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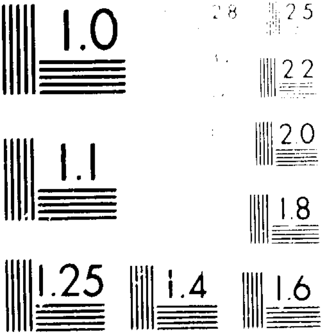
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1 August 1980
English

DEVELOPMENT OF THE COCONUT PRODUCTS AND BY-PRODUCTS INDUSTRY

SI/TTP/79/802

TRUST TERRITORY OF THE PACIFIC ISLANDS

Terminal report*

Prepared for the Government of the Trust Territory of the Pacific Islands
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of J. R. Santhiapillai, Industrial Economist and
Team Leader in co-operation with K. Puvaneswaran (Chemist),
S. Tilekaratna (Marketing Expert), and P. Bauer (Engineer).

United Nations Industrial Development Organization
Vienna

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CONTENTS

INTRODUCTION

1. The Trust Territory of the Pacific Islands (TTPI) consists of more than 2000 islands in an area 3000 miles wide in the Pacific Ocean. The total land area is 710 sq. miles andthe total population is about 136,000. TTPI is divided into seven districts: Ponape, Truk, Kosrae, Yap, Palau, Marshalls and the Marianas.

2. At present, TTPI consists of four separate government entities: the Northern Marianas, Marshall Islands, Palau and the Federated States of Micronesia (Ponape, Truk, Yap and Kosrae and has its capital in Ponape). All these entities remain part of the TTPI and will remain so until official termination of the Trusteeship Agreement in 1981.

3. The coconut is the most important economic crop of TTPI and has been given top priority for development by the Government. Except for two copra crushing plants with a total installed capacity of 66,000 tons of copra/annum in Palau and Marshalls, the rest of the manufacturing activities consists of small units to meet local district demand and cottage-type activities in the subsistence sector. The few activities directed toward production for the market economy are characterized by inadequate technical know-how, capitalization, poor management and untrained labour force.

4. Owing to the continuing deficit between government revenues and expenditures, and the possibility of reduction in U. S. financial assistance, most of the States (F.S.M., in particular) are trying to increase exports and reduce imports.

5. In view of the above, Ponape Agriculture and Trade School (PATS) is involved in a number of industrial and agricultural projects. The projects

include a small scale plant for making laundry soap, refined cooking oil, and hair/body oil from coconut oil. The copra crushing plant, soap-making plant and the refinery are in operation and the cost of production is high due to lack of trained people on the efficient utilization of men, methods, materials, machinery and money.

6. The State of Truk, in close collaboration with Ponape, proposed to set up small scale industries to manufacture consumer products like toothpastes, shampoos, and toilet preparations. Similarly, Palau District proposed to manufacture toilet soaps, shaving cream, shortening and ice-cream.

These industries were intended to be set-up on the basis of state/district specialization in coconut-based industries to avoid unhealthy competition among states/districts so that at least a part of the newly-processed goods will be assured of markets in the infant stages of production.

7. As a result of these activities, the TT Government requested UNDP/UNIDO assistance under Industrial Special Service. This assistance was given by providing four experts for a period of 10 man-months (m/m). The experts were (a) Joe R. Santhiapillai - Industrial Economist and Project Manager (4 m/m); (b) S. Tilekeratne - Marketing Expert (2 m/m); (c) K. Puvanesweran - Quality Control Chemist and Toilet Products Production Expert (3 m/m); (d) Peter Bauer - Mechanical Engineer (1 m/m).

The project was started in end February 1980 and completed in June 1980.

8. The objectives of the project were:

8.1 To determine in cooperation with the other experts the feasibility of setting up processing facilities for the production of laundry soaps, toilet soaps, toothpastes, shampoos and other toilet preparations for marketing in TTPI and Guam.

8.2 Within the framework of the feasibility study assess all relevant data such as equipment costs, total investment costs, working capital, market potentials, manpower requirements and analyze them in connection with the overall improvement of the coconut processing industry over the period form 1980 to 1985.

8.3 Advise the management of PATS on the efficient utilization of manpower, production methods, raw materials, equipment and finance in view of reducing the production cost.

8.4 Advise the management of PATS on the technical, economic and financial production control methods to be most suitably applied.

8.5 Train the management and staff on appropriate production processing.

9. The assignment was carried out on the above lines and objectives achieved in that:

a) Feasibility of the above industries investigated and plant and process suggested for manufacture of laundry soaps and toilet soaps in Truk and manufacture of shampoos and toilet soaps to be added in PATS.

b) Improvements were made in PATS to reduce labour, reduce processing time, reduce scrap, etc. thereby making major cost reduction.

10. Mr. Catalino Sam - Manager, PATS Plant and Chairman, Micronesian Coconut Product Authority (M.C.P.A.) could be considered the "counterpart" in all training activities.

SUMMARY AND CONCLUSION

1. The population, land area and estimated market size of the different products in the Trust Territory (excluding the Northern Marianas) is as follows:

		PONAPE	KOSRAE	TRUK	Y A P	PALAU	MARSHALLS	TOTAL
Est. Population	1980	23140	4940	38650	9320	14800	29670	120840
Land Area in Sq. Miles		146.5	42.0	45.4	46.8	177.6	69.3	527.6
PRODUCT	YEAR	ESTIMATED MARKET SIZE - IN SHORT TONS/ANNUM						
Laundry *	1980	113	12	112	NIL	NIL	80	317
Soaps	1985	145	5	156	1	55	128	500
Washing *	1980	17	3	36	1	92	53	202
Powder	1985	10	2	22	1	55	32	122
Toilet	1980	38	4	39	14	21	27	141
Soaps	1985	45	5	47	17	24	33	171
Total	1980	168	19	187	15	113	160	660
Soaps	1985	200	22	225	19	134	193	793
Shampoos	1980	1.7	0.2	2.5	0.3	2.7	3.1	10.5
	1985	2.0	0.25	3.0	0.35	3.2	3.7	12.5
Toothpastes	1980	1.6	0.2	2.3	0.15	1.9	2.0	8.15
	1985	2.0	0.25	3.0	0.2	2.4	2.5	10.4
Hair/Body Oil	1980	11	2	17	4	6	12	52
	1985	13	3	20	5	7	14	62
Cooking Oils &	1980	63	8	56	14	43	91	275
Shortening	1985	76	9	67	17	52	109	330

* Assuming locally-produced laundry soaps would capture 50% of the washing powder market in 1985 given sufficient tariff protection.

The market is full of sophisticated products and the consumer had jumped from almost zero consumption to a stage of sophisticated consumption with no transitional stage. As such, the consumer is left with the choice of either purchasing a high cost product or completely doing without the product. This vacuum in the market could be filled by intermediate products as is normally found in developing countries.

2. As the market size is extremely small, no large scale manufacturing units for consumer goods would be feasible. Manufacturing such goods for the export market is also not feasible as there are no advantages like cheap labour, availability of skilled labour, proximity to markets, cheap raw materials, etc. Even though coconut oil would be comparatively cheaper, production of the type of goods envisaged could be produced in other countries using cheaper oils and fats like tallow and soya oil.

3. Industry is practically nil, and it appears that industry is considered to be synonymous with large scale industries, involving several millions of dollars. Unless such projects are studied by technical experts, there is a very grave danger of these projects becoming a white elephant. Owing to the complete lack of know-how in running factories, it would be advisable to achieve industrialization by initially starting small and medium scale industries. This would enable them to acquire the necessary skills - technical, purchasing, marketing, planning, financial, distribution, laboratory, engineering, management, etc.

4. The Kosrae and Yap market for the coconut by-products is extremely small that even a small scale plant is not viable. Hence, the market requirements would have to be catered by production plants in Ponape and Truk. In the case of laundry soaps, both Yap and Kosrae could produce it by the cold process (which needs practically no capital investment) by obtaining coconut oil from Truk/Ponape. This process was demonstrated in Yap and in Truk.

5. Laundry Soaps

Since the market size in the individual districts is large, it is both advisable and feasible to manufacture laundry soaps in Ponape, Truk and Marshalls and at a later date, in Palau. A feasibility study and relevant data such as equipment costs, investment costs, working capital, manpower requirements have been assessed and analyzed for plants in the Marshalls and in Truk.

a. In the case of Marshalls/Palau, as coconut oil is already available, only a Soap Plant is required. The total capital investment required is $80,000 and the return on investment after allowing 15% interest on investment is 19%.

b. In the case of Truk, both an Oil Plant and a Soap Plant are required. The Total Capital Investment required for both plants is $150,000 and the return on investment after allowing 15% interest on investment is 16%.

The consumer price of the locally-manufactured soap would be the same as the present price of the imported laundry soap but in order to protect the local industry, an import duty of 50% on imported soaps is recommended.

6. Toilet Soaps

The capital needed to produce the imported type of toilet soaps (79% T.F.M.- Total Fatty Matter) would be high and production for the comparatively small market would not be feasible.

It is recommended that in Ponape, Truk and Marshalls 63% T.F.M. toilet soaps is manufactured as is done in most developing countries, and 50% of the existing toilet soap market could be converted to this type of toilet soap market could be converted to this type of toilet soap.

This 63% T.F.M. toilet soap could be produced on the plant producing laundry soaps and hence, no extra investment would be required, and could be sold profitably. Samples were produced and exhibited.

The price of the local 63% T.F.M. toilet soap would be kept equivalent to the present price of the imported 79% T.F.M. toilet soap but in order to protect the local industry an import duty of 75% on imported soaps is envisaged.

7. Washing Powders

Production of washing powders would not be feasible as the tonnage required is very low. In order to protect the local production of laundry soaps, an import duty of 75% on washing powders is recommended.

8. Toothpastes

Local production of toothpastes is not feasible, but the manufacture and marketing of cheaper toothpowders should be considered.

9. Shampoos

Production of the imported type of shampoos is not feasible as all ingredients would have to be imported.

It is recommended that shampoos made from coconut oil be produced in Ponape and marketed in all the districts. The method of manufacture was demonstrated and samples given.

An import duty of 100% on imported shampoos is recommended.

10. Hair/Body Oil

This can be produced only in Ponape as the capacity of the present refinery is sufficient to meet the entire market. Aggressive marketing is essential.

11. Cooking Oils/Shortening

Manufacture of shortening is not feasible. The entire market for cooking oils can be produced in Ponape, but no sales would be possible until the import tax on cooking oils is raised to at least 75%. At present, aggressive marketing of bulk sales to institutions like schools, canteens, restaurants, etc. should be pursued.

12. Ice-cream

Factory manufacture of ice-cream is not advisable as sophisticated laboratory and bacteriological controls would be needed.

13. PATS Plant

In 1974 "Hander" type of oil expelling unit was installed and attempts to sell the crude oil was not a success. In March 1979, the soap plant was started and in September 1979, the refinery was installed.

It was appropriate that expert help from UNIDO was given in March 1980 to help them in solving their various problems. March 1980 can be considered the turning point of the PATS Plant as it has entered a new era of development, in that, for the first time in its history, it has started showing profits from March 1980. This has created a sense of achievement and self-confidence in the management and work force.

Detailed notes and comments on the plant have been made so that the Management could understand their plant better and also to show the logical processes involved in problem-solving in a factory.

Some of the major problems of the Plant which were solved are:

1. The deodorization process has been the biggest problem from the day it had been installed, in that heating the oil to 350^{o}F was difficult and practically impossible. This was found to be due to the fact that on installation, no provision had been made for draining the cooling water in the jacket, and as a result, it was a miniature boiler using up all the heat supplied. When this was drained, the deodorizing cycle was reduced to 7-3/4 hours. This

not only reduced costs considerably but also prevented any unncessary capital investment on alternative heating system.

2. Using up the mountain (about 3 tons) of accumulated scrap soap
3. Prevention of build-up of scrap soap
4. Determining bottlenecks
5. Reduction of labour
6. Changing to cheaper and better formulations

Some improvements could not be implemented during our stay (March-May 1980) but would have to be implemented by the Management.

Manufacture of new products like Toilet soaps and shampoos have been demonstrated and samples given.

Some Laboratory and Quality Control methods have been established and some have to be done when the chemicals which had been ordered arrive. Unfortunately, a suitable assistant could not be recruited for proper training by the Chemist.

This plant would prove to be a very useful and profitable venture and all encouragement and help should be given by the Congress and the Legislature and by agencies like the UNIDO.

14. General

1. M.C.P.A. Meeting - A special meeting of the Micronesian Coconut Processing Authority was held on 29th May 1980 in Truk to discuss the proposed Oil/Soap Plant in Truk. It was agreed that:
   a. The plant should be installed most probably in Moen or Dublon depending on whether the industrial estate would come up in Dublon in the immediate future.
   b. The existing contract between the States of Ponape and Truk be modified to permit such a plant in Truk.

c. The Finance of $150,000 to be requested from the Congress ($100,000) and the Truk Legislature ($50,000).

3. Coconut and Copra Production

Statistical information is seriously lacking in all the districts, and a proper survey should be done. Copra production is now dependent on individual families. It is recommended that efforts are made to promote organized copra making to ensure maximum copra production.

RECOMMENDATIONS

1. Coconut Oil Plant and Soap Plant (for Laundry and 63% T.F.M. Toilet Soaps) to be installed in Truk.

2. Soap Plant (for Laundry and 63% T.F.M. Toilet soaps) to be installed in Marshalls.

3. Commence manufacture of Toilet soaps and Shampoos in the PATS Plant in Ponape.

4. The following import duties to be levied

a.	Laundry soaps	-	50%
b.	Toilet soaps	-	75%
c.	Washing Powders	-	75%
d.	Shampoos	-	100%
e.	Hair/Body Oils	-	100%
f.	Cooking Oils	-	75%
g.	Shortening	-	75%

5. Commence manufacture of Toothpowders on a small scale in all districts apart from Kosrae and Yap.

6. Commence manufacture of Laundry soap by the Cold Process in Kosrae and Yap.

7. At the PATS Plant:

   7.1 Purchase on oil burner for the copra scorcher

   7.2 Purchase extra oil expeller - Hander type

   7.3 Implement improvements suggested in the plant

   7.4 Improve packaging of cooking oils and hair/body oils by using transparent plastic bottles.

   7.5 Implement Stock Control procedures.

7.6 Establish an organized Distribution System

7.7 Improve maintenance of machinery and buildings

7.8 Establish Quality Control procedures

7.9 Follow up with Mobil Oil regarding suitability of Mobiltherm in the refinery.

8. Now that PATS Plant has started making a profit, the factory should be run as a proper commercial operation in that estimates of sales, purchases, etc. should be made and compared with actuals. Proper accounting and audit systems must be implemented.

9. Review of the Factory should be done every six months by PATS organization/MCPA as to the progress of the plant and to the implementation of improvements in this report.

10. Statistical survey to be undertaken in all the districts as regards area under coconuts, number of trees/acre, yield/tree consumption of nuts, etc.

11. Positive efforts to be made to popularize drinking of fresh coconuts to replace part of the imported soft drinks.

12. Ensure maximum copra production by promoting Cooperative Copra Kilns or Professional Copra makers.

13. UNIDO's continuing support is essential. This support could be given in the following manners:

13.1 Laboratory and Quality Control is extremely weak in the PATS Plant and the whole of TTPI in general. It is recommended that a Chemist be sent for 6 months to the PATS Plant to train not only the Manager but also another person who should be specially recruited for this purpose. This would be particularly useful if the Truk Plant is also installed.

13.2 When the Truk Plant is installed, a visit at that stage by a UNIDO expert might be necessary to ensure proper management of the factory. This could be requested by the Truk management at that stage if needed and would also help in a follow-up of the PATS Plant.

PART I

GENERAL

1. The U.S. Government had been the administering authority over the TTPI for the last 30 years, and has generally pursued the policy of installing the basic social infrastructures conducive to administration. The major source of operation funds for all district governments has been the annual subsidies from the U.S. Government which have been steadily increasing over the years. These subsidies have afforded the people to enjoy relatively higher levels of health care, education and other social amenities which they cannot pay by themselves without U.S. subsidies.

With the anticipated decrease in the U.S. subsidies when Trusteeship ends in 1981, it has been recognized in the District Development Plans to make the districts more financially and economically self-supporting in the coming years. For this, the development sectors should be given major emphasis over the social services area.

2. The Table below illustrates the imbalances which characterizes the Micronesian Economy.

EXPENDITURE ON GROSS DOMESTIC PRODUCT FY 1975

(excluding the Marianas)

	$Million
Private Consumption	54.7
Government Consumption	46.0
Gross Capital Formation	24.4
Exports	10.9
Less Imports	50.6
Total	85.4

In 1975, the total private and government expenditures in Micronesia exceeded GDP by $15.3 million. The deficit was made up by transfer payments from abroad solely by the U. S. Government. These transfer payments were mainly used to finance imports for the Government sector and indirectly, the private sector. This resulted in a trade deficit. The use of transfer payments to finance imports instead of being more directed towards production had then almost no consequential impact on the development of local resources.

It is recognized that new economic policies will be required and implemented to reduce Government consumption and to stimulate domestic production in the private sector.

Self-reliance and expansion of the private sector are two of the main objectives of the Development Plan.

To narrow the trade gap, a combination of two policies should be followed:

- Promotion of import substitution industries and export promotion
- Discouragement of imports of those goods which can be produced locally and, reduction of unnecessary consumption.

Both policies will involve an increase in import duties. Combined with import substitution. The import tax measures will have the following effects

- imports of consumption goods are reduced
- domestic savings are increased
- investment and local production are encouraged
- employment and income will rise
- tax base increased.

3. Industry is virtually non-existent in any of the districts. The only industries are in Palau and the Marshalls, where there is a Coconut Oil Mill in each district. Palau mill is both foreign-owned and foreign-managed; while the Marshalls mill is foreign-managed but government-owned. Bothe of these plants do not appear to have developed local skills to a great extent -- particularly the Palau mill where the skilled labour is also foreign.

4. It would appear that industry is considered synonymous with large scale industries, like in the developed countries. As a result of this conception, industries considered by the districts are of an extremely ambitious, and capital intensive in character which by the very nature are considered feasible on major assumptions based on possibilities rather than the present realities.

Examples of such industries being considered are:

(a) Integrated Industrial "Complex" in Truk - The proposal envisages a copra mill to produce oil and copra meal. The copra meal to be used for a new animal feed industry, which then means developing the livestock industry. The livestock industry to be used to obtain waste product to produce methane gas which in turn is to be used to melt junk cars and steel cans to produce re-enforcing bars and corrugated roofing. Capital needed would be extremely high.

(b) Production of Oil, Activated Carbon and Methane gas from whole coconuts in Yap—this plant envisages feeding whole coconuts at one end and obtaining the above products. The methane gas obtained to be used for driving the machinery and the excess used for industrial purposes. The capital needed for this process is of the order of $3.5 million.

They have started to organize large scale industries where large sums of money have to be spent. It is worthwhile recalling the words of Eugene R. Black, the past President of the World Bank that "it is a vital necessity to the developing world to realize that it is not just a matter of financing a project but is equally a matter of assuring that the project will be strong and solvent." If this is not done, the development process could be retarded and not advanced.

5. In all the districts, the essentials for industry like laboratory services, engineering services, skilled labour, etc. are not available. Hence, industrialization must be a gradual process and the best way would be to guide them to assume small and medium scale industries which do not require expensive and complicated equipment nor would they require much technical knowledge. This should enable them to attain higher techniques and establish their own steady and lasting industries.

6. As regards export markets for consumer goods like soaps, shampoos, cooking oils, etc. this would not be feasible unless a sound domestic base is established. There are no special resources like cheap labour, cheap power, freight advantages, etc. in this territory. Further, export marketing requires more specialized skills in marketing which could only be acquired after skills in marketing locally have been acquired.

LAUNDRY SOAPS

1. The Laundry Soap market is comparatively large and is 317 tons in 1980 and 500 tons in 1985. The market in Kosrae and Yap is extremely small and therefore, Kosrae market could be included under Ponape and the Yap market could be included under Truk.

The market size is as follows: (in tons)

	1980	1985
Ponape & Kosrae	125	160
Truk & Yap	112	157
Palau	NIL	55
Marshalls	80	128
	317	500

2. In the manufacture of laundry soaps the major portion of the raw materials (coconut oil) is available locally and the imported materials is only about 15% of the weight of soap. Hence, there is a great advantage in terms of freight when manufactured locally.

3. The process of laundry soap manufacture is simple and fairly straightforward. The laboratory and quality control procedures are comparatively easy and training could be done in a short period. Once the procedures are laid down, management of such a plant is also comparatively easy.

4. The manufacture of laundry soaps lends itself to small scale manufacture in that it is not capital intensive and is an ideal starting industry to learn the basics of industry, the production methods, planning, stock control, quality control, purchasing, shift work, etc., etc.

5. Ponape (PATS) has already started manufacture of laundry soaps on a reasonable and satisfactory plant. The capacity of this plant is sufficient to cater to the needs of Ponape.

It would be advisable to start laundry soap manufacture in Truk as well, on a plant similar to the one at Ponape as the market in Truk is also large and the plant could easily and efficiently be run in Truk. Further, this could be the stepping stone to industrialisation in this State.

6. For the above reasons it is recommended that in the FSM, both Ponape and Truk manufacture laundry soaps. Ponape plant would cater for both Ponape and Kosrae, and the Truk plant would cater for both Truk and Yap.

This would also have the extra advantage that the whole of FSM would not have to depend on one plant for its entire laundry soap requirements. In the event of a breakdown of supply in one plant (in these islands breakdown in supply easily occurs owing to various factors -- shortage of fuel, water, power, spares, raw materials, stoppages or changes in shipping schedules apart from breakdown in plant) there will not be a serious shortage of laundry soaps which is a basic essential item. Shortages of "luxury" items like shampoos, toothpastes, icecream, etc. would not cause a very serious problem like laundry soaps.

7. In the case of Palau and Marshalls the manufacture of laundry soaps is easier as oil is already manufactured on a large scale and available at a price cheaper than it could be produced in Truk.

In Palau there is no market at present for laundry soaps as the people only use washing powders. This market has to be created first before laundry soap is manufactured.

In the Marshalls the present market for laundry soaps is 80 tons; hence a soap plant of the same size as the one suggested for Truk is feasible, and produces a greater return on investment owing to the cheaper coconut oil.

8. Soap Plants. Feasibility study and relevant data such as equipment costs, investment costs, working capital, man-power requirements, have been assessed and analyzed for plants in Truk and Marshalls. For easier understanding, the oil and soap plants have been analysed separately.

(a) Truk

In the case of Truk, both an oil plant and a soap plant should be installed. The Total Capital Investment needed is $150,000 and at the present price of Copra ($250 per ton) and selling soap at the present price of imported soap there is 16% return on investment after paying 15% interest on investment. If investment is by Government grant and no interest has to be paid, the return on investment will be 31%. This rate of return is very good, considering the social cost benefits gained by industrialisation. Even if copra goes up in price by amother 50%, this plant will not run at a loss. In fact, the trend is for copra prices to drop below the present price, and imported soap prices would keep on rising every year.

(b) Marshalls

In the case of Marshalls, a similar size plant should be installed. There the production is taken as 80 tons/annum. Since oil is already available, the Total Capital Investment needed is $80,000 and the rate of return is 19% after paying 15% interest on investment.

9. The protection given to local industry is extremely low -- virtually non-existent. In the case of laundry soaps, the tariff protection is (a) Import Tax of 3% on F.O.B. cost, (b) Sales Tax of 3% at the first point of sale. This assumes that no Sales Tax and no Profit Tax is imposed on local industry as in Ponape. This means a total tariff protection of 5.23% of the imported cost (0.575/lb).

Incidentally it is difficult to understand why Import Taxes are based on F.O.B. cost and not on CIF costs.

If local soap is sold to the consumer at the present price of imported soap, the consumer would buy the imported soap even if the locally manufactured soap is of the same quality or better as there is a well established preference for imported article in the Trust Territory. It is suggested that there should at least be a 35% differential in price between the imported and locally manufactured laundry soap, to encourage purchase of the local soap. This would require and Import Tax of 50% on FOB cost.

MANUFACTURING PROCESS

Coconut Oil Manufacture

The manufacture of coconut oil from copra is as follows:

1. The copra is crushed into small pieces by a Copra Crusher.
2. The crushed copra is heated to about 110oC in a Copra Scorcher to facilitate expelling oil and also to remove some moisture.
3. The Scorched copra is sent through an expeller which produces coconut oil and copra cake.
4. The coconut oil is filtered by means of a Filter Press to remove the sediment and the oil pumped to the storage tank.

   The plant suggested is one similar to the plant in Ponape. Details of Plant and Costs are given later.

Laundry Soap Manufacture

Soap is manufactured by reacting fats and oils with caustic soda. This process is called saponification. Each oil or fat has a saponification value which enables the soapmaker to calculate the amount of caustic soda needed for complete saponificaiton. The saponification value is the amount of potassium hydroxide in mg. needed to saponify 1gm. of oil or fat.

Saponification value of coconut oil = 255

Hence, actual amount of caustic soda required for 100 parts of coconut oil =

$$= \frac{\text{Sap value}}{1000} \times \frac{\text{M. wt. of NaOH}}{\text{M. wt. of KOH}} \times 100$$

$$= \frac{255}{1000} \times \frac{40}{56.1} \times 100 = 18.2$$

Unless a person is well experienced in soap making slightly less caustic should be used. Hence, the figure used in subsequent calculations is 17.9.

Cold Process

The simplest method of producing soap is by the Cold Process (no heat). This basically involves mixing and stirring.

Caustic soda is dissolved in a container and checking the solution strength using a hydrometer. A suitable quantity of oil is poured into the reaction vessel. Caustic is poured on to the oil charge and the whole stirred continuously (about 1 1/2 to 2 hrs). The mixture thickens as the reaction proceeds and the consistency indicates completeness of saponification. When the soap mix is considered ready it is poured into cooling frames made of wood or metal. The frames area allowed to cool for a day or two and the soap block removed. The block is slabbed, barred and billeted.

This process is only suitable for very small scale of production and also does not allow usage of scrap arising out of the slabbing, barring and billeting operations, hence would be considered waste. Hence this process is not recommended for medium scale production. It can only be used in very small scale production.

Semi-Boiled Process

This is the process recommended for medium scale production and is merely a modification of the Cold Process. This process not only provides for usage of scrap but the heating also provides for complete saponification (hence better quality), for correction of inaccurate mixes and for usage of any other oils or fats.

The Coconut Oil is first raised to a temperature of $70/80^{o}C$ in the soap crutcher by means of steam. Caustic solution is prepared in the Caustic Mixing tank and the strength checked by means of a hydrometer (37^{o} Be at room temperature). The caustic solution must be prepared the day before, for use the next day.

The scrap is added to the oil and heated to $70/80^{o}C$ until the scrap is melted. The caustic solution from the Caustic Measuring tank is run into the Soap Crutcher and stirring continued till the reaction is complete. The colouring (dissolved in oil or water) is added and stirred until completely mixed.

The hot soap mix is run out from the botton into metal soap frames, the sides of which are detachable to facilitate of removal of the cooled solid soap block. The soap frames are fixed on a metal base on wheels for easy transport.

The soap frames are allowed to cool for a day and the frames removed. The soap block is then wheeled to the slabbing machine where it is cut into slabs. The slabs are then fed into the barring and tableting machine where the rectangular tablets are formed.

Size of tablet = 4" x 2.25" x 2", weighs approx. 11ozs.

No. of tablets per box = 60

The imported soap bar weighs approximately 15ozs. and is neither stamped nor perfumed. If necessary the tablet could be stamped with a couple of letters by a simple engraving on the tableting machine as in Ponape.

The scrap produced should be less than 15% if the dimensions of the soap frames and the cutting machines are correctly matched. This would be done by the equipment manufacturers.

Comments and Notes

1. Coconut Oil should be clean and free of dirt, etc. otherwise the soap would be dirty.

2. Caustic Soda is a most hazardous material and the solutions are very corrosive, hence the personnel dealing with caustic soda have to be provided with protective clothing, gloves and goggles.

Caustic Soda solutions attack tin, zinc, aluminum and alloys containing these metals, such as brass, hence vessels and pump made of these metals should not be used. Tanks are constructed of welded steel plates. Iron pumps can be used for pumping caustic.

Caustic Soda solid must be kept closed and stored in a dry place, otherwise it deteriorates, getting wet and being gradually converted into ordinary washing soda.

3. The correct quantities of oil and caustic soda should be added. In order to protect the safety of consumers the soap should not contain an excessive amount of caustic soda. This should be kept under strict quality control. An experienced soap maker could control it by taste and consistency. A drop of Phenolphthalein on the soap will trun red if alkaline and remain colorless if no caustic is present.

4. The scrap produced should be kept to a minimum as otherwise costs of recycling scrap would be high. Scrap should not exceed 15%.

5. Strict quality control on the weight and shape of the tablet should be maintained. This could easily be done by weighing and inspection of tablets at periodic intervals.

6. The consumer complaints in Ponape has been mainly that the soap is not as hard as the imported soap nor as long lasting. This can be attributed partly due to the addition of silicate and metasilicate, as such this is removed in the formulation. Both these chemicals tend to soften the product. The other reason is that the Ponape soap contains a great amount of unsaponified oil, this also tends to soften the soap. It is true that coconut oil soaps have the tendency to wash faster than tallow soaps.

7. Coconut oil soaps produce a much better lather than the imported soap and removes dirt better. This soap can also be used in salty water unlike the imported soap. These attributes have been noted and appreciated by the consumers in Ponape.

COSTING OF OIL AND SOAP PLANT

	OIL PLANT [1]	SOAP PLANT [2]	TRUK OIL & SOAP PLANT	MARSHALLS SOAP PLANT
1. Capital Investment Total	67305	80411	147716	78365
1.1 Land	NIL	NIL	NIL	NIL
1.2 Buildings	23000	36000	59000	36000
1.3 Equipment & installation	38125	32350	70475*	32350
1.4 Working Capital	6180	12061	18241	10015
2. Fixed Costs Total	26240	39872	66112	31115
2.1 Depreciation	5350	5635	10985	5635
2.2 Interest on Investment	10095	12062	22157	11755
2.3 Management [4]	-0-	10600	10600	2600
2.4 Operatives	8150	7250	15400	7250
2.5 Maintenance	1225	2050	3275	2050
2.6 Insurance	920	1025	1945	1025
2.7 Selling Costs	500	1250	1750	800
3. Variable Costs Total	35085	80090	53850	45730
3.1 Materials	31900	78400	49975	44040
3.2 Electricity	600	200	800	200
3.3 Fuel Oil	2460	1240	2700	1240
3.4 Water	125	250	375	250
4. Total Costs	61325	119962	119962	76845
4.1 Production Tons Oil/Soap	82	125	125	80
4.2 Cost per Ton Oil/Soap	748	960	960	960
4.3 Cost per lb. Oil/Soap	0.374	0.48	0.48	0.48
5. Cost of Imported Soap/lb [5]	-0-	-0-	0.575	0.575

6.	Sales Revenue	-0-	-0-	143750	92000
7.	Profit	-0-	-0-	23738	15155
8.	Rate of Return on Investment	-0-	-0-	16.1	19.3
9.	Break-Even Tons	-0-	-0-	92	54

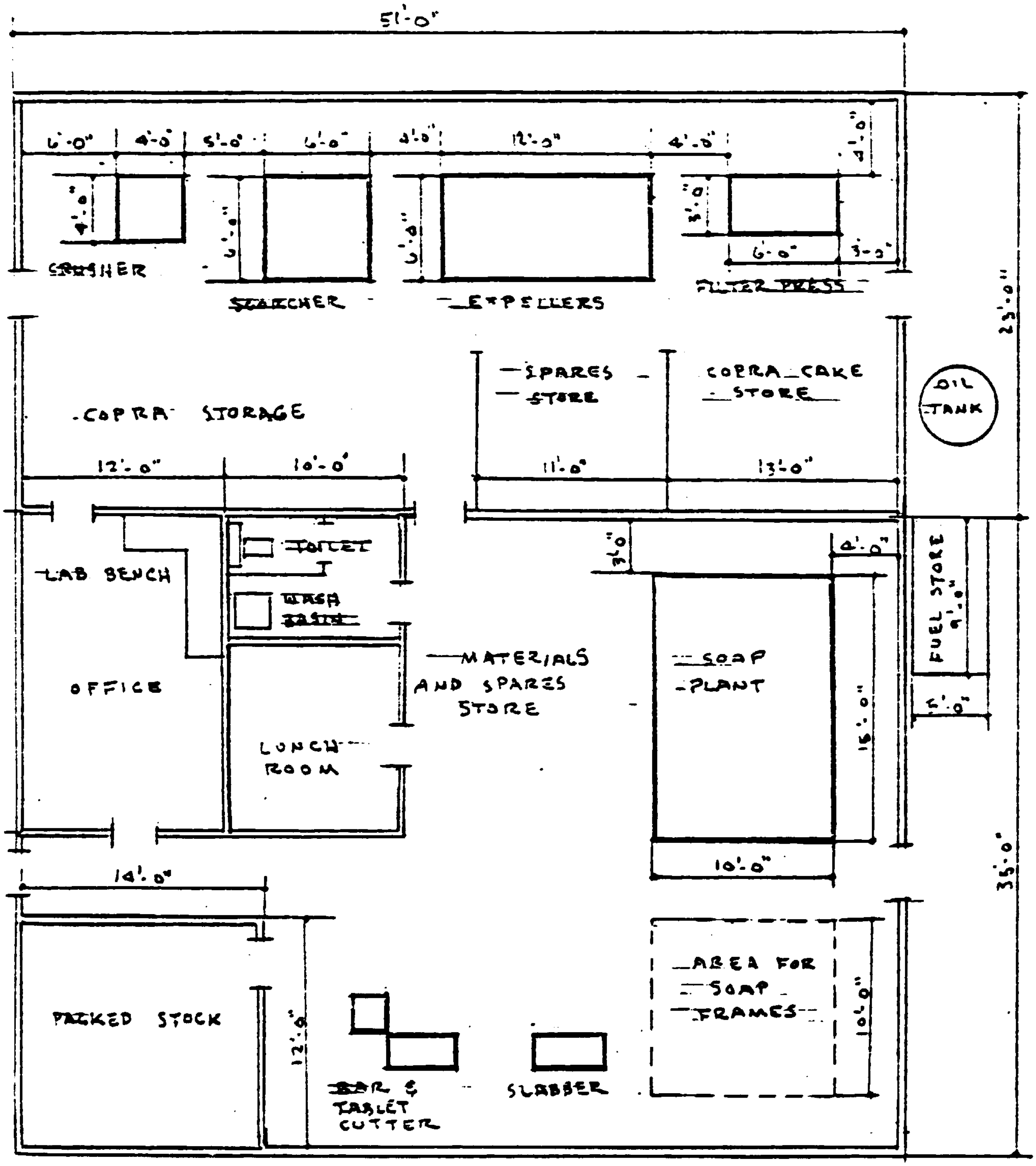
1 The calculations have been based on an output of 82 tons of oil per annum (requirements for 125 tons of soap). The capacity of the plant is 100 tons per annum and provision made to double the capacity by only purchasing another expeller at a cost of $5,600.

2 The calculations have been based on an output of 125 tons of soap per annum. The capacity of the plant is 200 tons per annum.

3 In the case of Marshalls the calculation has been based on the basis of the same plant, but output of 80 tons of soap per annum as this is the size of market in 1980. In the Marshalls the cost of oil would be much less as the oil was sold to the States at $630 CIF per ton in April 1980. This price is assumed for soap costing to allow for handling costs, etc. No provision is made for a Manager as the present Oil Plant Manager could look after this soap plant.

4 The cost of Management has been accounted under the Soap plant. This management is sufficient for the Oil Plant as well.

5 This is the cost of the imported soap to the wholesaler inclusive of Import Tax and Sales Tax. In the case of local manufacture it is assumed that no taxes will be imposed, like in Ponape.



LAYOUT FOR SOAP AND OIL PLANT

OIL PLANT

Output = 82 tons/annum - requirement for 125 tons of soap per annum.

EQUIPMENT REQUIREMENTS AND COST[1]

		No.	Imported or Local	Electrical or Manual	H.P.	Capacity Copra lbs/hr	Cost $
1.	Copra Crusher	1	Imported	Electrical	2	600	3600
2.	Copra Scorcher	1	"	"	1	500	4160
3.	Expeller	1	"	"	10	250	5600
4.	Filter Press & Pump	1	"	"	1	40gal/hr	4260
5.	Crude oil tank	1	Local	-	-	40gal/hr	60
6.	Filtered oil tank	1	"	-	-	80gal/hr	120
7.	Oil Pump	1	Imported	Electrical	1/2	-	850
8.	Extra Spare Parts	1	"	-	-	-	3500
9.	Accessories like hearth for scorches, wiring, piping, chains, weighing scale, etc. -		Imported/ Local	-	-	-	3000
							25150
	Other costs incl. cost of engineer from Japan[2] for one month for installation						8000
					Contingencies 15%		4975
							38125

Total Cost of Equipment = $38,125

Building Cost

Assuming cost per sq. ft. = $20.00

Cost of building = 23 x 50 x 20 = $23,000

1 The costs are based on quotations actually received from Hander Oil Machinery Corporation, P.O. Box 293 Central, Osaka, Japan, in March 19, 1980. Similar machinery is used at PATS.

2 Estimated

Land Cost

Government land would be available free or on nominal lease.

Material Requirements and Cost

Output as 82 tons/annum (which is the requirement for 125 tons soap).

Assuming 55% extraction (based on actual measurement at PATS).

Copra required = 149 tons.

Cost = 149 x 250 (CSB price of copra = $250 per ton on 9th June 80) to producer

= $37250

Copra Cake

Copra Cake produced is 36% (actual measurement at PATS)

Price of Copra Cake = $100 per ton

Revenue from Copra Cake = $149 x 0.36 x 100 = $5364

Hence Net Cost of Materials = 37250 - 5364

= 31886 say $31900

Manpower Requirements and Cost

The Manager of the soap plant can supervise the Oil Plant as well.

	No.	Salary $ per annum
Expeller Operator	1	2150
Crusher/Scorcher Operator	1	1700
Helper	1	1700
Mechanic	1	2600
	4	8150

Cost of Manpower = $8150

Electricity Requirements and Cost

Estimated KWH = 15,000 per annum at 4 cts. per unit

Cost = 15,000 x 0.04

= $600

Water Requirements and Cost

Estimated requirements = 25,000gal/annum

=125 tons/annum

Cost at $1.00 per ton =$125

Fuel Oil Requirements and Cost

Estimated requirements = 15gal/ton of copra

Hence cost at $1.10 per gal.

= 15 x 149 x 1.1

= $2460

Maintenance Costs

Estimated at 2% of Building Costs and Equipment Costs

= 0.02 x 61125

= $1225

Insurance Costs

Estimated at 1.5% of Building and Equipment Costs

= 0.015 x 61125

= $920

Selling Costs

Estimated at $500

Depreciation

Depreciation on equipment assuming 10 years lifetime	=	$3815
Depreciation on building assuming 15 years lifetime	=	1535
Total Depreciation	=	$5350

Working Capital

Estimated at 8 weeks of operating costs and comprises 4 weeks provision before start-up, 2 weeks for production and 2 weeks for oil in stock.

Hence, Working Capital $= \frac{7}{52}$ (rows 2.3 to 2.7 + row 3)

$= \frac{7}{52}$ (10795 + 35085) = $6180

Interest on Investment

Assuming 15% Interest -

Interest on Investment = 0.15 x 67305 = $10095

SOAP PLANT

Output - 125 tons of soap per annum, the size of market in 1980.

EQUIPMENT REQUIREMENTS AND COST

		No.	Imported or Local	Electrical or Manual	Landed Cost $	Capacity
1.	Steam Boiler	1	Imported	Electrical	3600	200lbs/hr
2.	Soap Crutcher	1	"	"	4000	850 "
3.	Soap Frames	9	"	-	900	300 "
4.	Fat Storage Tank	1	Locally Fabricated	-	2000	1500gal
5.	Caustic Mixing Tank	1	"	-	200	150 "
6.	Caustic Measuring Tank	1	"	-	50	30 "
7.	Soap Slabbing Mach.	1	Imported	Manual	1600	300lb block
8.	Bar & Tablet Cutting	1	"	"	1400	300lbs/hr
9.	Hand Pump for Caustic	1	"	"	100	30gal/mm
10.	Electric Pump for Oil	1	"	Electrical	1000	100gal/mm
11.	Extra Iron bases for Frames	3	"	-	180	-
12.	Accessories like weighing scale, hydrometer, goggles, gloves, fire equipment, lab testing, chairs, tables, etc.		Imported/ Local	-	5000	-
					20120	

Other costs including cost of engineer from Philippines	8000

	28120
Contingencies 15%	4220
Total Cost of Equipment = $32350	32340 say $32350

Building Cost

Assuming cost per sq. ft. = $20 per sq. ft.

Cost of Building = $36,000

Land Cost

Government land would be available free or on nominal lease.

Notes

1. The PATS Soap Plant inclusive of installation by an Engineer from the Philippines cost $10,800 (according to the books) and the plant was installed in 1979. The building (37' x70') to house the oil mill, soap plant and refinery only cost PATS $17,000.

The Soap Plant computation works out to about 3 times the cost which I feel not only reflects the high cost escalation but also perhaps that the PATS costing has not been stated correctly and that some building materials were provided free by the PATS school.

2. The freight of equipment has been estimated at 15% of the F.O.B. Price.

3. The F.O.B. cost of the main items in the above list has been worked on the basis that it would be 1.7 times the F.O.B. cost of the PATS equipment.

4. The suppliers of the PATS equipment would appear to be quite cheap and are now experienced to the conditions in the Trust Territory. The address

of the supplier is:

Optima Scientific Consultants

Suite 908, Pacific Bank Makati Bldg.

6766 Ayala Avenue, Makati, Metro Manila

Philippines

5. This plant is capable of producing about 200 tons/annum and hence would suffice for the next 10 years or more. Calculations have been based on an output of 125 tons of soap/annum the size of the market in 1980.

Material Requirements and Cost

Output - 125 tons per annum of 230 days working 8 hrs per day.

	Unit	Quantity	Price $ Per Unit	Cost In $
Coconut Oil	Tons	79.63	748	59564
Solid Caustic Soda	"	14.25	860	12255
Water	"	31.12	1.5	47
Color	Lbs.	125	3.60	450
Boxes	Nos.	6061	0.75	4546
				76862

Allowing 2% Losses for all materials.

Total Cost of Materials = $78400

Manpower Requirements & Cost

	No.	Salary $ Per Annum	Cost Per Annum
Manager	1	8000	8000
Supervisor/Tester	1	2600	2600
Operator	1	2150	2150
Cutting & Packaging	2	1700	3400
Helper	1	1700	1700
	6		17850

Fuel Oil Requirements and Cost

Estimated Fuel Oil required per ton of soap = 9.0 U.S. gal.

Total Cost of Fuel Oil at $1.10 per U.S. gal= 9 x 125 x 1.10

= $1240 per annum

<u>Electricity Requirements and Cost</u>

Estimated KWH = 5000 per annum

Total Cost 4¢ per unit

= <u>$200</u>

<u>Water Requirements and Cost</u>

Estimated requirements = 50,000gals/annum

= 250 tons/annum

Total Cost $1 per ton = <u>$250</u>

<u>Maintenance Costs</u>

Estimated at 3% of (Building Costs & Equipment Costs)

= $0.03 x 68350 = <u>$2050</u>

<u>Insurance</u>

Estimated at 1.5% of Building Cost + Equipment Costs

= <u>$1025</u>

<u>Selling Costs</u>

Estimated at $10 per ton = <u>$1250</u>

<u>Depreciation</u>

Depreciation on equipment assuming 10 years lifetime	=	$3235
Depreciation on building assuming 15 years lifetime	=	2400
		<u>$5635</u>

<u>Working Capital</u>

Estimated at

I) 3 months stock of imported items = 1/4 x 17251 = <u>$4313</u>

II) one month of Fixed Costs excluding Depreciation & Interest

= 1/12 x 22175 = $1848

III) 3 weeks of Variable Costs and Fixed Costs excl. Depreciation and Interest to allow for production and stocks of soap.

= 3/52 (80090 + 22175) = $5900

Total Working Capital = $12061

Interest on Investment

Assuming 15% interest

Interest on investment = 0.15 x 80411 = $12062

TOILET SOAPS

1. The market size of toilet soaps is quite small compared to the market size of laundry soaps. The total market is 141 tons in 1980.

	Market 1980
Ponape	38
Kosrae	4
Truk	39
Yap	14
Palau	21
Marshalls	27
	141

2. The imported toilet soap is of an extremely high standard and production of this type of toilet soap needs resources of a very high order - financial, laboratory, engineering management resources. This type of resources is not available now nor would be available in the near fu re in this area.

3. The production of imported type of toilet soaps is a more involved process. The bars produced as in the case of laundry soaps and then involves the following additional processes.

   3.1. <u>Chipping</u>. The bars are dried and fed into a chipper where they are reduced to chips.

   3.2. <u>Drying</u>. The chips are again air dried in a hot air dryer. This drying is needed as the 63% TFM (laundry soaps) has to be brought up to 79% TFM in the case of the imported type of toilet soaps, by getting rid of moisture.

   3.3. <u>Mixing</u>. The dried chips are passed to a blending/mixing machine where the additives like perfume, odor, chemicals, etc. are mixed with the soap chips.

3.4. Milling. The soap from the Mixer is fed into a Milling machine in order to ensure that the soap mix is thoroughly and intimately combined and also to ensure that the soap is in a plastic and homogeneous condition for subsequent operations. This Milling process is normally carried out two or three time The Milling machine reduces the soap mix into ribbons.

3.5. Plodding. The soap ribbons are fed into a hopper of a finishing plodder. The Plodder is a screw type intruder where the soap is forced by screw feed into a compression chamber and forced out through a nozzle die plate to the required shape. For good quality soaps vacuum plodders are used and are water pocketed for temperature control.

3.6. Cutting. As the soap leaves the plodder the soap is cut by rotary cutters into tablets of suitable size.

3.7. Stamping. The cut tablets are fed into a stamper when the soap takes its final shape.

3.8. Wrapping. The stamped tablets are wrapped wither manually or automatically in a wrapping machine. The imported type of toilet soaps is normally wrapped in a machine as three coverings are normally used. The first covering is of glassine to retain the prefume in the soap. The second covering is a cardboard stiffener to retain the shape of the tablet. The third and final outer wrapping which is normally luxurious.

Hence, production of the imported type of toilet soap would need a further capital investment of about $250,000 at least, and hence would not be economically feasible for such low tonnages.

4. The production of top grade toilet soaps would require the blending of bleached coconut oil and bleached tallow since soaps made from crude coconut oil only, will not produce high grade toilet soaps. In the Trust Territory bleached tallow would have to be imported and would increase costs further.

5. In the Trust Territory where the imported toilet soap is of an extremely high quality, production of this type of soap needs a great amount of effort expended on quality control not only at all stages of production but also in terms of packaging and presentation. This type of control would not be possible in this area at present.

6. If high quality toilet soaps are attempted to be produced in this area not only would it cost much more (even if import tax is raised to 100%), but also, the product is bound to be inferior in quality. Further the foreign exchange benefit would be negligible as most items including tallow would have to be imported.

7. In most developing countries the toilet soap market is in two segments:

   I) Toilet soaps at 79% TFM and of high quality as above.

   II) Toilet soaps at 63% TFM (like laundry soap) but perfumed, colored, stamped and wrapped. The production of this type of soap eliminates processes 3.1 to 3.6 and could use crude coconut oil only, without importing tallow, hence where a laundry soap plant exists the extra investment required would only for a hand stamper with dies - not more than $3000. Management and control is the same as in laundry soaps.

This type of toilet soap caters to the middle and low income groups where the demand is for a low prices product, a cheap product which is not sophisticated in terms of presentation, and therefore does not compete with the expensive sophisticated toilet soaps.

In developing countries this type of toilet soap comprises of about 60% of the total toilet soap market, and the sophisticated type is only about 40% of the market.

8. In the Trust Territory this intermediate type (63% TFM) of toilet soap is not available in the market as this type is not being imported. I am confident that this type of market exists but is unfortunately not being catered. This opinion is strengthened by the fact that in Ponape where perfumed laundry soap is produced it was found that several consumers use it for both laundry and toilet purposes even though the soap is not stamped properly nor wrapped.

9. For the above reasons it is recommended that the production of imported sophisticated type of toilet soaps (79% TFM) is not undertaken at present in any part of the Trust Territory as it would be most uneconomical owing to the small tonnage involved and also because technology and control is more complicated.

It is recommended that where laundry soap will be manufactured, i.e. in Truk and Ponape the production of the less sophisticated type of toilet soaps (63% TFM is also produced. Once this is produced, 50% of the toilet soap market could be converted to this type os soap, the tonnage would be:

	Total Toilet Soap 1980	50% 63% TFM Toilet Soap
Ponape & Kosrae	42	21
Truk & Yap	53	26
Palau	21	10
Marshalls	27	14
	141	71

Hence in the case of Truk and Ponape only about 25 tons of toilet soap have to be produced per annum for their own requirements and if successful a further 10-15 tons each would cater for the entire Territory. The capacity of the laundry soap plant is more than sufficient to cater to this requirement.

TOILET SOAPS - 63% TFM

1. Manufacturing Process

The process is exactly the same as the production of laundry soaps except that extra additives like perfume and chemicals are added at the time of color addition. Before manufacturing the toilet soap, the soap crutcher and soap frames have to be cleaned in order that the coloring of the laundry soap does not contaminate the toilet soap.

The toilet soap tablets shoudl be about half the weight of the laundry soap tablets, i.e., 5 1/2 ozs. per tablet.

Dimensions of Tablet = 3" x 2-1/4" x 1-3/8"

Weighs approximately 5-1/2 oxs.

These tablets can be produced by adjusting the wires on the slabbing and barring/tableting machines.

The tablets are then hand-stamped and hand-wrapped (glued) with an inner waxed paper/glassine and an outer wrapper.

The wrapped tablets are packed into boxes. Since the off-take is small it is suggested that the toilet soap is packed in small units, i.e. 48 tablets per box.

Internal Dimensions of Box = 12-1/8" x 9-1/8" x 4-1/4"

2. Extra Equipment

The only extra equipment needed is a hand stamper. Cost of which would be about $3000.

3. Materials

	Unit	Quantity for 25 T. Soap	Price per Unit $	Cost in $
Coconut Oil	Tons	15.93	$ 903	$ 14385
Caustic Soda	"	2.85	860	2451
Water	"	6.25	1.5	10
Color	Lbs.	25	5.0	125
Perfume	"	500	12	6000
Neutral Sod. Silicate	"	225	0.33	745
Magnesium Sulphate	"	37.5	0.50	19
Nerranaid B30	"	32.5	0.50	17
Inner Wrapper	Nos.	145455	.005	728
Outer Wrapper & Glue	"	145455	.015	2182
Boxes	"	3030	.40	1212
				27874

Allowing 5% losses we have

Cost of Materials for 25 tons = $29268

Cost of Materials per ton = 1171 for 63% Toilet Soap

Cost of Materials per ton = 728 for 63% Laundry Soap

Hence Extra Cost/Ton = $443

4. Cost per lb. of 63% TFM Toilet Soap

Hence allowing for extra working capital ($5000), etc., the

Minimum extra cost = $500 per ton

= 0.25 per lb.

Hence cost per lb. = 0.50 + 0.25 = $0.75 per lb.

5. Factory Selling Price and Tariff

The present minimum CIF price of imported 79% TFM Toilet Soap is $1.04 per lb.

If the price is corrected for 63% TFM, the price would be

$$= \$1.04 \times \frac{63}{79} = \$0.83 \text{ per lb.}$$

Hence to maintain the same price to the consumer we could sell the 63% TFM toilet soap at $0.83 per lb., which allows a reasonable profit margin.

Hence Factory Selling Price per tablet of 5-1/2 ozs.

$$= \$0.83 \times \frac{5.5}{16} = \$0.29$$

As in the case of laundry soaps to encourage the use of locally manufactured toilet soaps an increased import tariff of 75% should be imposed. This would not effect the present cost of living as alternative soap would be available at the present prices and only if the consumer is extremely keen he would purchase an imported soap.

TOOTHPASTE

1. The toothpaste market in the Trust Territory (Refer Table) is extremely small not only because of the population size but also because the habit of brushing their teeth is a completely new concept. Size of market in 1980:

a) F.S.M. = $25,568 = 4.25 tons = 27,200 tubes
(assuming 5 ozs/tube)

b) F.S.M. + Palau + Marshalls = $49030 = 8.15 tons = 52,160 tubes

2. For production of toothpaste, all equipment to be used would have to be of stainless steel - vacuum mixers and filling machine. Even for a small scale plant the capital requirement is comparatively high.

3. All materials (precipitated Calcium Carbonate, refined Glycerine, Flavour, Viscarin, tootphaste tube, cap, carton, ect.) would have to be imported for the manufacture of tootphaste. Hence no freight advantages (if any disadvantages) is gained in local production.

4. The quality control procedures adopted and maintained must be of an extremely high standard, and the laboratory techniques and equipment needed (measurements of viscosity, pH, bacterial contamination, etc.) would be sophisticated and expensive, Considering the present low level of lab facilities available the type of training needed would be very extensive.

5. For the above reasons, manufacture of tootphaste is not only net economically feasible (even if a 100% import tax is levied) but would also be undesirable at present as experience should be gained in laboratory and quality control procedures in the manufacture of soaps, etc. before considering manufacture of products like tootphaste.

6. The manufacture and marketing of tooth powders could be considered at

present as an intermediate stage. In most developing countries where the concept of brushing teeth has been in existence, tooth powder is extensively used by the low and middle income groups. In the case of tooth powders they do not even use a toothbrush but use the fingers to brush their teeth. Unfortunately in the Trust Territory they either use tootphaste or nothing at all as there is nothing available in between these two extremes - tooth powder might bridge the gap.

The formulation and method of manufacture is in the chemist's report and the equipment needed is virtually nothing. A small batch of raw materials could be purchased and this concept tried out in institutions like schools, etc. before embarking on a commercial venture.

The problem here is not one of economic feasibility but one of marketing and propaganda. Toothpowder could be used as a cheap and effective mehtod of dental care and hygiene and the help and support of the health department might have to be obtained. One dentist in Truk with whom this was discussed welcomed the idea.

SHAMPOOS

1. The total market size of shampoo per annum is only 11 tons for 1980 and 13 tons for 1985.

2. The shampoo market is a very sophisticated one and shampoos are used mainly by the high income groups. The success in selling a shampoo depends largely on the presentation of the pack and the marketing/advertising skills.

3. The imported shampoos on the market are manufactured from N.S.D. (nor soapy detergents) which are not available locally and if this type is manufactured all ingredients and packaging would have to be imported and would only mean mixing and packing locally. Owing to the small market size and the freight involved this would not be feasible, as the imported packaging costs would be extremely high, for such small quantities.

4. It is suggested that a coconut oil shampoo be produced and marketed locally and this could replace the imported shampoo at the bottom end of the market which is more price sensitive. This would probably replace about 30% of the imported shampoo, i.e. about 3 tons in 1980.

The production of coconut oil shampoo is comparatively easy and capital investment needed is extremely small. Even if sales are lower than estimate it wouldn't matter as it would still be profitable and further, marketing skills could be improved.

5. For the production of coconut oil shampoos, refined and deodorised coconut oil (RDCNO) has to be used and the oil needed for 3 tons of shampoo is only 0.75 tons. For this small quantity of refined and deodorised coconut oil it is not feasible to have a refinery plant, as such shampoos would have to be manufactured on PATS Ponape which could cater to the entire market with ease.

It is suggested that Sonape initially produces 0.5 tons of shampoo per annum for their own market (50% of the 1980 market = 0.5 tons of shampoo) and see the reaction of the consumer before producing large quantities for the entire market.

6. The formulation and process of manufacture is given in the Chemist's report. The equipment needed is only a stainless steel vessel of about 60 galls. capacity to make a batch of 350 lbs. shampoo and costs about $700. At present the 10 gal. stainless steel vessels available in PATS could be used.

7. The cost of producing 1000 lbs. of shampoo is as follows:

	Unit	Cost per Unit $	Quantity Per 1000 Lbs.	Total Cost for 1000 Lbs.
RDCNO	Lbs.	0.70	250	175
Pot. Hydroxide	"	2.0	61	122
Nervandaid B30	"	3.0	5	15
Formalin	"	10	0.5	5
Perfume	"	12	10	120
Colour yellow	"	5	0.03	2
Bottles (8 oz/bot.)	Nos.	0.30	2000	600
Labels (2 per bot.)	"	0.04	4000	160
Boxes (12 per bos)	-"	0.25	167	42
				1241

Hence Cost of Materials (allowing 5% losses) = $1300

Allowing for labour, selling costs, etc.;

The total cost = $1500 per 2000 bottles of shampoo

= 0.75 per bottle (8 oz.) of shampoo

The factory selling price could be $1.00 per bottle.

8. If Factory Selling Price of an 8 oz. bottle of shampoo is $1.00, the consumer

price would be about $1.45 per bottle.

An imported shampoo bottle of the equivalent wt. can now be purchased by the consumer at $1.60. This differential in price is insufficient to encourage the consumer to use the local product. It is felt that the differential in price should be about $1.00 at least i.e., the imported shampoo should cost the consumer about $2.50. This would therefore mean an import tariff of 100% as compared to the present tariff of 25%.

HAIR/BODY OIL

1. The estimated total size of the market for Hair/Body oil is 52 tons in 1980 and 62 tons in 1985. Virtually the entire market of this oil is home-made coconut oil as it is generally felt by the people that applying coconut oil is good and keeps them healthy.

This market has to be watched as it is quite possible for the market to dwindle if the people change their beliefs and habits.

2. This product under the brand name "Marekeiso" is being manufactured on Ponape at the PATS plant, the process is simply perfuming refined coconut oil and putting it into plastic bottles.

The capacity of the plant is sufficient to meet the entire requirements, hence it is suggested that this product be manufactured only in Ponape.

3. The present retail proce of "Marekeiso" is $1.35 per bottle of 7 fl. ozs., i.e. 19 cents per fl. oz. while the imported hair oil is about 80 cents per oz. and the imported baby oil is about, 38 cents per oz. Even though the local product is half the price it is suggested that the import tax be raised to 100%.

4. More aggresive marketing is needed now that the factory's porblem as regards the refinery is solved. This product should be advertised all over the Territory and agents appointed in all the Districts - Palau, Yap, Truk, Kosrae, Marshalls and Saipan. This would imporve sales considerably.

COSTING OF REFINED OILS - COOKING & HAIR/BODY OILS

Let us first consider the variable costs involved.

Variable Costs

a) Refining

	Cost/Ton $	
Crude oil	808	$800 pet ton + 1% losses
Caustic soda	Nil	As soap stock is used in soap making
Fullers earth	8	$1.46 per lb. + 5% losses
Fuel	25	$1.25 per gall.
Labour	105	5 men for 3 days @ $7 per man-day.
Spares	10	
Total	956	

Hence, Variable Costs = $956 per ton

= $0.478 per lb.

= $0.03 per oz.

= $0.0285 per fl. oz.

= $3.64 per gall.

b) Cooking Oil

	Cost/bottle $	
Refined Oil	0.92	$0.0285 per fl. oz. for 32 fl. ozs.
Plastic bottle	.31	
Cardboard box	.06	
Labour	.06	
Sales Costs	.05	
	1.40	

Hence, Variable Costs = $1.40 per bottle of 32 fl. ozs.

c) Hair/Body Oil

Cost per bottle
$

Refined oil	0.20	$0.0285 per fl. oz. for 7 fl. ozs.
Plastic bottle	.18	
Label	.02	
Cardboard box	.05	
Perfume	.06	
Labour	.06	
Sales Cost	.03	
	.60	

Hence, Variable Costs = $0.06 per bottle of 7 fl. ozs.

Fixed Costs

Considering only Depreciation & Admin. Overheads,

Depreciation

Cost of plant = $48,000

Depreciation on plant = $48000 per annum

Cost of building = $17,000

Apportioning 15% for Refinery = $2550

Depreciation = $170 per annum

Hence, Total Depreciation - $4970

Administrative Overheads = $2730 per annum

Total Fixed Costs = $7700 per annum.

Total Costs

Tons	Fixed Costs $		Cooking Oil 32 Fl. Ozs.		Hair/Body Oil 7 Fl. Ozs.	
Per Annum	Per Ton	Per Fl. ozs.	Fixed Costs	Total Costs	Fixed Costs	Total Costs
5	1540	.0457	1.46	2.86	0.32	0.92
10	770	.0229	0.73	2.13	0.16	0.76
15	515	.0153	0.49	1.89	0.11	0.71
25	308	.0091	0.29	1.69	0.06	0.66
50	154	.0046	0.15	1.55	0.03	0.63
75	103	.0031	0.10	1.50	0.02	0.62
100	77	.0023	0.07	1.47	0.02	0.62

Selling Price

For the local product to sell its consumer price should be less than the consumer price of the imported product. From the table, it can be noted that the Cost Price depends on the tonnage.

a) Hair/Body Oil

In this case the Factory Price is $1.00 per bottle which would appear to be reasonable, as this means the consumer price is $1.35 per pottle of 7 fl. ozs. while the minimum price of the imported product is double this price.

b) Cooking Oil

The Factory can now produce this oil quite easily as the refinery problem is now solved. The sales at present would be virtually impossible as the consumer price of the local product (7.2 cents per Fl. oz.) is the same as that of the imported cooking oil, while the consumer price of imported shortening (6 cents per oz., i.e. 5.7 cts. per Fl. oz.) is 20% lower.

This means that import tax have to be increased to at least 75% immediately for sales to take place.

The Factory could also consider reducing the price of its cooking oil to as low as $1.60 per bottle, i.e. 6.25 cents per fl. ozs. This price would still means a constribution towards fixed costs and perhaps the total contribution could be greater if sales are more than doubled.

COOKING OILS/SHORTENING

1. The estimated market size for 1985 is 148 tons of refined coconut oil assuming that 1/3 of the imported oils and shortening is substituted by the local product if sufficient tariff protection is available.

2. Shortening can't be made locally as fats would have to be imported for its manufacture as coconut oil by itself would not produce a shortening, hence this would not be economically viable.

3. Refined coconut oil as a cooking oil is now manufactured in Ponape at the PATS plant and the avialable capacity is sufficient to meet the entire demand. Hence it is suggested that production of cooking oil be done only at Ponape.

4. The present retail price of the locally manufactured cooking oil is $2.30 per 32 fl. ozs., i.e. 7.2 cents per fl. oz. or 7.6 cents per oz. Imported cooking oils is also abailable in the market at the same price and imported shortening is available in the market at even lower prices - 6 cts. per oz. Hence it is not surprising that sales in Ponape is virtually nil - only about 1 ton in 6 months, and of this sales, stocks are still in the shops.

5. The price of the imported product is cheap not only because the packaging costs would be cheaper but also because they are made out of oils which are cheaper in the world market than coconut oil.

6. The local product could only be sold if the price of the imported product is made much higher by increasing the import tax on cooking oils and shortening. It is suggested that the import tax be raised to at least 75%.

7. Even if import tax is raised to 75% the presentation of the product should

be improved. The oil should be packed in transparent bottles and packaging improved - refer report by Marketing expert.

8. The factory now sells in bulk (containers provided by the customer) to one customer at $6.00 per gall. This type of sale should be actively sought in institutions like schools, canteens, hospitals, restuarants, etc. This is not only more profitable but also helps to popularise the product.

COCONUT AND COPRA PRODUCTION

In order to determine the future trends in copra production and to determine the best possible solutions it is essential that coconut production should be studied in greater depth. This aspect is being neglected as no reliable statistical information is available as regards average yield per tree, yield/acre, consumption of fresh nuts, etc. in the various districts.

Coconut Production

The following is a table of the area of the various crops in the different districts in hectares.

Source: 1977 Annual Report to the Secretary of Interior.

	Kosrae	Ponape	Truk	Yap	Marshalls	Palau	Total
Coconut	647	8213	3278	2428	10225	1153	25944
Breadfruit	243	591	931	65	607	28	2465
Banana	162	607	304	81	121	32	1307
Taro	16	81	182	61	81	142	563
Yam, Cassava	4	51	36	61	-	344	496
Sweet Potato							
Citrus Fruits	61	5	4	6	2	10	88
Vegetables	4	4	4	1	-	17	30
Others	4	40	12	19	26	14	115
Total	1141	9592	4752	2722	11062	1740	31008
Land Area	10878	37943	11759	12121	17949	46000	136,648
% of Coconut	5.9	21.6	27.9	20.0	57.0	2.5	19.0
% of Total Crop	10.5	25.3	40.4	22.5	61.6	3.8	22.7

The following statistics is obtained from CSB Statistics June 30, 1976:

Av. Nuts per short ton of copra = 6000

Av. coconut tree production = 45 nuts/annum

Av. trees per hectare = 70 x 2.471 = 173

Av. nuts per hectare = 7784 nuts/annum

Av. coconut consumption - 2.15 nuts per person per day.

Let us now apply the above averages to the different districts:

	Kosrae	Ponape	Truk	Yap	Marshalls	Palau	Total
Coconut Hectares	647	8213	3278	2428	10225	1153	25944
Coconut Production in '000	5036	63930	25516	18900	79591	8965	201948
Copra Production 1979 in s. tons	600	1511	4500	1082	6906	200	14799
Nuts for Copra in '000	3600	9066	27000	6492	41436	1200	88794
Nuts for other purposes in '000	1436	54864	(1484)	12408	38155	7775	113154
Population 1979	4790	22445	37490	9040	28780	14355	117215
Nuts/person/annum	300	2444	(40)	1373	1326	542	965
Nuts/person/day	0.8	6.7	(.11)	3.76	3.6	1.5	2.6

From the above figures it would appear that 2.6 nuts/person/day is used for other purposes like home consumption, pig feed, etc. and also possibly not collected. This would appear to be extremely high specially considering the fact that copra production in 1979 was much higher than the previous years owing to the high price.

In other coconut producing countries the yield per hectare varies between 2000-5800 nuts/hectare. Judging from the condition of the coconut plantations seen in the Territory the yield of 7784 nuts per hectare would appear to be extremely high and the more reasonable figure of 4500 would mean that the nuts need for other purposes would then be only an average of 238 nuts per person per annum, i.e. 0.65 nuts/person/day in 1979.

It is therefore suggested that a statistical survey be undertaken in the different districts to obtain accurate and up to date figures. These figures would be extremely useful to determine the priorities as regards improving Copra Production. From these figures one could determine the uses of coconuts and also determine whether the nuts are wasted by not collecting them when prices are low or whether they are substituted for other uses.

COPRA PRODUCTION

The attached Tables give the copra production from 1965 in the various districts and the prices for the respective years. It would appear that copra production is dependent on the price, as such 1979 produciton figure of 14799 short tons is one of the highest figure obtained, and represents an increase of 31% over 1978. As discussed earlier it would be useful to know whether the nuts are used for alternate uses or whether they are left on the ground and goes to waste when copra production is low. It would appear that part of it is wasted as the people feel it is not worth collecting and making copra when the price is low. This is understandable as copra is made by the individuals even if they only make use of nuts from 5 trees or less as in Yap. If the owner and their family fall sick copra production is neglected. This system also causes variation in quality of copra produced.

As long as the above system prevails there is bound to be some wastage of nuts, hence this problem has to be tackled. One method might be, is to have one cooperative copra kiln where copra is continuously made. In Sri Lanka individual smallholders sell their nuts to copra makers who in turn specialize in collection and making copra.

Another interesting feature is the pricing of fresh nuts. Copra is made from fallen nuts only and the price of copra was 20.3 cents per lb. (highest ever) in 1979.

Hence the price obtained per nut = 6.7 cents after making the copra.

In the case of fresh nuts for drinking the nuts have to be plucked from the tree and the price ranges from 25 cents to 35 cents. It is difficult to understand why this can't be sold cheaper as this could partly replace imported canned soft drinks and save much more foreign exchange than exporting it as copra, instead of the price being dependent on the soft drink price and sales of fresh nuts for drinking being very low.

PRICING OF COPRA

The Coconut Stabilization Board (C.S.B.) determines the price at which copra is bought from the producer, and is dependent on the export price of copra. The Board endeavours to stabilize this price as much as possible but has not been able to do this very successfully perhaps due to the wide fluctuation in world prices and insufficient funds.

The attached table gives international prices of coconut oil, soybean oil and copra and the CSB price at the district center. The CSB price over the years would approximate to about 50% of the CIF Europe price of copra.

COPRA PRODUCTION

	Yap	Truk	Ponape	Kosrae	Palau	Marshalls	Total Copra
1965	817	2885	3219 [1]	-	578	5807	13306
1966	1151	3092	2732 [1]	-	552	5554	13081
1967	633	2759	2639 [1]	-	391	6272	12694
1968	644	2705	1970	606	386	6311	12622
1969	826	3611	2218	566	300	6400	13921
1970	586	3733	2818	530	287	7348	15572
1971	427	3055	1245	458	139	5344	10668
1972	397	2468	1616	306	138	5715	10640
1973	487	1839	1058	315	76	4574	8349
1974	652	3482	1413	446	37	6336	12366
1975	772	2801	1102	465	292	6482	11914
1976	303	1650	1629 [1]	-	128	5684	9394
1977	295	n.a.	n.a.	n.a.	n.a.	n.a.	-
1978	586	3000	1163	500 [4]	150 [4]	5876	11275
1979	1082	4500 [2]	1511	600 [4]	200 [3]	6906	14799

1 Ponape production figures includes Kosrae production.

2 Estimate based on 9 months actual.

3 Estimate based on 6 months actual.

4 Pure estimate.

COCONUT OIL

Until recently coconut oil had only been produced in the homes for their own home consumption. This coconut oil had traditionally been used for application on their hair and body. For cooking not much oil had been used except for frying fish.

In 1975 coconut oil was first manufactured by the use of expeller on a small scale at the PATS Plant in Ponape.

Subsequently in 1976 a large and modern oil mill was erected in Koror and in 1977 another oil mill was erected in Majuro.

KOROR (PALAU) Copra Crushing Plant

The installed capacity of this plant is 41,000 tons of copra per annum. The company is registered in Hong Kong, as much no details of their financial transactions is made available locally.

At present all the copra used in this plant is imported from Papua New Guinea and/or the Solomon Islands, and no copra from the TTPI is made use of. The coconut oil and cake is exported. It is extremely surprising that this plant does not offer to buy the local copra at prices higher than the price at which the local copra is now purchased. Most probably their imported copra is purchased at very low prices indeed for the plant to be viable.

The plant is run and managed most efficiently by the Filipino Manager, Mr. Vibar and his team of Filipino technicians. Local labour is used used only for the unskilled jobs.

MAJURO (MARHSALL ISLANDS) COPRA CRUSHING PLANT

The installed capacity of this plant is 24,000 tons of copra per annum. The plant is owned by the Government and efficiently managed by an American, Mr. John Smith. Apart from the Manager all other employees are Marshallese.

At present the copra use in the plant is only copra purchased in the Marshalls. The coconut oil and cake is exported. So far no copra has been purchased from the rest of the Trust Territory. Attempts are now being made to purchase the copra from Truk & Ponape at slightly higher prices than the CSB price. This would be advantageous to both the Marshall Islands and to the rest of the Territory. Perhaps it might be better to have government to government negotiations and negotiate a long term, perhaps yearly, contract based on world prices of copra. This contract could also cover the price at which the rest of the Territory could purchase the coconut oil from the Majuro plant, if it wishes to do so. This type of contract would benefit the whole of Micronesia in the long run.

INTERNATIONAL PRICES 1969-1980 (US $ PER MT)

	Coconut Oil Phil/Indo CIF ROTT 2	Soybean Oil Dutch FOB ex-mill 1	Copra Phil/Indo CIF Europe	Copra District Center Price	TTPI % of CIF Europe Price
1969	347	197	202	102	50
1970	379	286	222	112	50
1971	353	304	190	112	59
1972	254	241	142	90	63
1973	513	436	348	95	27
1974	998	832	670	260	39
1975	394	563	256	190	74
1976	418	438	275	115	42
1977	578	575	402	140	35
1978	683	607	471	190	40
1979	984	662	673	365	54
Jan 1980	885	609	587	318	54
Feb 1980	840	610	565	318	56
Mar 1980	760	580	520	318	61
1st Half Apr 1980	691	550	465	318	68
May 1980				318	
1st wk. June 1980				227	

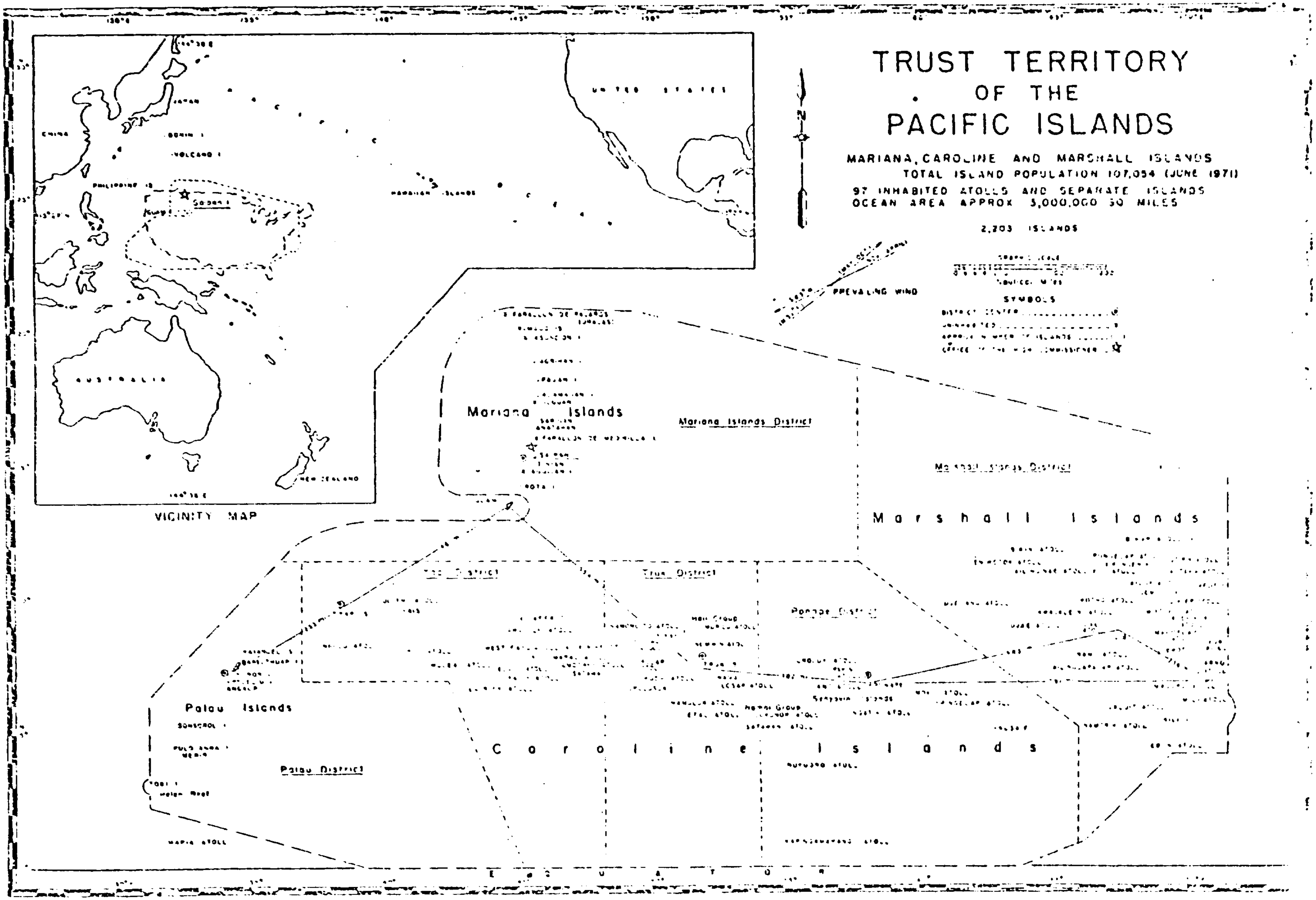
1. Prior to December 1970 - a.o. ex tank Rott.

2. Prior to January 1973 - Sri Lanka 1% bulk, CIF Eur. Ports.

Sources: Oil World Weekly

Market quotations, Reuter

CSB Prices for TTPI


TRUST TERRITORY
OF THE
PACIFIC ISLANDS
MARIANA, CAROLINE AND MARSHALL ISLANDS
TOTAL ISLAND POPULATION 107,054 (JUNE 1971)
97 INHABITED ATOLLS AND SEPARATE ISLANDS
OCEAN AREA APPROX 3,000,000 SQ MILES
2,203 ISLANDS
N
PREVAILING WIND
SYMBOLS
VICINITY MAP
CHINA
JAPAN
AUSTRALIA
NEW ZEALAND
UNITED STATES
HAWAIIAN ISLANDS
Mariana Islands
Mariana Islands District
Marshall Islands District
Marshall Islands
Yap District
Truk District
Ponape District
Palau Islands
Palau District
Caroline Islands
EQUATOR

ACKNOWLEDGMENT

My sincere thanks is due to all the people I had met during my assignment. If not for their help and cooperation, this project would not have been a success. My special thanks is due to Rev. Fr. H. Costigan, Mr. Catalino Sam and the PATS Staff for making my stay in PATS both pleasant and useful. My special thanks is also due to the M.C.P.A. for organizing a special board meeting and giving me an opportunity to discuss the project in detail.

My final thanks is due to Miss Lirio Soretes, PATS Staff, Miss Siony Monzon of UNDP and Miss Sonia Hradecky of the Bureau of Resources for their invaluable help in typing this report and also to the Staff of the Bureau of Resources, TTPI and UNDP Staff for their help in innumerable ways.

PERSONS INTERVIEWED AND PLACES VISITED:

1. SAIPAN

   1. Mr. Kozo Yamada, Director, Bureau of Resources
   2. Mr. David Idip, Chief of Agriculture, Bureau of Resources
   3. Mrs. Elizabeth Udui, Chief of Investment Branch, Bureau of Resources
   4. Mr. Vicente S. Borja, Agriculturist, Bureau of Resources
   5. Mr. Nahum Benzeevi, Project Manager and Senior Economic Planning Advisor, Development Planning for Micronesia, UNDP
   6. Farmers' Market, Saipan (to collect price data)
   7. Joe-Ten Department Store
   8. Mr. Nick A. Songsong, General Manager, United Micronesia Development Association

2. PALAU

9. Mr. Neil Morris, District Agriculturist
10. Mr. Salvador Ongrung, District Economic Development Officer
11. Mr. George Ngirallemau, Agricultural Extension Agent
12. Mr. Huan Polloi, Statistical Planning Officer
13. Mr. Tatsuo Atadisi, Statistician, District Planning Office
14. Mr. Jonas Olkeriil, Assistant to the President, Micronesian Industrial Corporation (MIC)
15. Mr. Jose S. A. Vivar, General Manager, MIC.
16. Mr. David J. Nolan, Jr., General Manager, Koror Wholesalers and KR Shopping Center, Sure Save Mart
17. Mr. Peter C. Tsao, General Manager, Western Caroline Trading Co.

3. YAP

18. His Excellency, Gov. John A. Mangefel, Governor, State of Yap
19. Mr. Sam Falanraw, Director, Resources and Development
20. Mr. Andrew Ruepong, Member, Copra Stabilization Board and M.C.P.A.
21. Mr. Philip Rig, Economic Development Officer
22. Mr. Tony Lubwag, Agriculturist
23. Mr. Russ Curtis, Yap Cooperative Association, General Manager
24. Mr. Willian J. Fitzsimmons, General Manager, Waab Transportation Co.
25. Mr. Herbjorn SKjervold, UN Economic Advisor, Yap State

The following stores were visited for price and market data:

Family Chain Store
Yap Farmers Market
ESA Store
Blue Lagoon Store
EMI Enterprises
Yap Coop. Association
Mark Loochaz Store

Chair-person and members of the United Nations Visiting Mission to the TTPI, 1980. (Joint Meeting)

4. TRUK

26. His Excellency, Erhart Aten, Governor, State of Truk

27. Hon. Kisande Sos, Senator, Truk Legislature
Member, Resources and Development
Member, Micronesian Coconut Processing Authority

28. Mr. Redley Killion, Director, Resources and Development

29. Mr. David Ivra, State Agriculturist

30. Mr. Rosenthal Smith, Agent for UMDA in Truk

31. Mr. Erik Thompson, Economic Adviser, Truk Legislature

32. Mr. Taka Mori, General Manager, Transco Shipping Co.

33. Mr. Les D. Aidel, Operations Manager, Truk Shipping Co.

34. Dr. Yulbert, Dentist of the Truk Hospital (information on toothpaste- using habit in Truk)

35. Science Laboratory, Truk High School (Discussion with the Science teacher on laboratory testing facilities for small-scale industry in Truk)

36. Interviews with selected men and women employees in the Department of Agriculture on their consumption habits (cooking oils, soaps, toothpaste and shampoos)

37. Visited the following stores for information on prices and the market situation:

Christopher Store
Nama Trading Co.
Susumu Store
Truk Trading Co.
T & S Mart
Circle Store
A Village in Moen Island
Suzuki Enterprise

5. PONAPE

38. The Hon. Tosiwo Nakayama, President, Federated States of Micronesia

39. The Hon. Strik Yoma, Lt. Governor, State of Ponape

40. Senator Saso H. Gouland, Chairman, R & D Committee, FSM Congress

41. Mr. Kikuo L. Apis, Special Assistant to the President, FSM

42. Mr. Andon Amaraich. Director/Department of External Affairs, FSM

43. Mr. Ambilos Iehsi, Director/Resources & Development, FSM

44. Mr. James Licke, Staff Attorney, FSM Congress

45. Mr. Peter Holla, UN Economic Advisor

46. Mr. Dan E. Perin, Acting National Planner, FSM

47. Mr. Catalino Sam, Chairman, Micronesian Coconut Processing Authority and Manager, Coconut Oil and Soap Plant

48. Rev. Fr. Hugh F. Costigan, S.J. Director, Ponape Agriculture and Trade School

49. Mr. Rosendo Andrew, Asst. Director, PATS, Ponape

50. Mr. Higinio Weirlangt, General Manager, Ponape Federation of Cooperative Associations

51. Meeting with the Committee/Resources and Development of the Ponape State Legislature (April 8). Those present were as follows:

    Hon. Edwel J. Santos, Speaker, Ponape State Legislature
    Senator Henry Conrad, Chairman, R & D Committee
    Senator Ambilos T. Senda, Vice Chairman, R & D Committee
        Dison H. Gideon, Legislator
        Sohl Damian, Legislator
        Moses Joseph, Legislator
        Peteres Silbour, Legislator
        Goodyear Pauue, Legislator
        Henry Biza, Legislative Staff
        A. H. Susaia

52. Mr. Bernard, Manager, Bernard Enterprises, Kolonia

53. Mr. Leo Etcheit, Manager, Leo's Store, Kolonia

54. Kolonia Cooperative Association

6. MARSHALL ISLANDS

55. Mr. Mike McEvoy, Secretary, Resources and Development

56. Mr. Grant L. Labaun, Chief, Division of Taxation and Revenue

57. Mr. John A. Smith, Tobolar Copra Processing Plant, Manager

58. Mr. Clyde B. Heine, Manager, Majuro Stevedor & Terminal Co. and Majuro Agent for P M & O Lines

59. Robert Reimers Enterprises

7. GUAM

60. Mr. Tommy Perez, Laison Officer, TTPI

61. Trade Statistics Division and the Economic Research Center Department of Commerce, Govt. of Guam

62. Visited the Public Market and all major super-markets to collect price and market information.

8. MICRONESIAN COCONUT PROCESSING AUTHORITY BOARD MEETING

On 29th May 1980 in Truk

63. Mr. Catalino Sam, Chairman (Ponape)

64. Hon. Kisande Sos, Board Member (Truk) & Senator Truk Legislature & Member R & D Committee

65. Mr. Kikuo L. Apis, Board Member (at large) & Sp. Asst. to President

66. Mr. Andrew Ruepong, Board Members (Yap), CSB Member & Chief Clerk Yap Legislature

67. Mr. Norman Skilling, Board Member (Kosrae) & CSB Member & Businessman

OTHER PARTICIPANTS

68. Mr. Reduley Killion, Director R & D, Truk

69. Mr. Dean Bergreen, Acting State Planner, Truk

70. Mr. Dave Ivra, State Agriculturist, Truk

71. Mr. Eric Thomson, Economic Advisor, Truk Legislature

72. Mr. Arthur Ansin, Agriculture Office

73. Mr. Fasy Nethon, Planning Office

74. Mr. Philip Stiles, Professor Arizona State University

9. SOAP MAKING DEMONSTRATION IN TRUK

On 30th May 1980

10. SOAP MAKING DEMONSTRATION IN YAP

On 3rd June 1980

11. MEETING AT TTPI BUREAU OF RESOURCES

On 9th June 1980

75. Mr. David Idip, Chief of Agriculture, Bureau of Resources

76. Mrs. Elizabeth Udui, Chief of Investment Branch, Bureau of Resources

77. Mr. Nahum Benzeevi, Project Manager and Senior Economic Planning Advisor, Development Planning for Micronesia, UNDP.

PART II

PATS PLANT - PONAPE

MARCH - MAY 1980

INTRODUCTION AND SUMMARY

The PATS Plant was started in 1974 by Rev. Fr. Hugh F. Costigan, Director, Ponape Agriculture & Trade School (PATS) and was the first industry in this Trust Territory.

Fr. Costigan quite rightly believed that if the Micronesians themselves were going to run and manage an industry, then, that industry should start at the grass roots level and gradually develop into a bigger industry. This learning process is needed not only in technical knowledge and other aspects like planning, purchasing, sales, etc., but also in creating self confidence and changes in attitudes of the people themselves.

He was fortunate in having Mr. Catalino Sam as the Manager of the plant. Mr. Catalino Sam, who is now also the Chairman of the Micronesian Coconut Processing Authority (M.C.P.A.), is completely dedicated to the plant and is able to weather the numerous frustrations and problems of industry in this area. It is certainly a great credit to him that even with his limited experience, he has managed to keep the factory going. He also shows a great keeness to learn.

In 1974, a Hander type oil expelling unit was installed to produce crude coconut oil. This crude oil was packed in old bottles and marketed but was not a success. In March 1979, soap manufacture was started but sales were extremely poor for various reasons till February 1980. In September 1979, a refinery was installed to produce refined coconut oil for the manufacture of cooking oils and hair/body oils.

At this juncture (in March 1980), it was appropriate that expert help from UNIDO was forthcoming to enable them to lay down proper procedures and guidelines and to help them in solving their various problems.

N.B. All calculations based on PATS purchase price of copra of $370 per ton. From June 9th, 1980 the purchase price of copra will be $270 per ton. Hence, the profits (made only from March 1980) would increase from June 1980.

March 1980 can be considered the turning point of this plant as it has entered a new era of development and, for the first time in its history, has started showing profits from March 1980. This has created a sense of achievement and self-confidence in the management and work force which would lead them to greater heights.

The following is a table showing the production and sales from 1978.

	OIL		SOAP				
	Copra Expelled Tons	% Efficiency	Sales Tons	Production Tons	% Effic.	Hair/ Body Oil Sales Lbs.	Cooking Oil Sales Lbs.
1978	6.0	3	Nil	Nil	Nil	Nil	Nil
1979	52.0	23	15.63	21.68	21	1554	2145
Jan 1980	1.56	8	0.99	2.36	23	126	8
Feb 1980	6.00	32	6.69	3.66	35	913	130
Mar 1980	10.32	55	9.74	7.73	74	68	24
Apr 1980	11.0	58	7.73	7.79	74	Nil	Nil

Detailed notes and comments on the plant have been made so that the Manage-ment could understand their plant better and also to show the logical processes involved in problem-solving in a factory.

The major problems of the factory have been solved, the following being some of them:

a) in the Refinery, the oil could not be heated in the deodorizer to the required temperature of 350°F;

b) using up the mountain of accumulated scrap soap;

c) prevention of build-up of soap scrap;

d) determining bottlenecks;

e) reduction of labour;

f) changing to cheaper and better formulations.

Some Laboratory and Quality Control methods have been established, and some have to be done when the chemicals which have been ordered arrive.

At present, the expeller is the bottleneck in production and is only running at 58% efficiency mainly because of absenteeism (factory is virtually shut when a funeral takes place) and owing to lack of firewood. It has been suggested that the factory purchases an oil burner for the scorcher to be used in case firewood is short in supply and to consider purchase of crude oil from Majuro to build up oil stocks. If sales are extremely high and the capacity of the expeller is utilized, the factory could purchase another similar expeller.

Marketing and distribution has to be improved. Advertising on a small scale should be done.

Stock control procedures should be implemented so that unnecessary large stocks are not carried and also to prevent running out of stocks.

It is also suggested that the PATS administration appoints a person with whom the Manager of the plant could discuss his problems at least once a month so that he would get the necessary encouragement. This would also help the Manager a great deal as some form of accountability would be established. At present, it appears that the Manager is all by himself.

Finally, it can be concluded that this industry would be a very useful and profitable venture and all encouragement and help should be given by the Congress and Legislature (specially by raising import tariffs) and by agencies like the UNIDO.

PLANT

1. WEIGHING SCALES

The scale used for weighing the copra purchases was reading six pounds higher for each bag of about 100 lbs. As a result of this incorrect weighing, the factory would be paying 6% extra for the copra.

Assuming purchase of 2000 lbs./working day

Loss = \$22 per day

= \$440 per month

This was corrected, but weighing scales will have to be checked daily. The maintenance of the scales will have to be improved by regular oiling, etc.

2. EFFICIENCY OF OIL EXTRACTION

This was determined by weighing a quantity of copra and weighing the oil and copra cake produced.

Weight of 20 bags of copra = 1954 lbs.	
Weight of oil obtained = 1077.5 lbs. =	55.2%
Weight of copra cake obtained = 702 lbs. =	35.9%
Weight of residue in Filter Press = 25 lbs. =	1.3%
	92.4%

3. COPRA CRUSHER

Type Hander Seed Crusher Type SS

Driven by Yanmar T.S 50

Measured maximum rate = 100 lbs/5 mins. = 1200 lbs/hr.

= 4.8 short tons of copra/day

= 1100 short tons/annum (230 days/annum)

NOTES AND COMMENTS

1. The copra from the hopper of the crusher is being pushed in by hand as the copra is otherwise slow. This could be avoided by slightly increasing the incline of the hopper.

2. The pieces coming out of the chopper are at times as big as 1". This might be improved by overhauling the machine.

3. The water from the Hanmar engine is at present directed by a corrugated sheet into a bucket and the operator periodically empties the bucket with a tin. This is not only unnecessary but also unsafe as the water is about 60/70°C. A hose or a pipe could be fitted with a funnel if necessary to direct the water outside This should be done for all Yanmar engines.

4. COPRA SCORCHER - 2

Type Hander Seed Scorcher II

Vessel size = 600 mm depth x 1000 mm diam. H.P. - 2

Pulley: Diameter = 5"

Driven by Yanmar TS 80

Present Rates

Building fire = 1/2 hr; Load = 250 lbs.; Loading Time = 5 mins.

Time heated = 30 mins.; Temp. of Scorched Copra = 130°C/135°C

Rate = 250 lbs./35 mins.

= 2785 lbs/day (6 ½ hrs. day - ½ hr. start up & 1 hr. chopping time

= 1.4 short tons/day

= 322 short tons/annum

Hence, available capacity = 644 short tons copra/annum

Notes and Comments

1. The temperature of the copra is on the high side and could be reduced thereby improving the colour of the oil and the taste of the oil.

This should be done by <u>reducing the heat in the heater</u> rather than by reducing the time of heating. This would also result in saving firewood. Controlling the draught by means of a sliding plate may be helpful.

2. At the present rate of production only one scorcher is sufficient. When one scorcher is used, an appreciable amount of heat is dissipated to the next section. <u>This section could be isolated</u> in which case, the draught will have to be reduced. This would result in saving firewood.

3. The scorched copra is emptied into a wooden box and from the box it is shovelled into a wheelbarrow and the wheelbarrow is taken to the expeller. <u>This operation can be avoided by having two boxes on wheels</u>, one box when full can be wheeled to the expeller. The capacity of each box should be about 300 lbs. of chopped copra.

5. <u>OIL EXPELLER</u>

<u>Type</u>: Hander Oil Expeller = H-54

Dimension: 1230 x 700 x 700 H.P. = 7-½ - 10

Pulley : Diameter 12", RPM 600

Driven by Yanmar TS 180 (also drives Filter Press pump)

<u>Rates</u>

Temp. of Feed = 80/100°C; Temp. of oil/cake = 100/105°C

Av. rate of oil = 165 lbs./hr. (expeller hopper at times empty)

= 1075 lbs/day of oil (6-½ hrs. only per day)

= 0.98 tons of copra/day

= 123 tons of oil/annum

= 225 tons of copra/annum

Maximum Rate = 3.2 lbs/min of oil

= 190 lbs/hr of oil

= 1235 lbs/day of oil (6-½ hrs. per day)

= 1.12 tons of copra/day

= 142 tons/annum of oil

= 258 tons/annum of copra

Notes and Comments

1. The capacity of the expeller is the "bottleneck" in production of oil. Hence, the operation of the expeller and its efficiency has to be carefully watched. One operator has to be full time at the expeller. He could also look after the Filter Press as well.

2. At present, the expeller operator, while feeding the expeller, is continuously prodding the hopper with a stick as it is felt that this operation speeds the expelling, and is necessary. As a result, when he is doing other jobs, the expeller is starved of copra. It was proved that this is an unnecessary operation and does not increase the rate of expelling. This has resulted in not only saving labour but also got rid of a tiring job.

3. At present the operator empties the small container in which the cake is discharged into a drum. When the drum is full, he shovels the cake from the drum into bags with the assistance of another worker. This double handling can be avoided by having a simple bag holder (3 hooks on a rim with a stand) instead of the drum. The operator can empty the copra cake direct into the bag and when full, remove it and hook on another bag.

4. As this is the most critical plant in terms of capacity of crude oil production, a standby Yanmar engine must be available in the event of breakdown. In fact, on the day time study was done, the engine packed up and 2-½ hrs. were lost.

5. Starting up and shutting down times must be specified and adhered to. One hour has been left for start-up for (a) as scorched copra would be available only 1 hr. after starting work; (b) during one hour the operator can fit the expeller, clean filter press, etc.; (c) ½ hr. left at end of day for cleaning, etc.

6. FILTER PRESS

Type : Hander Filter Press Type A

Chamber Size & No. = 7" x 7" x 10 ½ H.P.

Pulley : Diameter 9", R.P.M. 170

Filtering Area 7.4 sq.ft.

Rates - varies depending on quantity of sediment in Press. The press can handle the sediment produced in a day's run of the expeller, and can be cleaned once a day.

Notes and Comments

1. The oil from the expeller contains an appreciable amount of sediment and presently flows into a container via a sieve (it incidentally needs repair/replacement). The operator at times have to clean the sieve. This operation was simplified by having a gunny bag over the sieve. This bag could now be removed, emptied and replaced easily. This also reduces the residue in the Filter Press.

2. At present, the same hose is used, by moving it, for filtering the crude oil and pumping the filtered oil into the tank. A seperate pump would be ideal but in any event, provision could be made for 2 different hoses and connections.

3. To minimize contamination and save time, the filter press could be raised to a higher level and a tank (instead of using small containers as at present) kept below for filtered oil. This tank could be pumped to storage only 2 or 3 times a day instead of 10 times as at present.

7. SOAP PACKING

Soap is removed from the moulds after about 20 hrs., slabbed, barred, billeted and stamped. All the above operations are done manually.

Determination of Scrap

Expt. 1	Expt. 1		Expt. 2		
	Lbs.	%	Lbs.	%	Av. %
Scrap from Slabb Cutter	59	6.6	40	9.7	8.2
Scrap from Bar Cutter	122	13.7	51.1	12.3	13.0
Scrap from Billet Cutter	12	1.4	3.8	0.9	1.2
Scrap from Rejected Billets	204	22.9	36.6	8.8	15.9
Total Scrap	397	44.6	131.5	31.7	38.3
Packed Soap	493	55.4	282.5	68.3	61.7
Total Wt. of Blocks	890	100.0	414	100.0	100.0

Notes and Comments

1. Scrap: The scrap produced (which is reprocessed) is extremely high. Scrap from slab, bar, and billet cutters is approx. 23%. The scrap from Rejected Tablets is approx. 16%. In addition to this scrap, once in a while, the whole batch of soap is rejected owing to the soap being bad or solidifying in the crutcher. The total scrap at present is more than 40%. Since the scrap being reprocessed is only about 25%, there is continuous build-up of scrap in the factory and is not only taking valuable space, but also making the factory dirty, untidy and unsafe. The accumulated scrap must be more than 6000 lbs.

   Hence, the major problem (understatement) in the soap packing section is the quantity of scrap produced and is literally producing a "mountainous" problem. The quantity of scrap produced is only just below the quantity of soap packed.

   Hence, the following two objectives have to be achieved immediately.

   A. Reduction of scrap produced.

   B. Increased usage of existing scrap.

A. Reduction of Scrap Produced

i. Slab Cutter: The scrap produced = 8.2% and is mainly due to the caving-in of the block in the mould. This could be slightly improved by vibrating or shaking the mould when the soap is filled, but the scrap is not abnormally high. A standard of 7% could be allowed.

Height of Slab = 5 cms. (Variation noted 4.9 cms. - 5.1cms)

ii. Bar Cutter: The scrap produced = 13% and is due to the fact that the side off-cuts are very wide and should be reduced. The slab is cut into 4 bars and 2 off-cuts. The width of each box = 6.4 cms. Hence, minimum width of slab should be 4 x 6.4 = 25.6 cms. Allowing 0.3 cms. of off-cut on each side, width of off-cuts = 26.2 cms. Hence, width of slab should be = 26.2 cms.

At present, width of slabs vary between 29 cms. - 30.0 cms. resulting in high scrap. If width of slab is reduced to 26.2 cms., the scrap from this source would drop from 13.0% to 2%. In order to achieve this, the width of the soap moulds should be immediately reduced to 26.2 cms. or, in the alternative, make a smaller tablet as well, with the off-cut and market it.

iii. Billet Cutter: The scrap produced = 1.2%. Length of each billet = 9.9 cms. Hence, length of each bar should be = 6 x 9.9 + 0.6 = 59.4 + 0.6 = 60 cms. Hence, length of mould should be equal to 60 cms. and at present the length is 60.0 cms

N.B.: The above is absed on the av. weight of soap produced = 10.85 ozs/billet. If billet weight is to be reduced, the above measurements have to be recalculated.

iv. Rejected Billets: The average scrap by rejected billets = 16%. This is caused by (a) Improper filling of the soap moulds; (b) not vey good soap manufactured. Both these would be improved as the Crutcher Operator gets more and more experience and is discussed under Soap Manufacture.

A standard of 8% can be considered at present and improved with experience to about 3%.

SUMMARY

Reduction of Scrap

	Source of Scrap	Present		Achievable		Action Required
		As % of Soap Produced	As % of Soap Packed	As % of Soap Produced	As % of Soap Packed	
1.	Slab Cutter	8.2	13.7	7.0	8.6	Improvement in filling.
2.	Bar Cutter	13.0	21.7	2.0	2.5	Reduce width of soap moulds from about 29.5cms. to 26.2cms. or market a smaller tablet as well.
3.	Billet Cutter	1.2	2.0	1.2	1.5	Good
4.	Rejected Billets	15.9	26.5	8.0	9.9	Improvement in filling.
5.	Other	1.7	2.8	0.8	1.0	Improvement in Soap manufacture.
	Total Scrap	40.0	66.7	19.0	23.5	
	Soap Packed	60.0	100.0	81.0	100.0	
	Soap Produced	100.0	166.7	100.0	123.5	

Hence, the factory could easily achieve the following standards of scrap immediately:

% of soap packed = 25%

% of soap produced= 20%

This would lead to a very appreciable reduction in the present cost of producing soap.

1. Variation in Weight

The average wt. of the billets packed = 10.85 ozs.

The variation in weight observed was between 10.5 ozs. to 11.85 ozs.

Hence, it will be noticed that difference from the Av. Wt. for :

Heaviest Billet = + 1 oz)
Difference = 1.35 ozs.
Lightest Billet = - 0.35 ozs)

In this method of cutting, there will be a wide variation. A difference of 1 oz. in the heaviest and lightest billet is allowable. Hence, with a little more care, this difference of 1.35 ozs. could be reduced to 1 oz.

N.B.: The above wights were taken on one day's production only.

2. Variation in Shape and Size

Apart from variation in weight, there is a variation in shape that the billets are at times cut crooked. This is due to the fact that the wires are not taut and straight and/or movement of the slabs or bars while cutting. This can be avoided by (a) having the wires taut and straight; (b) having the bars or slabs positioned correctly by striking a metal rather than by positioning them by eye.

8. SOAP MANUFACTURE

Soap is manufactured in a jacketed vessel with a screw type mixer. Thermal oil is heated in a separate vessel by firewood and circulated through the jacket.

<u>Time Cycle</u>

	Start	Finish	Time Taken Mins.
Pumping Coconut Oil	12.55	1.05	10
Idle time - waiting for firewood	1.05	1.25	20 *
Thermal oil heating	1.25		
Stirring - when coconut oil is 70°C	1.43		18
			1
Adding Scrap	1.44	2.00	16
Hitting with Pole	2.00	2.15	15
			9
Adding Caustic	2.24	2.26	2
Stirring with Pole	2.26	2.30	4
Thermal Oil stopped		2.30	
Stirring started	3.03		33
			8
Adding Silicate	3.11	3.12	1
			3
Adding Bluing	3.15	3.16	1
			8
Adding Citronella	3.24	3.25	1
			7
Opening Valve at bottom and fitting moulds	3.32	3.45	13
Stopped Stirrer		3.45	
Cleaning Valve	3.45	4.05	20
Total Time	12.55	4.05	190

Time actually taken was 190 mins. of which 20 mins. was idle time and time allowed to rest without stirring could be reduced by 20 mins., hence, time cycle could be 150 mins., i.e. 2 hrs. 30 mins. The operator can therefore make 2 batches of soap per day easily and this allows him time to make the fire, make caustic solution, clean his area, etc.

Soap Produced/Day = 2 batches = 2 x 850 = 1700 lbs/day

= 0.85 short tons/day

= 195 short tons/annum.

Capacity of Soap Manufacture

	Two Batches/Day	
	At 40% Scrap	At 20% Scrap
Soap Produced		
Short Tons/Day	0.85	0.85
Short Tons/Annum	195.0	195.0
Soap Packed		
Short Tons/Day	0.51	0.68
Cases/Day	25.0	33.4
Short Tons/Annum	117.0	156.0
Cases/Annum	5750	7680

Notes and Comments

1. Caustic System

At present, the caustic soda beads are weighed into buckets on the ground floor and taken up and dissolved upstairs in open ended drums by taking water also in buckets from the ground floor. The caustic is stirred in the drums and when the right strength is obtained, it is bucketed by hand into the crutcher by standing on a bench. While emptying, it tends to splash on gear, wheels, etc.

This whole procedure is most unsatisfactory in that not only quantities could vary but more important, it is most unsafe and laborious. In fact, the operator's hands have burns due to caustic splashes.

This whole process can be simplified by dissolving the caustic on the ground floor and pumping the caustic solution by means of a hand pump to a small overhead tank near the crutcher. This tank could be provided with an overflow pipe back to the drum so that a fixed predetermined quantity is always taken. The quantity of caustic solution is only about 250 lbs. This will make caustic dissolving and addition safer, cleaner and also more accurate.

2. Addition of Silicate.

At present sodium silicate and metasilicate is added. This is unnecessary and can be eliminated.

3. Addition of Citronella.

This addition could be reduced/eliminated as the imported laundry bars has no perfume at all. This would help to reduce cost.

4. Filling Moulds.

The moulds, while being filled, should be slightly shaken or vibrated to help the soap to settle. Perhaps a simple method might be to place it on rollers and shake slightly.

After filling, the moulds could be transferred by a roller conveyor to the place where they are left overnight unlike the present manual system.

5. Moulds.

The moulds are now made of metal and the sides welded. In order to facilitate removal, the moulds are 1/2" wider and longer on one end. This results in more scrap and since they are welded, the moulds are dropped on the ground and to remove them is a laborious process, Moulds with removable sides would eliminate all these problems.

6. Capacity.

The capacity on two (2) batches/day = 156 tons per annum of soap packed. This capacity can be increased by 50%, i.e. 235 tons per annum if another man is used for preparing caustic soda, making fire and relieving operator.

9. CAPACITIES

Capacities in short tons per annum

Basis: 1. 230 working days/annum

[52 x 5 = 260 - 10 holidays - 20 (for funerals, feasts, absenteeism) = 230]

2. 8 hr./day and time allowed for starting up, etc., when necessary.

3. 80% capacity utilization as repairs, etc., takes a long time.

	Copra per Annum	As Oil per Annum	Packed Soap per Annum
Copra Crusher	880	485	
Copra Scorcher	515	285	
Oil Expeller	180	100	155
Filter Press	400	220	
Soap Crutcher	145	80	125[1]
Soap Packing	320	178	275

N.B.: The highest quantity of copra used at PATS was in 1979 and that was 51 tons, i.e. only 23% capacity utilization.

[1] The capacity can be increased to 190 tons of soap by having an extra man for preparing caustic soda, making fire, etc.

COST ANALYSIS FOR CRUDE COCONUT OIL FOR A DAY'S PRODUCTION USED AT PATS PLANT IN MARCH, 1980

	Cost in Dollars	Clarification Obtained
Copra 1552.5 lbs. @ .185 /lb.	287.21	This is based on a 59% extraction efficiency.
Labour	27.80	1 man @ $10 + 2 men @ $6.40 and indirect labour @$5.00
Fuel	12.40	10 gals. diesel @ $1.24 per gal.
Insurance	3.50	Not paid now but estimated at $3.50 per day.
Depreciation	8.00	Building $80/month (Total cost $17,000) Plant $70.67/month (Total cost $ 8,500)
Spare Parts	5.00	Estimated.
Contingencies	10.00	
Total Cost for 912 lbs. (120 gals.)	353.91	
Cost per gallon	2.95	
Cost per lb.	.39	

Notes and Comments

1. Costing based on a day's production of oil can lead to incorrect cost as this might bear no relation to actual cost over a period of time as the production quantity would be overstated in this case and would not give the actual picture; further actual costs could never be compared with standard.

It would be better to prepare a costing on a yearly estimate to arrive at the Unit Cost and then, compare it with actual cost monthly.

2. Copra - 59% extraction efficiency used for costing while the actual efficiency is only 55%.

3. Administrative Overheads - No administration expenses have been charged.

4. Interest. No interest capital is charged because the capital has been provided free (grants). For costing, it might be best to charge it in order to get a realistic picture and discount it later.

5. Copra Cake Credit. No credit has been given for sale of copra cake.

6. Contingencies. This is inappropriate in a costing. Contingency is allowed for in a Project proposal to allow for possible variations in estimates.

COST ANALYSIS OF CRUDE OIL AT PATS IN MARCH, 1980

Basis: Production of 100 tons of oil per annum.

Efficiency of extraction = 55%, hence, copra/annum = 182 tons.

1 U.S. Gallon = 7.6 lbs. of oil.

	Cost	Basis
Copra	67340	182 tons @ $370/ton
Fuel	2850	12.5 gals/ton copra; $1.25/gal.
Labour	7620	1 man @ $2500, 2 men @ $1600 per annum Indirect Labour - 60% of 2 men @ $1600/annum.
Sapres & Maintenance	1200	$100 per month.
Insurance	840	$70 per month.
Depreciation		
Plant	850	Cost of Plant = $8500 for 10 years
Building	570	Cost of Building = $17,000 for 15 years Apportion 50%.
Interest	2040	At 12% per annum for $17,000.
Administration O/H		
Manager + Clerk(1/3)	2715	$5000/year for Manager, $3145 for Clerk/Tester/Salesman and apportion 1/3 for oil production.
Office Expenses	240	
Marketing Expenses		Nil
Total Cost/100 tons	86265	
Less Cake Credit	6550	Cake obtained = 36%. Selling price of cake = $100/ton.
Cost/100 tons	79715	

Hence Cost Per Ton = $798

Cost Per Pound = $0.40

Cost Per Gallon = $3.04

Variable Expenses = $64840/100 tons of oil

= $6484/ton of oil

Fixed Expenses = $14875

Production of Oil Tons/Annum	Cost Per Ton	Cost Per Lb.	Cost Per U.S. Gal.
100 tons	$ 798	$ 0.40	$ 3.04
50 tons	946	0.473	3.60
25 tons	1244	0.622	4.73

COST ANALYSIS FOR SOAP FOR A DAY'S PRODUCTION

USED AT PATS PLANT IN MARCH, 1980

	Cost	Clarification Obtained
Crude Oil	177.00	60 gals. (456 lbs.) @ $2.95 per gal.
Caustic Soda	32.25	75 lbs. Caustic Soda @ $0.43 per lb. Total Weight of solution added at 31.3% (37^{o}Be) = 240 lbs.
Sodium Silicate	8.25	25 lbs. at $0.33 per lb.
Sodium Metasilicate	5.70	15 lbs. at $0.38 per lb.
Citronella	3.75	500 ml. @ $.0075 per ml.
Bluing	1.59	200gms. @ $0.00795 per gm.
Fuel	6.20	5 gals. @ $1.24 per gal.
Boxes	11.25	15 boxes @ $0.75 per box.
Labour	30.60	4 men @ $6.40 per day Indirect Labour of $5.00 per day.
Depreciation	2.00	Cost of Plant = $10794
		Monthly Depr. = $52.67
Admin. Overheads	16.00	
Spare Parts	1.00	
Contingencies	5.00	
Cost for 850 Bars (850 bars = 576 lbs.)	300.50	

Hence, Cost per bar = $0.36, Price ex factory = $0.40, Profit = $0.0004

Cost per lb. = $0.52, Cost per oz. = $0.033

Notes and Comments

1. Costing based on days production. This system of costing can lead to errors. Contingency not appropriate.

2. No Interest accounted for.

3. Depreciation - none for buildings.

4. The soap produced with these ingredients would produce about 735 lbs. of soap but soap packed is only 576 lbs. Hence, this does not take into account the difference. Hence, cost is overstated.

5. Marketing Expenses - not taken into account.

COST ANALYSIS OF SOAP PACKED AT PATS

Basis: Production of 100 tons packed soap = 4916 cases/annum.

5% losses allowed for all materials.

Crude Oil	51950	Cost/ton of oil = \$798; TFM = 62% in soap.
Caustic Soda	9211	10.2% NaOH in soap; Price \$0.43 per lb.
Sodium Silicate	2356	3.4% Silicate in soap; Price \$0.33 per lb.
Sodium Metasilicate	1596	2.0% Metasilicate in soap; Price \$0.38 per lb.
Citronella	879	0.135% Citronella in soap; Price \$3.10 per lb.
Bluing	455	0.06% bluing in soap; Price \$3.61 per lb.
Fuel	2100	16 gals/ton of soap; Price \$1.25 per gal.
Boxes	3871	40.69 lbs. of soap/case; Price \$0.75 per case
Labour	8100	1 man at \$2500/annum, 3 men at \$1600 Indirect Labour - 25% of 2 men at \$1600.
Spares & Maintenance	1200	
Depreciation: Plant	1080	Cost of Plant = \$10,800
Building	397	Cost of Building = \$17,000 for 15 years Apportion 35%
Interest	2010	12% per annum for \$16750

Administration	2715	$5000/annum for Manager, $3145 for Clerk/ Tester. Apportion 1/3 for soap.
Office/Lab Expenses	240	
Marketing & Distribution Expenses	840	High, because of transport of soap.
Cost/100 Tons	89000	

Hence, Cost of Packed Soap = $89,000/100 Tons

= $890 per ton

= $18.1 per case

= $0.302 per box.

Variable Expenses = Cost of Materials + Spares + Marketing Expenses

= $74458/100 tons

= $744.58/ton

Fixed Expenses = $14542/100 tons

Packed Soap Tons / Annum	Cost Per Ton	Cost Per Ton	Cost Per Ton
125	$ 861	$17.52	$0.292
100	890	18.11	0.302
75	938.5	19.09	0.318
50	1035.4	21.06	0.351

1 Bar = 10.85 ozs.

1 Case = 60 bars
= 40.69 lbs.

1 Ton = 49.16 cases

THE REFINERY

The production of refined coconut oil is done in the Refinery and consists of two processes - Neutralizing/Bleaching and Deodorizing. Both processes are done batchwise in 1-1/4 ton vessels.

In order to carry out the above processes, the refinery has the following systems: Steam Generator, Vacuum System and Heating System. The whole refinery had been designed and supplied by "OPTIMA SCIENTIFIC CONSULTANTS INC., PHILIPPINES."

1. Neutralizing/Bleaching

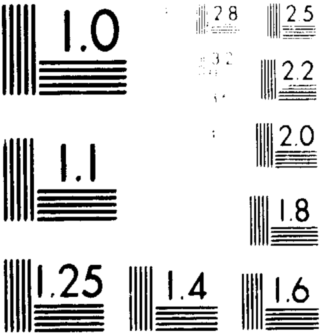
This operation involves heating the oil to 140°F by circulating hot thermal oil in the vessel jacket, neutralizing the F.F.A. in the oil by adding dilute caustic solution, draining the soap stock, removing the remaining soap in the oil by two water washes, heating the oil under vacuum to 210°F to remove moisture, adding bleaching earth for bleaching and then filter through a filter press.

Notes and Comments:

1.1 Heating the oil takes a long time and could be reduced. See comments on Heating System.

1.2 At present, addition of dilute caustic is immediately followed by addition of brine solution as well. This addition of brine is unnecessary and should be omitted. A brine wash would have to be done after the caustic wash only if the operator has emulsified the batch due to bad operation.

1.3 At present, for bleaching both bleaching earth and activated carbon are added. This is unnecessary as the colour of the crude coconut oil is very good and further, a slight golden colour of the final cooking/ hair body oil is desirable, as such neutral earth (5 lbs. per batch)



MICROCOPY RESOLUTION TEST CHART

only should be added, not for bleaching purposes, but for the purpose of polishing the oil and removing traces of soap in the oil.

1.4 From the filter press, the initial oil would not be clear, but this oil is also pumped to the deodorizer and is undesirable. A return line should be fitted so that the initial oil is fed back to the neutralizer and when the oil is clear, it could be directed to the deodorizer.

1.5 Presently, the caustic and water additions are done through the manhole on the top as the valve of the addition unit is stuck. It is better to add the caustic and water through this unit as the rate of addition would be constant. Further, at present addition through this unit necessitates the operator to stand up on the neutralizer which is unsafe as such a platform should be made.

1.6 The soap stock and water washes should be collected in a drum and small quantities added in each batch when making soap. This eliminates oil and caustic losses.

1.7 The neutralizer has no cooling system which is unfortunate as now the oil can not be cooled before filtering. Hence, care should be taken not to heat the oil above 210^{o}F.

1.8 Presently, the crude coconut oil is pumped from the storage tank to a measuring tank and then pumped to the Neutralizer. Pumping to the measuring tank is unnecessary as the oil can be pumped directly from the storage tank to the Neutralizer to a fixed level in the Neutralizer.

1.9 Neutralizing Time Cycle

	Time Mins.
1. Pump oil and heat to 140^{o}F with stirrer on[1]	120
2. Add dilute caustic while stirring	4
3. Stop stirrer	-
4. Settle	45

5.	Drain soap stock slowly	15
6.	Add water with stirring	4
7.	Stop stirrer	-
8.	Settle	30
9.	Drain 1st water wash	15
10.	Add water with stirring	4
11.	Stop stirrer	-
12.	Settle	45
13.	Drain 2nd water wash	15
14.	Heat oil to $210^{\circ}F$ with stirrer on and under vacuum[1]	100
15.	Add 5 lbs. neutral earth	3
16.	Continue stirring	10
17.	Filter oil	40
	Total Time Taken	450

[1] The total heating time is 220 mins. This can be reduced by at least 30 minutes. See Heating System.

Total time taken is 450 mins., i.e. 7-½ hrs. Hence, one batch of crude oil (2250 lbs.) can be refined in an 8-hour day.

2. **Heating System**

The Heating System employed in the factory is to circulate heated thermal oil (Mobiltherm) in the jackets or in the coils. The thermal oil is heated in a tank by means of firewood and the hot oil is circulated by means of a water cooled pump.

The rate of heating obviously depends on the quantity of wood fed and the type of wood used. Hence, in the case of neutralizing and deodorizing, the time taken largely depends on the rate of heating the thermal oil and the subsequent heat losses.

If rate of heating is to be improved in the future, the following could be considered:

a. Improve the type of fuel - coconut shells, oil burner.

b. Increase the size of hearth underneath the tank to accommodate more firewood.

c. Install an oil-fired boiler instead of the present thermal oil heating system. The specifications of the boiler needed would be one with an operating pressure of 200 p.s.i. and about 1000 lbs. of steam per hour.

At present, since the refined oil tonnage is low and their main problem on deodorization has been solved (See Deodorizer) (b) or (c) can be considered at a later stage.

As regards heat losses, much improvement can be made immediately at very little cost. The insulation on all vessels and pipelines are grossly inadequate in that the outside temperature of the insulation is at times higher than 200°F. The insulation at present is only about 1/4" thick of asbestos; this insulation (which is available) should be increased to a thickness of 1-1/2" at least on all vessels and pipelines. It is estimated that the increased insulation would save about 15/20% of the total heat, thereby, reducing the cost on firewood and also reducing the time cycle of the operations. If glass wool coulb be obtained, this obviously would be a better insulator.

This insulation should be undertaken as an urgent priority.

3. Vacuum System

The vacuum system comprises of a vacuum pump and a barometric condenser.

The system is working quite satisfactorily in that good vacuum are obtained both in the Neutralizer and in the Deodorizer.

It should be noted that machinery tend to get "stuck" if not used for a long period. This is particularly true of the vacuum pump, hence, it should be oiled and run periodically at least for a few minutes.

4. Steam Generator

The steam required for the deodorizer is generated by heating water in a cylindrical pressure vessel by circulating the hot thermal oil in coils.

The equipment is very simple in design and is working quite satisfactorily.

5. Deodorizer

The deodorizing operation involves heating the neutralized coconut oil under vacuum to a temperature of 350^{o}F. Direct steam from the steam generator is then injected through the oil for three hours and under these conditions, all odoriferous substances are stripped or removed from the oil. Throughout the deodorization process, the equipment is maintained under vacuum otherwise the oil is liable to get burnt and also have a burnt flavor.

After the three hours, direct steam is shut off and the oil cooled under vacuum to a temperature of 180^{o}F by circulating water through the jacket. Normally, this deodorized oil could then be pumped to the storage tank. But unfortunately in this factory, as the deodorizing is only done intermittently, the oil could have fine particles of rust, etc. as such it has to be filtered before storage.

The oil should now have a blant taste and be ready for filling in bottles.

Notes and Comments:

5.1 The [illegible] been [illegible] in the refinery from the [illegible] it [illegible] installed. [illegible], heating the oil to 350°F took a very long time and hence, the deodorizing cycle time was a minimum of 15 hours. At time, the heating had to be stopped and re-started again the next day.

On the first day of observation, it was noticed that heating the oil to about 250°F was comparatively short but after that, the temperature of the oil virtually refused to rise above 300°F even after 4 hours of intensive heating. On a detailed investigation, it was noticed that steam was issuing out from the jacketed water outlet pipe leading to the drain. Here was the "mysterious" reason for the long and tedious deodorizing time!

What happened was:

a. The jacket was full of water. After cooling the Deodorizer, the water inlet of the jacket (at the bottom) is shut while the water outlet at the top is open. When starting this deodorizer again, this jacket is still full of water - approx. 500 lbs. of wate.

b. On heating the oil by circulating thermal oil in coils within the vessel, this water is also heated and when the boiling point of water is reached about 212°F further increase of temperature would be possible only after all the water in the jacket is converted to steam - 500 lbs. Hence, the reason for the refusal to rise in temperature. The jacket was a miniature boiler using up all the heat supplied. To convert all this water to steam, you will need about 550,000 BTU. This quantity of heat is about double the quantity of heat required for the complete deodorizing process.

c. On installation of the plant no provision has been made for draining this water from the jacket. This has to be rectified immediately. Temporarily for the next run, the union on the water line was disconnected to drain out the water from the jacket.

d. This draining of the water in the jacket reduced the deodorizing cycle from 15 hours to 7-3/4 hours. This not only reduced costs considerably and also prevented any unncessary capital investment on alternative heating system. More important perhaps is the morale boosting of the men who dreaded the day when deodorizing was to be done.

5.2 The deodorized oil is now pumped and filtered through the same equipment used for nuetralized oil which causes contamination. The ideal situation would be to have a separate pump and filter press for the deodorized oil.

5.3 Deodorizing Cycle

	Time Hrs.
Heat oil under vacuum to 350°F	4-1/2
Inject steam and maintain temperature at 350°F	2-1/2
Cool oil to 180°F	1/4
Filter	1/2
	7 3/4

6. General

6.1 Machinery maintenance, cleanliness, tidiness and safety consciousness is lacking as industry is alien in the Territory.

7. **Capacity** of Refinery

If the refinery is run continuously and allowing 200 working days per annum, on the present system of running the Neutraliser one day and the Deodorizer one day, the capacity of the plant is 100 tons per annum on and 8-hour day basis.

This capacity of the plant can be doubled to 200 tons per annum by using the intermediate storage tank for neutralized oil and running the neutralizer and deodorizer on the same day. This could mean that an oil burner might have to be used to heat the thermal oil as the rate of heat input by firewood might be insufficient. This would have to be tried if the necessity arises, which is very doubtful.

8. Thermal Oil - Mobiltherm

Mobiltherm is now used in heating the coconut oil by circulating the Mobiltherm in the jacket or coils. At some time or other, there is a possibility of a leak occurring, in which event the coconut oil could be contaminated with the Mobiltherm, and should be noticed as the colour of Mobiltherm is very dark in colour.

In the event that accidentally this leak is not noticed, the refined coconut oil to the consumer could be contaminated with traces of Mobiltherm. The question therefore arises whether this would be harmful in any way. An inquiry as regards this has been sent to Mobil Oil Co. and an answer is awaited. If there is no harmful effect, then no problem exists.

If there could be harmful effects, then a serious problem exists and the thermal oil heating system would have to be scrapped immediately and an oil-fired boiler (200 p.s.i. and producing 1000 lbs. of steam per hour) installed.

Probably there would be no harmful effects as it is difficult to imagine that this problem would have been overlooked by the designers of the equipment.

MARKETING DISTRIBUTION

1. The plant is situated at PATS which at present is accessible only by boat and no communication by telephone is possible. There are no regular checks as regards stocks held by wholesalers or retailers. On a day's tour of the market, it was found that wholesalers sometimes run out of stock of the products, but find it too difficult to contact the factory and purchases are made on chance contacts with the Manager.

   This method of distribution is very unsatisfactory and would suggest that initially:

   a. A person from the factory visits the wholesalers (only about 7 or 8) twice a month, at least once a month, and pays random visits to retailers in the town as well, and book orders and promote sales. This should be done systematically and not on an ad-hoc basis.
   b. On his visits, he should look at competitive brands, and note prices, pack size, colour, method of packaging, appearance on shelf, consumer complaints, etc. and compare with the local product. If necessary, a competitive brand should be purchased for study in the factory. This type of market information is completely lacking. I would further suggest that the factory office has a few samples of the competitive products for purposes of comparison.
   c. On his visits, he could be given a few simple advertising material (xeroxed) to be given to the shops for their information and display.
   d. Records of sales to wholesalers be maintained on a card (per wholesaler) to study their pattern of purchase for purpose of planning. This statistical information is completely lacking.

   The above can be done by one person going around the town once a month.

All valves, gears, etc. should be oiled/greased at least once a month. Idle machinery should be "turned over" and run for a few minutes periodically.

Oiling and cleanliness of machines and surrounding area should be the responsibility of each operator and not on a General Cleaner, so that the operator has a sense of accountability and responsibility. This must be emphasize and supervised by the Manager.

6.2 When refinery is to be run, better planning and preparation must be done, for which one day before start-up should be set apart. Some of the items to be done on this day are:

a. Ensure adequate stock of firewood/coconut shells

b. Check run all machines like vacuum system, stirrer, etc.

c. Pump oil into Neutralizer.

d. Get ready caustic solution and water required in clean containers.

e. Get drum, etc. ready for soap stock and water washes.

f. Drain water from deodorizer jacket.

g. Have spare belts ready in case of breakdowns.

h. Check all vessels like Neutralizer, Deodorizer, Steam Generator, Heating System, Storage Tanks.

i. Clean and get ready filter press.

6.3 The whole factory (Soapery, Oil Mill and Refinery) and surroundings would need a "face lift". A drain right round the factory is necessary to run out the wash water and process water instead of making a muddy mess. A washing area for utensils should be made. The pipelines, etc. should be painted in different colours to indicate oil, water, etc. Factory roof leaks to be repaired.

ANNEX I

QUALITY CONTROL OPERATIONS, FORMULATION AND MANUFACTURING PROCEDURES OF DIFFERENT COCONUT BASED PRODUCTS AND THE STANDARD CHEMISTRY APPLIED THEREIN

The views expressed in the Annex I mainly refer to the Ponape Agriculture and Trade School (PATS).

SUMMARY AND CONCLUSIONS

This report refers mainly to the plant at PONAPE AGRICULTURE AND TRADE SCHOOL (PATS). In other places TRUK and YAP laboratory demonstrations were held to show the manufacture of soap from coconut oil and samples of coconut oil based toiled soap and shampoo made on a laboratory scale were submitted for assessment.

The plant at PATS manufactures laundry soap, cooking oil and an oil for body and hair applications marketed under the brand name MAREKEISO. All products are manufatured from coconut oil (CNO).

CURRENT PRODUCTS

In the manufacture of laundry soap, a high percentage of scrap soap (about 40% of the soap manufactured) resulting from off-cuts during slabbing, barring and billeting operations, is produced with every batch of soap manufactured. As only 15-18% of this scrap soap is recycled, the balance accumulates and about 6000lbs of soap has been put aside as unusable. A process has been developed to use 57-60% of the scrap soap for recycling so that there won't be a build up of scrap soap. Of the unusable scrap soap 3000lbs of soap has already been recycled and the balance will be used up soon. New moulds will be made to cut down the scrap soap produced as off cuts in slabbing, barring and billeting operations.

Consumer complaints on laundry soap are that the soap is soft and wastes faster than the imported soap. The soft texture of the soap has been improved by eliminating silicates from formulation and reducing the free oil content in the product from about 10% to about 3%. Regarding the complaint of wasting faster, it has been proved by laboratory tests that CNO soap dissolve faster and produce more lather than imported soap. Laboratory tests indicate, that the proportions of the solubility and lather forming in the imported and local soap compensate one other. As such, there is no difference in the wasting of soap between the local and imported soap.

The quality of cooking oil and MAREKEISO is quite satisfactory. These two products are made from refined deodorized CNO. The time cycle for deodorizing CNO has been reduced by 50% (please refer Project Manager's report - time cycle now is 7 1/2 hrs) and this shall make a further improvement in the quality of these products, especially the cooking oil.

NEW PRODUCTS

Two new products based on CNO have been made on laboratory scale and samples submitted for assessment.

The products are 63% TFM toilet soap and a coconut oil soap based shampoo - the imported ingredients in these two products are 12% and 8% respectively. The packaging materials for both products are imported. Formulations and process of manufacture are given in this report. The equipment for the manufacture of these products are available in the factory.

There is a strong possibility of making tooth powder a viable project in this area. As such, a recipe and the process of manufacture of tooth powder have been included in this report. The equipment to manufacture this product is a small mixing vessel. All ingredients for this product will have to be imported.

PRODUCT AND PROCESS CONTROL

Quality control procedures have been formulated with weight control charts.

Analytical standards have been laid down for all products. Testing procedures, basic priniciples of chemistry with regard to the various products and manufacturing procedures have been discussed and included in this report.

TRAINING PERSONNEL

The manufacture of products is done according to given laid down procedures and there is a lack of technical knowledge to adapt to changing conditions and carry out simple development work to make improvements or even to maintain the existing quality.

The manager of PATS plant is virtually doing everything ' as no one else suitable for training could be selected immediately, the manager underwent the training on basic controls and their applications in this industry. The manager of PATS plant is also the chairman of the MICRONESIAN COCONUT PROCESSING AUTHORITY (MCPA).

With the limited time available and with hardly any technical knowledge in the field of scientific controls of the various procedures, I must say, that the manager has made a very good effort to go through the quality control procedures, study the elementary principles of chemical reactions and carry out tests. However, the involvements of the various processes of manufacture to changing conditions and the physical and chemical properties of raw materials have not been clearly understood. This is very important in any industry in order to make valuable contributions to run the industry efficiently.

RECOMMENDATIONS

Further training of the personnel in the understanding and application of the physical and chemical tests, quality control procedures, in relation to productivity, and interpretation of results to make a positive approach to solving problems is imperative.

It is my view that in addition to training the manager, another suitable person has also to be trained. This is essential as the manager should spend his time more on administrative functions, setting up targets for production, simplify processes, make the factory environment a safe place to work etc, than in carrying out tests and quality control procedures.

MANUFACTURE OF LAUNDRY SOAP

At PATS soap factory, a very high percentage of scrap soap is produced in the manufacture of laundry soap. This percentage is approximately 40 and the main scrap comes from the large off cuts produced at the barring stage. This may be reduced by changing the moulds to give slabs to have an off cut of 0.3 cms on either side.

As a result of the above high percentage of scrap, about 6000lbs of soap has accumulated and this has been put aside as unusable. In addition to this, 40% of the soap produced comes off as scrap soap daily and only a part of it (about 18%) is recycled.

A process has now been developed to use about 57% of the scrap soap in the manufacture of laundry soap. As a result of this, 18% of the old scrap set aside as unusable is being used up every day when soap is manufactured. Already about 3000lbs of the old scrap has been used up.

PROCESS

242lbs coconut oil is taken into the crutcher and heated to 80 °C. About 500lbs of the scrap soap (the big pieces are cut into smaller pieces to facilitate easy mixing) are added to the hot oil and is mixed for about 45 minutes to one hour. One or two buckets of water (about 30lbs) are added during the mixing. The water helps the soap and oil to mix uniformaly. However, water is added only if necessary. When the soap/oil mixture has formed a uniform mass, sodium hydroxide solution (37 °Be) is added. Heating is stopped when the sodium hydroxide solution is added.

After complete saponification, the saponified soap is tested with phenolphthalein to ensure that there is no free caustic. The saponified soap will have a free oil of about 2%. Stirring is stopped and the saponified soap is left in the crutcher for 30 minutes. Then stirring is started and perfume and color are added to the soap. After complete mixing (about 15-20 minutes) the soap is emptied into moulds and allowed to solidify at room temperature. Following day the blocks of soap are slabbed, barred, billetted and packed into boxes.

CRUTCHER COMPOSITION

	lbs	
COCONUT OIL (3'4" ex top)	242	
SODIUM HYDROXIDE SOLUTION (37 ^{o}Be) - 2 1/2 buckets	138	
SCRAP SOAP (31 buckets)	496	
WATER (added if necessary)	30	
COLORING MATERIAL		200g
CITRONELLA OIL		250ml

When all the old scrap is finished, the scrap percentage in the crutcher composition will be less and this will be balanced with coconut oil. In order to take the exact quantity of oil required for saponification, the calibration of the crutcher for coconut oil at room temperature is given below.

CRUTCHER - CALIBRATION FOR CNO AT ROOM TEMPERATURE

Ex Bottom 51"

1" = 22lbs CNO

The present CNO intake with 496lbs scrap soap

= 242lbs = 11" = 51"-11" ex top

= 40" ex top

= 3'4" ex top

MANUFACTURE OF 63% TFM TOILET SOAP

Toilet Soap. Toilet soap normally refers to 78-80% TFM soap. This soap is manufactured from 63% TFM soap base. The 63% TFM soap base goes through different processes like cooling, drying, mixing, milling, plodding, and finishing.

In small factories the cooling and drying are done as follows: The molten soap is cooled into framed blocks. The blocks are cut into bars and chipped into thin flakes by a flaking machine. The flakes are then dried in tray driers.

In big factories, the processes of cooling and drying are different. The 63% TFM molten soap is fed to the surface of a steel chilling roll equipped with a small spreading roll. The hot soap forms a thin solid layer on the rotating surface of the chilling roll and is removed in the form of ribbons by a scraper blade. The ribbons are then fed to an enclosed air drier wherein the rate of feeding of ribbons, the temperature of drying and the amount of hot air are controlled so that when the ribbons come out, their moisture content will have dropped down to about 15%. The hot ribbons are cooled and conveyed to storage bins.

From the storage bins, the ribbons are taken into mixers. Here, color, perfume and other additives are added and uniformly mixed with the soap and the mixture is then fed to a set of milling rolls. The milling set consists of three or more heavy rolls which are carefully aligned for the clearance between each of them. A four-roll unit forms three pairs of rotating rolls in succession. The soap mixture when fed to the unit is pulled in between the 1st pair of rolls in a downward direction, then upwards between the 2nd pair and again downwards between the 3rd pair. It is finally scraped off the 4th roll by a scraper blade. The soap is thus subjected to a good deal of grinding and shearing action under considerable pressure. The milled soap thus attains the desired texture and uniformity so necessary in a toilet soap.

The soap from the milling rolls goes to plodders. The plodder is similar to a mincing machine. Inside the plodder, the soap is pushed through a face plate containing a number of small holes into a cone. The soap comes out of the perforated plate in the form of small rods and is then further compressed towards the narrow end of the cone. This end is closed with a removable plate which has a central opening of the desired cross-section of the tablet. The soap issues out through this opening in the form of a continuous bar which slides on small roller guides and is then cut into small pieces.

Due to the compression of soap during its passage through the plodder, considerable heat is generated. Therefore, the cylindrical portion of the plodder is jacketed and water is passed through it to keep down the temperature of the soap. On the other hand, the mouthpiece through which the soap is extended is kept warm. This warming imparts a gloss to the surface of the extended soap bar.

Final cutting of the bar into cakes and stamping and wrapping of the cakes are all done by automatic machines in a continuous manner.

Comments. The processes described above, involve heavy capital investment, and good quality control systems at various stages of manufacture.

In the alternative a 63% TFM toilet soap may be manufactured by a process identical to the manufacture of laundry soap. This soap may be produced at "PATS", using 100% coconut oil in the plant used to manufacture the laundry soap.

The 63% TFM toilet soap produced from coconut oil is very hard and brittle, produces quick foam, and cleans well in cold and warm water. Samples of toilet soap (63% TFM) made on a laboratory scale have been distributed to various people at PATS, Truk and Yap.

MANUFACTURE OF 63% TFM TOILET SOAP

The process of manufacture is the same as for laundry soap. The crutcher is cleaned well to eliminate contamination of laundry soap.

Coconut oil is taken into the crutcher and heated to 80^{o}C. Heating is stopped at 80^{o}C. Sodium hydroxide solution (37^{o}Be) is added slowly to saponify the oil. The saponified mixture will contain about 2% free oil. The mixture is tested with phenolphthalein to ensure that there is no free alkali in the soap.

After complete saponification, the ingredients listed in the product formulation are added. After all the ingredients have been added, the soap is mixed for 20 minutes and emptied into moulds and left to solidify at room temperature. The following day the soap is barred, billetted, wrapped and packed into boxes.

The off-cuts obtained from barring and billeting and any rejected toilet soap may be recycled into fresh toilet soap. The process of using the toilet scrap soap is the same as for laundry soap.

1. SAPONIFYING CHARGE

	%
COCONUT OIL	64
SODIUM HYDROXIDE SOLUTION	36
(37 Be)	100

The saponified soap will have a total fatty acid content (TFM) of 64%.

2. PRODUCT FORMULATION

	%
SOAP at 64% TFM	98.269
PERFUME	1.000
COLORING MATERIAL	0.001
MAGNESIUM SULPHATE (50% solution in water)	0.150
NEUTRAL SODIUM SILICATE 57^{o} TW	0.450
NERVANAID B30 (1:1 solution in water)	0.130
	100.000

INGREDIENTS for 100lbs of PRODUCT

	lbs
COCONUT OIL	62.890
SODIUM HYDROXIDE (solid)	10.620
PERFUME	1.000
COLORING MATERIAL	0.001
MAGNESIUM SULPHATE (solid)	0.075
NEUTRAL SODIUM SILICATE	0.450
NERVANAID B30 (undiluted)	0.065
WATER	24.899
	100.000

SOAP-BASE SHAMPOO FROM COCONUT OIL

The main function of a shampoo is to cleanse the hair, and leave it soft, lustrous and manageable after the soap has been washed away. Out of this function arises other properties such as ease of application, copious lather, easy rinsability, and tolerance to hard water.

Soap base shampoo performs quite satisfactorily as regards the main function of a shampoo. As regards the other properties of the shampoo, these properties can be obtained to a great degree by incorporating special additives in the formulation.

Soap base shampoos are clear liquid shampoos and are essentially solutions of potasium soap of coconut oil falty acid. Potasium soap is termed soft soap and is much more soluble in water than sodium soap.

Manufacture. The manufacture of soap base shampoo from coconut oil may be divided into three processes.

1. Manufacture of soft soap.
2. Manufacture of liquid shampoo.
3. * Winterization of liquid shampoo.

* Winterization is not absolutely necessary. This process is done to obtain an absolutely clear and sparkling product.

1. Manufacture of soft soap

The soft soap is manufactured by reacting oil with a solution of caustic potash. This reaction is termed saponification which refers to reaction of an oil or fat with caustic soda or potash.

Refined deodorized coconut oil is heated to 80 ^{o}C in a mixing vessel made of stainless steel. At 80 ^{o}C the heating is stopped and potasium hydroxide solution is added slowly. The free alkali of the saponified soap is controlled to 0.01-0.02%.

	%
Refined Deodorized Coconut Oil	60
Potasium Hydroxide solution (70 ^{o}TW - 37%)	40
	100

The soft soap made from the above process will have a total fatty acid content (TFM) of 60%.

2. Manufacture of liquid shampoo

The soft soap at 60% TFM is dissolved in water to get a TFM of 25% (Quantity of water to be added is 1.4 times the weight of soap). The ingredients listed in the product formulation are then added to the 25% solution of soap and dissolved by slow mixing.

Product formulation

	%
Soap solution at 25% TFM	98.447
PERFUME	1.000
Coloring material	0.003
FORMALIN	0.050
NERVANAID B30	0.500
	100.000

3. Winterization

The product (liquid shampoo) is cooled to a temperature of 18-20 ^{o}C and maintained at this temperature for 36 hours. The liquid shampoo is then filtered to obtain an absolutely clear, sparkling product.

Ingredients for 100lbs of liquid shampoo

	lbs
REFINED DEODORIZED COCONUT OIL	24.612
POTASIUM HYDROXIDE (solid)	6.070
PERFUME	1.000
COLORING MATERIAL	0.003
FORMALIN	0.050
NERVANAID B30	0.500
WATER	67.765
	100.000

TOOTHPOWDER

Toothpowder meets the basic needs of cleaning teeth, preventing tooth decay, avoiding gum disorders and making breath pure. Toothpowder is used in preference to toothpaste for economic reasons.

The manufacture of toothpowder is simple. All ingredients may be mixed together in a vessel and packed into suitable containers which are usually paper sachets, polythene/paper sachets, tin and plastic containers with screw caps. The pack usually contains 15-20 grams.

PRODUCT FORMULATION

	%
DICALCIUM PHOSPHATE or PRECIPITATED CALCIUM CARBONATE	93.8
EMPICOL LZ - SODIUM LAURYL SULPHATE	5.0
SACCHARIN	0.2
FLAVOR	1.0
	100.0

REFINING OF COCONUT OIL

Fatty acids can split off from triglycerides by enzymic action in the presence of moisture. They are then called free fatty acids.

Refining of coconut oil refers to neutralizing the oil to remove free fatty acids which are inherently undesirable and which will oxidize the oil to cause rancidity. The general process is to combine the free fatty acids with an alkali usually caustic soda to form a soap solution which can be separated from the oil. The oil is heated to 80-90 ^{o}C and caustic soda solution sprinkled on to it as it is stirred. Stirring is stopped after the addition of caustic soda and the soap solution is allowed to settle at the bottom. After settling for 30 minutes, the soap solution is drained out and the oil is washed with water (usually two water washes) to remove the soap in the oil. Settling time for water wash is about 20 minutes. Oil is then dried under vacuum and bleached with fullers earth. The fullers earth adsorbs color pigments and residual oxidized material which will later affect stability.

The oil is then pumped to a filter press to remove the fullers earth. The clear filtered oil is then collected in a tank.

NOTE--Neutralization in addition to removing the free fatty acid also has a slight bleaching effect in that the solution adsorbs some of the material responsible for color.

CALCULATION OF CAUSTIC SODA TO NEUTRALIZE F.F.A.

FOR REFINING AT PATS PLANT

1. MOLECULAR WEIGHT OF FFA (LAURIC ACID) IN COCONUT OIL — 200
2. MOLECULAR WEIGHT OF CAUSTIC SODA — 40
3. Strength of caustic soda solution used for refining (11o-Be) — 8%
   (11º Be)

4. Weight of oil taken for refining 2100lbs

5. Number of lbs of 8% caustic soda solution to a U.S. gallon 9lbs

6. Excess caustic soda solution used 20%

$$\frac{FFA}{100} \times \frac{40}{200} \times \frac{100}{8} \times 2100 \times \frac{1}{9} \times \frac{120}{100}$$

= FFA x 7 gallons of 8% NaOH solution for 2100lbs oil.

(This includes 20% excess caustic soda solution)

Standards of refined CNO

FFA as LAURIC	- $\leqslant$0.05 %
Soap	Traces (0.005%) or NIL

LAUNDRY SOAP (PATS PRODUCT)

The bar of soap is light blue in color and weighs 11ozs. The bar is stamped PCP and packed into a corrugated bax. The bar is unwrapped and 60 bars make one corregated box.

The consumer complaints of this soap are:

a. Product is soft.

b. Product wastes (wears) faster than the imported bar.

(a) Product is soft

This is due to the presence of sodium silicate, sodium metasilicate and a high percentage of free oil (about 8%) in the soap. The softness of the product has been inproved without affecting quality by removing the silicates from the formulation and reducing the free oil in the product from 8% to 2%.

(b) Rate of wear

Rate of wear is dependent mainly on the lather produced. Laboratory tests were done to determine the rate of wear by lather test, and wash down tests.

(I) Lather test. PATS soap produced twice the lather of imported bars.

(II) Wash down test. PATS soap wasted 1.8 times faster than the imported bars.

The lather produced by the PATS soap compensated the wastage in the washdown test. As such the rate of wear of both imported and local bars are the same.

Analytical Standards

TFM 63-64%

Free Oil 2-3%

Free alkali NIL

MAREKEISO OIL (FOR BODY AND HAIR APPLICATIONS)

The product is made from refined, deodorized coconut oil and perfumed. The perfume level is 100ml for 5 US gallons of oil (0.526% of the product). The oil is packed in green plastic bottles and the declared volume of each pack is 7 fl. ozs. Forty plastic bottles of oil are then packed into a corrugated box.

1. Analytical standards for product

Refined deod. CNO	FFA as LAURIC $\nless$ 0.05% Acid
	Soap - 0.005% or NIL
	Odor Bland
	Taste Bland

2. Packaging

The print on the paper label used for the plastic bottle shall be stable to oil. In other words, the print shall not smudge when oil is rubbed on it.

COOKING OIL (PATS PRODUCT)

Cooking oil is made from refined deodorized coconut oil. The odor and taste are satisfactory. The oil is packed in green colored plastic bottles and the declared volume of each pack is 32 fl. ozs. Ten plastic bottles of oil are then packed into a corregated box.

The deodorizing time cycle for coconut oil has been reduced by 50% (please see Project manager's report - time cycle now is 7 1/2 hours). This shall make a further improvement in the odor and taste of the oil - the oil will be completely bland in odor and taste.

1. Analytical Standards for Product

F.F.A. as LAURIC ACID	<0.05%
SOAP	Traces (0.005%) or NIL
ODOR	BLAND
TASTE	BLAND

2. Packaging

The print on the paper label used for the plastic bottle shall be stable to oil. In other words, the print shall not smudge when oil is rubbed on it.

WEIGHT CONTROL

DATE:

LAUNDRY SOAP

(Weight not declared on pack)

STANDARD WT.
PER PACKED CASE
OF 60 BARS

---

1. AV. WEIGHT OF FIVE PACKED CASES AT RANDOM - AM	1.	2.	3.
	4.	5.

AV. WEIGHT

2. AV. WEIGHT OF FIVE PACKED CASES AT RANDOM - PM	1.	2.	3.
	4.	5.

AV. WEIGHT

DEVIATION FROM STANDARD WEIGHT

REMARKS

WEIGHT CONTROL

DATE

COOKING OIL/MAREKEISO

DEC. VOL. COOKING OIL 32 fl. ozs.

" " MAREKEISO 7 fl. ozs.

PACKED VOL. COOKING OIL

" " MAREKEISO

1.	AV. TARE WEIGHT OF	1.	2.	3.	Wt. in ozs.
	FIVE BOTTLES TAKEN				
	AT RANDOM	4.	5.		

AV. TARE WEIGHT (TW)

2.	AV. GROSS WEIGHT (GW)	1.	2.	3.	
	OF TEN PACKED BOTTLES	4.	5.	6.	
	TAKEN AT RANDOM - AM	7.	8.	9.	
		10.			

AV. GROSS WEIGHT (GW)

(A) AV. NET WEIGHT (G-T)

3.	AV. GROSS WEIGHT (GW)	1.	2.	3.	
	OF TEN PACKED BOTTLES	4.	5.	6.	
	TAKEN AT RANDOM - PM	7.	8.	9.	
		10.			

AV. GROSS WEIGHT (G)

(B) AV. NET WEIGHT (G-T)

$$\text{PACKED VOLUME} = * \frac{\text{AV. NETT WEIGHT}}{0.91} \text{ fl. ozs.}$$

$$* \ \text{AV. NETT WEIGHT} = \frac{(A)+(B)}{2}$$

OIL STATEMENT

DATE:

---

1. COPRA RECEIPTS

No. of BAGS

GROSS WT.

TARE WT.

NETT WT.

TOTAL WT. OF COPRA RECEIVED lbs

2. OIL STORAGE TANK

(A) OIL MEASUREMENT AT BEGINNING OF WORK lbs

(B) OIL TAKEN BY SOAPERY

BATCH I EX TOP FT......INS...

BATCH II EX TOP FT.....INS...

BATCH III EX TOP FT....INS...

TOTAL OIL lbs

(C) CAUSTIC SODA FOR SOAPERY

SOLN °Be.......

1. Buckets
2. Buckets Total........lbs
3. Buckets

(D) OIL FOR REFINERY

MEASUREMENT ...FT...INS lbs

---

3. TOTAL OIL PRODUCED lbs

4. TOTAL OIL CONSUMED lbs

LABORATORY APPARATUS

A. FOR PATS	NOS.
1. Porcelain Crucibles - Capacity 50 mls.	4
2. Whatman Ashless Filter Paper	
Diameter 11 cms. - boxes of 10 each	10
3. Pyrex Glass Beakers with spout squat form	
Capacity 100 mls.	12
Capacity 250 mls.	12
Capacity 500 mls.	6
Capacity 1000 mls.	6
4. Pyrex Glass Beakers with spout conical form	
Capacity 250 mls.	12
5. Dropping and Dispensing Glass Bottles	
Capacity 125 mls.	6
6. Glass Burettes with straight bore stopcock	
Capacity 50 mls. - subdivided in 0.1 ml.	6
7. Burette Holders	4
8. Cleaning Brushes for Beakers	5
Cleaning Brushes for Test Tubes	5
9. Soxhlet Condensers complete with holding flask and ground glass joints for flask and condenser to distill and collect solvents in the laboratory.	
Capacity of flask 250 mls.	5
10. Density Bottles - capacity 50 mls.	4
11. Ordinary Glass Desiccator without vacuum pattern	
Int. diameter 20 cms.	1
12. Glass Stirring Rods 20 cms. long x 7 mm. diameter	10
13. Glass Tubing 150 cms. long x 5 mm. diameter	6

14.	Graduated Glass Cylinders with spout	
	Capacity 10 mls.	5
	Capacity 100 mls	5
	Capacity 500 mls.	5
	Capacity 1000 mls.	5
15.	Pipettes with permanently marked graduation line - bulb Type	
	Capacity 10 mls.	5
	Capacity 25 mls.	5
16.	Mortar and Pestle - Outer diameter 11 cms.	2
17.	Reagent bottles - Blank Label	
	Capacity 250 mls.	12
18.	Separating Funnels with stoppers	
	Spherical shape - Capacity 500 mls.	4
19.	Plain Test Tubes - 10 mls.	10
20.	Twaddel Hydrometers	
	Range 0-24° Tw	2
	24-48° Tw	2
	48-72° Tw	2
	72-100° Tw	2
21.	Thermometers 0°-100°C	2
	0°-400°C	2

B. FOR TRUK

ALL THE ABOVE ITEMS PLUS THE FOLLOWING:

22.	Triple Beam Balance - Capacity 1100g Beams Calibrated 0- 10g by 1g subdivided 0.1g 0- 100g by 10g 0-1000g by 100g	1
23.	Drying Oven - 200° maximum for laboratory work Please state voltage.	

ESTIMATION OF FREE FATTY ACID

PRINCIPLE The free fatty acid of an oil is estimated by titrating the oil in an alcoholic medium with sodium hydroxide solution.

REAGENTS

1. ETHANOL - 80% solution of ethyl alcohol in water. The alcohol is made neutral with 0.1 N. NaOH solution.
2. SODIUM HYDROXIDE SOLUTION - 0.1 Normal Solution
3. PHENOLPHTALEIN SOLUTION - 0.5% solution in 80% ethyl alcohol.

PROCESS

A weighed quantity of oil (See Note 1) is taken into a titration beaker and 25 mls. of neutral alcohol is added. The oil is warmed until the alcohol starts boiling. A few drops of phenolphtalein is added to the hot oil and the oil is titrated with 0.1 normal sodium hydroxide solution until a pink color permanent for 30 seconds is obtained.

CALCULATION

Normality of NaOH	0.1 normal
Volume of NaOH	V
Equivalent weight of the free fatty acid (Note 2)	E.W
Weight of sample	W

$$\% \text{ F.F.A.} = V \times \frac{E.W.}{1000} \times 0.1\,N \times \frac{100}{W}$$

$$= \frac{V \times E.W \times 0.01}{W}$$

NOTES

1. Crude oils 5g
   Refined and deodorized oils 25g
2. Equivalent weight of FFA in coconut oil 200
   Equivalent weight of FFA in tallow 282
   Equivalent weight of FFA in palm oil 256

ESTIMATION OF MOISTURE IN COPRA

PRINCIPLE — The sample is dried to constant weight in an oven at 110°C.

PROCESS — Copra is cut into small pieces and 5g is weighed into a petri-dish and left in an oven maintained at 110°C. The sample is weighed at intervals of 45mts until a constant weight to the 3rd place of decimal is obtained.

CALCULATION

Weight of petri dish	W_1
Weight of petri dish + copra	W_2
Weight of petri dish + copra after drying to constant weight	W_3

$$\% \text{ Moisture} = \frac{W_2 - W_3 \times 100}{W_2 - W_1}$$

NOTE : The above method may be used to estimate the moisture content in oils and soap.

ESTIMATION OF SOAP IN NEUTRALIZED OILS

PRINCIPLE A measured volume of oil under test is shaken with a very dilute solution of sulphuric acid containing methyl orange indicator. The presence of soap is indicated by color change of the sulphuric acid layer and the amount of soap present is determined by titration. The percentage of soap is expressed in terms of sodium oleate.

REAGENTS

1. Petroleum Ether B.pt. 40°C - 60°C
2. Solution A - 4mg methyl orange + 1.0ml. of 0.1 $N.H_2SO_4$ and the volume made up to 1000mls with distilled water.
3. Solution B - 4mg methyl orange + 15.0ml of 0.5 $N.H_2SO_4$ and the volume made up to 1000 mls with distilled water.

PROCESS

To 5mls of solution A, add 5mls of petroleum ether. Shake for ½ minute. Colour must not change. If this colour changes, it indicates the presence of acid or alkali and hence, the petroleum ether has to be purified*. (See NOTE A)

Add 5mls of oil to the mixture of solution A and petroleum ether. Shake for one minute and titrate against solution B until the colour of the water layer matches the colour of the blank which is prepared with 5mls of solution A and 5mls of petroleum ether.

CALCULATION

1. Solution B contains 15.0mls of 0.5 $N.H_2SO_4$/litre i.e. 0.3675g H_2SO_4/litre which is 0.008 Normal solution.
2. Equivalent weight of Sodium oleate is 304
3. 5mls of oil = 4.6g of oil
4. Let volume of solution B used for titration be V

$$\text{Then \% Soap} = V \times 0.008\,N \times \frac{304}{1000} \times \frac{100}{4.6}$$

$$= \underline{V \times 0.05}$$

NOTE A - The petroleum ether may be purified by distilling at 60°C in a glass apparatus.

ESTIMATION OF FREE ALKALI IN SOAP

PRINCIPLE The soap is dissolved in 96% ethanol, carbonates are precipitated by the addition of Barium chloride and the free hydroxide is titrated with normal sulphuric acid using phenolphthalein as indicator.

REAGENTS

1. 96% neutral alcohol - a few drops of phenolphthalein is added to the alcohol and neutralized with 0.1 Normal sodium hydroxide solution to the first pink colour.
2. Phenolphthalein - 0.5% solution in ethanol.
3. Sulphuric acid - 1.0 Normal solution
4. Barium chloride - 20% solution in water.

PROCESS

25g of soap is dissolved in 100mls of neutral alcohol by heating the sample in a steam bath. When dissolved, add 10mls. Barium chloride solution, a few drops of phenolphthalein, stir well and titrate against 1.0 Normal sulphuric acid ensuring complete mixing during titration. End point is disappearance of the pink color.

CALCULATION

Weight of soap 25g

Volume of 1.0 $N.H_2SO_4$ V

$$\text{Free alkali in terms of NaOH} = V \times 1.0\,N \times \frac{40}{1000} \times \frac{100}{25}$$

$$= \underline{V \times 0.16}$$

ESTIMATION OF FREE OIL IN SOAP

PRINCIPLE

The free oil in soap is estimated either by titration using excess sodium hydroxide solution and back titrating the excess sodium hydroxide solution against a standard acid solution to determine the quantity of sodium hydroxide solution used up by the oil or by extracting the free oil with diethyl ether.

REAGENTS

A. TITRATION METHOD

1. I.O.N. sodium hydroxide solution
2. I.O.N. sulphuric acid solution
3. 0.5% phenolphthalein in alcohol
4. 20% solution of Barium chloride in water
5. 96% neutral alcohol (ethanol).

B. EXTRACTION WITH ETHER

1. Diethyl ether
2. Acetone.

PROCESS

1. TITRATION METHOD

10g of soap is dissolved in 100mls of neutral alcohol in a steam bath. 50mls of 1.0 neutral sodium hydroxide solution is added to the dissolved soap and boiled for 10 minutes. After boiling for 10 minutes, the sample is titrated with 1.0 normal sulphuric acid using phenolphthalein as the indicator. Before the titration, 10mls of Barium chloride solution is added and a complete mixing is ensured during the titration. End point is disappearance of the pink colour.

CALCULATION

Weight of soap 10g

Volume of 1.0 normal NaOH V_1

Volume of 1.0 normal H_2SO_4 V_2

$V_1 - V_2 = V_3$ *

Equivalent weight of free oil

(CNO) 660

$$\% \text{ Free Oil} = V_3 \times \frac{660}{1000} \times 1.0\,N \times \frac{100}{10} = V_3 \times 6.6$$

* V_3 = Volume of NaOH that saponified the free oil.

2. EXTRACTION WITH ETHER

10g of soap is dissolved in 100 mls. of distilled water in a beaker by heating it in a steam bath. When dissolved, the solution is transferred to a separating funnel (500 mls capacity). The beaker is rinsed with distilled water and the rinses transferred to the separating funnel. The soap solution is then cooled to room temperature.

25 mls. of diethyl ether is added to the separating funnel. The contents are swirled well so that the free oil dissolves in the ether. Two layers are formed - one is the ether layer which contains the free oil and the other is the water layer which contains the soap. The water layer is transferred to another separating funnel and given an ether extract. This is repeated again, so that three ether extracts are given to the sample. All ether extracts are now combined and washed with distilled water. Two water washes are given to the ether extract which contains the free oil. The water is drained out, and the ether is transferred into a weighed flask. The ether is then evaporated on a steam bath using a Soxhlet condenser to collect the ether. When all the ether has evaporated, a few drops of acetone is added to the flask and is left in an oven maintained at 105°C. The flask is weighed to constant weight.

CALCULATION

Weight of soap 10g

Weight of flask W_1

Weight of flask + oil W_2

$$\% \text{ Free oil} = \frac{W_2 - W_1}{10} \times 100$$

$$= (W_2 - W_1)\ 10$$

ESTIMATION OF TOTAL FATTY MATTER IN SOAP

PRINCIPLE

The total fatty matter (total fatty acid) in soap is liberated by the addition of a mineral acid and extracted with dieyhyl ether.

REAGENTS

1. Sulphuric acid - 20% solution in water
2. Diethyl ether
3. Melhyl orange - 0.5% solution in water.
4. Acetone.

PROCESS

10g of soap is dissolved in about 100 mls of distilled water in a beaker by heating in a steam bath. The contents are transferred to a 500 mls separating funnel. The beaker is rinsed with distilled water and transferred to the separating funnel to ensure a complete transference of the soap solution into the separating funnel. Few drops of methyl orange are added to the contents in the separating funnel and 20% sulphuric acid is added until the water layer becomes pink in color. Now the soap solution is cooled to room temperature.

50mls of ether are added to the contents in the separating funnel. The separating funnel is stoppered well and the contents are shaken well. Care must be taken to release the pressure that develops inside the separating funnel due to the presence of ether while shaking. This is important as otherwise the separating funnel will burst.

The contents are allowed to separate and two layers are formed--the ethereal layer which contains the fatty acid and the water layer which may contain soap in the form of fatty acid. After a clear separation has been formed, the water layer is transfered to another separating funnel and the fatty acid is extracted with ether. Again, when a clear separation has formed, the water layer is transferred to a third separating funnel and extracted with ether. The water from the 3rd extraction is drained out and all ether extracts are combined together in one separating funnel. The ether extract is given two or three water washes and the water wash, after each time, is tested with methyl orange indicator for the presence of the mineral acid. When the mineral acid has been washed out, the ether layer is transferred to a weighed flask and evaporated on a steambath using a Soxhlet condenser to collect the ether. After the ether has evaporated, the flask is removed from the water bath and a few drops of acetone are added to the contents in the flask. The flask is then left in an oven at 105°C and weighed at intervals of 45 minutes until a constant weight to the 3rd place of decimal is obtained.

<u>CALCULATION</u>

Weight of soap	10g
Weight of flask	W_1
Weight of flask + fatty acid	W_2

$$\% \text{ Fatty acid (total fatty matter)} = \frac{W_2 - W_1}{10} \times 100$$

$$= W_2 - W_1 \times 10$$

<u>NOTE</u> The total fatty matter (TFM) by the above method will also include free oil, if any.

ESTIMATION OF LATHER OR FOAM IN SOAP

PRINCIPLE

The soap is dissolved in water and the solution is run through a standard orifice into a measuring cylinder and the volume of lather is measured in millilitres. The stability of this lather is determined by measuring the volume of this lather after five minutes.

PROCESS

5g of soap is dissolved in 500mls. distilled water and 400mls. of the solution is transferred to a separating funnel with a standard orifice. The balance 100 mls. of the soap solution is transferred to a 1000 ml. measuring cylinder.

300 mls. of the soap solution in the separating funnel is now run from a height of 3 ft. (3') into the 100 mls. soap solution in the 1000 ml. measuring cylinder. The volume of lather produced is measured immediately in terms of millilitres of lather (V_1). The lather is again measured after 5 mins. (V_2).

Immediate lather	V_1
Lather after 5 minutes	V_2

The difference between V_1 and V_2 will be small in stable lather and appreciable in unstable lather. This difference could be easily noticed in the lather produced from soap made out of 100% coconut oil and 100% tallow.

Coconut oil soaps produce quick short-lasting lather and tallow soaps produce slow-lasting lather.

ESTIMATION OF RATE OF WEAR IN SOAP

This is a subjective assessment indicating quantitatively the usage of soap during washing. This test becomes especially useful in determining the wear of soap produced from different formulations.

Tablets of soap under test are planed to the same size and shape. The tablets are weighed (W_1) and the weights of the tablets should also be about the same. The tablets (one at a time) are now washed under running water, the flow of which should be the same for all tablets. Washing is done as follows: Each tablet is held in the palm and washed with both hands by turning the tablet 50 times under the running water. The same person should wash all the tablets under test, in order to eliminate the errors due to the differences in the pressure applied to the tablets during washing.

The tablets are then allowed to dry at ambient temperature and weighed (W_2).

$$\% \text{ WEAR OF SOAP} = \frac{W_1 - W_2}{W_1} \times 100$$

The above test is repeated four times and the average of the four figures is taken as the percentage wear of the tablet of soap.

ESTIMATION OF SAPONIFICATION VALUE IN OILS

PRINCIPLE

The oil under test is saponified with an alcoholic solution of potassium hydroxide. The excess potassium hydroxide is titrated with hydrochloric acid to determine the quantity of potassium hydroxide that saponified the oil.

SAPONIFICATION VALUE is defined as the number of milligrams of potassium hydroxide required to saponify one gram of oil or fat.

REAGENTS

1. N/2 alcoholic solution of potassium hydroxide. Dissolve 7g of potassium hydroxide in 80% ethyl alcohol and make up the volume of the solution to 250 mls.
2. 0.5% solution of phenolphthalein in 80% ethyl alcohol.
3. N/2 hydrochloric acid.

PROCESS

One gram of oil is weighed into a flask and 25.0 mls. of N/2 alcoholic solution of potassium hydroxide is added to the flask. At the same time, a blank sample is prepared by adding 25 mls. of alcoholic solution of potassium hydroxide into another flask. Both sample (S) and the blank (B) are fitted with air condensers and are kept on a stem bath for 90 minutes.

Both flasks are then removed from the steam bath. The air condensers are washed with distilled water and removed from the flask. Both sample and blank are now titrated with N/2 HCL using phenolphthalein as the indicator. The end point is the disappearance of the pink color.

CALCULATION

Volume of N/2 HCL for Blank	V_1
Volume of N/2 HCL for Sample	V_2
Normality of HCL	N/2
Molecular weight of KOH	56.1
Weight of sample	W

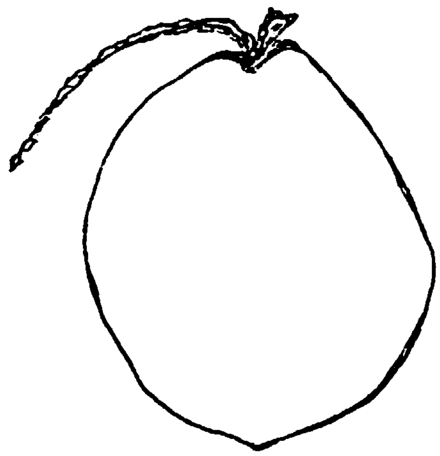
$$\text{Saponification Value} = (V_1 - V_2) \times \frac{N}{2} \times \frac{56.1}{1000} \times \frac{1000}{W}$$

$$= (V_1 - V_2) \times \frac{28.05}{W}$$

COCONUT OIL AND CHEMISTRY OF SOAP-MAKING

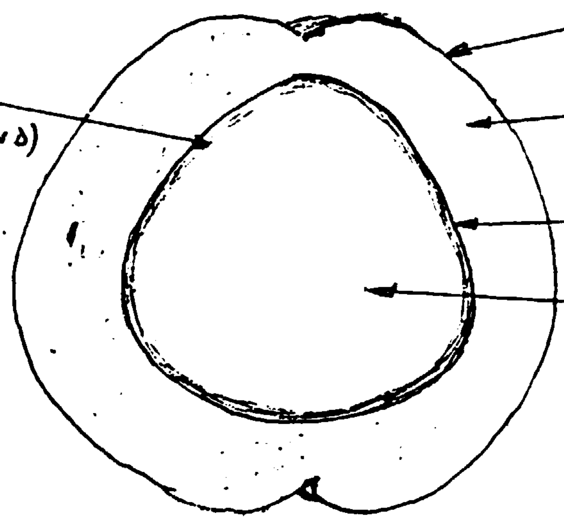
COCONUT OIL

Coconut oil is obtained from the white meat called the kernel or endosperm of the coconut.



FRESH COCONUT

SECTIONAL VIEW OF ONE-HALF OF THE FRUIT



The fruit is dehusked and broken into two halves. The traditional method of extracting the oil is to grate the endosperm (white meat) and the grated coconut is squeezed or pressed with the addition of water. The white liquid called an emulsion separates from the white meat. This emulsion is the coconut milk and is a fairly stable oil-in-water emulsion. It is relatively easy to grate the meat and extract the coconut milk, but is somewhat difficult to separate a pure oil product from coconut milk. Separation of coconut oil from the milk means, the oil globules must combine to form an oil phase. In other words, the emulsion of oil globules and the water phase must be destabilized or broken. This is done by boiling and filtering the milk. The filtered liquid phase is the oil. This process has several serious deficiencies.

1. The oil yield is low. The residue contains about 60% of recoverable oil.
2. The oil is brown and has a burnt odour and taste. It often becomes rancid in a few days.
3. The process is time-consuming.

The present method is to dehusk the fruit and break it into two halves and sun-dry or kiln-dry or both to obtain a moisture content of 5 - 6%. The copra (kernel and the testa) is then crushed by expeliers to obtain the oil.

<u>Specifications of Copra for Milling</u>

	%
Moisture Content	5 - 6
Oil Content	70 - 72 (Moisture-free basis)
Free Fatty Acid as Lauric acid	2 - 3
Oil yield by expeller	60 - 62
Coconut poonac yield	34 - 35
Losses	6 - 3
Residual oil in poonac	8 - 10

<u>Specifications of Coconut Oil</u>

Free Fatty Acid as Lauric Acid	2 - 3 %
Iodine Value	8 - 11
Saponification Value	250 - 264
Unsaponifiable matter	0.5% maximum
Setting Point	21 -23°C.

Density of Coconut Oil

°F	S.G
70	0.9224
80	0.9187
90	0.9150
100	0.9114
110	0.9078

Acidity in Coconut Oil

In copra, splitting of oil occurs due to enzymes in the presence of water. The enzymes may be derived from the plant tissues or from other micro-organisms like moulds. In clean dry copra, very little splitting occurs.

CH_2O COR	H OH			
CHO COR	(water)	Enzyme action		CH_2OH
CH_2O COR +		⟶ RCOOH	+	CHO.COR
OIL (Triglyceride)		fatty acid in		CH_2O.COR
		free state termed free fatty acid		(diglyceride)

In the above reaction, one molecule of fatty acid is liberated due to the action of enzymes on the oil in the presence of water. As the liberated fatty acid is found in the free state, it is termed free fatty acid.

The oil is termed a tri-glyceride as it contains three molecules of fatty acid combined to a molecule of glycerol. The oil will remain 100% tri-glyceride if not for the enzymic action. But the oil becomes subjected to the action of nature's catalysts called enzymes derived from the plant tissues or from microorganisms (bacteria, moulds) from outside source. The action of enzymes results in the splitting of oil which is termed fat splitting. As a result of fat splitting, fatty acid is liberated in the free state. The fat splitting caused by the enzymes derived from the plant tissues is very little. As such, the oil obtained from good, clean, dry copra should not have a free fatty acid of more than 2%. If the fat splitting from outside source is not controlled, the oil will become rancid, the end products of which (called in chemistry as methyl ketones) have heavy penetrating odours.

The following measures will help to ensure the freedom from water, micro-organisms, especially moulds, and consequent deterioration of the oil:

1. Well-dried copra - dried to 6% moisture.
2. The oil from copra must be collected in clean equipment.
3. It is very important to separate the "foots" (cake residue, mucilage, etc.) from the crude oil as quickly as possible by filtering or settling. If the separation is done by settling, the settling tanks should be frequently cleaned.
4. The oil for long storage must be stored as far as possible from the action of light and air. To exclude action of air, vessels are best kept as full as possible.
5. As coconut poonac is very prone to water absorption and consequent moulding and deterioration, the cake should be disposed of as quickly as possible. Otherwise, the place will harbour undesirable micro-organisms which will become a serious problem to eliminate.

FATTY ACIDS IN COCONUT OIL

	NAME	FORMULA	Approx. % in the oil
1.	Caprylic acid	$C_7H_{15}COOH$	6
2.	Capric Acid	$C_9H_{19}COOH$	6
3.	Lauric Acid	$C_{11}H_{23}COOH$	44
4.	Myristic Acid	$C_{13}H_{27}COOH$	18
5.	Palmitic Acid	$C_{15}H_{31}COOH$	11
6.	Stearic Acid	$C_{17}H_{35}COOH$	6
7.	Oleic Acid	$C_{17}H_{33}COOH$	7
8.	Linoleic Acid	$C_{17}H_{31}COOH$	2

The main fatty acid is lauric acid which has a molecular weight of 200. Fatty acids numbered 1-6 are termed saturated fatty acids and 7-8 are termed unsaturated fatty acid. The degree of unsaturation is measured by the test iodine value.

PARINGS OIL

Parings oil is the oil obtained from the testa of the copra. The testa is removed or paired from the copra during the manufacture of desiccated coconut and the oil obtained from the paired off testa is called the parings coconut oil. This oil is slightly darker than the oil obtained from the whole copra and has a free fatty acid content of about 5% and iodine value of 15-20.

Average Composition of Coconut Poonac

	%
Moisture	11
O i l	8
Protein	19 (N x 6.25)

S O A P

Soap is a detergent - the name given to any substance which has a cleansing effect -- the term being derived from a Latin word TERGERE meaning to wipe, rub or clean.

How does soap clean? It does not. It only helps water to remove the dirt. Dirt will always have a trace of grease or oil in it. That is what it makes stick (apart from a slight electrical attraction). Dirt which comes in contact with the skin is caught up by the natural greasiness of the skin and sticks on to the skin.

How does soap help water to clean? Water is very inefficient when it comes to making things wet. The surface tension of water prevents the making of a close contact for some time between the water and the object and there will be a layer of air between the water and the object making the contact difficult. This is where soap plays the part of a wetting agent. It reduces the surface tension of water, so that a solution of soap in water makes immediate and intimate contact with every crevice of the object being washed. A slight agitation of the soap solution will now dislodge the particles of dirt from the object and these particles of dirt are then washed away with fresh water.

SOAPMAKING

Chemically, soap is a compound formed from a fatty acid and an alkali-sodium hydroxide or potassium hydroxide (metallic soaps are excluded). In other words, it may be termed as an alkali salt of a fatty acid. Fatty acids are in turn derived from fatty oils. The reaction between the fatty acid of an oil and alkali to produce soap is called saponification. The reaction is as follows:

Oil + alkali   alkali salt + glycerol.

Oil is a triglyceride of a fatty acid. In other words, three molecules of fatty acid combined to one molecule of glycerol. To explain this by a chemical equation.

General formula of fatty acid - RCOOH

Formula of Glycerol - CH_2OH
1
CHOH
1
CH_2OH

Three molecules of fatty acid + glycerol = oil + water.

RCOOH		CH_2OH		CH_2OCOR	HOH
		1		1	
R COOH	+	CHOH	$\longrightarrow$	CHOCOR +	HOH
		1			
R COOH		CH_2OH		CH_2OCOR	HOH
(3 fatty acid)		(one glycerol)		(oil)	

During saponification, the oil reacts with the alkali as follows:

CH_2 OCOR		NaOH		RCOONa		CH_2OH
1						1
CH OCOR	+	NaOH	$\longrightarrow$	RCOONa	+	CHOH
1						1
CH_2 OCOR		NaOH		RCOONa		CH_2OH
1 molecule oil		3 molecules alkali-		3 mols. soap		1 mol. glycerol

The 'R' in the oil is chemically termed as the alkyl group and denotes the fatty acid structure of the oil. In coconut oil there are eight fatty acids and the R is represented by C_7H_{15}; C_9H_{19} ; $C_{11}H_{23}$; $C_{13}H_{27}$; $C_{15}H_{31}$; $C_{17}H_{35}$; $C_{17}H_{33}$ and $C_{17}H_{31}$. Of these, $C_{11}H_{23}$ forms the main fatty acid group and is termed Lauric acid which has the chemical formula $C_{11}H_{23}CooH$ and a molecular weight of 200.

The molecular weight of an oil may be determined by saponification equivalent or equivalent weight which is defined as the number grams of oil saponified by one Gram-Equivalent of potassium hydroxide. Saponification Equivalent is calculated from saponification value which is defined as the number of milligrams of potassium hydroxide required to saponify one gram of oil or fat. In other words, Saponification Equivalent = $\frac{56,100}{\text{Sap. Value}}$

56,100 = Equivalent weight of potassium hydroxide times 1000 (to convert into milligrams)

The saponification value of coconut oil = 255

$$\text{Saponification Equivalent} = \frac{56100}{255} = 220$$

The saponification reaction of coconut oil may be represented as follows:

$$3 \times 220 + 3 \times 40 \longrightarrow 688 + 92$$

(1) oil (3) sodium hydroxide (3) Soap glycerol

(i.e) 660 parts by weight of oil requires 120 parts by weight of sodium hydroxide.

∴ 100 parts by weight of oil will require 18.2 parts by weight of sodium hydroxide (solid).

Soap made from different fatty acids have different properties:

Example:

OIL	CONSISTENCY	FOAM	DETERGENT QUALITY	SKIN REACTION	AVERAGE % NaOH
Coconut	Very hard and brittle	Quick big bubbles short-lasting	Very good both in cold and hot water	Makes skin ~~rash~~ ROUGH	18
Palm Kernel	Same	Same	Same	Same	Same
Palm	Hard	Slow, small bubbles, lasting	Good	Very mild	14
Tallow	Hard	Slow, small bubbles, lasting	Good	Very mild	14

In the selection of an oil or fat for the manufacture of soap, the optimum balance between high solubility and free lathering on the one hand and lasting lather and good sudsing with high detergent and good water softening capacity on the other has to be obtained. Unfortunately, no single fat or oil has all these properties. So, various combinations of different oils are blended together to achieve these functions in a soap. Of course, the selection of oils will largely depend on availability and cost of oil.

The ready solubility and the good lathering in soaps produced from coconut oil make coconut oil an important raw material in the manufacture of soap. In the absence of coconut oil, a certain amount of potassium soap if included in the oil formulation for the manufacture of soap increases the effect of solubilizing in the product.

Soap may be manufactured by three conventional methods of saponification:

1. Cold process
2. Semi-boiled process
3. Full-boiled process

The manufacture of soap whichever method is employed consists of two distinct stages. The first is the preparation of the soap base and the second is the treatment of the soap base to obtain the finished product.

The first stage comprises the chemical reaction of saponification which may be achieved in a simple manner and in simple equipment as in the cold process or in a somewhat elaborate manner by the use of more elaborate equipment as in the full-boiled process. The second stage of treatment of the soap base involves several mechanical operations whose ultimate object is to convert the soap mass into a handy and attractive product.

Cold Process

Oil is taken into a convenient vessel and caustic soda solution at 36°--38° Be is gradually added with slow stirring of the mass. Stirring is continued. After about 45 minutes stirring, colour and perfume are added and mixed uniformly. Stirring is continued and the soap mass thickens up in about 90 mins. It is then allowed to set in the frames/moulds for a period of two to three days.

The cooled mass is taken out in the form of blocks, cut into slabs, then into bars, or billets and stamped. All these operations are normally done by hand machines.

Coconut oil is the most suitable oil for this process as it saponifies quickly.

There are, however, certain limitations and disadvantages in this method.

1. Since whatever goes into the vessel remains with the soap, the quality of the soap depends upon the quality of the raw materials. Therefore, care has to be taken in the selection of the raw materials.
2. As adjustments of alkali or oil cannot be made in the saponification by the cold process, any excess of either the oil or the caustic will remain in the final product. As such, it is desirable to have a slight excess of free oil than free caustic. This is achieved by adding 1 - 2 % less of the theoretical quantity of caustic soda for saponifying the oil.
3. The off-cuts (Scrap soap) produced in slabbing, barring and billeting operations cannot be recycled and go as waste.

Semi-Boiled Process

In this process, the oil is heated to 80°C with stirring and alkali solution at 36°-38° Be is added slowly to saponify the hot oil. After the addition of the alkali solution, the mass is stirred for about 30-45 minutes and the free alkali is checked. The free oil or free alkali is then corrected by the addition of either alkali or oil. When saponification is complete, the soap will appear bright and homogenous. Heating is stopped and the mass is allowed to set without stirring for 30 minutes. Stirring is then started and colouring material, perfume, and any other ingredients are added to the hot mass and mixed for about 20 minutes. It is then poured into frames/moulds and after 24 hours, the blocks of soap will undergo the same treatment as in the cold process.

In this process, the scrap soap can be recycled.

In both methods, cold and semi-boiled processes, glycerine remains with the soap.

Full-Boiled Process

This process is operated with more than one object in view.

1. Complete saponification of the oil has to be accomplished.
2. Soap formed is freed from any impurities present in the original oil stocks.
3. Soap shall contain the stipulated standards of free alkali and salt that are used during the process.
4. This process enables the economic recovery of the by-product - glycerine.
5. This process ensures good yield of a high quality soap.

In contrast with the other two methods, full-boiled process is elaborate and consists of several stages and involves heavy capital investment.