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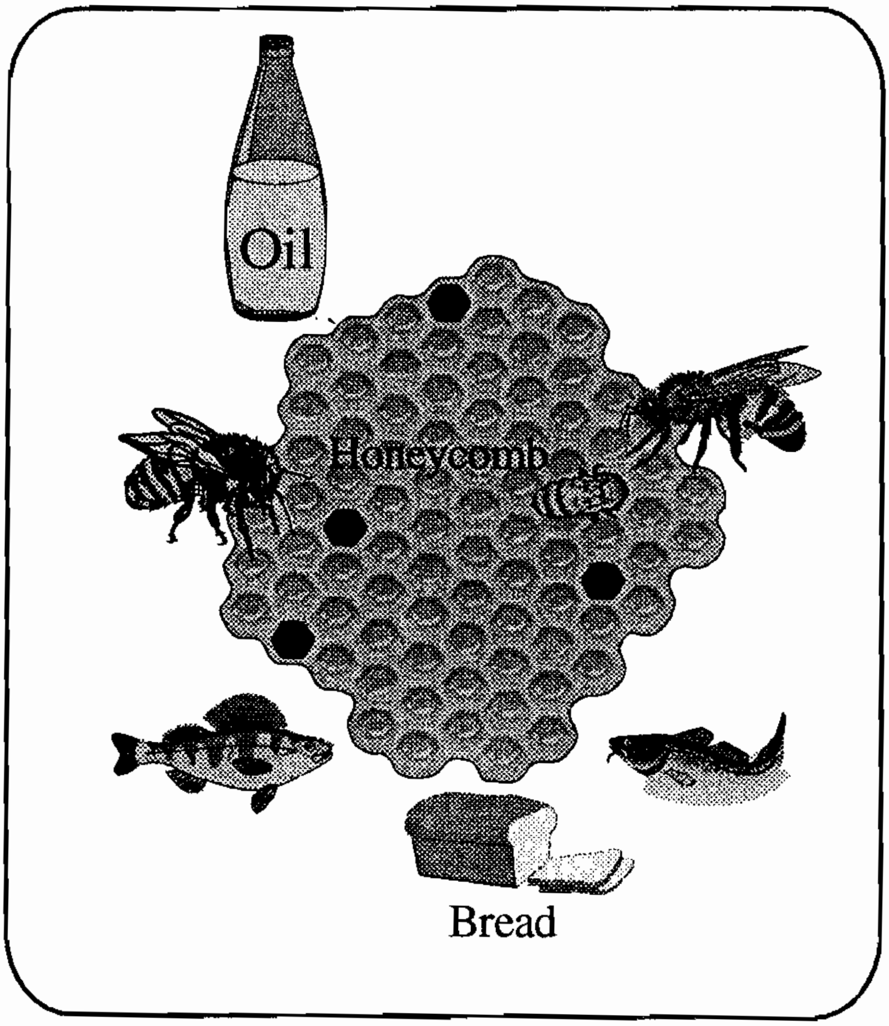
SMALL SCALE FOOD PROCESSING TECHNOLOGIES AND THEIR USE IN THE RURAL AREAS OF THE EASTERN AFRICA SUBREGION



October 1996
Addis Ababa, Ethiopia

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INTRODUCTION

Small-scale food processing technologies and their use in the rural areas of the eastern Africa subregion is one of the major step of implementing the decision of the Sixth Conference of African Ministers of Industry on the development of small-scale, cottage and rural industries as one of the priority subsectors in the industrial development decade. Small-scale industries have infact proved to be very effective in modernizing the economies of some developing countries particularly the rural areas of such economies.

In the case of Africa, most small-scale industrial entrepreneurs and potential ones are not in the position to determine the scope of small-scale industrial activities nor do they have the capacities to collect and make effective use of basic information relating to the types of products that can be manufactured by small-scale industries, processing technologies, equipment and their suppliers, manpower requirements, finance, marketing etc...

Since the programme for the implementation of the industrial development Decade for Africa puts emphasis on the promotion of resource-based and engineering core industries such as those processing locally grown agricultural products, some food products were selected in this first stage of assessment of products and process of small-scale industries.

Food processing constitutes a major economic sector in eastern Africa subregion for the following reasons: food processing allows the consumption of seasonal agricultural products over the whole year and therefore minimizes the important price fluctuations resulting from the periodic gluts and shortages of the fresh products; food processing generates substantial foreign exchange in the Eastern Africa countries like Kenya which produce a large surplus of agricultural products.

The choice of inappropriate food processing technologies results sometimes in subsidizing large scale food processing plants or to supply them in priority with the needed raw materials to the detriment of the existing small processing units. These latter units could use improved technologies which have already been successfully adopted in a number of countries of Eastern Africa subregion. Unfortunately, the detailed information on these small-scale food processing technologies is not readily available to small-scale producers in the countries of Eastern Africa subregion.

The publication of this information which deals with the contribution of the small-scale industries is considered appropriate in modernizing the economies of the countries of the Eastern Africa subregion, particularly the rural areas of such economies.

This document is divided into four chapters. The first chapter examines the current situation and the advantages of the utilization of food processing technologies in the rural areas of some countries of the Eastern Africa subregion. The second chapter is devoted to procedures for the food processing technologies for selected products. The third chapter formulates some

recommendations on manpower training and supporting services while the fourth chapter deals with the impact of small-scale food processing activities on the environment.

I. CURRENT SITUATION AND ADVANTAGES OF SMALL SCALE FOOD PROCESSING ACTIVITIES IN RURAL AREAS OF THE EASTERN AFRICA SUBREGION

Almost all countries of Eastern Africa subregion recognize the importance of the food processing sector and have developed and promoted food processing techniques. Unfortunately, a large number of them have not been able to maintain adequate balance between small-scale food processing units using labour intensive or intermediate techniques and large scale units using imported, capital intensive technologies. Because of the lack of technical and economic information on alternative food processing technologies, small-scale food processing units are being increasingly replaced by imported large scale plants.

Eritrea

Although the modern industry was introduced in Eritrea by the Italians in the 19th century, agriculture in this country is however characterized by very low productivity. The traditional subsistence farming is the main cause of low productivity. The significance of continuing increase in food import bill in Eritrea has been a matter of great concern. Aware of the gravity of the food import bill, the Eritrean Government is encouraging the rehabilitation and the development of the small-scale food processing enterprises with the goal of attaining food security of its population. Of the capital invested in the small-scale industries in 1993, 27.2 per cent was in food[1].

The following are the food products which are produced at small-scale level for the immediate and direct needs of specialized market, and for providing services directly to Eritrean customers: flour, bread, canned food, pasta, biscuits, macaroni, baby food, sweets, fish, vegetable oil, butter, berbere, salted pork and cheese.

It is known that fish is one of the main food production of Eritrea. The annual catch of fish in Eritrean waters in the 1960s was around 60,000 tonnes, but it is not known if such high harvesting levels were sustainable. Recent harvests have been as low as 4,500 tonnes per annum, and there are great hopes of increased production to boost the Eritrean economy.

The variety of fish species being immense, their exploitation and processing for domestic consumption as well as for export is one of the priority of the Eritrea government's economic policy.

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[1] Emergent Eritrea, Challenges of Economic Development. The Red Sea Press Trenton, New Jersey 1993

Fishery cooperatives are established in all fishing villages. There is the need to further develop and modernize the fishing methods in the rural areas, especially fish processing units, e.g. drying, salting and smoking. This will not only improve the quality and quantity of fish consumption capacity but will also create jobs for the people engaged in this activity.

Since the agricultural sector is vital as a basis of economic development, the Eritrean Government has decided inter alia, to expand agricultural ventures that use modern machinery, techniques and technologies so as to supplement and reinforce the traditional agricultural activities carried out by the majority of the population.

The implementation of the agricultural technology policy, accompanied by market-based input - output pricing system, would thus ensure the development of the small-scale food processing technologies and self sufficiency in food production in Eritrea will be attained.

Ethiopia

Considering the potential size of the market and the diversity of activities in the country, almost in the rural areas, Ethiopia offers wide opportunities for small-scale industrial activities. Ethiopia has about 7706 small-scale industries establishments. The gross value of production (GVP) of small-scale industries for the year is about Birr 457 million[2], of which the biggest share is contributed by food (44%)[3]. About 144 small-scale food and beverage industries are established only in and around Addis Ababa.

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2 1$ = Birr 6.30

3 Report on Survey of Private Manufacturing Industries. Ministry of Industry, Addis Ababa (Ethiopia) 1991

Table 1: **Small scale food and beverage industries in Addis Ababa**

Industrial type	No. of industries	Size of employment		Type of activities		
		Below 10	10 and above	Production	Production & service	Service
1. Vegetable & animal oil and fats	18	11	5	18	-	-
2. Grain mill products	14	14	-	-	14	-
3. Bakery products	72	38	34	62	10	-
4. Sugar confectionery	15	7	8	15	-	-
5. Macaroni and spaghetti	2	1	-	2	-	-
6. Other food products	20	14	6	17	3	-
7. Alcohol production from fermented materials	2	-	2	2	-	-
8. Honey factory	1	-	1	1	-	-
Total	144	86	56	117	27	

Source; 1) Field mission findings
2) Report on the survey of private industries in Addis Ababa 1990/1991

The rural economy of Ethiopia is made up mainly of the farming activity of the peasantry, which is a mix of cropping and animal husbandry. Major crops in the rural areas include the cereals group: teff, wheat, barley, sorgo and the pulses group: horse beans and chickpeas. A few variety and quantity of oilseeds and horticultural crops are also grown. Livestock, particularly cattle, holding or rearing by peasantry appears to be almost universal. This is mainly due to the diverse function livestock has actually in the peasant sector (source of milk, meat, draught power, manure for fuel and fertilizer, supplementary cash income, etc...).

The consumption of fresh or processed fish in the rural areas of Ethiopia has declined substantially due to the following reasons: (i) lack of appropriate landing and transport facilities puts a limit to the amount of fish which can be marketed before spoilage takes place; (ii) inadequate fish processing technologies used by small-scale fish processors, etc... In the absence of a storage, processing technologies and packaging system, the entire harvest runs the risk of perishing in the rural areas of Ethiopia. The preservation of legumes, fruits grains and other crops is difficult owing to the fact that the harvested products are often attacked by insects or simply rot.

Owing to the difficult situation facing the farmers, more efforts are being made in order to utilize food processing technologies in the rural areas of Ethiopia.

Kenya

The agriculture sector remains the most important sector in Kenya's economy. Kenya's agriculture systems have evolved since independence, ensuring the increased incomes and employment to the rural population especially small-scale producers who constitute over 75 per cent of Kenya's population. Table 2 shows the national food requirements in 1996.

Table 2: **National food requirements for 1996**

	Consumption Kg/Person/Year Urban	Rural	National food requirements in 1996 '000 tonnes
Maize	97.1	125.6	3,232
Millet/Sorghum	0	19.8	429
Wheat	24.7	10	347
Rice	13.1	1.4	99
Potatoes	14.8	26.4	650
Beans	13.8	14.2	80
Sugar	20.6	10.4	660
Milk	88.6	72.1	2,451
Beef	11.9	6.8	210
Fat	6.5	1.7	71
Vegetables	36.9	20.4	636
Fish	1.9	1.7	47

Source: National Development Plan - Kenya's seventh plan for the period 1994 to 1996

During the plan period 1994 - 1996, production of specific food commodities increased by 1.21%. Urban population was 4.17 million in 1990 and is estimated to grow at a rate of 4.9 per cent per year. Thus in 1996, it is expected to reach 5.65 million, which will be 20.8 per cent of total population of 27.18 million, compared to a rural population of 21.53 million, which will account for 79.22 per cent of the total population.

Since small-scale farmers form the bulk of Kenya farmers, programmes directed at boosting production in the agricultural sector was focussed on them in the Kenya's seventh plan. Offering target small-scale farmers subsidized credit has been the strategies applied towards increasing food production during the plan period.

The Government of Kenya supports small-scale food processing industries through economic, financial and regulatory policies that provide an enabling environment for sustainable growth and development. More private small-scale food processing units involvement are encouraged through provision of a range of measures and incentives intended to improve the small-scale food processing operations such as access to credit and provision of appropriate technology and training.

The structure of the small-scale industrial production since it's inception, has been based upon the import substitution strategy. Most of the production of agro-industrial raw materials such as oilseeds, fish, vegetables, bakery, cereals, fruits, coconuts are processed almost at the small-scale industries level.

Due to the large amount of foreign exchange involved in importation of palm oil and in order to provide the rural populations with cheaper vegetable oils, the Government of Kenya has intensified measures intended for setting up of rural oil processing facilities using intermediate technologies.

The need to urgently develop local substitutes and increase domestic production of vegetable oils are the main objectives of the development of the small-scale production process of vegetable oils in the rural areas of Kenya.

Artisanal fishing from both fresh water and marine sources in Kenya are important channels for securing fish. But the structure for fish handling and storage at the landing beaches are inadequate and therefore results in heavy post harvest losses. The Kenya's Government is encouraging the import and utilization of fish processing technologies in the rural areas.

The small-scale food production in Kenya contribute to the food security of Kenya and ensure that consistent and adequate amounts of food are available in every part of the country at all times.

Uganda

The investment plan of Uganda takes into consideration the development of the small-scale industrial activities especially in order to meet the post harvest needs of small farmer for major staple crops, animal and fisheries products.

It is estimated that about 40%[4] of the food grown in Uganda goes to waste due to post harvest losses. Due to lack of proper drying and processing facilities in the rural areas, cereals and fish are left in the open space for drying and as a result heavy losses are experienced.

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4 Public Investment Plan 1995/96 - 1997/98 Ministry of Finance and Economic Planning, Kampala, Uganda 1995

Uganda Produces about 4.0 million tonnes of fresh Cassava roots per year. It is mainly grown by small holder farmers. Fifty per cent of cassava is intercropped with various annual crops, such as groundnuts, beans, maize, etc... In the rural areas of Uganda, cassava is used as raw materials for small-scale production of starch. Meanwhile the groundnut oil, groundnut flour, paste and milk are obtained through the small-scale processing of groundnuts in the rural areas of Uganda using traditional equipment such as mortar pestle, board or grinding stone, bottle or cylindrical stone, strainer and clean linen.

The production of vegetable oil in Uganda declined due to the lack of post harvest management policy in the rural areas. In the absence of storage, processing and packaging system the vegetable oil consumption is still at a low level, especially in rural areas. The small-scale mixing and the raphia cloth press used in small-scale processing of palm nuts into palm oil in the rural areas are the traditional small-scale technological production processes.

Uganda programme of the promotion of vegetable oil is concentrated on the promotion of small-scale oil presses to farmers in the rural areas in order to develop the small-scale production of palm oil.

Concerning the fishing activity, it is almost exclusively carried out by artisanal fishermen using unimproved technologies. There are about 200,000 people deriving their livelihood from the fishing industry either through catching, processing, distribution, boat building or manufacture of other fishing implements.

The traditional fish processing methods practice in the rural areas of Uganda include hot smoking, salting, grilling or frying using fats and sun drying. The ongoing study in Uganda covers the improvement of fish processing technologies in the rural areas, mainly: ice making machines, improved fish smoking kilns, fish salting vates, appropriate fish stores for the processed fish, etc...

The Government of Uganda believes that the introduction and development of appropriate post harvest technologies in the rural areas would thus help improve and increase harvests as well as increasing the income of low populations in the country.

It is expected that the use of the small-scale food processing technologies in the rural areas of the Eastern Africa subregion can constitute the immediate solution to the food problems during and after harvest. It is expected also that the promotion of small-scale food processing technologies in the rural areas will be an important factor to develop larger centres around semi-urban rural areas. Therefore, part of the population who are at present depending on land could be diverted to industry and avoid the constant trek from the rural areas to the towns in search of imported food products can be reduced.

This publication of the small-scale food processing technologies and their use in rural areas of Eastern Africa subregion is intended to provide technical and economic information on the basic elements involved in the processing of four selected major food products (edible oil, fish, bread and honey) that also enjoy wide consumption and circulation within the country, i.e. methods of procurement and marketing of products, infrastructural locations, inputs to processing units, source of raw materials, source of finance, type and source of machinery and equipment as well as making proposals for future development plans for the small-scale food processing technologies in the rural areas.

II. SMALL-SCALE FOOD PROCESSING TECHNOLOGIES FOR SELECTED PRODUCTS

The countries of the Eastern Africa subregion recognize the importance of the food processing sector and are focusing their efforts on the promotion of food processing technologies for the improvement of existing food products within the subregion. The preservation of legumes, fruits grains and other produce is difficult owing the fact that the harvest products are often attacked by insects or simply rot. In the absence of storage, processing and packaging system, the entire harvest runs the risk of perishing. The increasing efforts are being made to utilize processing technologies for the production or increased production of whatever commodity that might help the populations of Eastern Africa subregion substitute their usual eating habits with a lighter, healthy and balanced diet based on various types of locally produced edible oils, fish, bread and honey.

2.1. Small scale edible oil processing technologies

The oils play an essential role in the provision of food and nutrition for the vast majority of the population of the Eastern Africa countries. Among these plants or legumes whose seeds and fruits yield protein - rich edible oils are the groundnuts and palm oil.

This study on oil extraction from groundnuts and palm nuts covers the pre-processing of raw materials. It is also concerned with the choice of technology for the extraction of unrefined oil from groundnut kernels and palm oil by small-scale mills to be installed in rural or small urban areas. This follows from the fact that a majority of the population in the countries of the Eastern Africa subregion reside in rural and small urban areas, and that the techniques they may use for oil extraction should not require sophisticated technology.

A number of factors which led to the choice of the extraction of groundnut oil from groundnut kernels and palm oil from the palm nuts, include the following:

(a) A significant indigenous consumption of groundnut and palm oil in the countries of Eastern Africa subregion;

(b) A substantial demand for unrefined oil in these countries; and

(c) The relatively high oil content of groundnuts and palm nuts.

2.1.1. Oil extraction from groundnuts

Prior to describing the various oil extraction technique, it is necessary to consider the raw materials involved (groundnuts) and the pre-processing operations.

A. Raw materials

Groundnuts are grown in the countries of eastern Africa subregion. It is a low growing annual plant with a soft stalk 20 - 60cm in length and branches stemming from the base. The varieties of groundnuts fall into two groups depending on their characteristics:

(i) bushy bunched types: this type matures in 3 - 4 months;

(ii) runner or spreading type: this type matures in 4 - 6 months. Some intermediate hybrids do exist. The bunch type contains kernels that average 65 - 75 per cent of the whole nut. A good average yield, under suitable conditions, would be 1000 - 1350 kg/ha.

Groundnuts grow well throughout Burundi, Ethiopia, Eritrea, Kenya, Rwanda, Uganda, the United Republic of Tanzania and Zaire because of their adaptability to tropical climate with a minimum temperature of ±20°C, a minimal rainfall of 100mm per month during the growth period and a light, slightly acid or neutral soil.

B. Pre-processing of groundnuts

The crop is ready to harvest if the majority of the kernels are fully developed and take on a mature colour. Harvesting consists of either digging or pulling up the plants manually or using mechanized means such as a digger or southern plough.

After the groundnuts have been harvested, they are inverted and placed in windrows in the field where they are left to dry for about two weeks. During this period, the moisture content of the pods is reduced to about 10 per cent. In humid areas, the pods are sometimes picket off first and dried on mats so that they can be stacked or covered in the event of rain.

Removing the kernels from the pods is generally referred to as shelling or "decorticating". This is usually carried out on the farm just before the farmer sells his produce for the following two reasons:

(i) kernels do not store as well as nuts in the shell; and

(ii) groundnuts in the shell are 50 per cent heavier than kernels alone and are therefore costlier to transport. This is a laborious and labour - intensive operation. Fortunately, a number of simple hand - operated decorticators are now available. These decorticators can be fitted with a simple feeder to improve the performance of hand - operated groundnut shellers.

C. Traditional technological production process of groundnut oil

The following equipment are used for the traditional production of groundnuts oil:

(a) pestle and mortar
(b) board or grinding stone
(c) bottle or cylindrical stone

Two procedures are currently used by the people of the Eastern Africa subregions' countries for the production of groundnuts oil:

First process

Having been shelled, the nuts are sifted, sorted out then sometimes mixed with coarse sand to prevent them from burning. They are roasted in a pan. Constant stirring is recommended during this operation. The nuts are then removed from their skin, split and then pounded to a paste in a mortar and finally ground to a smoother paste on a board or grinding stone. After the paste has cooled in the mortar, the former is mixed with a little cold water (¼ of a glass) and beaten using a pestle. This causes the oil to be separated from the nuts residue. The pounding smoothens the residual paste. The oil produced is separated from water particles through heating.

Second process

The groundnuts are sorted then pounded in a mortar and ground on a board to give a smooth paste. Having been ground on a board, the paste is put back into the mortar with a little water and pounded with a pestle. The oil thus obtained is heated to remove the water. The oil is used in all types of culinary preparations. The following by-products are also obtained through the traditional production of groundnuts oil using equipment such as: mortar, pestle, strainer and clean linen:

(i) Groundnuts flour

The groundnuts are sorted and roasted, with care being taken to avoid burning them. They are then cooled and dried in the sun after which their skin is removed. They are pounded in a mortar and then sifted. These two operations are repeated several times. The fine sifted powder is the groundnuts flour. This flour can be used in the preparation of porridge, cakes, etc. The flour can be stored in a cool dry place after being packed in cloth sacks, well sealed bags or dry, clean barrels.

(ii) Groundnuts paste

Having been sorted, the groundnuts are roasted carefully to avoid burning. Once the skin has been removed, the groundnuts are then placed in a mortar where they are pounded and then ground to give a very fine paste. The groundnut paste can be eaten with bread or fritters or used in the preparation of various sauces.

(iii) Groundnuts milk

The groundnuts are sorted and soaked in water for 3 to 4 hours. Their skin is then removed and they are washed before being pounded in a mortar until they form a fine paste. The latter is mixed with water at the ratio of three glasses of water to one glass of groundnuts and then heated for 20 minutes. The diluted paste is filtered through clean linen. The white liquid thus obtained is the "groundnuts milk". A pinch of salt and a tablespoon of honey or sugar may be added to the "groundnuts milk" for taste. The residue is used in the preparation of fish or meat balls, sauces, etc. The groundnuts milk can be stored in a cool place for 2 to 3 days. However, in the rural areas it is advisable to consume it within 24 hours.

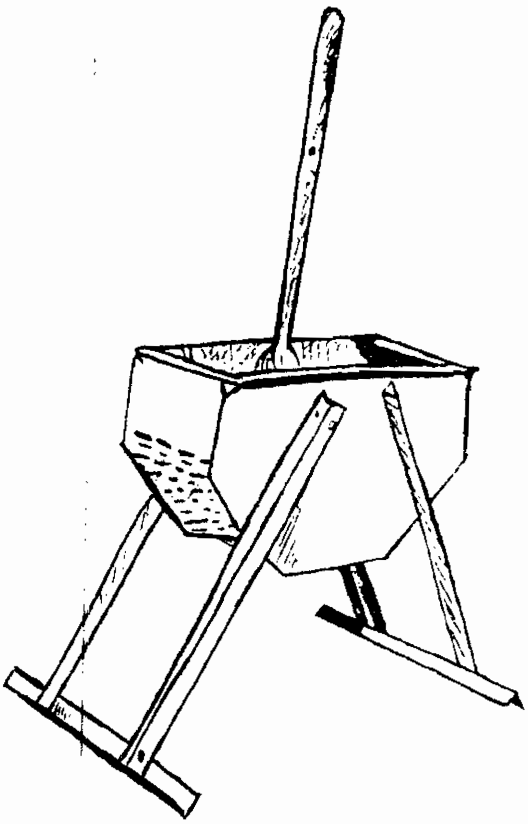
D. Improved technological production process of groundnut oil

(i) Improved decorticator

An improved decorticator involves the shelling of groundnut in a drum-shaped device with heavy, curved grates forming the lower half of the drum, and a revolving beater inside the drum which crushes the pods against the ridges in the grates. The clearance is sufficient to avoid injuring the groundnut kernels when the shell is crushed. Groundnuts and broken shells drop through the openings in the grates, and the shells are siphoned off by air suction. After the groundnuts are shelled, the kernels are passed over oscillating shaker screens and separators where foreign material, undersize kernels, unshelled groundnuts and split kernels are removed. On completion of this operation, the kernels are placed on a conveyor belt where defective kernels and any remaining foreign material can be removed by hand.

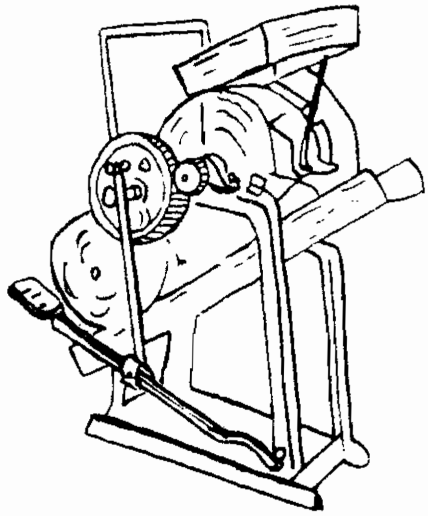
A number of groundnut shellers are available for various scale of production and powered by various means (manual, diesel engines, electric motors, etc... Some of these shellers are illustrated and described below:

Figure 1: Groundnut sheller



This groundnut sheller is a reciprocating decorticator equipped with inter-changeable screens for groundnuts of different sizes

Figure 2: Foot operated groundnut sheller



Fitted with a flywheel for easier operation and with a blower to separate the shells from the kernels. This machine can be operated and fed by one person and can shell 200kg in a eight hour day.

Figure 3: Automatic groundnut decorticating machine

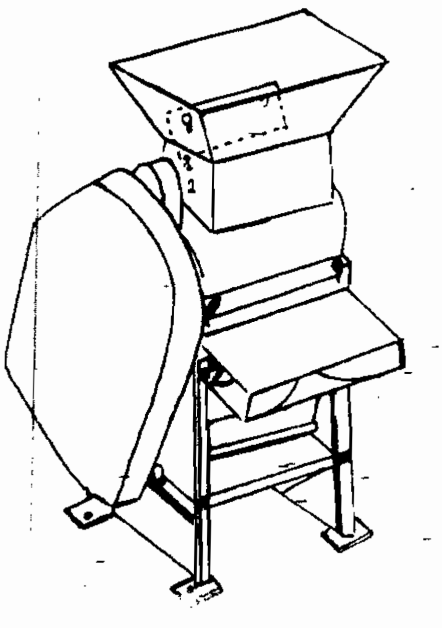
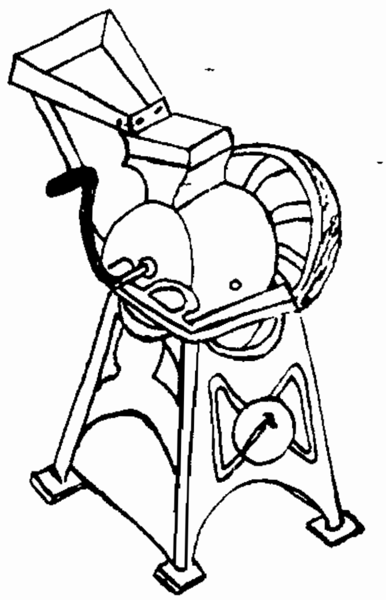


Figure 4: Hand operated groundnut decorticator



The hopper at the top of the machine is filled with nuts to be shelled. A ribbed feed roller feeds the nuts into the beater chamber where they are struck by rotating flexible beaters. The broken shells and the kernels are forced out through the perforated cylindrical steel shelling screen (available in three size). The kernels and broken shells fall into a duct which has a wire - mesh delivery chute at its lower end. A fan blows the shells upward and out of the shell outlet spout.

The work capacity of this machine can be varied by adjustment of the hopper flap.

(ii) **Storage**

Tests have indicated that the storage life of groundnuts begins at the field. Therefore, the nuts should have a high initial quality. The bad effects of improper storage, it must be remembered, are cumulative and irreversible.

Table 3: Relationship between temperature and storage time of groundnuts

Temperature	Time of retaining edible quality	
	Unshelled nuts	Shelled nuts
70°F (21.1°C)	6 months	4 months
47°F (8.33°C)	9 months	6 months
32°F (0°C)	3 years	2 years
25°F (-3.9°C)	7-8 years	5 years
10°F (-12.2°C)	15 years	10 years

The temperature in the storage should be low as shown in table 1. The relative humidity should be between 65 - 70 per cent. Above 70 per cent, the nuts are likely to grow mould. Below 65 per cent, the nuts lose weight, become brittle and may split during handling. the atmosphere in the storage area should be free of odours and well aerated, because nuts readily absorb odours and flavors from the surroundings.

E. Oil extraction from groundnuts

Once the groundnuts have been pre-processed, the next stage is oil processing. The improved technological process for the production of groundnuts oil follows the various stages as cited below:

(a) Washing to ensure that the nutshells containing the nuts are clean;
(b) The clean nuts are shelled to separate the grains from the shells;
(c) After removing skin from the nuts, they are ground, the paste is heated and moistened;
(c) The oil is extracted using the hot pressure continuous or discontinuous system.

* Discontinuous: The first application of pressure produces 31 per cent first grade oil. The second application produces 5 to 10 per cent second grade oil. The remaining 55 per cent is oilcake.

* Continuous: at 80° - 90°, the rate of oil extraction is 45 per cent. At 100° to 110° the rate is 47 to 48 per cent. Oil can also be extracted from the oilcake expelled, thus reducing its oil content from 4 to 5 to about 0.5 per cent.

- Removal of mucilages: to produce oil that is free of mucilages.

- Neutralization: to produce oil without free fatty acids.

- Bleaching: to give the oil a beautiful colour.

- Deodorization: to remove unpleasant odour from the oil.

- Storage and packaging in drums, bottles or cans.

These stages are described for the following six types of plants: macro - plant, power mill, small expeller mill, small package expeller mill, medium and large expeller mills, solvent extraction plant and west - processing.

(i) Power ghani mill[5]

The imposed power ghani mills can crush the quantity of seed of up to 15 kg in approximately 1.5 hours or close to 100kg per day. They have an oil extraction efficiency which is fairly close to that of small-scale expellers especially in rural areas. But it is important to analyse all the requirements for the successful adoption of ghani mills prior to investing in such units. It is therefore recommended to investigate whether qualified labour is available in rural areas, whether the repair and maintenance of ghanis can be carried out without much difficulty by the miller or local mechanics.

(ii) Small expeller mill

The small expeller mill to be used in the rural area has a capacity of 45 to 55kg per hour. By working only one day shift, which is normal for such small plants, the units can process between 350 and 450 kgs. of groundnuts per day. But the operations and precise capacities vary

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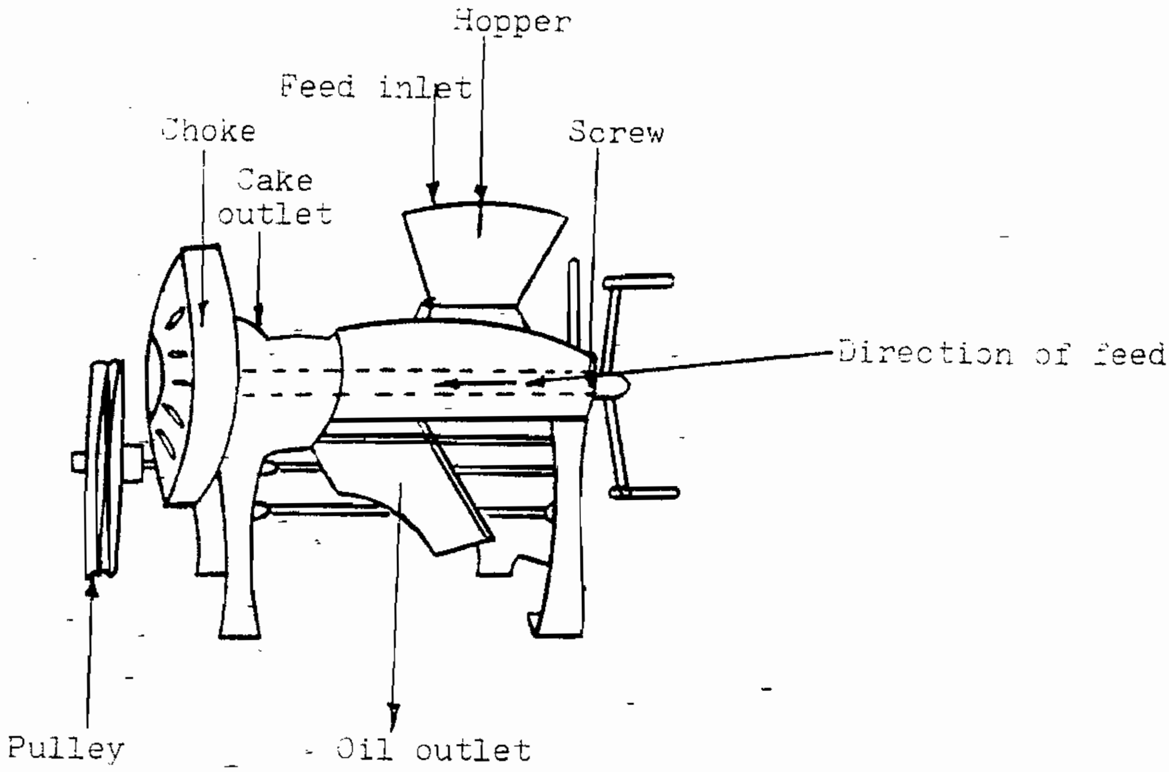
5 The power ghani mills were originated from India. These indigenous oil crushers have been improved over time.

from machine to machine.

Figure 5



This small expeller has the following characteristics:

- capacity: 45 - 55kg per hour
- power requirement: 3hp
- 300 rpm

It is capable of producing the assumed oil yield in a single pass.

Most of the oil is extracted in the first pass, but a significant additional amount is yielded by the second pass. The expeller must be capable of completing the processing of the daily input in the two pass manner. Therefore, the capacities of each of the single passes must be higher than the daily input.

The extraction of groundnut oil in small expellers is a highly skilled job as it is necessary to add groundnut shells to the kernels in order to prevent the forming of peanut butter. The adding of shells is necessary because groundnut kernels have little fibre.

When ordering the equipment, the mill operator should specify the type of raw materials to be processed as the spacing between the bars (which are part of the expeller barrel) is a function of the type of oil seed.

Expellers require periodic maintenance and repairs, the principal wearing pieces being the liner bars, the worms and the distance pieces. The periodicity of maintenance and repairs is a function of the rate at which the above piece of equipment is worn out by the abrasive action of the raw materials and that of foreign matter (e.g. sand, pieces of iron). The abrasive action of foreign matter is particularly harmful and can considerably shorten the life of various parts of expellers.

The choice of expeller is a difficult task to make as the mill owner should consider both the current scale of production as well as an eventual expansion of the mill. Although no precise advice may be given without knowing the exact circumstances under which a mill is being established, a general rule for small rural mills is to start with a relatively cheap expeller which may process, in one or two passes, the daily input of raw materials.

Regarding oil extraction from groundnuts on page 14 states that "**oil is extracted using the hot pressure continuous or discontinuous system**". But this document recommends also the process using hot direct pressure, which has the advantage of not being very costly and not requiring very skilled labour.

Figure 6: **<u>Groundnuts oil production diagram</u>**
(Direct hot pressure method)

Through this technological procedure, the rate of oil extraction is 45% for groundnuts, the rest (55%) being oil cake, containing 25% proteins and 10% carbohydrates.

The main stages in the extraction of groundnut oil by the direct hot pressure process can be summed up as follows:

a) Silo: This is the place where groundnuts are deposited

b) Bucket elevator: This is used for the conveyance of the grains to the first machine after the removal of metallic particles with an artificial magnet attached to the outlet.

c) Vibrating sifter: This is used to remove foreign bodies, strings, straw, pebbles etc... and to evenly distribute the products in the hammer mill.

2.1.2. Palm and palm-kernel oil

The palm oil is cultivated in an environment with conditions that are favourable for its growth. It is a continuous growing plant that requires sunshine and approximately 150mm per month. Therefore, it requires the most consistent climatic conditions possible throughout the year.

For this plant that needs an evenly distributed rainfall of 1500mm per annum, and an average temperature of 20°C, the conditions exist in some countries of Eastern Africa subregion, such as Burundi, Kenya, Rwanda, Uganda, the United Republic of Tanzania and Zaire. In case of Zaire, the oil palm grows extensively over the entire territory.

The palm oil is a monoecious plant. the inflorescences known as clusters are spikes. They are unisexual and situated at the exil of leaves.

A. Raw materials

The main raw material used in the production of palm oil or palm kernel oil is the palm nut. The palm nut pulp and kernel (fruit) both contain oil. The pulp, which contains 40 to 55 per unit of its weight in oil, yields palm oil while the kernel which contains 48 to 52 per cent of its weight in oil produces palm kernel oil. The fruit, palm nuts have a soft, oily orange and black peel, a fibrous greasy, orange pulp and a hard stone containing a grain known as a kernel. Palm oil must be processed as close as possible to the harvest ground. Once harvested, palm nuts are difficult to preserve. They have to be processed without delay because palm oil contains palmitic acid whose content increases with time. In fact, the quality of palm oil depends on how quickly the crop is processed in the oil mill after the harvest. Its other uses

include its application in the cold rolling of fine plates in iron and steel plants and in cold tin-plating.

B. Traditional technological production process of palm oil

(i) Small - scale traditional technological production processes of palm oil

The technologies (equipment) described below are used in small-scale processing of palm nuts into palm oil:

- Small-scale mixing: the materials used in this kind of mixing include a half-barrel and a wooden rod with transverse sticks that facilitate the dislodgement of the pulp from the husk.
- Raphia cloth press: this press is used to separate the fibres from the oil.

At the small-scale level, there are two distinguishable types of procedures used to facilitate stalking, boiling, mixing, separation of products and the extraction of oil:

First procedure

Palm nuts are brought to the boil, preferably in a barrel. Blending is done using feet if the quantity of nuts is considerable. For a small quantity of nuts, the blending is done with the use of pestle and mortar. The magma is placed in a receptacle into which water is added until the volume is doubled to dilute the dough in order to separate nuts and fibres. The blend is stirred until a thick froth appears on the water surface. The oil then floats on the water and is separated by decanting. It is brought to the boil to yield a high quality palm oil.

Second procedure

After bringing the nuts to a boil, they are pounded in a mortar. The husks are separated from the magma. This magma is placed in a raphia cloth and wrung. The oil that flows out is collected in a receptacle.

(ii) Small-scale modern technological production processes of palm oil

There are several modern methods for the extraction of palm oil, but they are all based on the same procedure whose main stages are as follows:

- sterilization;
- stalking;
- extraction of oil;
- clarification;
- drying and storage of crude oil.

The only major differences between all these systems concern the process for the extraction of oil which can be done by pressing, centrifugation or washing. The fittings that comprise the apparatus are of differing shapes and layouts, depending on their manufacturer.

Palm Kernel Oil

(i) Small-scale traditional technological production processes of palm kernel oil

Two small-scale technological processes are used in the production of palm kernel oil, they are:

First process

Palm kernels are soaked in water for 48 hours. They are then pounded in a mortar until they produce a milky paste. This paste is placed in a receptacle containing water and stirred until it froths. The froth is removed and heated until it boils. A clear and high quality oil is thus obtained.

Second process

The kernels are cleaned and roasted in a pan until they start releasing oil. They are then placed in a pot to be heated to boiling point. Oil floats above the water and is removed. This process yields a dark oil; 10kg of kernels produce approximately 0.71kg of palm kernel oil.

(ii) Small-scale modern technological production processes of palm kernel oil

Consumption of palm oil in the countries of Eastern Africa subregion exceeds that of palm kernel oil. This explains the concerns of member states, private companies and the people regarding the improvement of small-scale production technologies in rural areas and using technologies designed to increase the production of palm oil. In general, the production using modern technological process of palm kernel oil are generally processed in oil mills in importing countries, depending on the market for expellers.

This oil, like coconut oil has a particularly high content of lauric acid. Its major uses after refinery are in food preparation and soap making because it facilitates lathering.

C. Palm oil as a raw material in the small - scale production of soap

(i) Raw materials

In rural areas of Eastern Africa subregion member countries, the people use the following raw materials to produce soap by means of small-scale technological processes:

- very liquid, well filtered palm oil with no trace of residue. This is palm oil that they themselves have produced using small-scale technological processes;

- caustic soda;

- ordinary table salt.

In the rural areas of the concerned countries of the Eastern Africa subregion, the people use the following methods to produce caustic soda:

- They take a fair amount of coffee rinds or other rinds dried after shelling;

- These rinds are dried out in the sun, then burnt to give ashes; these ashes are then left to cool before they are placed on a piece of cloth which serves as a filter;

- Hot water is gently poured over the ashes. The blackish liquid that drains off is collected in a container. This black liquid which stings the fingers and skin a little, contains the caustic soda used in soap making. The liquid is very dangerous to the eyes. Normally, a very large quantity of caustic soda is prepared (about half a drum) in order not to interfere with later production processes.

(ii) <u>Equipment and materials</u>

The containers used in the rural areas are those made from steel or copper which can withstand prolonged heating, for instance a half barrel.

It is unadvisable to use an aluminum container since aluminum is not resistant to caustic soda.

Additionally, a system is installed that allows the half barrel to be heated from beneath. Straw is recommended for the fire to keep the heat moderate. Charcoal is strongly discouraged.

(iii) <u>Production method</u>

A half barrel is filled up to a third with well filtered oil that is free from any solid matter. The free space in the container is needed to enable the soap to boil if necessary.

The oil is warmed on a fire fuelled by straw to a temperature tolerable to the touch.

Caustic soda will gradually poured over the oil. The mixture is stirred steadily and vigorously without stopping while a low heat is maintained.

Gradually the oil becomes pasty and increasingly harder to mix.

The mixing must not be stopped as every last drop of oil must make contact with the caustic soda.

Having obtained a very heavy paste, approximately 200gm of salt is dissolved in water and then mixed into the paste. The salt helps harden the soap.

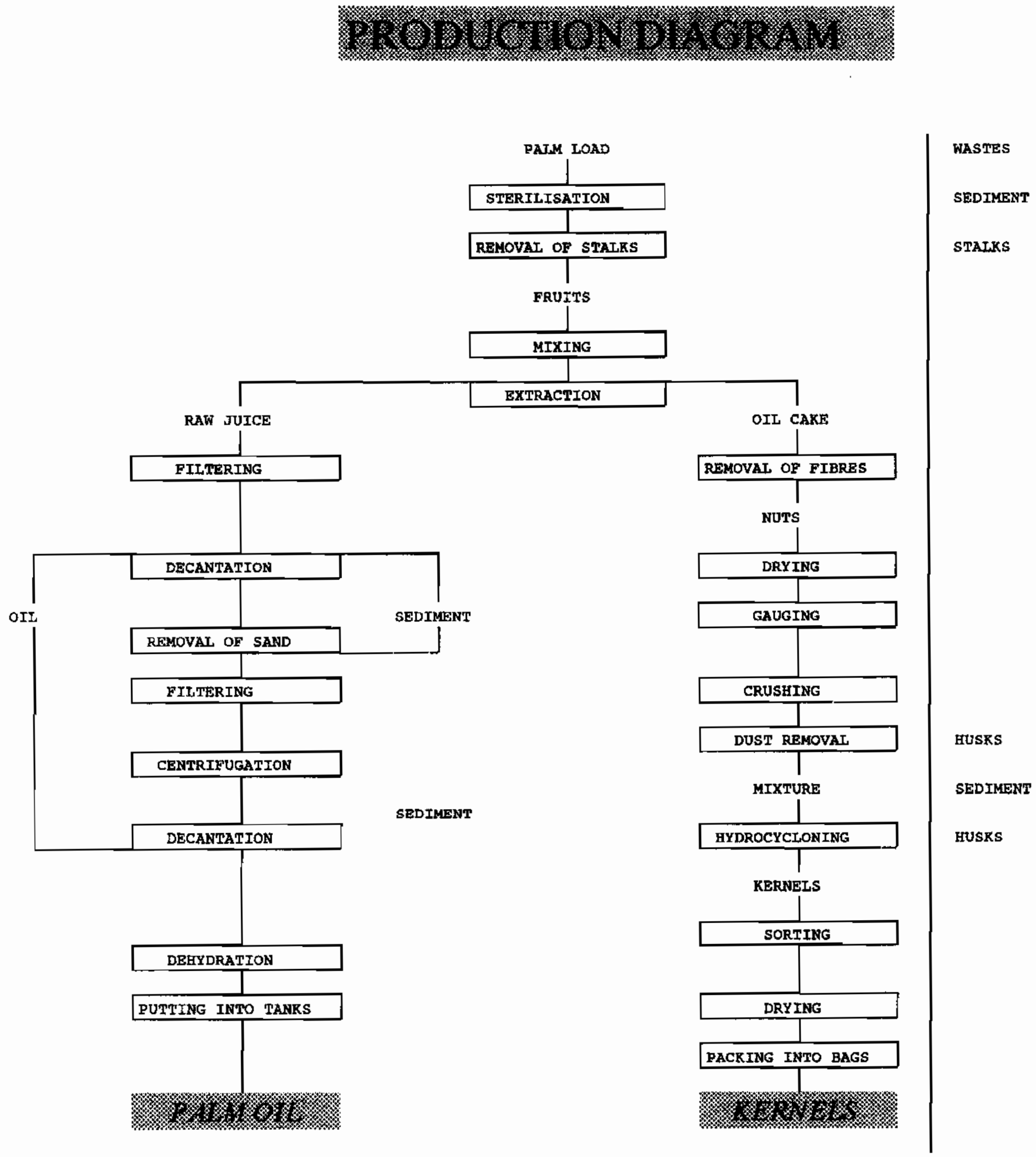
The soap is finally allowed to cool before it is cut up and packaged in readiness for the market.

D. <u>Recommended modern technological process for palm oil extraction</u>

There are various modern systems for the extraction of palm oil. However, it is recommended that the modern technological process such as the one used in a factory for the extraction of palm oil from palm nuts using the water method as indicated in the production diagram (Figure no. 7) should be used.

Production Diagram

Figure 7



Each of the various stages featured in the palm oil production diagram has a very precise objective. These include:

- Sterilization: During this operation, enzymes that convert matter into oil are extracted and the contents of the free fatty acids are stabilized. This facilitates the removal of stalks from the fruit.

- Removal of stalks: The objective of this operation is to separate the sterilized load into stalks and fruit.

- Mixing: This prepares the fruit for the easy extraction of oil. The pulp is detached from the nuts and the oleiferous cells are crashed, thus releasing the oil they contain.

- Extraction: The mixed fruit forms magma in which most of the oleiferous cells are crashed. The nuts are crashed in this mass whose temperature is 100°C. Several methods are used to extract oil from the mass.

- Clarification: The crude oil issuing from the extraction equipment consists of an emulsified mixture of oil, water, colloidal matter and solid impurities. The next step is the separation of oil from its impurities by decantation.

- Finishing of oil: The oil emerging from clarification generally still contains 1% water. The oil is dehydrated again until it contains less than 0.1 to 0.2% water and very little solid impurities.

2.1.3. Methodology for the estimation of production costs and revenue of groundnut and palm oils

The following methodology is of a general nature and may be used to estimate production costs of groundnut:

(i) Cost of raw materials

- To determine the daily and yearly quantities of raw materials (palm nuts, groundnuts) to be processed, taking into consideration the local availability of materials and intended capital investments.

- To determine the number of shifts worked per day and the number of days worked per year.

- To calculate the output, using the extraction rates associated:

With the adopted process and the input of raw materials:

- Oil output - extraction yield of oil x M tonnes/year of raw materials.

- Cake output - extraction yield of cake x M tonnes/years of raw materials.

(ii) <u>Fixed investment cost</u>

To determine the cost of the following items:

L = Cost of land
B = Cost of buildings
D = Cost of drying grounds
E = Equipment cost (local and imported)
S = Cost of initial spare parts (equal to 5 per cent of initial imported equipment). Therefore Fixed Investment Cost (FI) = L + B + D + E + S.

(iii) <u>Working capital and total investment cost</u>

The working capital required is dependent on the adopted levels of stocks of finished goods and raw materials. It may be estimated on the basis of the following formula:

Working capital = 1.1 x A x M/day x C

Where:

A = The sum of the number of days during which raw materials input and the finished goods are kept in storage.
M/day = Amount of raw materials input (in tonnes)
C = cost of 1 tonne of raw materials input.

The total investment cost is the total sum of investment costs and working capital:

(iv) <u>Fixed investment annual cost</u>

The fixed investment annual cost for every investment component, is a function of the interest rate assumed. Let this be 1% per year.

Given the value of 1 and knowing the useful life of the piece of equipment, the annual fixed investment cost of the latter can be calculated in the following manner: For interest 1% p.a. and a useful life U, to obtain the corresponding factor F from a discount table appendix). For example, given a value of 1 of 10 per cent and a useful life of 10 years, we find F = 6.145. Let the investment cost of the component be Z: then the annual fixed investment cost is equal

to Z/F. In this manner, one may calculate this cost for each investment item including building, drying grounds and equipment. Since land has an infinite life, the annual cost may be assumed to be equal to the annual rental rate. The annual cost of spares and maintenance - which may be assumed to be equal to 7.5 percent of total equipment costs - should be added to the other annual fixed costs in order to obtain the total annual fixed costs.

Other calculations are as follows:

a) Working capital annual cost as the annual interest paid on the amount of working capital;

b) Total fixed annual costs as the sum of annual fixed costs and interest paid on working capital;

c) The sum of the annual variable costs. These costs include the annual costs of:

(i) Raw material (M tonnes/year) x (cost of tonne);
(ii) Water
(iii) Electricity
(iv) Diesel
(v) Wood or other local fuel
(vi) Filter cloth requirements
(vii) Tins or drums
(viii) Labour (number required X yearly wage)

d) Total annual costs as the sum of annual fixed costs and annual variable costs

2.1.4. Illustrative example for the estimation of production costs and revenue of oil extraction from groundnuts

The methodological framework described is used to evaluate a two small-scale mill for the extraction of groundnut oil.

(i) Cost of raw materials

Input - 560kg of groundnuts per day (151.2 tonnes per year)

Organisation of production: 1 shift per day, 270 working days per year.

Output:
- oil: 0.389 x 151.2 = 58.82 tonnes/year
- cake (11 per cent oil in cake) = 0.541 x 151.2 = 81.79 tonnes/year

(ii)	**Fixed investment cost**	US$ 7,755.00
(iii)	**Working capital**	
	2 days' finished goods + 7 days' raw material = 9 days Therefore, working capital = 1.1 x 9 x 0.56 tonnes x US$ 470/ton =	US$ 2,605.00
(iv)	**Total investment cost (ii + iii) =**	US$ 10,360.00
(v)	**Annual fixed investment cost**	US$ 1,352.50
(vi)	**Annual working capital cost**	
	10 per cent interest on working capital of US$2,605	US$ 260.50
(vii)	**Annual total fixed investment cost (v + vi) =**	US$ 1,613.00
(viii)	**Annual variable costs**	**US$**
	- Raw material (groundnuts): 151.2 tonnes at US$470/tonne	71,064.00
	- Water	nil
	- Electricity	nil
	- Diesel fuel: 2,430 litres at US$0.40/litre	972.00
	- Wood	nil
	- Filter cloth: 24 at US$ 1.50 each	36.00
	- Tins (18kg): 3,300 at US$0.60 each	1,980.00
	- Labour: 2 labourers at US$ 1,000 each	2,000.00
	Subtotal	76.052.00
(ix)	**Total annual costs (vii + viii) =**	**US$ 77,667.00**

2.1.5. Input to groundnut and palm oil processing unit

a) Raw material requirements, intermediates and accessories per month:
Minimum expenses = ±SUS 10,453.00

(i) Palm seeds, groundnut (500 - 600kg), etc
(ii) Tin containers (18 kg)

(iii) Gunny bage
(iv) Glass bottles 75 cl to 20 litres
(v) Plastic containers/bottles

b) Utilities per month: Minimum expenses: $US 200.00

- Power (approx. 30 kwh)
- Water
- Lubricant
- Packaging materials
- Fuel for boiler

c) Other contingencies (per month) - Minimum expenses: $US 300.00

- Postage and stationary
- Consumable stores
- Repair and maintenance
- Transport charges
- Advertisement and publicity

d) Fixed capital

(i) Land and buildings: Minimum cost = ±$US 6,200.00
- Land 350 square metres
- Built area: working shed 175 square metres
- Storage room 25 square metres
- Office stores etc. 50 square metres

(ii) Machinery and equipment: Minimum cost = ± $US 5,400.00

- One oil expeller - crushing capacity 1 tonne
- One 20 H.P. motor with starter switch, main switch, gear, etc.
- One small boiler with super heater
- One filter press 16" x 18" x 18 plates with plunger pump and filter cloth
- Three oil storage tanks 200kg capacity
- One weighing scale plat form type 100kg capacity

(iii) Various installation charges

-	Electrification and installation charges (10 per cent of the cost of machinery and equipment	540.00
-	Cost of tools, fixture, belt and pulley	300.00
-	Furniture	200.00
		$US 1,040.00

Minimum total cost of machinery and equipment
(ii + iii) = $US 5,400.00 + 1,040.00 = $US 6,440.00

Minimum total fixed capital = (i) + (ii) + (iii) =
$US 6,200 + 5,400 + 1,040 = 12,640.00

(e) Personnel (skills and labour requirements)

In general, two or three family members should suffice for the production of groundnut or palm oil by using the small-scale traditional technological production process. In that case, the mill owner should have the necessary skills for the running of the equipment, as well as for maintaining and repairing the latter.

But the following skills and labour requirements should be taken into consideration when using the modern technological production process for groundnut and palm oils:

1. Personnel (skills and labour requirements)

	Function	Number	Salary per month (minimum $US)	Total
i)	Manager (chemist)	1	150.00	$US 150.00
ii)	Store Keeper (accountant)	1	120.00	120.00
iii)	Mechanic	1	100.00	100.00
iv)	Purchase and salesman	1	80.00	80.00
v)	Skilled worker	1	60.00	60.00
vi)	Unskilled worker	4	40.00	160.00
	Total salaries and wages	=		$US 670.00
	Perquisites 15 per cent of the salary			+ $US 100.50
	Total			$US 770.50

f) Minimum total capital investment required to establish the unit

i)	Minimum total fixed capital	±$US 12,640.00
ii)	Minimum total working capital	±$US 11,723.50

- Raw materials:	$US 10,453.00
- Utilities:	200.00
- Other contingent expenses:	300.00
- Personnel:	770.50

Minimum grand total capital investment requirement =
$US 12,640.00 + 11,723.50 = $US 24,363.50

2. Source of finance

a) Own savings
b) Subsidy from the government
c) Credit or loan form:

- Finance corporation
- Industrial development bank
- National or commercial bank

d) Any other sources

3. Sources of raw materials

The raw materials are available locally

4. Sources of machinery and equipment and addresses of suppliers

When you make enquiries, and in order to satisfy your requirements, please indicate if you would like to receive complete machinery and equipment or only some parts (see annex 1).

2.2. Small-scale fish processing technologies

It is known that fish protein contains large amount of amino acids which are important, indispensable and nutritive substances for domestic animals as well as for human beings. In fact a fish meal containing a large quantity of amino acids is such an excellent livestock feed that hens fed on it and lay a larger number of eggs; and the flesh of livestock improves in nutritive value too. Fish oil also becomes one of an important material for industrial soap, and the gravy can be concentrated and mixed with rice bran or wheat bran for use as livestock feed.

From past experiences, it has been well recognized that domestic animals such as the milk cow, store cattle, pig and poultry show remarkable results of rapid and better growth when fed with rich fish meal fodder, as it is known to contain high quantity of protein and phosphoric acid. For feeding chicken in poultry farms, the fish meal fodder is most suitable. Unfortunately, consumption of fresh or processed fish in the countries of Eastern Africa subregion has not progressed and in some cases, has actually declined. A number of reasons explain this situation: lack of adequate infrastructure at landing areas, such as lack of cold storage; inadequate fish processing technologies used by small-scale fish processors, etc...

The lack of appropriate landing and transport facilities puts a limit to the amount of fish which can be marketed before spoilage takes place. In the countries of Eastern Africa subregion, the spoilage of fish can take place within six hours at ambient temperatures. Inadequate transport facilities and marketing channels also make local fisherman dependent of fish wholesalers or retailers who tend to pay them low prices for their catches.

Fish processing is a fairly wide field, covering a large number of processing techniques, fish species and fish product. This document covers the following fish processing technologies suited for small-scale producers. Fish salting, drying and fermenting and fish smoking and boiling.

But, since spoilage of fish may take place before, during or after processing, it is important to reduce wastage and losses to the lowest possible level. In fact, fish get spoiled very quickly and small-scale fish processing enterprises can easily loose profits through wastage. In general, it has been estimated that approximately 25% of a catch of fish may be lost through one cause or another before consumption. The following are the measures to prevent or minimize the spoilage of fish before, during and after processing.

2.2.1. Prevention of spoilage of fish before processing

A great deal of spoilage may occur before the fish is processed. In general, the lower the temperature of the fish, the slower the change which causes spoilage. If the fish are handled properly and good hygienic measures are taken, the spoilage may be reduced.

In order to avoid or minimize spoilage of fish, it is recommended to improve the cold storage, transport facilities and hygienic environment.

In the rural areas when the large catches of fish are taken, the lack of handling facilities and the distribution causes the spoilage of fish. A long period of time elapse before the fish can be processed. In this case, a high percentage of the fish become unsuitable for processing. To avoid such spoilage of fish, it is recommended to introduce the cold storage facilities in proximity of the catch areas or adequate transport facilities. Such transport facilities should be equipped with a refrigeration system. It is also advised that processing plants such as salting,

drying and fermenting and fish smoking and boiling, should be located near the catch areas in order to avoid the need for extensive transport facilities.

In the rural areas of some countries of the Eastern Africa subregion, fish can be chilled with ice and they may be kept in an edible condition for an increased period. But, if ice is not available in sufficient quantities, fish may then be kept relatively cool as follows:

a) keeping the fish in the shade out of direct sun;
b) placing damp sacking over the fish. this helps reduce the temperature as the water evaporates. The sacking must be kept wet and the fish must be well ventilated;
c) mixing the fish with wet grass or water weeds in an open sided box so that the water can evaporate and cool the fish. In this method, the fish should be kept continuously wet.

It is recommended to maintain the good hygienic environment. The fish which have been handled cleanly and carefully will be in a better condition than fish which have been handled carelessly.

2.2.2. Prevention of spoilage of fish during processing

During processing, all tools, fish boxes, boat holds, cutting tables etc... should be clean by washing them with clean water. It is advisable to use the drinking water to wash the fish before and during processing. The working area should be cleaned regularly, at least once a day by removing all offal and dirt which might contain bacteria or attract insect pests such as flies. All offal should be removed from the working site.

Fish processors and hands handling food should always be washed before starting work and particularly after visiting the toilet. Anyone who is infected wounds, stomach complaints or any other contagious diseases, should not be allowed to handle the fish. Work, such as cutting fish prior to salting or drying, must be carried out on tables, not on the ground where the fish will become dirty and pick up bacteria.

In order to avoid the spoilage of fish through bacterial, mould or insect attack, fish should be protected from rain and salt should be used immediately during drying.

During processing, fish should be always protected from insect infestation. Such protection can be done only ensuring that processing is properly disposed of so that there are no places for insect to breed. Salting techniques may help since insect larvae are not attracted by heavily salted fish. Drying processes are also useful in countering blowflies.

2.2.3. Prevention of spoilage of fish after processing

The storage life of cured fish will depend on the adopted curing methods and packaging. The fish from river and lakes in the countries of Eastern Africa and cooked at temperatures over

50°C, although higher temperatures are usually used to reduce the time required to complete the process. Cooked fish, such as boiled or hot smoked products, must also be salted and/or dried if a storage life of more than two days at tropical temperatures is required. It is necessary to ensure that sufficient drying of the fish has been carried out properly in order to avoid attacks by certain bacteria or moulds during storage. After packaging, to store packaged goods in cool storage areas protected from dust, insect, etc...

2.2.4. Processing methods

This document describes briefly fish salting method, but gives sufficient details on the drying method in order to allow processing on the basis of the provided information.

A. Salting method

During salting, the flesh of the fish looses some of its water and is impregnated with salt. Salting can be done by a number of methods. The resultants are influenced by such factors as climate, salt quality, type and quality of the fish used, the type of product desired by consumers and cost. The juices extracted from the fish during dry salting can be allowed to drain away or they can be contained in order to keep the fish covered by a salty liquid.

There are three main salting methods: kench salting, pickle curing and brining.

(i) Kench salting

This method is more popular for large lean fish species. Kenching can be carried out in shallow concrete tanks fitted with a drain, or on raised platforms or racks of approximately $1m^2$ area and 8 - 10cm off the ground. Starting at the center of the rack, 2 or 3 rows of prepared fish are laid flesh side up over a bed of salt. Salt is then sprinkled or rubben all over the fish, more being put on the thick parts of the fish than on the thin parts. Whenever scores have been made, these should be filled with salt. A pile of fish is built up by moving outwards from the centre, and sprinkling each layer of fish with slat before covering with the next layer. To ensure good drainage, the centre of the pile should be about 10cm higher than the outside edges and it should not be higher than about 2m.

In the countries of Eastern Africa subregion with tropical temperature, fish can be left in the kench pile for 24 to 48 hours after which it is dried. However, the salt may not have completely penetrated the fish during this time, and penetration may continue during drying. In rainy weather, the fish may be left in the kench pile for longer periods. In this event, the pile should be broken down and a new pile made up so that the top fish from the first pile are placed at the bottom of the new pile. In making the first kench pile, 30 - 35 parts by weight of salt should be used for each 100 parts of fish.

(ii) **Pickle curing**

In pickle curing a barrel or tank is used to hold the brine which forms as the salt mixes with the water contained in the fish. From 20 to 35 parts by weight of salt to 100 parts by weight of fish may be used depending on the curing method required. In this salting method, a layer of dry salt is spread over the bottom of the tank upon which the first layer of fish is laid. There is, however, no need to stack fish higher in the centre as drainage is not required. The layers of salt and fish are stacked up, care being taken to ensure that no fish are overlapped without a salt layer between them since this could cause the fish to stick together.

Pickle curing is recommended in preference to kench salting as it produces a more even salt penetration and provides a better protection of the fish against insects and animals since they are covered with brine.

(iii) **Brine salting**

In brine salting, the fish are immersed in a solution of salt and water. This method is commonly used in developed countries when a smoked product is to be made and the salt concentration required in the final product must be lower than 3% (e.g. as for hot smoked mackerel).

A fully saturated brine contains about 360g of salt to each litre of water. A sack of salt should be hung in the brine to ensure that the latter remains at full strength.

(iv) **Salt quality**

A good fishery salt contains from 95 per cent to 98 per cent of common salt known chemically as sodium chloride.

The type and quality of salt used affect the appearance, flavour and shelf life of cured fish. If pure sodium chloride is used for curing, the product is pale yellow in colour and soft. A small proportion of calcium and magnesium salts is desirable as the latter yield a whiter, firmer cure which is preferred by most people. However, if the proportion of these chemicals is too high, the rate at which the sodium chloride impregnates the fish is slowed down Furthermore, the salt becomes damp as the chemicals absorb moisture from the air and make the product taste bitter.

The composition of sun or solar is determined by various factors outside the control of the processed fish producer. Therefore, if salt from one source proves unsatisfactory another source should be sought or the curer should consider making his own salt.

All processing equipment and surfaces must be thoroughly washed with fresh water to help prevent pinking. Light growths can be brushed off from the fish surface and the product redried.

B. Drying method

During drying, water is removed from the fish by evaporation in two phases. During the first phase, only water on the surface of the fish or very close to the surface evaporates. The rate at which the fish dry depends on the surface area of the fish, the air temperature, the speed of the current of air passing over the fish and the relative humidity or wetness of the air. The drying rate during the first phase may be increased by:

- Increasing the fish surface area by splitting the fish and scoring them;
- Choosing a drying site where the air is dry and to avoid, if possible, marshy areas and places where the air has blown over water;
- Choosing a drying site where the wind is strong.

Once the surface is dry, water will evaporate at the rate at which it rises from inside the flesh to the surface of the fish. This rate slows down as the fish gets drier.

During the second phase, the drying rate is function of:

- The type of fish. For example, the rate at which water rises to the surface is slower for fatty fish;
- The thickness of the flesh;
- The temperature of the fish;
- The water content of the fish; and
- The wetness of the surrounding air.

(i) Conventional sun drying

Natural or air drying uses the combined action of the sun and wind without the help of equipment. It is important to dry the fish quickly before they get spoiled, and that all surfaces of the fish be open to the drying action of the wind. Where only a few large fish are to be dried, this may be done by hanging the fish up. Split fish may be hung on hooks, by tying them up with string, or by tying the fish in pairs by the tail and hanging them across a pole or line.

Large quantities of fish should be dried on racks. Suitable materials for drying racks include chicken wire, old fishing nets, and thin rods or poles such as reeds or sections of bamboo. The surface of the racks should slop if split large fish are to be dried. A flat surface is preferred for drying small intact fish. These racks can be easily covered with plastic sheets to protect the drying fish from the rain. Where large quantities of very small fish are to be dried, a netting rack may be impractical. Suitable drying surfaces may be made instead, with raised floors of wood, concrete, bamboo strip or, where none of these materials are available, well compacted clay.

Wooden boards, weighted with clean rocks or other suitable material, should be placed on the pile of fish in order to flatten them which give them a better appearance, and also speed up the process by which water moves from the inside of the fish to the outside, so that they will dry more rapidly the following morning.

However, even when racks are used, sun drying has many limitations: long periods of sunshine without rain are required; drying rates are low; and in areas of high humidity, it is often difficult to dry the fish sufficiently. The quality of sun dried fish is likely to be low due

to slow drying, insect damage and contamination from air born dust. Also it is difficult to obtain a uniform product.

(ii) <u>Artificial drying</u>

The following factors can be controlled when drying fish artificially to ensure optimum drying conditions:

- <u>Temperature</u> - the higher the temperature, the quicker the drying. This, however, has to be balanced against the damage which is caused by over-heating the fish and the extra cost of increasing the temperature in a mechanical drier. In general, the initial drying temperature should be restricted to 25 to 45°C. In some countries of Eastern Africa subregion, fish can withstand a higher processing temperature (35 - 45°C) during drying with no signs of heat damage as compared to temperate fish which may not withstand temperatures higher than 25 - 30°C.

- <u>Relative humidity (RH)</u> - the moisture content of the air is important for two reasons: it controls the drying and influences the appearance of the final product. The drier the air, that is the lower the relative humidity, the faster the drying rate. If, however, the air is too dry, the surface of the fish will dry too quickly resulting in hardening. The relative humidity is dependent on local conditions but, as a guideline during initial drying, a 50 - 60 per cent RH is suitable for optimal drying. This can be lowered by raising the air temperature during the later drying stages.

- Air speed - a faster flow of air over the fish results in even and rapid drying. This is due to a more uniform temperature distribution and a quicker removal of moisture from the fish. A compromise must be made between the higher cost of faster air circulation with a mechanical drier and the improved drying rate gained with a high air speed. Therefore, an air speed between 60 and 120m per minute is normally used when drying fish with a mechanical drier.

- Surface area and volume of fish - large whole fish take longer to dry than small fish due to the greater difficulty of removing water from inside the flesh of the fish. Large fish should, therefore, be split to increase the surface area. The flesh should also be scored if it is thicker than 2 cm.

Artificial drying offers better control than natural drying, resulting in greater product uniformity and quality. The initial investment on equipment and expenditures on energy inputs are, however, high and may not always be justified. In general, artificial drying is advantageous when drying by conventional methods.

(iii) Solar drying

The use of solar dryers has been investigated as an alternative to traditional sun drying. Solar dryers employ some means of collecting or concentrating solar radiation with the result that elevated temperatures and, in turn, lower relative humidities are achieved for drying. When using solar dryers, the drying rate can be increased, lower moisture contents can be attained, and product quality is higher. The dryers are less susceptible to variations in weather, although drying is obviously slower during inclement weather, and they do provide shelter from the rain. The high internal temperatures discourage the entry of pests into the dryer and can be lethal to any which do enter.

In fine weather conditions fish can be dried within 3 days, compared with 5 days for sun drying. The quality of the solar dried fish is higher. During the initial constant rate period of drying (dependent largely on air movement), drying rates in the solar tent and on sun drying racks are broadly similar. A suitable method for fish drying might be to use racks, in the first instant, and complete the process inside the solar tent.

Solar drying reduces the effect of insect infestation on fish. In addition to causing losses in quality and quantity, insect pests are potential carriers of pathogenic bacteria and thus represent a serious health hazard. The temperatures found in solar dryers can kill any insects or larvae present on the fish, thereby presenting a means of disinfestation. A period of 20 hours at 45°C is recommended for a complete disinfestation of drying fish.

2.2.5. Inputs to the dryer processing unit

(a) Raw material requirements, intermediates and accessories per month:
Minimum cost $US 17,000

(i) Fish about 1T/day
(ii) Bags
(iii) Tin containers, etc.

(b) Utilities per month: Minimum expenses = $US 600

- Electric power facility
- Water facility
- Heavy oil or steam is economical and is used as fuel
- Packaging materials

(c) Other contingencies per month - Minimum cost = $US 400.00

- Postage and stationery
- Consumable stores
- Repair and maintenance
- Transport charges
- Advertisement and publicity

(d) Fixed capital

(i) Land and building: Minimum cost = $US 6,500.00

Land 3,000 square metres
Construction of the unit consists of: steal frame, lower part, concrete block; upper part, mortar finish on metal, bathing requirement is floor space = 1,320 square metres

Building (storage, processing, packaging and office areas)

(ii) Machinery and equipment - Minimum price = $US 40,000

- Delivery car
- Fish tray
- Pre-dryer
- Dryer
- Rail
- Blower
- Oil burner

- Electric motor

(iii) Various installation costs

-	Electrification and installation charges (10 per cent of the costs of machinery and equipment)	$US 4,000
-	Other costs	" 600

Minimum total cost of machinery and equipment: Total 4,600
(ii + iii) = $US 40,000 + 4,000 + 600 i.e. $US 44,600

Minimum total fixed capital, (i) + (ii) + (iii) =
$US 6,500 + 40,000 + 4,600 = $US 51,100

(e) personnel (skills and labour requirements)

	Function	Number	Salary per month (minimum $US)	Total
(i)	Manager	1	150	150.00
(ii)	Store keeper (accountant)	1	120	120.00
(iii)	Fishermen	2	50	100.00
(iv)	Purchaser	1	60	60.00
(v)	Driver	1	80	80.00
(vi)	Mechanic	1	100	100.00
(vii)	Skilled worker	1	40	40.00
(viii)	Unskilled workers	4	30	120.00
	Total salaries and wages =			770.00
	Perquisites, 15 per cent of the salaries +			115.50
	Total =			885.50

(f) Minimum total capital investment required to establish the fish dryer unit

(i) Minimum total fixed capital = ±$US 51,100.00
(ii) Minimum total working capital = ±$US 18,885.50

- Raw materials:	$US	17,000.00
- Utilities:	"	600.00
- Personnel:	"	885.50
- Other contingent expenses:	"	400.00

Minimum grand total capital investment requirement =
$US 51,100 + 18,885.50 = 69,985.50

2.3. Small-scale bread making technologies

Bakery is one of the important and popular food processing units in all countries of Eastern Africa subregion. It provides nutritions breakfast and food to a large number of house holds in cities; towns and Eastern Africa villages. Bread consumption is increasing every day in Africa. In fact bakery manufacturing units can be established in smaller towns, villages and rural areas of the countries of the Eastern Africa Subregion. Such units can provide a good number of employment opportunities at different levels.

2.3.1. Process description

It is recommended to knead all the ingredients together in the machine for the preparation of dough. At intervals of 40 minutes, the bowl is removed and mixed. The mixed dough is fermented for two hours, knocked back, and is rested for 30 to 40 minutes. The dough is ready for dividing. The dividing is done as per the size of loaf to be manufactured. The divided dough pieces are panned and kept for final processing. When the dough attains a particular raising, they are baked for 40 minutes at 420°. Baked bread is cooled sufficiently, sliced and then wrapped.

2.3.2. Inputs to bread making unit

(a) Raw material requirements: Minimum expenses = ±$US 3,840.00 (including packing requirements - per month)

- Wheat flour	17 tons
- Sugar	70 kg
- Salt	30 kg
- Shortening	300 kg
- Dried baker yeast	2 kg
- Vegetable fat	25 kg
- Mineral yeast food or dough conditioner	-
- Wrappers	6,200 kg

(b) Utilities (per month): Minimum expenses = ±$US 200

- Power KW
- Fuel
- Water

(c) Other contingencies (per month): Minimum expenses = ±$US 400

- Rent
- Postage and stationery
- Telephone
- Consumable stores
- Repairs and maintenance
- Transport charges
- Advertisement and publicity

(d) Fixed capital

(i) Land and building: Minimum = ±$US 250

- Land = 500 square metres
- Building = 250 square metres

(ii) Machinery and equipment: Minimum cost = ±4,410.00

- One floor shifter motorized
- One dough kneader motorized 90 kg/charge
- One dough moulding m/c caps 500
- One baking oven locally erection with bricks (standly)
- One bread slicing and wrapping and sealing m/c
- One baking oven electrically operated
- One baking rans, moulds etc.
- One rack
- Office furniture and equipment

(iii) Electrification and installation charge (10 per cent or cost of machines and equipment) = $US 441

Minimum total cost of machinery and equipment (ii + iii) =
$US 4,410 + 441 = 4,851.00

Minimum total fixed capital (i + ii + iii) =
$US 250 + 4,410 + 441 = $US 5,101.00

(e) Personnel (skills and labour requirements)

Function	Number	Salary
Manager (accountant)	1	$US 100.00
Store-keeper	1	" 40.00
Clerk-typist/salesman	1	" 30.00
Baker	1	" 60.00
Skilled workers	3	" 60.00
Unskilled workers	3	" 60.00
Cycle boys	2	" 40.00
Total salaries =		$US 390.00
Perquisites 15 per cent		" 58.50
Total		$US 448.50

(f) Minimum total investment required to establish the unit

(i) Minimum total fixed capital ± $US 5,101.00

-	Land and building	$US 250.00
-	Machinery and equipment	$US 410.00
-	Electrification and installation Charges	$US 441.00

(ii) Minimum total working capital ± $US 4,888.50

-	Raw materials	$US 3,840.00
-	Utilities	" 200.00
-	Personnel	" 443.50
-	Other contingents expenses	" 400.00

Minimum grant total capital investment requirement =
$US 5,101 + 4,338.50 = $US 9,939.50

2.4. Small-scale industrial production of honey

2.4.1. The benefits of honey in the Eastern Africa subregion

Honey is a natural sweet substance produced by bees and is used both as a food product and medicament. Honey possesses the following ingredients:

-	Honey water (moisture content)	17.20%
-	Levulose (fructose)	38.19%
-	Dextrose (glucose)	31.20%
-	Maltose	7.31%
-	Sucrose	1.31%
-	Other carbohydrates	1.50%
-	Honey acid	0.57%
-	Mineral (sodium, calcium, magnesium, manganese)	0.17%
-	Enzymes, vitamins and others	2.21%
-	Undetermined	0.34%
		100.00

The development of the honey production process in the rural areas of the countries of Eastern Africa subregion is very important for the following reasons: honey is a highly energy generating element and has ingredients that improve physical fitness for people of all age groups. It strengthens the muscles of the heart and thereby regulates blood flow.

Honey contains also carbohydrates, enzymes and other elements and is therefore excellent for the purpose of body - building. Honey is also good for the brain and blood streams. It not only provides the body heat to the old persons, but also enhances the digestive capability of the innards to give them stamina.

Athletes who eat honey are physically fit and it helps to increase body integrity and speed. Pregnant women who eat honey two months before delivery they will find that it softens their womb and decrease birth difficulty.

Apart from its nutritional values, honey has many curative qualities. Some of its medicinal qualities are as follows:

(a) It eases quickly rheumatic pains and other diseases related to internal complications and Asthma;

(b) Honey possesses anti-bacterial properties and is hygroscopic in nature. It is therefore, a speedy remedy when applied to fire and other wounds;

(c) It is an effective protective against cold and infection of the throat;

(d) If children are fed milk with honey, it helps to enhance brain maturity, strengthens bone structure and develops the body;

(e) Cures headaches;

(f) Honey if eaten before sleep, avoids bed wetting;

(g) In some countries of the Eastern Africa subregion, traditionally honey is used to produce beverages. Eventhough it satisfies the need of alcoholic drink producers, it has no nutritional value. Honey cannot only be used as a foodstuff and medicine in the rural areas of the countries of Eastern Africa subregion, but also as a source of income. The pure honey can be exported or sold locally on the market, to airlines, hospitals, hotels and groceries.

2.4.2. Honey production process

Crude honey can be collected from the collection centres of different areas of the country. Plastic barrels are used for collection and transported up to the processing plant. Water bath melter is used to liquidity the honey and then pass to stainer through plastic pipe. After the liquid honey is filtered and allowed to settle, then connected to the filling tank. Purified honey is then fill into the glass jar ready for marketing.

Following are the detailed operations of the honey production process:

(a) Honey collection

There is no difference in the quality of honey whether it has been collected from traditional or modern hive. However the quality could be reduced due to improper handling. In order to assure production of high grade honey, the factory can conduct classes to honey producers on methods of production, collection and after handling. If the factory's collection containers are tight, the honey will not be affected by either air or moisture. This would help it to retain its natural taste and aroma throughout the production process.

(b) Laboratory test of the crude honey

Before entering the filtering section, the collected honey undergoes tests in the laboratory to determine: purity, type of plant species from which it is obtained and to detect foreign elements such as corn syrup, cane sugar that may have been mixed with the honey by dealers.

After the laboratory test, the honey is liquified in the melting tray and is separated from the wax. Liquid honey enters filtering equipment and it passes through fine gauze.

(c) Liquefying process

After laboratory test, the honey is liquified in the melting tray. The liquefying equipment controls the temperature of the honey. During this process of liquid honey, the wax is separated from the honey.

(d) Filtering process

The obtained liquid honey enters filtering equipment and it passes through the fine gauze. At this stage, the last remnants of impurities are removed properly.

(e) Storage tankers

The filtered honey is drawn into special honey storage tankers by electrical power connector which have their own temperature control system.

(f) Laboratory test of purified honey

Before it is distributed on the local market for several uses, the honey should be checked again for its quality grades and certified as edible food.

(g) Packing and container facilities

The purified honey is transferred to the preparation and packing department. The honey is prepared in liquid as well settled forms and packed into containers of different sizes. It is recommended to carry out the market surveys in order to select the different size of the containers to be used. It should be put in containers which give long service by keeping the high grade quality of the honey. The containers are washed by chemical to ascertain that they are hygienic. As the lids are anticorrosive, the keeping quality of the honey would not be affected.

The small-scale honey processing unit can process up to three thousand tons of honey and one thousand ton of wax annually. If the unit can operate on a full time basis, it will be possible to double production and to be able to satisfy the demand of the consumers in the market.

2.4.3. Inputs to honey processing unit

(a) Raw material requirements, intermediates and accessories per month (minimum expenses) = ±US$ 6,900

- Crude honey
- Plastic container (200kg)
- Glass jar (500gm)

(b) Utilities per month: minimum expenses = ±US$ 270.00

- Power
- Water
- Packing materials

- Lubricants

(c) Other contingencies (per month): minimum expenses = US$400

- Postage and stationary
- Repair and maintenance
- Transport charges
- Advertisement and publicity

(d) Fixed capital

(i) Land and buildings: Minimum cost = ±US$ 22,371

- Land 400 m^2
- Processing house ($100m^2$)
- Storage ($50m^2$)
- Office ($12m^2$)
- Others ($12m^2$)

(ii) Machinery and equipment: minimum cost = ±US$ 62,900

- A.O.C. honey strainer, water bath
- Water bath meter
- Double jacket tanker
- Mixer and filler
- Heating element and refractometer

(iii) Various installation charges (US$ 1000)

- Office furniture
- Telephone installation
- Power installation
- Water system installation

Minimum total cost of machinery and equipment (ii + iii) = US$ 63,900

Minimum total fixed capital = (i) + (ii) + (iii) = US$ 86,271

(e) Personnel (skills and labour requirements)

	Function	Number	Salary per month (minimum $US)	Total
1.	Processing manager	1	170	170
2.	Marketing officer	1	160	160
3.	Purchaser and dispatcher	2	120	240
4.	Skill labourers	8	50	400
5.	Store keeper	1	40	40
6.	Guard	4	30	120
7.	Driver	1	40	40
	Total salaries and wages			1170
	Perquisites 15 per cent of the salary			175.50
	Total			1345.50

(f) Minimum total capital investment required to establish the unit

(i) Minimum total fixed capital 86,271
(ii) Minimum total working capital 8,815.50

- Raw Materials: 6900
- Utilities: 270
- Other contingent expenses: 400
- Personnel: 1345.50

Minimum grand total capital investment requirements = 95,086.50

Source of finance

Credit or loan based

Sources of raw materials

Raw materials in this case, crude honey is an available resource within the country.

Sources of machinery and equipment and addresses of suppliers

Some European countries like German, France and Italy have a complete set of the processing plant. The processing plant as such not so complicated. Spare parts are also easily available from the suppliers.

III. ASSISTANCE TO THE SMALL-SCALE FOOD PROCESSING UNITS IN THE RURAL AREAS OF THE EASTERN AFRICA SUBREGION

3.1. The socio-economic and infrastructural requirements

The small-scale food processing units in the rural areas have not, in general benefitted much from governmental support. There are many reasons for this neglect. The main ones include the relative isolation of the small-scale food processing activities, resistance to the introduction of new technologies, lack of qualified manpower to operate the modern small-scale food processing technology, lack of financial assistance, doubts on the economic viability of small-scale food processing units in the rural areas, etc... These reasons may not, however, justify such neglect as they also apply to other sectors of the economy such as agriculture which have benefitted often from extensive governmental assistance.

Given the importance of the existence of various small-scale food processing activities in the rural areas greater attention should be paid to the improvement of manpower in order to facilitate the introduction of modern small-scale food processing technologies.

Any assistance in favour of the small-scale food processing activities in the rural areas should take into consideration the socio-economic framework of each activity.

This framework may include the following social groups: crop harvesting farmers, fishermen, the small-scale food producers in the rural areas (e.g. harvesting staff and their family), crop and fish traders, the suppliers of various materials inputs and equipment and local consumers. Any assistance provided to the small-scale food processing units in the rural areas should be carefully analyzed in terms of its acceptance by the above groups, its impact on productivity and incomes, and its effectiveness in bringing about the desired changes.

Sometimes, the assistance to small-scale modern technology will rather contribute to worsening than improving the living conditions of small-scale producers and consumers in the rural areas, for the following reasons:

a) Lack of knowledge and skills to operate the small-scale modern technology, in order to improve the quality of the products and meet the needs of the consumers;

b) Non availability of financial inducement in the form of generous credit to invest in improved equipment and quality of products.

In many rural areas of the countries of the Eastern Africa subregion, small-scale food producers lack the infrastructures such as storage, transport, marketing services, trading cooperatives, etc... The lack of energy or fuel for operating the small-scale food processing technology constitute additional constraints to the development of the small-scale food processing activities in the rural areas of the countries of the Eastern Africa subregion.

In the agriculture sector and specially in the case of groundnut and palm oils, a sufficiently large storage capacities are yet required from the pretreatment to the post treatment stages.

The investments which are specific to the small-scale food processing units in the rural areas are mostly needed for the appropriate food processing technologies, raw materials and oil storage (finished goods) infrastructures. The acquisition of appropriate food processing equipment and technologies as well as the establishment of adequate infrastructures, require financial assistance which are not generally available.

The same constraints apply to the fishing communities in the rural areas which lack the infrastructure necessary for chilling or freezing fish, such as cold storage, ice making plants and for marketing fresh and cured fish at some distance from the fish fishing areas of the rural areas.

Infrastructure required for fish landing area located in an important commercial centre:

(a) An ice-making plant with a production capacity of four times the weight of the daily catch, and a storage capacity equal to six times the weight of the daily catch;

(b) Cold storage rooms (- 2°C and -18°C) which can accommodate three or four times the volume of a maximum daily catch;

(c) Infrastructure required for landing areas which is not located in an important commercial areas;

(d) An ice making plant with a production capacity equal to 2/3 of that described under (i) above;

(e) Fish freezing equipment to accommodate 50% of the maximum daily catch;

An additional infrastructural requirements may include a roofed area for sorting, cleaning, washing and packaging fish before transport or storage.

The lack of cold storage or ice-making plants in the rural areas constitute generally a constraint to the expansion of fish supply by small-scale fisheries.

The assistance to the small-scale food processing units in the rural areas should be determined on the basis of a national food processing policy. Such a policy should include the following: (a) the extend to which food processing activities should be shared between small-

scale and large scale food processing units; (b) the small-scale food processing technologies which should be promoted in the rural areas, taking into consideration the demand and needs of consumers, the infrastructures such as storage, transport, marketing, etc...

3.2. Establishment of cooperative in food production, processing and marketing in the rural areas of the Eastern Africa subregion

Cooperatives play an important role in the multiple stages of the agricultural business, system, from production to terminal market points.

As a strategical structures, cooperatives should be placed at rural locations, thus emphasizing their eligibility to be developed as focal organizations for rural development.

In the small-scale food processing subsector, edible oil and fish cooperatives should be established in order to share in their respective markets. The traditional small-scale oil processing activities are popular in the rural areas of the Eastern Africa subregion. About 80% of edible oil produced traditionally are consumed for cooking. It is recommended to establish the following cooperative structures in the rural areas of the Eastern Africa subregion:

3.2.1. Cooperative storage and marketing structure

Where large populations exist in the rural areas, cooperatives for marketing of food products have to be established in order to organize and coordinate credit and marketing functions. Such cooperatives will be in charge of input distribution and marketing of processed food products. They will assist the small-scale food producers in procurement of modern equipments and setting up the small-scale food processing technologies in the rural areas.

In this connection, they will formulate and distribute inputs, purchase the processed food products, store and transport them on behalf of the producers for selling in the urban areas. The cooperative marketing structure will encompass secondary and terminal markets of food products in the rural areas of the Eastern Africa subregion.

3.2.2. Consumer and training cooperative structure

The consumer and training cooperative structure is expected to organize the wholesale and retail of food products and training in the rural areas. This cooperative will operate through the small-scale food producers. Its training operations will include all food products, such as edible oil, fish, vegetable, juice, etc... Concerning the training programme, the cooperative will identify the training needs and coordinate training of various cooperative members in the field of food processing, storage, marketing, trading, etc.

3.3. Training programme

The availability of skilled labour often constitutes a constraint to the establishment of a small-scale modern food processing units in the rural areas of the countries of the Eastern Africa subregion. Therefore, it is strongly recommended to provide and extend the training facilities that would enable the small-scale food producers to keep up and develop their production efficiencies as well as their productivities in the rural areas.

Training is playing an important role in changing social status and living standards of mankind. This is evidenced by the active participation of the same in socio-economic activities and the development of human resources. It is vital to improve natural talents, knowledge and skills of persons gained through experience and to cop up with modern appropriate food processing technology.

Any activities or skills have to operate according to the existing environmental situations. In order to upgrade and promote activities and meet the needs of the clients, it is important to be familiar with the modern food processing technology and needs of the community. Training programme in the rural areas should include the training that would enable the small-scale food producers to cope with new small-scale food processing technologies, storage and marketing technics.

The provision of training to small-scale food producers, storage personnel, traders, etc..., will generally be needed in order to induce the latter expand the supply of food products and to increase productivity and incomes in the rural areas. Training programme should preferably be under the responsibility of the Ministry of Agriculture, Department of Food Processing if any. But the training itself should be organised through the consumer and training cooperative structure in the rural areas.

IV. ENVIRONMENTAL PROBLEMS RELATED TO THE SMALL SCALE FOOD PROCESSING ACTIVITIES

When selections are made concerning raw materials for food processing activities, transportation and distribution of food products, etc... environmental problems should be taken into account before they arise. Such an approach most effectively addresses the waste of food products and, thus, adverse environmental impacts in the rural areas. For example, in the case of small-scale fish processing operations, the waste fish and air pollution represent the risks to humans and the environment.

4.1. Waste fish

The reservoir from which water is obtained for use in processing is the ultimate destination of water borne wastes. If the wastes are not treated properly before disposal, they may cause pollution of the water body and make it unsuitable for use. It can also result in the upset of the biological balance in the water body causing a change in the animal and plant life. It is recommended that all contaminated water discharged from fish processing operations should be treated so as to keep pollution of natural waters to a minimum. The types of waste water produced can be divided as follows:

a) Blood water and contaminated process water. This water results mainly from the washing of fish and contains fish blood and some fish protein;

b) Ice melt water and used ice containing fish protein, blood and bacteria;

c) Wash down water containing larger pieces of fish and fish protein;

d) Domestic sewage from toilets and urinals; and

e) Specialized waste waters such as press liquor and stick water from fish meal operations and cooling water from canning operations, etc.

In most fish processing operations, there will be a certain amount of solid waste. This may be in the form of fish offal, heads and trimmings from cutting operations, or waste fish which may be too small to use. These wastes must be treated properly if they are not to become a nuisance and hazard to public health.

Where small quantities of waste are produced in a small-scale operation, then the most feasible way of disposing of them may be to bury them in a pit. The pit should be deep and offals, once put into the pit, should be buried. This will stop the residues becoming infested with flies, etc...

Small quantities of fish waste can be also used for feeding animals such as ducks and chickens. Where larger quantities of waste are being produced, then it may be feasible to produce the following by products from the main fish processing operation:

a) Cod stomach, gills and guillets can be salted for preservation and human consumption;

b) Viscera can be fermented to produce sauces and pastes or can be sold on the market at a very low prices thus providing protein and food for the less well off members of the rural and urban areas;

c) The acidification of fish offals with mineral and organic acids (usually formic acid) can produce a liquid product known as fish silage. This liquid can then be dried for inclusion into chicken feeds or can be fed as a liquid to pigs.

d) Fish glue can be made from skins and heads of fish by steaming fresh material over a perforated screen within a steam jacketed vessel for about 8 hours. Fish glues were once used in furniture making, book binding, leathergoods, etc... But with the production of synthetic glue from petro chemicals, fish glues have gone out of the market;

e) Filleting waste or small trash fish or shrimp waste can be sun dried and used as a fertilizer to improve crop production on the land in the rural areas;

f) Fish oils may also constitute an important by product from fish wastes processing. This oil can be used for either human consumption in the production of margarine and cooking fats, or it can be used for the production of various compounds such as paints and varnishes. Oils extracted from the livers of fish are often high in vitamins A and D.

4.2. Air pollution

Although the air pollution caused by fish processing operations is not dangerous to health, it can cause unpleasant smells and an unpleasant environment. To reduce odours as much as possible, raw material for fish meal production must be as fresh as possible, and processing should begin as soon as the raw material arrives at the processing unit.

In the rural areas, the following fish processing methods cause unpleasant smells:

a) Smoking operations: with smoking operations, small quantities of fish usually has unpleasant smell of which are seldom for a cause of complaint from the surrounding population.

b) Sun drying operations: The smell generated during the process can be strong and unpleasant, specially when elasmobranch fish such as sharks and rays are being

salted and sun dried. It is important that fish curing yards be sited away from rural areas' residences.

The small-scale food producers involved in the early stages of the food processing activities have a special responsibility to make possible environmental adaptation throughout the entire product cycle. The application of an integrated preventive environmental strategy will enable to improve efficiency and reduce risks to humans and the environment.

ANNEX I

QUESTIONNAIRE ON SMALL SCALE FOOD PROCESSING TECHNOLOGIES AND THEIR USE IN THE RURAL AREAS OF THE EASTERN AFRICA SUBREGION

I. GENERAL INFORMATION

1. Indicate the food products produced: ______________________________

____

____

2. Type of machine or equipment used including source and price per unit: __________

____

____

____

3. What is the capacity of machine or equipment (hrs/day/month): ______________

____

____

____

4. Total annual production 1994 and 1995 (tons/litres): ______________________

____

____

____

5. Number of processing (production) units (set of machines or equipment). Specify the machine or equipment required for the complete food processing process from meat, fish and agricultural crops to the required food product: ______________________

____

____

____

6. Procurement of equipment, meat, fish and agricultural crops and supplies done by*:

(a) Self [ ]; (b) Central procurement body (government) [ ]; (c) Co-operatives [ ];

(d) Subsidized by government [ ]; (e) NGOs donation [ ] → specify ____________

7. Marketing of food products done by*: (a) Self [ ]; (b) Central shop (government) [ ];

(c) Co-operatives shop [ ]; (d) Other [ ] → specify ______________________

9. Assistance provided by * government [ ], NGOs [ ] in:

(a) Preparation of studies [ ]; (b) Credit at low interest [ ]; (c) Donation:

(i) Financial [ ]; (ii) Equipment or machine [ ]; (iii) Other [ ] → specify ______;

(c) subsidized [ ]; (d) Training [ ]; (e) Management [ ]; (f) Tax exemption [ ];

(g) R&D [ ]; (h) Advise and support in improving operation of food production [ ];

(i) Advertizing [ ]; (j) Land provided by government: Yes [ ]; No [ ] specify ____

II. SPECIFIC INFORMATION

1. Name of plant, establishment, unit (also of contracting company, if any): _________

____

____

---

* Tick of the selected box.

2. Location/Address (specify industrial estate or central promotional organization - if any):

____

____

3. Year established: ______________________________

4. Total covered area of plant (m^2): ______________________________

5. Total investment (US$): ______________________________

6. Indigenous ownership (%): ______________________________

7. Total labour force: ______________________________

8. Products from meat, fish and agricultural crops,

(a) Example:

- Dairy products ☐
- Cream cheese ☐
- Sausage ☐
- Fish meat ☐
- Fish paste ☐
- Dry fish ☐
- Jams and juices ☐
- Palm oil ☐
- Palm Kernel oil ☐
- Peanut oil ☐ (ground nut)
- Sunflower oil ☐
- Flours from manioc (cassava) ☐
- Flours from maize ☐
- Starch ☐

- Dehydrated vegetables ☐
- Confectionery ☐
- Vegetable and fruit canning sauces ☐
- Soft drinks ☐
- Rice milling ☐
- Bread ☐

(b) Specify for meat, fish and agricultural crops: Tons/litres, local/imported; supplying country; cost per unit.

(c) Indicate any other food product which can be produced at small-scale level in your rural area for the immediate and direct fulfilling of the needs of specialized markets, and for providing services directly to customers.

9. Utility requirements per year
(a) Water (m^3)________________
(b) Electricity (kwhr) ________________
(c) Other fuels: specify (tons/litres etc.)_______

10. Capacity of production and sales.

Products items	Type of machine or equipment	Annual capacity (tons/litres/m^2)	1994 and 1995 production (tons/litres/m^2)	1994 and 1995 ex-factory sales (value in US$)	Unit price (US$ value)
(a) (b) (c) (d)					
Total					

11. After production actions:

(a) Storage provided by: (i) self ☐; (ii) government ☐; (iii) Co-operative ☐;

(iv) none ☐;

(b) Location of shops for sale of food products produced in the rural area, in town or elsewhere (specify): ______________________________

____

____

(c) Transport for distribution (sales): (i) Own ☐; (ii) Government ☐;

(iii) Cooperative ☐; (iv) Other ☐ → specify ______________

12. Plans for expansion and diversification

Product	Expansion Additional annuai capacity (tons/litres)	Year of operation	New products annual capacity (tons/litres)	Year of operation
(a) (b) (c) (d)				

13. Brief description of process and technology of existing plant (including mention of major machinery and equipment and their suppliers).

ANNEX II

REFERENCES ON OIL EXTRACTION AND FISH PROCESSING

A. List of institutions involved in oil extraction

1. FAO, Fats and Oils Section
   Commodities and Trade Division
   Economic and Social Department
   Via delle Terme di Caracalla
   00100 Rome
   Italy

2. African Groundnut Council
   P.O.Box 3025
   Lagos
   Nigeria

3. Asian Coconut Community
   2nd Floor, Pantja Niaga Building
   94 - 96 Djalan Kramat Raya
   Djakarta
   Indonesia

4. Oil Technological Research Institute (OTRI)
   Anantapur
   Andhra Pradesh
   India

5. Philippine Coconut Oil Producers Association
   Singson Building
   Room 309
   Manila
   Philippines

6. Coconut Research Institute of Ceylon
   Bandirippura Estate
   Lunuwila
   Sri Lanka

7. Tropical Products Institute
   Oil Palm Advisory Bureau
   56/62 Gray's Inn Road
   London WCI

United Kingdom

8. National peanut Council
1120 Connecticut Avenue
Washington, D.C. 20036
United States

9. Department of Transport, Works and Supply
P.O.Box 1108
Boroko
Papua New Guinea

10. Australasian Manufacturers' Directory
Manufacturer Publishing Co. Pty Ltd.
Elizabeth and Hill streets
North Sydney
N.S.W. Australia

11. Thomas' Register of American Manufacturers
Thomas Publish Col
461 8th Avenue
New York, N.Y. 1001
United States

12. Europ. Production
ABC der Deutschen Wirtschaft
Berliner Allee 8
61 Darmstadt
Federal Republic of Germany

13. Kompass Directories
Kompass International AG
Neuhausstrasse 4
8044
Zurich
Switzerland

B. SOURCES OF SMALL SCALE OIL PROCESSING BREAD MAKING TECHNOLOGIES AND ADDRESSES OF SUPPLIERS.

(i) Oil Prossessing technologies

Belgium

De Smet,
265 avenue Prince Baudouin,
Edegem-Antwerp

Brazil

Masiero Industrial S.A.
P.O.Box 218-219,
Jan Sao Paulo,

China

China National Machinery Import
adn Export Corporation
Shandong Branch,
82 Fan Hsiu Road,
Tsingtao

Federal Republic of Germany

- Fred Krupp,
  Harburger Eisen-Und Bronzewerke,
  21 Hamburg, Harburg,
  Pestfach 105, Germany

- Christiansen & Meyer,
  Hamburg-Harburn Aussenmulhenweg 10

- Borsing Aktiengesellschaft
  1, Berlin 27 (Tegel) Posfach 12
  Germany

- Muller, Fritz Pressenfabrik, 73 Esslingen (Neckar), Postfach 310, ERG

- Reinarts, Mathias maschinenfabrick, 404 Neus, Postfach 137 ERG

- Extraktions, Techik, Gesellschaft für Anbagenbaumbh, P.O.Box 7501447 D-2000, Hamburg 76 w.6

<u>France</u>:

- Etablissments Olier, 63-Clermont-Ferrand, Bureaux: 12 Avenu

- Socite des anciens établissements, Lhnilhier, 5, rue Amedee-Bargy, 2-Dijon, France

- Compagnie Hobart, 11, rue galilee, Ivry-Port (Seine), France

- R. Desmulles, 9, rue Paul Doumer, Aubervilliers (Seine), France

<u>India</u>:

- M/s. Delhi Iron and Steel Co. (P) Ltd. G.T. Road, Post Box No. 7, Ghiaziabad (U.P.), India

- Lyllupur Engg. Co. G.T. Road, Post Box No. 9, Ghaziabad (U.P.), India

- Punjab Engg. Works 32, Rama Krishna Samadhi Road, Calcutta - 54,

- M/s. Swastic Engg. Works, 198, Panjera Pole Road, Bombay - 4, India

- Sunstone Engineering Industries (P) Limited P.O. Kuchaman Road - 341509 Rly. Stn Nawa City. District Nagour (Rajasthan), India

- S.P. Engineering Corp.,
  P.O.Box No. 218,
  Kanpur
  India

- United Engineering (Eastern)
  Coperation,
  22 Biplabi Rash Behari,
  Bose Road,
  Calcutta 1
  India

- United Oil Mill Machinery and Spares,
  D-298 Defence Colony,
  New Delhi
  India

- Numex Engineers,
  P.O. Box 820,
  Bombay
  India

Israel

H.L.S Ltd. Industrial Engineering Company
P.O.Box 193
Petah - Tikuah
Israel

Italy

Construzzioni Meccaniche Bernardini
C.M.B.
Via Petronella,
0040 Pomezia (Roma)
Italy

Japan

- Chuo Baeki Goshi Kaiska (CECOCO)
  P.O.Box 8
  Ibraki City
  OSAKI
  OSAKA Pref.
  JAPAN

- Moritani and Co. Ltd., International Trading and Engineering, 4-33, Yaesu 1-chome, Chuo-ku, Tokoyo 103-91, Japan

- Fuyi Machinery Co. Ltd. 14-10, 2-Chome, Kamejima, Nakamura-Ky Nagoya 543, Japan

- The Yokohama Industrial Institute, Nihon - Odori 11, Nara-Ku, Tokohama, Japan

Malawi

- Agrimal (Malawi) Ltd.
  P.O.Box 143,
  Blantyre

Netherlands

- Strock-Apparatenboun BV,
  P.O.Box 3007,
  Amsterdam

Switzerland

- Buss AG, CH-4133, Prattelin

- Nova-Werke AG, Vogelsangstrasse 24, CH-8307, Effretikon

- Chemap AG, Alte Landstrasse 415, CH-8708, Mannedorf

United Kingdom

Messrs. Rose, Downs and
Thompsons Ltd.,
Cannon Street,
Hull

R. Hunt and Co. Ltd.,
Atlas Works,
Earls Colne,
Colchester
Essex CO6 2EP

United States

- Anderson IBEC,
  19699 Progress Drive,
  Strongfield,
  Ohio 44136
  USA

- French Oil Mill Machinery Company,
  Pique,
  Ohio 45356
  USA

- Dravo Corporation, Chemical Plants
  Div.
  One Oliver Plaza,
  Pittsburgh,
  Pa 15222
  USA

- Bauer Brothers Co.,
  Springfield,
  Ohio
  USA

India

- M/s. Oriental Machinery Supplying Agency, P-21, Mission Row Extension Calcutta, India.

- M/s. Ever Fresh Products, Rambaug, Indore (M.P.), India.

- M/s. Baker Co. (P) Ltd., Omrigar Building, Oppo. Crawford Market, Bombay-400 003, India.

- M/s. Nagpal Bros. (Reqd.), 2789, Hamilton, Road, Delhi-110 006, India.

- M/s. Mangal Engineering Works, Lahori Gate, Patiala (India).

- M/s. New Era Industries, Firozepur Road, Ludhiana, India.

- M/s. Semoni Industries, Hoshiarpur Road, Jullundur City (pb.), India.

- M/s. Verma Bros. Engg. Industries Regd., Industrial Area, Rajpura (pb.), India.

- M/s. Brady & Morris Engg. Co., Ltd., 12/4, Veer Nariman Road, Brady House, Fort, Bombay-400 023, India.

Japan

- Moritani and Co. Ltd., International Tracking and Engineering, 4-23,
  Yaesu 1 - Chome, Chuo-ku
  Tokyo 103-91
  Japan

- Fuji Machinery Co. Ltd. 14-10
  2, Chome, Kamejina Nakamura-ky
  Nagoya 543
  Japan

- The Yokohama Industrial Institute
  Nihon-Odori 11, Nara-ku
  Tokohanna
  Japan

Switzerland

- Glatt, Masch. und Apparatebau AG, Kraftwerkstrasse 3, CH-4133 Prattelin, Switzerland.

- BAFAG, backonfenfabrik, CH-5334, Signau, Switzerland.

  Sigg Aktein - Gesellschaft, Walznuhlestrasse 51, CH-8500, Frauenffid, Switzerland.

  Beschbach AG, F. Industriestrasse 20, CH-5001, AARAU, Switzerland Buss AG, CH-4133, PRATTELIN, Switzerland.

Germany

DRAISWERKE GmbH. Mannheim Waldhof, P.O.Box 310220, D-6800, Mannheim 31, Germany.

C. LIST OF PUBLISHED MATERIALS CONSULTED

(i) Selected bibliography on small-scale production and processing of edible oils and fats.

- Les plantes et leurs valeurs nutritives, par Mukoko Matondo. Centre de vulgarisation agricole, Kinshasa 1990

- De, SS. and Cornelus. J.A: Technology of production of edible flours and protein products from groundnuts

- L'arachide, par P. Gilbert et sylvestre. Maisonneuve et Larose. Paris, 1959

- Godin, V.G. and Spensley, P.C.: oil and oilseeds. **Crop and Product Digests No.1 London, TPI, 1971**

Rao, P.V.S.: A study of village oil industry in India (Lucknow, Appropriate technology Development association, 1980).

- Le palimier à huile, par C. Surre, R. Ziller. Maisonneuve et Larose, Paris 1959
- Oléagineux. Janvier 1961 No.1
- Guidelines for the establishment and operation of vegetable oil factories. UNIDO. New York, United Nations, 1977
- FAO Yearbook - Trade Vol. 47, 1993
- International Fiancial statistics. FMI, 1994
- La situation mondiale de l'alimentation et de l'agriculture. FAO, Rome 1994
- Appropriate industrial technology for oils and fats. UNIDO, New York. United Nations, 1979

(ii) Selected bibliography on small-scale fish production and processing

- Smoke curing of fish, FAO Fisheries Paper No. 88, FAO ROME, 1970.
- The prevention of losses in cured fish, FAO Fisheries Paper No. 219. FAO ROME, 1981.
- "An illustrated guide to fish preparation" by Rogers, J.F., Cole R.C., and Smith J.D. with Barron, J.O. Report G83, London, TPI 1975.
- "How to smoke fish in a drum smoker" by Watanabe K and Joeris, L.S. C.F.R.I. Zambia, UNSF and FAO Project, 1971.
- "Dried fish handling in Vigena" by Rothings, J and Hay ward, L.A.W. Food Mamifacture, Oct. 1972.
- Flexible and semi-rigid containers for heat sterilization" in Heiss, R. (ed.). Principles of Food Packaging, FAO Rome, 1970.
- "The production of dried fish". FAO Fisheries Technical Paper No. 160. Rome, 1976.
- "A short guide to fish preservation", by Dawson, G.C. FAO/UN, Rome, 1966.

- "Equipment and Methods for Improved Smoke. Drying of Fish in the Tropics", Fisheries Technical Paper No. 104, Rome, 1971.

- An experimental fish drying and smoking plant on Volta Lake, Ghana. Design, construction and economic considerations, by Watanabe, K. See Tropical Science No. 17 (2), 1975.