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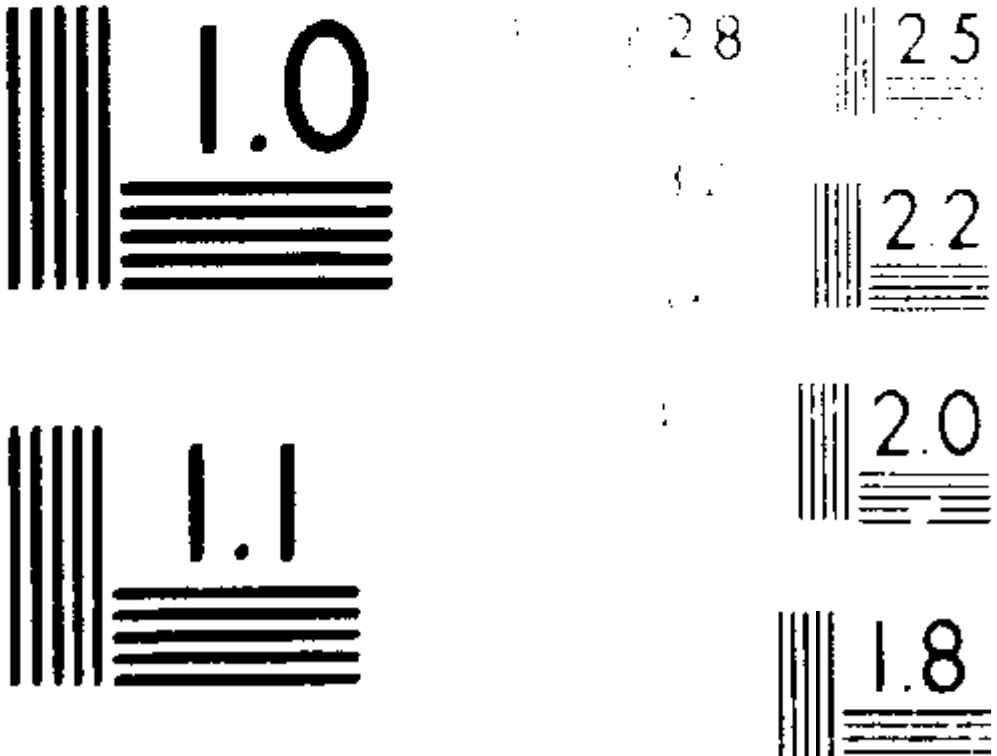
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REPORT ON THE DEVELOPMENT OF THE COCONUT INDUSTRY IN ZANZIBAR

SI/URT/82/801

This report may be considered in preparation of the forthcoming project DP/URT/81/028

Mission report*

Prepared for the Government of the United Republic of Tanzania
by the United Nations Industrial Development Organization

Based on the work of
J. Bulot, expert in coconut processing

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Abstract and Conclusion

In summarizing this report, we can draw the conclusion that the production of copra is unsatisfactory both in Zanzibar and Pemba due to bad harvesting and seasoning conditions and also owing to lack of drying time and unsuitable equipment which badly effect the quality of the raw material, the oil production and its quality as well as the cake.

- Methods of production and equipments are obsolete and lack of maintenance causes most parts of the machines to be out of repair.

- Dispersal of small obsolete oil mills means high losses of oil, higher consumption of energy and inferior quality of end-products.

- It would be advisable to concentrate on only one or two factories and close down the others. There are two plants which can be up-graded and modernised which should then be able to process all the coconut production of Zanzibar.

- The semi-existing solvent extraction plant (which is not ready to be mounted) is doubtfully economical because of its small production capacity especially for processing copra.

- Any kind of control does not exist either for commercialization of raw material or for the production of oil and cakes. Under these conditions it is difficult to assess what is being done and also to detect eventual problems during processing.

- A control laboratory is an absolute necessity.

- No co-ordination exists between the different stages of the coconut exploitation (harvesting), seasoning, copra production commercialization, oil mills, etc.

- To improve the existing situation, it is absolutely necessary to establish a Coconut Authority in order to co-ordinate the different stages of coconut's exploitation, and particularly between the agricultural, commercial and industrial aspects of coconut production.

- Valorization of by-products is in fact very poor. There exists a coir production which is badly affected by the out-dated equipment which needs to be replaced in order to be able to better compete in the world and local market.

- Already now it is possible to create and develop a cottage scale charcoal industry.

- These different aspects are described in this report.

Development of the Coconut Industry in Zanzibar and Pemba

I. Existing situation

a) Availability of raw material

Copra purchase of Zanzibar State Trading Compnay (ZSTC) is as follows:

1974/1975	12,406 tons
1975/1976	12,154 tons
1976/1977	5,127 tons
1977/1978	10,544 tons
1978/1979	11,588 tons
1979/1980	13,184 tons
1980/1981	

The production capacity of the existing oil mills (Zanzibar and Pemba) is the following:

Daily: 41,5 tons (in 7 hours only)
Yearly: 12,450 tons (300 working days).

Under the present working conditions (24 hours), one can assess the actual production potential as being approximately 41,000 tons. It seems that the actual production is limited due to the availability of the raw material which can be estimated at not more than 14,000 tons (for industrial purposes), whereas only the "oil complex" would be able to process under normal condition about 16,000 tons at least per year.

b) Quality of the raw material

The copra coming out from the drying kilns is not sufficiently dried. We can roughly estimate the moisture content as being approx. 15 per cent. This is the expert's own assumption since there is no available analysis figure owing to the lack of a control laboratory. Under such conditions the copra becomes mouldy in a few hours, the FFA of existing oil increases considerably, the protein cotents in cakes becomes lower.

I have noted also the presence of Aspergillus Flavius which probably means the presence of Aflatoxin, and probably toxicity of the produced cakes.

This raw material is also of flexible texture which makes the further grinding before pressing difficult.

c) Production of raw material

Harvesting

Harvesting is done only four times per year because of the age of the plantations (60 years or more for some of them) and the height of the trees which is understandable seeing it from the climbers point of view. Normally it should be done every six weeks.

The proportion of green nuts are stacked directly on the ground for seasoning. Under such conditions, some of the nuts start to germinate, others deteriorate because of lack of ventilation from the bottom of the heap, and the further oil and cakes yields becomes badly affected.

Dehusking of nuts

This operation seems to be done normally, therefore, no comments need to be made.

Opening of nuts

This is done immediately before drying and it is done the usual way.

Drying of opened nuts

All the existing kilns in Zanzibar and Pemba are traditional direct smoke dryers of Tayabas type which are used in the Philippines by small holders. (See Figure 1). However, in the Philippines, the kernels are scooped out of the shell prior to drying causing the cycle time to be 3 days. In Zanzibar, the cycle time is only 1 to 2 days and dehulling is done after drying. This explains the bad results obtained and the insufficient drying of copra which, after "drying" has a moisture content of at least 15 per cent (subject to appreciation). After "drying", the copra is packed in bags and sold to ZSTC.

Storage of copra

Copra is stored in the ZSTC's warehouse without any protection against insects and other rodents. It is commercialized by ZSTC and sold to the oil mills. ZSTC classifies their copra in two grades, according to its apparant dryness. The first grade which according to them is the best, comes directly from the copra they received from the dryers, after five to six months of storage in ZSTC's warehouse.

However, storage of a wet copra can only worsen the initially bad quality of this type of copra, seeing it from the oil extraction view point. A quality test should be made on the following:

Moisture content;
Oil content;
FFA content of the oil;
Protein content of the meat.

All these analysis may be done with a special equipment (semi-automatic) which does not require the help of a team of chemists. It is the only way to establish the quality of the copra and its normal commercialization.

d) Processing of raw material

In Zanzibar and Pemba, there are nine oil extraction plants of which one is in Pemba and the others are located in Zanzibar City. With the exception of the Oil Complex (Annex 1) which has been erected by EIW (Ernst Thalmann-Magdebourg-Burkau East Germany) according to a modern design, all the others are working in the same unsatisfactory method, namely no preliminary cleaning, mechanical handling, proper grinding and no boiler. Even the Oil Complex does not possess a boiler and the cooking of the meat is not possible in all the oil mills including the solvent extraction plant.

In particular the following observations may be noted:

- Fitting of the solvent extraction and steam refining plants is in progress, supplied by De Smet and Sharpless (India).
- In all plants, the level of maintenance is practically non-existance.
- There does not exist any kind of control to check the quality of the production.
- All these plants are working with interruption, not more than seven hours per day. The Oil Complex works only five hours.
- This results in considerable losses of oil in the cakes, extremely high power consumption, high abrasion of all the equipments.
- By not continually operating this kind of expellers, the capacity of all the production declines since an expeller working normally (24 hours per day), with an average processing capacity of let us say, 20 tons per 24 hours of copra does not mean $\frac{20 \times 7}{24} = 5,8$ tons within 7 hours, but considerably less, perhaps only approximately 3,5 to 4 tons without taking into consideration the lack of cooking which has an influence also on the production capacity and on the loss of oil.
- Due to a total lack of control it is difficult to know exactly what these losses may represent. However, I think the cakes have at least 12 to 15 per cent of residual oil content.
- All the oil mills are working in single pressure, except No. 6 (see Annex 1) which is working in double pressure without any kind of mechanical handling.

In brief we can say that due to the quality of the raw material, it is hardly possible, even with the best equipment to obtain a high quality standard product. In order to obtain products (oil and cakes) of a normal standard, the output is also low. The process presently used (without cleaning, proper grinding lack of cooking, etc.) increases the losses. Consequently the ratio between power consumption and production is high.

Without any kind of control, it is very difficult to know what is exactly needed to be done to improve the quality and to lower the operating costs.

II. Development action to be taken

It is practically necessary to take action on each stage of the production chain, starting from plantations to the final oil and cake. It is possible to take action as regards the quality of the raw material in the following three different stages:

Harvesting
Drying
Commercialization.

Harvesting

- It would be possible to improve the actual seasoning of nuts by using trays or shelves to avoid the direct contact with the earth and to allow the air to pass through the heap and to prevent an accumulation of water on the bottom of the heap.
- The time of seasoning should not be less than five weeks
- When a mixed crop is harvested, it is essential to separate the green nuts from the brown nuts, store the former for seasoning for one month (5 weeks) and process the latter into copra without preliminary seasoning.
- The harvesting of green unripe nuts must be prevented by more careful supervision.
- Unripe green nuts should never be mixed with dry coconuts.

Drying

Owners of drying kilns are mostly conservative people and it would therefore, be difficult to change their habits. To convince them one would need to prove that up-dated drying systems are more profitable although the drying time will be longer and the quantity of quality copra produced will be less (100 kg of copra at 15 % moisutre content, 90 - 91 kg at 6 - 7 %).

Improved modern demonstration kilns may be set up and also a charcoal production pilot plant constructed in order to profitably utilize the shells (100 kg of shells may produce about 20 to 25 kg charcoal). The charcoal production may increase the profit of owners of the kiln driers who are at the same time shell producers (See Annex 1).

Traditional but out-dated drying method

After dehusking and opening, the halves nuts are directly dried on the kiln and only after drying, the kernels are scooped out. The shells slow down the drying process and increase the duration of the operation. It is easier to dehul the nuts after an initial pre-drying period.

Pre-drying

According to the weather condition, it is possibe to pre-dry copra by using direct sun in the open air. After seasoning, the de-husked nuts are cracked allowing the water to flow out. The split nuts are spread evenly with their face upwards on a clean place or better on a cemented floor. After a few hours, the initial moisture content of the wet nuts (50 %) decreases considerably (approximately 25-30 %).

If the weather condition does not allow this kind of natural pre-drying, the halves nuts are directly dried on the kiln. However, after the first day, in order to accelerate the drying process, the shells be removed from the meat which is again to be placed on the drying kiln for one or two more days.

Drying

The existing Tayaben type kilns are direct smoke dryers, and smoke does affect the quality of copra.

- It is possible to use smokeless dryers, by using only dried shells as fuel instead of husks. However, the best way is to use indirect heat dryers for the production of high quality white copra i.e. heating the coconut meat indirectly.

- Instead of direct smoke, hot combusted fuel gas heats the clean air through a heat exchanger. The hot air comes into contact with the drying coconut meat not carrying any impurities.

- It would be possible to improve the existing kilns by adapting them to use only dry coconut shells as fuel, in order to reduce the smoke considerably or to almost prevent the smoke completely. The only thing which needs to be done is to put each half shell next to another in such a way that when the row is ignited at one end, the fire moves slowly from one shell to the other. Thirty to fourty shells placed in such a way would be enough to keep the heat for 3 to 3.5 hours, thus the amount of heat discharged is controlled.
To simplify the method, it is possible by stringing the shells out on an iron rod which may be prepared in advance, and if necessary, one or two such skewers may be used at the same time in the kiln.

- It would best be to construct a pilot plant using the indirect drying system in which any kind of fuel may be used.
The benefits one gets by using such a kiln are the following:

  - Excellent quality white copra can be produced provided that the dryer is operated properly. This, however, will not hold true if the heat exchanger has leaks which would allow smoke to penetrate and get in contact with the copra.
  - Edible grade copra is possible, if proper treatment of kernel is ensured to avoid contamination and deterioration prior to drying.
  - Due to the excellent quality of copra, deterioration during storage or shipment can be minimised thus decreasing the loss of oil during storage and a better quality oil when expelled.

The disadvantages, however, by using this type of dryer are:

- Higher fuel consumption compared to direct dryers, depending on the heat transferred to the hot air.
- Higher cost of maintenance caused by the replacement of the tunnel with second hand drums.

The dryer shown in fig. 1 consists of a flue made of 200 liters second hand drums, connected to a chimney of about 15 centimeters diameter and 4 meters high. Five drums are connected to each other by means of soft steel straps without air leakage. Tightness of straps may be obtained by a mastic compound made of clay in order to resist the heat.

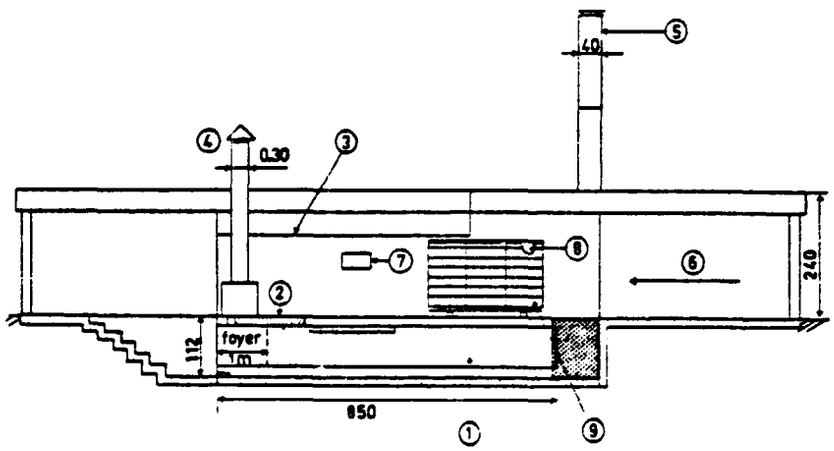

Fig. 1

Plan of a hot air oven

1. Heating tubes
2. Insulating elements
3. False ceiling of 5 m length
4. Smoke stack (tube diameter 0.30)
5. Chimney for the evacuating of moist air
6. Movement of trolleys
7. Registering thermometer
8. Controlling thermometer
9. Trolley with trays having a wire-mesh bottom

The flue may be placed in a kind of trench or into two walls supporting a wooden structure to hold a 3,70 x 1,80 m platform on which the kernels are loaded. In the latter case the hot air chamber is enclosed/covered with old jute bags which have been soaked in diluted cement grout to make them fire-proof.
The flue must have a slight slope from hearth up to the chimney, in order to create a natural draft. The fire at the open-end of the flue tunnel is started with husks and shells and then fed only with husks. The combusted gasses and smoke travel through the flue tunnel and escape through the chimney. Pure clean air heated by the hot flue tunnel rises through the kernels drying them.

This type of drying kiln has been considerably improved in an uncomplicated and unsophisticated way by the IRHO in Grand-Drewin in Ivory Coast. It is roughly similar to the above indirect heat dryer but instead of one copra tray, seven to eight copra trays are suitably arranged in the drying system. At each end, the system is closed by tight doors allowing the hot air stream to enter at one end and to come out at the other end. The hot air coming from the heating flue passes through the copra trays and leaves through a chimney by natural draft.

It is very important to prevent any entry of cold air in the drying corridor during heating period and gaskets must be fitted at each door in order to close the corridor tightly.

Sizes of existing Grand-Drewin's drying kiln are as follows:

Drying corridor: 9 m x 2.80 m x 2 m (height)
Heating flue: 8.50 m x Ø 0,50 m (each)

There are two parallel flues at about 0,50 m away from one another. Each of them has a small smoke chamber directly connected to its own chimney (one chimney per flue). At the other end of each flue there is a hearth in which husks are used as fuel.

The system is constructed in order to be able to receive several trays of each 0.90 m x 0.90 m and 0.15 m high. Each tray is able to receive about 30 kg of pre-dried copra (sund-dried, weather permitting).

Although the height of the drying corridor would allow more, the normal loading is not more than 7 to 8 superimposed trays, i.e. 63 to 72 clays in all, i.e. 1.8 to 2.1 tons of kernels (3 x 3 = 9 clays per superimposed row of clays).

The overall size of the platform is 2.70 x 2.70 m.

The operating procedure is as follows:

Every morning the hearth is lighted at 6 o'clock and regularly fed with husks until 19.00 hours. They are then lighted again the day after. The drying corridor has a capacity of 3 fully loaded trucks. One truck of dried copra comes out of the corridor every morning and gets replaced by another one load with fresh kernels.

The daily production results in one truck per day, i.e. about 780 kg under the actual condition in Zanzibar. (In Zanzibar, 7,000 nuts are necessary to produce 1 tonne of copra, whereas in Ivory Coast 5,000 nuts would be enough). The normal load of a truck is about 5,000 nuts.

Fuel

Husks are used as fuel, there are already partially and naturally dried at the moment they are used and its burning time is almost constant.

In order to get a good steadiness of heat, hearthes are loaded every 20 minutes. The necessary amount of husks varies according to ambient temperature, about 30 husks are used per hour and per hearth. (i.e. 60 husks per kiln).

According to experience, it is necessary to burn about 8 to 12 hours at the same time, and per hearth in order to maintain the proper temperature of heated air. During the heating time, the temperature of the air over the truck beside the hearth i.e. over the most dried copra, is permanently of the range of 65 - 76°C during the heating period, and 40 - 45°C during the night.

In order to properly adjust the feeding of the hearthes according to the suitable range of temperature, it is advisable to use a dial thermometer.

Manpower

Only two persons are operating the drying kiln. The first one from 6 a.m. to 2 p.m. and the second one from 12.p.m. to 7 p.m. They maintain the fire and check the temperatures, the loading and unloading of copra, filled them into bags and weigh the bags. The truck coming out from the kiln at 6 a.m. is unloaded during the course of the morning, the copra is put into bags, weighed and then stored. During the course of the afternoon, the trays are filled and loaded on the truck and the truck is placed at the entry of the drying corridor. Last feeding of the hearths is done at 7 p.m. just before departure of the personnel.

The sizes of such a drying kiln may be adjusted according to the foreseen production. It is always possible to reduce or to increase them.

More detailed descriptions and operating procedures with different types of kilns have been studied in the document of the Asian and Pacific Coconut Community: "Coconut Harvesting and Copra P[illegible]n" in which methods described in the document would be usef[illegible]ould be applied in Zanzibar.

Preservation and raw material

The main causes of copra quality degradation are:

1. Insects.
2. Fungi i.e. microscopic mushrooms growing generally in the presence of air.
3. Yeasts which are monocellular organism, the development of which is encouraged by a slight acid pH. In anaerobian surrounding, they decompose their support to get the energy required for their development. They originate from fermentation.

4. Bacteria which are encouraged by a slightly alcaline medium and which are multiplied by division of cells.

The condition which develop yeasts and bacterias is influenced by the moisture content of the copra.

Preservation measures to be taken

Yeasts, mould and bacteria are among the main causes of deterioration, however this can only take place if the raw material is wet. The first precaution would be to only store dried material. At a moisture content of 7 per cent, in the case of copra, yeasts, mould and bacteria can not develop.

Damages due to insects are more difficult to prevent but can be consideraly reduced with appropriate treatment. To prevent insects attacks one should consider the following, namely the floor of the warehouses must be cemented, the soil, the surface have to be treated with lime wash adding one per cent of kerosen. It is also possible to use some insecticides in the form of a solution or powder. If the walls are made of riddles, injection of insecticide under pressure would give good results. (Linda, Cerethon Roethonon give good results).

The bags which are stacked may be treated with fumigations of methylbromin after covering them with tight tarpaulins. These various treatements needs to be repeated regularly, at least four times a year.

Commercialization

As it has already been pointed out, new methods of commercialization should be used in order to pay the copra's producers according to the real quality of their products and not according to the present ZSTC's method. This is the only way, to give an example of what can be obtained in order to encourage the copra dryers to produce better quality.

With the present kilns, copra bought by ZSTC has a moisture content of may be 12 to 15 per cent. By preliminary sun-drying them for a few hours and then drying them on the existing kilns for 3 days instead of one or two days, the copra obtained will not be absolutely perfect but it will be considerably improved and should not have more than 6 to 7 per cent moisture content. Under these conditions, it will be less subject to insect attacks and practically free from mouldiness or bacterial action.

The acidity contained in the oil should be reduced to not more than 2 per cent or even less, (as lauric acid) and after expelling the oil yield will be increased. The copra with 6 - 7 per cent moisture content can be stored for a longer period without much damage. While awaiting the setting up of a control laboratory which will only take place some time, it would be possible at present to use a very simple way of testing to estimate the moisture content of copra.

Copra with a low moisture content burns easily which is not the case with copra with a higher moisture content. The folowing are the characteristics of thin sliced copra at various moisture levels:

Moisture content:

Less than 7 per cent:	burns readily
Between 7 and 10 per cent:	flame splutters
Between 10 and 15 per cent:	burns with difficulty
More than 15 per cent:	does not burn at all.

Working conditions

Out of the nine existing oil mills or extraction plants, eight are located in Zanzibar city and only one in Pemba. Among these oil mills, two are modernly designed, namely:

The Oil Complex

The Solvent Extraction Plant which is not finished to be mounted. All the others are obsolete and are in a very poor condition due to total lack of maintenance. The present Oil Complex (East German equipment), works only five hours per day, however, the equipment is designed to continuously operate for 24 hours/24. Under the present situation, it does not operate economically.

An expeller designed for daily capacity of let us say, 24 tons per 24 hours, i.e. one ton per hour will have its capacity reduced to may be 0.7 - 0.6 tons or less.

The absence of a boiler means that there is no possibility to cook the raw material which is another contributing factor to the low production. The existing FIW expellers are able to produce a copra cake with 7 per cent or less, residual oil content, but under the actual condition, the oil content in cakes should be at the range of 15 per cent, or perhaps more.

Properly adjusted and fitted with new worms and barrels, and working under normal conditions, the existing Oil Complex will be able to produce cakes with not more than 7 per cent of oil (by single pressing) or with 15 per cent (prepressing) in case of a further solvent extraction.

From the present production of 6 tons in 5 hours, we can estimate a normal capacity of about 30 - 35 tons per day, by single pressing (cakes with 7 per cent oil) or of about 55 tons by prepressing before solvent extraction (cake with 15 per cent oil). This means a yearly capacity of 10,500 tons (single pressing) or 16,500 tons (pre-pressing and further solvent extraction).

With raw material availability of 14,000 tons, the existing oil complex would be able, after some readjustments, to process the total production for Zanzibar.

Renovating the oil complex would mean adding the following:

1. One boiler and its water treatment;
2. One vibrating screen or a screening tank.
3. Automatic recycling of fines coming out from presses, vibrating screen and filter cakes.
4. Over-feeding of meat conveyor to expellers to allow higher regularity.
5. Excess of meat coming from meat conveyor should be replaced and mixed with fresh meat and recyled material coming from 3.

6. Increase of filter press capacity
7. Renovation of expellers
8. Maintenance workshop
9. Spare-parts for two years.
10. Control laboratory.

At present it would be advisable to request EIW for a tender to renovate and improve this plant.

Solvent extraction plant

The equipments supplied by the NIDC (National Industrial Development Corporation) of India is in fact not ready but it is in progress. The buildings seems to be constructed according to NIDC's instructions. In fact, only the extractor is finished to be mounted, the other parts of the equipment are still pending.

Steam refining unit

This has also been supplied by NIDC. The degumming section is from Sharpless (India) and of a continuous type. All equipments for the solvent extraction as well as for the steam refining unit appear to be made from mild steel.

The capacities are (per 24 hours) the following:

- Solvent extraction plant: 30 tons of copra cakes at 15 % oil;
- Steam refining unit: 25 tons oil.

Boiler

This is foreseen but does not as yet exist. It must be used for steam refining unit for the solvent extraction plant and for the pression section which is actually working with the same bad condition as the other oil mills of Zanzibar.

The technician who are actually in charge of the Solvent Extraction Plant, and of the steam refining unit has been trained for some weeks in India but he seems to lack a sound technical background which is a serious handicap. For a certain period it would be necessary for him to be assisted by an experienced oil technologist who is well aware of steam refining and solvent extraction.

Laboratory

For the Solvent Extraction Plant as well as for the Steam Refining Unit, a laboratory is still tentative. However, without a laboratory, the steam refining and solvent extraction plant will not be able to operate satisfactorily and therefore, such a laboratory would be a necessity.

Later in this report it shows that the Solvent Extraction Plant will be doubtfully economical due to its small size and also because of other reasons.

Concentration of the oil mills of Zanzibar City

Except the Oil Complex and the Solvent Extraction Plant, which is not finished to be mounted, all the other plants are obsolete and are in a real bad condition.

Eight oil mills to process raw material of approximately 14,000 tons per year, or averagely less than 5 ton per mill per day (250 working days per year) would be uneconomical. This kind of dispersion would mean a real waste of energy and increase the loss.

To improve each oil mill would be too expensive because six of the mills would need their equipment to be changed completely. Under these conditions, it would be better to concentrate on the production in the Oil Complex and in the pressing section of the Solvent Extraction Plant.

A. In the case of expelling in one single pressure, with the production of cake at 7 per cent of residual oil content, and with 300 working days per year, we would have the following:

Oil Complex: daily capacity 35 t
yearly capacity 35 x 300 = 10,500 t
Available for pressing section of the Solvent Extraction Plant/ 14,000 - 10,500 = 3,500 t.

Pressing Section of Solvent Extraction Plant:
daily capacity: 3,500 : 300 = 11,7 t.

B. In the case of pre-pressing before solvent extraction, with the cake production at 15 % residual content:
Oil complex: daily capacity 55 t
yearly capacity 55 x 300 = 16,500 t.

For A. it will be necessary to work 300 days per year and also to complete the pressing section of the solvent extraction plant with the following:

- mechanical handling
- cleaning equipment
- more suitable grinding
- adjustment of expeller
- increase of filtering equipment
- vibrating screen or screening tank
- recycling of the feets coming out of the expeller vibrating screen or screening tank, filter's cake, and mixing of oil recycled material with the fresh meat coming from grinding.
- boiler for cooking of meat.

For B. the pressing section of the sovlvent extraction plant will work only in case of emergency and all the prepressed material will come from the Oil Complex.

For both cases, the Oil Complex needs to be renovated and all modifications should take place only after ensuring the quality of the raw material.

Products of the coconut industry

The main by-products of the coconut industry are husks and shells. A significant amount is directly used in the drying kilns for copra preparation, however 700 tons of coir per month is not utilized in spite of an export market of 500 tons per month. This is due to the operating costs which are higher than the market price caused by the existing equipments which are obsolete and in a real poor condition.

In principle, the baling press should be replaced by a modern one in order to lower the operating costs. There are actually 400 tons of coir on stock and the production is stopped owing to lack of its utilization, even locally. 1,500 to 1,550 kg are used monthly for the production of ropes and 350 square meters are weaved and the existing market is at least, triple. However, the production of ropes and carpets is entirely manual because of lack of spinning and weaving machines. Such small machines would be of help to the small scale industry.

As regards the shells, it is presently already possible to create a cottage scale industry for charcoal (See Annex 1).

A small handicraft market exists but with no effect on the real utilization of coconut shells.

With the coir and also with the waste coming from coir production, may be possible to consider the manufacturing of particle boards.

Coconut may also be considered as a new energy source. Considering a standard coconut plantation of 150 trees per hectare and bearing 10,000 nuts/year, the calculated energy obtainalbe from the shell, husk and petiole amounts to 54.5 million kg-calories which is equivalent to 5170 litres of gasoline per year). Research is actually in progress in order to fully exploit these energy sources.

III Competent national organization in charge of the coconut industry development work in Zanzibar and Pemba

In actual fact, the coconut industry is like a chain with independent links. Plantations, harvesting, drying commercialization of copra, oil extraction and cake production are all independent from each other. At present there is no co-ordination between the different links of this chain. Without a suitable coordinating authority/body it will not be possible to improve the present situation.

A "Coconut Industry Development Authority" should be in charge of all relevant actions to be taken to improve the present situation and apply and develop the suggestions made in this report, and it should be competent in different fields of the coconut industry such as:

- Plantations;
- Harvesting;
- Seasoning and drying;
- Oil industry;
- Utilization of by-products;
- Commericalization of copra oil cake.

It should be able to act as a competent counterpart for an eventual forthcoming UNIDO project. Without a National Coconut Authority, the project may be delayed, or cancelled due to lack of a competent counterpart.

The creation of this Authority must be a priority target and be the first step of the coconut industry development in Zanzibar and Pemba. It would be desirable if this Authority be considered not only as a co-ordinating and consulting agency, but also as an executive one upon approval of the ministries concerned.

To summarize the above suggestion and to define the duties of this Authority, the development action it will have to take will be at short, medium and long-term.

The short term actions may be started immediately and are simple.

Short-term actions

1. Harvesting conditions: try to harvest only the ripe nuts;
2. Classifying of the nuts and separating the green nuts from the ripe one before seasoning. In any case these nuts must not be mixed;
3. Improving the seasoning, by the use of bricks in order to avoid direct contact with the soil and to allow the air to pass through the heaps from the bottom.
4. Construction of a pilot kiln (drying time: 3 days)
5. Production of charcoal from coconut hulls (pilot plant)
6. Valorization of the by-products.

In actual fact 7,000 nuts are necessary to produce one ton of copra with at least 12 % moisture content. It is generally known that 5,000 nuts are enough to produce one ton of white copra with 6 % moisture content. The difference is caused probably by a too big amount of green nuts processed at the same time as the ripe one which is due to lack of classification after harvesting and before seasoning.

This classification will improve the profit of dryers because of the increase of copra production and also the final oil yield and the quality of oil and cake.

Medium term action

1. Boiler for the oil complex
2. Boiler for the solvent extraction plant (pressing section)
3. Request EIW for a tender for the eventual renovation of the existing plant and to complete it.
4. Creation of a control laboratory.

Long term actions

1. Renovation and completion of the Oil Complex
2. Completion of the Solvent Extraction Plant according to the above suggestions and adjustments to be made enable the it to work in single pressure only.
3. Renovate and improve the plantations which is beyond the competence of the industry, however, it is an important point to be considered by the Coconut Authority.

IV Relevant technical justification

Difference between the actual process and the one suggested

Under the present condition, it is necessary to process 2 tons of copra to obtain one ton of oil. On the dry material basis, copra has an average oil content of 66 to 68 % i.e. 67 %. From these figures the real extraction rate for different moisture content in the raw material are:

For copra with 12 % moisture content we have the following:

100 - 12 = 88 of dry material with 67 % of existing oil,

i.e. existing oil = 88 x 0.67 = 58.96

i.e. oil in cake = 58.96 - 50 = 8.96

i.e. weight of cake = (88 x 0.33) + 8.96 = 38

i.e. cake at: $\frac{8.96 \times 100}{38}$ = 23.58 % residual oil content

Oil extraction rate: $\frac{50 \times 100}{58.96}$ = 84 %

In case of copra with 6 % moisture content:

Dry material with 67 % existing oil: 100 - 6 = 94

Existing oil 94 x 0.67 = 62.98

Theoretical deciled cake 94 - 62.98 = 31.02

Weight of cake with 7 % residual oil content: $\frac{3.02}{0.93}$ = 33.35

Produced oil: 94 - 33.35 = 60.65

Oil extraction rate: $\frac{60.65 \times 100}{62.98}$ = 96.30 %

Oil extraction rate = $\frac{\text{oil extracted} \times 100}{\text{existing oil}}$

Actually, from 14,000 tons of raw material with 12 % moisture content, 7,000 tons of oil is extracted. From the same weight of raw material but with 6 % moisture content and after renovating the equipments, it would would be possible to obtain the following:

$\frac{7,000 \times 96.3}{84}$ = 8.025 tons of extracted oil

i.e. an increase of production of 1.025 tons of oil per year.

This difference represents practically the exportation of coconut oil in 1979/80, for a value of 11,035,557 T sh. (it would certainly be more for 1983).

For cakes we shall have a decrease in the production. Per ton of processed raw material we have actualy a production of 0.380 T of cake. With the new process one should have 0.3335 T only i.e. a difference of 0.0465 ton.

For 14,000 tons processed material it represents the following:

0.0465 x 14,000 = 651 tons only, for a value on the world market (1979) of 83.301 US$. This kind of loss is highly balanced compared to the oil's profit.

2. Case of the solvent extraction (after pre-pressing)

With the same figures as above, we should obtain:

Meal with 1 % residual oil content: $\frac{31.02}{0.99} = 31,333$

Produce oil (from pre-pressing and solvent extraction)

94 - 31.333 = 62.667

Oil yield with regard to the results of the improved process:

62.667 - 60.65 = 2.017

or per ton of processed material/ 0.2017 tons of oil only.

The solvent extraction plant has a daily capacity of 30 tons of pre-pressed cake with 15 % of residual oil (in 24 hours).

Oil extraction rate with solvent extraction:

$$\frac{62.677 \times 100}{62.98} = 99.5\ \%$$

14,000 tons of raw material means a daily processing (with a yearly 250 working days) of 56 tons only, out of which a pre-pressed cake with 15 % residual oil content will be produced, i.e.

$$\frac{31.02 \times 56}{0.85 \times 100} = 20.4 \text{ tons}$$

The oil obtained from these 20.4 tons will be less than:

2,017 x 10 x 56 = 1,129 kg of oil only with regard to the single pressure process.

Under such conditions, it is doubtful whether this extraction plant will be economical with regard to the single pressure process and will cover the operating and equipment costs.

The yearly oil yield, with regard to the results of single pressure process will be:

1,129 t x 250 = 280.25 tons only, i.e. less than 24,950 US$ yearly.

Only the solvent losses, 3 kg per ton processed material shall represent yearly the follwoing:

20.4 x 250 x 3 = 15,300 kg of Hexan, i.e. $\frac{15.300}{0.6}$ = 25,500 liters of Hexan.

Production costs for one tone of coconut oil (indicative)

		T.sh.
1.	Copra 2,000 kg at T.sh 4,00	8,000.00
2.	Fuel and power 1 KVA at T.sh 150.00	150.00
3.	Labour cost for 25 workers, etc.	500.00
4.	Transport for 2,000 kg of copra (50 litres at T.sh. 9.22)	461.00
5.	Containers, 5 drums at T.sh. 315.00	1,575.00
6.	Office expenses and stationery	20.00
7.	Licence, insurance and rates	20.00
8.	Oil and grease for machines	20.00
9.	Spare parts for machines	20.00
10.	Depreciation	15.00
11.	Total costs	10,811.00
12.	5 % margin profit on total costs	540.55
13.	Ex-factory price per ton	11,351.55
14.	Additional sales tax of ex-factory price	2,837.90
15.	Whole sale price per ton	14,189.45

Source: ZSTC; Ref.: NCDP

Copra purchase of ZSTC

Years	74/75	75/76	76/77	77/78	78/79	79/80
Tons	12,456	12,154	5,127	10,544	11,588	13,184

Source: ZSTC
Ref.: NCDF

Zanzibar copra exports 1975 - 1980

Years	Bags	Remark
1975	1,000	
1976	Nil	1,000 copra = about 18 bags
1977	Nil	
1978	104,957	
1979	9,755	
1980	168,395	

Source: Ministry of Agriculture (Zanzibar Produce Inspection Section)

Ref.: NCDP

Zanzibar Coconut Oil Export - 1975/76 to 1979/80

Years	Tons	T.shs.
1975/76	2,678	10,570,123.50
1976/77	685	4,445,859.35
1977/78	846	5,839,278.50
1978/79	665	5,320,012.25
1979/80	1,021	11,035,557.80
1979/80	N.A.	N.A.

Source: ZSTC

Ref.: NCDP

Costs and return prices for kiln dried copra in Zanzibar (1979-1980)

Returns

Copra output per day:	500 kg
Market price, grade II	2,65 T.sh/kg
Gross return:	1,075 T.sh. per day

Costs

3,000 nuts (farm price):	900 T.sh.
Transport to kiln:	100 T.sh.
Husking of nuts	90 T.sh.
Halving of nuts	90 T.sh.
Copra transport to market (30 km)	30 T.sh.
Labour at kiln, interest, repairing, and depreciation of kiln:	65 T.sh.
Total:	1,275 T.sh.

Source: NCDP

At present, the price ratio of copra/fresh coconuts is influeced by the official pricing policies.

ANNEX 1

Existing Equipments

Oil Mill No.	Capacity in 7 h	TYPE OF EXPELLERS						SOLVENT EXTRACTION	STEAM REFINING	REMARKS
		ROSEDOWN	WILBOROUGH	ANDERSON	H.E.B W.GERMANY	E.I.W E.GERMANY	INDIAN	DE SMET INDIA	SHARPLESS INDIA	
1	9 t	1		1	1					No steam and no mechanical handling.
2	4 t		1				2			" "
3	4 t	2								" "
4	4 t	2		1						" "
5	2.5 t		1							" "
6	4 t		3							" "
7	6 t						1	30t/24h	25t/24h	Capacity limited by filter-press
8	6 t (in 5h)					4				Modern design, with mechanical handling but without steam.
9	2 t	2								No steam and no mechanical handling

Oil mills No. 1 - 8, located in Zanzibar
Oil mill No. 9, located in Pemba

ANNEX 2 - Standard Specification for Copra (from Asian and Pacific Coconut Community)

Characteristic	Grade 1	Grade 2
Moisture content (per cent by weight) Max.	6	8
Oil content (on moisture free basis) per cent by weight, Min.	68	66
Free Fatty Acid (FFA) as Lauric per cent by weight, Max.	1	3.5
Impurities % by weight, Max.	0.5	1
Immature kernels (wrinkled cups) % by weight Max.	Nil	5
Mouldy cups, % by count Max.	Nil	4
Charred or black cups % by count Max.	Nil	4
Broken cups or chips % by weigh Max.	Nill passing through 3/8" mesh sieve	Not more than 1 % passing through 3/8" mesh sieve
Colour of the expelled oil on 5 1/4 cell on the Lovibend couler scale, expressed as Y not deeper then.	10	12

ANNEX 3 - Maintenance

A good maintenance of all the parts of the plant including the smallest one is one of the most important keys to a satisfactory economical running of the plant all along. Maintenance is a matter of preventing rather than repairing. One should not wait until the machi machine fails to operate but think of the lubrication or even replace some parts of it on time. Once the machine needs to be repaired, it is not only time consuming but also costly in comparison to a normal and regular maintenance. Maintenance must be done at the most convenient time without disturbing the production, whereas if it breaks down, it would affect the operating of the factory for a longer period.

Complete interchangeability of parts must be a general rule in order that in the case of emergency, parts belonging to another machine may be used should teh required spare parts not be available or on stock due to circumstances.

Maintenance team and equipments

Good maintenance can be performed only with appropriate tools and by well trained and skilled people who are able to use the suitable tools for a clearly defined purpose.

Maintenance and doing odd jobs are two different things, the maintenance team must be a real team of skilled and trained people and not persons who only have a general knowledge.

The maintenance workshop must be able to undertake all kinds of works, such as cutting, soldering, bending of pipes, lathing, drilling, fitting, milling, sheet metal work, re-coiling of electrical motors, etc. for which appropriate tools should be used.

ANNEX 4 - Charcoal production from coconut shells (ccttage industry)

A 200 liters steel drum is used for this process. The lid is cut cleanly to obtain a hole of about 35 - 40 centimeters of diameter. A full lid of another drum is used as a cover. The bottom of the drum has several holes of 1.5 centermerts punched into it to allow air to flow into the drum. One hole at the center and the other six on per center diameter of about 30 centimeters. A second hand jute bag and a stone are also required.

The useful life of a drum is 8 to 12 months during which time the drum will give about 200 burnings. The capacity of each drum is k0 kg of raw shells which give a yield of 20 kg charcoal (25 %). On the basis of 5 burnings per week and 50 weeks per year, the annual capacity per drum is 5 tons of charcoal. These drums can be operated by one person. (See fig. 8).

Process

Manufacture of charcoal requires optimum carbonization of raw shells in a limited supply of air so that thereis neither unburnt shell nor ash due to complete combusion.

The steel drum is placed on top of two pieces of galvanized iron pipes or 3 stones to elevate the bottom of the drum. This facilitates the entry of air through the holes at the bottom during carbonization.

To start the process, burn a shovelful of coconut shells on the cover of the drum. When the shells are burning fiercely, throw them into the drum. Throw more shells, just enough to put out the flames but not the fire. Continue to feed more shells, making sure that the shells do not burn fierecely because a good adjusted burn gives the highest yield and the least ash.

In about 4.5 hours, when the burning reaches its top, spread the wet jute bag on the top, then place the lid in position and cover it with sand or mud. The pipes, or stones under the drums are to be removed to stop entry of air. Make sure that sand or mud does not contaminate the charcoal.

To cool the drum, it would take about 2.5 hours. One men can operate about 20 drums in a working day. There are some other types of charcoal production kilns but this one is really simple and convenient for cottage industries. Other types are described in the documents issued by the Asian and Pacific Coconut Community.