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KENYA

Technical report: Development of the pulp and paper industry in Kenya
Part II: Report on the feasibility of producing fine paper from bagasse in Kenya*

Prepared for the Government of Kenya
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of T. Jeyasingam,
consultant on pulp and paper

United Nations Industrial Development Organization

* This document has been prepared without formal editing.

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ABBREVIATIONS

ADT	AIR DRY TON
ADTPY	AIR DRAY TON PER YEAR
BDT	BONE DRY TON
BL	BLEACHED
CEH	CHLORINE/CAUSTIC EXTRACTION/HYPO
CEHH	CHLORINE/CAUSTIC EXTRACTION/HYPO/HYPO
D.D.	DOUBLE DISC
FTPY	FINISHED TONS PER YEAR
GCV	GROSS CALORIC VALUE
GSM	GRAMS PER SQ.METER
KW	KILOWATT
KSHS.	KENYA SHILLINGS
M^3	CUBIC METER
MPM	METERS PER MINUTE
MM	MILLIMETER
MWH	MEGA WATT HOUR
NCV	NET CALORIC VALUE
OD	OVEN DRY
T	TON
TPD	TONS PER DAY
TPH	TONS PER HOUR
US$	US DOLLAR
WT	WEIGHT

EXPLANATORY NOTES

Value of the local currency - KENYAN SHILLING (K.Shs.) during the period of the mission in terms of United States Dollars:

1 US$ = 15.00 K.Shs.

ABSTRACT

This Report presents the results of a Study of using the bagasse and "Cane Tops" of Mumias to produce writings, printings and machine coated paper.

It is concluded about 10,000 TPY of Fine Paper could be produced from "Surplus Bagasse" and about 20,000 TPY from "Cane Tops". making a total of 30,000 TPY or 100 TPD.

The total capital investment needed would be KShs.523,447,000 (Exclusive of Working Capital). The Return on Investment is estimated at 31.2%.

It is recommended that serious consideration is given to implement the project and a further study is conducted in close collaboration with Mumias Sugar Mill in respect of the following:

- Obtaining surplus bagasse by introducing energy conservation programmes and adopting other measures.
- Producing invert Sugar and obtaining fibre from Cane Tops.
- Collecting Cane Tops independent of Invert Sugar production to obtain the needed fibrous material for paper.

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ANNEXES

RECOMMENDATIONS

1. A high demand in writings and printings is predicated due to the high emphasis given to education and the need for more exercise books and text books.

2. The capacity of the existing mill to produce writings, printings and newsprint on one single machine of 33,000 TPY is not sufficient for future requirements.

3. It will be necessary to plan and implement a second mill to produce fine grades of paper immediately.

4. The proposed second mill will have to also include the manufacture of machine coated grades to meet the needs of text book publishers and magazine printers.

5. It is recommended the proposed second mill is based on bagasse, as wood supply for the paper industry is in short supply.

6. The proposed location of the second mill would be Mumias. Since this is the largest sugar mills in Kenya and it is possible to get surplus bagasse by adopting both energy conservation measures as well as by planting sugar cane with higher fibre content.

7. It is also possible to use the cane tops which are presently discarded in the sugar field to produce invert sugar and release the fibrous material for the paper mill.

8. The proposed fine paper mill at Mumias would provide direct employment to 680 persons and indirect employment to several hundreds in the collection, handling and transport of cane taps.

9. The project besides giving benefits as outlined above is economically attractive for investment with a ROI of 31.2%.

10. If the study is accepted it is recommended a further detailed study is made of the project.

1.0 INTRODUCTION

Kenya currently has 5 paper mills operating with a total installed capacity of 85,600 TPY of paper and paper board. The afore-mentioned 5 mills have plans to expand to 125,400 TPY within the next 2 to 3 years.

The indigenous pulping capacity is only 58,000 tons of chemical pulp and 8,000 tons of mechanical pulp per year at PANAFRICAN PAPER MILLS, WEBUYE. Therefore, the other 4 mills depend mostly on waste paper for their fibre requirements. The supply of raw material for the PANAFRICAN PAPER MILLS is based on PINE AND CYPRESS from "Man-made plantations". There will be a further demand on this source of supply when the proposed MADHU PAPER MILLS at THIKA goes into production. This mill at THIKA will require wood to produce about 20,000 TPY of chemical pulp.

It is feared Kenya is heading towards a shortage of wood and in particular for domestic fuel requirements both in the form of firewood and wood charcoal. It is, therefore felt at this stage further planning of pulp and paper mills based on wood does not look promising with only 20% of the land area available in Kenya both for agriculture as well as forestry. On the other hand Kenya needs more paper. The demand for paper during the last 5 years has been growing at the rate of 5%. It is expected the future growth will be around 6 to 7%, with a high demand for cultural grades of paper on account of the growth in school going population.

The Department of Industries in the Ministry of Commerce and Industry, sensing this problem, initiated the need for a study to look into the

aspect of using non wood materials for pulp and paper manufacture. To conduct this study a pulp and paper expert was requested from UNIDO. He arrived on 9 November 1984 for a three-month assignment in Kenya.

The following report is Part II of the investigations and studies related to the use of non-woody raw materials for the production of pulp and paper, made up into five parts:

PART I	-	Development of the Pulp and Paper Industry in Kenya
PART II	-	A Report on the Feasibility of Producing Fine Paper from Bagasse
PART III	-	A Report on the Feasibility of Producing Hard Tissues From Sisal Waste
PART IV	-	A Report on the Feasibility of Producing Corrugating Medium From Straw
PART V	-	A Report on the Feasibility of Producing Hand Made Paper from Cotton Waste.

2.0 BASIS OF STUDY

The basis of this Study is to produce fine paper such as writings and printings from bagasse at MUMIAS.

The only mill that produces writings and printings in Kenya is PANAFRICAN PAPER MILLS. This is done on a single Fourdrinier machine of capacity 33,000 TPY. From 1984, it has added to its range of production, besides writings and printings, the production of Newsprint on this machine.

With the emphasis given by the Government for more and better education, there is an increase in the school going population. In consequence there is a high demand for exercise books, note books, drawing books, text books etc.

Even though PANAFRICAN, have plans to add a third machine, the consumer demand for paper as forecast in PART I of this report with a growth rate of 6% per year will necessitate the planning of a second mill to produce fine papers. In addition to fine papers the proposed mill would also produce machine coated printings which is so far not manufactured in Kenya.

PANAFRICAN's production of fine paper is based on wood; which is now in short supply (See PART I of Report - woody materials). For this reason, the study for the proposed mills is based on the production of Fine papers using bagasse.

2.1 LOCATION

Bagasse is a bulky material and fresh bagasse contains about 48 to 50% moisture. Therefore the transport of bagasse could prove to be expensive. To avoid high transport cost, the location recommended is a site close to the MUMIAS Sugar factory, so that the bagasse could be conveyed by conveyor belt after wet depithing to the paper mill.

The other advantages in locating a paper mill close to the sugar mill are sharing of Service facilities such as steam and electric energy. By the sharing of a common facility the Thermal and Electric energy utilization efficiency would be much higher for both the Sugar mill as well as the paper mills. This would be discussed further under Electric Power Supply.

2.2 CAPACITY

The capacity considered for the proposed mills is 30,000 TPY. This production would be handled on a single fourdrinier machine. The capacity of 100 TPD or 30,000 TPY is selected to give the optimum size for the project.

2.3 BAGASSE SUPPLY

Bagasse is not normally available from Sugar mills as it is used by the Sugar mills to generate steam and electricity for sugar processing, to operate the crushers, evaporate the sugar juice etc. The basis on which bagasse could be made available to the paper mills were discussed under PART I of this report. The calculations pertaining to this basis and the specifics to this project are given in Appendix 6 of this report.

It could be noted there are 4 ways open for bagasse to get released for the paper industry:

(1) Fuel Replacement Bagasse
(2) Surplus Bagasse
(3) Use of Cane Tops
(4) Planting cane with high fiber content.

2.4 FUEL REPLACEMENT BAGASSE

In the case of Mumias the possibility of obtaining Fuel replacement bagasse was examined as per calculations and formula shown in Appendix 6. It will be noted at a fuel* price of US$ 160/Ton or KShs. 2,400 /Ton the cost of bagasse for the paper mill would be KShs.997/ Ton of OD bagasse.

* Fuel oil of GCV 10,000 K cal/kg

This when compared to the price of wood at KShs. 450/BDT is too expensive for the paper industry and has to be therefore ruled out.

2.5 SURPLUS BAGASSE

The price of surplus bagasse applying the formula as shown in Appendix 6 works out to KShs. 78/- per ton OD bagasse. This is quite attractive to the paper mill, but the quantity that could become available at Mumias works out to only 22,750 OD ton/year as good fibre and equivalent to 10,000 tons of Bleached Pulp. This quantity therefore has to be supplemented by the use of "cane tops" as per details given below:

2.6 USE OF CANE TOPS

About 30% of the cane stem is now allowed to rot in the fields. This is because it is not economical to crush this part of the cane due to poor sucrose content. In other parts of the world the cane tops have a use as cattle fodder. In Kenya the cane tops have no value as cattle fodder, because the local cattle is grazed in grasslands.

It is therefore possible to obtain invert sugar from these cane tops in Kenya and release this fibrous material for the paper industry. As per details given in Appendix 6 the quantity of bagasse that would become available by this method would amount to 75,000 tons of OD bagasse equivalent to 20,000 tons of bleached pulp.

By combining both the surplus bagasse and the cane top bagasse a production of 30,000 tons of writings and printings could be achieved at Mumias.

2.7 PRICE FOR CANE TOP BAGASSE

This has to be worked out by a separate study on the economics of producing invert sugar. If this is not feasible it may be even economical for the paper mill to collect this part of the stem and crush it only for the purpose to obtain the fibre. These details have to be worked out through a separate study.

If sufficient interest is shown by an investor in this Study, further details and investigations could be made by UNIDO.

2.8 PLANTING HIGH FIBRE CONTENT SUGAR CANE

Besides obtaining surplus bagasse by applying energy conservation methods as considered above, there is also the possibility to plant such species of cane that would give a higher fibre content without sacrificing the sugar production. The outgrowers therefore must be provided the right incentive to grow those varieties that could produce the surplus fibre for the paper industry. To promote this idea a higher price could be paid for the cane by the Sugar mill and this could be charged to the paper mill. As an example on the 1½ million tons of sugar cane crushed per year at Mumias a 2% increase of fibre content in the cane would yield 30,000 tons of good fibre, equivalent to 13,500 tons of Bleached pulp per year.

2.9 PLANT SITE

The actual selection of a plant site was not made during this study. As pointed out earlier, the plant has to be located very close to MUMIAS SUGAR MILLS so that the bagasse could be conveyed by the belt conveyor. These details could be worked out through a subsequent study.

The land needed together with a housing colony for the key personnel would be about 125 to 150 Ha.

2.10 WATER SUPPLY

The mill will draw its water supply from NZOIA river. A mill such as envisaged would require about 20,000 m^3/day of water initially. Allowing for further expansion possibilities by installing a second machine at a future date the requirements would be 40,000 m^3/day eventually.

2.11 ELECTRIC POWER SUPPLY

The mill would be able to generate about 50 to 55% of its electric energy through co-generation of steam for

process and electric energy for mill motors using its own Turbo generator. It would be therefore necessary to purchase about 45 to 50% of the energy from the national grid.

Another alternative that has to be examined is for the paper mill and sugar mills to have a centralized unit and get into co-generation of both steam and electric energy for both sugar and paper. By doing so there are 2 advantages.

- Reduced cost of heat and electric energy for both sugar and paper production.
- More bagasse would become available for the paper industry as this operation would be more boiler efficient.

In this method of co-generation proposed, the boilers would be rated for high pressure operation of 45 to 50 Kg/ cm^2 with process steam extracted for both sugar and paper at low pressure from the Turbo generator.

The details of such a proposal and the Thermal balance of the two operations (sugar and paper) has to be made through another study. For purposes of this study however it is assumed that bagasse is made available as surplus bagasse and fibre from cane tops as described above, and with the paper mill generating its own steam and electric energy with a separate unit.

The amount of electricity needed totally by the pulp and paper mill would be 4000 Kw as average load and 6,000 Kw as peak load. Allowing for further expansion the total load eventually would be say 10,000 Kw. The mill turbo generator will have an installed capacity of 2.75 MW and an average load of about 2.15 Mw.

2.12 PERSONNEL

The mill would provide direct employment to 590 daily paid employees and 91 salaried personnel.

There would be several nundreds indirectly employed in the collection, handling and supply of cane tops.

2.13 TRAINING

No specialized training in overseas mills is required. Personnel with the required skills could be hired locally and this would be supplemented by foreign experts who would provide the know how for a period of 1 to 2 years through the phases of commissioning, Start up and commercial operation.

On-the-job training under local conditions carried out by selected experts is condsidered to be the best for this type of project, rather than getting trained in an overseas mill where the operating conditions are different.

2.14 TRANSPORT

Mumias is well linked both by road as well as by rail up to Butere and this should facilitate access to the market and facilitate supply of incoming raw materials and chemicals to the mills.

2.15 GRADES OF PAPER

The grades of paper that will be produced would be mainly, writings for school exercise books, printings for text books, and machine coated printing grades.

On account of the development in printing technology, machine coated printing grades are in high demand. At the moment there are no facilities to produce this grade of paper in Kenya. An off machine coater is presently under installation in Nairobi but this unit would not be able to produce the cheap coated printing and cannot be competitive in price to paper machine coated paper.

The machine coated grades are required both for textbooks as well as for printing magazines and journals where high reproduction characteristics are required for printing at high speeds.

3.0 MILL PROCESSING SYSTEM

The mills would be designed to produce 30,000 TPY of writings, printings and machine coated paper. The bleached pulp produced would be from bagasse using the soda process.

3.1 BAGASSE PREPARATION

The equipment needed would consist of depithing, cleaning, cutting and conveying equipment to convey the bagasse from the preparation area to the digesters.

The study presently provides for a dry cleaning system, but at the time of working out the details during the subsequent study, a wet cleaning system would be also considered.

3.2 PULPING, WASHING AND SCREENING

Caustic Soda process would be applied and KRAFT PROCESS is not considered to keep sulphur emissions out.

The pulping process would employ batch type of digesters and direct steaming to make the equipment flexible to operate and maintain.

Washing would be conducted in counter current vacuum washers set for 4 stage operation.

Screening would employ Johnsson Screens for coarse Screening and Pressure Screens for fine Screening. The final cleaning would be done in centrifugal cleaners arranged in 4 stages.

The cleaned pulp will be raised to a consistency of 12% and stored in H.D. Towers.

3.3 BLEACHING

This would employ a CEHH Sequence using inter-stage vacuum washers. Chlorine dioxide is avoided.

3.4 CHEMICAL RECOVERY AND CHEMICAL PREPARATION

The pulp mill would be provided with Multiple Effect Evaporators and 6 effects, a chemical recovery boiler, causticizing equipment and lime kiln.

3.5 CAPTIVE CAUSTIC SODA AND CHLORINE PRODUCTION PLANT

The mill would operate a captive Caustic Soda and Chlorine plant to produce its own requirements of Caustic Soda and Chlorine.

3.6 STOCK PREPARATION

There would be two lines one for the mechanical treatment of Bagasse pulp and the other for KRAFT Wood Pulp. The lines will be balanced to use 80% bagasse pulp and 20% kraft pulp as long fibre.

DD refiners or wide angled conical refiners would be used for bagasse pulp so as to prevent the cutting action to the fibre.

Kraft pulp would be processed using a pulper followed by D.D. refiners.

Magnetic stock flow proportioners would be used to blend the fibrous stock.

3.7 PAPER MACHINE

The paper machine would be a "FOURDRINIER" capable of producing fine paper of B.wt. 30 to 120 GSM. It will carry features such as:-

- Hydraulic Head Box
- Press system incorporating pick up and a Bi-Nip or Tri-Nip press.
  Use of Crown controlled rolls etc.
- Drying system with enclosed gear drive, central lubrication, totally enclosed hood, pocket ventilation, heat recovery etc.
- A single calender stack with 7 Rolls and with high Nip pressure and combined with CC Rolls at 2 positions.
- Sectional electric drive for the wet end, calender and reeler.
  Line shaft drive by Turbine for the dry end and with exhaust steam to the dryer group.

3.8 FINISHING DEPARTMENT

The equipment supply would consist of sheeters, trimmers, rewinders and super calender.

3.9 SERVICES

Steam would be made available mainly through the chemical recovery boiler, with the power boiler available for stand by operation. The boilers would be rated for a high pressure of 45 to 50 Kg/cm^2 so that a Turbo generator could be worked with extracted steam for process.

The boilers would be rated for 35 TPH and the average load would be about 25 TPH.

3.10 ELECTRIC POWER

The mill Turbo generator would be rated for 2.75 to 3 MW. The extra power needed by the mill would be purchased from the National grid or from Mumias Sugar Mill if the Thermal balance of the sugar mill would permit such a possibility and then release the surplus bagasse to the paper mill.

3.11 WATER TREATMENT

The mill would need water treatment and would be equipped with a CLARI-FLOCULATOR and rapid gravity sand filters. The mill would require initially 20,000 m^3/ 24 Hrs.

3.12 WORKSHOP

Since Mumias Sugar Mills has an upto date large workshop with a foundary, an elaborate workshop for the paper mills may not be necessary. The equipment that would be needed would be greatly reduced to save capital expenditure.

3.13 EFFLUENT TREATMENT

The effluent will undergo the necessary treatment to satisfy both Kenyan as well as International standards so that the effluent could be safely discharged to the accepting water.

This treatment will consist of primary treatment followed by secondary treatment. Aerators would be used and holding lagoons provided to meet the required standards so that the aquatic life is not endangered.

3.14 HOUSING, WELFARE AND CANTEEN

The essential personnel will be provided housing facilities. This will include key operators and maintenance personnel.

First aid post as well as a medical dispensary would be provided.

Canteen facilities, and Recreation amenities would be made available.

4.0 COST ESTIMATES

4.1 THE MANUFACTURING COST ESTIMATES

Details of the manufacturing cost estimates are given under Appendix 2. A summary of the estimates is produced here below:

	Item	Amount/year KShs.
-	Bagasse	16,005,000
-	Kraft (Wood Pulp)	59,850,000
-	Chemicals	27,200,000
-	Fuel Oil	26,664,000
-	Other Materials	16,000,000
-	Purchased Electric Power	8,100,000
-	Labour	8,368,000
-	Administration and Overhead	9,181,000
-	Contingencies	2,570,000
-	Total	173,938,000

The data employed for calculating the manufacturing cost estimates is given under APPENDIX 1. The staff, labour and overhead expenses are all estimated and the details could be found under various estimates in APPENDIX - 2.

4.2 CAPITAL COST ESTIMATES

Preliminary estimates of capital costs for the proposed mill are contained in APPENDIX 3 and are summarized below:

ITEM	AMOUNT IN K.SHS.
- STRUCTURES	101,238,000
- EQUIPMENT	252,759,000
- CONSTRUCTION EXPENSES	55,660,000
- ENGINEERING AND CONTINGENCIES	50,600,000
- TOTAL PLANT CAPITAL	460,257,000
- WORKING CAPITAL	48,399,000
- INTEREST DURING CONSTRUCTION	-
- DUTY	63,190,000
TOTAL INVESTMENTS	571,846,000

The capital cost estimates contained in this report have been based on data from previous projects of similar nature. They are therefore approximate values as they were not obtained based on tender offers or quotations. For the purpose of this study they are considered to be sufficiently accurate.

If this study is accepted in principle a futher study has to be conducted to establish the actual capital requirements.

The duty has been assumed for this study at 25%. It is conceivable that the invester might be able to bring the plant and machinery into the country duty free on the basis that the equipment when operating would save foreign exchange to the country.

STRUCTURES

The cost of structures includes all buildings and civil works.

EQUIPMENT

The equipment used would be well designed and adapted to produce high quality fine papers from bagasse pulp. The design features will employ methods to conserve heat, electric energy and water.

Although the latest technology would be applied, the system would be suitably adapted to provide the appropriate technology to suit the local conditions in Kenya.

CONSTRUCTION OVERHEAD

An allowance has been made to provide the following:

Job management and supervision, accounting, purchasing, expediting, miscellaneous labour cost such as job clean up, unloading, handling and storing of equipment and material, establishment and operation of a construction camp, temporary workshop and services and the rental and maintenance of construction equipment.

ENGINEERING AND CONTINGENCIES

The amount included in the estimates are for engineering services including field surveys and investigations, calling of tenders, and recommendations for equipment supply, preparations of contract documents, detailed design, the preparation of detailed drawings and specifications for construction, engineering supervision of contract work and assistance with operation during the start up period.

An allowance has been included for contingencies to provide for items of cost presently unforeseen, the need for which may become apparent only during the detail design,

construction or preliminary operating stages of the project. This allowance is not intended to provide for changing currency exchange rates or for inflationery changes in the costs of equipment material and labour.

INTEREST DURING CONSTRUCTION

No provision has been made, on the assumption that purchasing would be done on a deferred payment basis.

WORKING CAPITAL

Estimates are shown under Appendix 4 and covers all raw materials, chemicals, fuel etc.

DUTY

This has been calculated on the basis of 25%.

CURRENCY RATE

At the time of writing this report 1 US$ = 15 Kenyan Shillings and this conversion rate was applied.

4.3 EARNINGS ESTIMATE

Product sales prices have been recorded under Appendix 2. From these figures and the estimated annual manufacturing costs, the gross annual profit and the return on investment were determined as given in APPENDIX 5. A summary of this calculation is given below:

- ANNUAL MILL NET SALES	-	337,500,000
- ANNUAL DIRECT MFG.COST	-	173,938,000
- GROSS PROFIT BEFORE DEPRECIATION AND INTEREST	-	163,562,000
- CAPITAL INVESTMENT EXCLUDING WORKING CAPITAL	-	523,447,000
- GROSS RETURN ON INVESTMENT	-	31.2%

The gross return has been calculated on the investment excluding working capital, since it has been assumed that the working capital would be obtained as a short-term bank loan to be repaid out of initial earnings.

The earnings estimate indicate a gross return of 31.2% on the investment.

ANNEX 1

COST DATA

	ITEM	UNIT	AMOUNT
-	Bagasse	Sh/ADT	300
-	Wood Pulp Bl. Kraft	Sh/ADT	9,000
-	Caustic Soda	Sh/T	4,800
-	Chlorine	Sh/T	2,900
-	Limestone	Sh/T	150
-	Alum	Sh/T	3,600
-	Size	Sh/T	10,000
-	Talc	Sh/T	2,200
-	Fuel Oil	Sh/T	2,400
-	Electric Energy	Sh/MWH	600

ANNEX 2

MANUFACTURING ESTIMATES

SUMMARY

ITEM	UNIT	AMOUNT
RAW MATERIALS		
- Sales Paper	- TPPY	30,000
- Bagasse (Clean and depithed)	- ADTPY	53,350
- Wood Pulp (Bl Kraft)	- ADTPY	6,650
CHEMICALS		
- Caustic Soda	- TPY	1,250
- Chlorine	- TPY	1,920
- Lime Stone	- TPY	1,680
- Alum	- TPY	1,050
- Size	- TPY	500
- Talc	- TPY	3,000
- Fuel Oil (Steam)	- TPY	8,350
- Fuel Oil (Kiln)	- TPY	2,760
- ELECTRIC ENERGY (TOTAL)	- MWH	29,000
ELECTRIC ENERGY (GENERATED)	- MWH	15,500
ELECTRIC ENERGY (PURCHASED)	- MWH	13,500
- WATER	$M^3 \times 1000$	6,000
- Labour		
= Daily Paid	Pers.	590
= Salaried	Pers.	91
= Total	Pers.	681
- ANNUAL OPERATING DAYS	Days	300

ANNEX 2, cont.

MANUFACTURING COST

	ITEM	RATE	COST/YEAR
-	Bagasse	300 Sh./ADT	16,005,000
-	Wood Pulp (Kraft)	9,000 Sh/ADT	59,850,000
	CHEMICALS		
-	Caustic Soda	4,800 Sh/ T	6,000,000
-	Chlorine	2,900 Sh/ T	5,568,000
-	Lime Stone	150 Sh/ T	252,000
-	Alum	3,500 Sh/ T	3,780,000
-	Size	10,000 Sh/ T	5,000,000
-	Talc	2,200 Sh/ T	6,600,000
-	Fuel Oil (Steam)	2,400 Sh/ T	20,040,000
-	Fuel Oil (Kiln)	2,400 Sh/ T	6,624,000
-	Electric Energy (Purchased)	600 Sh/MWH	8,100,000
-	Other Materials		16,000,000
-	Labour		8,368,000
-	Administration and Overhead		9,181,000
			171,368,000
	CONTINGENCIES		2,570,000
			173,938,000

ANNEX 2, cont.

ESTIMATE 1

PAPER MACHINE

	ITEM	UNIT	AMOUNT
-	Basis Wt. Range	GSM	120 - 30
-	Wire Width	MM	4,900
-	Trim at Winder	MM	4,260
-	Finished Production	TPY	30,000
-	Finishing Losses	%	6
-	Average Machine Production	TPD	110
-	Moisture Content	%	6
-	Fibre Loss	%	3
-	Annual Operating Days	Days	300

ANNEX 2, cont.

ESTIMATE 2

DAILY PAID PERSONNEL

SUMMARY DEPARTMENT	NO. OF Pers.	COST/YEAR
Bagasse Supply	40	384,000
Bagasse Preparation	40	480,000
Digester House	16	326,400
Washing, Screening and Bleaching	20	283,000
Stock Preparation	16	326,400
Paper Machine and Winder	32	556,800
Quality Control and Laboratory	4	33,600
Finishing	120	1,329,600
Dispatch	20	168,000
Chemical Recovery	12	230,400
Lime Kiln	4	67,200
Causticizing	4	67,200
Boiler	12	230,400
Turbine and Power generation	8	192,000
Water Supply and Filteration	8	115,200
Effluent Handling	4	33,600
Engineering and Maintenance	120	2,544,000
Mill Stores	12	100,800
Transport and yard	50	420,000
Mill Office	12	100,800
Housing	6	50,400
Mills Security and Fire Protection	30	324,000
	590	8,368,800

ANNEX 2, cont.

ESTIMATE 3

SALARIED PERSONNEL

POSITION	NO. OF EMPLOYEES	K.SHS. MONTHLY RATE	KSHS. COST/YEAR
ADMINISTRATION			
- MILLS MANAGER	1	24,000	288,000
- MILLS ACCOUNTANT	1	15,000	180,000
- ADMINISTRATIVE AND PERSONNEL OFFICER	1	12,000	144,000
- SUPPLIES OFFICER	1	7,000	84,000
- STORE KEEPER	1	5,000	60,000
- TRANSPORT FOREMAN	1	3,000	36,000
- OFFICE SECRETARIES	6	1,500	108,000
- CLERKS	10	1,200	144,000
- TELEPHONE CUM RECEPTIONIST	1	1,000	12,000
- FIRST AID NURSE	1	1,500	18,000
	24		1,074,000
PRODUCTION			
- PRODUCTION MANAGER	1	20,000	240,000
- PULP SUPERINTENDENT	1	15,000	180,000
- PAPER "	1	15,000	180,000
- CHEMICAL "	1	15,000	144,000
- FINISHING "	1	12,000	1,176,000
- FOREMEN	14	7,000	
	19		2,100,000

ANNEX 2, cont.

ESTIMATE 3

SALARIED PERSONNEL

QUALITY CONTROL

	NO. OF EMPLOYEES	K.SHS. MONTHLY RATE	KSHS. COST/YEAR
CHEMIST	1	12,000	12,000 x 12
ASST. CHEMIST	2	7,000	14,000 x 12
LAB. TESTERS	16	2,500	40,000 x 12
	19		792,000

ENGINEERING AND MAINTENANCE

CHIEF ENGINEER	1	18,000	18,000 x 12
MECHANICAL ENGINEER	1	15,000	15,000 x 12
ELECTRICAL AND POWER PLANT "	1	15,000	15,000 x 12
FOREMEN	12	7,000	84,000 x 12
	15		1,584,000

SALARIED MILL PERSONNEL

TOTAL 77 5,550,000

ANNEX 2, cont.

ESTIMATE 4

SALARIED PERSONNEL

SALARIED HEAD OFFICE PERSONNEL

POSITION	NO. OF EMPLOYEES	MONTHLY RATE	COST/YEAR
GENERAL MANAGER	1	28,000	336,000
CHIEF ACCOUNTANT	1	22,000	264,000
MARKETING MANAGER	1	15,000	180,000
PURCHASING OFFICER	1	10,000	120,000
OFFICE SECRETARIES	4	3,000	144,000
TELEPHONE/RECEPTIONIST	1	1,500	18,000
CLERKS	5	1,200	72,000
	14		1,134,000

ESTIMATE 5

ADMINISTRATION AND OVERHEAD

SUMMARY

ITEM	NO. OF EMPLOYEES	COST/YEAR
SALARIED		
MILL PERSONNEL	77	5,550,000
HEAD OFFICE	14	1,134,000
	91	6,684,000
GENERAL OVERHEAD EXPENSES		
MILLS		1,997,000
HEAD OFFICE		500,000
	TOTAL	9,181,000

ANNEX 2, cont.

SALES ANALYSIS

GRADES	QTY.	SALES PRICE (K.SHS.)	SALES VALUE (K.SHS.)
- * PRINTINGS	15,000	11,250	168,750,000
- WRITINGS	15,000	11,250	168,750,000
			337,500,000

* Including machine coated grades

Conversion Rate 1 US$ = 15 K.Shillings.

ANNEX 3

CAPITAL COST ESTIMATES

SUMMARY

PART 1 - STRUCTURES

	Description	K.Shs. Labour	K.Shs. Material	K.Shs. Total
-	Site	174,000	174,000	348,000
-	Transportation	58,000	174,000	232,000
-	Sewers & Effluent Disposal	116,000	463,000	579,000
-	Fire Protection	-	116,000	116,000
-	Town site	-	-	-
-	Office and Laboratory	-	-	-
-	Mill Stores	58,000	174,000	232,000
-	Workshop	232,000	809,000	1,041,000
-	Fuel oil storage & Handling	58,000	58,000	116,000
-	Water Supply & Distribution	-	-	-
-	Steam " "	809,000	2,544,000	3,353,000
-	Power " "	232,000	809,000	1,041,000
-	Bagasse Handling & Storage	-	-	-
-	Bagasse Preparation	463,000	1,849,000	2,312,000
-	Digester Plant	694,000	2,775,000	3,469,000
-	Washing and Screening	4,335,000	13,121,000	17,456,000
-	Bleaching	Included under washing and screening		
-	Evaporator Plant	112,000	223,000	335,000
-	Lime kiln	195,000	444,000	639,000
-	Causticizing	237,000	515,000	752,000
-	Chemical Recovery Furnace	1,140,000	2,641,000	3,781,000
-	Stock Preparation	1,850,000	4,856,000	6,706,000
-	Paper Machine	8,434,000	26,252,000	34,686,000
-	Finishing	3,236,000	8,670,000	11,906,000
-	Ware House	3,468,000	8,670,000	12,138,000
		25,901,000	75,337,000	101,238,000
				*$ 6,749,200

ANNEX 3, cont.

CAPITAL COST ESTIMATES

PART - 2 - EQUIPMENT

Description	Labour K.Shs.	Material K.Shs.	Total K.Shs.
Site	-	-	-
Transportation	-	694,000	694,000
Sewers and Effluent Disposal	-	-	-
Fire Protection	116,000	925,000	1,041,000
Office and Laboratory	-	350,000	350,000
Mill Stores	-	8,000,000	8,000,000
Workshop	115,000	1,160,000	1,275,000
Fuel Oil Storage & Handling	462,000	1,041,000	1,503,000
Water Supply and Distribution	1,502,000	8,325,000	9,827,000
Steam Supply and Distribution	1,965,000	7,515,000	9,480,000
Power Supply and Distribution	578,000	7,285,000	7,863,000
Bagasse Handling and storage	-	1,156,000	1,156,000
Bagasse Preparation	578,000	3,468,000	4,046,000
Digester Plant	694,000	4,740,000	5,434,000
Washing and Screening	925,000	5,896,000	6,821,000
Bleaching Plant	3,468,000	22,755,000	26,223,000
Evaporator Plant	528,000	5,400,000	5,928,000
Lime Kiln	306,000	4,535,000	4,841,000
Causticizing	278,000	2,502,000	2,780,000
Chemical Recovery	1,975,000	11,436,000	13,411,000
Stock Preparation	4,046,000	22,733,000	26,779,000
Paper Machine	4,394,000	99,700,000	104,094,000
Finishing	462,000	10,751,000	11,213,000
Ware House	Included under Finishing		
	22,392,000	230,367,000	252,759,000
			$ 16,850,600

Conversion 1 US $ = 15 Kenyan Shillings.

ANNEX 3, cont.

PART 3 - CONSTRUCTION EXPENSES

- .	Construction Over Head	55,660,000
-	Engineering & Contingencies	50,600,000
Sub-	Total	K.Shs.106,260,000
	Structures	101,238,000
	Equipment	252,759,000
	Total Plant Capital (Excluding Duty)	K.Shs.460,257,000
		$ 30,683,800

Conversion Rate 1 US$ = KShs.15/-

ANNEX 4

WORKING CAPITAL AND OPENING-UP EXPENSES

ITEM		K.SHS. AMOUNT
Bagasse	1 month	1,334,000
Imported Pulp	3 months	14,962,000
Caustic Soda	(from Captive Plant)	
Chlorine	(from Captive Plant)	
Lime Stone	1 month	21,000
Alum	3 months	945,000
Size	3 months	1,250,000
Talc	3 months	1,650,000
Fuel Oil	1/2 month	1,111,000
Other Materials	3 months	4,000,000
Miscellaneous		1,720,000
Finished Products	1/2 month	14,062,000
Total		41,055,000
Insurance Premiums and Sundary Advances		1,360,000
Opening-up Expense		
- Administrative Salaries	6 months	3,340,000
- Overhead	3 months	625,000
- Labour	2 months	1,394,000
- Other Expenses		625,000
Total Opening-up Expense		5,984,000
TOTAL (Working Capital and Opening Expense)		48,399,000

ANNEX 5

EARNINGS ESTIMATE

ITEM	UNIT	AMOUNT
PAPER PRODUCTION	FTPY	30,000
NILL NET SALES	KSHS./YR.	337,500,000
DIRECT MANUFACTURING COST	KSHS./YR.	173,938,000
		163,562,000
CAPITAL INVESTMENT EXCLUDING WORKING CAPITAL	KSHS./	523,447,000
GROSS RETURN BEFORE DEPRECIATION AND INTEREST	%	31.2%

ANNEX 6

BAGASSE AVAILABILITY FOR PAPER MILLS

BASIC DATA USED IN CALCULATION

On an average 100 MT of cane ground will produce:-

11.2 tons Raw Sugar (98.5% Pol.)
5.0 tons Surplus Bagasse (49% Moisture)
2.7 tons Molasses (89 BRIX Sp.gr. 1.47)
3.0 tons Filter Mud (at 80% Moisture)
0.3 tons Furnace Ash
1,300 KWH Surplus Electricity

The above values are indicative and are based on the assumptions:

Sucrose % Cane	-	13.0
Fibre % Cane	-	13.0
Mill Extraction	-	95%
Overal Recovery	-	85%
Purity of Mixed Juice	-	84%
Steam Consumption	-	500 Kg/Ton Cane

2.3 Tons of Steam/Ton Wet Bagasse

ANNEX 6, cont.

BAGASSE REQUIREMENTS AS RAW MATERIAL FOR PAPER INDUSTRY

BASIC DATA USED FOR CALCULATIONS

1. CALORIFIC VALUE OF BAGASSE

Gross Calorific Value - 2340 K.cal/kg (4,200 BTU/lb.)

Net " " - 1920 K.Cal/kg. (3,450 BTU/lb.)

2. CALORIFIC VALUES OF SUBSTITUTE FUELS

	Gross Cal. Value	Net Cal. Value
- Fuel Oil	10,000 KCal/kg.	9,300 KCal/Kg.
- Bitumius Coal	6,700 KCal/kg.	6,500 KCal/kg.
- Natural Gas	12,250 KCal/kg.	11,200 KCal/kg.
which is equivalent to	8,900 KCal/m^3	8,100 KCal/m^3
- Wood (green) 30% Moisture	3,225 KCal/kg.	2,800 KCal/kg.
- Wood (AD) 15% Moisture	3,990 KCal/kg.	3,600 KCal/kg.

3. BOILER EFFICIENCIES FOR DIFFERENT TYPES OF FUEL (AVERAGE VALUES)

Efficiency	Fuel Oil	Coal	Gas	Wood
Basedon GCV -	84	82	82	70
Based on NCV -	90	85	89	82

4. BOILER EFFICIENCIES FOR BAGASSE FURNACES

	STEP GRATE	HORSE SHOE	WARD	SPREADER STOKER
- GCV of Bagasse (K Cal/Kg.)	2,340	2,340	2,340	2,340
- NCV of Bagasse (K Cal/Kg.)	1,920	1,920	1,920	1,920
- Inlet Feed H_2O Temp ^oC	85	85	85	85
- Exit Temp gases ^oC	180	180	180	180
- Excess Air required %	80	70	40	30
- Boiler Efficiency				
= Based on GCV	58.8	62.5	66.5	67.1
= Based on NCV	71.6	76.1	81.0	81.7
- Kg. Steam generated / Kg. bagasse as fired				
= 7 Kg./cm^2 Saturated	2.39	2.54	2.70	2.72
= 10 Kg./cm^2 250^{o}C	2.23	2.37	2.52	2.54
= 20 Kg/ cm^2 300^o C	2.16	2.30	2.45	2.47
= 40 Kg/ cm^2 350^o C	2.04	2.17	2.31	2.33

5. BASED ON THE ABOVE THE CONVERSION RATE FOR 1 TON MILL RUN BAGASSE (49% MOISTURE) IS EQUIVALENT TO:

- 0.18 Ton Fuel Oil
- 0.28 Ton Bituminous Coal
- 0.15 Ton Natural Gas on 0.209 m^3
- 0.55 Ton Wood (AD)

6. 1 Ton of Mill run Bagasse (49% Moisture) Generates About 2½ Tons Steam

7. Steam requirements in a Raw Sugar factory are as follows:

a) Old factory partially electrified
- 500 to 550 kg. Steam/Ton Cane

b) Modern factory electrified,
Low to medium pressure
Quadruple - 450 to 500 kg. Steam/Ton Cane

c) Modern factory, electrified
Medium to High Pressure
Quintuple - 425 - 450 kg. steam/ Ton

The above factories should reach thermal balances with fibre % cane at approximately

a) 11 to 12 %
b) 10 to 11 %
c) 9 to 10 %

8. BALING OF BAGASSE

- Size of Bale 46 x 56 x 81 cms -
- Wt. 115 Kg = 59 Kg Fibre + 56 Kg Moisture
- Density 55 $/m^3$
- Capacity of Baler 100 to 200 tons of Mill Run Bagasse/24 Hrs.

HIGH DENSITY BALES

- Size 30 x 30 x 50 cms
- Wt. - 40 Kg.
- Density - 890 Kg./m^3

STANDARD STACKS

- 37 Meters long x 20 meters wide x 9 meters Height
- Contains about 12,000 Bales = Approximately 700 Tons dry fibre

ANNEX 6, cont.

BAGASSE AVAILABILITY FROM MUMIAS SUGAR MILLS AS SURPLUS BAGASSE

DATA USED

- Cane Crushing Capacity at MUMIAS - 8000 TCD/Maximum
- Crushing Season - 10 Months
- Proposed Crushing For 1985 - 1½ Million Cane/year

SURPLUS BAGASSE AVAILABILITY ON THE BASIS OF STEAM DEMAND AT MUMIAS (1ST METHOD)

CRUSHING CAPACITY Based on 1985 (Target) - 1,500,000 TCY

$= \frac{15,000,000}{10 \times 30 \times 24} = \frac{1,500,000}{7200} = 208$ TCH

General standard of steam used at 500 kg/TCH

This works out to = 208 x 500 = 104 Tons Steam per hour

At 2.25 tons of Bagasse for 1 ton steam production

104 Tons of Steam per hour requires $\frac{104}{2.25}$ = 46.2 tons of Bagasse as fuel for Mumias Boiler

Cane normally contains 15% Fibre

or

30% Fresh Bagasse

Therefore 208 TCH will produce = $208 \times \frac{30}{100}$ = 62.4 Tons Fresh Bagasse

The surplus Bagasse Availability = 62.4 - 46.2 = 16 2TPH of fresh Bagasse

The surplus Bagasse Availability per year = 16.2 x 7,200 = 116,640 Tons of fresh Bagasse

- Allowing 50% Moisture for OD Bagasse = 58,320 Tons of OD Bagasse
- Allowing 30% Pith the true fibre = 40,824 Tons of True Fibre
- Allowing 15% Dirt = 34,700 Tons of Good fibre
- 34,700 Tons of Good Fibre = 34,700 x 0.45 = 15,600 Tons of Pulp

SURPLUS BAGASSE AVAILABILITY AT MUMIAS (2ND METHOD)

Working on the Formula generally accepted by Sugar Mills of 100 TCH will give 5 Tons Bagasse (at 49% Moisture)

- 1,500,000 TCH/yr. = $\frac{1,500,000}{100}$ x 5 = 75,000 Tons Mill Run Bagasse
- Allowing 49% Moisture = 75,000 x 0.51 = 38,250 Tons Bagasse (OD)
- Allowing 30% Pith = 38,250 x 0.70 = 26,775 True fibre (OD)
- Allowing 15% Dirt = 26,775 x 0.85 = 22,758 Tons Good Fibre (OD)
- 22,578 Tons fibre = 10,200 Tons pulp
  Say 10,000 Tons of pulp

ANNEX 6, cont.

COST OF BAGASSE AS A RAW MATERIAL FOR PROPOSED MILL

I. The formula generally applied is as follows for SURPLUS BAGASSE

$$0.67 + 1.85\,Y + Z$$

Where

Y is the cost of Labour in US$ per man hour

Z the cost of depithing in US$ per Ton of mill run bagasse

0.49 = % of Fibre in Bagasse the rest is Moisture

$$\frac{0.67 + 1.85\ (0.2) + 1.50}{0.49} = \$\ 5.18 \text{ per ton of BD Bagasse}$$

$$= 77.75 \text{ K.Shillings}$$

II. The formula generally applied for FUEL OIL REPLACED BAGASSE is as follows:

$$0.79 + 1.85Y + 0.187x + Z$$

Where

- Y is the cost of Labour in US$ per Man Hour
- Z is the cost of depithing in US$ per Ton of Mill Run Bagasse
- X is the cost of Fuel Oil in dollars per Ton
- 0.49 = % of Fibre in Bagasse and the rest is Moisture

$$\frac{0.79 + 1.85\ (0.2) + 0.187\ (160) + 1.50}{0.49} = 66.49$$

$$= 997 \text{ Kenyan Shillings}$$

$$\frac{0.79 + 0.37 + 29.92 + 1.50}{0.49} = 997 \text{ Kenyan Shillings}$$

ANNEX 6, cont.

AVAILABILILTY OF FIBRE FROM CANE TOPS

30% of the weight of the cane is wasted in the fields as "Tops"

This amounts to for Mumias working on 25% of the weight of cane

$1,500,000 \times \frac{100}{75} = 2,000,000 - 1,500,000$

$= 500,000$ Tons of Tops

500,000 Tons of Tops = $500,000 \times \frac{30}{100} = 150,000$ Fresh Bagasse

150,000 Fresh Bagasse = 75,000 OD Bagasse

Allowing 30% Pith = $75,000 \times 0.70 = 52,500$ Tons Truefibre.

Allowing 15% dirt and Debris = 44,600 Clean good fibre

Bl. Pulp of 45% = 20,000 Tons

Total Bleached Pulp possible at Mumias

- As Surplus Baggase	=	10,000
- As Fibre from Tops	=	20,000
Total		30,000 Tons/Year

= 100 TPD