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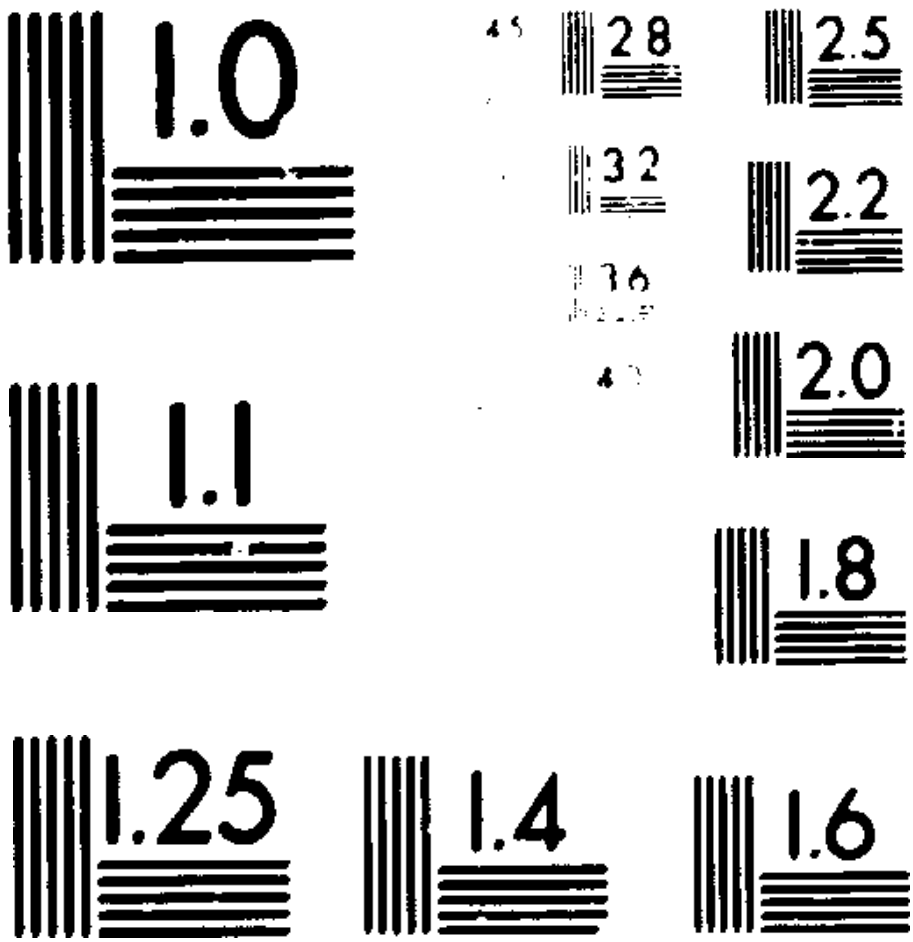

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KENYA

Technical report: Evaluation of the vegetable oils and animal fats industry in Kenya*

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

Based on the work of J. Pulot,
consultant on vegetable oils and animal fats

United Nations Industrial Development Organization
Vienna

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EXPLANATORY NOTES

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

1 US$ = 14.75 K.Shs.

ABBREVIATIONS

DM = Dry matter
E.A.I. = East African Industries
K.M.C. = Kenyan Meat Commission
RPM = Rotations per minute

ABSTRACT

To study and evaluate the situation of the vegetable oils and animal fats industry with particular reference to:

- Availability of raw materials from domestic and foreign sources;
- The processing and refining capacities in the sub-sector;
- Assess the annual consumption of edible and non-mineral industrial oils and animal fats in the country and project domestic demand up to the year 2000. Recommend, where necessary, the restructuring of the oils and fats industry to suit the qualitative and quantitative demand of every consumer;
- Assess the annual production of oil seeds oil fruits, and animal fats and suggest ways and means of increasing production to enable the country to achieve self-sufficiency within a foreseable period of time. Suggest a plan to integrate the local oils and fats manufactures in local oilseed promotion. Evaluate whether an oil Crops Development Board is required for the promotion of local oil seeds;
- Survey the existing industry to assess its capacities in extracting oil from seeds and fruits and to produce rendered fat both for edible and industrial purposes. Assess the prospects of improving recovery rates of oils and fats from the materials available with or without any change in the technology or equipment in use, or in the need to expand the production capacity over the period 1984-1988. Identify specific projects required and prepare profiles of the projects identified;

- Survey the edible oil refineries and hydro-genation plants to determine how their dependence on the imported inputs can be decreased substantially and to determine which structural changes or expansions of the existing installed capacity will be required over the next five years;

- Assess the prospects of the country's entry into the export market of refined, hydrogenated or crude vegetable oil and recommend a long-term plan to achieve the same, if it is found profitable and economically justifiable;

- Prepare a five-year programme for the development of the industry in order to achieve self-sufficiency in the production of edible (including butter and butter oil) and non-mineral industrial oils and fats.

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RECOMMENDATIONS

It is possible for Kenya to reduce considerably its imports of vegetable oils and animal fats and even later to become an exporter. But to reach this target, a great effort is recommended to be made in the following directions:

- Vegetable oil bearing crops, animal fats, utilization of by-products, cattle breeding, etc..may be developed in a kind of Integrated Agro-Industrial Complexes.

- Existing oil mills, slaughter houses as source of raw material for fat rendering plants, existing plantations (coconut trees) may and must be improved. Quality of raw materials has also to be improved.

- It will be necessary to increase and to develop new plantations and to rehabilitate some others (specially for coconuts). Losses and wastage of all kinds must be stopped. (even the smallest)

- For cotton seed and copra oil mills, multiplication of small oil mills cannot allow the use of suitable equipment in order to obtain the highest possible yield. Only a concentration of processing capacity in one single mill for copra and one for cotton seed can improve the actual situation.

- Unsuitable equipment, obsolete process, lack of controls, poor maintenance are also responsible for high losses and wastage of raw material. It also affects the quality of produced oils, and even of raw material.

- Some existing oil mills can be improved by addition of some new equipment and their production increased and even doubled with addition of solvent extraction.

- Anarchic development of new oil mills must be stopped for they are responsible for additional losses, and increasing scarcity of raw material.

To summarize, it will be necessary within the coming years and up to the year 2000 to act on these different points:

(1) At short term (within five years)

Creation of a Vegetable Oil and Animal Fat Authority

The functions of this Authority will include:

- Control of imports of raw material rather than of finished products
- Reorganization of oil industry
- Stoppage of the incredible proliferation of new small oil mills, increasing outbid of raw material's price and its decreasing quality (particularly for copra)
- Improvement of existing oil mills and refining plants
- Creation of new plantations of oil bearing crops
- Rehabilitation and development of coconut plantations
- Recovery and valorisation of by-products
- Advisory services for oil millers.

(2) At Medium and long terms

- Decentralization of major slaughter houses
- Development of new plantations of suitable oil bearing crops in the framework of integrated agro-industrial complexes.
- Creation of new large oil mills and refining plants (It must begin during the three coming years)

I. EXISTING VEGETABLE OILS AND ANIMAL FATS IN KENYA

1. General

In Kenya, the following Vegetable Oil Crops are existing or may be grown:

Cotton seed	Sunflower seed	Coconut
Maize germ	Rapeseed	Groundnut
Sesame	Castor bean	

But the only oil crops available for oil millers are:

Sunflower, cottonseed and coconut.

- Sesame and Groundnut are directly consumed, or exported (See Annex 2)
- Rapeseed, despite successful trials does not look popular.
- Castorbean is entirely exported (See Annex 2)
- Actual cotton seed production is actually in the range of 17 to 18 thousand tonnes. But one third of the crop is kept for sowing and the available share for oilmills is only about 12,000, may be 13,000 tonnes.
- Sunflower, despite successful beginning has dropped down.
- For Coconuts only one third of existing potential is industrially processed.
- Maize germ is a by-product of maize industry. Its composition varies according to the process which has been used to separate it from maize, wet or dry process.

  By wet process its oil content 40 to 50%
  Dry process gives a germ at 18 to 20%.

Both processes are used in Kenya, and it is difficult to know the share of each process.

Amongst the different oil mills we have visited, only one was processing maize germs. Its yearly consumption (300 days) is 18,000 tonnes out of which 2,700 tonnes of oil are extracted. From this result, it seems that wet process is mostly employed, and these 18,000 tonnes seem to represent the actual availability of maize germ.

For animal fats, tallow production is not more than 5,500 tonnes per year.

Lard does not represent more than 250 to 300 tonnes per year.

Concerning the processing capacity of vegetable raw material it does not seem to pass 70-80,000 tonnes per year, but real capacity utilization is less than 40% (see tables 1 and 2, pages 27-29).

Refining capacity is in the region of 150,000 Tonnes scattered in 16 refining plants, out of which 9 (56%) are completely obsolete.

But these obsolete plants do not represent more than 11,000 tonnes, i.e. 8.8% of the whole refining plants capacity.

2. COTTON SEED

Availability

It may vary from one year to the other, as shown in the following table.

From Cotton Lint and Seed Marketing Board, seedcotton production in '000 metric tons has been as follows:

	1976	1977	1978	1979	1980	1981	1982	1983	1984
Seed Cotton	15.8	16.3	27.2	27.6	38.1	25.5	24.4	26.3	?
Cotton Seed	10.5	10.75	18.	18.7	25.1	16.8	16.	17.35	?
Available for Mills	7.35	7.5	12.6	11.76	17.6	11.76	11.2	12.14	?

Available cotton seed for oil millers has been calculated from the relation:

100 seed cotton < 33 Cotton
66 Cottonseed

70% of the cottonseed is available for oil millers and 30% is set aside for planting. According to the Cotton Lint and Seed Marketing Board, they expect to obtain this year (1984) a production of 77,000 bales (185 Kg each) of cotton.

It represents 14,245 tonnes of cotton, i.e 28,490 tonnes of cottonseed out of which 30% will be kept for planting.

Forecasted availability for oil millers should be close to 19,000 tonnes (from interview with Mr. MUTHAURA of Cotton Lint and Seed Marketing Board.

From the oil millers's point of view, existing cotton seed has an irregular, but always too high, lint content which makes it very difficult to dehull properly.

A visit to one ginnery at Malindi revealed that, ginning machines there are of a very old type, and it is not possible to reach same efficiency with them as with the modern ones fitted with 144 or more circular saw blades. But this modern equipment needs a rather expensive maintenance, and a special machine tool to sharpen the entire sawshaft every week.

It is necessary to have a spare shaft, completely fitted with saws, ready to replace the one in operation in order for the ginning machine not to lose time during the sharpening of saws.

In Kenya, cotton is ginned in several small ginning plants scattered close to the production areas.

Dispersion of these ginning plants reduces the individual production of each of them and makes uneconomical the use of such modern equipment, for maintenance cost will be multiplied by the number of ginneries. The only solution for the oil miller, is to delint the seed properly. Unfortunately, same problem appears because the available crop is shared between at least 13 oil millers.

The 12,000 tonnes available in 1983 represents a share of less than 900 tonnes only to each mill (probably less). A normal cottonseed oil mill must be fitted with the following equipment, for obtaining crude oil only:

1) Cleaning equipment of reception of seeds
   (special for cotton seed)

2) Convenient storage of seeds in bulk (special silos or store house)
3) Cleaning before processing (may be same as for 1)
4) Delinting machines (special for cotton seed)
5) Dehullers (special for cotton seed)
6) Special separation of meat from hulls
7) Device to separate the small particles of kernels which may remain in hulls (Trommel type)
8) Appropriate grinder
9) Cooker able to cook the meat properly
10) Single pressing expeller, specially fitted and adjusted for cotton seed, or solvent extraction plant.

This kind of equipment is absolutely uneconomical and unthinkable for existing oil mills.

A normal small size cotton seed oil mill cannot economically work under at least 50 tonnes daily capacity, which represents 12,000 tonnes of seeds on 240 working days.

With a forecasted production of about 19,000 tonnes of seed, one single mill of 75 tonnes daily capacity will process it easily.

Actual losses due to inapropriate equipment

According to a recent analysis of a cottonseed sample, oil content appears to be in the region of 21%. Cake coming from the same seed had more than 12% residual oil content. A normal, well prepared cottonseed, processed with a modern heavy-duty expeller gives a cake with 6% oil content, in one single pressing. (more often between 4 and 6%).

The average composition of well ginned cottonseed is:

Hulls content: 40%
Kernels " : 60%

Existing seeds have at least 10% lint content and their composition should be (calculated from above one):

Lint content	10%
Hulls "	36%
Kernels "	54%
Total oil content in seed	21%

Due to bad dehulling, and to a bac separation of hulls from meat, we can consider the existence in the meat of about 15% impurities. (lint + hulls).

Out of 100 original seed we have 54% kernels. With a meat at 15% impurities we have:

existing meat: $\frac{54}{0.85} = 63.5\%$

63.5% meat contains the 21% existing oil, Cake is made of dry matter (DM) and of residual oil: (12%)

In this case DM = 63.5 - 21 = 42.5
and cake at 12% oil is: 42.5: 0.88 = 48.3%
Recoverable oil: 63.5 - 48.3 = 15.2%

Out of 21% existing oil, recovery is only

$$\frac{15.2 \times 100}{21} = 72.4\%$$

With a well prepared seed (delinted, well dehulled, proper grinding) and use of a heavy duty expeller, with one single pressing, 6% residual oil content in cake is obtainable

With same seed as above, processed in good conditions, we should obtain:

100 seed = 54 Kernels, or meat
DM = 54 - 21 = 33
cake at 6% = $\frac{33}{0.94} = 35.1\%$
Recoverable oil: 54 - 35.1 = 18.9%

With regard to existing oil, recovery is:

$$\frac{18.9 \times 100}{21} = 90\%$$

The loss is 90 - 72.4 = 17.6%, with regard to existing oil in seed. With the 12,000 tonnes processed in 1983, it represents a loss of about 480,000 liters crude oil (at least)

3. SUNFLOWER

Availability

Since 1979 production of sunflower has dropped suddenly. Total sunflower handled by National Cereals and Produce Board has been as follows:

1977	-	59,340 tonnes
1978	-	42,300 "
1979	-	15,210 "
1980	-	21,750 "
1981	-	525 "
1982	-	1,170 "

Actually, farmers seem to prefer to grow maize rather than sunflower. It may not be a matter of price, but with maize they are sure to be paid cash. For some millers or cooperatives, it is not the same and the only ones who do not have problems concerning the availability of raw material are those who pay cash to the farmers. Therefore, this apparent scarcity looks to be more a kind of economic factor, rather than a technical one.

From oil millers point of view, there exist two varieties of sunflower according to their oil content:
Varieties with a low oil content - 22 to 32%
Varieties with a high oil content - 50% or more
Hulls content vary from 35 to 45% and kernels from 55 to 65%.

Processing

- Dehulling

Dehulling has to be done with a special dehuller followed by a hulls and kernels separation. After dehulling, kernels must appear almost unbroken. After separation of hulls, it is necessary to allow 5 to 6% (about) in meat, in order to process it in the following expeller without difficulty.
The meat coming from dehuller has to be cooked at a temperature of about 80°C to 85°C.
The expeller must be specially adjusted for sunflower.
Assembling of wormshaft is almost same as for cotton seed.
With a modern expeller, residual oil content in cake is in the

region of 6% when seed is processed in one single pressing.

Actual Processing

Dehulling is done with a hammer mill or by a disc dehuller without any kind of special adjustment. The result is a kind of coarse powder from which it is impossible to separate properly meat from hulls.

Losses of Sunflower in actual processing

With such a kind of heterogeneous mixture, it is very difficult to feed properly and regularly the expeller.

This heterogeneity appears clearly in recent analysis on samples of sunflower seed and dehulled sunflower seed:

Oil content in sunflower seed - 32.2%
Oil content in dehulled sunflower seed - 15.3% !!!

This contradictory results prove two things:

1) Hetereogeneity of meat
2) Presence in meat of a too high proportion of hulls due to a particularly bad separation of hulls from meat.

From oil content in seed we can guess this seed belongs to the variety with a high hulls content. (45%)

1) Let us say:

100 seed = 45 hulls + 55 kernels
Kernel = 32 oil + DM (dry material)
100 seed = 45 hulls + 32 oil + DM
DM = 100-(45 + 32) = 23
Oil content in kernels:

$$\frac{32 \times 100}{55} = 58.18\%$$

From these different figures we can calculate the oil yield. Hulls content in meat should be in the region of 30%.

Meat after dehulling and 30% remaining hulls:

$$55/0.7 = 78.57$$

Meat = oil 32 + DM or DM = 78.57 - 32 = 46.57

Cake at 10% oil content:

$$46.57/0.9 = 51.74$$

Recoverable oil:

$$78.57 - 51.74 = 26.83$$

Oil extraction rate:

$$\frac{26.83 \times 100}{32} = 83.8\%$$

2) From same seed, a proper dehulling and only 5% hulls in meat above calculation will show an oil extraction rate of 91.8%.

3) But with seed at 50% oil, processed in a modern expeller, after a good dehulling and with 5% hulls in meat, the extraction rate will rise up to 96.98%.

4) With the same seed (50% oil), with the same bad dehulling as for (1) with 15% remaining hulls in meat, extraction rate will be 87%.

4. COPRA

Availability

According to Ministry of Agriculture and Livestock Development in Mombasa, about 35,000 hectares are planted with coconut trees. This figure matches that one of Mr. Catanaoan's report* (34,248 ha).

It has not been possible to find reliable statistics concerning availability of dry copra, and since Mr. Catanaoan's visit, no change has apparently happened concerning production, which from same report, seems to be in the region of 6,000 tonnes.

But the number of oil mills has increased from 9 in 1983 to, at least, 11 and some more are planning to start operating next year.

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*) See report: UNIDO/IO/R/114 of 20 March 1984.

This anarchic proliferation of oil mills is highly prejudicial to existing oil millers. It increases scarcity of raw material, cannot improve the production or quality of copra and results in copra being sold to the highest bidder (from 4.5 to 6.6 KShs. per Kg.

The only winners are copra producers who are sure to sell their production at the highest price, whatever its quality, and by this way they are not encouraged to improve it.

Still, the 35,000 ha planted with coconut trees represent a potential of about 18,700 tonnes copra per year, and only about one third is available to oil producers.

Remaining potential of 12 or 13 thousand tonnes, is either not exploited, or is reserved for direct consumption (toddy or other beverages, meat, etc.)

Quality of raw material

It is one of the worst which exists:

- Average moisture content is in the range of 20 to 30% instead of 5 to 7%.
- Acidity of oil frequently overpasses 15%
- Copra is completely mouldy and already now the problem of aflatoxin in cake has arisen.
- Due to its too high moisture content which even after a further drying, gives to copra a kind of soft and flexible structure, it is not possible to press it properly and the oil yield is low (50 to scarcely 60% with regard to raw material processed).
- Some Oil Millers seem to believe it is possible to improve moisture content after a storage of two or three months. It is true, but quality has worsened, oil content is affected, quality of cake lowered.
- Some oil millers seem not to know that copra oil may be an edible oil, and not only an industrial one. But with the actual quality of raw material it is not possible to obtain anything else than an industrial oil.

The result of these facts is a real wastage of raw material.

Normally a good copra should not have more than 7% moisture content. Generally it is dried up to 6%, in one single operation.

Simple test may be helpful to estimate the moisture content from some thin slices of copra:

- less than 7% - burns readily
- 7 to 10% - flame splutters
- 10 to 15% - burns with difficulty
- more than 15% - does not burn at all.

According to "Uniform Standard Specification for Copra"* from the Asian and Pacific Coconut Community*, there are two grades specified irrespective of the process used for making copra. The various characteristics specified for the two grades are given here under:

Characteristic	Grade I	Grade II
1) Moisture content max.	6	8
2) Oil content (on moisture free basis)	68	66
3) FFA (% as Lauric) max.	1	3.5
4) Impurities (% by weight)	0.5	1
5) Immature kernels (wrinkle cups) % by count max.	Nil	5
6) Mouldy cups (% by count) max.	Nil	4
7) Charred or black cups (% by count)	Nil	5
8) Broken cups or chips (% by weight)	Nil	5
	Nil Passing through ¼" mesh sieve	Not more than 1% passing ¼" mesh sieve

In Kenya, we are very far from these specifications and the difference explains the poor results and the very bad quality of the produced oil.

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* See UNIDO/IOD/377 of 11 September 1980 - Coconut processing technology information document part I, p.61.

Actual Processing

- Drying

After opening the nuts, the halves are sun dried, or sometimes, kiln dried. Anyway, the result is always poor due to insufficient time of drying, and also a too long time during which the opened nuts stay before being processed.

Time taken for drying is very important as once deterioration of the copra has started, it may continue until the product is properly dry.

In case of sun drying, the temperature of 30°C to 40°C encountered is inadequate to destroy the microorganisms.

During kiln drying, where temperatures are between 50°C and 70°C, all the microorganisms are inactivated.

Deterioration of fresh coconut meat commences as soon it is exposed to air, that is immediately the nut is split.

The lapse of time between opening the nut and commencement of drying should be as little as possible.

Some experiments have been done in Malaysia and the following results have been reported. *

Expt No 300 nuts per trial	Delay period before drying (hours)	White Copra	Slightly discoloured or dirty copra (%)	Red to Reddish Black copra (%)
1	Nil	82	18	0
2	2	80	20	0
3	4	75	25	0
4	6	70	29	1
5	9	61	35	4
6	12	36	42	22
7	24	10	48	42
8	48	0	17	83

Change in colour is related to deterioration of copra.

* See UNIDO/IOD/377 of 11 September 1980 - Coconut processing technology information document part I, p.61.

- Pressing of Copra

The only preparation is a coarse crushing which reduces copra in pieces of about 3 to 4 centimeters.

Then it is directly introduced into the expeller, without any preliminary cooking, for first pressing.

The first pressing cake is pressed again in the second pressing expeller, without any kind of cooking.

Sometimes a third pressing follows the second one.
It results in a cake with an average of 11% residual oil content, often more. One Oil Miller pretended to reach 7% after a third pressing.

There does not exist any kind of control during all the process, and very often feeding of expellers is manually done.

Oil yield seems to be in the range of 50 to 60% with regard to processed copra.

This very primitive way of processing cannot give anything else than poor results. Anyway, due to the particularly bad quality of raw material, it is difficult and even impossible to grind the copra properly.

Its kind of rubber consistence cannot allow to reduce it to a kind of fine sand.

Lack of cooking, principally after first pressing, affects the oil recovery.

Expellers used seem not to be properly adjusted, for it is exactly the same assembling of wormshaft which is used for cottonseed.

Quality of equipment is rather poor. Under these working conditions, even a better equipment will give poor results.

Normal processing of Copra

In order to process copra with the highest efficiency it is necessary to have a good raw material (white, free of mould, less than 6-7% moisture content), the oil mill should be fitted with the following equipment:

1) Cleaning equipment at reception of raw material
2) Storage capacity well protected against insects and rodents
3) Cleaning before processing (may be same as for 1)
4) Grinders (the existing onesmay be sufficient).
5) Roller mills to reduce ground copra into a kind of fine sand
6) Cooking
7) Pressing → A) Single pressing (cake at 7% max)
   → B) Double pressing → a) cake at 20 to 25%
   → b) cake at 6% or less

Case A: Single pressing heavy duty expeller (cake at 7% max.)

Case B: Double pressing with → a) cake at 20/25%
   → b) cake at 6% max.

a) a first pressing with specially adjusted expeller, then after
b) grinding of cake, second pressing with another specially adjusted expeller for 2nd pressing after cooking of meat coming from ground first pressing cake.

Of course, this way of processing is not possible with the very bad quality of existing raw material.

Actual losses due to quality of raw material and inappropriate process

Existing coconuts, if properly processed, are able to give a good copra, with a higher oil content (let us say 65%) and a normal moisture level (less than 7%).

Actual oil revovery is 50 to 55% with regard to the processed raw material after a double and sometimes a triple pressing.

With modern expellers, specially fitted for copra processing in single pressing it is possible to obtain less than 7% residual oil content in cakes. By double pressing we should have less than 6%.

Due to the relatively low availability of raw material, even if the total potential of 18,000 tonnes of copra is processed, it will not be more than a daily availability of 60 tonnes (300 working days per year).

To work in double pressing does not appear to be economical for such a relatively small amount of raw material, for it will represent not more than 44 tonnes of copra oil in case two thirds of potentiality will be processed (12,000 tonnes).

With the actual way of processing, it is obtained on average 55% oil with regard to the weight of processed raw material. Out of 6,000 tonnes, it represents 3,500 tonnes oil. From a well dried copra at less than 7% moisture content, free of mould, we can obtain a cake at 7% oil content. Out of 6,000 tonnes of copra, we should have - (with copra at 65% oil content)

100 copra → 65 existing oil → recoverable oil: 63.92

100 copra → 35 dry material → cake at 7% : 36.08

For 6,000 tonnes copra it represents: 6,000 x 0.6392=3,835.2 tonnes.

i.e. 335 Tonnes more than actual production (+9.57%)

This small difference may appear too low to justify a complete change in the actual habits. But we have to take into account that it will be mostly edible oil instead of industrial one. Anyway, actual production concerns 12 small mills for which the same problem as for cottonseed oil mills appears: the size of existing copra oil mills is an obstacle for a further improvement.

5. ANIMAL FATS

There are three fat rendering plants in Kenya:

- Kenya Meat Commission (or KMC) in Athi River (close to Nairobi)
- Kenya Meat Commission " in Mombasa
- Uplands Bacon Factory in Uplands.

Kenya Meat Commission (Athi River)

This slaughter house has a daily capacity of 750 heads, i.e. a yearly capacity of 750 x 260 = 195,000 heads. But on average they process only 130,000 heads per year. According to what they said, they recover on average 40kg. of fat per bovine, which should represent, yearly, 130,000 x .04 = 5,200 tonnes of tallow.

They obtain two grades of tallow:

- Grade A of a light yellow colour
- Grade B of a dark yellow colour.

For some years, they have noticed a decline in quality of meat and tallow, due probably to breeding conditions and to drought, which has increased the production of quality B at the expense of quality A.

They believe that about 50% of cattle escape the industrial slaughter houses, and are processed in small slaughter houses scattered in the country side, which do not have any kind of fat rendering plants.

Only some country butchers recover for themselves a very small part of this fat which appears to be of edible quality.
In KMC (Athi River) they recover fats coming from:

- Stripping from meat
- Bowel and internal organs
- Skeleton and bones
- Water coming from cleaning of floors
- Bodies

The recovery rate per head is:

- Bones and skeleton - 2 kg
- Bodies - 10 kg
- Bowel - 4 kg
- Foot - 0.4 liters
- Stripping of meat - 24 kg

Total 40 kg per head

Tallow A is coming from stripping of meat, thin flank and breast. Tallow B is coming from all the other parts of the animal and from the recovered fat from decanted washing waters.

The rendering plant is working with 10 cookers at 115°C under a pressure of 2 Kg per cm^2 during 3 hours. (Normal conditions with this type of equipment).

After draining of fats, greaves are centrifuged in order to recover some more tallow, and after grinding are used as animal feedstuff..

The fat content, after centrifugation of greaves is on average of 11%, which seems normal with this process. It could be improved up to 6%, by use of specially fitted expeller instead of centrifuges.

Kenya Meat Commission (Mombasa)

Roughly, rendering of fat is performed with same process, except for cooker which is an up to date one from a Danish well known supplier, and render the fat in about 15 minutes only. Only tallow B is produced because the fat is not stripped from meat.

- In 1983, from 5,488 bovines they obtained 28,440 kg of tallow
- In 1984 up to 20th September 23,604 bovines = 61,740 kg "

This represents for 1983, a fat recovery of 5.8 kg per head
" " 1984, " " 2.6 kg only per head

The odd result of 1984 compared with this of 1983 may come from different reasons, such as origin of animals, aggravating of drought, may be some mistake in their records. But the difference with KMC (Athi River) comes from stripping of fat from meat, which is not done in Mombasa. Anyway, it seems difficult for both KMC to recover more than the actual results, with the actual conditions of transport of cattle.

According to what we have ascertained, a lot of cattle arriving at slaughter house are looking more as kind of walking skeltons, rather than wellfed ones.

From KMC Staff, cattle are loosing up to 30% of their normal weight during their convoying, walking during hundreds of kilometers. KMC's slaughter houses do not represent more than 50% of the total slaughtered cattle in this country. The other 50% is processed in small slaughter houses, scattered all over the country, in which there does not exist any kind of fat recovery, except some butchers who are rendering a little tallow for edible purpose.

From the Statistical Abstracts 1983, purchases of cattle for slaughter has been as follows:

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Cattle & calves	159.5	134.1	228.5	158.1	68.1	67.7	55.9	61.2	75.3	?
Sheep & Lambs	11.3	25.8	12.2	11.2	11.6	10.1	6.2	7.2	11.4	?
Goats	6.5	7.2	4.6	6.1	10.4	2.0	2.6	1.3	3.2	?
Pigs	38.3	40.9	44.6	47.2	51.0	45.4	36.9	36.3	36.7	?

These figures seem to be in complete contradiction with those of KMC which, only for cattle processing the average is 130,000 heads per year.

Uplands Bacon Factory

This plant is processing only pigs. They produce 3 types of fats:

Cooking fats, pure lard and Tallow.

Their average production is 5 tonnes per week (max. 10 tonnes) i.e. yearly 260 to 300 tonnes.
Pure lard is obtained from stripped fat from spine dry melted.
Greaves are pressed and sold to retailers (edible)
Cooking fat, coming from belly, and some other external parts of the body, is obtained by a steam cooking, then decanted.

Tallow is obtained by cooking under pressure of the remaining parts of pork (bones, bowel, etc.) in a special horizontal cooker. After draining of tallow greaves are recovered for preparation of animal feedstuff.

Under existing conditions, total yearly tallow production seems to be in the region of:

KMC Athi River	-	5,200tonnes
KMC Mombasa	-	61.74 tonnes
Uplands	-	65 tonnes
		5,326 Tonnes

Let us say a maximum of 5,500 to 6,000 tonnes.

For Lard they are producing on average 5 tonnes per week, which represents a yearly production in the region of 250, max. 300 tonnes.

Suggestions

Instead of existing concentration of industrial slaughter houses, it looks logical to have some smaller ones, located in some suitable places in order to reduce considerably this terrible long walk.

It is also necessary to reduce the existing bottle neck at KMC, Athi River, where sometimes they cannot unload the cattle immediately after arrival of wagons or lorries.

Due to a too long stay in these waggons, it so happens that some of the animals die of thirst, even of starvation.

In this case, which seems to happen too often, carcases are buried instead of being cut up, (as in a knacker's yard) and processed in fat rendering plant. (Tallow grade B)

In these medium sized slaughter houses, it should be possible to strip the crude fat of the meat, to store it in cold store, awaiting the arrival of the collecting refrigerated van from the rendering plant.

Under this condition, it should be possible to produce edible tallow (premier juice) and to improve considerably the average quality of actual existing one.

The other parts (bones, bodies, bowel, etc..) could be processed immediately in a small adjoining rendering plant for production of tallow grade B, may be A.

It should be also possible for the same van to collect fresh meat to transport it.

By this way, it is possible to reduce, even to put down the losses coming from exhaustion of cattle, to recover a great part of cattle which actually escapes industrial slaughter houses and to increase the quality of meat and tallow which are actually badly affected by the actual conditions of cattle transportation.

Rough calculation of profitability

After their long walk, about 50% of the processed cattle are completely exhausted and have lost 30% of weight. In other words, out of 130,000 heads, 65,000 are in good condition (A) 65,000 are exhausted (B) and have lost 70% in weight.
Out of 5,200 tonnes of recovered tallow, the share of A and B should be: cattle A = 100 and cattle B = 70 or for cattle A,

recovered tallow - $\frac{5,200 \times 100}{170}$ = 3,058 tonnes 3,058 tonnes

and for cattle B recovered tallow - $\frac{5,200 \times 70}{170}$ = $\frac{2,142}{5,200}$ tonnes tonnes

These above figures represent a fat recovery per head.

Cattle A - $\frac{3058}{65,000}$ = 47 kg

cattle B - $\frac{2142}{65,000}$ = 33 kg

With cattle in good condition, the fat recovery becomes:

130,000 x 0.047 = 6,110 tonnes insted of 5,200 tonnes.

If only the half of the cattle that actually escapes the slaughter houses is recovered, we should recover:

65,000 x 0.047 = 3,055 tonnes

Or in all, a total recovery of:

6,110 + 3,055 = 9,165 tonnes instead of 5,200 tonnes.

That is an improvement of 76% of the actual recoverability which will affect also the meat, without speaking of the quality of tallow as well as meat.

II. SUMMARY OF EXISTING VEGETABLE OIL PLANTS

1. OIL MILLS

Out of 22 oil mills we have visited, only four are working properly (see table 1). All others are processing according to the same wrong way, and are using the same very old equipment or new ones of same old models.

Normally, an oil mill requires the following sections to obtain crude oil, and needs controls practically at each step of the process:

1. Reception
2. Cleaning
3. Storage and protection against pests and rodents
4. Cleaning before processing
5. Delinting (in case of cotton seed)
6. Dehulling
7. Separation of hulls from kernels
8. Grinding up to the most appropriate granulation
9. Cooking
10. Pressing
11. Filtration of crude oil

With the exception of 4 oil mills, the other mills have the same defectiveness:

1. Reception - no control
2. Cleaning - does not exist
3. Storage - Due to the short time of storage, raw material is generally stored in bags, except for copra which is stored in bulk. For the same reason, protection against insects or rodents is relatively poor (not more than 1 or 2 fumigations and use of cats)
4. Cleaning before processing - Never done
5. Delinting - Never done

6. Dehulling - Each seed requires a specially adapted dehuller. There does not exist any kind of universal dehuller, and the use of a disc dehuller or of a hammer mill as a multi-purpose dehuller is a big mistake because it results in a kind of coarse flour from which it is impossible to remove properly the hulls, and also the lint in case of cotton seed.

7. Separation of hulls from kerneis - Not possible for the above reason, and kernels are reduced to powder.

8. Grinding - Unadapted for the same above reason.

Normally every kind of seed must be ground up to an optimal size. The degree of crushing depends on the type of the concerned seed. For Example, for cottonseed (previously dehulled) we have to reduce the kernels in small pieces the size of small rice grains. For copra, it has to be reduced to a kind of fine sand, which is impossible to obtain in Kenya because of the kind of "grinders" actually used and also the awfully bad preparation of copra.

As a general -rule, the good size is that one which gives to the crushed seed the maximum apparent density, for we have to try to fill the barrel of the press with the maximum possible weight of raw material, in order to allow the expeller to develop its maximum pressure and output.

This operation is very important and from it depends the residual oil content in the cake.

If the size of the particle (called also "meat) is too big, it will be possible to press it, but with poor results and a higher supplementary expense, because the expeller will have also to work partially as a crusher.

If particles are too fine (texture of a fine flour) and present a too low apparent density, it will be very difficult, even impossible, to press it, and the expeller may reject it.

9 - Cooking (or thermal preparation)

Very badly done, even non-existent in some mills.

The target of this operation is double:

a) It changes the wall structure of the oil bearing cells making it permeable to the oil.

b) Rising temperature increases the fluidity of the oil which can flow more easily through the cake.

Generally the average convenient temperature of the meat at the entry of the expeller should be in the range of 80-90°C and not 50°C or less as we have witnessed.

During the cooking, the moisture content adjustment is very important particularly in cottonseed, and I have personally observed a reduction from 9 to 5% of the residual oil content in the cotton seed cake, only by adjustment of the moisture content of the meat.

This will mean also a relative increase of the protein content of the cake which should make its marketing easier and more profitable.

Another indirect result of a proper cooking is a reduction of energy consumption of the expeller, due to a higher fluidity of the oil, and also to the change of structure of oil bearing cells, which can reach in certain cases 20%. (in terms of consumed energy for the same amount of produced oil).

This results in a notable reduction in the maintenance cost of the expeller which is connecting and reflecting on the energy consumption.

PREPARATION OF SEED before pressing MUST BE CONSIDERED AS IMPORTANT AS THE QUALITY OF THE EXPELLER, and the best expeller of the world will give poor results without a proper preparation of the seed.

10 - Pressing

The expeller has to be adjusted according to the type of seed it has to process. It has also to be adjusted according to the pressing process: single pressing, double pressing or first pressing before solvent extraction.

The main points of adjustment of expellers are:

a) Assembling of the wormshaft
b) Gaps between the bars of barrel
c) Rotation speed of the wormshaft

For each kind of seed, there is a certain disposition of worms and adjustment of barrel which will give the best result. We can also say that the possible different assemblings are derived from two main ones depending on the two main types of seeds: hard or concrete, and fluid or soft.

From these two types of assembling which are really differing from each other, some slight adjustments allow to process different kinds of seed inside the same group (hard or soft).

In case of a double pressing, the adjustment concerns also the rotation speed of the wormshaft:

For a first pressing, or prepressing, it has to be higher than for second or single pressing, (in the region of 16 RPM instead of II RPM) and the assembling cannot be the same.

As we have had the opportunity to ascertain, this VERY IMPORTANT MATTER CONCERNING ADJUSTMENT OF EXPELLERS seems completely unknown to the oil millers of this country, who are processing cotton seed, sunflower seed or copra with exactly same expleilers, same assembling and same adjustments whatever the pressing conditions.

Adjusting of throttle system of expellers.

We have also ascertained a too big thickness of cake at the exit of the second pressing expellers.
Millers must try to obtain thinner cake (3-4 mm or less). But without the help of an amperemeter, directly connected to the engine of the press, it is almost impossible to know exactly when the critical point is close to be reached, in order to adjust properly the position of the cone just before this point, and to avoid a sudden stoppage and a total clamping of the expeller.

Disregard for or ignorance of these important points 5 - 10 (page 28) results in a lower capacity of the equipment, a higher residual oil content and lower protein value in cakes, a lower oil recovery, a higher maintenance expense, and to summarize a real wastage of raw material and a lower profit for the oil millers.

Point 4 (cleaning) affects the quality of the oil and cake, and also the maintenance cost.

2. Solvent extraction plants

There is one solvent extraction plant of a 60 tonnes daily capacity which is working practically at full capacity. (CMB Bernardini) It uses maize germ as a raw material. This plant is among the four best in this country.

Another one is under construction and will use as raw material oil seed cakes coming from first pressing.

3. REFINING PLANTS

Out of 22 oil mills we have visited, 17 have refining plants. Apart from these 17 refining plants, there is the East African Industries which does not produce oil, but which has a 50,000 tonnes yearly refining capacity.

E.A. I. belongs to Unilever group and produces also margarines, shortenings, soaps, detergents, etc.. They are refining all kinds of oils. local or imported, and is managed like the other plants of this group. Out of these 17 refining plants, only six are working properly. All others are completely obsolete, the majority of them operating without any kind of laboratory control, by routine, and the two worst we have seen belong to cooperatives. All these bad plants are fitted practically with the same type of equipment:

1 multipurpose kettle in which neutralizing, washing, bleaching are done.
Sometimes 1 deodorizer
1 Filterpress

Out of the six refining plants working normally (2-3-8-22-23 and EAI) one is fitted with a "Sharpless" continuous refining plant, two with a continuous physical process refining plant (working on palm oil).

The four others are batch process plants but of a modern design, and all these six plants have regular laboratory controls.

On cottonseed oil, only one of them seems to neutralize the oil in two steps. First by addition of about half of the calculated amount of caustic soda solution, in order to eliminate gums and gossypol, second step, to finish the neutralization. This process gives generally a lower refining loss and a lighter colour to the oil.

All the other refining plants are characterized by a kind of routine work and lack of or insufficient laboratory contols.

Under these conditions, the refining losses cannot be other than very high.

Out of 16 refining plants we have visited, 8 are obsolete, but they represent only 5.1% of the total refining capacity we have seen. Furthermore, six of them are not working and the two others are working at less than 30% of their small capacity which is not more than 0.2% of the total capacity.

By-Products

a) Hulls coming from dehulling

There are relatively few, due to the bad dehulling which seems to be more a kind of grinding, rather than a real dehulling. They are generally used as cattle feedstuff, or as fuel for the boiler.

b) Cakes and Meals

Used as cattle feedstuff or for preparation of compound feedstuff.

c) Soapstocks

In some of the refining plants, soapstocks are decomposed by sulfuric acid, in order to obtain an acid oil usable for soap making. Sometimes it is directly used for soap making. Soapstock from cotton seed oil at the Coast is mainly thrown away to waste.

TABLE 1

OIL MILLS VISITED

	Oil Mills	Raw Material	Daily Capacity	Capacity Utilization	Shifts	Remarks
1.	Nakuru Oil Mills	Cotton, Sunflower Rapeseed	30T	50%	3 x 8h	
2.	Elianto Kenya Ltd.	Maize Germ	60T	100%	3 x 8h	Solvent extraction*
3.	Rift Valley Products	Sunflower, Cotton Rapeseed, Maize Germ	50T	40%	3 x 8h	Single pressing Anderson + French *
4.	Arkay Industries	Sunflower, Cottonseed, Maize germ	35T	Stopped	3 x 8h	
5.	Kitale Industries	Sunflower	8/9T	Stopped	2 x 12h	
6.	Malaba Malakisi	Cotton seed	100T/week	stopped	-	Obsolete
7.	Kibos Industries	Cotton seed	10-12T	20%	3 x 8h	
8.	Aberdares Oil Millers	Cotton seed, Sunflower Maize Germ	50T/month 100/150T/Month (finished products)	100%	3 x 8h	7 days per week *
9.	Kapa	Sunflower	30T	Dismantled in 1979	3 x 8h	Single pressing (Anderson)
10.	Elephant Soap (Oil mill for)	Copra	5T	60%	1 x 8h 30	
11.	Kisumuwala Oil Industries Ltd.	Copra Cotton seed	1000T/Y 200T/Y	20% 0		
12.	Pwani Oil Mills	Copra	4T	100%	2 x 12h	To acquire 2 new crushers of capacity 5 tonnes per day

cont. p.35

TABLE 1 (Continued)

	Oil Mills	Raw Material	Daily Capacity	Capacity Utilization	Shifts	Remarks
13.	Pereira & Sons	Copra	4T	50%	1 x 12h	Ordered one giant expeller from India of capacity 20 tonnes per day.
14.	Mombasa Soap and Oil Manufacturers (Oil Mill)	Copra Cottonseed	20T	35%	3 x 8h	3-4 months on copra 1 month on cotton
15.	Mombasa Soap and Oil Manufacturers (Soap Factory)	Copra Oil	8T	N.A.		Laundry Soap - 3000 tonnes capacity p.a. Toilet soap - 1000 tonnes capacity p.a.
16.	Coast Manufacturers	Copra	80T	40%	3 x 8h	
17.	Coastal Industries	Copra, Cotton seed Sunflower	25T	30%	3 x 8h	Better dehulling than the others due to adjustment of Disc dehuller and use of Trommel.
18.	Modern Soap Factory (Oil Mill for)	Copra	5T	50%	3 x 8h	
19.	Eastern Industrial Works Ltd.	Copra	20 - 25T	100%	2 x 12h	
20.	Malindi Industries	Cotton seed	9/10T	N.A	1 x 8h	Existing since 2 months
21.	Kilifi Oil Mills Ltd.	Cotton seed Copra	1T 3T	-	-	
22.	Voi Oil Mills	Cotton seed	10T (crude Oil)	50%	3 x 8h	*

Note: * Best Oil Mills.

TABLE 2

OIL PRODUCTION CAPACITIES

Ref.No..	Full production Daily, T	Capacities Yearly	Actual Production
1.	10-12	2,800	1,400
2.	9	2,700	2,700
3.	20	5,200	2,300
4.	14	3,600	0
5.	3.6	1,000	0
6.	3	780	0
7.	11	450	90
8.	3.2	960	960
9.	12	3,120	closed
10.	2.5	650	390
11.	2	520	104
12.	2	520	520
13.	2	520	260
14.	10	2,600	910
15.	N.A	-	-
16.	40	10,400	4,160
17.	12.5	3,250	975
18.	2.5	650	325
19.	10	2,600	2,600
20.	5	1,300	N.A
21.	1.5	390	N.A
22.	1.5	390	195
TOTAL		44,400	17,889

Capacity utilization - 40%

Note: No. 20 - existing since only 2 months
No. 21 - Pretends not to know.

TABLE 3

REFINING CAPACITIES

References (Table 1)	Daily Capacity T	Yearly Capacity	Type	Observations	controls
1.	2.	520T	Obsolete	Not enough steam when when presses in operation	Insufficient
2.	10	2,600T	Batch Mod.	Good	Good
3.	10	2,600	Continuous "Sharpless"	Works partially crude oil sent to EAI	rather good
4.	5	1,300	Obsolete	Too high losses in soapstock which FFA after splitting is 15 to 18%!!	Insufficient
5.	10	2,600	Obsolete	Cannot work when presses in action	Very good
6.	3	780	"	Routine work	Zero
7.	1 - 2	-	"	Stopped since long time	-
8.	10	2,600	Batch	Modern Bernardini	Good
11.	6	1,560	Obsolete	No deodorizer	Insufficient
14.	3	780	"	No bleaching No deodorizing	doubtful
17.	10	2,600	"	Same as 14	doubtful
20.	3	780	"	Bleaching in very bad conditions	doubtful
22.	9	2,340	Modern batch		Good
East Africa Industries	50-60	50,000	Modern batch	UNILEVER	Very good
23. (KAPA)	120	36,000	Actual Chemical physical de Smet	Working at full capacity on palmoil. Will start in 1985	Good
TOTAL		125,060			

III. CONSUMPTION OF EDIBLE AND INDUSTRIAL VEGETABLE OILS AND ANIMAL FATS IN KENYA

Annual consumption of edible oils and animal fats may be estimated from tables 4 and 5.

Vegetable oils and tallow for soap production represent about 75% to 80% of produced soap (in weight). It should not be more than 24 to 25,000 tonnes (calculated from table 4).

For edible use (cooking oil, ghee, or fat production), we can estimate it from table 5 to be in the region of 50,000 tonnes. But these statistical figures cannot match the actual production added to total imports of oil and animal fats which seem to be more reliable than the statistical abstracts.

Actual oil production seems to be about 18,000 tonnes (table 2).

Imports (following table) are in the region of 115,000 tonnes (average). Production of tallows and lard is not more than 5,800 tonnes (let us say 6,000 tonnes).
Total national consumption should be 139,000 tonnes. (In 1984)

Actual population (1984) is estimated to be 19,000,000.
With a growth rate of 3.9% it should be in 16 years (2000)

= 19 x 1.844 = 35.036 million

The increase in consumption of fats and oils will grow as population, but the rate may not be the same, depending also on average income and on some other local factors which are difficult to forecast. It will probably be less and shall not overpass the population's growth rate. It will be less than = 139 x 1.8 = 250 thousand tonnes.

To face this problem, actual vegetable oil and fats production must be increased close to eleven times its present level, in only 16 years, in order to stop imports, and possibly to begin exporting.

We have counted Tallow and Vegetable oil together, because if it is not possible to increase cattle more than a certain extent, it is always possible to produce some kind of tailor-made fats from hydrogenated oils. The beginning of this process, was to replace tallow for soap making, far before being used to produce margarine.

TABLE 4

IMPORTS AND VALUE

	1980		1981		1982	
	Kg	Value KSh	Kg	Value KSh	Kg	Value KSh
Tallow	13,331,555	100,498,403	15,044,844	92,033,519	7,835,343	59,009,124
Soyabean oil crude	25,000	266,307	10,000	10,756	-	-
Soyabean oil refined	185,541	4,902,761	2,492,991	23,455,175	1,368,555	14,195,271
Sunflower oil	6	52,745	10,000	175,708	-	-
Olive oil	20,349	541,670	12,767	407,236	11,255	446,130
Rapeseed oil	500	6,520	50,384	327,032	582,702	4,717,327
Linseed oil	138,783	1,207,312	59,725	634,171	92,195	1,041,334
Palm oil crude	66,322,653	308,075,956	31,376,970	148,404,529	91,964,646	396,511,619
Palm oil refined	5,123,725	19,999,571	66,635,230	192,777,406	1,091,299	7,239,415
Copra oil	364,620	2,151,565	609,000	4,420,104	4,212,902	28,299,478
Palm kernel oil	-	-	1,023	34,870	2,209	37,279
Castor oil	16,780	198,244	70,552	495,379	26,773	427,776
Fatty acids and acid oils from refining	1,269,910	7,514,304	1,463,332	9,913,293	927,540	8,985,104
Other	182,390	2,035,390	101,113	1,118,767	4,914	203,673
TOTAL	86,981,806	447,450,748	117,937,931	474,207,945	108,120,336	521,113,530

TABLE 5.

SOAPS PRODUCTION AND CONSUMPTION (Metric tonnes)

Year	1974	1975	1976	1977	1978	1979	1980	1981	1982
Production	29,838	23,915	29,207	22,364	20,936	21,072	25,714	35,350	29,603
Consumption	22,176	25,552	NA	28,761	24,485	25,288	17,096	28,799	23,189
Balance	+7,662	-1,637	?	-6,394	-3,549	-4,216	+8,618	+6,551	+6,414

(Source = Statistical Abstracts 1983)

If we consider the figures from 1980, balance shows a possibility for exporting soaps.

For the whole period, since 1974, balance remains favourable for exports (+13,449 tonnes)

The 1976 consumption figure seems absolutely unreliable in statistical abstracts (50,904 tonnes !!

TABLE 6

COOKING OILS, GHEE AND FATS PRODUCTION (Metric tonnes) ('000 liters)

	1976	1977	1978	1979	1980	1981	1982
Ghee and Fats (Tonnes)	12,232	30,876	35,566	37,790	46,551	42,201	46,601
Cooking oil ('000 Liters)	4,923	4,163	3,965	3,338	3,189	3,464	3,164

Source = Statistical Abstracts 1983.

IV. IMPROVEMENT OF EQUIPMENT AND INCREASING OF THE PRODUCTION CAPACITY

Kenya is actually obliged to import about 115,000 tonnes of vegetable oils and animal fats to face its consumption of 140,000 tonnes. This represents 82% of its actual consumption.

Local production is actually around 17-18,000 tonnes (vegetable oils) and represents 40% of working capacity.

Normally, raw material should be less expensive than final product, and it should be more economical to import raw material rather than vegetable oil, in order to allow the existing oil mills to work at their full capacity.

- Existing equipment is able to produce 45,000 tonnes oil, i.e. a difference of 22,000 tonnes, or in rape seed equivalent to 52,000 tonnes. (Rape seed with 45% oil content, free from erucid acid). Or in sunflower seed at 50% oil content, 49,000 tonnes. (both cases have been calculated with an oil revovery of 90% only)

  By this way existing oil mills will be able to work at their full capacity, and at full employment of manpower. It will also represent an economy in terms of foreign exchange.

- More than 50% of refineries are obsolete, and only 6 are working properly. But due to their small size it cannot be economical to modify the existing equipment, and they represent not more than 5% of the total refining capacity.

- Concerning copra production, existing raw material is of the worst quality which may be seen. This comes mainly from its very bad preparation.

It is not so difficult to dry it properly.

Existing equipment is also obsolete and often inappropriate and for millers, due to the small size of their factories, it cannot be economical for them to change anything.

In fact, improvement of quality of raw material, and of equipment will not represent more than 10% in oil production, but considerably more concerning its quality. (mostly edible oil instead of industrial one). Only 30% of existing coconuts is processed. It is possible to improve this situation.

Creation of a kind of industrial estate able to process coconuts in industrial drying kilns, or even locally made, and extract copra oil with a suitable equipment, may be envisaged, in order to exploit at least the half of actually not recovered nuts, and to produce edible oil. This will represent at least 3,800 tonnes of oil.

Next year, Aberdares Oil millers, will start a solvent extraction plant which will double its capacity, i.e. a supplementary oil production of close to 1,000 tonnes.

Addition of such an equipment to some other oil mills may also double their capacities, on condition they can be sure to have enough raw material to process. (Oil mills No. 3,22,4). This may represent in all about 28,000 tonnes of raw material to import, or to produce, for an additional increment of about 12,500 tonnes of oil production.

To summarize the following table shows what is possible to obtain from improvement of existing equipment (addition to solvent extraction plants), and raw material to find in order to work at full capacity.

TABLE 7

	Oil production increase (tonnes)	Raw material needed	
		Rape seed (Tonnes)	Sunflowerseed (Tonnes)
Full production of existing equipment	22,000	52,000	49,000
1985 - New solvent extraction plant	1,000	2,500	2,250
1986 - 1989 - 3 other solvent extraction plants	9,600	23,730	21,340
TOTAL	32,000	78,230	72,590

Later:		
Double actual coconuts production	3,800	Existing but not collected
Improvement of tallow recovery	6,000	Existing but not processed industrially

Raw material requirements have been calculated from:

Rape seed	oil content	45%
Sunflower seed	" "	50%
Extraction rate:		90%

This extraction rate is very pessimistic. Normally with a solvent extraction plant it should be more than 99%.

In order to try to enable Kenya to become independent of imports we have calculated according to a very pessimistic point of view, its future consumption with same growth rate as the population's (3.9%).

All figures in following table are in thousand tonnes, and existing oil production remains at the same level. But new plantations will give every year 15,000 tonnes oil more, with sunflower seed it will represent about 20,000 hectares of new plantations more every year, until 1995. (with sunflower seed at 50% oil content).

In 1989 improvement of actually existing mills will give a supplement of 32,000 tonnes oil. In 1995 it will be possible to export - (table 9).

But it is a really pessimistic forecast, for consumption growth should be lower than that of population and Kenya may become an exporter before 1995. To reach this target, 200,000 hectares must be planted with sunflower of the best variety (oil content of seed more than 50%, and at least 1,500 kg seed per hectare)

With rape seed at 45% oil content and a production of 2 tonnes of seed per hectare it will represent about 16 to 17,000 ha per year, or in ten years 170,000 ha. To process this production, new oil mills should be erected. From the following table we can see in 1986 the total production capacity of existing oil mills will be saturated.

In 1995, total production should be 218,000 tonnes of oil.

TABLE 8

Year	Consumption	Production	New Production	Total Production	Balance
1984	140	18	0	18	-122
85	145.4	18	0	18	-127.4
86	151	18	+15	33	-118
87	157	18	+15	48	-104
88	163	18	+15	63	-100
89	169.5	18	+15+32	128	- 41.5
90	176.1	18	+15	143	- 33.1
91	183	18	+15	150	- 25
92	190	18	+15	173	- 17
93	197.5	18	+15	188	- 9.5
94	205	18	+15	203	- 2
95	213	18	+15	218	+ 5
96	221.5	18	+15	233	+12
97	230	18	+10	243	+ 13
98	239	18	+ 5	248	+ 9
99	248	18	+ 5	253	+ 5
2000	258	18	+10	263	+ 5

From 1986 to 1995 the oil production should be increased by: 218,000 - 33,000 = 185,000 tonnes. It will represent in rapeseed to process: 185,000 x 2.2 = 407,000 tonnes. (we have chosen rapeseed for its lower oil content, otherwise with sunflower it should be 400,000 tonnes).

To process 407,000 tonnes of seed in 1995 it will be necessary to install in nine years seven new oil mills, each with a daily crushing capacity of 200 tonnes.

Land availability for further farming

It does not seem to be a problem, and a recent study by Mr. K. R. Bikwetti from Ministry of Industry assess that there exists actually at least 2 million hectares of available land for farming, which represent a considerable potential.

This available land is distributed in different parts of the country, particularly in Western, Nyanza, Central and Coast Provinces.

Refining capacity

Existing refining capacity seem to match the actual oil consumption. But in 1995 it will be short by about 90,000 tonnes, and two new refining plants of 150 tonnes daily capacity must be forecasted or four of 75 tonnes each. In some refining plants, we have ascertained too high refining losses, due mainly to complete lack of chemical control and to routine work.

A sample of cotton seed soapstock, has been found to contain 60% of neutral oil due probably to a very bad decantation and to the use of unsuitable equipment.

Refining losses come also from use of obsolete equipment such as multipurpose kettles in which neutralizing, washing, drying and even bleaching are operated in the same vessel. It should be more profitable to sell the crude oil to specialized refining plants. Very often, cottonseed soapstocks are thrown away, instead of decomposing them into acid oil. Despite the black colour of this acid oil, it could be valuable by-product after distillation to obtain white fatty acids, directly usable even for toilet soap making.

It could be interesting for some refineries to have such a distillation plant, and to collect the acid oil from different other small refineries.

Margarines, shortenings and other hydrogenated products

Consumption of hydrogenated products for edible purposes has considerably increased from 1977 until now (see table 6, p.40). But after a sudden rise from 12,232 tonnes (1976) up to 30,876 tonnes (1977) it has continued to increase but with a continuous declining rate, and will probably reach the same level as that of population growth.

Due to shortage of tallow for soap production, importance of hydrogenated products will increase more considerably in the coming years when Kenya will be close to match its own consumption of vegetable oils and to become independent from imports. Some new hydrogenation plants will be necessary, following population and also income growth rate.

By-Products

Hulls

Hulls are mainly used directly in boiler, or as a cattle feedstuff. But with appropriate kilns, it is possible to obtain better results for calorific value of hulls is on average between 2,500 - 3,500 kcal/kg. Calorific value of fuel oil is about 10,000 Kcal/kg. In other words, 4 kg of hulls may replace, at least, 1 kg of fuel oil.

1 kg of fuel oil = 12 kg steam (in modern boilers)

4 kg of hulls = 10 kg steam (because of a lower output of kilns). Of course, kilns have to be specially fitted to use hulls as fuel.

Sunflower hulls may also be used for manufacture of particle boards, and as such constitute a very good insulating material. Hydrolysis of hulls with dilute solution of sulphuric acid, at low temperature (30 - 50°C) and further distillation will give furfura and a good compost as by-product.

By-Products coming from coconut processing

The three main by-products are:

Shell
Coir
Water

It seems they are practically not utilized in Kenya. Nevertheless;

Shells after removal of coir, may be used for preparation of charcoal, and even of activated charcoal of highest grade.

Coir is generally used for manufacture of ropes, mats, carpets, brush mats, etc.

Water which flows out during opening of nuts contains interesting nutritious elements for animal feedstuff (sugar, mineral salts, etc.) It seems also this water is suitable for cholera patients who are unable to keep any other type of liquid aliments.

Cakes and Meals

Cakes are the main by-products of oil industry. They are generally directly used as cattle feedstuff, but some of them are of a great importance for preparation of proteins.

Among those available in Kenya, cottonseed and sunflower cakes are really interesting due to their high protein value.

Copra cake, and meal, despite its relatively low protein content (17-20%) is used as cattle feedstuff. But due to quality of existing copra in Kenya, analysis of samples have shown in some of them less than 1% protein and already there is the problem of presence of aflatoxins.

ANNEX 1

EXPORT OF ANIMAL FATS AND VEGETABLE OILS

in Kg

	1981	1980
Animal oils and fats	7,429	235,926
Soya bean oil	22	52
Linseed oil	216	25
Palm oil	1,639	5,103.
Copra oil	2,823	174,866
Palmkernel oil	3	Nil
Fatty acids and Acid oils (from refining)	51,219	35,429
Total	63,351	451,401

Source: Statistical Abstract 1983

ANNEX 2

EXPORT OF RAW MATERIAL

in Kg

	1981	1980
Oil seeds and oleaginous fruits	8,473,434	9,579,439
Oil seeds and oleaginous fruits, whole or broken for extraction of soft fixed vegetable oils	5,483,474	3,525,921
Groundnuts	23,600	248,002
Sunflower seed	3,886,695	2,199,800
Sesame	1,570,000	862,833
Oil seeds and oleaginous fruits used for extraction of fixed vegetable oils includes non-defatted flours and meals from oilseeds and oleaginous fruits	2,989,960	6,053,518
Copra	522,550	3,647,515
Linseed	22	Nil
Castor oil seeds	2,362,973	2,379,624
TOTAL	25,312,708	28,496,652

Source: Statistical Abstract 1983