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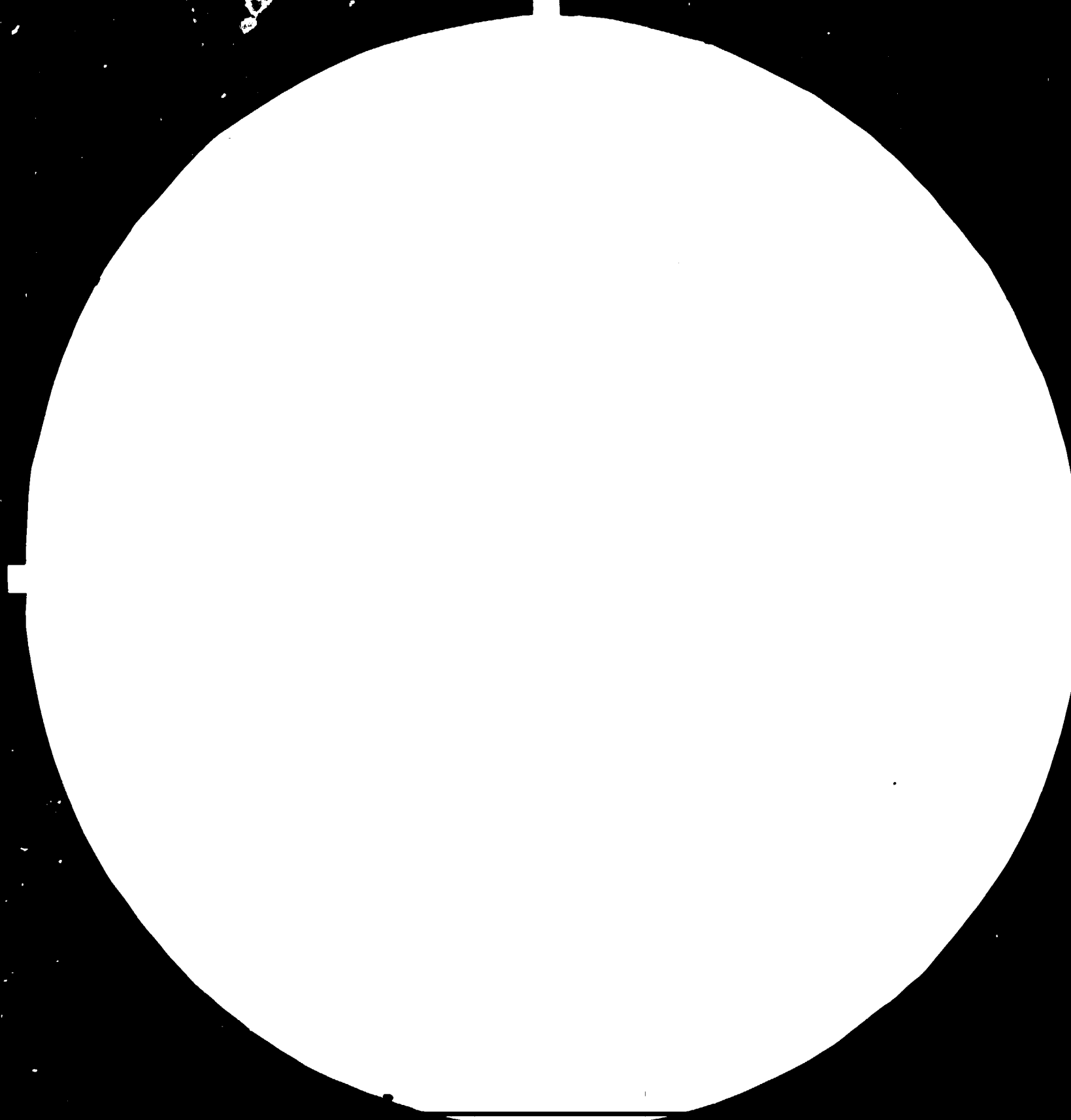
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Mozambique.

ASSISTANCE FOR THE PREPARATION OF A
REHABILITATION PROGRAMME FOR THE SUGAR INDUSTRY.

MOZAMBIQUE

SI/MOZ/84/801

Technical Report*

Prepared for the Government of the People's Republic of Mozambique
by the United Nations Industrial Development Organization

Based on the work of Georg Anderle,
Expert in Cane Sugar Industry Development

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I. INTRODUCTION

The sugar industry in Mozambique has an installed production capacity of about 300,000 tonnes sugar/year, while actual production is only about 50,000 tonnes (estimation for 1984 crop). Sugar is produced in six sugar mills - Marromeu and Luabo in the Zambezi Delta, Mafambisse and Buzi near the city of Beira and Incomati and Maragra, some 70 to 100 km North of Maputo. The national demand for sugar is at least 150,000 tonnes and there are existing options for export of sugar above world market price levels.

The reasons for the substantial decrease of production are many, but can be principally summed up as:

- lack of spare parts for machinery and equipment; and
- lack of qualified, experienced and skilled personnel.

These two factors cause problems in the cane fields with irrigation, application of fertilizers and pesticides, field preparation and cane transportation, and in the factories with sugar recovery (machinery breakdowns and the energy balance).

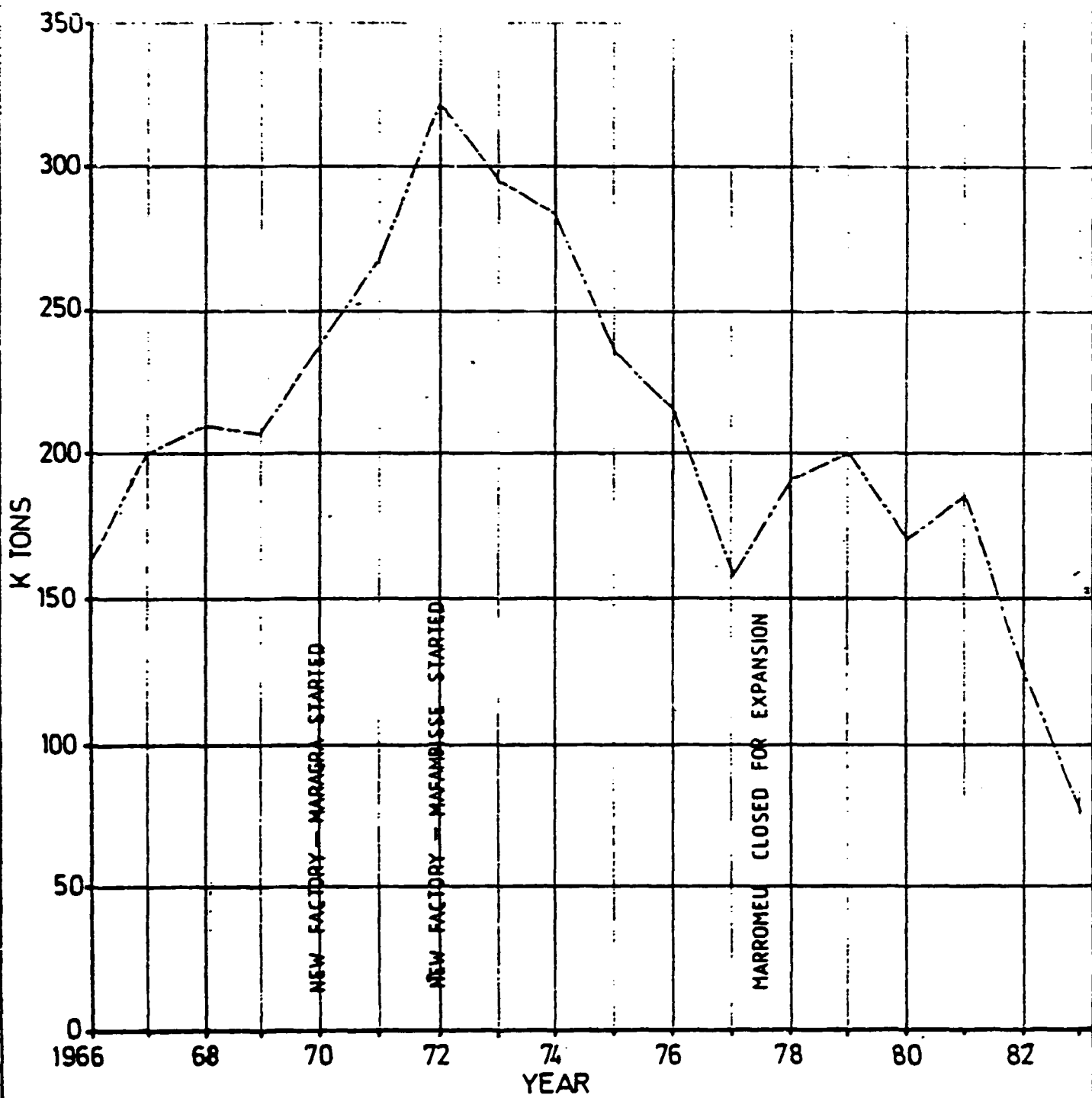
Sugar production has decreased constantly in the last nine years due to the above-mentioned problems, and in recent years, sugar production has been even more aggravated by a two-year drought.

Sugar production since 1966 is illustrated in Diagram 1.

The Government of Mozambique is fully aware of the situation in the sugar industry and in 1981 contracted the Engineering Company, IMEXPAL, Havana-Cuba, with the objective of analysing the needs for optimal operation of the sugar companies. Other projects have followed, making different proposals for the rehabilitation of the sugar industry. In 1983, the National Sugar Institute (INA) requested assistance from UNIDO for the rehabilitation programme.

The mission of the expert commenced on 28 September 1984 in order to provide assistance for the Preparation of the Rehabilitation Programme (See Annex 1, Job Description).

DIAGRAM 1



MOÇAMBIQUE SUGAR PRODUCTION

Regarding the duties of the expert, INA requested that priorities should be given to:

- (i) a description of each facility to be used as an "Investment Promotion Profile";
- (ii) an estimation of the total investment costs for the rehabilitation programme;
- (iii) the analysis of the existing information and collection of additional information for eventual techno-economic evaluation; and
- (iv) the preparation of the terms of reference for the rehabilitation programme.

Furthermore, the expert was requested to analyse co-operation possibilities with Brazilian companies and institutes and to collect and submit data on Brazilian equipment, machinery - and sugar factory rehabilitation costs. This information was collected during a mission to Brazil on the way back from Mozambique. Background for this request was required to provide INA with some necessary information for the comparison of offers and auxiliary material for the negotiation of a joint venture. Another reason was the expectation of possible assistance from Brazil (Government or Institutes) in the rehabilitation programme. All technical information and special detailed price list of equipment has already been submitted to INA.

II. SUMMARY AND RECOMMENDATIONS

The situation of the sugar industry is that only 50,000 tonnes of sugar/year are produced, while the installed capacity is 300,000 tonnes. The principle reasons being lack of spare parts, machinery and maintenance and of qualified and experienced personnel.

It is estimated that total rehabilitation costs will be approximately US\$ 150 - 200 million. Interest for joint ventures from foreign investors with experienced staff in sugar production exists to take over one or two estates, however, more interested investors should be attracted.

The remaining estates for which no foreign investors will be attracted, shall be rehabilitated by INA, and converted into Integrated Agro-Industry Complexes, producing and processing sugar and sugar by-products. Preparation of bankable projects and negotiations of the loans will take a certain time—so that rehabilitation of these estates will probably start after those ones to be rehabilitated by foreign investors.

During the period of negotiations, it is recommended that all factories are kept running on 'bottleneck' capacity. However, as far as possible, elimination of bottlenecks and a slight increase in production should be tried, as low production is not economic at all. due to the high fixed cost share.

III. ACTUAL SITUATION

There are existing studies for the rehabilitation of the sugar industry carried out by IMEXPAL, Cuba; ECB (Batman), South African Republic; and Tate and Lyle, U.K. The Tate and Lyle study deals only with two factories, the Batman study with all six, however in three cases based on the IMEXPAL figures, while the IMEXPAL study is based on a detailed assessment of all six existing estates.

Tate and Lyle has analysed only Luabo and Marromeu and concluded that under the present world market sugar price situation, sugar production in both estates is not feasible; in Luabo due to transportation and communication problems (because the estate is situated on the other side of the River) and in the case of Marromeu - due to the assumption that sugar production is not attractive financially in this estate.

The IMEXPAL study emphasizes the 'optimization' of the sugar production. It proposes an investment of more than US\$ 200 million for new machinery, spare parts, engineering and training. It proposes also substitution of some existing machinery and technology, although some of it is working properly and is adapted to the conditions in the country.

The Batman study recommends to achieve in the first stage the minimum production of 150,000 tonnes which is considered a prime necessity. To achieve minimum production,

they are recommending to rehabilitate those estates with the lowest repair costs leaving the unrehabilitated ones at the 1983 production levels.

They assume that this minimum production can be achieved at a minimum time and with minimum investment by rehabilitating Incomati and Maragra as follows:

Rehabilitation of Incomati to produce	40,000 t.
Rehabilitation of Maragra to produce	60,000 t.
The remaining estates producing	<u>50,000 t.</u>
Total	<u>150,000 t.</u>

The capital required for this case is estimated at US\$ 20 million. For the rehabilitation of all six estates, the study estimates a total investment of US\$ 120 million, to increase sugar production up to 303,000 tonnes/year. (In comparison the Cuban study has indicated a US\$ 118 million investment for production of 248,000 tonnes of sugar).

Forecasts for production in comparison to capital requirements are higher in the Batman study than in the IMEXPAL, as is shown in the following table for three sugar mills.

TABLE 1
COMPARISON OF THE RESULTS

	Area in ha.		Production Forecast		Capital in US\$ X 1000	
	IMEXPAL	Batman	IMEXPAL	Batman	IMEXPAL	Batman
INCOMATI	7,000	5,000	38,000	40,000	17,781	12,671
MARAGRA	6,700	6,700	31,000	60,000	7,218	12,082
MAFAMBISSE	10,500	8,700	50,000	72,000	13,967	10,475
	24,200	20,400	129,000	172,000	37,966	35,228

Table 1 shows that Batman is calculating with higher yields in the cane fields and better factory recovery than IMEXPAL, therefore, indicating higher sugar production of the estates, and lower rehabilitation costs per ton of sugar.

IMEXPAL is calculating a productivity of only 5 tonnes sugar/ha while Batman, some 9 tonnes, which seems to be the more realistic figure considering soil condition, existing irrigation and the technological level of the sugar factories in Mozambique. In comparison, Brazilian sugar mills in the Sao Paulo region are working with 8 - 10 tonnes/ha sugar recovery.

In comparison to the Batman and IMEXPAL estimations, the experts estimates are given in Table II. These have been based on a score system, which indicates in percentage, the necessary replacement of machinery, equipment and technology required to bring up production to 100 per cent nominal capacity. Evaluation of the technical condition has been based on the two mentioned studies, discussions with INA - management and the impressions obtained from the Maragra visit. (It was not possible to visit the other estates due to local conditions). Cost indications are based on information from Brazilian equipment suppliers and sugar producers. The evaluation sheets are attached as an Annex.

The estimates have been made for factory equipment, technical assistance, training and agricultural machinery in foreign exchange, and for civil work, reconstruction of agricultural and factory infrastructure and new plantations, in local currency.

The value of replacement in the most optimistic case, is at least more than 10 per cent of total value, as for maintenance under normal conditions, already 3 - 5 per cent of equipment value is calculated.

Under "Technical Assistance" it is considered that several activities have to be carried out in each factory such as: elaboration of new drawings for equipment and a layout of each factory (estimated at about US\$ 0.5 million) and direct technical assistance and training of personnel (at least US\$ 1 million). For Buzi and Maragra, higher amounts for technical assistance are required as they seem to have more problems than the other estates.

TABLE II

PRESENTATION OF ESTIMATED REHABILITATION COST

	Foreign Currency Part (in millions US\$)						Local Currency Part (in millions US\$)	
	New Factory Investment	Factory Rehabilitation	Software (Engineering, Training, etc. Expatriates)	Agricultural Equipment	Irrigation Equipment	Total	Local Currency Part	Total
INCOMATI	15.0	6.3	1.5	3.0	3.0	13.8	9.3	23.1
BUZI	15.0	7.5	2.5	4.0	2.0	16.0	9.0	25.0
MARAGRA	22.0	5.0	2.5	5.0	2.0	14.5	10.0	24.5
MAFAMBISSE	22.0	4.1	1.5	2.0	2.0	9.6	9.6	19.2
LUABO	26.0	5.2	1.5	6.0	3.0	15.7	11.0	26.7
MARROMEU	26.0	5.2	1.5	6.0	-	12.7	9.5	22.2
	126.0	33.3	11.0	25.0	12.0	82.3	58.4	140.7

For the complete rehabilitation a total requirement of US\$ 140 million is estimated from which about US\$ 80 million is in foreign exchange and US\$ 50 million in local currency for activities such as installation, local maintenance, cane field rehabilitation and some civil work.

With this investment, the total milling capacity would come to about 25,000 TCD - 30,000 TCD.

The total investment necessity of nearly US\$ 150 million seems to be very high, however, it seems to be justified as today, internationally, the value of 6,000 TCD mill is calculated at about US\$ 75 to US\$ 100 million, therefore, a 25,000 TCD capacity (4 units) would represent a value of about US\$ 400 million. The estimated rehabilitation costs are about 35 per cent of the total value of the units, and will bring up production capacity from 15 per cent to 100 per cent. With 35 per cent of the estimated total value, 85 per cent production could be achieved. The time required for rehabilitation under optimistic conditions, would be about 4 - 6 years, considering execution by specialized foreign engineering/consulting companies.

However, due to the lack of local management capacities and bad condition of infrastructure and the cane fields, it is assumed that rehabilitation will take more than 6 to 8 years. Within this time, not only all cane fields would be re-organized, but also enough local personnel would have to be trained who would be able to run the estates properly on full capacity and technically and economically feasible.

As in the estates, technical staff is lacking to carry out the programme and INA does not have enough personnel to implement the programme without foreign assistance. Therefore, it is considered that some of the factories (maybe three), will be offered to foreign investors for joint venture participation. INA has already some proposals, however, they are requesting the assistance of UNIDO's Investment Promotion Service to attract the attention of potential investors. (Information profiles concerning each estate are attached as Annexes).

The remaining estates are expected to be rehabilitated by INA hopefully with the assistance of UNIDO|UNDP. For financing of the programme, loans from the World Bank, the African Development Bank and|or other soft loan-giving banks will be requested. (The Terms of Reference for UNIDO assistance projects are annexed to this report).

The INA has already stated that all types of international assistance and co-operation would be appreciated, specially from advanced sugar producing countries with conditions similar to Mozambique. In this context, Brazil has appeared as a perfect partner and the Brazilian Embassy representative in Mozambique has demonstrated high interest of his country in co-operation with the Mozambique sugar industry. Within this project, Brazilian institutions were visited in order to introduce the sugar industry rehabilitation project, to analyse possibilities of several kinds of assistance and to collect technical data with respect to equipment and rehabilitation costs.

Based on arrangements made by the Brazilian Embassy in Mozambique, for January 1985 a high-level Government mission is planned to visit Mozambique to discuss future co-operation between both countries and which will place the sugar industry project as a high priority.

The following institutions were contacted in Brazil: EMBRAPA, COPERSUCAR, FUNDAP and PLANALSUCAR, who indicated possibilities of providing their technical assistance and training on a prime-cost basis; the engineering Company

DEDINI was also contacted, which offered to carry out bankable projects for the programme on a soft-loan basis or even a local cost-transportation basis in case of a certain warranty by the Government. Government officials could not give any immediate commitment but emphasized the priority of the sugar industry in a possible future co-operation programme with Mozambique.

IV. CONCLUSIONS

The present situation reveals that the most attractive estates for joint venture proposals are INCOMATI, MARAGRA and MAFAMBISSE, which it appears that LUABO, MARROMEU and BUZI are to be rehabilitated by INA in the future. Even if real interest already exists in joint venture, it might take until the end of 1985 when rehabilitation of the first estate will start. For the other estates, the start of the programme will be even later, considering the preparation of the technical proposals, the bankable project, its negotiation and approval.

For this period, it is recommended that all the estates (as far as possible) will be kept running basing the capacity on the bottleneck in production. That means that all machinery and technology should be adapted to the bottleneck.

For example, in case cane transportation is only 1,000 TCD, in a 5,000 TCD mill, cane preparation, milling, boiler, evaporation, crystallization, must be adapted to this capacity. It has to be tried not to run all boilers on low capacity, but one on full (or next to full). The same is applicable for evaporators, centrifuges, juice decanter and other machinery.

It should be tried to eliminate or at least diminish bottlenecks where it can be done at the lowest cost and in the most promising factories, therefore, concentrating the available funds on such estate where maximum results can be expected.

With respect to the rehabilitation of the remaining estates, for BUZI it is recommended: to transform the estate to an agro-industry complex, also processing sugar and alcohol

to glucose (for example) or liquors, and by-products to yeast, animal feed and other products of high added-value. In this agro-industry complex, processing of cotton and livestock and other agricultural products also could be incorporated; for LUABO and MARROMEU, it is recommended to create an agro-industry complex similar to BUZI as the Zambezi River delta is famous for its excellent possibilities for agricultural opportunities, however, before starting such a project, the complete infrastructure including railway, river transport and harbour facilities must be restructured and repaired.

ANNEXES

- ANNEX 1 Job Description
- ANNEX 2 Description of Sugar Mill "INCOMATI"
- ANNEX 3 Description of Sugar Mill "MAFAMBISSE"
- ANNEX 4 Description of Sugar Mill "MARAGRA"
- ANNEX 5 Description of Sugar Mill "LUABO"
- ANNEX 6 Description of Sugar Mill "MARROMEU"
- ANNEX 7 Description of Sugar Mill "BUZI"
- ANNEX 8 Terms of Reference - Assistance to Rehabilitation of Sugar Industry
- ANNEX 9 Terms of Reference - Rehabilitation of BUZI
- ANNEX 10 Evaluation sheets of sugar estates

UNITED NATIONS



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO

20 August 1984

Project in the People's Republic of Mozambique

JOB DESCRIPTION

SI/MOZ/84/801/11-01/31.7.C

Post title	Sugar Cane Technologist
Duration	One month
Date required	As soon as possible
Duty station	Maputo with travel within the country
Purpose of project	To provide assistance for the preparation of a rehabilitation programme.
Duties	<p>The expert will be expected to</p> <ul style="list-style-type: none">- make an assessment of the sugar industry;- analyse all existing information;- contact potential suppliers of equipment;- prepare terms of reference for rehabilitation programme; and- describe inputs and involved costs. <p>The expert will also be expected to prepare a final report setting out the findings of his mission and his recommendations to the Government on further actions which might be taken.</p>

Qualifications

An expert in agro-industrial development with extensive experience in sugar cane technology.

Language

Portuguese and English

Background information

Sugar production in Mozambique decreased from 293,000 tonnes in 1973 to 178,000 tonnes in 1981. For 1982 no statistical data was available, but estimates show that production was below 100,000 tonnes. This implies that importation of sugar became necessary, while some years ago sugar was exported.

To stop the continuous decrease in production the Government of Mozambique set priorities for rehabilitation of the sugar industry. As there are no statistical data available and only few documentation it is quite difficult to formulate the rehabilitation programme to estimate its costs and identify priorities. Therefore, the Government asked for UNIDO's support in assisting in the preparation of a rehabilitation programme.

ANNEX 2

PROFILE OF SUGAR ESTATE "INCOMATI"

1. General Aspects

INCOMATI Sugar Mill is situated some 120 km. north of Maputo near the city of Magde in the Incomati Valley. It was established in 1920, has a good road connection with the capital, Maputo, and is connected to the national railway system. There is also a railway connection to the MARAGRA Sugar Mill located some 40 kms. from INCOMATI.

2. Agronomic Aspects

The estate covers an area of nearly 9,000 ha. from which about 4,000 ha. are cultivated with cane. Most of the area is irrigated; some 2,500 ha. by the furrow system, some 1,500 ha. by aspergation. A detailed agronomic study exists which proves that based on climatic, topographic and soil conditions, the area is appropriate for cane cultivation. All the necessary machinery exists to carry out agricultural activities, the cane is cut manually and transportation is carried out by rail and road (trucks).

3. Industrial Aspects

The factory is one of the oldest in the country. It started operation in 1920 and some of the original equipment is still in operation. It is designed to produce raw sugar and plantation white sugar through sulfitation. The main equipment installed is as follows:

(i) Cane reception

- Complete system existing.

(ii) Cane preparation:

- First cutter with 34 knives, driven by electric motor, 200 kw.;
- Second cutter with 34 knives, driven by electric motor, 200 kw.

- the cane belt is driven by a vapour machine.

(iii) Cane mills

- Five tandems "Cail" 32" x 67" driven by steam turbines of 450 kw, 450 kw. and 225 kw. (450 kw. for two tandems);
- "Cush cush" and belt conveyor system.

(iv) Juice treatment

- All necessary equipment exists for liming, pre-heating and sulfitation including intermediate tanks;
- Two decantation vessels "Dorr" (classic) 154m³ tanks;
- One filter "Dorr" (8" x 9")
- One filter "Dorr" (8" x 16")

(v) Evaporation

- One 4-stage evaporator with heating surface 4 x 232 m²;
- One 4-stage evaporator with heating surface:
 - 1st 540m²
 - 2nd 372m²
 - 3rd 2 x 174m²
 - 4th 2 x 174m²

(vi) Vacuum Pans and Crystallizer

- For "A" syrup - one 85m³
- For "B" syrup - one 25m³
- For "C" syrup - three 25m³
- 10 crystallizers with total volume 198m³.

(vii) Centrifuges

- For "A" syrup - three "Roberts" 40" x 30"
- For "B" syrup - five "Roberts" 40" x 30"
 - ten "Roberts" 30" x 20"
- For "C" syrup - four "Roberts" 40" x 30"

(viii) Sugar Dryer for nominal capacity.

(ix) Steam Generation

- Two boilers "Cail-Steinmüller, 27 tons/hour
20 kg./cm², 320°C.
- One boiler B/W, 40 tons/hour, 20 kg/cm², 320°C.

(x) Electricity generation

- Two generators 500 kw., 440V, 50Hz.
- One generator 1000 kw., 440V, 50Hz.
- Three diesel generators, total 900 kw.
- One transformer to public line "Sonefe"
with 530 kVA.

(xi) Utilities

Water supply is from the Incomati River and stations exist treating water for processing and boiler, including refrigeration for cooling water.

4. Technical Deficiencies

INCOMATI is considered to be the "best" running sugar mill in the country although it faces similar problems (lack of spare parts and skilled manpower) as the other mills. INCOMATI's specific problem is that it is one of the oldest mills in the country and most of the equipment should be replaced in the near future; a new irrigation and transportation system should also be considered.

5. Estimation of investment for rehabilitation

(i) Foreign currency

- | | |
|---------------|-------------|
| - agriculture | US\$ 3.0 m. |
| - factory | US\$ 6.3 m. |
| - software | US\$ 1.5 m. |

(ii) Local currency (equivalent) US\$ 10.0 m.

Total US\$ 20.8 m.

ANNEX 3

PROFILE OF SUGAR ESTATE "MAFAMBISSE"

1. General Aspects

Mafambisse Sugar Mill is situated some 80 km. north east of the city Beira in the Province Sofala. It was established in 1968/1969. The nominal capacity of the estate is to produce about 65,000 tonnes of sugar/year.

2. Agronomic Aspects

The estate covers an area of nearly 9,000 ha. for sugar cane plantation. A detailed agronomic study exists analysing the cane production including soil classification, the existing irrigation, cultivation, soil preparation and cane transportation system.

The area under irrigation is about 6,000 ha. Transportation of the cane is carried out by road (trucks).

3. Industrial Aspects

The factory started operation in 1970. It has been designed to produce raw sugar and white sugar. The main equipment installed is the following:

- (i) Cane reception through two cranes and two washing tables;
- (ii) Cane preparation
 - first cutter with 50 knives, driven by electric motor 375 kw. ;
 - second cutter with 80 knives, driven by electric motor 375 kw. ;
 - desfibrador (Searby) 43" x 84", driven by electric motor 550 kw.

(iii) Cane milling

- first tandem, Fives Cail, 43" x 84", self-adjusted, driven by steam turbine, 830 kw.;
- second tandem, James Brown, 43" x 84", driven by steam turbine 410 kw.;
- third and fourth tandem, James Brown, 38" x 72", driven by steam turbine 400 kw.;

Transportation between tandems is through belt conveyor, two screens, (DSM) are installed.

(iv) Juice treatment

All necessary equipment exists for liming, pre-heating and preparation of chemicals and intermediate tanks.

The main equipment consists of:

- one clarifier (Polycell type), 133 m³ volume;
- three filters, Dorr Oliver, 8" x 16"

(v) Evaporation

- two evaporation units (4 stage), total surface 3062 m².

(vi) Vacuum pans and crystallizers

- "A" syrup, two pans, 260 m² and crystallizer with total volume of 170 m³;
- "B" syrup, one pan, 260 m² and crystallizer with total volume of 210 m³;
- "C" syrup, two pans, 260 m² and crystallizer with total volume of 340 m³;

All crystallizers are equipped with a cooling system.

(vii) Centrifuges

- "A" syrup, four "Roberts" (automatic) 48" x 30";

- "B" syrup, three "Roberts" (automatic) 48" x 30";
- "C" syrup, nine continuous, 34" x 34" and one continuous for $1.7 \text{ m}^3/\text{hour}$.

(viii) Sugar Dryer, for capacity of 30t/day.

(ix) Steam generation

- Three boilers, Babcock-Wilcox, 36t/day, 30 kg/cm^2 , 385°C .

(x) Electricity generator

- two generators, Siemens, 3000 kw.;
- one generator, Siemens, 6000 kw.; and
- one transformer, connecting to public network, 7500 kva.

(xi) Utilities

All the necessary equipment and vacuum exists for water pumping, refrigeration and treatment of process and boiler water, also equipment for preparation of necessary chemicals.

4. Deficiencies, problems

The estate is facing several problems in cane production and sugar production, such as:

- bad technical condition of irrigation and drainage equipment and agricultural machinery due to lack of spare parts and bad maintenance;
- overall low exploitation of machinery and equipment due to lack of spare parts, chemical products and utilities;
- serious damage of instrumentation due to wrong handling and spare parts problems.
- low-level skills of workers and technical staff.

5. Perspectives and estimation of investment costs for rehabilitation

To rehabilitate the industry, it is necessary to replace or repair all damaged machinery (transportation system, equipment, instrumentation, etc.), introduce a maintenance programme, including rehabilitation of the workshop and install a strong management for the implementation of the rehabilitation, and to ensure supply of all utilities.

6. Economic aspects

Based on a rough evaluation, the following investment for rehabilitation is estimated.

(i) Foreign currency:

- Agriculture	US\$ 6.0 million
- Factory	US\$ 4.1 million
- Software	<u>US\$ 12.0 million</u>
Total	<u>US\$ 23.6 million</u>

ANNEX 4

PROFILE OF SUGAR ESTATE "MARAGRA"

1. General

MARAGRA Sugar Mill is situated some 70 km. North of Maputo near the city of Mantica in the Incomati Valley. The estate was established in 1972 and started operation in 1976.

2. Agronomic Aspects

The estate has an area of nearly 7000 ha. from which about 6500 ha. are used for cane plantation, and the remaining for breeding cattle and small-scale production purposes. A detailed agronomic analysis exists which indicates that climatic and soil conditions are appropriate for cane production. All of the area where cane is planted is irrigated artificially through aspergation and there are in some areas drainage and salination problems.

Machinery exists for cultivation and transportation, however, in a very bad condition which requires rigid maintenance and substitution in some cases. Due to several problems in recent years, the cane fields are in bad condition. There is a strong "smut attack" and a large part of the drainage and irrigation system is damaged. Complete repositioning and re-organization is required.

3. Industrial Aspects

The factory started operations in 1976. It was designed to produce raw and refined sugar. Machinery and equipment for production and control was selected at the time at the existing level of technology. It consists of:-

(i) Cane reception

- Four tables, Cameco type.

(ii) Cane preparation

- Three cutters (the first driven by turbines with 328 kw., the second with turbines at 336 kw., and the third driven by two electric motors (324 kw. each).
- One desintegrator (Searby) driven by turbine 336 kw.

(iii) Milling

- One tandem (Fives Cail) 38" x 72", self-adjusting driven by turbine 582 kw.;
- Five tandem (James Brown) 38" x 72" driven by turbine 410 kw.
- Transportation between tandems through belt conveyor.

(iv) Juice treatment

- All the necessary equipment exists for pre-heating, liming and sulfitation;
- Two clarifiers (Polycell type) with 250 m³ and 150 m³ volume;
- Three filters (Dorr Oliver) 8" x 16"

(v) Evaporation

- One four stage evaporator:
 - 1st stage 129.9 m²
 - 2nd stage 649.6 m²; 556.8 m² and 556.8 m²
 - 3rd stage 556.8 m²
 - 4th stage 556.8 m²

(vi) Vacuum Pans and Crystallizers

- "A" syrup 227 m²
- "B" syrup 227 m²
- "C" syrup 7.5 t/hour

Crystallizers in sufficient quantity for designed capacity.

- (vii) Centrifuges for designed capacity.
- (viii) Sugar Dryer and sugar handling for capacity of about 30 t. sugar per day.
- (ix) Steam generation - 130 t/hour, 30 kg/cm²
 - 3 Babcock and Wilcox boilers
- (x) Electricity generation
 - One generator (Siemens) - 6000 kw.
 - Two generators (Siemens) - 4000 kw.
- (xi) Utilities, existing for water treatment
- (x) Refrigeration, for factory and boiler.

4. Technical deficiencies

The estate is facing at present several problems both in agriculture and industry, such as:

- serious damage of the irrigation and drainage system;
- low exploitation of agricultural machinery due to lack of spare parts and low efficiency in maintenance;
- lack of pesticides, fertilizers and other utilities;
- low saccharose extraction due to several breakdowns and technical problems in cane preparation and mills (adjustment or low capacity);
- low efficiency in sugar production due to lack of skilled manpower, technology and equipment maintenance;
- difficulties with instrumentation, due to lack of spare parts, wrong handling and operational knowledge;
- overall problems with utility supply (water, steam, electricity) due to wrong handling, lack of spare parts, technology/knowledge) and maintenance problems.

5. Estimated Investment for Rehabilitation

-	<u>Foreign currency</u>		
-	Agricultural machinery	US\$	5.0
-	Irrigation system	US\$	2.0
-	Software	US\$	1.5
-	Factory	US\$	5.0
-	<u>Local currency</u>	<u>US\$</u>	<u>10.0</u>
	Total	US\$	<u>23.5</u>

ANNEX 5

PROFILE OF SUGAR ESTATE "LUABO"

1. General Aspects

Luaba Sugar Mill is situated on the North bank of the Zambezi River, some 100 km. from town of Delta. The estate started sugar production in 1927 and was established by the Jenh Sugar Company. There is no railway nor proper road connections, however, there is existing a fluviol and sea transportation system by boats and ships which easily could be rehabilitated.

2. Agronomic Aspects

The estate includes more than 10,000 ha. of land from which about 7500 ha. are irrigated with water from the Zambezi river. Complete machinery exists for cane cultivation and the transportation is by rail. Agricultural and transport equipment is in bad condition due to lack of spare parts and maintenance. An agricultural laboratory and detailed studies exist on cane plantations, varieties and topography and the transportation system.

3. Industrial aspects

The installed capacity is to process 4,800 TCD. Most of the machinery was replaced up to 1972, following a long-term expansion programme. It consists mainly of:

(i) Cane reception

- unloading CAMECO system including cane washing system;

(ii) Cane preparation

- transportation through two belts "slats" 72" electric motor driven;
- first cutter, 66 knives, driven by two electric motors 450 HP and 250 HP;
- second cutter, 78 knives, driven by one turbine 750 HP, (Peter Brotherhood);

(iii) Cane milling

- First tandem (Fletcher Stewart) 38" x 72" driver by turbine (750 HP (P. Brotherhood));
- Second, third, fourth, fifth (Fletcher Stewart) 36" x 72" driven by two turbines 750 HP (P. Brotherhood);
- Sixth tandem (Fletcher Stewart) 36" x 72" driven by turbine 750 HP (P. Brotherhood);
- Transportation between tandems is with belt conveyor, each tandem has installed a feed roller;
- Bagacillio is separated on vibration sieves "Link Belt".

(iv) Juice treatment

There is equipment for production of raw sugar and plantation white sugar through sulfitation. All intermediate tanks, closing tanks and several pre-heaters are existing. The main equipment consists of:

- One sulfitation tower for sulfitation;
- One decanter ("Rapidorr") capacity 600 tonnes/hour;
- 3 Filters Oliver Campbell;

(v) Evaporation

- One 4 stage evaporator 1,200 ft.²
- Three 4 stage evaporator 7,000 ft.²
- Four 4 stage evaporator (Fletcher) 8,500 ft.²

(vi) Vacuum pans and crystalizers

- "A" syrup 4 pans 25m³ (Fletcher);
- "B" syrup 3 pans 25m³ (Fletcher);
- "C" syrup 3 pans 25m³ (Mirrless);

All necessary receivers and crystalizers for "C" massecuite are type Blanchard.

(vii) Centrifuges

- "A" syrup 4 Mirrless Watson 124 x 76cm;
- "B" syrup 4 Mirrless Watson 124 x 76cm;
- "C" syrup 8 Broadbent conti. 107 x 64cm;
3 Broadbent conti. 107 x 76cm;

(viii) Dryer:

- One for raw sugar 15 t/hr. rotative;
- One for white sugar 15 t/hr. rotative;

(ix) Steam generation

- Nine ol. Stirling 2,500 lb/hr.
- Two B/W 35,000 lb./hr. 150 psig
- Two B/W 80,000 lb./hr. 250 psig

(x) Electricity

- One turbo-generator 1,500 kw.
- Two turbo-generator 750 kw.
- One turbo-generator 500 kw.
- One diesel generator 1,000 kw.
- One diesel generator 200 kw.
- One diesel generator 175 kw.
- One diesel generator 50 kw.

A separate generation system for the irrigation of the fields exists.

(xi) Utilities

The necessary water treatment for process water and steam generation, water refrigeration and equipment for the preparation of chemicals exists.

4. Technical Deficiencies

The estate is facing serious problems due to lack of spare parts, low maintenance level and lack of skilled personnel.

The drainage system and transportation system (rail) is extensively damaged. The factory's efficiency is low due to bad cane preparation, bad feeding, bad condition of control equipment, pans, crystallizers and boilers, and vacuum equipment.

There are serious infrastructure problems as the best transport facility for sugar is by river and many of the boats and ships are out of operation.

5. Estimation of investment for rehabilitation

(i) Foreign exchange

- Agronomics	US\$ 6.0 million
- Irrigation (in case of aspergation) for rehabilitation of 6,000 ha.	US\$ 3.0 million
- Factory	US\$ 5.2 million
- Software	US\$ 1.5 million

(ii) Local currency

US\$12.0 million

US\$30.7 million

ANNEX 6

PROFILE OF SUGAR ESTATE "MARROMEU"

1. General Aspects

Marromen Sugar Mill is situated on the south bank of the Zambesi River, some 100 km. from the city Marromeu. Railway connections to the federal railway company mainline exist which connects the south with the north of the country. The distance to the railway main line is about 120 km., however, 50 km. have been destroyed and at present not in use. The only transportation is at moment by ship through the Zambesi River to the next port. The loading facilities are in bad technical condition.

2. Agronomic Aspects

The estate includes about 10,000 ha. of land, without any irrigation system.

All the machinery for cane plantation and transportation exists. Cane transport is carried out by rail, covering a total network of nearly 200 km., which presently is extensively damaged. 97 per cent of the cane harvest is carried out manually.

3. Industrial Aspects

The old equipment installed in 1927 still exists, to which new equipment has been added continuously. The last expansion of the mill was in 1977. The new mill has a capacity of 6,000 TCD.

During the expert's stay in Mozambique, technical information on the machinery and equipment was not available.

4. Deficiencies

Lack of spare parts and low qualification of personnel are the main problems, as in the other estates.

The specific problem of Marromeu is infrastructure. The railway connection to the main line to Beira is interrupted and the harbour facilities at the Zambezi River are in bad technical condition. Concerning shipping, the estate depends on the capacity of Luabo, which is not sufficient to carry out their own transportation necessities. Rehabilitation of Marromeu strongly depends upon a solution being found to the infrastructure problem.

5. Estimation of Rehabilitation Costs^{*} (without infrastructure)

(i) Foreign exchange

- Agricultural sector	US\$ 6.0 million
- Factory	US\$ 5.2 million
- Software	US\$ 1.5 million

(ii) Local currency US\$ 12.0 million

Total US\$ 24.7 million

* based on IMEXPAL estimations.

ANNEX 7

PROFILE OF SUGAR ESTATE "BUZI"

1. General

The agro-industry complex Buzi is situated some 50 km. south east of the city of Beira on the side of the River Buzi. The main activity is sugar production, but there are also other activities within the estate such as alcohol production, livestock production, some forestry and copra production. The area of the complex includes about 10,000 ha., the sugar factory has a capacity of 2,640 TCD and the distillery - 10,000 lt./day. The estate was established around 1900.

2. Agronomic Aspects

The estate comprises an area of about 7,000 ha. for cane plantation from which about 5,500 ha. are under irrigation. There is existing a detailed agronomic study indicating climatic conditions and soil characteristics. Cane transportation is carried out by rail and road. The field preparation is modernized and the cane harvesting is done manually. All the necessary equipment and machinery to carry out agricultural activities exist, however, in bad condition due to lack of spare parts and low maintenance level.

3. Industrial Aspects

The factory is designed to produce raw sugar and white sugar. There is installed the following equipment for milling 2,500 TCD:

(i) Cane reception through crane and several transportation bands powered by a steam machine.

(ii) Cane preparation

- One set of knives, powered by electric motor, 250 HP, 580 rpm (18" dist.);
- One set of knives, powered by electric motor, 300 HP, 600 rpm.

- (ix) Electricity generation - two generators, 1,000 kw.
440 V, 50 hz.
- (x) Utilities - water treatment and cooling existing.
- (xi) Distillery - for 10,000 lt. alcohol/day is installed
and in good operating condition.

4. Deficiencies, technical problems

The estate is facing several problems which are causing substantial reduction of the installed production capacity such as:-

- the irrigation and drainage system is incomplete and requires substantial repair;
- also substantial repair is necessary for all agricultural machinery, transport system (railway and roads) and factory equipment;
- lack of spare parts for most machinery and equipment;
- lack of chemical products;
- lack of skilled workers and necessity of instructors;
- some equipment is worn out and must be substituted in the near future, such as the clarifier, evaporator and generator; and
- complete rehabilitation including repair of remaining production equipment necessary.

5. Estimation of rehabilitation costs

(i) <u>Foreign exchange</u>	
- Factory	US\$ 7.5 million
- Agriculture	US\$ 4.0 million
- Irrigation	US\$ 2.0 million
- Software	US\$ 2.5 million
(ii) <u>Local currency</u>	US\$ 9.0 million
Total	<u>US\$ 25.0 million</u>

ANNEX 8

DRAFT PROJECT PROPOSAL

ASSISTANCE TO THE REHABILITATION OF SUGAR INDUSTRY IN MOZAMBIQUE

1. Objectives

- to assist in carrying out the rehabilitation programme;
- to define the modalities of the programme; and
- to train local personnel for implementation of the programme.

2. Activities

- analyse proposals for the rehabilitation programme and the related offers in technical and economic terms;
- advise and prepare the local authorities for the negotiations of proposals and offers in technical and economic terms;
- prepare terms of reference for international bidding;
- prepare a manual for the rehabilitation programme indicating monitory proceedings, follow-up, time-schedule, implementation modalities, standardizing of documentation, purchase procedures, transportation, etc.
- to give instructions on project follow-up methods and to visit recently rehabilitated or enlarged sugar estates abroad.

3. Inputs

- Assistance of a CTA, split mission for co-ordinating consulting company, experts training.
- Assistance of experts for sugar cane field machinery and transportation systems (2 m/m).

- Assistance of international sugar marketing and sugar production economics expert (2 m/m);
- Assistance of expert for cane sugar processing machinery (2 m/m);
- Assistance of a consulting company to carry out continuous assistance to INA and to prepare manual for rehabilitation; and
- Organization of a study tour.

4. Outputs

- A defined rehabilitation programme;
- A manual for the implementation of the programme (including follow-up modalities);
- Contracts with companies which are in line with the programme objectives and the implementation modalities of the manual; and
- Personnel (about 4 people) trained on how to implement the rehabilitation programme.

ANNEX 9

DRAFT PROJECT PROPOSAL

ASSISTANCE IN REHABILITATION OF "BUZI SUGAR ESTATE"

1. Objective

- Rehabilitation of sugar production;
- Improve economics of sugar production through intensive by-product utilization and further sugar processing;
- Creation of an all-year-round working agro-industry complex.

2. Activities

- Definition of products to be processed and produced;
- Definition of quantities;
- Preparation of a detailed techno-economic study for presentation to World Bank and African Development Bank;
- Preparation of modalities and procedures for project implementation.

3. Outputs

- Definition of rehabilitation programme for Buzi sugar estate;
- Bankable project for receiving soft loans for project implementation; and
- Manual of project implementation procedures.

4. Inputs

- Chief Technical Adviser, split mission for
co-ordination (duration 2 man-months);
- Expert for specific technological assistance
(duration - 1 man-month);
- Consulting company to prepare bankable project
and manual for implementation.

EVALUATION SHEETS OF SUGAR ESTATES

BUZI Nominal capacity - 2,500 TCD	Installed capacity	Actual Production	Requirements estimated in % of total investment cost	
	In % of nominal capacity		For maintenance and machinery	For software
Cane preparation	75	25	50	20
Cane milling	50	25	50	20
Juice treatment	50	25	50	20
Evaporation	70	25	40	10
Vacuum pans	60	25	40	10
Centrifuges	60	25	30	20
Dryer	80	25	20	10
Boiler	60	25	30	20
Turbines generator	60	25	40	10
Water treatment	80	25	40	10
Other Utilities	70	25	20	10
Motors, engines, drives	70	25	30	10
Pumps and piping	80	25	20	10
Instrumentation	50	25	40	10
Isolation	60	25	20	20
Total	60	25	40	15

EVALUATION SHEETS OF SUGAR ESTATES

INCOMATI Nominal capacity - 2,640 TCD	Installed capacity	Actual Production	Requirements estimated in % of total investment cost	
	In % of nominal capacity	In % of nominal capacity	For maintenance and machinery	For software
Cane preparation	70	40	30	10
Cane milling	70	40	40	10
Juice treatment	70	40	30	10
Evaporation	80	40	30	10
Vacuum pans	80	40	30	10
Centrifuges	80	40	40	10
Dryer	90	40	20	10
Boiler	70	40	30	10
Turbines generator	90	40	40	10
Water treatment	80	40	20	20
Other Utilities	80	40	20	20
Motors, engines, drives	70	40	30	10
Pumps and piping	70	40	30	10
Instrumentation	50	40	40	10
Isolation	60	40	30	10
Total	approx. 60	40	40	10

EVALUATION SHEETS OF SUGAR ESTATES

MARAGRA Nominal capacity - 4,300 TCD	Installed capacity	Actual Production	Requirements estimated in % of total investment cost	
	In % of nominal capacity		For maintenance and machinery	For software
Cane preparation	80	15	30	20
Cane milling	70	15	30	20
Juice treatment	70	15	30	20
Evaporation	60	15	50	20
Vacuum pans	70	15	20	20
Centrifuges	60	15	20	10
Dryer	80	15	10	10
Boiler	80	15	10	10
Turbines generator	70	15	20	20
Water treatment	90	15	10	20
Other Utilities	90	15	10	10
Motors, engines, drives	80	15	20	10
Pumps and piping	80	15	10	10
Instrumentation	60	15	40	20
Isolation	50	15	10	10
Total	70	15	25	10

EVALUATION SHEETS OF SUGAR ESTATES

LUABO Nominal capacity - 5,000 TCD	Installed capacity	Actual Production capacity	Requirements estimated in % of total investment cost	
	In % of nominal capacity		For maintenance and machinery	For software
Cane preparation	40	20	50	20
Cane milling	80	20	20	10
Juice treatment	80	20	10	10
Evaporation	80	20	10	10
Vacuum pans	70	20	20	10
Centrifuges	60	20	30	10
Dryer	80	20	20	10
Boiler	60	20	50	10
Turbines generator	90	20	20	10
Water treatment	-	20	20	10
Other Utilities	-	20	20	10
Motors, engines, drives	75	20	30	10
Pumps and piping	75	20	30	10
Instrumentation	50	20	50	20
Isolation	70	20	20	20
Total	70	20	20	10

EVALUATION SHEETS OF SUGAR ESTATES

MAFAMBISSE Nominal capacity -	Installed capacity	Actual Production	Requirements estimated in % of total investment cost	
	In % of nominal capacity		For maintenance and machinery	For software
Cane preparation	80	20	20	10
Cane milling	80	20	20	10
Juice treatment	80	20	50	10
Evaporation	70	20	10	10
Vacuum pans	70	20	30	10
Centrifuges	70	20	10	10
Dryer	90	20	10	10
Boiler	90	20	30	10
Turbines generator	90	20	10	10
Water treatment	80	20	20	10
Other Utilities	80	20	20	10
Motors, engines, drives	80	20	20	10
Pumps and piping	80	20	20	10
Instrumentation	70	20	30	10
Isolation	70	20	20	10
Total	70	20	20	10

