse preparation plant will be operated only during the cane crushing season so that it is estimated that the number of operating days will be about 110 each year.

The depithed bagasse will be sent either to the digester plant of the pulp mill or to storage. Sufficient bagasse must be processed during the cane crushing season to supply the pulp mill during the full year and the capacity of the depithing station would need to be 960 BDMTPD of bagasse (fibrous material). Depithed bagasse will be stored in bulk piles at the moisture content at which it leaves the depithing station. As discussed in Report P2368/1 the moisture content of the bagasse would not be expected to change appreciably during storage.

For pulping, the depithed bagasse either directly from the depithers or from storage would be washed and then impregnated with caustic soda before being fed to a continuous digester. The yield through the digester should be about 50 percent although higher yields would be possible.

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The bleach plant, which is designed to provide a pulp with a minimum brightness level of 86 G.E., would consist of four stages: chlorination, alkaline extraction and two sodium hypochlorite stages. The bleached pulp would be fluff dried and baled for shipment.

A chemical recovery plant has been included and based on similar recent installations. It would be expected to operate at an overall recovery efficiency of 80 percent. Lime used in the associated causticizing step would not be recovered as its disposal would provide a means of removing the silica that is normally present in bagasse pulping liquors. There are alternative approaches to removing silica and it is considered that these should be investigated further when a full feasibility study is carried out.

Primary treatment of the mill effluent, largely from the bleach plant, would be undertaken to permit the use of this water for irrigation in the cane fields. As this approach has not as yet been carried out on a commercial scale, the suitability of the treated effluent for irrigation purposes would have to be verified. Results from limited trials with similar crops have shown promise in this regard.

As about 7 metric tons of chlorine and essentially the equivalent weight of caustic soda will be required on a daily basis a chloralkali plant of this size has been included. Salt would be obtained locally. Local requirements in Mauritius of chlorine for water treatment and of caustic soda for such applications as bottle washing could also be supplied from the plant as provision for liquefaction of the chlorine has been included. Only the additional facilities to bottle the chlorine for sale would have to be provided.

Process steam would be generated by the recovery boiler and a power boiler burning fuel oil. As insufficient electric power is available on the island to supply the pulp mill, the mill requirements would be produced by turbo-generator, operated by high pressure steam from the power boilers.

Machine shops and mill stores required to maintain the mill equipment have been included.

No provision has been made for transportation facilities as it has been assumed that the local transport company which now handles the transport of sugar from the sugar factories, would be used to truck both the bagasse to the mill and the pulp bales to the port facilities.

Case 2 - Building Board Plant

The proposed building board plant would have a nominal capacity of 45 BDMTPD of various types of board and would be operated three shifts a day for 250 days a year. By locating it adjacent to the F.U.E.L. sugar factory all of the requirements of bagasse could be obtained from this factory and the pith returned for use as fuel. The bagasse would have the average characteristics defined for the pulp mill in Case 1.

Bagasse would be received from the factory in bulk by belt conveyor and the pith returned by the same means. As for the pulp mill, depithing would be carried

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out on green bagasse as received from the sugar factory. A single stage depither to remove 35 percent of the bagasse would be used. All depithing would be done during the cane crushing season and to provide for the total annual requirements, the capacity of this equipment would be 160 BDMTPD of bagasse fibre. All depithed bagasse would be sent directly to bulk storage.

After storage, the depithed bagasse would be further refined mechanically and would then be dried in a fluff dryer. This material would be mixed with resin and formed into a three-layer mat to assure good surface finish so that only a minimum of sanding would be required. To provide the degree of flexibility that would be required to supply the market in Mauritius, a large single opening press has been proposed.

No provision has been included for the remanufacture of board by veneering and laminating although it is assumed that this would be done. As the variety of products that could be produced is very large, each with its specific costs and sales values the justification for installing the required facilities would have to be the subject of a separate study. However, based on several existing installations the return on investment is usually higher than the return for the board plant itself.

A small steam plant, based on the use of fuel oil is included and also the required facilities for maintenance and administration. The product would be trucked by the local carrier to domestic markets and to the port for export.

Case 3 - Combined Pulp and Building Board Mill

For this case, the proposed installation includes a pulp mill to produce 100 ADMTPD of bleached pulp and a building board plant to produce 45 BDMTPD of board. The pulp mill would be operated 330 days and the board plant 250 days a year. Annual output would thus be 33,000 ADMT and 11,200 BDMT of pulp and building board respectively. Location would be adjacent to the F.U.E.L. sugar factory.

Facilities and conditions for each unit would be as described for Cases 1 and 2. However, bagasse preparation would be a common function as would all the service facilities such as maintenance, power plant (for both steam and electric power) warehousing, and administration.

CAPITAL COST ESTIMATES

Summary

The capital cost estimates for the three cases that have been considered are shown in Table 20. Further details of the mill capital cost estimates are recorded in Appendix 3 and of the working capital and opening-up expense in Appendix 4.

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Table 20 - Capital Cost Estimates (X 1,000)

Item	Case 1 Pulp Mill		Case 2 Building Board Plant		Case 3 Combined Mill	
	US $	Rs	US $	Rs	US $	Rs
Mill Capital	12,300	68,300	3,100	17,200	15,000	83,300
Working Capital	1,090	6,100	285	1,600	1,400	7,800
Opening-Up Expense	500	2,800	340	1,900	650	3,600
Total	13,890	76,200	3,725	20,700	17,050	94,700

Mill Capital

The estimates for mill structures and mill equipment for the three cases have been prepared on the basis of cost data which provide for direct costs only. These direct costs are defined as the invoice cost of material and equipment plus applicable freight and delivery charges and the direct cost of labour employed in the erection of material and equipment. Indirect costs such as the cost of contractor's superivision, purchasing, expediting, warehousing and accounting; the cost of renting or otherwise providing construction equipment, tools and temporary facilities; personnel costs and the cost of providing and operating a construction camp and contractor's profits have been estimated separately on the basis of current experience on similar projects, and are identified as Construction Overhead.

The structural cost estimates are based upon estimated material quantities and upon unit costs available from Mauritius and from Sandwell records concerning similar installations in other countries.

The equipment cost estimates and installation labour estimates have been based upon data from Sandwell records which have been modified as required to reflect the conditions in Mauritius. Equipment costs are based on European or North American prices together with an allowance to cover ocean freight and delivery charges. No provision for taxes or import duties has been included as it has been assumed that these charges would be waived by the Government of Mauritius as an aid to establishing industry there.

The estimates include an allowance for the provision of engineering services including field surveys and investigations, calling of tenders and recommendation of competent contractors and equipment suppliers, the preparation of contract documents, the design of the mill, the preparation of detailed drawings and specifications for construction, and resident engineering supervision of contract work.

The capital cost estimates include a contingency allowance to cover the cost of possible unforeseen changes in process and design. This contingency allowance is not intended to provide for inflationary changes in the cost of equipment, material and labour. Separate provision for such possible changes would have to be allowed for in financing the project.

Working Capital

Details of the working capital estimate are recorded in Appendix 4. These estimates provide for inventories of raw materials and finished products, prepaid expenses, accounts receivable and accounts payable which would normally be anticipated for a pulp mill or a board plant under conditions prevailing in Mauritius.

Opening-Up Expense

Details of the opening-up expense are shown in Appendix 4. These estimates are based on data from Sandwell records concerning the experience of similar installations in other countries. This expense includes allowances for salaries and wages of staff engaged prior to start-up, staff training, consultants and sundry supplies. An allowance has also been included to cover the cost of a management and operating team of experienced foreign personnel that will be required during the pre-operating period and for sometime after start-up.

An allowance has been included for expenses incurred in providing the initial chemicals, fuel oil, general supplies and other expenses of a similar nature. No provision has been made for excess operating costs that will be incurred during the initial period of operation.

Interest During Construction

As the method of financing which might be arranged for the three cases has not been developed, no allowance has been included in the capital cost estimate for interest during construction or for any other costs associated with the financing of the projects.

MANUFACTURING COSTS ESTIMATES

Summary

The manufacturing cost estimates for the three cases for a normal operating year at full productive capacity are summarized in Table 21. Details are provided in Appendix 2, with pertinent statistical and cost data recorded in Appendix 1.

Basis of Estimates

The estimates are based on the assumption that the mill would operate to maintain full production throughout a total operating period of 330 days per year. The quantities of bagasse, of chemical raw materials for the pulp and board mills and for the production of chlorine and caustic soda, and of fuel for process and the generation of electric power used in the estimates have been based upon experience at similar mills in other countries.

Table 21 - Annual Manufacturing Cost Estimates

Item	Case 1 Pulp Mill	Case 2 Building Board Plant	Case 3 Combined Mill
Bagasse	US $ 405,000	US $ No Value	US $ 490,000
Salt	43,000	-	43,000
Sulphuric Acid	3,500	-	3,500
Graphite	8,500	-	8,500
Burned Lime	129,000	-	129,000
Sodium Metabisulphite	41,000	-	41,000
Urea Formaldehyde Resin	-	252,000	252,000
Fuel Oil			
- Power Generation	295,000	-	332,000
- Process	335,000	48,000	381,000
Electric Power	-	57,000	-
Other Materials	270,000	31,000	315,000
Labour	81,000	45,000	105,000
Administration and Overheads	90,000	58,000	111,000
Management and Operating Assistance	250,000	150,000	300,000
Contingencies	89,000	29,000	119,000
Mill Manufacturing Cost	US $ 2,040,000	US $ 670,000	US $ 2,630,000
Allowance for Head Office	90,000	90,000	90,000
Total Annual Manufacturing Cost	US $ 2,130,000 Rs 11,800,000	US $ 760,000 Rs 4,220,000	US $ 2,720,000 Rs 15,100,000

The labour estimates are based on the use of Mauritian labour and the rates are those now in effect in Mauritius for equivalent functions. Manning requirements have been based on experience at similar mills in other countries. These estimates cover only the direct labour costs. Indirect labour charges such as social services, holidays, and miscellaneous expenses have been included in overhead.

Administration and overhead cost estimates cover management, supervision general office expense, accounting, purchasing, plant engineering, indirect labour and salary costs and allowances for other expenses at the mill.

Sandwell considers that experienced foreign personnel to provide senior management, some supervisory and certain senior operating functions will be required on a permanent basis. These personnel might be chosen from Europe or North America. A separate allowance to cover this management and operating assistance has been included.

An allowance has also been included to provide for a head office, which might be located in Port Louis.

GROSS EARNINGS ESTIMATES

Summary Estimates

Gross earnings estimates, before interest, depreciation and taxes, have been calculated based on the estimates of mill net prices and the manufacturing and capital costs recorded in preceding sections of this report. Table 22 summarizes the gross earnings for each case for a typical year after start-up when the mill is at full productive capacity but during the initial tax holiday period.

Table 22 - Gross Earnings Estimates

Item		Case 1 Pulp Mill	Case 2 Building Board Plant	Case 3 Combined Mill
Annual Sales				
- Pulp	ADMT	33,000	-	33,000
- Building Board	BDMT		11,200	11,200
Mill Net Sales Value	US$1,000	4,125	1,344	5,469
Annual Manufacturing Costs	US$1,000	2,130	760	2,720
Annual Gross Profit	US$1,000	1,995	584	2,749
Total Investment	US$1,000	13,890	3,725	17,050
Gross Return	%	14	16	16

Discussion

Based on the estimates of gross earnings, the gross returns on total investment would be as follows:

Case 1	-	Pulp Mill	-	14%
Case 2	-	Building Board Plant	-	16%
Case 3	-	Combined Mill	-	16%

Net returns can not be estimated until the method of financing the projects has been developed.

Sandwell considers that the estimated returns may be optimistic in that the unit manufacturing costs are below the averages reported by similar installations in other countries. These unit costs, as developed in Appendix 2, are as follows:

Pulp	-	US $64.55
Building Board	-	US $67.80

These costs are low largely because the bagasse has been charged to the process at no cost other than the transportation charge to truck it to the use point. This approach should be possible if the sugar factory owners in Mauritius become participants in the venture. If an independent pulp mill or board plant is established a nominal charge would undoubtedly have to be paid for bagasse and thus the above manufacturing costs would increase.

During the initial period after start-up, additional administrative and operating assistance would be required while local personnel could be trained in the specific operations associated with the running of a pulp mill or board plant. This assistance from experienced technicians is considered to be required to assure that a good quality product is produced which would be accepted in export markets. For the first year of operations this assistance has been estimated to cost nearly US $200,000 and for the second year about US $100,000. For succeeding years the costs shown in the manufacturing cost estimates should be applicable.

For a large mill, with a corresponding large cash flow, a gross return of 15 percent on investment is considered to be a minimum acceptable level by normal business standards. For smaller mills a greater rate of return is usually required especially by private investors. However, the installation of a pulp mill or a building board plant in Mauritius would provide certain advantages to the economy of the country. The bagasse that would be used is now surplus and is burned for disposal. This material could be converted to pulp for export or building board for both domestic use and for export which would enhance the foreign trade balance of the country. These facilities would also require a large staff or supervisors and operators on a full-year basis and would thus become a major factor in combatting unemployment on the island. Because of the prospect of obtaining certain benefits to the economy of the country as a whole, the Government of Mauritius may be interested in fostering the development of such facilities and may choose to become a participant. Under these conditions the actual gross return on investment might be considered to be of secondary importance providing the level of return is sufficient to pay interest on and to retire debt and to amortize the investment in plant and equipment.

CONCLUSIONS

This report has presented an assessment of the sugar industry in Mauritius, of the potential markets for bagasse products and of the potential earnings which might be realized by the development of bagasse using industries. From this assessment the following conclusions have been reached.

1. Because of the scarcity of available land, future growth of the sugar industry is restricted and output will increase from the present level of 600,000 metric tons to only 660,000 and 690,000 metric tons of raw sugar by

1975 and 1980, respectively. By 1975, the quantity of whole bagasse available is estimated to be 770,000 bone-dry metric tons. About 123,000 tons of this will be surplus to the fuel requirements of the sugar factories. If pith is used as fuel, the availability of surplus whole bagasse would be increased to 166,000 bone-dry metric tons.

2. The collection and use of surplus bagasse from several factories would be economically more attractive than the use of all the bagasse from one or two factories on a fuel replacement basis.

3. Future domestic markets for pulp and paper products would not be sufficient to support a viable mill. Domestic markets for about 5,600 BDMTPA of building board products could be developed by 1975 if present imports of various building products are replaced by a bagasse - based building board.

4. Export markets for both pulp and building board products might be developed in East Africa or Europe.

5. Because of limited availability of water, the nature of potential markets and the value of replacement fuel the optimum utilization of the bagasse available would be to use only that which is surplus to the sugar factories' fuel requirements for the manufacture of 100 ADMTPD of pulp or 45 BDMTPD of building board products or both. The pulp would be exported, preferably to East Africa. Half of the building board products would be used domestically, the remainder exported.

6. Three sites on the island, adjacent to the sugar factories at F.U.E.L. Medine and Beau Champ, have adequate supplies of water to support a small pulp mill. At the first two, the mill effluent would have to be processed to permit its use as irrigation water. At Beau Champ ample water, which is not required for irrigation purposes, is available but less bagasse could be obtained from the local factory. A preliminary comparison indicates that the F.U.E.L. location is preferred and has been used as the basis for the comparison of the cases considered.

7. Gross return on the total investment required for the pulp mill would be 14 percent and for the building board plant and the combined mill 16 percent.

8. The gross returns are not considered to be sufficient to be of interest to private investors.

9. Manufacturing facilities of the type considered would require a large number of employees on a full-year basis and the sale of the product would be a factor in improving the foreign trade balance in Mauritius. Because of these potential benefits to the island's economy the Government may wish to consider the projects further.

RECOMMENDATIONS

It is recommended that:

1. The effect of establishing a pulp mill and/or a building board plant on the economy of Mauritius be evaluated, and

2. If the results for this evaluation are favourable a full feasibility study be carried out.

Prepared by ______________
J. C. Easton

____
D. E. Read

Approved by ______________
Sandwell and Company Limited

APPENDIX 1

SANDWELL

APPENDIX 1

STATISTICAL AND COST DATA

(P2368/2)

UTILIZATION OF BAGASSE
IN MAURITIUS

APPENDIX 1 - STATISTICAL AND COST DATA

GLOSSARY OF TERMS

A	- Annum
ADLT	- Air dry long ton (10% moisture, 90% bone-dry fibre)
ADMT	- Air dry metric ton
ADMTPA	- Air dry metric ton per annum
ADMTPD	- Air dry metric ton per day
BDMT	- Bone dry metric ton
BDMTPA	- Bone dry metric ton per annum
BDMTPD	- Bone dry metric ton per day
Bl	- Bleached
cal	- Calorie
CIF	- Cost, insurance and freight
D	- Days
D/A	- Days per annum
FAS	- Free alongside ship
Gcal	- Gigacalories
g/m^2	- Grams per square meter
kg	- Kilogram
Kcal	- Kilocalories
Kcal/ADMT	- Kilocalories per air dry metric ton
Kcal/BDMT	- Kilocalories per bone-dry metric ton
kW	- Kilowatts
kWh	- Kilowatt hours
kWh/ADMT	- Kilowatt hours per air dry metric ton
kWh/BDMT	- Kilowatt hours per bone-dry metric ton
kWh/Gcal	- Kilowatt hours per gigacalorie
kWh/m^3	- Kilowatt hours per cubic meter
kWh/MWh	- Kilowatt hours per megawatt hour
mh	- Manhours
mh/A	- Manhours per annum
m^2	- Square meters
m^2/A	- Square meters per annum
m^3	- Cubic meters
m^3/A	- Cubic meters per annum

GLOSSARY OF TERMS (Cont'd.)

MT	- Metric ton
MTPA	- Metric ton per annum
MW	- Megawatt
MWh	- Megawatt hours
MWh/A	- Megawatt hours per annum
ppm	- Parts per million
Rs	- Rupees
Rs/A	- Rupees per annum
U.S.$	- United States dollars
U.S.$/A	- United States dollars per annum

STATISTICS

BAGASSE REQUIREMENTS

Item	Units	Amount
Pulp Mill		
- Green Whole Bagasse	MT/BDMT(Bl)	7.24
- Fibre Content of Whole Bagasse	% Green Weight	49
- Whole Bagasse Fibre	BDMT/BDMT(Bl)	3.55
- Depithing Loss	%	35
- Depithed Bagasse	BDMT/BDMT(Bl)	2.31
- Storage Loss (Average)	%	6
- Depithed Fibre for Pulp	BDMT/BDMT(Bl)	2.18
	BDMT/ADMT(Bl)	1.96
Particle Board Plant		
- Green Whole Bagasse	MT/BDMT(Board)	3.22
- Fibre Content of Whole Bagasse	% Green Weight	49
- Whole Bagasse Fibre	BDMT/BDMT(Board)	1.57
- Depithing Loss	%	35
- Depithed Bagasse	BDMT/BDMT(Board)	1.03
- Storage Loss	%	10
- Depithed Bagasse Fibre for Board	BDMT/BDMT(Board)	0.92

CHEMICAL RAW MATERIALS

Item	Units	Amount
Bleached Soda Pulp Mill		
Caustic Soda		
- Pulping	kg/ADMT(Bl)	47
- Bleaching	kg/ADMT(Bl)	25
Chlorine		
- Bleaching	kg/ADMT(Bl)	70
Burned Lime		
- Bleaching	kg/ADMT(Bl)	23
- Recovery	kg/ADMT(Bl)	132
Sodium Metabisulphite		
- Bleaching	kg/ADMT(Bl)	6
Fuel Oil		
- Recovery	kg/ADMT(Bl)	5
- Pulp Drying	kg/ADMT(Bl)	95
Chloralkali Plant		
Salt	kg/MT Cl_2	1,800
Sulphuric Acid	kg/MT Cl_2	3
Graphite	kg/MT Cl_2	3

Particleboard Plant

Item	Units	Amount
Urea Formaldehyde Resin	kg/BDMT (board)	80
Fuel Oil		
Drying	kg/BDMT (board)	105

HEAT

Pulp Mill

Pulping and Washing	Mcal/ADMT$_{(Bl)}$	1,200
Bleaching	Mcal/ADMT$_{(Bl)}$	1,000
Pulp Drying	Mcal/ADMT$_{(Bl)}$	140
Recovery Auxiliaries	Mcal/ADMT$_{(Bl)}$	400
Evaporators	Mcal/ADMT$_{(Bl)}$	830
Heat from Recovery Boiler	Mcal/ADMT$_{(Bl)}$	1,500
Mill General	Mcal/ADMT$_{(Bl)}$	400
Heat from Fuel Oil	Mcal/MT	8,500

Board Plant

Total Board Plant	Mcal/BDMT$_{(Board)}$	500

ELECTRIC POWER

Pulp Mill

Bagasse Handling	kWh/BDMT$_{(Depithed\ Bagasse)}$	12
Bagasse Depithing	kWh/BDMT$_{(Depithed\ Bagasse)}$	25
Pulping and Washing	kWh/ADMT$_{(Bl)}$	130
Bleaching	kWh/ADMT$_{(Bl)}$	150
Pulp Drying	kWh/ADMT$_{(Bl)}$	125
Recovery Auxiliaries	kWh/ADMT$_{(Bl)}$	130
Evaporators	kWh/ADMT$_{(Bl)}$	122
Recausticizing	kWh/ADMT$_{(Bl)}$	20
Mill General	kWh/ADMT$_{(Bl)}$	30
Steam Plant	kWh/Gcal	12
Water Supply	kWh/m^3	0.7
Effluent Disposal	kWh/m^3	1.0
Substation Loss	kWh/MWh	20
Chloralkali Plant	kWh/MT_{Cl_2}	3,600

Board Plant

Fibre Drying	kWh/BDMT$_{(Depithed\ Bagasse)}$	125
Plant General	kWh/BDMT$_{(Board)}$	20

WATER

Pulpmill

Item	Units	Amount
Total Water Usage	m^3/ADMT(Bl)	150

Board Plant

Item	Units	Amount
Total Water Usage	m^3/BDMT (Board)	2

Raw Material Costs

Item	Units	Amount Rs	Amount US$
Whole Bagasse			
- Local Sugar Factory	BDMT	No Value	No Value
- Other Sugar Factories	BDMT	41.00	7.35
Burned Lime	MT	140.	25.00
Salt	MT	55.50	10.00
Sodium Metabisulphite	MT	1,150	207.00
Fuel Oil	MT	144	26.00
Sulphuric Acid	MT	2,850	515.00
Urea Formaldehyde Resin	MT	1,530	275.00
Electric Power	MWh	110	20.00
Graphite	MT	6,700	1,200.00

Monetary Exchange Rate

Item	Units	Amount
Exchange Rate	Rs/U.S.$	5.55
	Rs/£ Sterling	13.33

[illegible]ENDIX

SANDWELL

APPENDIX 2

MANUFACTURING COST ESTIMATES

(P2368/2)

SANDWELL

UTILIZATION OF BAGASSE
IN MAURITIUS

DATE 5 DECEMBER 1969

APPENDIX 2 - MANUFACTURING COST ESTIMATES

CASE 1 - 100 ADMTPD BLEACHED PULP

STATISTICS

Item	Units	Amount
Pulp Production	ADMTPA	33,000
Whole Bagasse Purchased		
- from local factory	BDMTPA	13,800
- from other factories	BDMTPA	54,800
Salt	MTPA	4,280
Sulphuric Acid	MTPA	7.1
Graphite	MTPA	7.1
Burned Lime	MTPA	5,120
Sodium Metabisulphite	MTPA	200
Fuel Oil		
- Power Generation	MTPA	11,400
- Process	MTPA	12,900
Electric Power		
- Generated	MWh/A	42,500
Water	m^3/A	5,000,000
Labour	mh/A	328,000
Labour Force		
- Hourly	Men	166
- Salaried	Men	23
Production Days	D/A	330
Operating Days		
- Pulp Mill	D/A	350

SANDWELL

MANUFACTURING COST

Item	Rate	Unit Cost US$/ADMT	Annual Cost Rs	Annual Cost US$
Bagasse				
- Local Factory	No Value	-	-	-
- Other Sugar Factories	Rs 41.00/BDMT	12.27	2,250,000	405,000
Salt	Rs 55.50/MT	1.30	238,000	43,000
Sulphuric Acid	Rs 2,850/MT	0.11	20,000	3,500
Graphite	Rs 6,700/MT	0.25	48,000	8,500
Burned Lime	Rs 140/MT	3.91	715,000	129,000
Sodium Metabisulphite	Rs 1,150/MT	1.24	230,000	41,000
Fuel Oil				
- Power Generation	Rs 144/MT	8.94	1,640,000	295,000
- Process	Rs 144/MT	10.15	1,860,000	335,000
Other Materials		8.18	1,500,000	270,000
Labour		2.45	450,000	81,000
Administration and Overhead		2.73	500,000	90,000
Management and Operating Assistance		7.59	1,400,000	250,000
Contingencies		2.70	449,000	89,000
Total Mill Cost		61.82	11,300,000	2,040,000
Allowance for Head Office Expense		2.73	500,000	90,000
Total Annual Manufacturing Cost		64.55	11,800,000	2,130,000

PULP MILL

Item	Units	Amount
Bleached Pulp Production	ADMTPA	33,000
Depithed Bagasse to Digester	BDMTPA	64,600
Caustic Soda		
- Pulping	MTPA	1,550
- Bleaching	MTPA	830
Chlorine		
- Bleaching	MTPA	2,310
Burned Lime		
- Bleaching	MTPA	760
- Recovery	MTPA	4,360
Sodium Metabisulphite		
- Bleaching	MTPA	200
Fuel Oil		
- Recovery	MTPA	160
- Pulp Drying	MTPA	3,140
Heat		
- Pulping and Washing	Gcal/A	40,000
- Bleaching	Gcal/A	33,000
- Pulp Drying	Gcal/A	4,500
- Evaporators	Gcal/A	27,500
- Recovery Auxiliaries	Gcal/A	13,000
- Total	Gcal/A	118,000

PULP MILL (Cont'd)

Item	Units	Amount
Electric Power		
- Pulping and Washing	MWh/A	4,300
- Bleaching	MWh/A	5,000
- Recovery Auxiliaries	MWh/A	4,300
- Evaporators	MWh/A	700
- Recausticizing	MWh/A	700
- Pulp Drying	MWh/A	4,000
- Total	MWh/A	19,000

CHLORALKALI PLANT

Item	Units	Amount
Chlorine Requirement	MTPA	2,380
Caustic Soda Requirement	MTPA	2,310
Salt	MTPA	4,280
Sulphuric Acid	MTPA	7.1
Graphite	MTPA	7.1
Electric Power	MWh/A	8,600

BAGASSE PREPARATION

Item	Units	Amount
Depithed Bagasse to Digesters	BDMTPA	64,600
Storage Losses	BDMTPA	4,000
Depithed Bagasse	BDMTPA	68,600
Pith Removed	BDMTPA	37,000
Whole Bagasse Required	BDMTPA	105,600
Electric Power		
- Bagasse Handling	MWh/A	800
- Depithing	MWh/A	1,700
- Total	MWh/A	2,500

BAGASSE SUPPLY

Item	Units	Amount
Whole Bagasse Required	BDMTPA	105,600
Whole Bagasse from Local Factory	BDMTPA	50,800
Pith Returned to Local Factory	BDMTPA	37,000
Whole Bagasse Purchased from Local Factory	BDMTPA	13,800
Whole Bagasse Purchased from Other Factories	BDMTPA	54,800

ELECTRIC POWER

Item	Units	Amount
Bagasse Preparation	MWh/A	2,500
Pulp Mill	MWh/A	19,000
Chloralkali Plant	MWh/A	8,600
Water Supply and Effluent Disposal	MWh/A	8,500

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ELECTRIC POWER (Cont'd.)

Item	Units	Amount
Mill General	MWh/A	1,000
Steam Plant	MWh/A	2,100
Substation Loss	MWh/A	800
Total	MWh/A	42,500

STEAM PLANT

Item	Units	Amount
Heat Requirement		
- Pulp Mill	Gcal/A	118,000
- Mill General	Gcal/A	13,000
- Total	Gcal/A	131,000
Recovery Boiler Output	Gcal/A	50,000
Heat from Steam Plant	Gcal/A	81,000
Power Generation		
- Back Pressure	Gcal/A	28,000
- Condensing	Gcal/A	69,000
Total Heat from Power Boiler	Gcal/A	178,000
Fuel Oil		
- Power Boiler - Power Generation	MTPA	11,400
- Power Boiler - Process Steam	MTPA	9,600
- Recovery Boiler	MTPA	160
- Pulp Drying	MTPA	3,140
- Total	MTPA	24,300
Electric Power	MWh/A	2,100

WATER SUPPLY AND EFFLUENT DISPOSAL

Item	Units	Amount
Water	m^3/A	5,000,000
Electric Power		
- Water Supply	MWh/A	3,500
- Effluent Disposal	MWh/A	5,000
- Total	MWh/A	8,500

SANDWELL

OTHER MATERIALS

Item	Rate	Annual Cost US$	Annual Cost Rs
Bagasse Handling and Depithing	$1.00/BDMT	105,000	583,000
Pulp Mill			
- Pulping and Washing	$0.75/ADMT (Bl)	25,000	139,000
- Flash Drying	$1.25/ADMT (Bl)	41,000	228,000
- General	$0.20/ADMT (Bl)	6,500	36,000
Maintenance Shops	$0.50/ADMT (Bl)	16,500	92,000
General	$0.20/ADMT (Bl)	6,500	36,000
Laboratory	$0.05/ADMT (Bl)	1,500	8,000
Water Supply and Treatment	$0.01/$m^3$	50,000	278,000
Steam Plant	$0.10/Gcal	18,000	100,000
Total		270,000	1,500,000

LABOUR

Summary

Department	Operating Force	Mh/A	Annual Cost Rs	Annual Cost US$
Bagasse Handling and Preparation	23	30,000	38,000	6,900
Pulping, Bleaching and Pulp Drying	43	84,200	120,000	21,600
Steam and Recovery	30	61,400	87,000	15,700
Technical Control	6	14,400	20,700	3,700
Maintenance	46	91,600	119,000	21,500
General Labour	12	22,800	27,400	5,000
Shipping	6	14,400	20,700	3,700
Allow for Overtime	-	9,200	17,200	2,900
Total	166	328,000	450,000	81,000

ADMINISTRATION AND OVERHEAD

Summary

Item	Annual Cost Rs	Annual Cost US$
Salaries	256,000	46,000
General Overhead Expense	100,000	18,000
Payroll Additives		
- Labour	67,000	12,000
- Salaried	77,000	14,000
Total	500,000	90,000

MANAGEMENT AND OPERATING ASSISTANCE

	Rs	US$
- Salaries	870,000	156,000
- Travelling Expense, Living Allowance, Benefits, Misc.	530,000	94,000
Total	1,400,000	250,000

ALLOWANCE FOR HEAD OFFICE EXPENSE

	Rs	US$
Salaries	200,000	36,000
General Expense and Office Rental	240,000	43,000
Payroll Additives	60,000	11,000
Total	500,000	90,000

SANDWELL

UTILIZATION OF BAGASSE
IN MAURITIUS

DATE 5 DECEMBER 1969

APPENDIX 2 - MANUFACTURING COST ESTIMATE

CASE 2 - 45 BDMTPD PARTICLEBOARD PLANT

STATISTICS

Item	Units	Amount
Particleboard Production	BDMTPA	11,200
	$1,000m^2$/A	1,170
Whole Bagasse Purchased		
- Local Sugar Factory	BDMTPA	11,500
- Other Sugar Factories	BDMTPA	-
Urea-Formaldehyde Resin	MTPA	900
Fuel Oil	MTPA	1,850
Electric Power	MWh/A	2,870
Water	m^3/A	23,000
Labour	mh/A	190,700
Labour Force		
- Hourly	Men	93
- Salaried	Men	17
Operating Days		
- Board Plant	D/A	250
- Depithing Plant	D/A	110

MANUFACTURING COSTS

Item	Rate	Unit Cost US$/BDMT	Annual Cost US $	Annual Cost Rs
Bagasse	No Value	-	-	-
Urea-Formaldehyde Resin	Rs 1,530/MT	22.50	252,000	1,400,000
Fuel Oil	Rs 144/MT	4.29	48,000	266,000
Electric Power	Rs 110/MWh	5.09	57,000	316,000
Other Materials		2.77	31,000	170,000
Labour		4.02	45,000	250,000
Administration and Overhead		5.18	58,000	320,000
Management and Operating Assistance		13.40	150,000	830,000
Contingencies		2.55	29,000	168,000
Total Mill Manufacturing Cost		59.80	670,000	3,720,000
Allowance for Head Office Expense		8.00	90,000	500,000
Total Annual Manufacturing Cost		67.80	760,000	4,220,000

PARTICLEBOARD PLANT

Item	Units	Amount
Particleboard Production	BDMTPA	11,200
	$1,000m^2/A$	1,170
Stored Depithed Bagasse to Process	BDMTPA	10,300
Urea Formaldehyde Resin (solids)	MTPA	900
Fuel Oil Dryer	MTPA	1,200
General Heat	Gcal/A	5,500
Electric Power		
- Dryer	MWh/A	1,440
- General	MWh/A	220
- Total	MWh/A	1,660

BAGASSE PREPARATION

Stored Depithed Bagasse to Process	BDMTPA	10,300
Storage Losses	BDMTPA	1,200
Depithed Bagasse	BDMTPA	11,500
Pith Removed	BDMTPA	6,100
Whole Bagasse Required	BDMTPA	17,600
Electric Power		
- Bagasse Handling	MWh/A	140
- Depithing	MWh/A	920
- Total	MWh/A	1,060

BAGASSE SUPPLY

Whole Bagasse Required	MTPA	36,000
	BDMTPA	17,600
Whole Bagasse from Local Factory	BDMTPA	17,600
Pith Returned to Local Factory	BDMTPA	6,100
Whole Bagasse Purchased	BDMTPA	11,500

WATER SUPPLY AND EFFLUENT DISPOSAL

Water	m^3/A	23,000
Electric Power		
- Water Supply	MWh/A	17
- Effluent	MWh/A	23
- Total	MWh/A	40

STEAM PLANT

Item	Units	Amount
Heat Required		
- Total Particleboard Plant	Gcal/A	5,500
Total Heat from Power Boiler	Gcal/A	5,500
Fuel Oil		
- Power Boiler	MTPA	650
- Bagasse Dryer	MTPA	1,200
- Total	MTPA	1,850
Electric Power	MWh/A	70

ELECTRIC POWER

Bagasse Preparation	MWh/A	1,060
Drying	MWh/A	1,440
Water Supply and Effluent Disposal	MWh/A	40
Plant General	MWh/A	220
Steam Plant	MWh/A	70
Sub-Station Loss	MWh/A	40
Total	MWh/A	2,870

OTHER MATERIALS

Item	Rate	Annual Cost $	Annual Cost Rs
Bagasse Handling and Depithing	$1.00/BDMT (Bagasse)	11,500	63,000
Particleboard Plant			
- Flash Drying	$1.00/BDMT (Board)	11,200	62,000
- Pressing	$0.50/BDMT (Board)	5,600	31,000
- General	$0.30/BDMT (Board)	3,500	19,000
General Mill	$0.30/BDMT (Board)	3,500	19,000
Laboratory	$0.10/BDMT (Board)	1,100	6,000
Water Supply	$0.01/$m^3$	200	1,000
Total		$ 31,000	Rs 170,000

SANDWELL

LABOUR

Summary

Department	Operating Force	Mh/A	Annual Cost Rs	Annual Cost US$
Bagasse Handling and Preparation	12	17,300	22,700	4,100
Particleboard Plant	35	70,000	92,300	16,600
Technical Control	4	8,000	12,400	2,200
Maintenance	25	58,000	75,800	13,600
General Labour	11	20,800	25,200	4,600
Shipping	6	12,000	15,600	2,800
Allowance for Overtime	-	4,600	6,000	1,100
Total	93	190,700	250,000	45,000

ADMINISTRATION AND OVERHEAD

Summary

Item	Annual Cost Rs	Annual Cost US$
Salaries	180,000	32,500
General Overhead Expense	50,000	9,000
Payroll Additives		
- Labour	40,000	7,500
- Salaries	50,000	9,000
- Total	320,000	58,000

MANAGEMENT AND OPERATING ASSISTANCE

- Salaries	520,000	93,000
- Travelling Expense, Living Allowance, Benefits, Misc.	310,000	57,000
- Total	830,000	150,000

ALLOWANCE FOR HEAD OFFICE EXPENSE

Summary

Salaries	200,000	36,000
General Expense and Office Rental	240,000	43,000
Payroll Additives	60,000	11,000
Total	500,000	90,000

SANDWELL

WORKING CAPITAL ESTIMATE (Cont'd.) Rs US$

UTILIZATION OF BAGASSE
IN MAURITIUS

DATE 5 DECEMBER 1969

APPENDIX 2 - MANUFACTURING COST ESTIMATE

CASE 3 - 100 ADMTPD BLEACHED PULP MILL AND 45 BDMTPD PARTICLEBOARD PLANT

STATISTICS

Item	Units	Amount
Bleached Pulp Production	ADMTPA	33,000
Particleboard Production	BDMTPA	11,000
	1,000 m^2/A	1,170
Whole Bagasse Purchased		
- Local Sugar Factory	BDMTPA	13,800
- Other Sugar Factories	BDMTPA	66,300
Salt	MTPA	4,280
Sulphuric Acid	MTPA	7.1
Graphite	MTPA	7.1
Burned Lime	MTPA	5,120
Sodium Metabisulphite	MTPA	200
Urea-Formaldehyde Resin	MTPA	900
Fuel Oil		
- Power Generation	MTPA	12,800
- Process	MTPA	14,700
Electric Power Generated	MWh/A	45,100
Water	m^3/A	5,000,000
Labour	mh/A	422,000
Labour Force		
- Hourly	Men	215
- Salaried	Men	27
Production Days		
- Pulp Mill	D/A	330
Operating Days		
- Pulp Mill	D/A	350
- Board Plant	D/A	250
- Depithing Plant	D/A	110

SANDWELL

MANUFACTURING COSTS

Item	Rate	Annual Cost Rs	Annual Cost US$
Bagasse			
- Local Sugar Factory	No Value	-	-
- Other Sugar Factories	Rs 41.00/BDMT	2,720,000	490,000
Salt	Rs 55.50/MT	238,000	43,000
Sulphuric Acid	Rs 2,850/MT	20,000	3,500
Graphite	Rs 6,700/MT	48,000	8,500
Burned Lime	Rs 140/MT	715,000	129,000
Sodium Metabisulphite	Rs 1,150/MT	230,000	41,000
Urea-Formaldehyde Resins	Rs 1,530/MT	1,400,000	252,000
Fuel Oil			
- Power Generation	Rs 144/MT	1,840,000	332,000
- Process	Rs 144/MT	2,120,000	381,000
Other Materials		1,740,000	315,000
Labour		583,000	105,000
Management and Operating Assistance		1,670,000	300,000
Administration and Overhead		615,000	111,000
Contingencies		661,000	119,000
Total Mill Cost		14,600,000	2,630,000
Allowance for Head Office Expense		500,000	90,000
Total Manufacturing Cost		15,100,000	2,720,000

PULP MILL

See Case 1

CHLORALKALI PLANT

See Case 1

PARTICLEBOARD PLANT

See Case 2

BAGASSE PREPARATION

Item	Unit	Amount
Depithed Bagasse to Process	BDMTPA	74,900
Storage Loss	BDMTPA	5,200
Depithed Bagasse	BDMTPA	80,100
Pith Removed	BDMTPA	43,100
Whole Bagasse Required	BDMTPA	123,200
Electric Power		
- Bagasse Handling	MWh/A	960
- Depithing	MWh/A	2,000
- Total	Mwh/A	2,960

OPENING-UP EXPENSE ESTIMATE

BAGASSE SUPPLY

Item	Unit	Amount
Whole Bagasse Required	MTPA	251,500
	BDMTPA	123,200
Whole Bagasse from Local Factory	BDMTPA	56,900
Pith Returned to Local Factory	BDMTPA	43,100
Whole Bagasse Purchased		
- Local Factory	BDMTPA	13,800
- Other Factories	BDMTPA	66,300

STEAM PLANT

Heat Requirement		
- Pulp Mill	Gcal/A	118,000
- Mill General	Gcal/A	13,000
- Particleboard Plant	Gcal/A	5,500
- Total	Gcal/A	136,500
Recovery Boiler Output	Gcal/A	50,000
Heat from Steam Plant	Gcal/A	86,500
Power Generation		
- Back Pressure	Gcal/A	28,000
- Condensing	Gcal/A	81,000
Total Heat from Power Boiler	Gcal/A	195,500
Fuel Oil		
- Power Boiler - Power Generation	MTPA	12,800
- Power Boiler - Process Steam	MTPA	10,200
- Recovery Boiler	MTPA	160
- Pulp Drying	MTPA	3,140
- Particleboard Plant	MTPA	1,200
- Total	MTPA	27,500
Electric Power	MWh/A	2,300

WATER SUPPLY AND EFFLUENT DISPOSAL

Water		
- Pulp Mill and Board Plant	m^3/A	5,000,000
Electric Power		
- Water Supply	MWh/A	3,500
- Effluent Disposal	MWh/A	5,000
- Total	MWh/A	8,500

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ELECTRIC POWER

Item	Unit	Amount
Bagasse Preparation	MWh/A	2,960
Pulp Mill	MWh/A	19,000
Chloralkali Plant	MWh/A	8,600
Particleboard Plant	MWh/A	1,660
Water Supply and Effluent Dispo	MWh/A	8,500
Mill General		
- Pulp Mill	MWh/A	1,000
- Particle Board Plant	MWh/A	220
Steam Plant	MWh/A	2,300
Sub-Station Loss	MWh/A	860
Total	MWh/A	45,100

OTHER MATERIALS

Item	Rate	Annual Cost $	Annual Cost Rs
Bagasse Handling and Depithing	$1.00/BDMT(Bagasse)	123,000	680,000
Pulp Mill	$2.20/ADMT(Bl)	73,000	400,000
Maintenance Shops			
- Pulp Mill	$0.50/ADMT(Bl)	16,500	92,000
General		10,000	56,000
Laboratory		2,600	14,000
Water Supply and Treatment		50,000	278,000
Steam Plant	$0.10/Gcal	19,500	108,000
Particleboard Plant	$1.80/BDMT(Board)	20,400	112,000
Total		315,000	1,740,000

LABOUR

Summary

Department	Operating Force		Annual Cost Rs	Annual Cost US$
Bagasse Handling and Preparation	23	30,000	38,000	6,900
Pulping, Bleaching and Pulp Drying	43	84,200	120,000	21,600
Steam and Recovery	30	61,400	87,000	15,700
Particleboard Plant	35	70,000	92,300	16,600
Technical Control	8	18,400	26,000	4,700
Maintenance	53	108,000	138,000	25,000
General Labour	12	22,800	27,400	5,000
Shipping	11	24,400	31,700	5,800
Allow for Overtime	—	12,800	22,600	3,700
Total	215	422,000	583,000	105,000

(P2368/2, App.2, Case 3)

WORKING CAPITAL ESTIMATE (Cont'd.) Rs US$

ADMINISTRATION AND OVERHEAD

Summary

Item	Amount Rs	Amount US$
Salaries	290,000	52,000
General Overhead Expense	150,000	27,000
Payroll Additives		
- Labour	88,000	16,000
- Salaried	87,000	15,000
Total	615,000	110,000

MANAGEMENT AND OPERATING ASSISTANCE

	Rs	US$
- Salaries	1,020,000	183,000
- Travelling Expense, Living Allowance, Benefits, Misc.	650,000	117,000
- Total	1,670,000	300,000

ALLOWANCE FOR HEAD OFFICE EXPENSE

Summary

	Rs	US$
Salaries	200,000	36,000
General Expense and Office Rental	240,000	43,000
Payroll Additives	60,000	11,000
Total	500,000	90,000

APPENDIX 3

SANDWELL

APPENDIX 3

CAPITAL COST ESTIMATES

(P2368/2)

UTILIZATION OF BAGASSE IN MAURITIUS

DATE 5 DECEMBER 1969

APPENDIX 3 - CAPITAL COST ESTIMATES

CASE 1 - 100 ADMTPD BAGASSE PULP MILL

SUMMARY

Account No.	Department	Structures	Equipment	Total
110.00	Site	$ 90,000	$ -	$ 90,000
120.00	Transportation	40,000	55,000	95,000
130.00	Sewers and Effluent Disposal	250,000	55,000	305,000
140.00	Fire Protection	30,000	140,000	170,000
210.00	Offices and Laboratories	80,000	40,000	120,000
220.00	Mill Stores	60,000	330,000	390,000
230.00	Maintenance Shops	incl. in 220.00	210,000	210,000
260.00	Fuel Storage and Handling	20,000	110,000	130,000
270.00	Water Supply and Distribution	100,000	150,000	250,000
280.00	Steam Supply and Distribution	50,000	550,000	600,000
290.00	Power Supply and Distribution	50,000	750,000	800,000
320.00	Bagasse Preparation Plant	100,000	850,000	950,000
410.00	Digester Plant	200,000	410,000	610,000
420.00	Washing and Screening	incl. in 410.00	470,000	470,000
430.00	Bleach Plant	incl. in 410.00	1,200,000	1,200,000
450.00	Evaporator Plant	incl. in 460.00	200,000	200,000
460.00	Recovery Boiler Plant	200,000	960,000	1,160,000
470.00	Causticizing Plant	50,000	300,000	350,000
611.00	Chloralkali Plant	30,000	870,000	900,000
850.00	Pulp Flash Drying Plant	40,000	500,000	540,000
890.00	Pulp Warehouse	30,000	30,000	60,000
	Total	$ 1,420,000	$ 8,180,000	$ 9,600,000
	Construction Overhead			1,100,000
	Engineering and Contingencies			1,600,000
	Total Plant Capital			$ 12,300,000

REPORT P2368/2
UTILIZATION OF BAGASSE

UNITED NATIONS
NEW YORK U.S.A.

UTILIZATION OF BAGASSE
IN MAURITIUS

DATE 5 DECEMBER 1969

APPENDIX 3 - CAPITAL COST ESTIMATES

CASE 2 - 45 BDMTPD PARTICLEBOARD PLANT

SUMMARY

Account No.	Department	Structures	Equipment	Total
110.00	Site	$ 5,000	$ -	$ 5,000
120.00	Transportation	6,000	-	6,000
130.00	Sewers	8,000	-	8,000
140.00	Fire Protection	5,000	15,000	20,000
210.00	Office and Laboratory	20,000	12,000	32,000
220.00	Mill Stores	incl. in 230.00	100,000	100,000
230.00	Maintenance Shops	12,000	60,000	72,000
260.00	Fuel Storage and Handling	4,000	32,000	36,000
270.00	Water Supply	5,000	7,000	12,000
280.00	Steam Supply	5,000	57,000	62,000
290.00	Power Supply	5,000	12,000	17,000
320.00	Bagasse Preparation Plant	25,000	215,000	240,000
350.00	Particleboard Plant	150,000	1,650,000	1,800,000
890.00	Warehouse	10,000	10,000	20,000
	Total	$ 260,000	$ 2,170,000	$ 2,430,000
	Construction Overhead			290,000
	Engineering and Contingencies			380,000
	Total Plant Capital			$ 3,100,000

APPENDIX 3 - CAPITAL COST ESTIMATE

CASE 3 - 100 ADMTPD BAGASSE PULP MILL AND 45 BDMTPD PARTICLEBOARD PLANT

SUMMARY

Account No.	Department	Structures	Equipment	Total
110.00	Site	$ 90,000	$ -	$ 90,000
120.00	Transportation	47,000	55,000	102,000
130.00	Sewers and Effluent Disposal	258,000	55,000	313,000
140.00	Fire Protection	35,000	155,000	190,000
210.00	Offices and Laboratories	80,000	45,000	125,000
220.00	Mill Stores	60,000	430,000	490,000
230.00	Maintenance Shops	incl. in 220.00	240,000	240,000
260.00	Fuel Storage and Handling	20,000	110,000	130,000
270.00	Water Supply and Distribution	100,000	150,000	250,000
230.00	Steam Supply and Distribution	50,000	550,000	600,000
290.00	Power Supply and Distribution	50,000	760,000	810,000
320.00	Bagasse Preparation Plant	100,000	900,000	1,000,000
350.00	Particleboard Plant	150,000	1,650,000	1,800,000
410.00	Digester Plant	200,000	410,000	610,000
420.00	Washing and Screening	incl. in 410.00	470,000	470,000
430.00	Bleach Plant	incl. in 410.00	1,200,000	1,200,000
450.00	Evaporator Plant	incl. in 460.00	200,000	200,000
460.00	Recovery Boiler Plant	200,000	960,000	1,160,000
470.00	Causticizing Plant	50,000	300,000	350,000
611.00	Chloralkali Plant	30,000	870,000	900,000
850.00	Pulp Flash Drying Plant	40,000	500,000	540,000
890.00	Warehouse	40,000	40,000	80,000
	Total	$ 1,600,000	$ 10,050,000	$ 11,650,000
	Construction Overheads			1,350,000
	Engineering and Contingencies			2,000,000
	Total Plant Capital			$ 15,000,000

APPENDIX 4

APPENDIX 4

WORKING CAPITAL AND OPENING-UP EXPENSE ESTIMATES

(P2368/2)

UTILIZATION OF BAGASSE
IN MAURITIUS

DATE 5 DECEMBER 1969

APPENDIX 4 - WORKING CAPITAL AND OPENING-UP EXPENSE ESTIMATES

CASE 1 - 100 ADMTPD BLEACHED PULP MILL

WORKING CAPITAL ESTIMATE

Summary

Item	Rs	US$
Cash Reserve	330,000	60,000
Accounts Receivable	1,970,000	350,000
Inventories	4,050,000	730,000
Prepaid Expense	580,000	100,000
Total	6,930,000	1,240,000
Accounts Payable	830,000	150,000
Total Working Capital	6,100,000	1,090,000

Details

Inventories		Rs	US$
- Bagasse	- 7 months	1,310,000	235,000
- Salt	- 1 month	25,000	5,000
- Sulphuric Acid	- 3 months	5,000	1,000
- Graphite	- 3 months	12,000	2,000
- Burned Lime	- 1 month	60,000	10,000
- Sodium Metabisulphite	- 3 months	58,000	10,000
- Fuel Oil	- 3 months	870,000	157,000
- Other Materials	- 6 months	750,000	135,000
- Finished Products (at cost)	- 1 month	960,000	175,000
- Total Inventories		4,050,000	730,000

WORKING CAPITAL ESTIMATE (Cont'd.)

		Rs	US$
Accounts Receivable			
- 2 months (at cost)		1,970,000	350,000
Prepaid Expenses			
- Insurance		170,000	30,000
- Prepaid Freight	- 2 months	410,000	70,000
Cash Reserve (5% of current assets)		330,000	60,000
Total Current Assets		6,930,000	1,240,000
Accounts Payable		830,000	150,000
Total Working Capital		6,100,000	1,090,000

OPENING-UP EXPENSE ESTIMATE

		Rs	US$
Administrative Salaries			
- Mill Manager	- 18 months	60,000	
- Secretary	- 12 months	8,000	
- Pulp Mill Superintendent	- 12 months	25,000	
- Mill Controller	- 12 months	20,000	
- Chief Engineer	- 12 months	25,000	
- Draughtsman	- 12 months	7,000	
- Remainder	- 2 months	25,000	
		170,000	30,000
Labour	- 2 months	70,000	12,000
General Overhead Expense		25,000	4,000
Payroll Additives			
- Salaried		45,000	7,000
- Labour		10,000	2,000
Management Assistance		930,000	165,000
Total		1,250,000	220,000
Head Office Expense		1,000,000	180,000
Mill Start-Up Expense			
- Chemicals, Specialists Services, Supplies, and Other Expenses		550,000	100,000
Total Opening-Up Expense		2,800,000	500,000

APPENDIX 4 - WORKING CAPITAL AND OPENING-UP EXPENSE ESTIMATES

CASE 2 - 45 BDMTPD PARTICLEBOARD PLANT

WORKING CAPITAL ESTIMATE

Item	Rs	US$
Cash Reserve	85,000	15,000
Accounts Receivable	700,000	125,000
Inventories	850,000	150,000
Prepaid Expense	215,000	40,000
Total	1,850,000	330,000
Accounts Payable	250,000	45,000
Total Working Capital	1,600,000	285,000

Details

Inventories			
- Bagasse	- 7 months	No Value	No Value
- Urea-Formaldehyde Resin	- 3 months	350,000	62,000
- Fuel Oil	- 3 months	65,000	12,000
- Other Materials	- 6 months	85,000	15,000
- Finished Products (at cost)	- 1 month	350,000	61,000
- Total Inventories		850,000	150,000
Accounts Receivable			
- Export Market	- 2 months (at cost)	700,000	125,000
Prepaid Expenses			
- Insurance		55,000	10,000
- Prepaid Freight	- 2 months	160,000	30,000
Cash Reserve (5% of current assets		85,000	15,000
Total Current Assets		1,850,000	330,000
Accounts Payable		250,000	45,000
Total Working Capital		1,600,000	285,000

OPENING-UP EXPENSE ESTIMATE

		Rs	US$
Administrative Salaries			
- Plant Manager	- 12 months	30,000	
- Secretary	- 12 months	8,000	
- Board Plant Superintendent	- 6 months	10,000	
- Controller	- 6 months	10,000	
- Chief Engineer	- 12 months	20,000	
- Draughtsman	- 12 months	7,000	
- Remainder	- 2 months	15,000	
- Total		100,000	18,000
Labour	- 2 months	20,000	4,000
General Overhead Expense		10,000	2,000
Payroll Additives			
- Labour		5,000	1,000
- Salaried		30,000	5,000
Management Assistance		685,000	125,000
Total		850,000	155,000
Head Office Expense		750,000	135,000
Mill Start-Up Expense			
- Chemicals, Specialists Services, Supplies, and Other Expense		300,000	50,000
Total Opening-U Expense		1,900,000	340,000

APPENDIX 4 - WORKING CAPITAL AND OPENING-UP EXPENSE ESTIMATES

CASE 3 - INTEGRATED 100 ADMTPD BLEACHED PULP MILL AND 45 BDMTPD PARTICLEBOARD PLANT

WORKING CAPITAL ESTIMATE

Summary

Item	Rs	US$
Cash Reserve	390,000	70,000
Accounts Receivable	2,500,000	450,000
Inventories	5,220,000	940,000
Prepaid Expense	790,000	140,000
Total	8,900,000	1,600,000
Accounts Payable	1,100,000	200,000
Total Working Capital	7,800,000	1,400,000

Details

		Rs	US$
Inventories			
- Bagasse	- 7 months	1,600,000	290,000
- Salt	- 1 month	25,000	5,000
- Sulphuric Acid	- 3 months	5,000	1,000
- Graphite	- 3 months	12,000	2,000
- Burned Lime	- 1 month	60,000	10,000
- Sodium Metabisulphite	- 3 months	58,000	10,000
- Urea-Formaldehyde Resin	- 3 months	350,000	63,000
- Fuel Oil	- 3 months	990,000	175,000
- Other Materials	- 6 months	870,000	155,000
- Finished Products (at cost)	- 1 month	1,250,000	229,000
- Total Inventories		5,220,000	940,000

WORKING CAPITAL ESTIMATE (Cont'd.)

		Rs	US$
Accounts Receivable			
Allowance	- 2 months	2,500,000	450,000
Prepaid Expense			
- Insurance		220,000	40,000
- Prepaid Freight	- 2 months	570,000	100,000
Cash Reserve (5% of current assets)		390,000	70,000
Total Current Assets		8,900,000	1,600,000
Accounts Payable		1,100,000	200,000
Total Working Capital		7,800,000	1,400,000

OPENING-UP EXPENSE ESTIMATE

		Rs	US$
Administrative Salaries			
- Mill Manager	- 18 months	60,000	
- Secretary	- 12 months	8,000	
- Pulp Mill Superintendent	- 12 months	25,000	
- Board Plant Superintendent	- 6 months	10,000	
- Controller	- 12 months	20,000	
- Chief Engineer	- 12 months	25,000	
- Draughtsman	- 12 months	7,000	
- Remainder	- 2 months	25,000	
Labour	- 2 months	90,000	16,000
General Overhead Expense		40,000	8,000
Payroll Additives			
- Salaried		55,000	10,000
- Labour		15,C00	3,000
Management Assistance		1,220,000	220,000
Total		1,600,000	290,000
Head Office Expense		1,200,000	210,000
Mill Start-Up Expense			
- Chemicals, Specialists Services, Supplies, and Other Expenses		800,000	150,000
Total Opening-Up Expense		3,600,000	650,000

APPENDIX 5

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APPENDIX 5

ILLUSTRATIONS

(P2368/2)

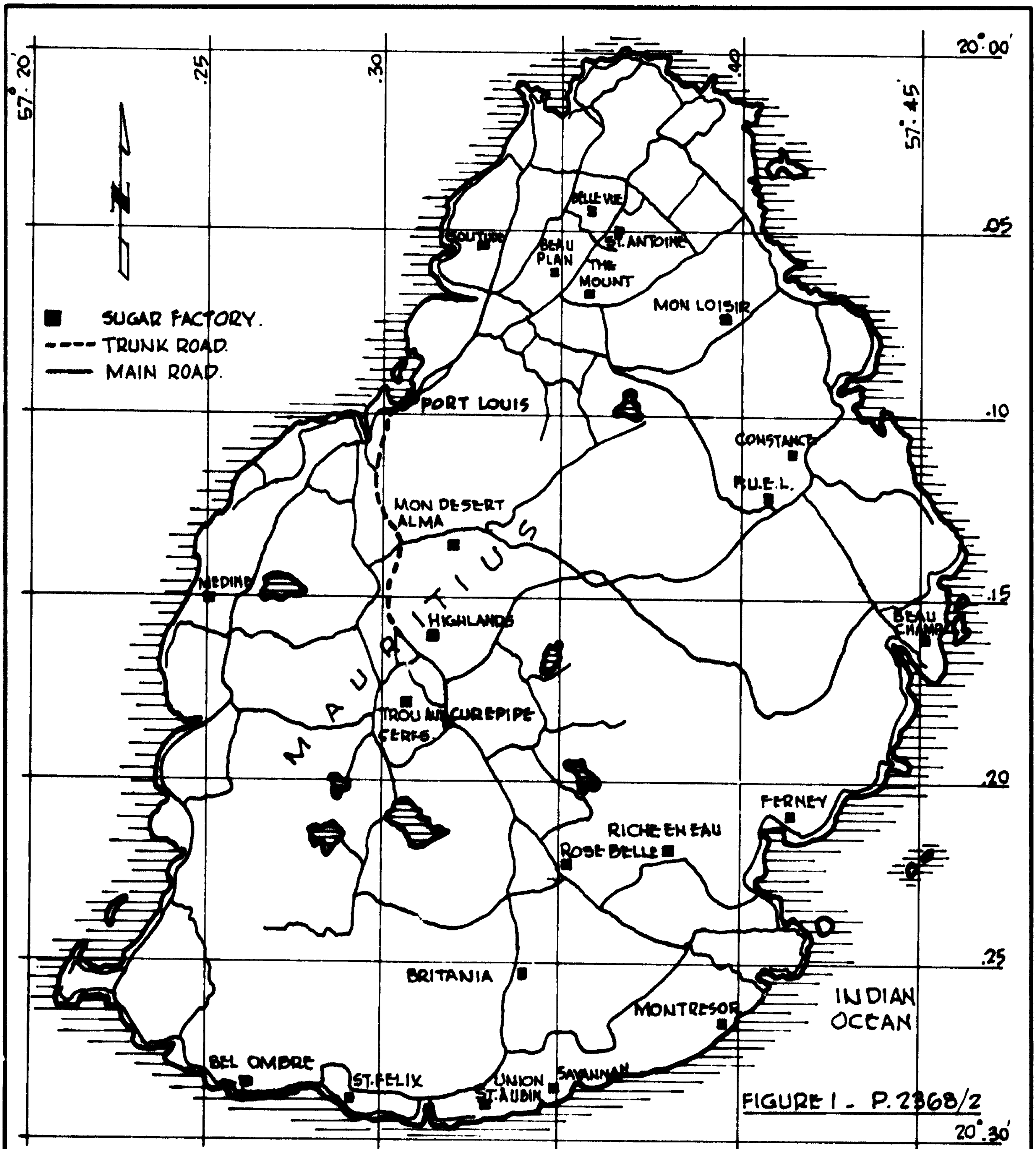

FIGURE 1 - P.2368/2

DWG. No.	REFERENCE	REF. No.	REV.	BY	DATE	REVISION	APP'D.

APPROVED	SCALE	—	DAY	MO.	YR.
DATE	DR'N.	G.W.	16	9	69
	CH'K'D.				
A	APP'D.				
	APP'D.				

UTILIZATION OF BAGASSE

PART 2. UTILIZATION OF BAGASSE IN MAURITIUS

LOCATION MAP

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UNITED NATIONS
NEW YORK. N.Y.

DWG. A. 2368 - 6 REV

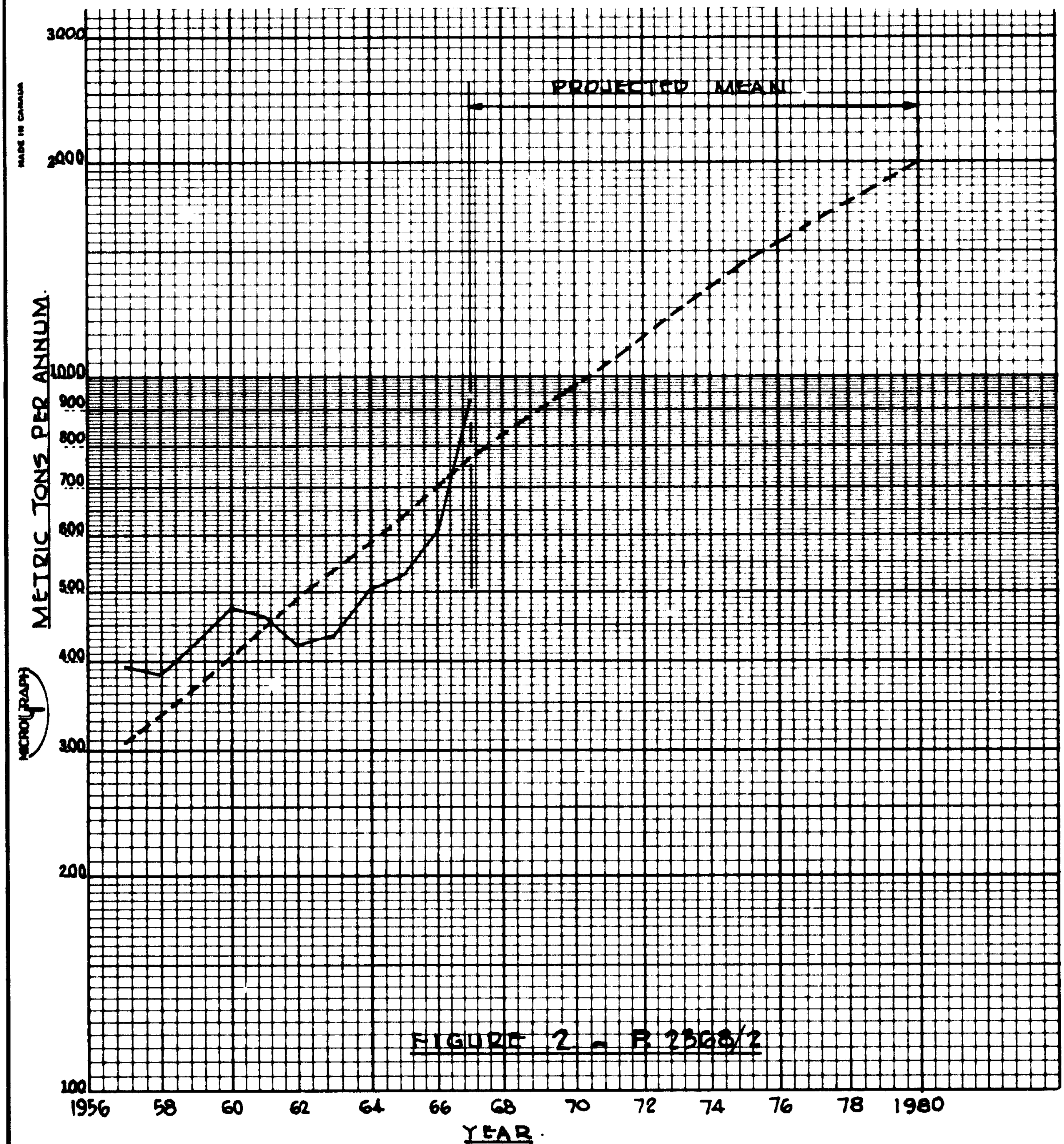

FIGURE 2 - R 2368/2

DWG. No.	REFERENCE	REF. No.	REV.	BY	DATE	REVISION	APP'D.

			DAY	MO.	YR.
APPROVED	SCALE	—			
DATE	DR'N.	G.W.	17	9	69
	CH'K'D.				
A	APP'D.				
	APP'D.				

UTILIZATION OF BAGASSE.

POTENTIAL BAGASSE PULP CONTENT IN CULTURAL PAPER PRODUCTS.

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DWG. A.2368 - 7 REV

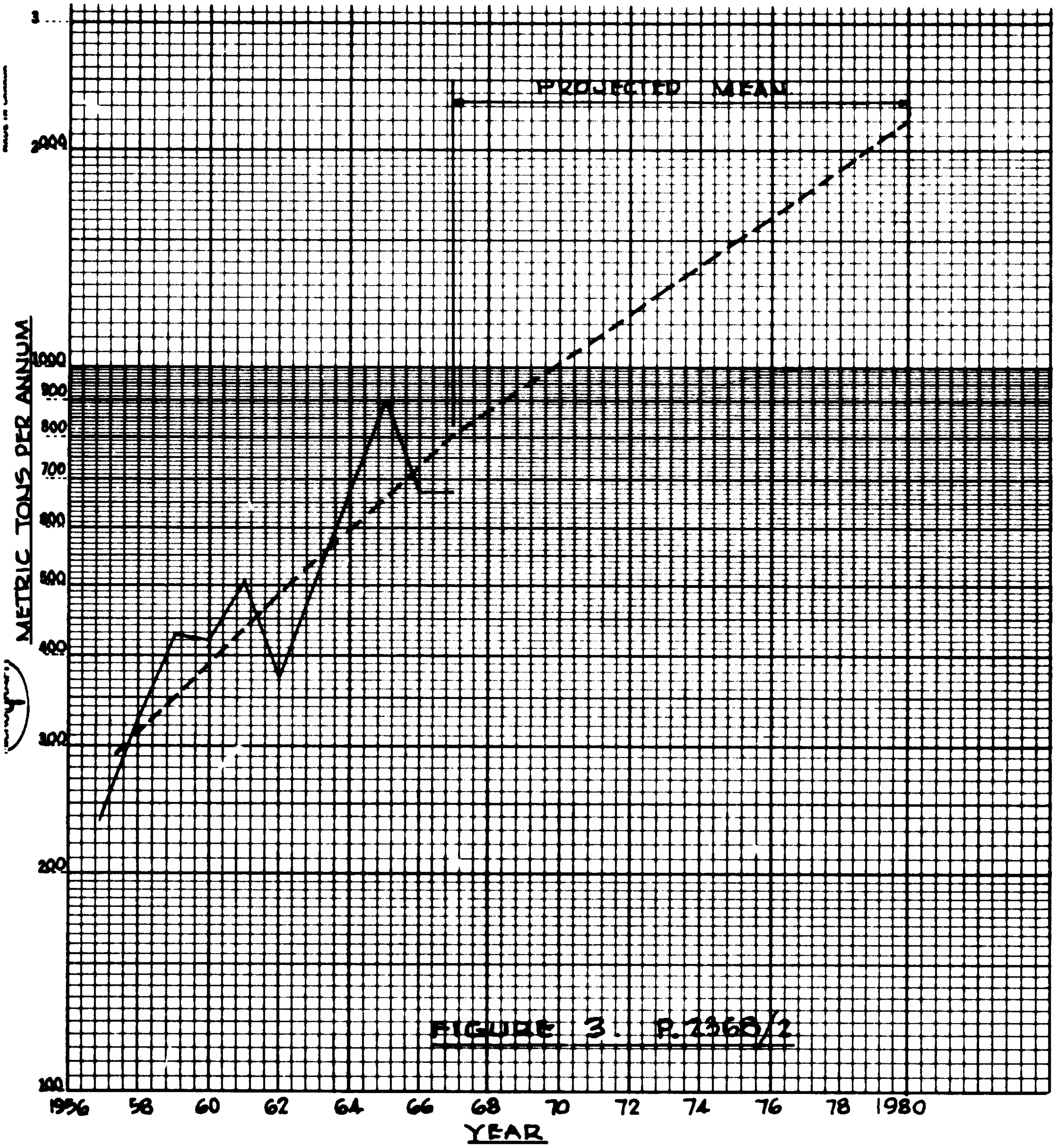

FIGURE 3. F.2368/2

DWG. No.	REFERENCE	REF. No.	REV.	BY	DATE	REVISION	APP'D.

			DAY	MO.	YR.
APPROVED	SCALE	—			
DATE	DR'N.	G.W.	18	9	69
	CH'K'D.				
A	APP'D.				
	APP'D.				

UTILIZATION OF BAGASSE

POTENTIAL BAGASSE PULP CONTENT IN INDUSTRIAL PAPER PRODUCTS IN MAURITIUS

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DWG. A.2368 - 8 REV

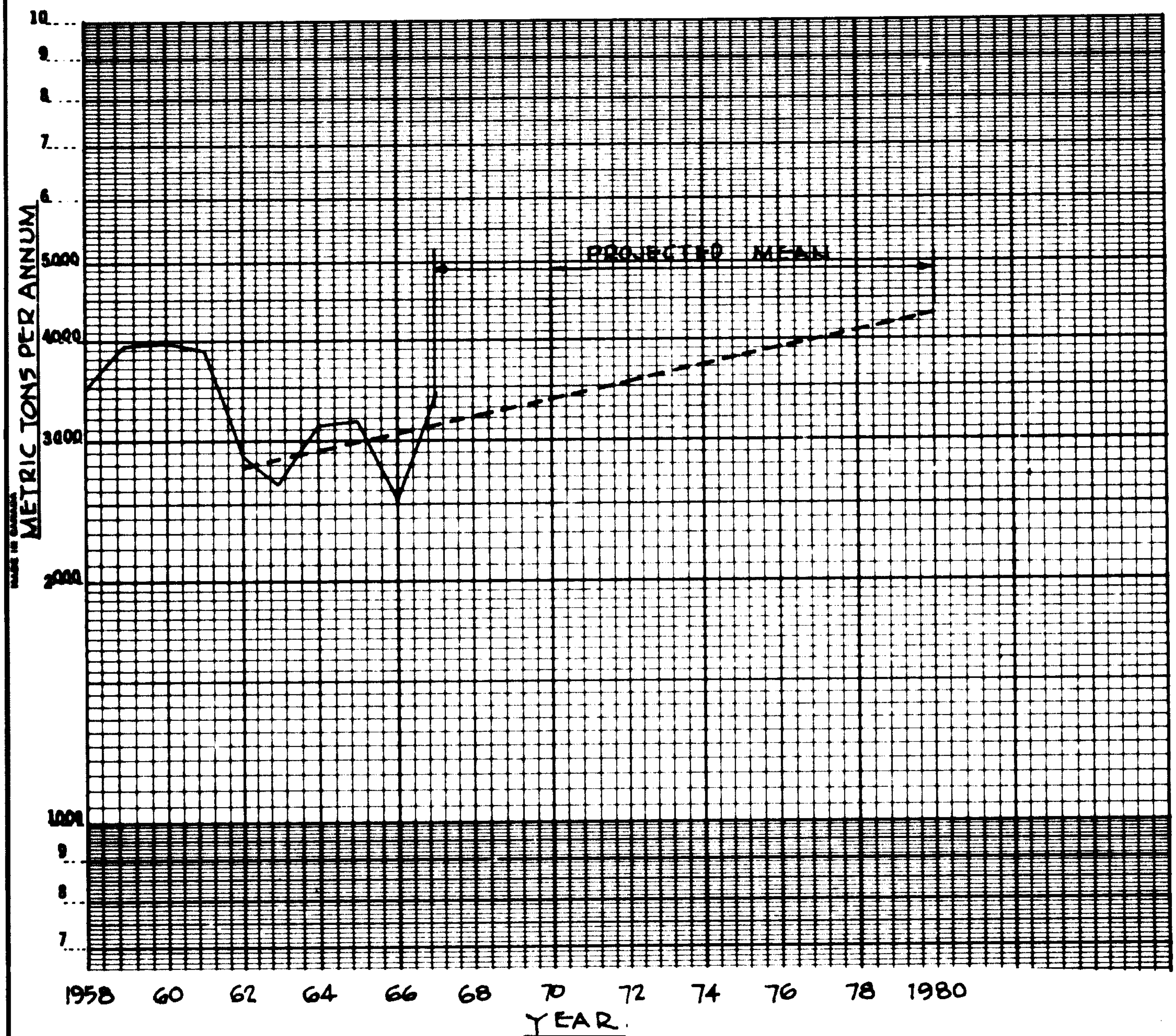

FIGURE 4 - P. 2368/2.

DWG. No.	REFERENCE	REF. No.	REV.	BY	DATE	REVISION	APP'D.

APPROVED	SCALE	—	DAY	MO.	YR.	UTILIZATION OF BAGASSE.
DATE	DR'N.	G.W.	18	9	69	REQUIREMENT OF PARTICLE BOARD TO REPLACE
	CH'K'D.					VARIOUS IMPORTED BUILDING PRODUCTS.
A	APP'D.					
	APP'D.					

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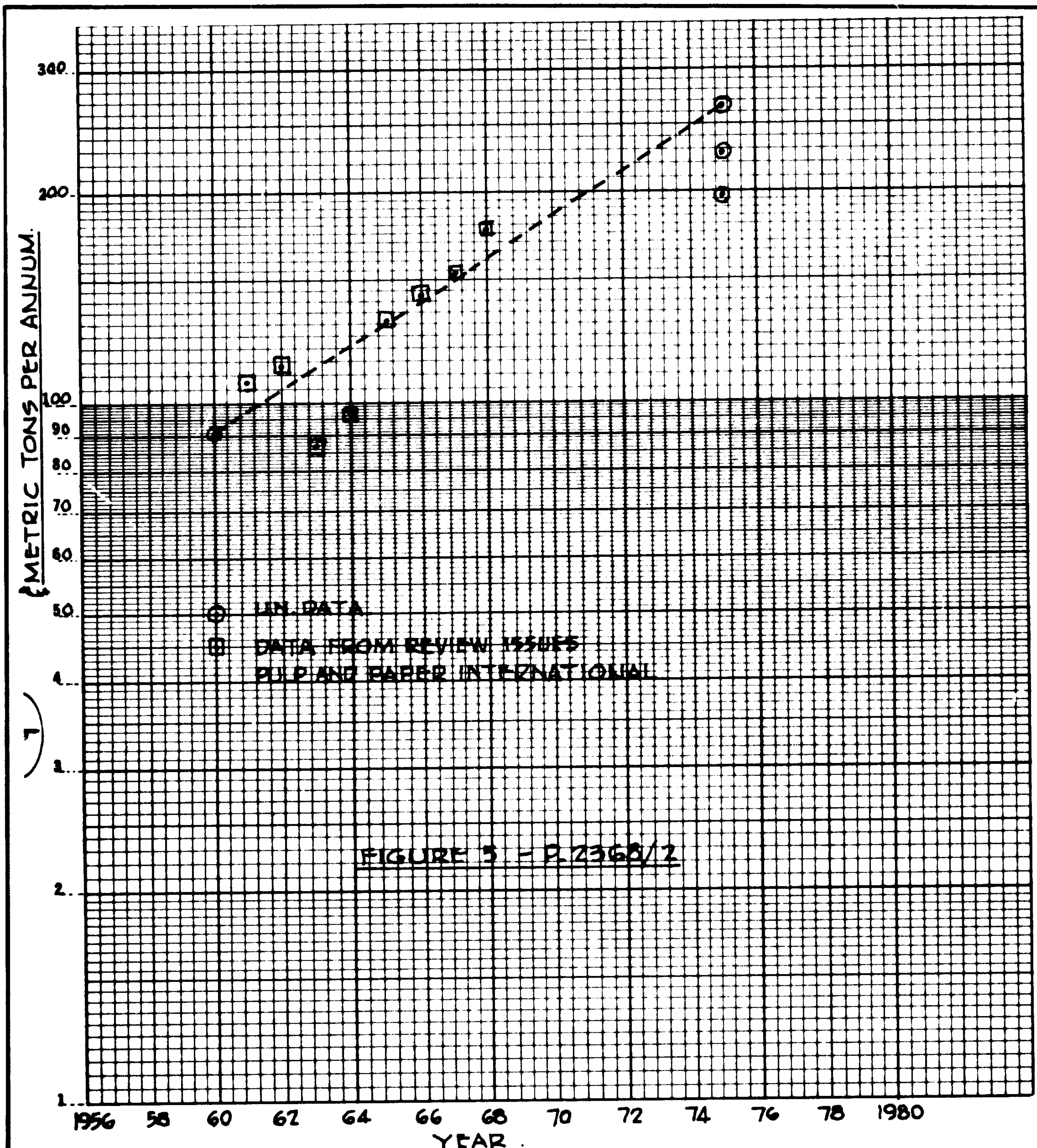
DWG. A. 2368 - 9 REV



DWG. No.	REFERENCE	REF. No.	REV.	BY	DATE	REVISION	APP'D.

APPROVED

DATE

A

		DAY	MO.	YR.
SCALE	—			
DR'N.	G.W.	19	9	69
CH'K'D.				
APP'D.				
APP'D.				

UTILIZATION OF BAGASSE

PAPER AND BOARD REQUIREMENTS IN EAST AFRICA.

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DWG. A.2368 - 10 REV

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