OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

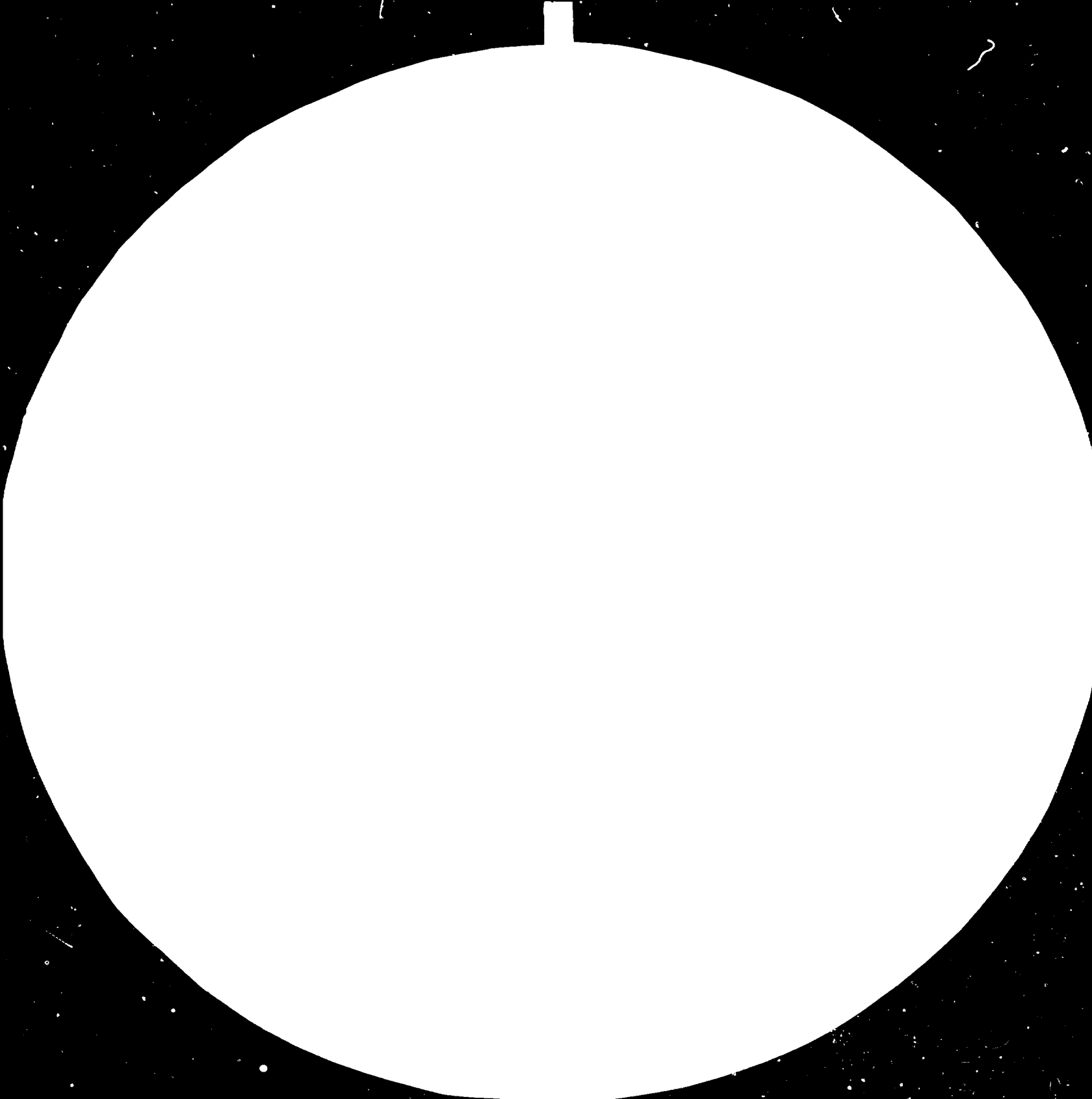
FAIR USE POLICY

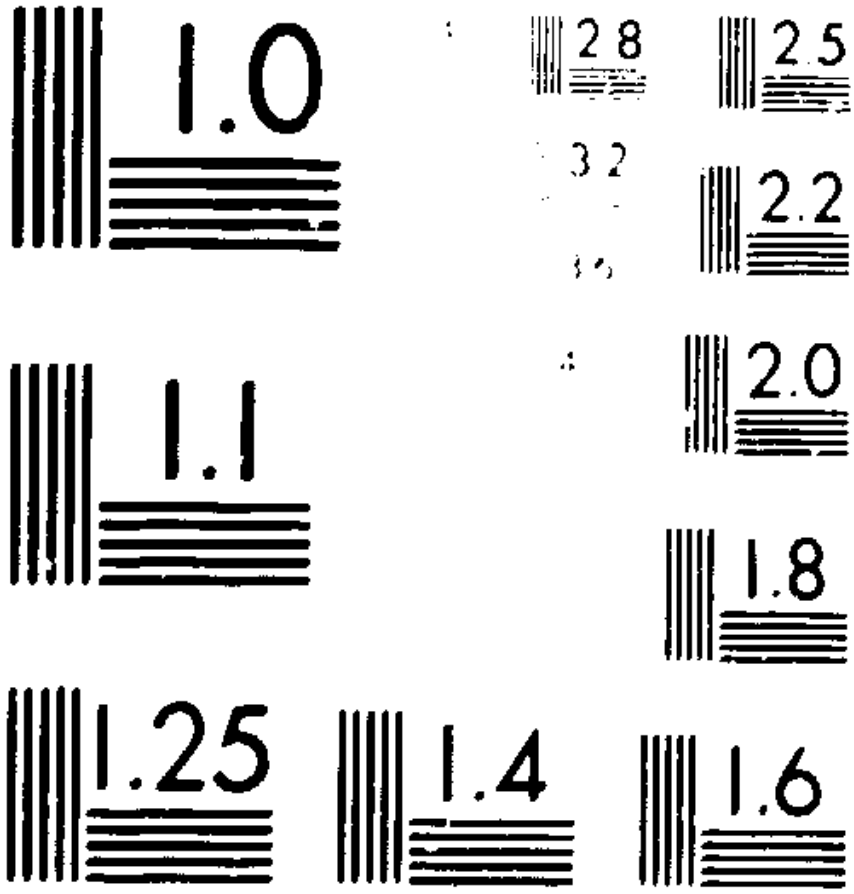
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org




1.0
2.8
2.5
3.2
2.2
1.1
2.0
1.8
1.25
1.4
1.6

RESTRICTED

13101

DP/ID/SER.A/485

25 November 1983
English

FOOD PROCESSING REHABILITATION AND EXPANSION PROGRAMME

DP/ANG/80/002

ANGOLA

Technical Report

TECHNICAL ASSESSMENT OF THE SUGAR INDUSTRY*

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

Based on the work of G. Anderle
expert for sugar production

United Nations Industrial Development Organization
Vienna

1220

* This document has been reproduced without formal editing.

V.83 64353

TABLE OF CONTENT

Abbreviations

TCD	Metric tonnes sugar cane per day
TC	Metric tonnes per day
TCH	Metric tonnes cane per hour
Ha	hectar
t	metric tonne
lt	litre
°GL	grade Gay Lussac

I. INTRODUCTION

Sugar production was established in Angola in 1908 near the village Bom Jesus. Today, there are four sugar factories in the country, of which two are near Luanda and two near Benguela, in the South.

The factories are the following:

- "Herois De Caxito", 60 km north of Luanda, established in 1933, nominal capacity: 1800 TCD;
- "Amizade Angola-Cuba", 40 km north-east of Luanda, established in 1908, nominal capacity: 700 TCD (since three years not operational);
- "Primerio de Maio", located between Lobito and Benguela, established in 1926, nominal capacity: 2500 TCD, with a distillery producing 5.100.000 l alcohol per year;
- "Quatro de Fevereiro", 50 km south-east of Benguela, established in 1914, nominal capacity: 1200 TCD.

The production capacity of the sugar industry has increased considerably during their history. From 1967 to 1973, from 60.000 t to 80.000 t/year, whilst the peak production period was in 1977 totalling 83.000 t.

The sugar consumption in Angola has increased even more rapidly than the production, from about 24.000 t in 1959 to 110.000 t in 1980.

In 1980/81, the sugar production was approximately 26.000 tonnes, which represented about 25 per cent of the consumption, or about 30 per cent of the production of 1977. The decrease of the sugar production in the factories in the North was 90 per cent, in the South about 30 per cent.

To overcome the loss in sugar production, the Government of Angola estabished a programme to rehabilitate and develop the sugar industry. It is an emergency programme given priority against other similar programmes.

According to this programme, the sugar production should be increased as quickly as possible within the next years compared to the production in 1974. In implementing this programme, the Ministry of Energy has signed a contract in 1979 with the Belgian Company SOPEX which should

elaborate a project where all aspects concerning sugar production had to be examined and proposals for each factory should be made regarding the rehabilitation and development of the sugar industry.

Within a co-operation programme with Cuba until 1979, Cuban technicians have assisted the Angolan sugar industry. In 1980, Tate and Lyle of U.K. was contacted to present a study about rehabilitation of the Angolan sugar industry.

In 1983, the Government of Angola agreed that following a co-operation programme with Cuba, Cuban technician would assist the sugar production in Angola for now and in the future, to rehabilitate the sugar production.

The objective of the visit of the UNIDO expert was to revise and comment on the studies made by SOPEX and Tate and Lyle, make assessment of the existing sugar production facilities and to make recommendations in connexion with the rehabilitation and development of the Angolan sugar industry.

II. CONCLUSION

II.1. Conclusion of the SOPEX study

According to the rehabilitation programme of SOPEX, the production of 67.000 t of sugar per year would be reached within five years.

It is recommended to close down the Amizade Angola Cuba factory and rehabilitate only the remaining three factories. They conclude that a total investment of 680 million Kw.. (approximately 23million US$) would be necessary for the rehabilitation.

According to the SOPEX study, 369 million Kw would be necessary to be invested in repairing and renewing the industrial equipment, and about 270 million Kw to change the cane transportation system in two factories.

Additionally, the following is recommended:

- to implement study programmes for the personnel:
- to engage skilled technician from foreign countries:
- to motivate the workers; and
- to reorganize the spare-part handling.

After the rehabilitation programme, a "development programme" should be executed to achieve self-sufficiency in sugar. The production should increase to 116.000 t per year. To reach this target, SOPEX recommended to inplant two additional sugar mills, each processing 4.000 TCD. The investment required for one complex is estimated at about 5.000million KW. (US$155,000.000).There are several places which have been suggested for the installation of the "new mills".

For the utilization of the by-products, SOPEX recommended to list bagasse exclusively for energy production (steam) and molasses as raw material for alcohol production. The alcohol production should be annexed to the sugar mills.

II.2 Conclusion of the Tate and Lyle Study

The study is based on visits in 1980 and 1981 in connexion with the rehabilitation of the existing sugar mills but not giving any suggestions for the development of the sugar industry in Angola.

They concluded that after a revision programme of six years, Angola would be able to produce 76.000 t of sugar in three factories. For the revision programme, they estimate an amount of 50 million Kw in foreign currency (US$9.000,000) is required. The fourth one, Amizade Angola Cuba, should be convereted into a distillery. The alcohol should be produced directly from cane and for the molasses from Caxito should be used for chemical industry and liquor production. In the agricultural field, Tate and Lyle recommended replanting the fields, renewing some cane varieties and repairing several parts of the irrigation and drainage system and to substitute the railway transportation by a road transportation system.

In the industry they recommended to start a repair programme. For the rehabilitation Tate and Lyle offers specialists to undertake the work. There is no estimation on the total investment.

II. Conclusion of the Assessment of the Factories

In the last two years much of the work suggested in the studies has already been concluded. Several areas of cane have been replanted, the irrigation system in some areas has been improved and the cane transportation system was completely renewed in two factories. For repair works and maintenance, skilled workers have been engaged. Therefore, the factories are now in a better condition than at the time when the studies were made. Not so much equipment was replaced by new ones as recommended in some parts of the studies as it did not appear to be necessary. Many of them can still be repaired (steam boilers) and do not need to be replaced. Others only need to be adjusted (evaporation) to function satisfactorily in the future. The main cause for the actual low production and the low yields is a "human" factor. There are not enough skilled workers and technicians in the factories, the present workers are not motivated enough to give better results. Some incitements for the worker as some drinks or perhaps a radio or a bicycle would motivate the people for better results in their work. There is a lack of qualified technicians.

There are some Angolan technicians who studied sugar technology in foreign countries, but most of them are now employed in administration in other fields. On the other hand, the management of the sugar factories is extremely overworked because they have to face each "case" themselves and find a solution.

Another reason for the low sugar production is the decrease in cane production which is caused by irrigation problems, availability of fertilizers and field renovation. In the sugar process, the principle problems are:

- insufficient chemical control which cause losses in sugar, low quality of sugar and high consumption of chemical production:
- insufficient maintenance control due to several breakdowns, there is a lot of production time lost for repairs, which causes losses in sugar:
- not equilibrated energy balance, there is not one factory with a good energy and equilibrated balance, the steam consumption for sugar boiling is too high:
- lack of spare parts and imported chemical products, there is a large stock of several parts, but those which are actually needed are not available.

To overcome these problems, the following is recommended:
- more chemical control of the process, implantation of processes and technologies which are easy to handle and to control;
- to establish a maintenance control programme;
- to recalculate the energy consumption of each factory and elaborate a new energy balance: to reform the evaporators (to try to keep the fuel oil consumption at practically zero);
- to make the purchase of chemical and foreign equipment less bureaucratic.

Regarding the personnel problem, it is recommended to undertake a "motivation" programme and a training programme. The training programme should not be a theoretical one, but a practical one in which the workers should be trained by skilled people to handle at least one machine and do one process step properly.

III. DEVELOPMENT OF THE SUGAR INDUSTRY

It can be assumed that actually there is a demand of about 120.000 t of sugar which is expected to increase within the next ten years to at least 140.000 t.

At the "1^{o} de Maio" factory, there is insufficient land, at the "4 de Fevereiro", there are problems regarding the water supply. The only factory which has no limitation in terms of cane cultivation is Caxito.

Based on these agricultural considerations, the future sugar production could be:

	after rehabilitation	after expansion
at 1° Maio	35,000 t	35,000 t
at 4 de Fevereiro	15,000 t	40.000 t
at Hereois de CAXITO	25,000 t	50.000 t
	75.000 t	125.000 t

To rehabilitate these production figures, the following investments are necessary in the "4 de Fevereiro" mill: consturciton of a dike and improvement of the irrigation systems, increase of the evaporation and the crystalization station in the factory, some process changes, reconstruction of the mill. In the "Herois de Caxito" mill: increase the area of plantation. The ccaplete reconstruction of the dike in "4 de Fevereiro" is not considered economical; there are two possibilities: the one is that Caxito production will be increase to about 75.000 t sugar/year, the other is that the alcohol factory - "Amizade Angola Cuba" the production of sugar would be started again. In this case, a new area about 10 km down the River Kwarza, must be cultivated with cane.

From the economic point of view, it seems more advisable to increase the production in Caxito from 25.000 t to 75.000 t as it is considerably cheaper than to increase to 50.000 t and to establish an additional "new" 25.000 t sugar production unit.

In the development of the sugar industry, the demand of molasses for yeast and alcohol production should also be included. For yeast production about 6.000 t molasses will be required and for alcohol production in the Bom Jesus factory, about 8.000 t. The total demand in the North will be about 14.000 t/year what corresponds to about 50.000 t of sugar production tons per year.

IV. ASSESSMENT AND COMMENTS

IV.1 Herois De Caxito

- The sugar mill "Herois de Caxito" produced during the period 1970 to 1974 an average of about 27.000 t of sugar per year. This production dropped down to the lowest level of about 1.000 t in 1980. However, it is now improving. In 1982, already 3.400 t of sugar were produced and in 1983, 6.000 t of sugar are expected to be produced.

e) Summary of the studies

In 1979, SOPEX stated in their study that after 44 days of examination, the factory reached the following results:

- The milling capacity reached only 783 TCD instead of the 1600 TCD installed;
- The yield was 7,4 per cent (instead of 8,9 per cent as in former years);
- The fuel oil consumption was 62,9 kg/TC.

To rehabilitate the Caxito Sugar Mill, SOPEX recommended a complete maintenance and repair programme for the factory equipment. After repairs, the factory should be able to process 1.600 TCD. The only bottle-neck expected in the equipment is the dryer for sugar.

They also recommended to install a new water treatment and to improve the boilers and the evaporation unit.

They observed that the main reason for the low sugar production and low yield was in the lack of skilled workers and the lack of knwoledge of the staff in sugar production. Therefore, they recommended that technicians should be contracted to assist the production of sugar and the repairs of the equipment as well as to motivate the workers to increase their performance.

Tate and Lyle stated the following:

From the 3200 ha of the available area, 2700 ha are planted with cane. Due to several problems for some years, there was no replantation and no proper care of the property was taken, which resulted in having to replant and renew the area. In the factory, the equipment is able to process 75 TCD, but general maintenance and reapir needs to be done of the following equipment.

- The steam boiler needs serious repair and the workers need to be trained;
- The evaporators have to be repaired and workers trained to handle the equipment properly;
- The crystalization system should be changed using three mass cooking instead of two mass cooking:
- The process control must be improved to decrease the losses during the process
- The maintenance system must be improved.

b) Comments and recommendations

In the past two years some work have already been done as recommended in both studies. At the cane fields some 1400 ha have already been replanted with cane, the irrigation system in many parts was maintained and some fields were prepared for mechanical harvesting. The old transport system by rail was substituted by a modern and more efficient road system. A programme to motivate the workers was started in order to increase the results in cane cutting. The cane cutting machines are going through a complete maintenance programme and due to the availability of spare parts, it is expected that at least three or four machines will be in working condition for the present harvest. In the factory there is also a maintenance programme going on since two years. A new unloading systems (CAMECO 45°) was also installed.

This rehabilitation programme started two years ago and already showed results in the last operational period where 3400 t sugar were produced in comparison to slightly over 1000 t in 1981.

However, the yield was still very low (5,9 per cent). The effective days of production were less than 50 per cent and the milling reached only 50 per cent of their designed capacity (37 t per hour). The main reason for the low production and low yield are the following:

- quantity of cane;
- quality of cane (low sugar and high fibre content, old cane):
- losses at the cane milling, inefficient cane preparation, regulations of the mills (velocity, condition of rolls "bagaceira" and the hydraulic system, regulation of the inhibition water, losses due to leakage):
- losses due to inversion:
- losses due to leakage of pipes and valves.

To avoid these process losses, a strict control is necessary. It is also necessary to show the workers and explain to them how to handle equipment (or process steps) properly and efficiently.

With more efficient process control the yield should improve by about 10 per cent, the consumption of lime and sulphur should decrease by 50 per cent from the actual figure (normal lime consumption is 1.5 to 2.0 kg/TC).

The cane preparation with two knives seems to be fit for a capacity of about 1600 TCD, but the efficiency of the preparation should be checked. In the future, a complete reconstruction of the cane preparation, including a desintegrator should be considered. The cane mill was repaired last year. New rolls and new knives as well as other parts were installed. The regulation of the turbines was not checked because of lack of spare parts.

A better performance of the mill is expected, hwoever, this year compared to previous years. The capacity of the installed euqipment for liming, sulfication and clarification is to handle about 80 TCH. There is applied heat combined liming and sulfitation, where at first the juice is limened and then sulfitated. There are some problems in the regulation of the lime and the sulfur addition quantities because the control of the pH with paper is not efficient. A pH-meter should be installed immediately to guarantee the exact pH-measurement. The importance of the pH for liming and decantation should also be explained to the workers to avoid losses through invertation and to have a good decantation.

To avoid incurstation at the juice heater, cleaning during operation should be carried out. The filter seems to be in a good condition.

There are five evaporation steps (one five-stage evaporator). Originally, it was an evaporation system with one or two pre-evaporation and a 3 or 4-stage evaporation unit where the "sangria" from the pre-evaporators was used to the vacuum pans and the juice heater.

The analyses shows that the concentration of juice was often very low (about 30°B instead of 60°B), which was probably caused by bad handling of the evaporation system. Using the original system with "PRE" the capacity of the evaporation would increase to 1600 TCD and the steam balance of the system of preheating-evaporation-crystalization would improve considerably. The installation of the preheater for juice

before entering the evaporation would increase the evaporation capacity even more. A detailed study should be done on this matter.

In the past operational period, there have been some problems with the vacuum pans because syrup with low concentration was used. The cooking system was also changed several times which confused the workers, and had no results.

In 1983, the original "classic" three-product system will be used and better results are expected.

The capacity of the installed centrifuges is big enough to process all sugar extracted by the mills. There are some (BROADBENT) which are in a bad technical condition and consequently need to be replaced.

There are two boilers installed whose capacity is not known, presumably between 50 and 80 t/hour. In the studies the bad condition of the boilers is mentioned as they are now going through a repair programme and therefore better performance can be expected.

The main problems of the boilers and the steam balance are:

a) the bagasse is too damp. This is because energy and boiler surface are used to dry the bagasse instead of burning them.

For example: 100 kg bagasse

Case 1 50 per cent water 50 kg water to evaporate
50 per cent fibre 50 kg for energy ratio is 1 : 1

Case 2 60 per cent water
40 per cent fibre ration is 1.5 : 1

In case 2, fifty per cent more water has to evaporate per fibre unit.

b) steam losses due to stop and breakdowns:

c) higher specific consumption of steam in the turbines due to lower capacity:

d) evaporation - vaccine pan problem (already mentioned):

e) uncontrolled juice dilution by leaking of tubes, filters and other parts:

f) problems in water preheating and condensate.

Actually 60 kg of fuel oil/TC is needed for burning in addition to bagasse. After revising the actual specific energy consumption and elaborating a new balance, the fuel oil consumption should be practically zero.

Both studies also mention that problems are caused by lack of skilled workers and their motivation. Some skilled workers for maintenance have already been engaged and are doing the job properly. A strong management has also been established for the rehabilitation programme. However, a sugar chemist and/or technologist are still missing and so are supervisors in charge of electricity, milling, sugar house and steam boiler.

According to the management, a Cuba co-operation contract was signed and a specialist will arrive during the crushing period to assist the factory.

Regarding the motivation for the 1983 operation period, a programme has already been started, it will guarantee the supply of food for the workers (those who really work) and premiums such as radios will also be given for extraordinary results.

IV.2 Amizade Unidade Angola Cuba

The factory in Bom Jesus has not been producing sugar for three years now. The last production was 350 t sugar in 1979/80.

The mill which consists of one two-roller crusher and four three-roller tandem needs to be completely reconstructed.

The equipment used on liming and decantation is scarp iron. Evaporation and vacuum pans could probably be restored locally. Centrifuges lack many spare parts and are of different origin (English and French) and it would be probably cheaper to purchase a new machine than to repair it.

The boiler station would need overhauling, although it is still in working condition. As there is now water treatment, the tubes of the boiler became dented and many of them are leaking.

The cane fields have not been taken care of for more than three years and were also not looked after before that. Many other plants are growing already in the cane fields, complete replantation must be considered. Also the irrigation system (by aspergation) needs to be looked at as many parts (pipes, pumps and springler) are missing, and the factories as well, where parts such as motors are also missing. The electrical distribution should also be renewed.

As it is known, a factory not being in operation, also deteriorates although the remaining staff and workers are doing their best to keep it up.

a) Summary of the studies:

Due to the bad condition of the unit, SOPEX recommended to close down the unit and Tate and Lyle suggested to use it for alcohol production.

b) Comments and recommendations

In fact there are 1300 ha for cane plantation which would yield about 80.000 t to 90.000 t of cane from which 8000 to 9000 t of sugar can be derived.

To rehabilitate the sugar production, high investments would be necessary and the factory still would remain inefficient and therefore, not able to compete with others. It is therefore advisable to consider, from the economic point of view, that available cane and molasses should be utilized for alcohol production as recommended by Tate and Lyle.

Should the demand of sugar increase in the distant future, 5000 ha of land about 5 - 10 km up the Kwanza river, can be used for cane plantation. The total area of 6300 ha of cane would yield about 48.000 t of sugar and about 7 mil lit of alcohol (96^{o}GL), if production of both can be simultaneously done. All equipment purchased from the first stage of the project (alcohol production), would also be used for the second stage of the sguar and alcohol production. The transformation of the existing mill into a distillery should be based on the following parameters:

Production figures

cane: 80.000 - 100.000 t produce 4.8 million lt. alcohol*

molasses: 6.000 - 8.000 t produce 1.6 million lt. alcohol

6.4 million lt. alcohol 95° GL

*the yield for alcohol is calculated always for the lower quantities of cane and molasses.

6.4 million lt alcohol 96° GL corresponds to about 13 million lt alcohol 45° GL.

Process figures

- continuous alcohol production 200 days/year (days of operation period should be fixed in accordance with the agronomy project to guarantee cane of good quality all over the operation period).
- daily production 32.000 lt alcohol 96°GL.
- daily raw material consumption: 400 - 600 TC
  30 - 40 t of molasses
- steam production from average 500 TCD (12,5 t steam per hour). The process should guarantee that bagasse will be the only product used for steam production !
- alcohol qualities: the alcohol qualities should meet the requirements of European standards (French, German, Austrian), as much as possible first grade alcohol should be produced.
- liquor; the liquors will be produced by mixing alcohol, water, sugar and aromatic components together; it is important to guarantee the supply of the aromatic components.

Equipment

Agriculture: a lot of machinery and equipment exist which are out of use due to lack of spare parts and no maintenance. Recuperation should be tried as much as possible from this equipment before buying new ones.

Industry: for cane preparation, milling, juice preparation and steam production, the equipment should be recuperated, so far as possible. New equipment is necessary for fermentation, distillation and liqour production; equipment for CO_2 and yeast recuperation should be taken into consideration.

It should be noted that the investment estimation from Tate and Lyle with 7,9 million £ for the industrial part of the project seems to be extremely high (half of the investment is considered for similar projects in Brazil).

A re-evaluation of the proposal, respectively the elaboration of a new detailed project should be considered.

IV.3 Primeiro de Maio

The sugar mill "Primeiro de Maio" is the biggest sugar producer in Angola. The highest sugar production was 33.000 t in 1972. 5250 ha belong to the plant and actually about 4750 ha are cultivated with cane. There are no possibilities for extension.

The equipment of the factory is in fairly good condition and under good maintenance.

There is also a distillery with nominal capacity of 12.000 lt alcohol per day, it is processing the molasses from this factory and from the "4 de fevereiro" mill. It is the only existing distillery in the country.

a) Summary of the studies

SOPEX stated that the sugar mill is capable of processing 2.200 TCD. They recommended following changes, respectively the implantation of new equipment:

- substitution of the knives in the cane preparation by new ones;
- reconstruction and modernization of one mill and elimination of the other;
- installation of a preheater for the evaporation;
- installation of two new boilers.

For the distillery they proposed to install a new distillation unit, because of the bad technical condition of the old equipment which does not produce alcohol that meets the standards of European first-grade spirit.

They estimated the costs of reparation investemnt on 126.500.000 Kwanzas and the substitution of obsolete equipment on 294.000.000 Kwanzas.

For technical assistance they offer services for 25.000.000 Kwanzas. The rehabilitation of the destillery is estimated to be about 45.000.000 Kwanzas. With the above mentioned investment, the factory will be able to process 2.200 TCD.

In the agricultural section SOPEX is suggesting a sophisticated drainage system to recuperate a small area where actually there are some drainage problems (because there are no possibilities to extend the cultivations).

Tate and Lyle states that with appropriate agricultural methods 397.000 t cane could be produced from the existing plantations. This amount of cane could yield 39.700 t of sugar. Tate and Lyle is convinced this production figure could be reached within five to six years.

For the agricultural department they offer their technical assistance.

At the factory they recommend the installation of new knives for the cane preparation, and to consider the use of only one of the two mills. Concerning the clarification and filtration section and the evaporation there are no recommendations. For the crystalisation it is recommended to use the 3 mass boiling system, instead of the actually used 2-boiling system.

The steam generation should be reformed, because the boilers are already used up. The generation of electric energy is sufficient; there is one 2.000 kW turbine-generator and 2 x 450 kW hydroelectric generators.

The installation of the workshops are considered good, it is only recommended to train more people in diagnostic and maintaining technics.

As there are problems to co-ordinate all the activities of an industrial sugar proudction, it was recommended to nominate people with experience (expatriates) as factory manager, chief-engineer and sugar technologist.

b) Comments and recommendations

As already stated in the studies there are 4750 ha available for cane plantation. Extention of the area is not possible. The maximal average production should be estimated on about 350.000 t of cane, due to the climatic conditions (35.000 t of sugar) and not 397.000 t as mentioned by Tate and Lyle.

Even an improved irrigation and drainage system will not yield 100 t cane/ha, because of the soil and the already mentioned climatic conditions.

During the visit it was observed that the cane was flourishing because of lack of fertilizers in the first growing stages. This will result in a high content of fibres and a lov content of sugar this year.

In general the plantations are in good conditions and mechanically well maintained. The whole cane is cut by hand and transported continuously to the factory. There is no storage facility for cane in the factory.

The factory is in a good technical condition. To process the 350.000 t of cane, the equipment should have a capacity to process 80 to 100 t of cane per hour (considering 2000 t of cane per day).

The situation of the equipment is the following:

- at the cane preparation station the knives have been changed by a kind of fixed hammers, that do not cut the cane but smash it. This means that some parts of the cane are ground into a very fine mash and some other parts are very inconsistent. These non-homogenous cane preparations makes the adjusting of the mills difficult and because of the resulting bagasse also the regulation of the boilers. It can be assumed that better results will be obtained by traditional adjustment.
- one of the two mills should be able to process 100 TC H after an appropriated regulation and adjustment. A profound study on this subject should be considered.

- in the clarification station, liming and sulfitation tanks decanter and filter are big enough for the 100 TCH capacity.
- the two evaporators (4 stages each) are also big enough to process 100 TCH consideration should be given only to install a pre-evaporator for "sangria" which should heat juice heater and pans.
- crystalisation: the equipment is big enough.
- steam production: both studies are dealing with the peculiar steam situation: this year the Tompson boiler (30 t/h) will be ready for operation and a second new 30 t/h-boiler is already foreseen. With an improved energy balance (appropriatly adjusted mills, sangria at the evaporators) the production of 60 t steam for 100 t processed cane is sufficient. Anyway, one boiler should be provided in case of emergency.
- electric energy there is installed a 2000 kW - BBC - generator, and four 450 kW hydrogenator, which are enough to supply the factory, the irrigation pumps and the offices with electric energy.

The workshop is well equipped for maintenance work and for the production of some spare parts. It has been noted that some foreign workers have been contracted and it is recommended to request them to train "on spot" local workers to increase the number of well skilled workers. Further it is recommended to improve the planning of maintenance to keep the duration of repair of breakdowns during the harvest as low as possible (i.e. to eliminate breakdowns as far as possible).

There is a very big spare part storage. But it was noted that just the sparepart which is needed at a certain time is not available, while other parts are stored for many years. This system is blocking (binding) a large amount of money which could be used meanwhile for other purposes. It is recommended to facilitate the importation of spare parts (and also other products as chemicals) to enable the factory to purchase important parts and products within a short time. However, the equipment is in good-enough working condition to produce sugar in

regular quality with regular yield. This aim was not reached during the last operating period (1982/83) when 235.058 TC with 10.9° Pol were processed and only 15.417 t of sugar and only 6.012 to of molasses produced. This corresponds to a yield of 6,56 per cent. The lowest in the history of the factory.

There are several explanations for this low process result:
- several breakdowns in the steam supply;
- breakdowns due to mechanical problems;
- lacking in process control (as high/low pH).

The breakdown supports chemical destruction of saccharose due to invertation and fermentation.

Normally the inverted sugar appears in the molasses. As the quantity of produced molasses was also low it is assumed that the main reason for the losses are:

- low responsibility of the workers for the production;
- insufficient knowledge on handling the machinery and the equipment (or disinterest or low motivation to handle the machinery in an appropriated way - just let the things run).

It must be assumed that quantities of sugar just disappeared, to the channel through leaking valves and pipes, or not appropriately closed valves, etc. It is practically impossible to "loose" such big quantities of sugar (two years ago the yield was still nearly 9 per cent and 1974 more than 9.5 per cent).

It is supposed that with better motivation and stimulation the results would be better. Anyway the technology applied is traditional and should be improved (step by step):

- better cane preparation and mill adjustment should result in decrease sugar losses in bagasse in about 30 to 40 per cent;
- better control of pH value in decantation should decrease losses in sugar invertation;
- also it should be considered to apply a technology which is easy to handle and to understand for the worker.

Therefore, it is recommended only to implant a process which is easy to understand and to handle, but also to install an efficient controlling system (organ), say contract an experienced sugar technologist and shift technicians to implement and control simple but efficient sugar production.

Motivation and stimulation for the workers also have to be provided to convince them that with good results their work will be gratified.

c) Distillery

The distillery is joined to the sugar factory and has a capacity of 12.000 l alcohol 95°GL per day.

Six tanks are installed to prepare the molasses, two vessels for pre-fermentation and six for main fermentation. The distillation unit is of copper and more then twenty years old. Some leaking parts have already been replaced. There are two centrifuges for molasses clarification but not one for yeast separation.

The equipment generally is in good working condition. As copper is "consumed" by the corrosive alcoholic mash, some parts of the distillation unit have to be replaced with time but not the complete unit as SOPEX recommended.

There is a steam boiler installed which only serves for the distillery. The capacity is not known, but it seems to be small, because during sterilisation of the molasses, the distillation of alcohol must be interrupted.

Due to these stoppages the distillery produces only 8000 l per day. On the other hand, these interruptions also decrease the yield because of losses during starting and stopping of the production and also decreases the quality of the alcohol. Therefore, it was recommended during the visit to use for the fermentation molasses which is only diluted and treated with acid and sulfate.

This recommendation had the effect that the production rapidly increased, some 50 per cent to nearly 12.0001. The reason for the increase is more time for distillation and a better performance of the fermentation.

The addition of acid and mineral salt to the molasses preparation also has been changed in the following way:

OLD	NEW
270 kg H_2SO_4	150 kg H_2SO_4 (pH control 4.0 - 4.5)
150 kg $(NH_4)_2$ SO_4	50 kg $(NH_4)_2$ SO_4
	10 kg Super phosphate
	+ 10 kg Super phosphate in each pre-fermentation

The change in the molasses preparation was not only recommended because of the low production (in comparison to the nominal capacity) but also because of the low yield. The average consumption is about 7 - 8 kg molasses per liter alcohol, while with good process control and appropriated fermentation technology about 4 kg molasses are consumed per liter alcohol.

It is assumed that great importance is not given to the alcohol production because the sugar production has priority.

Anyway, it should be noted when the units "4 de fevereiro" and "1° de maio" will run at full capacity, the molasses production will be about 17.000 t per year.

Considering the actual yield, this corresponds to about 2.1 million liters alcohol per year (or 10.000 l/day during 210 days continuous running), but considering normal average yield of 4 kg/l alcohol it would correspond to a production of about 4.0 million liters alcohol.

As the yield is very low it also should be considered if there are not very high "undetermined" losses. A better control is recommended.

Furthermore, it is recommended to change the actual fermentation system (without yeast recirculation) to a system with yeast recirculation.

There is no alcohol technologists in the factory, and therefore, it is recommended to arrange a fellowship for the actual chief of the distillery for about 2 or 3 months where he could be trained in the practice on alcohol production.

IV.4 "Quatro de Fevereiro"

This sugar mill is situated at about 60 km south of Benguela. The total area available for cane plantation is about 3200 ha. But there are actually only 2500 ha cultivated (which are even decreasing) because of lack of water for irrigation.

The sugar production in the years 1970 - 1974 was about 16.000 t per year, in 1979 it was 7000 t/year and in 1982 about 5000 t.

As long as water supply is not improved, there is no chance to increase the sugar production considerably.

a) Summary of the studies

SOPEX in their study dealt with rehabilitation of the plant to produce 14.000 t of sugar from 150.000 t of cane. To reach this aim SOPEX recommends to change the cane transportation system (road instead of train) and to improve the irrigation and drainage.

Regarding the factory they stated that the equipment is in good condition and capable to process 1170 TCD. To reach the production figure of 14.000 t of sugar, SOPEX recommended to revise the cane preparation, the steam production and the electric generator; to reconstruct the evaporation system and the vacuum pumps because of their bad performance.

In the process control they recommend better connexion between laboratory and factory and better control in the water treatment.

Finally, they offer to increase in a second step with their technical assistance the milling capacity to 1500 TCD what corresponds to a production of 20.000 t sugar per year.

Tate and Lyle study concluded also that the decrease in water supply for irrigation caused the decrease of sugar production.

About the factory, their comments are the following:

- on chemical control: there are some "inconsistencia" which should be investigated due to Pol Q, Brix of the cane in connexion to the result offactory; anyhow the chemical control seems to be good.
- on cane "patio", CAMECO system seems to be efficient and to handle at minimum 40 TCH;
- on cane preparation: as the milling extraction is 91 per cent, the preparation seems to be efficient, maximum capacity is 45 TCH.
- on mills: in fairly good condition:
- on clarification: no comments because no operation:
- on evaporation: heating surface sufficient to handle juice from 50 TCH (up to 65° Brix) is under condition that the tubes is cleared vacuum is sufficient and operation is appropriated.
- crystalisation-centrifugation: the applied system (3 mass) is due to the good Q all right;
- steam supply and steam distribution: two 18 t/h boilers sufficient for 45 TCH, but maintenance necessary and spare parts, etc.;
- electric energy generator: it is supposed that the factory needs about 600 - 800 kW, for houses and lights the demand is 440 kW during the day and 560 kW during the night.

As the total installation is only 1600 kWH (1000 kWH)steam generator and 600 kWH diesel generator), it is recommended to increase the steam-generator capacity to 1600 kWH, because an additional installation of a 5 HP motor could actually cause a breakdown of the complete electric energy distribution system.

- maintenance is considered good, but often lacking some specific spare parts.

b) Comments and recommendations

Both studies agreed that the equipment of the factory has the capacity to process 1100 - 1200 TCD.

The cane preparation according to the comments of the technical staff is satisfactory. The mills seems to be in good condition and easily capable to mill 60 to 70 TCD. As in the last years, the results of the bagasse analysis were good (Pol 2.5 - 3.0 per cent, water 50 per cent) appropriate regulation and handling can be admitted.

Actually one of the boilers (there are two with capacity of 18 t/h each) is being reconstructed. Because of the lack of bricks the reconstruction cannot be finished, the other one is in repairs. At least one should be substituted by a new one as soon as possible.

Equipment for pre-heating, sulfitation, liming and decantation is sufficient for the 50 TCD capacity. Improvement in operation could be reached by installing a pH-meter.

The evaporation (4 stages) has sufficient heating surface to process the juice from 1500 TCD. There are problems reported with the vacuum, due to the high temperature of the water, which is used in the condensation system that is actually installed for the elimination of the condensates from the several stages, due to the not very "easy to handle" system. The evaporators need after the next harvest a complete overhaul: the heating system has to be replaced (the acquisition of a new evaporator should be considered). The pans are in good condition. There is only the problem to maintain the vacuum of the pans because of the "warm" cooling water for the condensation system, and probably also to a deficiency on the vacuum pumps (capacity for 50 to 60 t filling, not for 70 t as sometimes laoded).

The centrifuges seem to be in good condition, but a complete maintenance should be taken into consideration (under supervision of the maintenance engineer from BROADBENT).

The sugar dryer operates without any problems.

In the studies, mentioned was made of a lov production of electric energy. One 500 kWh generator has already been ordered. As the factory was not operating, comments on the performance of the equipment could not be given.

The operating period 1982/83 was the worst in the history of the factory. From 105.000 TCD, 5230 t sugar and 4938 t molasses were produced. This represents a yield of only 5 per cent on processed cane.

The bad results have several reasons:

- because of delays with the new cane transport system, there was no harvest in 1981 and as a result, the cane cut for 1982 was from 1981 and more than 24 months old.
  which is damaging pumps and other equipment and increasing the interruptions and losses due to invertation, infection and direct losses.
- because of the damage of one filter, the sludge of one clarifyer was drained instead of being filtered.
- there were several other breakdown which resulted in loss of Pol, as break in the bagasse transportation, loss of vacuum in evaporation and in vacuum pans.
- problems with electricity supply - centrifuges stops, etc.
- and others.

Anyway the staff is aware of these problems and is doing its best to overcome them.

There is a good equipment workshop for maintenance and spare parts production but due to the lack of enough skilled workers and technicians, not all the necessary work can be executed in quality and quantity.

The process control is good but sometimes exists the problem to prevail the recommendations in the reality of the factory. The laboratory is well equipped but needs to substitute some equipment is already worn out (pH-meter, balance).

There exist good literature on sugar production and also records on the production of the past years. The chemical control is carried out very carefully. Only some errors have been made on the calculation of the factory yield because of different modifications on the method in the past.

The water treatment for the feed water of the boiler is similar to the other factories working with cationic and anionic ion-exchanger. Sometimes problems occur due to the lack of chemicals. The operators know how to handle the equipment appropriately.

Recommendation

The main problem of the "4 de fevereiro" mill is lack of water. There is not enough water for appropriate irrigation of the fields and not even for the factory.

Therefore, construction of a dike is absolutely necessary to enable the "4 de fevereiro" also in the future to produce sugar. As the cane plantation is divided by a river which is normally dry during the harvest, a bridge should be constructed as soon as possible to guarantee cane transport also when the river is flowing.

For the factory it is recommended to substitute, in the next one or two years, the already used-up equipment (as mill filter, evaporator) to elaborate a preventive maintenance programme and a programme for repair and substitution of equipment.

Spareparts should be purchased only according to this programme to avoid that unnecessary parts (as valves) are stocked and to guarantee that sufficient necessary spare parts are always available. A simplification of the actual "high bureaucratic" purchasing system would help the factory a lot to maintain a stock of sapre parts and chemicals at lower costs.

To improve the actual process it is recommended to plan:

- a cane washing system with water recirculation:
- water recirculation and water cooling for the falling water
- energy balance (providing systems to economise steam, e.g. "SANGRIA"): and
- material balance and more process control to decrease intermediate losses and the quantity of molasses.

V. ANNEX - Visit to the Yeast Factory in Luanda

The main purpose of the visit was to obtain information about the actual yeast production and the molasses consumption in the factory and the future development of production and future demand on molasses.

Actual production:	1.100 t yeast/year
Molasses consumption:	1.100 t* /year

There is a project to expand the production in the next three years to about 4080 t yeast per year. The molasses consumption will be about 6000 t.

Remark: 6000 t of molasses correspond to a sugar production of 20.000 to 25.000 t. This quantity Caxito plans to produce in about 4 years and to send it to the alcohol factory in Bom Jesus.

Based on the "actual" yield the molasses consumption would be nearly 8000 t for the desired 4080 t of yeast. Therefore, it should be examined:

- why is the actual production yield so low, and what can be done to improve it.
- what molasses quality is desired for the future yeast production.

Based on a detailed examination of the molasses situation, both projects (alcohol and yeast) should be co-ordinated.

Comments on the yeast factory

The yeast factory is the only one in Angola. Some equipment is already more than 50 years in use but gives a good impression in general. The centrifuges are very old but will be replaced even this year.

There are problems in the bread supply in Angola, sometimes due to lack of wheat flour and sometimes because of lack of yeast. The technicians of the factory mentioned, that there are a lot of problems with electric energy and water supply which makes it difficult to increase the actual production. On the other hand, amplification is projected.

---

*This consumption was "theoretical" but it was admitted that normally some 50 per cent or even more are consumed (last year 2000 t).

It was also observed that there are some misunderstandings about the consumption figures (as for instance the quantity of air). Maybe the visit was too short to clear all questions. The following are still unanswered:

- why is the yield so low (only losses by lacking separator)
- if there are already problems with water and electricity supply, what measures are provided for the expansion.
- experience shows that reconstruction takes about 3 years. What measures are taken to guarantee in the meantime the supply with yeast at least for the Luanda area (3 t/day at maximum peak).

VI. SUMMARY

Actually Angola is producing 25.000 t sugar. The demand is more than 100.000 t. The capacity of the mills is to produce 75.000 t sugar.

To rehabilitate the production it is recommended:

a) in the agriculture field:
   - reform of the plantations
   - improvements in the irrigation and drainage system
   - implementation of new varieties
   - proper application of herbizides and fertilizers.

b) in the factories:
   - maintenance and substitution of some equipemnt
   - better and more efficient process control
   - implementation of "easy to handle" technologies
   - elaboration of energy balances and implementation of energy efficient processes
   - implementation of practical training programme

All implementations of new equipment or new processes must be based on economical concerns. More importance should be given to the utilization of the by product molasses; molasses is an important raw material for the yeast and alcohol industry and the available quantities should be balanced as source for the two products.

For the development of the sugar production it is recommended to keep producing sugar only in three factories, but to increase produciton considerably in the Caxito-factory. As the demand on sugar is growing with the population, it is estimated to be in ten years about 140.000 t. To reach this production already at the rehabilitation phase, the future development of the sugar industry should be projected.