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THE DEMONSTRATION AND EVALUATION OF A SMALL SCALE EXPELLER UNIT FOR THE PRODUCTION OF COCONUT OIL FROM COPRA IN THE COOK ISLANDS

US/GLO/83/033

Terminal report *

Based on the work of J.C. Barrett, T.W. Hammons and R. V. Harris of the Tropical Research and Development Institute, London, United Kingdom

Backstopping Officer: H.Koenig, Agro-based Industries Branch

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The TDRI team wishes to thank the staff of the Kia Orana Food Corporation for their collaboration and assistance during the field trials of the copra processing equipment. In particular, thanks are due to Mr M Benns, Managing Director, for his support, and also to Mr D Tuaeu, counterpart officer in the experimental programme.

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Last and not least, the assistance and support provided by Mr K Southwell of TDRI's Oilseeds and Edible Nuts Section must be placed on record. Mr Southwell spent four weeks in the Cook Islands, funded by TDRI, to undertake work of interest to the Institute in relation to the copra processing project funded by UNIDO, and during this period he carried out analyses and related laboratory work which helped the project team significantly.

EXCHANGE RATES

Exchange rates at the time of the visit to the Cook Islands, and used in this report, were

£1 = NZ$3.00
£1 = US$1.48

SUMMARY

This report describes an assignment carried out by the Tropical Development and Research Institute (TDRI), London, funded by the United Nations Industrial Development Organisation (UNIDO), to demonstrate and evaluate the small-scale processing of copra in the Pacific Region with a view to the potential transfer of this technology elsewhere.

Following a Preparatory Phase of the assignment, in which the Cook Islands were identified as a suitable location for the field work, equipment for small-scale copra processing was selected, assembled and given preliminary testing at TDRI in England. This equipment comprised a knifemill for copra chopping, a heater for preheating copra prior to pressing, a screw press, and a filter press. The overall processing capacity was in the region of 100 tonnes copra per year, on single shift operation.

In the Operational Phase, a two-man team comprising a technologist and a marketing economist visited the Cook Islands in the period August-November 1986, to undertake installation, testing and evaluation of the equipment; supplies of copra were also investigated and potential markets for coconut oil and copra were assessed.

The equipment was found to process copra very well with few technical difficulties. The copra pre-heater was found not to be necessary, because of the low moisture content of the available copra. Processing copra at ambient temperature, throughputs in the range 60 to 70 kg per hour were consistently achieved, with yields of clarified oil and copra cake in the region of 55% and 40% respectively on a weight basis. Double-pressing the oil cake led to higher oil yields from the copra, but this was not considered worthwhile, for operational reasons.

Operating along commercial lines, with three full time staff, this set of equipment could process 94.5 tonnes per year (over 250 working days) to produce about 57,000 litres of clarified coconut oil and about 38 tonnes of copra cake.

A consumer survey carried out on Rarotonga indicated that the coconut oil produced using the demonstration equipment was widely acceptable as a cooking oil. It was estimated that approximately 50% of current imports of cooking oil could be substituted by locally produced coconut oil if marketed at NZ$2.25

per litre, a slightly lower price than currently imported products. However, this would not absorb the entire potential output of the equipment.

An additional potential market for the coconut oil was identified as a raw material for soap manufacture, which could be a viable activity if oil were made available at NZ$1.75 per litre. At the outset of the field work, no significant soap manufacture took place in Rarotonga, but by the end of the visit the interest generated by the UNIDO project had led to one entrepreneur taking steps to establish a soap production venture based on the teams' recommendations.

The copra cake produced sold readily to local pig farmers at a price of NZ$280 per tonne.

A basic project model was developed using the production and cost data obtained at the time of the operation of the demonstration equipment and assuming that sufficiently large markets for the outputs could be established to permit full capacity utilisation. This showed an internal rate of return of 49.0%, with a pay-back period of just over 2 years on an initial establishment cost of just under NZ$100,000. This represents an attractive investment opportunity in the Cook Islands.

Sensitivity analysis shows that the financial profitability of small scale copra processing can vary considerably if assumptions concerning projected costs and revenues are changed within a plausible range that might be encountered in other locations. This indicates a degree of risk associated with the venture, and shows the limit to the direct transferability of the basic financial evaluation of this report to other potential copra processing sites outside the Cook Islands. This report therefore provides a methodology and framework for the evaluation of similar ventures at other locations in the Pacific region.

Economic considerations which favour this type of venture include:

- net foreign exchange benefit for countries such as the Cook Islands which export copra and import cooking oil, animal feed and soap;

- employment creation, not only directly in copra processing but also through the scope for stimulating downstream economic activity such as local soap-making and livestock production;

- increased security of income to copra producers;

- increased consumer satisfaction as locally produced products become available at lower prices than imported products.

Overall, the prospects appear very encouraging for small-scale processing of copra on Pacific islands, using the type of equipment tested on Rarotonga, and it is recommended that the information derived from this study be disseminated as widely as possible, in an appropriate form, to foster interest in the concept.

Follow-up to this assignment is recommended both in relation to the Cook Islands and other potential sites for the equipment. It is recommended that further support is given in the context of the Cook Islands, to ensure that the project so far operated on a trial and demonstration basis is established on a sound commercial footing. It is also recommended that case studies be carried out on a number of other Pacific islands, where circumstances are likely to be broadly similar to those prevailing in the Cook Islands. These case studies would be of a pre-feasibility nature concerning the prospects for small-scale copra processing at each specific location. These case studies would then provide a broader information base upon which national and international development agencies and private investors could make their own assessments.

SECTION 1 INTRODUCTION

1.1 Background to the assignment

Coconut cultivation and copra production are a characteristic of many tropical countries. For many island communities in the Pacific Ocean they are major economic activities and copra forms an important export commodity. The value of the copra to the exporting country is, however, invariably reduced by transport costs. Processing of the copra is carried out overseas, and the products, edible oil and livestock feed, are subsequently imported, usually at a high price due to further transport costs and trader's margins. Many observers have noted that if these often remote and isolated communities had access to small-scale copra processing units they would be able to produce edible oil and livestock feed for their own local consumption to replace these expensive imports. In addition to providing food and animal feed locally, employment opportunities would be created and value added to their agricultural production.

The Tropical Development and Research Institute (TDRI) has worked for some years on small-scale oilseed processing and has collaborated with a UK engineering company in the development of a small powered expeller with a capacity in the region of 25-50 kg/hr. Previous work has demonstrated the unit's potential for processing sunflowerseed and this has culminated in the establishment of a number of Cooperative-owned processing facilities in East Africa.

More recent work at TDRI in the UK has shown that the expeller, together with certain items of ancillary equipment, also operated efficiently on copra, providing a good yield of coconut oil. With copra of an appropriate quality this oil would be suitable for human consumption and opportunities to carry out field trials on the copra processing system were sought. UNIDO became aware of these developments and contracted TDRI to carry out an evaluation and demonstration of the system in a Pacific location.

The project was divided into two distinct phases: a Preparatory Phase and an Operational Phase. The Preparatory Phase covered the selection of a suitable site in the Pacific for the trials, the procurement of the necessary equipment and its shipment to the selected location. The Operational Phase covered installation and commissioning of the equipment, operation of the system, data

collection and evaluation, the drawing up of conclusions and recommendations, and reportage to UNIDO.

The Report of the Preparatory Phase, based on field work by Dr R V Harris in 1985, appears as Annex A of this Report. It describes the initial drawing up of a short list of possible host countries, correspondence with these countries, and a visit to the two most promising locations to select a precise site for the trials and to finalise local arrangements. It recommended the Kia Orana Fruit Processing Factory in Avarua, Rarotonga in the Cook Islands as the site for the Operational Phase trials. This recommendation was agreed by UNIDO.

1.2 Conduct of the Operational Phase field visit

TDRI proceeded to procure, assemble and test the necessary equipment at the Institute's Industrial Development Department in England, prior to arranging its transportation by sea to Avarua, where it arrived in late July 1986.

Mr T Hammonds, TDRI copra processing technologist, spent from 2 August to 4 November in the Cook Islands,

- to organise the installation of the equipment;
- to demonstrate its operation;
- to train counterpart and operators;
- to investigate the quality of available copra;
- to investigate options for operation of the equipment, including various machine settings, the use of pre-heated versus unheated copra, recycling of residues, and double-pressing of copra cake;
- to determine production parameters for use in the subsequent financial evaluation of the equipment; and
- to investigate the potential for utilisation of coconut oil in local soap-making.

Mr J Barrett, TDRI oilseed marketing economist, visited the Cook Islands from 16 August to 11 September 1986,

- to investigate the local market for coconut oil for edible use, for soap-making, and for other uses, and the market for copra cake in animal feeding;
- to investigate the supply of copra;
- to assemble appropriate cost information and undertake financial and economic evaluation of small scale copra processing.

During the field work, visits were made to persons and organisations, as listed in Annex B. All the period was spent on the island of Rarotonga, except for a short visit to Aitutaki which proved necessary in order to investigate the scope for improving the quality of copra available for processing.

1.4 Scope and content of the report

This report provides a comprehensive and detailed record of the findings, conclusions and recommendations which result from the Operational Phase. Section 2 describes the equipment as installed at the Kia Orana factory on Rarotonga, and presents a technical evaluation covering the installation and operation of the equipment, and related experimental work. Section 3 presents recommendations for the operation of the small-scale copra processing equipment, based on the experience gained in the visit to the Cook Islands. With a view to appraising the viability of small-scale copra processing as a commercial venture, Section 4 describes the production and marketing of copra in the Cook Islands and Section 5 analyses the market in the Cook Islands for coconut oil and copra cake. This leads in Section 6 to financial and economic evaluation of small-scale copra processing, based on the Cook Islands experience. Finally, conclusions and recommendations which emerge from the overall assignment are presented in Section 7. Supplementary material is contained in seven Annexes to the main text.

SECTION 2 TECHNICAL EVALUATION

2.1 Process Description

Since commercial copra is composed of pieces which are too large to feed directly to the screw press, the first stage of the oil expelling process requires the use of a chopper to break down the copra into suitably sized fragments.

A copra heater can be used to heat the chopped copra and reduce its moisture content, if necessary, before it is fed to the screw press. The screw press continuously expels crude oil from the chopped copra and at the same time, produces a copra cake by-product from the residue.

After the crude oil has been allowed to sediment, it is clarified by passing it through the filter press which removes the small proportion of suspended sediments associated with it. The main products of the process are clarified coconut oil and copra cake.

The process is summarised in Figure 2.1. Detailed specifications of the equipment are given in Annex C.

2.2 Installation of Equipment

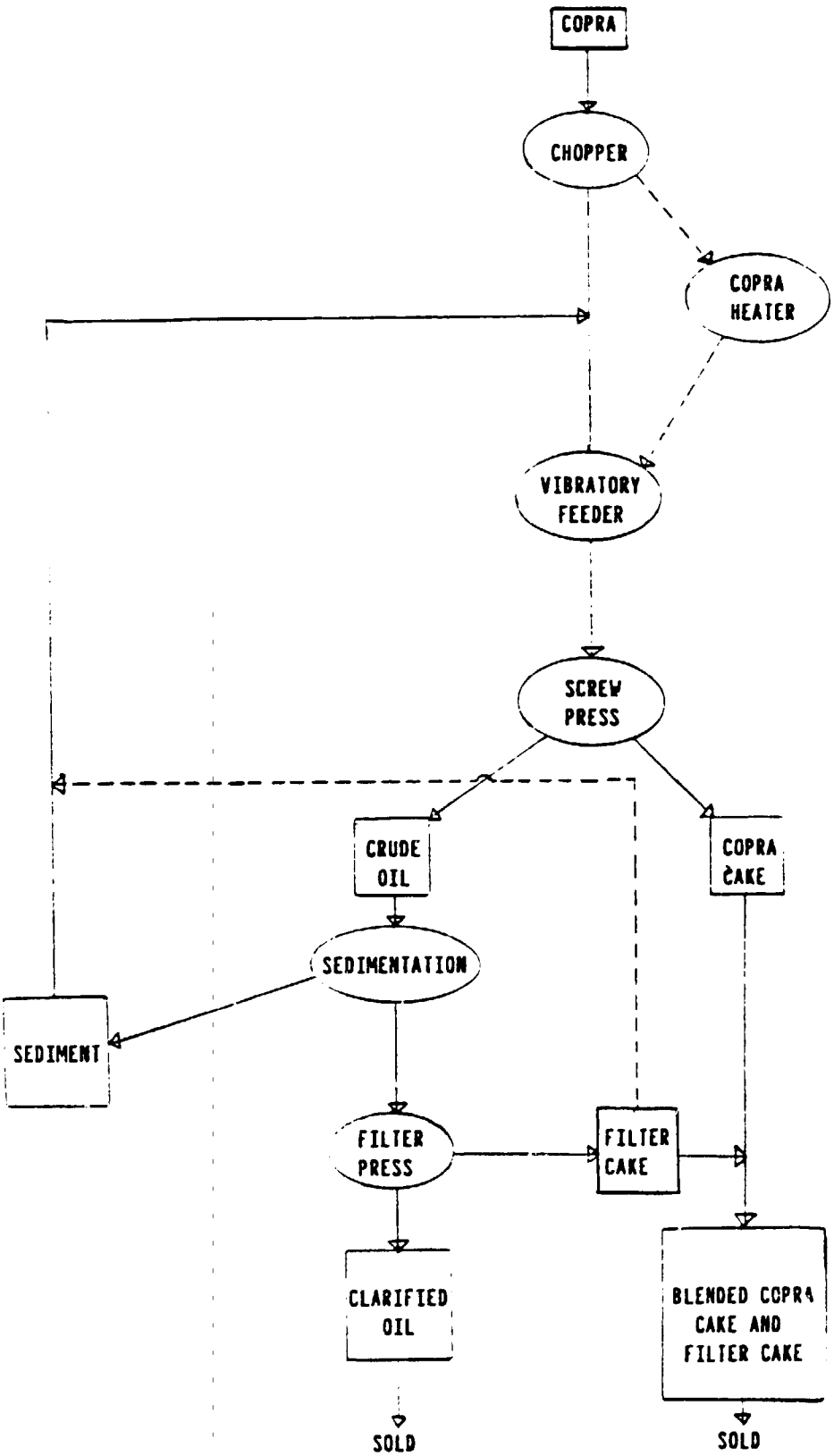
2.2.1 Selection of Site

During the preparatory phase of the project (see Annex A) the Kia Orana Factory, Avarua, Rarotonga was chosen as the location for the trials.

At the beginning of the operational phase two available sitings for the equipment in the factory area were inspected and a site was selected inside a warehouse, adjacent to an outside wall partially glazed with louvered windows. This site had the advantage of good ventilation, a large outside door at one end for access and a small room at the other which could be used as a small office and store room for tools and spares.

Figure 2.1

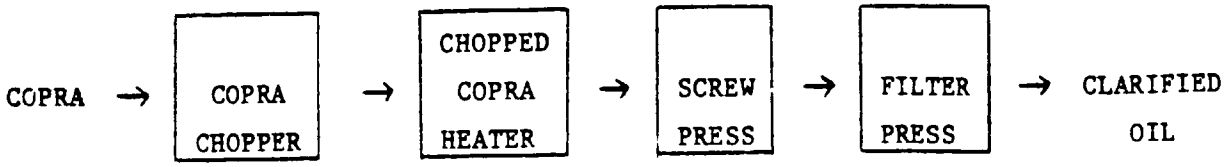
Flow chart for small scale Copra Processing.



2.2.2 Installation Work

The equipment was arranged alongside the outer wall so as to provide the flow line for the process shown in Figure 2.2.

Figure 2.2 LAYOUT OF EQUIPMENT



The installation of the equipment required the provision of electricity supplies to each of the units, the construction of a hearth for the seed heater, a concrete plinth for the screw press, and the securing of the copra chopper and the filter press to the floor with bolts. As a compressed air supply was available in the factory, the filter press inlet was piped into the system.

2.2.3 Construction Work

2.2.3.1 Concrete plinth for screw press

It was found that the working drawing supplied by the screw press manufacturers provided sufficient information to enable the concrete plinth to be constructed quickly and accurately by the Cook Islands Public Works Department.

2.2.3.2 Hearth for Chopped Copra Heater

The working drawing supplied by the manufacturers was found to give insufficient construction details and lengthy remedial work was required by the Public Works Department before the unit became operational. Further, as described later, the flue design was found to give ineffective fume extraction.

Future installations of copra heater hearths would require some preliminary design-development work and the provision of an adequately detailed working-drawing.

2.2.3.3 Electrical Work

Local contractors found no difficulty in installing the wiring required for the units, and they were able to provide the rotary hammer action drill necessary to bore the holes required in the concrete floor for the equipment securing bolts.

2.3 Evaluation of Equipment

The performance of the items basic to the oil producing process, i.e. the copra chopper and the screw press, was investigated, together with an evaluation of the contribution of the ancillary items of equipment, the copra heater and filter press, to the overall efficiency of the process.

2.3.1 Operation of Copra Chopper

Overall the copra chopper was found to function satisfactorily, and the hourly production rate of chopped copra was in excess of the demands of the screw press.

A steady throughput of about 165 kg copra per hour was easily achieved provided the larger pieces of copra were broken into two before feeding to the mill. Over 90 per cent of the copra particles produced were found to be less than 0.5 cm in size. No processing loss could be measured, and copra batches were found to have the same weight before and after grinding. The operation of grinding was found to produce a small heating effect on the copra, with temperature rises of about 9°C being recorded.

2.3.2 Operation of Chopped Copra Heater

Overall, although the chopped copra heater was found to be satisfactory in its function of heating chopped copra, its use was found to be unnecessary for processing Cook Islands copra using the other items of equipment selected.

Approximately 0.75 kg of butane gas was required to heat the furnace to 65°C. Heating 1000 kg of copra to 65°C was found to require about 12 kg gas. The most suitable mode of operation was to heat the copra in 25 kg batches. This was found to take about 15 to 20 minutes, and enabled the production of heated copra to match the throughput demand of the screw press, consistent with minimising the delay before processing and thus the time available for the copra to cool.

The use of firewood as an alternative to butane gas was also investigated and although it provided a satisfactory heat source, problems encountered with the operation of the flue resulted in clouds of smoke issuing from the front aperture of the furnace.

2.3.3 Operation of the Screw Press

Overall the screw press with its associated vibratory feeder operated satisfactorily. No operational difficulties were encountered and average oil extraction rates of 84 to 90 per cent were obtained when unheated copra was processed. As variations in the operating conditions of the screw press were investigated during the trials an account of the mode of operation of the screw press is given below as a guide to the considerations involved.

The processing section of the screw press comprises a worm shaft which rotates at a speed of about 100 RPM inside a closely fitting barrel composed of separate rings spaced apart by shim washers. The gaps between the barrel rings are relatively wide at the low pressure or feed end of the screw press and narrower at the high pressure or "choke" end.

The rotation of the wormshaft conveys the chopped copra into the barrel where it is subjected to compressive, shearing and frictional heating action which expels the oils from the copra through the gaps between the barrel rings.

The passage of the processed copra out of the barrel is restricted by a choke, consisting of a ring with a taper bore which engages with a taper plug at the end of the wormshaft. The size of the gap between the taper plug and the taper bore controls the pressure to which the copra is subjected in the barrel and is adjusted by moving the wormshaft axially by means of a choke operating screw at the feed end of the screw press.

The size of the gap is indicated by the thickness of oil-cake expelled through the choke ring. Routinely, oil-cake was produced in the form of flakes about 1 mm in thickness.

The crude oil has associated with it about 7 per cent sediment which gives the freshly produced oil a dark colour and which requires removal to obtain clarified oil.

The relatively fast speed (around 100 RPM) at which the wormshaft operates imparts a strong shearing action on the copra resulting in a pronounced frictional heating effect which facilitates the compressive release of oil from the oil cells in the copra.

As a result of the heating action, some moisture is lost from the system in the form of vapour and the oil cake produced contains less total moisture than the copra from which it was obtained.

The chopped copra may be processed at ambient temperatures or may be processed hot after treatment in the copra heater.

The average fuel consumption of the screw press was found to be about 11.7 litres of diesel fuel per tonne of copra processed.

A summary of the results obtained in processing old and new copra under ambient conditions and when heated is given in Table 2.1.

2.3.3.1 Processing at Ambient Temperatures

Freshly Prepared Copra

Using freshly prepared copra (66.7 per cent oil), which had a moisture content averaging about 5.3 per cent, an average throughput of about 63 kg of chopped copra per hour was achieved with the screw press operating at 95 to 100 RPM and the choke set to give a 1 mm thick oil-cake. These operating conditions produced an average yield of 560 kg of oil plus sediment, and about 421 kg of oil-cake from 1000 kg of chopped copra, with an associated 19 kg loss mainly the result of the evaporation of moisture during the oil expelling process. The average mass balance obtained is shown in Appendix D, Table D4.

In later trials, the throughput of chopped copra increased to about 71 kg/hr and the oil yield was found to improve to 580 kg with about 390 kg of oil-cake being produced from 1000 kg of copra with a processing loss of about 30 kg. This improvement in oil yield could be attributed to the screw press becoming 'run in' and/or to variations in the quality of the copra processed. Operating the screw press for six hours a day at these throughput rates, between 378 and 414 kg of chopped copra could be processed, yielding from 212 to 241 kg of crude oil and from 159 to 162 kg of oil-cake wi an average oil content of about 26.9 per cent.

TABLE 2.1 AVERAGE OIL AND CAKE YIELDS OBTAINED DURING TRIALS

RUN DATES FROM	21 AUG	5 SEP	25 SEP	22 OCT
TO	3 SEP	31 OCT	24 OCT	31 OCT
PROCESSING TEMPERATURE	AMBIENT	AMBIENT	65°C	AMBIENT
AGE OF COPRA	OLD	NEW	NEW	NEW
NUMBER OF RUNS	12	14	5	3
TOTAL COPRA PROCESSED, Kg	592	1806	750	255
COPRA THROUGHPUT, Kg/hour	61.7	62.9	71.4	70.8
TOTAL TIME, hours	9.6	28.7	10.5	3.6
TOTAL OUTPUT:-				
CRUDE OIL, Kg	357	1012	433	148
OIL CAKE, Kg	225	760	280	99.4
YIELD PER TONNE COPRA:-				
CRUDE OIL, Kg	603	560	577	580
OIL CAKE, Kg	380	421	373	390
FILTER CAKE AND SEDIMENT, Kg	41	41	46	41
FILTERED OIL, ESTIMATED, Kg	562	519	531	539
FILTERED OIL, ESTIMATED, litres	626	578	591	600

Data obtained from individual trials using new stock copra is given in Annex D, Table D.1.

2.3.3.1.2 Old Stock Copra

Using the best material that could be selected from old stock copra (67.4 per cent oil, and apparently mould free), which had a moisture content averaging about 4.3 per cent, an average throughput of about 62 kg chopped copra per hour was achieved with the screw press operating at 95 to 100 RPM and the choke set to give a · mm thick oil cake. These operating conditions produced an average yield of 603 kg of oil plus sediment and about 380 kg of oil cake from 1000 kg of chopped copra, with an associated moisture and processing loss of about 17 kg. The average mass balance obtained is shown in Annex D, Table D.5.

Operating the screw press for six hours a day on old stock copra, about 372 kg of chopped copra could be processed, yielding about 223 kg of crude oil and about 142 kg of oil cake with an average oil content of about 19.7 per cent. Data obtained from individual trials using old stock copra is given in Annex D, Table D.2.

2.3.3.2 Processing Heated Copra

Copra heated to 65°C

Chopped new stock copra was heated in 25 kg batches to 65°C in the copra heater before being fed to the screw press. Heating reduced the moisture content of the chopped copra from about 5.3 per cent to about 3.7 per cent.

On processing, the throughput of the heated chopped copra increased to an average of 71 kg per hour in comparison with the overall average of about 63 kg per hour for unheated copra and the 71 kg per hour for unheated copra in later trials.

The output of crude oil was about 577 kg from 1000 kg of chopped copra, an increase from the 560 kg average for unheated copra but similar to the average of 582 kg for unheated copra in later runs when the screw press had 'run in'. As the trials with heated copra were also conducted towards the end of the running trials it would seem that no gain in crude oil yield was achieved by heating copra to 65°C.

The yield of cake was 373 kg in comparison with the average 421 kg found for unheated copra, the reduction being mainly the result of the moisture lost during the heating of the copra.

It was also noted that, although the sediments in the oil tended to take longer to settle than those in the oil from unheated copra, no resulting adverse effects were experienced during the later stage of oil filtration (see Figure 2.4).

Operating the screw press for six hours a day, about 432 kg of heated copra could be processed, yielding about 250 kg of crude oil and about 161 kg oil-cake with an average oil content of about 23.9 per cent. Data obtained from individual trials using new stock copra heated to 65°C is given in Annex D, Table D.3.

Copra heated to 80°C

Processing copra heated to 80°C gave little advantage in oil extraction efficiency; crude oil yield was equivalent to about 591 kg from 1000 kg copra.

Other considerations

Although heating the copra produced little or no overall gain in oil extraction efficiency when processing the 5.3% moisture content copra available in the Cook Islands, heating would be beneficial in areas where the available copra moisture contents were higher.

For instance, when a special batch of copra prepared by the team was processed unheated at a moisture content of about 9.2 per cent, the crude oil extraction rate was reduced to about 37.1 per cent in comparison with the overall average of 56.0 per cent found for unheated copra at a moisture content of 5.3 per cent.

In previous development work carried out at TDRI, the oil extraction efficiency of the continuous screw press was at an optimum when processing copra at moisture contents between 3 and 6 per cent. The results obtained during these trials tended to confirm this finding.

2.3.3.3 Variations in Operating Conditions of the Screw Press

Choke Settings

The standard choke setting selected for the trials gave an oil cake about 1 mm thick. Choke settings to give a cake thickness less than 1 mm resulted either in blockages or in excessive amounts of copra fines being expelled through the barrel rings. Settings which gave a thicker cake resulted in lower oil yields.

Spacing of Barrel Rings

The crude oil produced by the screw press always contains a proportion of copra fines. Since losses of oil are associated with the presence of these fines it is important to restrict their production as far as possible. Although the closer the barrel rings are set together, the less is the proportion of fines expelled with the oil, a point is reached when the flow of oil becomes impeded and excessive amounts of oil remain within the barrel causing the wormshaft to slip. This results in a lowering of the copra throughput rate of the screw press and a consequent reduction in the efficiency of oil extraction. Thus it is important to set the barrel rings as close as possible while at the same time maintaining an effective drainage rate for the oil expelled from the copra.

A number of spacer settings were tested during the trials and the setting given below in thousandths of an inch was found to be the closest setting that could be used consistent with good oil drainage from the barrel.

FEED END 30, 30, 20, 10, 5, 5, 5, 5, 5, 5, 5 CHOKE END

Wormshaft Rotational Speed

The effect of altering wormshaft rotational speed was investigated. The screw press operated smoothly at 80 and 100 RPM, but at 110 RPM excessive vibration from the diesel engine began to become apparent and the level of vibration experienced above 110 RPM made operation at higher speed impractical. Alteration of the belt drive ratio of the press could probably allow higher wormshaft RPM, but it was not possible to test this during the trials.

As would be expected, the rate of copra throughput was altered according to wormshaft RPM. Hourly copra throughputs were 53 kg, 63 kg and 67 kg at respectively 80 RPM, 100 RPM and 110 RPM.

As similar yields of about 61 to 62 kg of crude coconut oil per 100 kg copra were obtained at all these speeds it was decided to use 100 RPM as the standard setting throughout the trials as being consistent with vibration free running and the fastest practical copra throughput per hour.

Recycling Oil Cake (Double pressing)

When oilcake was ground in the copra chopper and passed again through the screw press, about 19 kg of additional oil plus sediment was recoverable from 100 kg of oil cake at a throughput of about 45 kg/hr.

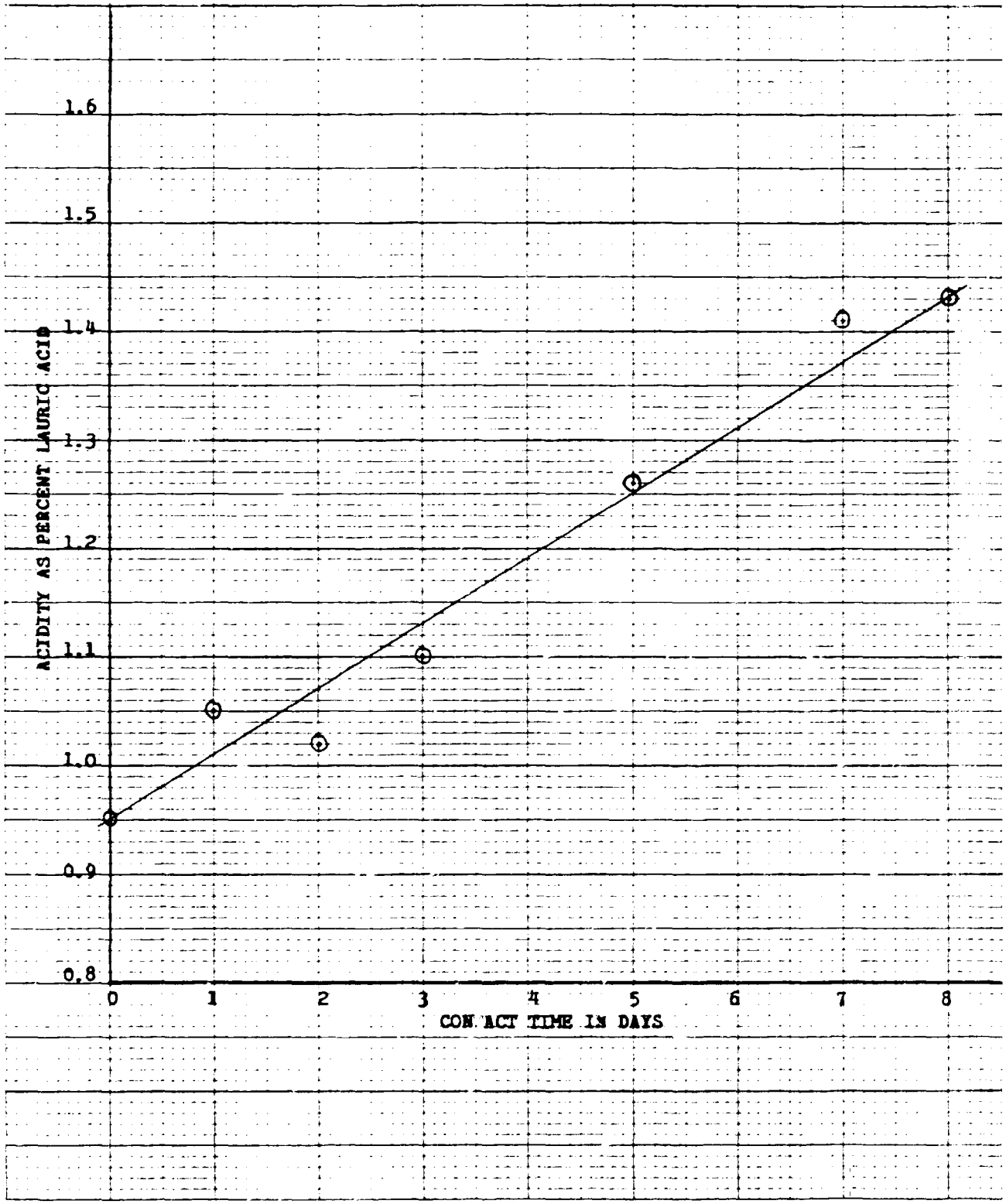
However, the operation of the screw press using oil cake was more difficult to control than when copra was used, with constant adjustment of the choke control being required to avoid blockages and to maintain a steady throughput. The screw press was also under greater stress than when copra was processed. This was shown when breakage of one of the barrel rings occurred during an experimental trial using oil cake. In contrast, no barrel rings broke during the processing of chopped copra. The additional amount of crude oil recoverable by recycling the oil cake produced from 100 kg of copra would be about 8.0 kg. This additional oil would be produced at a rate of about 8.6 kg/hr in comparison with the average production rate of 35 kg an hour of crude oil obtained from chopped copra processing.

Double pressing would reduce the amount of oil cake yielded by 100 kg of copra to about 31.9 kg (oil content 12.9 per cent) in comparison with the 42.1 kg average obtained by single pressing.

As a ready animal feed market existed for the oil cake produced by single pressing and in view of the much lower oil yield obtained per hour and the increase in wear on the screw press found during double pressing it was concluded that double pressing was not a worthwhile operation.

FIGURE 2.3

DEVELOPMENT OF ACIDITY IN COCONUT OIL STANDING IN CONTACT WITH SEDIMENT



2.3.4 Operation of the Filter Press (Clarification of Oil)

Overall the filter press produced a satisfactorily clarified oil at a rate of about 100 kg an hour. This filtration rate fitted in well with the operating requirements for the processing of 200 kg of oil and 400 kg of copra per day. The yields of clarified oil obtained from copra processed under different conditions are summarised in Table 2.2.

2.3.4.1 Oil Settling Time

Since free fatty acid levels increased in crude coconut oil left in contact with sediment (see Figure 2.1) it is important to minimise the delay between extraction and filtration if optimum quality oil is to be obtained. Preferably the oil should be filtered the day after extraction.

2.3.4.2 Filtration

A day's production of about 200 kg of crude oil, produced from unheated copra, typically contained about 14 kg of sediment.

As unacceptably slow filtration rates of about 33 kg/hr of oil were obtained when crude oil was filtered on the day it was produced, it was preferable to allow crude oil to stand overnight before filtration so that some of the coarser sediment particles could settle out.

After allowing the batch of oil to stand undisturbed overnight about 8.6 kg of sediment settled out to form a layer at the bottom of the crude oil container, from which the oil could be decanted, or more normally, was left in place until the filtration process had finished. These solid sediments were not passed into the filter press.

The rest of the sediment, about 5.4 kg, was of a finely divided nature which did not settle readily and which imparted a dark colour to the oil. This finely divided sediment was removed from the oil by passing it through the filter press.

The maximum filtration rate of the filter press was in the region of 3 litres of clarified oil a minute, but when the sediments built up as filter cake on the filter cloths, the filtration rate decreased and the operating pressure increased.

The best operating procedure was to halt filtration and clean the filter cloths after about 100 kg of oil had been filtered which took about 60 minutes. At this point the filtration rate had usually fallen to the region of 1 kg of oil per minute. The filter press could be cleaned and restarted again in about 20 minutes, and thus it was possible to filter 200 kg of oil in about 2½ hours.

When the compressed air inlet was used to empty the filter press at the end of a filtration cycle, about 4 kg of additional clarified oil was obtained and about 8 kg of unfiltered oil remained in the press. As this procedure could take from 30 to 60 minutes to complete, it may not be a worthwhile operation.

2.3.4.3 Processing of sediment and filter cake obtained from the oil clarification process

As the sediment typically contained about 79.9 per cent oil and the filter cake about 42.2 per cent oil, recycling methods that could be used to recover this oil were investigated. Whereas sediment could be recycled without re-appearing as additional sediment when the crude oil was settled overnight, addition of filter cake tended to increase the amount of filter cake produced when the oil was filtered. It would be preferable therefore to dispose of the filter cake by blending it with the oil cake.

As oil in contact with sediment develops off-flavours rapidly, re-cycling the sediment or filter cake should be approached with caution when oil for edible purposes is being produced. Only freshly obtained sediment should be used and it may be preferable to omit recycling altogether in the case of edible oil production. For cosmetic oil and soap production the recycling of sediment would be feasible.

Processing copra at Ambient Temperatures

Under ambient processing conditions it was possible to mix the sediment and filter cake obtained from the filtration process with the chopped copra fed to the screw press. This produced no processing problems but whereas 'solid' sediment could be added back to the feed without increasing the proportion of 'solid' sediment deposited by the oil when it was allowed to stand, additions of filter cake tended to marginally increase the amount of filter cake obtained during the subsequent filtration (see Table 2.2). Thus although reprocessing

the 'solid' sediment was feasible, it was preferable to dispose of the filter cake by blending it with the oil-cake.

The sediments in oil from copra with added, recycled sediment took longer to settle than those present in the oil produced from copra with no added sediment (see Figure 2.2). However, the later filtration stage was not impeded.

The overall effect of recycling the sediment and filter cake was to produce an increase in the yield of oil-cake with minimal effect on the amount of oil produced.

The copra throughput rate was about 63.8 kg/hr yielding about 599 kg of crude oil and about 419 kg of cake from 1000 kg of copra. Operating the screw press for six hours a day about 383 kg of copra plus sediments could be processed, yielding 229 kg of crude oil and 160 kg of oil cake.

Processing heated copra

When heated copra was processed with filter cake and sediment added back the results were similar to those obtained under ambient processing conditions. No processing difficulties were experienced and increases in the yield of crude oil were obtained. However the sediment took longer to settle than that in the oil produced from heated copra without added sediment (see Fig. 2.4). The amount of 'solid' sediment deposited when the oil was allowed to stand tended to be marginally more compared with that found when the sediment was not added back. The amount of filter cake obtained during the filtration process was also significantly increased (see Table 2.2).

The copra throughput rate was about 68 kg/hr, yielding about 628 kg of crude oil and about 359 kg of oil cake from 1000 kg of heated copra.

About 408 kg of heated copra plus sediment could be processed in a six hour day, yielding about 256 kg of crude oil and 146 kg of oil-cake.

2.3.4.4 Yields of Clarified Oil

From Copra Processed under Ambient Conditions

(a) Without addition of sediment and filter cake

The performance of the filter press was examined towards the end of the trials when the average yields from 1000 kg of copra were in the region of 583 kg of crude oil and about 391 kg of oil cake.

On standing the crude oil deposited about 25 kg of settled sediment and on passing the supernatant oil containing the suspended sediment through the filter press a yield of about 541 kg of clarified oil was obtained with about 16 kg of sediment retained as filter cake.

(b) With addition of sediment and filter cake
When about 18 kg filter cake and 27 kg of settled sediment were added to 1000 kg of chopped copra average yields of about 599 kg crude oil and 419 kg oil cake were obtained. On standing, the crude oil deposited about 26 kg of sediment, and on passing the supernatant oil through the filter press a yield of about 546 kg of clarified oil was obtained with about 27 kg of filter cake.

From copra processed at 65°C

(a) Without addition of sediment and filter cake
On processing 1000 kg copra heated to 65°C yields of about 570 kg of crude oil and about 377 kg cake were obtained.

On standing the oil deposited about 28 kg of settled sediment and on passing the supernatant oil through the filter press a yield of about 524 kg of clarified oil was obtained with about 18 kg of filter cake.

(b) With addition of sediment and filter cake
When about 19 kg of filter cake and about 31 kg of settled sediment were added to 1000 kg copra and processed at 65°C, yields of 628 kg of crude oil and 359 kg of oil cake were obtained.

On standing the oil deposited about 53 kg of settled sediment and on passing the supernatant oil through the filter press a yield of about 544 kg clarified oil was obtained with about 32 kg of filter cake.

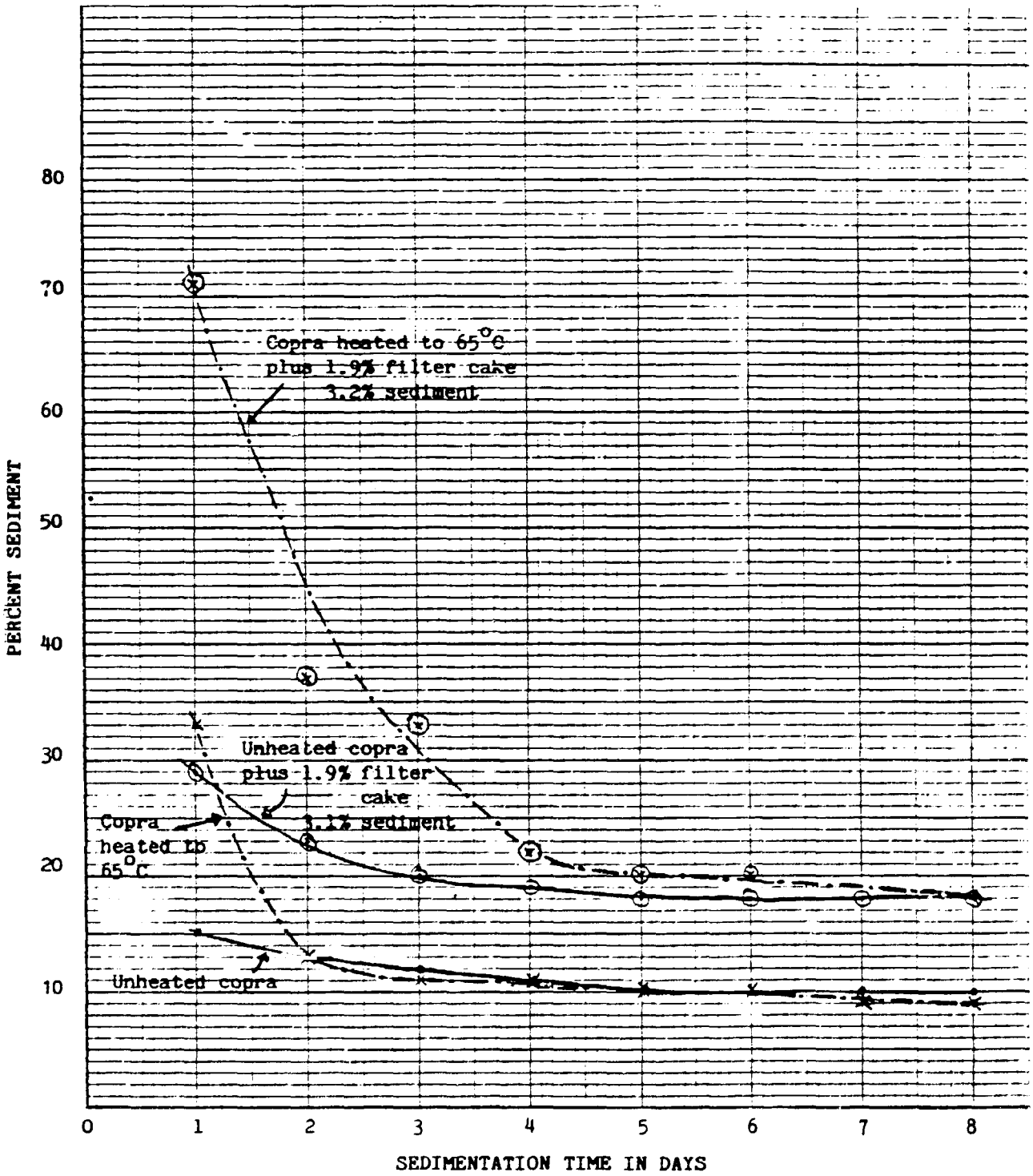
These results are summarised in Table 2.2, which highlights the consistency of clarified oil yield under a range of different processing options. For the purpose of financial evaluation in Section 6, clarified oild yield is assumed to be 600 litres (approximately 545 kg) per tonne of copra. Oil cake yield is

estimated at 410 kg, assuming filter cake is added to the expeller cake, and sediment is recycled.

Table 2.2 PROJECTED YIELDS OF CLARIFIED OIL FROM 1000 KG NEW STOCK COPRA PROCESSED UNDER DIFFERENT CONDITIONS

PROCESSING TEMP °C	ADDED FILTER CAKE KG	ADDED SEDIMENT KG	AVERAGE CRUDE OIL YIELD KG	AVERAGE CAKE YIELD KG	AVERAGE FILTER CAKE KG	AVERAGE SEDIMENT KG	AVERAGE CLARIFIED OIL YIELD KG	AVERAGE YIELD CLARIFIED OIL LITRES
AMBIENT	0	0	583	391	16	25	542	602
AMBIENT	18	27	599	419	27	26	546	607
65°	0	0	570	377	18	28	524	582
65°C	19	31	628	359	32	53	543	603

FIGURE 2.4: SEDIMENTATION RATE OF CRUDE COCONUT OIL (DAY OF PRODUCTION = 0)



SECTION 3 RECOMMENDED OPERATING PROCEDURES

3.1 Selection of Copra

Based on experience gained with Cook Islands copra, a general guide to the considerations involved in the selection of copra for the production of oil for different end uses is given below.

3.1.1 Copra for Edible Oil Production

For edible use it is important to obtain an oil of the finest possible flavour. The main influences on the flavour of the oil are its acidity and the age of the copra from which it has been produced. Oil acidity levels should be as low as possible, because high acidity levels give the oil an unpleasant sharp flavour. Fresh copra that has been dried without delay to a moisture content below 6 per cent yields an oil with a fine coconut flavour and aroma and a low acidity whereas oil from old copra tends to have a stale flavour and higher acidity levels.

Copra needs to be specifically prepared and selected for edible oil production in situations where refining is not anticipated. The copra used should be fresh, premium quality i.e. white and mould free with a moisture content below 6 per cent, and should produce a coconut oil with an acidity level below 0.4 per cent.

3.1.2 Copra for Cosmetic Oil Production

To produce oil for cosmetic purposes, old premium grade copra or copra with a slight surface covering of mould can be used. The moisture content of the copra should be below 6 per cent, and oil with an acidity not higher than 1.3 per cent can be accepted.

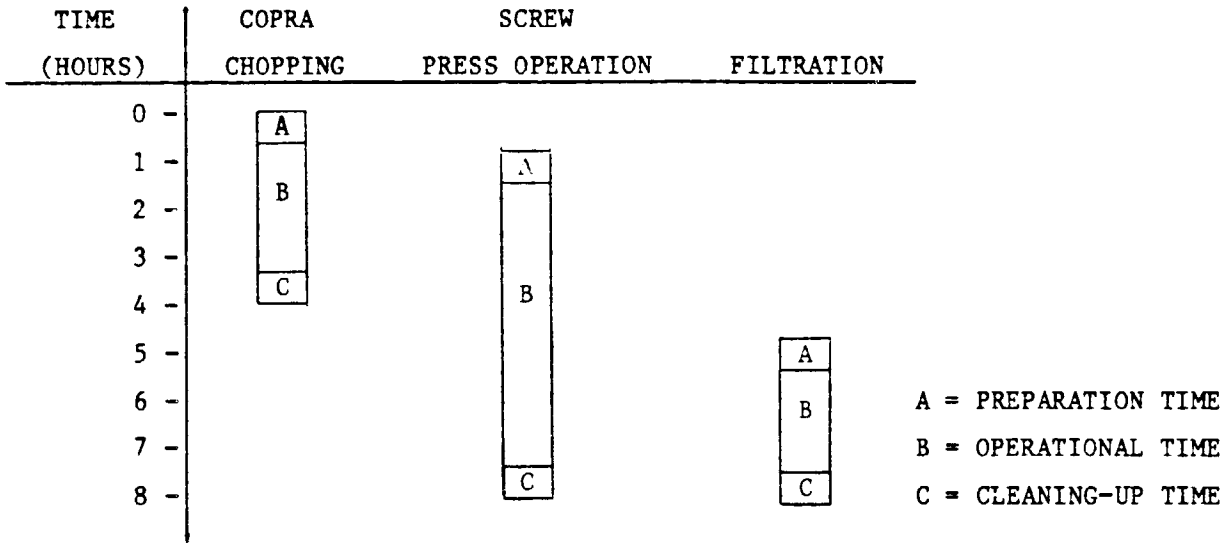
3.1.3 Copra for Soap Oil Production

For the production of oil for soap making, copra with more extensive mould damage, or old discoloured copra may be used, but the copra should not be in such a deteriorated state that an unacceptable colour is given to the soap made from it.

3.2 Organisation of working day

It was concluded that a working day, in which the screw press is operated for six hours, is best organised according to the schedule in the bar chart below.

Figure 3.1 Schedule for Working Day



The first operation of the day is to begin the preparation of chopped copra. After about 60 kg of copra has been chopped the oil expelling operation should be started. The oil filtration operation should start after all the chopped copra required has been prepared.

3.3 Operational Considerations

3.3.1 Copra chopping

Only the copra required for each days production should be prepared since it is best to process the copra as soon as possible after it has been chopped so as to minimise deterioration of the oil. Care must be taken to ensure that possible contaminants of the copra such as stones or pieces of metal are removed before the copra is chopped. Large pieces of copra should be broken in two before being fed to the chopper to avoid blockages. The total weight of copra chopped should be entered in a Process Record Book. Any added sediment should be distributed uniformly by hand throughout the chopped copra feedstock in the same proportion to its production rate i.e. the sediment obtained from processing 1000 kg copra should be blended with 1000 kg copra.

3.3.2 Operation of the Screw Press

When first starting up the screw press the choke should be set just wider than the usual operating position to give an oil cake about 1.5 mm in thickness. The vibratory feeder should be set to a low setting so that the chopped copra is fed in extremely slowly through the hopper and directly onto the wormshaft. The copra feed rate should be such that the supply of copra is just sufficient to come halfway up the wormshaft. If a squealing sound is heard the choke control should be slackened so as to produce a slightly thicker oil cake.

Smooth operating conditions have been established when the copra has started to pass through the barrel and emerge as oil cake, accompanied by no squealing sounds or interruption in throughput. At this point, the copra feed rate should be slowly increased until the wormshaft is completely covered.

Once smooth operation is again achieved with the wormshaft completely covered with copra, the vibratory feeder can be speeded up so that the feed hopper is kept filled with chopped copra.

After two or three minutes running, the choke control should be carefully closed until an oil cake of about 1 mm thickness is obtained.

The weight of the crude oil and oil cake produced should be entered in the Process Record Book on a regular basis.

At the end of the run, the wormshaft should be removed from the screw press, and the oil cake remaining inside the barrel should be cleaned out. If this residual oil cake is not cleaned out immediately at the end of the run, it tends to harden and ultimately become difficult to remove. Cake left in place in the barrel causes blockage problems to occur on restarting the press.

3.3.3 Operation of the Filter Press

The crude oil produced by the screw press should be allowed to stand undisturbed overnight before filtering in order to allow the sediments to settle. Before starting filtration, the setting of the relief valve should be checked to ensure that pressure is being applied to its diaphragm by the pressure controlling spring

On starting filtration, the pump should be primed by holding the flexible inlet pipe upright and filling it with crude oil. Care should be taken not to disturb the sediment when placing the flexible feed pipe to the filter press into the drum containing the crude oil. The feed pipe should be positioned well above the sediments to begin with and only lowered as necessary with the fall in level of crude oil in the drum as filtration proceeds.

The first oil to emerge through the outlets of the filter press will not be entirely clear. This should be collected separately and returned to the input. After a few minutes operation when the oil becomes clear it can then be run into the output drum.

Initially the pressure relief valve should be set to open at about 2 bar. When the pressure relief valve starts to operate, the crude oil bypassed through the valve should be collected in a separate bypass drum so as to avoid the disturbance to the sediment in the main input drum. This would occur if the bypassed oil was allowed to fall directly into the drum. When the bypass drum becomes full of oil, the feed pipe to the filter press is then repositioned to draw off the oil from the bypass drum.

By switching the feed pipe between the main input drum and the bypass drum, the filtration proceeds quickly with the minimum disturbance of sediment. As the filtration operation proceeds and the flow of crude oil bypassed by the pressure relief valve becomes excessive, the valve should be adjusted to open at steadily increasing pressures up to a maximum of 7 bar.

When the output rate of filtered oil falls below about 1 kg of oil per minute or when the operating pressure rises to 7 bar the filtration should be stopped to allow the filter press to be opened and the filter cloths cleaned.

When the filter pump is switched off, the pressure should be allowed to fall before the press is opened. Before opening the press the outlet valves should be shut to avoid contamination of the filtered oil in the output drum.

When the press is opened the unfiltered oil that is released from within the press should be collected and returned to the bypass drum.

The sediment or filter cake on the filter cloths should be removed by careful scraping with a plastic scraper such as those used to remove ice from a deep

freeze. Metal scrapers should not be used as these will damage the filter cloths.

When the filter cake has been removed from the cloths, the filter press should be carefully reassembled making sure that the cloths are properly in place. The filtration process can then be started again as before, with the first oil to emerge from the outlet ports being collected separately and returned to the input until a clear filtered oil is obtained. The weight of oil filtered should be entered in the Process Record Book.

3.3.4 Disposal of filtration sediment and filter cake

(a) Settled Sediment

The sediment deposited by the oil may be blended with the chopped copra feedstock to the screw press. However as the flavour of the oil in the sediment rapidly deteriorates, incorporation of the settled sediment should be approached with caution. Only fresh separated sediment should be added to edible oil production runs and it may be preferable to omit it altogether. However, the addition of freshly separated sediment to the feedstock for cosmetic oil production would be acceptable.

For the production of oil for soapmaking, the age of the sediment is not so critical, although it should be processed as soon as possible in order to avoid problems with the development of rancid odours.

An alternative solution would be to dispose of freshly settled sediment by blending it with oil cake, as described below for filter cake.

(b) Filter cake

Filter cake should be disposed of by blending it uniformly with the oil cake in proportion to the rate at which it is produced i.e. the filter cake obtained from the processing of 1000 kg of copra should be blended uniformly with the oil cake produced from 1000 kg of copra.

3.3.5 Summary of Operational Considerations

1. The feed stock to the screw press should consist of freshly-chopped un-

heated copra blended where appropriate with the solid sediment deposited by the oil.

2. The screw press should be set to operate at about 100 rpm.

3. At the start of the oil expelling operation the choke control should be adjusted so that an oil cake of about 1.5 mm in thickness is obtained, and the feed rate should be carefully controlled so that the chopped copra does not completely cover the feed end of the wormshaft visible at the bottom of the hopper.

4. Once the smooth operation of the expeller has been achieved the feed hopper should be kept filled with chopped copra and the choke control set to give a 1 mm thick oil cake.

5. Prior to filtration, the crude oil produced should be allowed to stand overnight to allow the coarse sediment to settle out.

6. Before starting the filter press pump the setting of the pressure relief valve should be checked and the pump should be primed by filling the inlet pipe with oil.

7. During filtration the pressure relief valve should initially be set to open at about 2 bar and the input pipe of the filter press should be carefully positioned so as not to disturb the settled sediments. Oil bypassed by the relief valve should be led into a separate bypass drum. When the amount of oil bypassed becomes excessive, the relief valve should be re-set to open at higher pressures up to a maximum of 7 bar. The filter press input pipe should be repositioned to draw off the oil from the bypass drum when this becomes full.

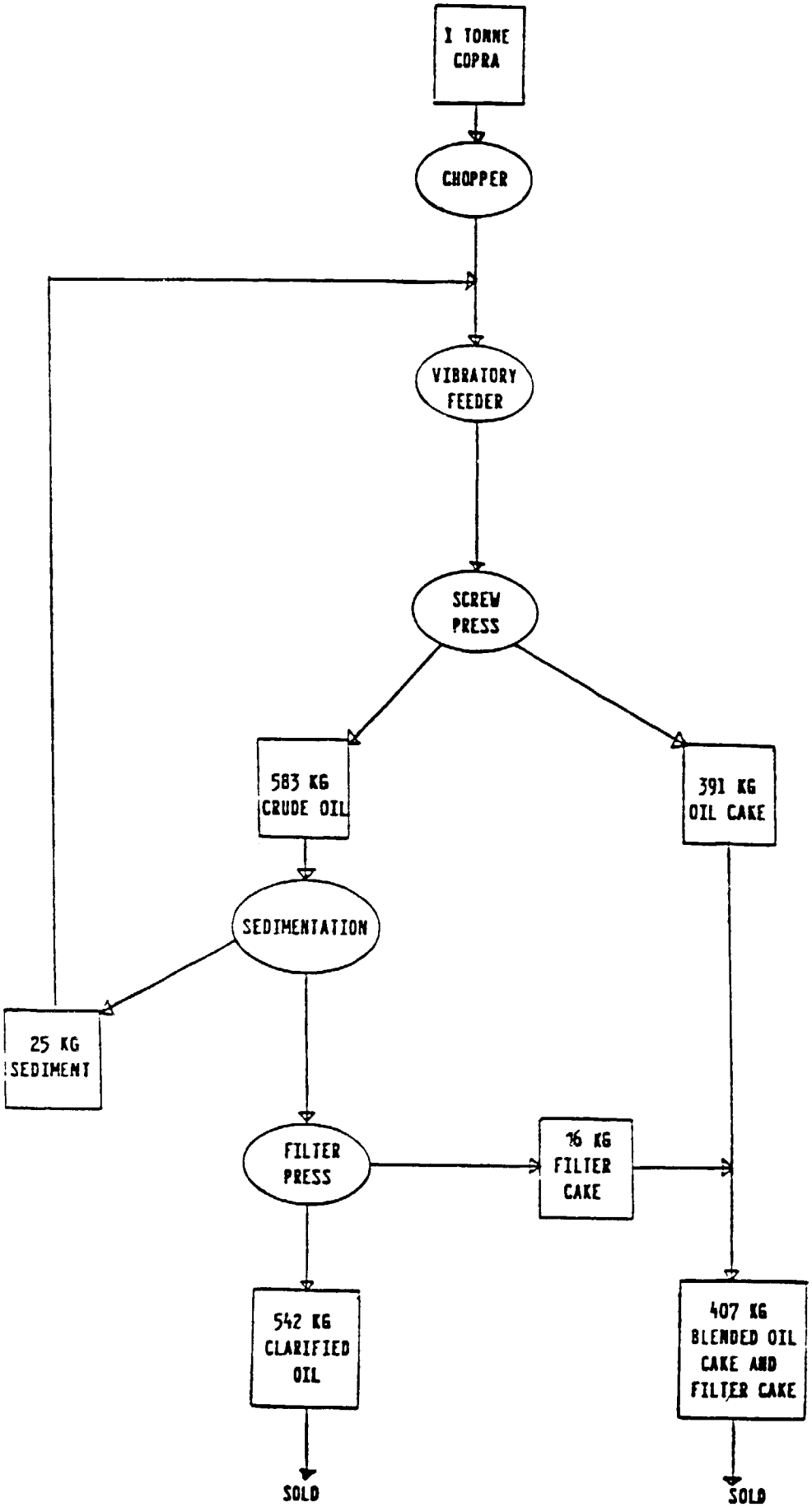
8. Filtration should be stopped and the filter cake cleaned from the filter cloths after about 100 kg of oil has been filtered, or when the filtration rate drops below about 1 kg oil per minute or when the operating pressure rises to 7 bar.

9. The filter cake obtained should be disposed of by blending it uniformly with the oil cake in proportions similar to their relative production rates.

10. At the finish of the day's operation the wormshaft should be removed from the screw press and residual cake removed from the barrel.

Figure 3.2

Flow chart showing recommended op... ing procedure.



SECTION 4 THE PRODUCTION AND MARKETING OF COPRA IN THE COOK ISLANDS

4.1 Production of copra

In the period 1965 to 1985, copra production in the Cook Islands has ranged from 585 tonnes to 1750 tonnes per year, averaging about 1000 tonnes per year in the 1980s. Fluctuation in production is in part due to climatic factors - for example the record low output in 1983 was attributed to prolonged dry weather; copra production is also responsive to market factors - when prices are very low people simply give up making copra, and let the coconuts either rot or feed them directly to pigs.

Previous studies (UNIDO, 1981; ESCAP, 1985) suggest that copra production has been declining slowly in the Cook Islands in the last two decades, partly reflecting inadequate replanting, and partly reflecting a slow decline in the human population through migration to Rarotonga and New Zealand, with an associated decline in most economic activities. On the two main islands where copra is produced, production of pearl shells is an alternative economic activity which has taken labour away from copra production at times of low copra prices.

According to a survey carried out by the Agricultural Planning Unit of the Ministry of Agriculture in December 1985, the Northern Group has a coconut palm density of 375 trees per hectare, with an annual yield of 3.2 kg of copra per producing tree, or 400 kg of copra per hectare. This compares with feasible production of up to 1250 kg of copra per hectare on a properly managed plantation, indicating that "there is still a lot of room for improvement of the copra production on the Northern Islands". Coconut rehabilitation programmes are at present limited in extent.

Production is concentrated in the Northern Group of islands, (see Table 4.1) where it has often been the sole source of cash income. On Rarotonga, which is the most populated island, most of the coconuts are used for direct human consumption (it is estimated that a typical Polynesian home uses about five coconuts per day); nuts are also fed directly to pigs, and a coconut cream factory processes more nuts than can be supplied locally, and it offers prices per nut above the level appropriate to copra production. Apart from these factors, per capita incomes on Rarotonga are sufficiently high (among the highest in the Pacific islands) to make copra-making an unattractive occupation.

Table 4.1 Production of copra in the Cook Islands, by island, 1977 to 1984 (Metric tonnes)

		1977	1978	1979	1980	1981	1982	1983	1984	Annual Average 77 to 84	
A Northern group											(%)
1	Manihiki	279	230	503	132	324	219	124	344	269	28
2	Penrhyn	131	131	493	118	136	308	75	195	198	20
3	Rakahanga	217	159	289	121	146	225	81	262	188	19
4	Pukapuka	174	86	207	144	157	177	147	157	156	16
5	Nassau (1)	...	...	...	...	...	59	53	55	21	2
6	Suwarrow	nil	nil	nil	nil	nil	nil	nil	nil	nil	0
B Southern group											
7	Palmerston	23	13	12	33	33	36	43	30	28	3
8	Aitutaki	119	21	87	132	84	62	19	58	73	8
9	Mauke	23	2	11	15	5	5	6	2	9	1
10	Atiu	neg	neg	1	3	16	38	..	21	12	1
11	Mitaro	neg	neg	5	14	9	2	5	neg	4	0
12	Manuae	neg	neg	neg	21	51	6	8	neg	11	1
13	Mangaia	neg	neg	neg	2	1	1	neg	neg	1	0
14	Rarotonga	nil	nil	nil	nil	nil	nil	nil	nil	nil	0
15	Takutea	nil	nil	nil	nil	nil	nil	nil	nil	nil	0
	Cook Islands:	966	642	1608	735	962	1138	575	1124	969	100

Source: Statistics of Commercial Agricultural Production and Prices, 1983/84.
Agricultural Planning Unit, Ministry of Agriculture, Rarotonga.

Notes: (1) In the period 1977 to 1981, production on Nassau is included with Pukapuka.

(2) 'neg' indicates negligible quantity.

In the Northern Group, it is reported that most copra is sun-dried, hot-air drying being practised only in times of wet weather. Cooler and generally wetter weather prevails in the Southern Group, where copra is most commonly prepared by hot-air drying. Because of problems experienced with the poor quality copra available in Rarotonga at the beginning of the field work (discussed below), the team visited neighbouring Aitutaki (which was accessible by air) to investigate copra production and marketing systems. It was reported by both the Ministry of Agriculture and the Northern Islands Copra Marketing Board that methods and standards in the Northern Group are much better than was observed on Aitutaki. Unfortunately, because of the time and expense involved, it was not feasible to visit any islands in the Northern Group.

4.2 Copra marketing

A government Copra Marketing Board was established in 1976 and operated a stabilisation fund to maintain a steady year-to-year price for producers. This Board was disbanded in 1980 as part of a strategy to hand over control to a growers' organisation. Subsequently the Northern Islands Copra Marketing Board (NICMB) was established as a private company representing producers' interests; although it has no legal monopoly powers, it is in effect the only firm handling the export of copra from the Cook Islands, and deals with the production from all of the islands.

Ministry of Agriculture copra extension officers visit copra producers on a regular basis to provide advice and to maintain standards of production; these officers are also responsible for quality control of copra delivered to central stores for export. Only one grade of copra is now recognised (in the past several grades have been defined) and no instances of copra being rejected are known to the team. Upon delivery of copra to the central stores, producers are not paid in cash. Payment is authorised only when the copra is received into the Rarotonga stores under the supervision of the NCIMB, at which time money is issued by the NCIMB through the Government Post Office Banks. This is commonly up to 6 weeks after the producer has delivered his copra.

Prices paid to producers are in theory related to long-term trend international prices, with the difference between the fixed price and the international market price being diverted to or from a stabilisation fund. At the beginning of the 1980s, the producer price was NZ$400 per tonne, but was subsequently dropped to NZ$350 per tonne, which was the current price at the time of the visit. At this

price level, the NCIMB had completely exhausted its stablisation fund and was on the verge of insolvency, because of very low international prices for copra in the period 1984-85. Indeed, international prices for a period had barely been sufficient to cover the cost of freight of copra to New Zealand, and NCIMB had not been buying copra since late 1985 at the time of the team's visit to Rarotonga in August-December 1986.

Negotiations were under way in late 1986 to lower the copra support price to NZ$300 per tonne, or possibly lower, and Government assistance was being sought to refinance the stabilisation fund. This would be a positive development from the point of view of small scale copra processing on Rarotonga, as the price of raw material would be lowered significantly.

In 1986, the costs of transporting copra from the central stores on each of the islands to main stores on Rarotonga ready for export to New Zealand was in the region of NZ$100 per tonne, averaged over all production. This comprised mainly the cost of freight and gunnies. For some islands where there is no deep water harbour, inter-island ships have to be loaded by small boats, so that lighterage charges are significant. Unloading charges at Rarotonga are incurred, and agency fees are payable to the Treasury for administration of the payment to producers via the Post Office banks. Other minor charges are also incurred, including insurance, turnover tax, and tarpauline hire.

On the basis of a producer price of NZ$350 per tonne, the landed Rarotonga price of copra is approximately NZ$450 per tonne. If the producer price is dropped to NZ$300 per tonne, as currently being discussed in the Cook Islands, the landed-Rarotonga price will drop accordingly to NZ$400 per tonne.

4.3 The quality of Cook Islands copra

Generally, the quality of copra produced in the Cook Islands appears to have been very acceptable to international buyers. In the past, most exports have gone to the Abel's company in New Zealand, who have reportedly paid the full international price for copra plus a small premium, and have not complained about quality standards. When the coconut oil is going to be refined after extraction from the copra, a certain level of deterioration in the copra can be tolerated. From the point of view of small-scale copra processing, without refining, with a view to making an edible oil, quality requirements are clearly likely to be more stringent.

When the team arrived to undertake the field trials with the copra expeller, the only copra available in Rarotonga had been in store for over 8 months because of the slump in international prices, and some of the copra was so deteriorated that it was no longer exportable. While supplies of fresh copra were being arranged, initial trials of the equipment were undertaken using the best material that could be hand-sorted from the available stocks. Oil produced from this copra had an acidity of about 1 per cent, detectable as a burning sensation at the back of the mouth shortly after the oil was tasted. A preliminary market survey conducted using this oil is described in Section 5.2. Although more people disliked the oil than liked it, the team was encouraged at the number of people who indicated they found it acceptable as a cooking oil, despite the poor quality of the copra from which it was prepared.

A subsequent batch of copra specially prepared on Aitutaki (a neighbouring Southern Group island) was found to be of inferior quality on arrival at the project on Rarotonga. It was smoke damaged and considered by the team to be unsuitable for edible oil production.

A consignment of freshly produced copra from the Northern islands arrived at the project in the second half of the field visit. Quality was very mixed: some sacks were of premium quality, and some were of very poor quality. Processing the 'premium' copra gave a coconut oil with an acidity in the range of 0.3 to 0.4 per cent, compared with 0.8 to 1.5 per cent using the inferior copra. Oil produced from the premium copra was used in the main consumer survey to test the acceptability of coconut oil as a cooking oil, as described in Section 5.2. Consumer reaction to the product was mixed, but in summary it could be estimated that about 50 per cent of current consumption of imported cooking oil could be substituted by this coconut oil (see section 5.2.2), without loss of consumer satisfaction. This was considered a very encouraging result with respect to the availability of copra of a satisfactory quality for the project.

The copra which is not of sufficient quality for edible oil production is generally suitable for soap making or cosmetic use, so that the prospects for project raw material supplies are very good. If the proportion of premium grade copra in the average production is inadequate for the project's needs, it may be necessary to pay a small premium for the better grade copra. It is unlikely that such a premium would need to be very large.

To investigate the potential for producing a really good grade of copra, a batch of nuts were dehusked on Aitutaki under the supervision of the Ministry of Agriculture, and sun-dried sufficiently to permit removal of the flesh from the shells. At this stage the raw material was air-freighted to Rarotonga and drying was completed at the Totokoitu Research Station under the supervision of the station Director, Mr J Campbell, using a solar dryer. This resulted in the production of a very high quality copra which gave coconut oil with an acidity below 0.1 per cent. This oil had a fresh, sweet, coconut taste, in contrast with the distinctive copra taste of oil produced from more stale raw material. This demonstrates the potential for improvement of the existing copra supplies.

SECTION 5 MARKET ANALYSIS

5.1 Introduction

The project is based upon local marketing of the output from the screw press, and in view of this, investigations were carried out concerning the scope for local sale of coconut oil, copra cake, and also for local sale of soap which might be made from coconut oil which is either of too poor quality for human consumption, or surplus to the market requirement for edible oil.

5.2 The market for coconut oil in the Cook Islands

5.2.1 Coconut oil as a hair and body oil

Coconut oil is already available in the shops in the Cook Islands. It is sold principally as a hair and body oil, a traditional use for coconut oil, which in the past would have been prepared from freshly grated coconut using artisanal techniques. Nowadays, most of the commercial coconut oil formulations are based on industrially prepared coconut oil, either imported in retail packaging, or in bulk for packaging on Rarotonga.

Retail products imported from other South Pacific islands, principally Tahiti, are sophisticated in their packaging, and have added perfumes and colourants. One popular brand, 'Monoi Tiare Tahiti', is perfumed, coloured red, and described on its label as 'refined coconut oil'; it retails in Avarua for NZ$4.55 for a 120 ml bottle. Another popular imported brand, 'Monoi Solaire', retails in the region of NZ$8.50 for a 150 ml bottle. These products are bought mainly by tourists as sun tan oils, but also by Cook Islanders.

The biggest share of the coconut oil market is probably represented by sales of oil imported by an Australian entrepreneur (Mr J Abbott, Ariki Industries Ltd). He imports coconut oil in 200 litre drums which land at about NZ$4 per litre. This is bottled in 750 ml plastic bottles (of the non-screw-top type used by Kia Orana for orange juice) and distributed to small shops around the island, with a retail price of up to NZ$12 per bottle. Much smaller plastic bottes (about 100 ml) of oil with added perfume and colour retail at between NZ$3.00 to NZ$4.00; these are sold in smaller volumes, mainly through tourist shops. Overall, the majority of sales of these imported oils, bottled on Rarotonga, are to Cook Islanders who use the product as a hair and body oil.

Trials at the Ariki factory using coconut oil with acidity up to 1.3 per cent, produced on the small-scale screw press, showed that these oils could successfully replace imported oil in the formulation of perfumed hair and body oils.

About 20 per cent of the Cook Islands market for coconut oil is presently represented by 'Mauke' oil, produced on Mauke island by traditional methods and including a blend of local herbs. This sells for about NZ$5 per 200 ml bottle.

Total sales of coconut oil in the Cook Islands are presently estimated to be less than 1,000 litres per year, which is very small in comparison with the potential output of the 'Mini 40' screw press unit, in the region of 150 to 200 litres per day. There may be some scope for increasing sales of sun tan and body oil preparations based on coconut oil if the price is reduced and market promotion is undertaken. However, it is clearly necessary to identify additional markets for coconut oil in the Cook Islands, if the copra processing unit is to operate at more than a small fraction of its installed capacity, which is essential for financial viability. The two major potential outlets (in terms of the domestic market) are as a cooking oil and/or for soap manufacture.

5.2.2 Coconut oil as a cooking oil

The taste of coconut oil is basic to Polynesian cooking. Many types of food are prepared by cooking in coconut cream, traditionally prepared in the home by expression from freshly grated coconut. It is also common to add coconut sauce, based on coconut cream, to dishes after cooking. But the use of coconut oil as such as a cooking oil is not known in the Cook Islands. Most Islanders keep pigs, and therefore the use of home-prepared lard as a cooking fat is common. For cooking and salad oil, many people now use imported vegetable oils, mainly soya bean oil.

Imports of soya bean and similar oils totalled some 49,000 litres in 1982 and 36,000 litres in 1983 (latest available statistics). Present imports of cooking/salad oils are estimated to be in the region of 45,000 litres per year. Current landed price per litre for soya bean oil ranges from NZ$2.50 in 200 litre drums to NZ$4.30 in 500 ml bottles. This is inclusive of import levy (10 per cent). Vegetable oil is subject to price control in the Cook Islands. The permitted wholesale margin is 10 per cent plus a 1 per cent turnover tax payable to government. The margin between landed cost and retail price is set at 32 per cent.

The volume of present imports (45,000 litres per year) is of the same order of magnitude as the potential total coconut oil output from the copra processing unit - 50,000 litres per year on the basis of 200 litres per day and 250 working days per year.

It is highly unlikely that complete substitution of soya bean oil by coconut oil would be feasible. Market penetration will be sensitive to consumer acceptance of the new product, and also its price. Preliminary financial analysis undertaken in the Cook Islands, using provisional cost and production data, suggested that it would be feasible (operating at full capacity) to produce coconut oil at an ex-factory price significantly lower than the current landed price of soya bean oil. The key factor therefore appeared to be whether or not the consumer would find unrefined coconut oil an acceptable substitute for imported (refined) soya bean oil.

5.2.2.1 Preliminary market survey

The only copra available in Rarotonga at the beginning of Mr Barrett's visit (as marketing economist on the project team) was of a poor quality. Oil prepared from this copra had a stale taste and odour detectable by some people, and a free fatty acid (ffa) level probably between 1 and 2 per cent. A better quality oil would be made from fresher copra, and there was reluctance to undertake extensive test-marketing using an inferior product that could jeopardise the product's image. However, as a preliminary exercise designed as much to test the questionnaires for later, wider use as to test the coconut oil, a survey was organised, involving 25 people working for the Ministry of Agriculture or otherwise associated with the project. Consumers were provided with two litres of filtered coconut oil which had been prepared from the best available copra sorted from the old stock. The consumers were asked to use the oil as a substitute for their usual cooking oil, and to fill in a questionnaire describing their assessment of the product.

The overall reaction to the coconut oil was neither strongly negative nor positive. More people disliked the oil than liked it but the majority of people indicated that they would buy some coconut oil if it was available in the supermarket at a lower price than their usual oil. Some people said that they disliked the smell of the oil, either in the bottle or more particularly during the cooking process: this probably reflected the presence of volatile products due to breakdown of the oil during long storage of the copra. Oil produced from

fresher copra should not have the same smell. While the results of this limited survey were not conclusive, it was felt that the oil produced from old copra would be a poor competitor for imported soya bean oil, and it was decided to defer further consumer testing until fresher copra was available for processing.

As a result of the preliminary survey, a number of modifications were made to the scope and content of the questionnaire.

5.2.2.2 Main consumer survey of coconut oil as a cooking oil

Subsequently, copra of an improved quality became available for processing through the screw press. With the assistance of the Statistics Department and the Agricultural Planning Unit of the Ministry of Agriculture, an extensive consumer survey was undertaken in the period 22-29 September 1986. 104 households were identified by the Statistics Department, representing a 5 per cent sample of the households in Rarotonga. Households were selected to give a representative cross-section of the population, taking into account geographical and economic factors. Each household was given a 2 litre sample of coconut oil and asked to try it for domestic cooking over a one week period. The consumers were asked to fill in a daily diary recording their use of the oil, and their observations on its acceptability for each type of food cooked. At the end of the week, an interviewer visited each household to collect the diary, and filled in a questionnaire in cooperation with the consumers, recording more specific details of the consumers' experience with the coconut oil. The full results of this consumer survey are reproduced as annex E.

The main result of the survey concerns the degree to which consumers would change from purchasing their present cooking oil to purchase coconut oil instead, if it were available in the Cook Islands at a slightly lower price than soya bean oil. 48% of respondents indicated that they would buy coconut oil in preference to their present oil, although this included 35% who would still continue buying some quantity of their present oil. 52% of respondents indicated that they would continue mainly consuming their present oil, including 32% who indicated that they would buy some coconut oil.

In very round terms, it appears that approximately 50% of present total consumption of cooking oils in the Cook Islands could be substituted by coconut oil while leading to an increase in consumer satisfaction, at less expense to

the consumer. If the price differential between coconut oil and imported soya bean oil were increased, it is likely that consumers would shift to coconut oil consumption to an even higher degree, for example if import duties on imported vegetable oils were increased. However, it must be noted that a significant proportion of respondents simply disliked coconut oil as a cooking oil, as reflected by the number of respondents (20%) who indicated in the survey that they would not buy any coconut oil even if it was slightly cheaper than soyabean oil. There is likely to remain a baseline demand for cooking oils other than coconut oil.

The degree of market penetration that might be achieved with coconut oil cannot be assessed precisely on the basis of this limited exercise. Tastes can change over time, and it is quite possible that demand for coconut oil may grow after it has been on the market for some time and people have become accustomed to it. Consumption can be affected by advertising and other forms of promotion. Consumers' attitudes to the product will also depend to some extent on the image developed for the product, as reflected, for example, by packaging.

5.2.2.3 Test marketing of coconut oil as a cooking oil

It had been planned and organised to further develop the test marketing. The main supermarket on Rarotonga (Foodlands; manager - John Wichman) had agreed to sell coconut oil produced by the copra processing unit, for a trial period. A promotional campaign involving radio advertising had been discussed, and Foodlands were prepared to organise a promotional stall at which the product would be presented to customers, including the preparation of food in the supermarket for tasting by customers. The oil would have been bottled in 2 litre plastic bottles at the Kia Orana Food Corporation, and sold at a unit price of NZ$6.50, based on an ex-factory price of NZ$2.25 per litre for the oil, 50 cents for the bottle, and an appropriate margin for the supermarket. This compared with retail prices of between NZ$9.40 to NZ$12.40 for imported soya bean oil in 2 litre bottles.

Unfortunately, this exercise could not be completed during the time that the project team was in the Cook Islands, as the Kia Orana factory bottle-making machine was out of operation. At the time of preparation of the report, no further information was available from the Cook Islands concerning whether this market test had been subsequently completed.

5.2.2.4 Overall prospects for coconut oil as a cooking oil

There are grounds for optimism that coconut oil could be successfully marketed in the Cook Islands as a cooking oil. However, it seems unlikely that this market could absorb the full output of coconut oil if the screw press is run at full capacity on a single shift. Primarily on the basis of the consumer survey described above, it is estimated that no more than 50 per cent of the present soya bean oil imports could be substituted by coconut oil. This amounts to sales in the region of 22,500 litres per year, given that current imports of cooking oil have been estimated at 45,000 litres per year. This is of the order of 40 per cent of the potential annual output of the Mini-40 screw press; in this circumstance, it will be almost certainly necessary to identify additional markets for coconut oil if the venture is to be financially viable.

5.2.3 Coconut oil for soap manufacture

The Cook Islands import large quantities of soap each year, including both laundry bars and toilet tablets. Soap-making can be a simple process and is already carried out in the Cook Islands on a very limited scale by one entrepreneur. Coconut oil is very suited to soap manufacture, and this therefore represents an attractive possibility for using the oil output from the screw press. An additional advantage is that soap manufacture has much less stringent requirements than cooking oil for quality of oil used. This means that lower grade copra could be acceptable in making coconut oil for soap.

The Cook Islands imported 67 tonnes of soap (excluding detergents) in 1982 and 68 tonnes in 1983 (latest available statistics). Importers say that there is a trend away from the use of soap in favour or detergents, particularly as more people buy washing machines, but the local market for soap remains and is expected to continue to be sizeable. While retail sales of soap account for the large majority of consumption, demand for mini-bars (about 20 g per bar) for guest use in hotels appears significant and one commercial laundry on the island, which uses mainly detergents in its machines, has a small but regular requirement for pure soap for washing woollen garments.

From discussions with wholesalers, the retail market breaks down as approximately 50 per cent laundry soap in bars and 50% toilet soap in tablets. The

laundry soap is sold in unwrapped 400 g bars (main brands Naturu and Turtle) while the toilet bars are mainly the wrapped brands of the multinational companies Lux, Colgate-Palmolive, and Knight's Castile, among others.

According to one of the major importer/wholesalers, the Naturu laundry soap lands in Rarotonga at just over NZ$60 per carton, which contains 48 x 400g bars. This importer reported regularly bringing in 30 cartons per month, which amounts to nearly 7 tonnes per year, for this one brand. The same importer was bringing in about 3.4 tonnes per year of toilet bars, including three different brands, in cartons of 72 x 150g tablets (coloured, scented, wrapped), with a landed-Rarotonga cost of about NZ$50. This importer also handled about one tonne per year of Palmolive guest soaps for hotel sales, in cartons of 500 x 20g tablets (white, unscented, unwrapped), landing at just over NZ$32 per carton. These figures translate into landed prices for soap in the region of NZ$3.10 to NZ$4.60 per kg.

There are at least three major importers operating on Rarotonga: the Cook Islands Trading Corporation, Import Traders Ltd, and Vanwil Agencies Ltd. Another company, SPINCO Ltd, was reported to have recently gone out of business. These importers mainly serve the small shops and hotels on Rarotonga and the outer islands. The main supermarket in Avarua, the capital of Rarotonga, imports directly from New Zealand itself, including over 10 tonnes per year of soap. A number of the smaller shop owners also occasionally import directly, and the larger hotels whose guest soaps are specially packaged have their own supply arrangements.

Coconut oil makes a soap which characteristically dissolves very readily, foams well (even in salt water), and has a very strong cleansing action. This is likely to be very suitable for a laundry type soap, provided it does not dissolve so readily that it has a much shorter life than the commercial products.

5.2.3.1 The market for laundry soap made from coconut oil

Estimating the present domestic market for laundry soap (ie excluding toilet bars) in the Cook Islands at about 35 tonnes, this would be equivalent to the potential use of coconut oil in the region of 20,000 litres per year, if 100 per cent substitution of current imports could be achieved. This could make an important contribution to the viability of copra processing in the Cook Islands.

It was decided to examine whether a locally produced laundry soap, made using an artisanal method, would prove acceptable on the local market. Several small batches of soap were produced using a 'cold process' (TDRI, 1979: see Annex G) and samples were shown to wholesalers and retailers, who felt that the product was worth trying on the market. Subsequently, approximately 150 kg of laundry bars were prepared, which, after 2 weeks maturing period, were planned to be used in a trial marketing exercise scheduled for December 1986. At the time of preparation of this report, the results from this exercise were not available.

Costing the coconut oil at NZ$1.75 per litre would permit production of laundry soap for an ingredients cost of about NZ$1.50 per kg. This would give an appropriate margin to cover labour, other overheads and profit margin, to compete with current imports of laundry soap landing at just over NZ$3.00 per kg.

5.2.3.2 The market for toilet soap incorporating coconut oil

A soap based on pure coconut oil would not be ideal as a toilet soap, as it may be too aggressive in its action on the skin. A milder and more suitable formulation could be developed incorporating up to about 20 to 30 per cent coconut oil, the balance of the oil/fat component in the soap comprising lard and/or tallow. However, it must be noted that one Cook Islands entrepreneur already makes pure coconut soap on a very small scale, selling his product under the name 'Mokonut' in one of the major hotel gift shops. The product appears to sell very quickly at prices up to NZ$4.00 per bar. In general, toilet soap made completed or partly of coconut oil would have potential not only as a supermarket product for everyday use, but might also be sold to hotels as guest soap tablets and as a souvenir item for tourists (approximately 28,000 tourists per year).

It was possible to make an attempt to test the market for laundry soap in Rarotonga, in view of the simple nature and presentation of existing products. However, it was difficult, within the scope of the team's visit, to explore the possibility for marketing toilet soaps - more sophisticated formulation would be required, including for example tallow, perfumes and colourants; wrapping and mechanical pressing of the bars to achieve a regular appearance may also be appropriate for non-tourist sales.

A major difficulty in evaluating the potential use of coconut oil in soap manufacture in the Cook Islands was the lack of anyone making soap on a significant

scale at the outset of the project. At least two entrepreneurs living in Rarotonga expressed interest in setting up soap production, aiming at not only domestic but also regional export markets. By the end of the team's visit to the Cook Islands, one of these entrepreneurs (J Abbott, Ariki Industries Ltd) had set up simple facilities for production of soap in 70 kg batches, in liaison with the team. Bars of coloured, perfumed soap were produced, for sale to tourists as hand-crafted souvenirs, and appeared to be selling quite well, with a high profit margin.

Mr Abbott had plans to import machinery to scale up the operation, and to develop export markets; he purchased 1800 litres of coconut oil produced by the team, at prices between NZ$2.00 to NZ$2.25 per litre, and expressed interest in purchase of a further 4,800 litres at an appropriate price to be negotiated. If this venture proves successful in the long run, soap manufacture could absorb the entire coconut oil output from the copra processing project. But there is some degree of uncertainty associated with this possible development, and these price levels could be sustained probably only for production of high value tourist-oriented products.

5.2.3.3 Overall prospects for coconut oil for soap manufacture

In the final analysis, the market for domestically produced soap in the Cook Islands will depend on the price and quality of the product, which cannot be specified until it is known how the product would be made, and by whom. The possibility of integrating a soap production unit into the copra processing operation was discussed with the Ministry of Agriculture; the general concensus was that this was not an appropriate activity to be carried out as a public sector venture in the Cook Islands, particularly if there was potential interest by private sector investors. Such interest was being clearly and positively expressed by several parties by the end of the field work.

5.2.4 Other possible markets for coconut oil in the Cook Islands

At present the technology for production of diesel fuel substitute from vegetable oils is fairly well documented at a research level. Commercial systems are available for the conversion of coconut oil to methyl esters on a small scale, although at present there is limited published information on technical success in commercial operation.

The Cook Islands import in the region of 800,000 litres of fuel per year, mainly to run the power stations on the islands. From a technical viewpoint, a methyl ester fuel could conceivably be produced from local copra. From a financial viewpoint, this does not appear an attractive proposition at present. At the time of the visit, diesel fuel was retail priced at only NZ$0.57 per litre, which is about 25 per cent of the price required to make small-scale copra processing a viable proposition. Coconut cooking oil is hoped to wholesale in the region of NZ$2.25 per litre.

Solely for financial reasons, prospects for conversion of copra into a diesel fuel substitute cannot be seriously considered as far as the Cook Islands are concerned at present.

Minor potential markets for other products that could be made from coconut oil, for example washing-up liquids, shampoos and other cosmetic preparations were identified; but these were either too small or presently ill-defined for consideration in this study.

5.3 The market for copra cake in the Cook Islands

Copra cake is essentially a by-product of coconut oil production and is usable as an animal feed ingredient. It can be incorporated in feeds for some monogastric animals (ie pigs) up to 40 per cent of the ration, provided it is blended with other feedstuffs to provide a properly balanced diet. Opinion is divided on the scope for inclusion of copra in poultry rations - the high fibre content of copra cake limits its value for this end-use. The copra processing operation could produce about 39 tonnes of copra cake per year, at full throughput on a single shift basis.

Imports of animal feeds and ingredients were recorded as totalling 352 tonnes in 1982 and 981 tonnes in 1983: far in excess of the potential output of the copra processing unit. Most of these feeds were used for pig farming, and most of the feeds are consumed on Rarotonga. Availability of feeds is recognised as a major constraint to livestock production in the Cook Islands. Visits to pig farmers revealed a strong interest in copra cake, for which there is expected to be a good demand at the right price.

Imported pig pellets land at 64 NZ cents per kg, and at present these imports are channelled through the Ministry of Agriculture so that there is no whole-

sale margin before sale to the farmer. After discussion with pig farmers and staff at the Ministry of Agriculture, it was decided to try selling the copra cake at a price of 28 NZ cents per kg, as a pig feed supplement. The cake was marketed in returnable sacks (deposit payable) in 25 kg quantities, through the government agricultural sales outlet. Using this system (which had the advantage that no cash had to be handled at the project site), and at the price of NZ$7.00 per bag, all copra cake sold as soon as it became available.

The Ministry of Agriculture was planning to advise feeding fattening pigs on a diet comprising 50% copra cake, 28% meat and bone meal (imported), 20% dried cassava chips, and 2% premix (vitamins and minerals; imported). Costings by the Agricultural Planning Unit indicated that a balanced feed based on this formulation, and pricing copra cake at 28 NZ cents per kg, could be feasible for less than NZ$0.50 per kg compared with imported pig pellets at NZ$0.64 per kg. Many back yard pig producers are expected to be happy feeding their animals on copra cake supplemented by household scraps and domestic subsistence crops with no other commercial ingredients.

5.4 Summary of market prospects

In terms of potential revenue, the market for coconut oil is more important than the market for copra cake. In the Cook Islands, it appears that coconut oil would prove acceptable to consumers as a cooking oil, and could be produced at a price that would enable about 50 per cent substitution for present imports of cooking oil. This is equivalent to about 22,500 litres of coconut oil, which is approximately 40 per cent of the potential output of the screw press unit.

For copra processing to be viable in the Cook Islands, additional markets for coconut oil need to be established. There are good prospects for viable production of soap in the Cook Islands using coconut oil, and entrepreneurs are actively interested in such an enterprise, but at the time of the visit regular commercial production of soap had not been established. The future of this downstream industry will be critical for the success of small-scale copra processing in the Cook Islands.

While copra cake as a by-product of coconut oil production is easily marketed in the Cook Islands as a pig feed ingredient, it is low in value compared with

coconut oil and will make only a small contribution to the viability of copra processing. However, the stimulus to local livestock production is seen as a significant economic advantage in the project.

SECTION 6 FINANCIAL AND ECONOMIC ANALYSIS

6.1 Introduction

This section investigates the profitability of small scale copra processing on a typical Pacific island such as Rarotonga. The approach is to evaluate a hypothetical model of how a small scale copra processing unit might be set up and operated in a situation similar to that found in the Cook Islands, given what has been learnt from the operation of the plant tried out in Rarotonga. It is assumed that such a new project would be an independent venture, not necessarily part of a larger organisation such as the Kia Orana Food Corporation.

The analysis draws heavily on the actual costs and production data relating to the plant set up and operated at the Kia Orana site in Avarua. However, this unit was set up primarily as a demonstration and experimental plant, and would not necessarily be reproduced exactly in setting up commercial operation at other locations. From operation of the unit it is now concluded that some items of equipment (for example, the copra heater) are not essential. Also, because of the unique circumstances of the project location, certain costs (for example land and building costs) were not incurred, which may be incurred in setting up a similar project elsewhere. For these reasons the analysis is not based entirely upon the cost data for the demonstration unit; equally, the parameters of financial performance calculated here are not specifically applicable to the plant installed at the Kia Orana factory.

The financial analysis was prepared in the form of a microcomputer spreadsheet, which is reproduced as Annex F. This spreadsheet was set up using Supercalc 3 software on an Apricot microcomputer. The analysis uses Autumn 1986 prices.

6.2 Capital costs

6.2.1 Fixed capital costs

The fixed capital costs for the project total NZ$95,449, as detailed in Table 6.1. Of this total, approximately 50 per cent is accounted for by the landed cost of the equipment (ie items 3 to 14 in Table 6.1).

The allowance for land and buildings, estimated at NZ$35,000, accounts for 36.7 per cent of the toal fixed costs, and would be higher if actual purchase of land were involved. In the Cook Islands there is a very complicated system of land tenure whereby most land is owned by extended families rather than individuals, and Crown land is limited. The normal situation is therefore to lease land, with the purchase cost of the lease essentially representing a goodwill payment, and the rent payable depending very much on the location of the property.

The building cost relates to the cheapest type of building that could be envisaged for the project - a concrete floor, timber frame, corrugated iron roof, fibrolite clad walls with louvre windows, assuming 2.5 metre height at the eaves and 4.0 metres as the ridge, and a minimum of interior partition walls. According to the Chief Draughtsman of the Planning and Design Service of the Ministry of Works, a buiding of area 100 square metres could be put up for a cost of about NZ$300 per metre, including provision of basic utilities (assuming supplies already connected to the site).

An alternative approach for the analysis would have been to assume that appropriate premises were rented; on balance, leasing land and construction of a building was considered the more likely option.

While the building cost is not in itself a very large sum, given the small scale of the project it has a disproportionate impact on the financial performance of the project. In circumstances where the copra processing equipment can be set up in an existing but unused building, as was the case at the Kia Orana site, total capital costs can be economised greatly, with consequent improvement in the viability of the project. This is one of the elements considered within the scope of the sensitivity analysis in Section 6.5.

Installation costs for the equipment should not be underestimated. This will include wiring up of equipment, preparation of a substantial concrete plinth for the Mini-40 screw press, bolting of the filter press and copra breaker to suitable floor mountings, and fitting of exhaust venting for the diesel engine.

6.2.2 Working capital costs

A working capital provision is set at NZ$12,536, based on the requirements for salaries, utilities and other consumables, plus money tied up in working stocks

of copra, coconut oil and copra cake. Given the assumptions firstly that copra will be purchasable at short notice from producers throughout the year and secondly that output from the screw press will be sold very shortly after production, these stock levels have been set at comparatively low levels, equivalent to 10 days' throughput on the equipment.

In contrast to the fixed capital costs, the working capital required by the project is dependent upon the assumed throughput of the plant, and upon prices for the copra and products. Table 6.2 is derived under the assumption of full capacity operation, with a throughput of 94.5 tonnes of copra per year, and products valued as specified in the notes to the table.

6.2.3 Total capital costs

In summary, total capital costs for the project amount to NZ$107,985, of which 88.4 per cent is represented by the fixed capital costs and 11.6 per cent by working capital requirements. These costs will be incurred in the first year of the project. In addition, it is envisaged that there will be need for replacement of the diesel engine twice during the ten year life of the project, in years 4 and 7. The budget for this is NZ$4,133 in each of these years.

All of the working capital will be recovered at the end of the project. The equipment is assumed to have no final residual value, but it is assumed that the building will have a residual value of NZ$15,000 ie equal to half its original cost.

6.3 Operating costs

6.3.1 Fixed operating costs

Those operating costs which are not dependent on the level of throughput of the equipment are specified as fixed operating costs. These amount to NZ$27,376 per year, as detailed in Table 6.3, of which the majority (NZ$24,200; 88.4 per cent) is on account of staff costs.

Day-to-day operation of the copra processing equipment, at the level of throughput proposed, can be accomplished by three workers, one of whom would be semi-skilled and responsible for the overall production. Some higher level management is likely to be necessary, whether it is for marketing, financial

control or simply to organise the production along efficient lines. This would not be a full time activity for a manager, and indeed it is doubtful that the project could bear the overhead costs of a full time manager. This is a point that would have to be resolved in the circumstances of any specific project. If the copra plant is operated under the auspices of a larger organisation, part-time management by someone not fully occupied within the organisation may be feasible. For the present analysis, a management budget of NZ$3,000 per year is estimated on the assumption of one day per week input from someone of middle-management calibre.

Other fixed operating costs include land rent, servicing, maintenance and insurance of buildings and equipment, and other minor expenses, all of which come to an estimated NZ$3,176 per year.

6.3.2 Throughput-dependent operating costs

With three staff, and operating on a single shift, the full daily throughput on the screw press is estimated at 378 kg of copra, based on 6 hours at 63 kg of copra per hour - as obtained in the field trials with the screw press at the Kia Orana factory. This throughput is flexible to a degree, as the length of the shift could be extended or reduced. Assuming 250 working days per year, annual throughput of copra is estimated at 94.5 tonnes. Operating costs based on this level of throughput are summarised in Table 6.4.

Copra buying is budgeted at NZ$500 per tonne, based on the current landed-Rarotonga price for NICMB copra (see section 4.2) plus a premium to encourage supply of higher grade raw material. Annual cost of copra will be NZ$47,250.

From the known electrical ratings of the equipment, and the actual fuel usage of the diesel engine during the recent trials in Rarotonga, consumption of electricity and diesel is estimated to be comparatively little, representing an annual cost of some NZ$920 per year, or about NZ$4 per day, on the basis of unit utility costs incurred by the Kia Orana factory at the time of the trials.

A potentially major variable cost will be the cost of replacement wear parts on the screw press, principally the worm shaft and barrel-rings, which have a limited life. The worm shaft does not fail suddenly but wears down gradually with a slow decrease in efficiency. Judgement of the optimum replacement time

is difficult. In the field trials carried out in the Cook Islands, limited wear was observable on the worm shaft after processing a total of 5.4 tonnes of copra. If the worm shaft is replaced after every 20 tonnes of copra processed, ie about five times per year, the annual cost would be some NZ$5,358 per year, the second largest throughput-dependent operating cost after raw material purchase. The barrel-rings wear out gradually, but are sometimes liable to sudden, complete failure, and have to be replaced when they break. With careful operation of the screw press, breakage can be minimised; for the present analysis, it is conservatively assumed that a complete new set of rings will be required on average for every 20 tonnes of copra processed.

6.3.3 Total operating costs

Total operating costs are estimated to be NZ$84,848 per year, or NZ$339 per day over 250 working days at a throughput of 94.5 tonnes of copra per year. Fixed operating costs, principally comprising staff costs, would account for 32.3 per cent of this total, while variable operating costs, principally the purchase of copra, would account for the balance of 67.7 per cent.

6.4 Revenue projections

Revenue to the project would derive from sales of coconut oil and copra cake. For this analysis, it is assumed that one tonne of copra will yield 600 litres (approximately 545 kg) of filtered oil and 410 kg of cake, based on the field trials carried out in Avarua. The project can therefore produce up to 56,700 litres of coconut oil and 38.7 tonnes of copra cake per year.

Revenue from sale of coconut oil for edible consumption is estimated assuming:

- 50% penetration of the Cook Islands domestic market for presently imported soya bean cooking oil, giving total sales to a maximum of 22,500 litres per year;
- oil will be sold wholesale, at a lower price than imported soya bean oil - NZ$2.25 is taken as the price per litre for the following analysis (see Section 5.2.2);
- this price does not include bottling and marketing; these costs are calculated to be within the mark-up between the production of filtered oil and the retail price.

Revenue from sale of coconut oil for soap manufacture is estimated assuming:

- all oil that cannot be sold for edible consumption will be saleable for soap manufacture;
- the price for coconut oil for soap manufacture will have to be less than that feasible for edible oil, in order to make soap manufacture a viable proposition. It must be feasible to operate a differential pricing system that will avoid the possibility of people buying oil at the soap price and then selling it for human consumption.
- the price used in this analysis is NZ$1.75 per litre, which would permit the production of a standard laundry-type soap for NZ$1.50 per kg, or NZ$0.60 per 400 g bar, including the cost of oil, caustic soda and any perfumes/colourants, but excluding labour and other overhead costs; this compares with landed costs in the region of NZ$3.10 to NZ$4.60 per kg for imported soaps (see Section 5.2.3).

Revenue from sale of copra cake is estimated assuming:

- all copra cake produced can be sold at the price (NZ$280 per tonne) set during the field trials in Avarua, which met with a strong demand for the product from pig farmers.

With all these assumptions and the given level of throughput, the project would generate an annual revenue of NZ$121,324 per year, or NZ$485 per working day, of which over 90 per cent would derive from sale of coconut oil, as shown in Table 6.5.

6.5 Analysis of financial viability

6.5.1 The basic model under standard assumptions

It is assumed that the project has a ten year life, after which the equipment would need to be replaced. The cash flow for the project is summarised in Table 6.6, which includes presentation of the net present value for a range of discount rates, and also the internal rate of return.

The establishment costs incurred in year 1 of the project include the fixed capital costs of NZ$95,449 plus working capital requirement of NZ$12,536. Operating costs (NZ$84,848 per year) and revenue (NZ$121,324 per year) are

assumed to be constant throughout the project. Replacement of the diesel engine in years 4 and 7 incurs a cost of NZ$4,133 in each of these years. In the final year of the project, all working capital is recovered plus 50 per cent of the initial cost of the building.

After the first year of the project, there is a subsequent positive cash flow during the remainder of the project life, with a payback period of just over 2 years. The financial internal rate of return (IRR) on the project is 49.0 per cent. Cook Island Development Bank charges an interest rate of 10 per cent on loans for full-time agro-industrial projects based on Rarotonga; at this discount rate the project would have a net present value (NPV) of NZ$131,633, equivalent to an average annual net revenue of NZ$18,561 (ie dividing the NPV by the ten year, ten per cent annuity factor).

The analysis demonstrates that small scale copra processing would be a profitable activity, if carried out under specific circumstances assumed to exist in the above basic model of the project. This level of profitability is very much dependent on the assumptions made concerning project costs and revenue, and the latter depends on estimates which have been made concerning the size of the local market and the degree of market penetration that might be achieved. Not all of these assumptions and estimates will be applicable at other potential locations for the project. The following section therefore looks at effect on the profitability of the project if these assumptions and estimates are varied within an appropriate range of possibility.

6.5.2 Sensitivity analysis

The profitability of the project is sensitive to variations in the revenue, capital costs, and operating costs that can be envisaged as within the range of possibility.

6.5.2.1 Revenue variations

Perhaps the most critical aspect of the financial performance of the project will be the total revenue that can be generated. This may be constrained by the price that can be achieved for sale of coconut oil, and the size of the market may limit the level of output at which the equipment can be operated. Equally, throughput on the equipment could possibly be reduced (or increased)

for technical reasons.

Table 6.7 shows the effect on the project IRR of varying the average price at which coconut oil is sold by the project (between NZ$1.40 to NZ$2.50), in relation to varying the throughput on the equipment.

In the basic project model considered in Section 6.5.1, with edible-grade oil selling at NZ$2.25 per litre and soap-grade oil at NZ$1.75, the average price is approximately NZ$1.95, with the given market shares of respectively 39.7 per cent and 60.3 per cent. Project viability appears reasonably robust: in this price range the project could bear a 30 per cent reduction in throughput and remain viable. Equally, at full throughput the average price could drop as low as NZ$1.60 per litre and the venture is still profitable.

In a situation where all of the project output could be marketed for sale as a cooking oil, the average price for calculating project revenue would be identical to the cooking oil price, ie in excess of NZ$2.20 per litre, and the IRR at full throughput would approach 90 per cent. At an oil price of NZ$2.20 per litre, throughput could be reduced by 40 per cent and the IRR (at 17.7 per cent) is still very acceptable. At NZ$2.40 per litre, a 50 per cent reduction in throughput could be tolerated (IRR drops to 14.1 per cent).

In the Cook Islands, where the market for cooking oil is estimated at 45,000 litres per year, the project would become viable only if market penetration of close to 75 per cent could be achieved with coconut oil, which is not considered practicable. At least in the Cook Islands, the project could not succeed producing oil for cooking purposes only, given the other assumptions used in the basic model.

At the other end of the range of possibilities, coconut oil may prove entirely unacceptable as a cooking oil in some locations, and the project revenue would depend on the sale of oil for soap manufacture, for which a lower price can be expected. Table 6.7 shows that at full throughput, the small-scale expeller would be viable producing oil for soap manufacture only, even at prices as low as NZ$1.60 per litre.

6.5.2.2 Capital cost variations

In the basic project model, the allowance for land and buildings (principally

the building) is NZ$35,000 and accounts for 36.7 per cent of the total capital costs. This section considers the implications for the project if these costs are not incurred, and no rent is incurred for the use of any existing building in which the equipment is installed. This was the situation in the Cook Islands, which may arise elsewhere.

Capital costs are reduced to NZ$60,449 and the project IRR increases to 104.6 per cent, all other assumptions remaining unchanged from the basic project model. The project naturally becomes even more profitable, and viability is even less sensitive to reduction in throughput or average oil sale price, compared with the basic model with full capital costs. With an average oil price of NZ$1.95, the project could bear a 40 per cent reduction in throughput (IRR 13.7 per cent) but not a 45 per cent reduction (IRR 5.1 per cent). Operating at full capacity, the project could bear a 20 per cent reduction in oil price (IRR drops to 22.4 per cent) but probably not a 25 per cent price reduction (IRR: 8.1 per cent). Thus, in the specific context of the Cook Islands, where no building costs were incurred, it would have been feasible to set up a unit producing oil for soap production only at a price of NZ$1.60 per litre.

6.5.2.3 Other cost variations

Apart from the possibility that building and land costs may not be incurred in setting up a copra processing unit, there is also the possibility of general variation in capital costs as a function of exchange rate variations (for the imported items), differences in location and other factors. Table 6.8 shows that even with a 20 per cent increase in capital costs, the project remains profitable, showing that financial performance is not very sensitive to the capital costs.

Among the operating costs, the major fixed cost is the staff costs, and the major throughput-dependent operating cost is incurred in purchase of copra. Both of these items could vary from the cost levels assumed in the basic model, but probably not outside a range of plus or minus 20 per cent. Table 6.8 shows that the financial performance of the project is more sensitive to copra price than to capital or staff cost variation: a 20 per cent cost increase reduces the IRR to 38.5 per cent in the case of staff costs and to 30.1 per cent in the case of copra price. In both cases the project becomes less attractive than under the assumptions of the basic project model, but still worthwhile.

Any reduction in the producer price for copra from the present level will be advantageous to the project; the possible reduction of the producer price from NZ$350 per tonne to NZ$300 per tonne w being discussed in the Cook Islands in late 1986 in view of the low international prices for copra, and the insolvency of the NCIMB price stabilisation fund (see Section 4.2). Off-setting this potentially positive factor, it may be necessary to pay a premium above the basic price for copra, in order to secure a supply of premium grade copra suitable for edible oil.

6.5.2.4 Conclusions concerning sensitivity analysis

The small-scale processing of copra can be shown to be a very profitable venture, with an internal rate of return of 49.0 per cent, based on a model of production which could be easily envisaged in the Cook Islands. However, the financial performance of the project is sensitive to several parameters which could, in some circumstances, vary signficantly from the values assumed in the basic model presented above.

The most critical of these parameters is probably the average price at which the coconut oil can be sold, largely determined by the relative share of output which is sold for cooking oil versus soap manufacture. The size of the market may limit the throughput of the equipment, which could also affect viability. Variation in capital and operating costs, within the range of possibility, could also have a significant effect on profitability of small-scale copra processing.

At locations other than the Cook Islands, some of these possible variations will have a positive effect and some a negative effect on the project's potential vaibility; it cannot be assumed that the two groups of effects would necessarily cancel each other. It would be inappropriate to attempt to make a general conclusion about the profitability of small-scale copra processing on the basis of the basic model presented above. Specific case studies would have to be made for each separate location at which a project was considered for possible implementation; in this context, this report provides a rigorous approach to the evaluation of such projects, without necessarily representing a blueprint for the assumptions and estimates that would have to be made.

6.6 Economic analysis

Ideally, economic analysis of this project would use appropriate shadow factors for labour, foreign exchange and other inputs, plus raw materials and project output valued at border-equivalent international prices, to recalculate the cash flow in order to derive an economic internal rate of return. This is not practicable, and in any case would be of very limited meaning, for a number of reasons:

- discussions at the Ministry of Development and at the Cook Islands Development Bank revealed that there is no coherent framework for the economic evaluation of development projects in the Cook Islands. Development investment is not under government control or planning; therefore shadow factors for use in economic analysis have not been defined.
- there are very few opportunities for investment in the Cook Islands, so that the opportunity cost of capital is not readily definable: no guidance was available upon an acceptable economic rate of return for investments in the Cook Islands.

In these circumstances, it appears appropriate to confine economic analysis of the project to qualitative discussion. The main benefits of the project can be identified:

(i) Net foreign exchange benefit arises as the foreign exchange saved by substitution of current imports of vegetable oils and animal feeds outweighs the earnings foregone from copra export.

(ii) Creation of a domestic market for copra improves the stability of demand for the output of copra producers, and therefore should help to stabilise their income. This has added economic significance, since most copra production takes place on the northern islands, which are the most under-developed within the Cook Islands as a whole.

(iii) Consumers in the Cook Islands will benefit through the availability of cooking oil at a lower price than at present.

(iv) The processing of copra on the Cook Islands will generate employment. This is limited to the creation of only three full time jobs directly, although further employment will be created indirectly through services required by the

project (eg utitilies, maintenance, financial services) and downstream industries.

(v) Availability of locally produced coconut oil in the Cook Islands may lead to development of downstream industry, in particular soap manufacture, with further foreign exchange benefits, increased consumer surpluses, and employment creation, as already mentioned.

(vi) Availability of animal feed ingredients at a lower price than imported ingredients should stimulate the livestock sector. Improved viability of animal production could lead to increased revenues for farmers and/or increased supply of meat to consumers at lower prices, with associated foreign exchange benefits as locally produced meat substitutes for current imports.

Provided that the project is financially sound, there do not appear to be any economic grounds upon which to disfavour the project.

TABLE 6.1 FIXED CAPITAL COSTS (1)

	Sterling	%	NZ$(6)	Note
1. Land (purchase of lease)...	1667		5000	(2)
2. Building.....	10000	36.7	30000	(3)
Sub-total.....	11667		35000	
3. Screw press.....	3159		9477	
4. Ancillary equipment.....	800		2400	
5. Diesel engine.....	1089	21.2	3267	
6. Initial stock of spares....	1700		5100	
Sub-total.....	6748		20244	
7. Copra breaker.....	2100		6300	
8. Ancillary equipment	200	7.2	600	
Sub-total.....	2300		6900	
9. Filter press.....	4500	14.1	13500	
10. Stock of filter cloths.....	70		210	
11. Avery weighing scale.....	500		1500	
12. Office equipment.....	500	4.9	1500	(4)
13. Tools and lab equipment....	500		1500	(4)
14. Carriage and freight.....	2200	6.9	6600	
15. Installation.....	1000	3.1	3000	(4)
16. Contingency allowance.....	1832	5.8	5495	(5)
TOTAL FIXED CAPITAL COSTS..	31816	100.0	95449	

Notes

(1) Except where otherwise specified, costs are based on actual costs for the equipment as installed in the Cook Islands.

(2) Team estimate based on discussions with local solicitors.

(3) Based on 100 sq m at NZ$300 per sq m as estimated by Ministry of Works.

(4) Team estimate.

(5) Contingency allowance, calculated as 10% on items 3 to 15, to cover minor items not specified in the table.

(6) Exchange rate £1 = NZ$3.00.

TABLE 6.2 WORKING CAPITAL REQUIREMENTS

	NZ$	Allowance for	Note
Fixed operating costs.....	4563	2 months	(1)
Utilities.....	230	3 months	(2)
Other consumables.....	1000	Fixed sum	(3)
Raw material.....	1890	10 days	(4)
Coconut oil in stock.....	4419	10 days	(5)
Copra cake in stock.....	434	10 days	(6)
TOTAL.....	12536		

Notes

(1) See Table 6.3.

(2) See Table 6.4.

(3) Team estimate.

(4) Copra, valued at NZ$500 per tonne, landed Rarotonga.

(5) Coconut oil valued at a weighed average (39.7: 60.3) of the prices for cooking oil (NZ$2.25 per litre) and for soap manufacture (NZ$1.75 per litre).

(6) Copra cake valued at NZ$280 per tonne.

TABLE 6.3 FIXED OPERATING COSTS

(a) STAFF COSTS

	NZ$ per man-year	Ann. req. (man-years)	Ann. Cost NZ$	Note
Management overheads...	15000	.2	3000	(1)
Foreman.....	9000	1.0	9000	(1)
Labourers.....	5000	2.0	10000	(1)
		Sub-total.....	22000	
		Social overheads.....	2200 (10%)	(2)
TOTAL ANNUAL STAFF COSTS.....			24200	
		(DAILY STAFF COST.....	97)	

(b) OTHER FIXED COSTS	Equipment Servicing and maintenance.	1066	(3)
	Building maintenance.....	900	(4)
	Land rent.....	300	(5)
	Insurance on building and equipment.	410	(6)
	Miscellaneous expenses.....	500	(7)
	Sub-total.....	3176	

TOTAL FIXED OPERATING COSTS..... 27376 NZ$ per year

110 NZ$ per day

Notes

(1) Based on public and private sector wage rates in the Cook Islands in 1986.

(2) To cover pension contributions, national insurance and other social contributions.

(3) Estimated at 3 per cent per year for items 3, 4, 5, 7, 8 and 9 in Table 6.1.

(4) Estimated at 3 per cent per year for item 2 in Table 6.1.

(5) Based on typical rents in the Cook Islands in 1986.

(6) Estimated at 0.5 per cent per year on building plus the landed cost of equipment.

(7) Office stationery, etcetera.

TABLE 6.4 THROUGHPUT-DEPENDENT OPERATING COSTS

(a) RAW MATERIAL COSTS

	Producer price (per tonne) NZ$	Landed Rarotonga (per tonne) NZ$	Annual cost NZ$	Daily cost NZ$	Notes
Copra.....	350	500	47,250	189	(1)

(b) UTILITIES

	Cost per unit of utility	Units used per kg of copra	Total cost of utility per year	per day	
Diesel fuel...	.42 NZ$ per litre	.012	476	2	
Electricity...	.27 NZ$ per unit	.0174	444	2	
Total.....			920	4	(2)

(c) REPLACEMENT WEAR PARTS

	Cost per part/set			Replacement rate per part			
	fob UK Sterling	cif Raro Sterling	cif Raro NZ $	T copra per year	Parts per year	Cost per year	
Worm shaft on expeller...	315	378	1134	20	5	5358	
Barrel-rings on expeller.....	217	260	781	20	5	3691	
Filter cloths (set of 7).....	70	84	252	94.5	1	252	
TOTAL.....						9301	(3)

TOTAL THROUGHPUT-DEPENDENT OPERATING COSTS ..... 57,472 NZ$ per year
230 NZ$ per day

Notes

(1) Based on prices and costs provided by the Northern Islands Copra Marketing Board, and incorporating a premium to encourage supply of higher grade raw material.

(2) Utility prices as paid by the Kia Orana Food Corporation in August 1986. Units used esimated on basis of field trials in Avarua.

(3) Team estimate: see text.

TABLE 6.5 REVENUE PROJECTIONS

	NZ$ per year		Notes
Coconut oil for edible consumption....	50625		(1)
Coconut oil for soap manufacture.....	59850		(2)
Sub-total.....	110475		
Copra cake.....	10849		(3)
TOTAL REVENUE.....	121324	NZ$ per year	
i.e.	485	NZ$ per day	

Notes

(1) Based on NZ$2.25 per litre and 22,500 litres per year.

(2) Based on NZ$1.75 per litre and 34,200 litres per year.

(3) Based on NZ$280 per tonne and 38.745 tonnes per year.

TABLE 6.6 DISCOUNTED CASH FLOW ANALYSIS

PROJECT YEAR	1	2	3	4	5	6	7	8	9	10
Fixed capital costs (1)	(95449)			(4133)			(4133)			15000
Working capital costs (2)	(12536)									12536
Total operating costs (3)	(84848)	(84848)	(84848)	(84848)	(84848)	(84848)	(84848)	(84848)	(84848)	(84848)
Revenue..... (4)	121324	121324	121324	121324	121324	121324	121324	121324	121324	121324
Annual net cash flow.....	(71509)	36476	36476	32343	36476	36476	32343	36476	36476	64012
Cumulative net cash flow..	(71509)	(35033)	1443	33786	70262	106738	139081	175557	212033	276045
Discount rate:	18%	16%	14%	12%	10%	8%	6%	4%	2%	0
Net present value:	74245	85703	98868	114052	131633	152076	175947	203950	236954	276045
Internal rate of return...	49.0%									

Notes

(1) See Table 6.1 and Section 6.2
(2) See Table 6.2 and Section 6.2
(3) See Tables 6.3 and 6.4 and Section 6.3
(4) See Table 6.5 and Section 6.4

TABLE 6.7 EFFECT OF VARIATION IN THROUGHPUT AND AVERAGE COCONUT OIL PRICE ON THE PROJECT IRR (1)

Throughput		Average coconut oil price (NZ$ per litre)											
%	T/yr	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20	2.30	2.40	2.50
120	113.4	5.1	16.0	27.5	40.0	54.4	71.3	91.9	117.7	151.2	196.4	260.9	360.3
110	104.0	(0.3)	9.8	20.0	30.9	42.8	56.3	72.1	91.1	114.4	143.9	182.4	235.0
100	94.5	(5.9)	3.6	12.8	22.3	32.3	43.2	55.6	69.8	86.5	106.6	131.3	162.4
90	85.1	(12.0)	(2.9)	5.7	14.0	22.6	31.6	41.4	52.3	64.5	78.7	95.2	114.9
80	75.6	-	(9.8)	(1.7)	5.9	13.3	20.9	28.9	37.4	46.6	56.8	68.3	81.3
70	66.2	-	-	(9.7)	(2.6)	4.2	10.8	17.4	24.2	31.3	38.9	47.1	56.1
60	56.7	-	-	-	(11.7)	(5.4)	0.5	6.3	11.9	17.7	23.5	29.6	36.0
50	47.3	-	-	-	-	(-)	(10.5)	(5.3)	(0.3)	4.6	9.3	14.1	18.9

Notes

(1) Values in the table are the project IRR, as calculated using the spreadsheet in Appendix F. Figures in brackets are negative and - indicates a negative IRR outside the calculation range of the computer program used.

TABLE 6.8 EFFECT OF VARIATION IN CAPITAL COSTS, COPRA PRICE AND STAFF COSTS ON THE PROJECT IRR (1)

Variation from basic model	-20%	-10%	0	+10%	+20%
Capital cost	68.2	57.2	49.0	42.7	37.6
Copra price	73.0	60.2	49.0	39.1	30.1
Staff costs	61.1	54.8	49.0	43.6	38.5

Notes

(1) Values in the Table are the projected IRR as calculated using the spreadsheet in Appendix F.

SECTION 7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions concerning technical evaluation of the project

Small-scale copra processing, using a copra chopper, screw press and filter press, is a straightforward operation from a technical point of view. The equipment tested in the Cook Islands performed very well and presented very few problems in operation. It was concluded that a copra heater would not be necessary as part of a small-scale copra processing unit in the Cook Islands; however, at other locations where copra has a high moisture content, the copra heater may be needed.

The individual items of equipment functioned satisfactorily and were found to be well matched in respect of capacity.

Using copra available from present suppliers, it was possible to make coconut oil of sufficient quality for edible purposes, which could also be used for soap-making with good results.

The overall conclusion is that small-scale copra processing is highly feasible from a technical viewpoint, using the equipment tested in the Cook Islands.

7.2 Conclusions concerning financial and economic evaluation of the project

Small-scale copra processing can be a highly profitable venture using the equipment evaluated in the Cook Islands, and using copra of presently available quality, providing that sufficient demand for the products, principally coconut oil, can be identified. In this respect, the market study carried out in the Cook Islands was encouraging. The consumer survey carried out in Rarotonga in September 1986 suggests that up approximately 50% of present consumption of imported vegetable oils could be substituted by locally produced coconut oil, if this oil is marketed at NZ$2.25 per litre, just below the price of current imports of cooking oil.

While this is very promising with respect to the potential for the project on other Pacific Islands with larger populations, this level of demand would be insufficient to absorb the entire potential output of the copra processing unit in the specific case of the Cook Islands, and additional outlets for coconut oil needed to be identified. Although there is presently no soap

manufacture on a significant scale in the Cook Islands, this is an industry that appears to be potentially viable based on coconut oil available at a lower price, in the region of NZ$1.75 per litre, than that which could be obtained for cooking oil.

If sales of coconut oil for soap manufacture could be developed in the Cook Islands, small-scale copra processing would be a viable proposition, as shown in Section 6.4. On the basis of the lessons learnt in the field trials, and assuming that a new project would have to incur building and land costs, a small-scale copra processing unit set up in Rarotonga to operate as a commercial company could expect to generate an internal rate of return of 49.0 per cent.

Economic considerations generally favour the implementation of small-scale copra processing projects on Pacific islands such as Rarotonga, although it is difficult to assess these benefits within a quantitative framework.

7.3 Transferability of the project to other Pacific islands

While evaluation of the basic project model indicates an attractive investment opportunity, the analysis carried out in Section 6.5 reveals that the financial performance of the project is sensitive to changes in the projected costs and revenue, which could arise if the assumptions used in the analysis are varied within plausible limits. This means that in other islands, where it is highly likely that the assumptions appropriate to the Cook Islands will not be directly transferable, the financial viability of small-scale copra processing is likely to vary significantly from the level calculated in the appraisal of section 6.5. There are no reasons to presuppose that the Cook Islands enjoy any strong advantage compared with other Pacific islands in respect of the potential viability of small-scale copra processing; therefore it seems very likely that other locations could be found where projects of this nature could be very profitable enterprises.

7.4 Recommendations

It is recommended that the information which has derived from the present study be disseminated as widely as possible, in an appropriate form, to promote the possible implementation of small-scale copra processing projects at other locations in the Pacific.

It is recommended that visits are made to other selected Pacific islands to investigate the scope for small-scale copra processing. This could be carried out by a two man team comprising a technologist and an economist, who would spend up to two weeks at each location assembling cost and market information sufficient to enable pre-feasibility evaluation of potential projects. This would enable the preparation of a report presenting case studies for a range of countries, providing a broader information base upon which national or international development agencies and private investors could assess the scope for investment in small-scale copra processing.

It is recommended that further support is given to small-scale copra processing in the Cook Islands, to ensure the successful establishment of this venture on a sound commercial basis. This will be a positive factor in promoting similar ventures elsewhere. To date, the copra processing equipment on Rarotonga has been operated primarily for demonstration and development purposes. Successful commercial operation will require a further period of regular production, adopting the recommended procedures described in Section 3 of this report. Further work is required to develop and test market the products. The assistance required is envisaged to comprise a further three month field visit by a technologist who would be able to develop local soap-making as well as supervise running the copra processing equipment. During the technologist's visit, an additional two to three week visit by a marketing economist should be made in order to advise on and to organise further test marketing where appropriate.

ANNEX A

UNIDO Project US/GLO/83/033

UNIDO Contract 84/85

Demonstration and Evaluation of Small Scale Expeller Unit for the Production of Coconut Oil from Copra

INTERIM REPORT ON PREPARATORY PHASE

1. INTRODUCTION

This project, the subject of a contract between UNIDO and the Tropical Development and Research Institute, London, England (TDRI) entails the installation and commissioning of a small scale copra processing system on an island in the Pacific Region, operation of the equipment for a period, and the collection and evaluation of technical and economic data on its performance.

The project is divided into two distinct phases, a Preparatory Phase and an Operational Phase. The Preparatory Phase covers the selection of a suitable site in the Pacific for the trials, the procurement of the necessary equipment, and the shipping of this equipment to the selected location. The Operational Phase covers installation and commissioning of the equipment, operation of the system, data collection and evaluation, the drawing up of conclusions and recommendations, and reportage to UNIDO.

This Interim Report deals with the initial stage of the Preparatory Phase, the selection of a suitable site for the trials.

2. SELECTION OF SITE

2.1. Short list of potential host countries

An initial desk survey was carried out on all copra producing countries in the Pacific Region. Particular note was taken of countries, or districts within countries, which up to now have been considered to be too small, remote or scattered to support a large scale centralised coconut oil extraction facility and thus remain in the position of exporting copra but importing both edible oil and oilcakes for annual feed. In many cases the Institute had earlier, quite independently, received enquiries on small scale copra processing indicating an existing inherent interest in the subject

From a combination of TDRI's own knowledge of the area, and details of the copra and copra processing industries contained in the Country Review Papers issued from UNIDO Project RAS/79/031, a short list of five potential host countries was drawn up and agreed with UNIDO. These comprised - Vanuatu, Papua New Guinea, the Solomon Islands, the Cook Islands and Kiribati.

2.2. Correspondence with potential host countries

Correspondence was initiated with the appropriate Government Department in each of these selected countries. With the covering letter outlining the background of the exercise and the local imputs that would be required, was enclosed a questionnaire. The latter sought information on the country's copra and edible oil industry and requested details of any specific site that was considered to be suitable for installation and operation of the equipment. The counterpart organisation in the host country would be expected to be responsible for the necessary local imputs such as transport of the processing system equipment from port of entry to the site of the trials, transportation of project officers during the trials, provision of secure undercover housing for the processing equipment, supply of copra and fuel, provision of storage facilities for copra, copra cake and oil, and the salaries and wages of a counterpart supervisor (who would be given training in the operation of the processing equipment) and labourers. The technical suitability of proposed sites would be assessed on the basis of adequate supplies of raw material copra and other consumables (eg. fuel, packaging), suitable infrastructure (housing for equipment, power supplies, storage space, accommodation for project officers, marketing assistance, transport, communications etc.) and the existence nearby of workshop and analytical facilities.

A specimen letter and the questionnaire appear as Appendices 1 and 2, respectively, of this Report.

The responses to the letters and questionnaires can be summarised as follows:

(a) Vanuatu. Did not wish to be considered as a location for the trials since it had engaged consultants to carry out a feasibility study on establishing a large scale plant suitable for processing the bulk of the copra currently exported. This would replace the private sector facility on the island of Santo, which had been destroyed during the civil disturbances that preceded independence. The Government considered that the future of the copra industry in Vanuatu lay in the direction of coconut oil export and did not wish to see the

situation complicated by a proliferation of small mills. Additionally, doubts were cast on whether the local imputs could be provided.

(b) Papua New Guinea. Despite an encouraging response from the University of Technology, Lae, where it was felt that the facilities available at the Appropriate Technology Development Institute might make this an ideal site for the trials, the Government indicated that it did not wish Papua New Guinea to be considered as a venue for the trials.

(c) Solomon Islands. The Ministry of Agriculture and Lands responded enthusiastically and felt that several suitable sites could be found in or near Honiara and that there would be no great difficulty in providing the local inputs required. A visit was welcomed to discuss the matter further and choose between the various proposed sites.

(d) Cook Islands. The Ministry of Agriculture considered that Rarotonga would make an ideal location for the trials and indicate that a Government owned fruit processing factory in Avarua could provide the infrastructure and facilities required for the trials. Little difficulty was foreseen in providing the local inputs indicated.

(e) Kiribati. The Ministry of Natural Resources Development was very interested in the project but advised that it already operated two small expeller units as experimental facilities (largely for a copra cake supply for livestock development projects) and did not consider it worthwhile to establish a third.

2.3. Conclusion

Thus from the short list of five potential host countries consulted, two, the Solomon Islands and Cook Islands had unreservedly expressed interest in hosting the trials, had indicated that a precise site with the required infrastructure was available and had accepted the committment for local inputs.

2.4. Preparation Phase Visit

The Preparatory Phase Visit was therefore undertaken to these two countries to examine in more detail the facilities available at the suggested sites, and to discuss with the appropriate authorities the local inputs that would be needed for the Operational Phase. This visit took place between 11 March and 2 April 1985 and also included a visit to Fiji where the project was discussed with the

UNIDO Representative for the Pacific Region. The itinerary and list of individuals consulted appears as Appendix 3 of this Report.

2.4.1. Solomon Islands.

The Solomon Islands are a scattered Melanesian archipelago in the South Western Pacific east of Papua New Guinea. There are 21 large islands and very many small ones. The principal island is Guadalcanal on which is situated the capital, Honiara. The population is estimated as about 234,000 and copra exports in 1983 totalled 25,500 tonnes, down from 34,000 tonnes in 1982. Imports of edible oil in 1982 were valued at SI$511,000 representing an annual per capita consumption valued at about SI$ 2 although a significant proportion of the imports will have been used at the fish canning plant and thus re-exported. Edible oil products retailed in Honiara at an average price of SI$ 5.50/litre, mainly soya bean, sunflower, groundnut and blended oils from Australia and New Zealand, and palm olein from Singapore. Melanesians were said in general to be "boilers and bakers" rather than "friers" and thus have a low dietary consumption of edible oils and fats.

Arrangements for the visit were the responsibility of the Undersecretary (Agriculture) of the Ministry of Agriculture and Lands, and his staff. Four possible sites for the Operational Phase trials were initially considered - the Oil Palm factory at Solomon Islands Plantations Ltd, Lunga Coconut Plantation, the Solomon Soaps Ltd. factory and Do Do Creek Agricultural Research Station. Possible administrative and financial complications arising from the provision of local inputs (labour, utilities, consumables etc) cast doubt on the practicality of holding the Government sponsored trials at the first three sites, which were private sector owned and operated installations, and they were rejected on these grounds. The facilities available at Do Do Creek were thus examined in more detail.

Do Do Creek is a Ministry of Agriculture Research Station situated some 20 km South East of Honiara along the coast road, beyond the airport. It carries out research and development work on most of the crops grown in the Solomon Islands Group and includes on its staff agronomists, entomologists, economists etc, some of whom are ex-patriate appointees of International Agencies and Government Aid Programmes.

Features of the site in the context of the current project, together with the agreements reached with the Government on local inputs can be summarised as follows:

(a) Location - Do Do Creek Agricultural Research Station, Honiara.

(b) Site for trials - Open sided but roofed "Dutch Barn" type outbuilding, previously a vehicle garage, but now disused except for small fuel and insecticide store.

(c) Secure Housing and Store for equipment, raw materials and products - Two 2½ metres by 2½ metres store rooms. Unsuitable and insufficient is size for either processing equipment or storage of copra, oil and oilcake. New security fencing will need to be erected, and storage space will have to be found elsewhere on the Research Station.

(d) Electrical Power - No power supply. Nearest power outlets are some 100 metres distant. Installation of extension cable will be required to bring power to site.

(e) Labour - Ministry of Agriculture will provide a counterpart operator and general labourers for project. Staff at Research Station includes a skilled mechanic.

(f) Copra - All copra in the country is purchased and exported by the Solomon Island Copra Board. Agreement in principle was obtained during the visit for up to 10 tonnes of copra to be supplied, without charge, to the project during the trials, to be collected as required by project personnel. The Directors of the Board will have to consider and approve this at their next Board Meeting.

(g) Laboratory - A small but relatively well equipped laboratory exists at the Do Do Creek Station and this would be able to undertake the majority of the routine analyses required during the

trials. A check on facilities, equipment and chemicals revealed a few items that were not available but these can readily be supplied by TDRI and shipped out with the processing equipment.

(h) Communications - Telex services are available at Ministry of Agriculture and the British High Commission. Telephone installed at Do Do Creek.

(i) Diesel Fuel - Would ovided by Ministry of Agriculture.

(j) Bulk Containers - Used 200 litre oil drums which will be required for settling and storing the crude coconut oil, together with 50 kg sacks for storing the copra cake, will be provided, at no cost, by the Copra Board, subject to the agreement of the Directors at their next meeting as mentioned above. Metal working equipment for modifications to oil drums is available at Do Do Creek Research Station Engineering Workshop.

(k) Platform Scales - Arrangements will be made to borrow on a temporary basis, from the Department of Weights and Measures. Alternatively, a spring balance will be provided by TDRI and shipped out with the processing equipment.

(l) Marketing of Oil - The Solomon Island consumer is at present unfamiliar with coconut oil, either crude or refined, as an edible oil. Marketing trials will therefore have to be undertaken as part of the Operational Phase of the project. All supermarkets and general stores in Honiara carry imported edible oil, usually in 750 ml or 2 litre containers, and these will have to be approached and persuaded to place the product on their shelves. Adequate retail packaging is likely to prove a difficulty

since no local enterprise has a bottling operation. Used beer or soft drink bottles appear to be the only alternative but this is very unsatisfactory since the crown cork closure is non-reusable. Project personnel will need to be responsible for distribution. Solomon Soaps Ltd. who manufacture from palm oil (obtained from S.I. Plantations Ltd.) and coconut oil (extracted from copra within their own organisation) would be willing to purchase crude coconut oil in bulk but it would be far preferable to examine the potential of the oil as an edible product during the trials.

(m) Market for Oilcake

The Solomon Island Livestock Development Authority is planning to open a 8 tonne/day feed mill on Guadalcanal, and this should provide a suitable market for the copra cake. It currently purchases copra cake from the soap factory's copra crushing operation and would be willing in principle to purchase copra cake from the project trials.

(n) Accommodation and Transport for Project Personnel

Some accommodation is available at Do Do Creek Research Station but its availability for project personnel would depend on timing and the demands of Do Do Creek's own staffing situation. Otherwise several hotels can be found in Honiara, about 30 minutes drive away. The Government could not, during the visit, guarantee transport for project officers during the trials; this again would depend on the demands of its own staff. Hire cars and mopeds are widely available in Honiara.

In conclusion, the Solomon Islands would be capable, in general, of hosting the Operational Phase trials. Good features include the enthusiasm of the Government and Copra Board for the concept, the existance of a relatively well equipped laboratory at the proposed site plus ready and abundant supplies of copra

in the country. Market disadvantages include the lack of a ready electricity supply and convenient storage facilities for copra and processed products at the proposed site, likely difficulties in marketing the oil as an edible product eg lack of suitable retail packaging and distribution network, and the low per capita consumption of edible oil in the country.

2.4.2. Cook Islands

The 13 inhabited and two uninhabited islands which comprise the Cook Islands Group lie midway between Samoa and Tahiti in the Southern Pacific Ocean. The total population at the 1981 census was 17,227. The capital is Avarua on Rarotonga. Copra production in 1984 totalled about 1,200 tonnes, all produced by small-holders. About 35 tonnes of edible oils were imported in 1982, or about 2kg/head of population. Polynesians, the predominant ethnic group in the Cook Islands were said to make much more use of edible oils and fats in their traditional cooking than do Melanesians. Edible oil retail prices average NZ$ 7/litre in the stores in Avarua.

Arrangements for the visit were the responsibility of the Acting Secretary of the Ministry of Agriculture and his staff. The precise site they had in mind for the Operational Phase trials was the Kia Orana Fruit Processing Factory in Avarua. Established in 1960 by a New Zealand Company it initially carried out a wide range of packing and processing operations on a variety of tropical fruit, primarily for export to New Zealand. When the New Zealand Company ceased operations and withdrew in 1979, the facility was purchased jointly by the Government and a local businessman. Many of the earlier packing and processing activities were discontinued and the factory now manufactures a more limited range of products, primarily single and 5 times concentrated juice from orange, pineapple and paw paw for export and local retail sale. Consequently large areas of the original factory block are currently disused and empty thereby providing, in the context of the present project, ample space for storage of copra, oil and oilcake products and housing for processing equipment.

Features of the site, together with the agreements reached with the Government and the co-owner of Kia Orana Food Corporation Ltd. on local inputs can be summarised as follows:

(a) Location - Avarua, Rarotonga

(b) Site

Kia Orana Food Corporation Ltd., Fruit Processing Factory situated in the centre of Avarua.

(c) Secure Housing and Store for equipment, raw materials and products

Ample secure undercover areas for storage. Wide flexible sliding doors provide excellent access and ventilation for diesel powered expeller. A number of alternative precise positions within the factory shell for the expeller and ancillary equipment were discussed during the visit with the factory management. Final decision on this will be taken at the time of arrival of the project personnel and commissioning of the equipment.

(d) Electric Power

Numerous power outlets available throughout factory, including 3 phase.

(e) Labour

General labourers will be provided from the Kia Orana workforce. Ministry of Agriculture/ Kia Orana officer will be selected as counterpart operator. In addition a U.N. Food technologist Volunteer is assigned to the factory at present assisting with the fruit processing enterprise.

(f) Copra

No copra is produced on Rarotonga itself but production from the Southern Group of Islands is trans-shipped at Avarua harbour by the Copra Producers Association and arrangements will need to be made to retain some for the trials. Agreement in principle was given during the visit to supply up to 10 tonnes of copra, without charge, to the project but the Copra Board directors will need to consider and approve this decision at the next Board Meeting.

(g) Laboratory

Basic laboratory facilities at the factory

service the fruit processing operation but equipment and consumables specifically for oilseed and edible oil analysis are not available. The necessary additional items for this will be supplied by TDRI and shipped out with the processing equipment.

(h) Communications - Telephone installed at factory. Telex services available at Ministry of Agriculture and the Kia Orana Food Corporation's General Manager's Office.

(i) Diesel Fuel - Would be provided by Ministry of Agriculture

(j) Bulk Containers - Bulk Edible Oil is imported by two local wholesale traders in 200 litre oil drums and these can be purchased after use. Metal working equipment is available at the factory workshop and at the Central Engineering Workshop of the Ministry of Works. Copra from the Southern Group of islands is transported in sacks and these can be used to store copra cake.

(k) Platform Scales - Available in several sizes within the Kia Orana fruit processing factory.

(l) Marketing of Oil - The Cook Islands consumer is at present unfamiliar with coconut oil as an edible product although a local company imports crude coconut oil from Fiji for use in cosmetic preparations. Three local trading houses active in the wholesale and retail trade on Rarotonga were approached and expressed interest in assisting with marketing of oil for edible purposes. Occasional shortages of edible oil were said to occur. With regard to packaging, the single strength fruit juice produced by Kia Orana is retailed in 500ml plastic bottles with resealable

closures which would be very suitable for trial marketing of the coconut oil. The Government Printing Office can provide simple up-to-3 colour labels. The Kia Orana Food Corporation itself has a distribution network to retail outlets on Rarotonga for its single strength fruit juices and for other trading activities of the businessman co-owner and this can be used for distribution of the oil. Accounting and book-keeping expertise is also available within the Corporation. Shipping and marketing of consumer goods in the other islands is dominated by SPINCO (South Pacific Import Network Co. Ltd); this company also expressed interest in assisting with the marketing trials. The cosmetic manufacturer referred to above would be willing to purchase limited quantities of coconut oil in bulk.

(m) Market for Oilcake

No animal feed production takes place at present in the Cook Islands, preformulated livestock feed all being imported from New Zealand. Periodic shortages occur, particularly of pig rations, and several pig farmers consulted expressed great interest in utilising locally produced copra cake from the project.

(n) Accommodation and Transport for Project Personnel

Several hotels and self-catering bungalow complexes are situated near Avarua; 5-10 minutes drive from the factory. Transport will be supplied by the Ministry of Agriculture; hire-cars and mopeds are widely available.

In conclusion, the Cook Islands would be capable of hosting the Operational Phase trials and the fruit processing factory of Kia Orana Food Corporation represents an ideal site. All the facilities required for the trials exist at this factory with the exception of some items of laboratory equipment and consumables which can be readily provided by TDRI and shipped out with the processing equipment. The availability of retail packaging for the coconut oil and

the existence of a good distribution network to retail outlets would considerably ease the difficulties of trial marketing the oil as an edible product. The main disadvantage of the Cook Islands lies in its limited production of copra and the complete absence of production on Rarotonga itself, but supplies from the Southern Group are regularly trans-shipped at Avarua by the Copra Producers Association and these will (subject to the agreement of the Board of Directors) be made available for the project.

3. CONCLUSIONS AND RECOMMENDATIONS

This Preparatory Phase visit has enabled detailed discussions to be held with the two possible host Governments on the background, objectives, and local input requirements of the project and provided the opportunity to examine the facilities available at the precise sites offered for the Operational Phase trials.

The Governments and Copra Marketing agencies of both countries were very interested in hosting the project and were able to provide the bulk of the local inputs required.

The Solomon Islands had advantages in the abundant local production of copra and could offer the services of a small but relatively well-equipped laboratory. These factors were, however, outweighed by the superiority of the precise site for the trials available in the Cook Islands. The site suggested in the Solomon Islands, Do Do Creek Agricultural Research Station had serious defficiencies in access to power supplies and space available for both processing activities and storage. In contrast the Cook Island site, Kia Orana Food Corporation had excellent physical infrastructure and facilities, and ample storage space. In addition, it could provide considerable assistance, by virtue of the availability of suitable retail packaging and a pre-existing distribution system, with marketing the oil as an edible product. This important aspect of the project could lead to great difficulties if the Operational Phase were to go ahead in the Solomon Islands.

It is therefore recommended that Operational Phase of the project, commissioning and operation of a small scale copra processing venture, should be staged at the Kia Orana Food Corporation fruit processing factory on Rarotonga, Cook Islands. As soon as UNIDO have indicated their agreement with this recommen-

dation, TDRI should proceed with selecting and procuring the necessary equipment and arrange shipping to Rarotonga, with a view to commencing the Operational Phase in January 1986.

Dr R Harris
TDRI
May 1985

APPENDIX I Specimen of Letter Sent to Government of Vanuatu, Papua New Guinea, Solomon Islands, Cook Islands and Kiribati

This Institute has been awarded a contract by UNIDO to evaluate the technical and economic potential of small scale copra expelling in the Pacific Region.

The operational phase of this project will entail the commissioning and operation of a small copra expelling system, with a throughput of 25-50kg/hr for 2-3 months. During this period the technical performance of the unit will be assessed, data obtained on the economic and financial implications of its operation, and the local market for the derived crude coconut oil (as an edible oil) and oilcake (as livestock feed) examined.

The preparatory phase of the project includes the selection of a precise location for this exercise. Selection will depend both on economic and financial factors which indicate eventual viable operation of such a venture, and on the technical suitability of the site with regard to adequate supplies of raw material copra and other consumables (e.g. fuel, packaging), suitable infrastructure (e.g. housing, transport, communications), the necessary workshop and analytical facilities, and suitably qualified counterpart assistance.

This letter is being addressed to several states in the Pacific Region as an initial step in the Preparatory Phase of the project, i.e. locating a suitable site. A questionnaire is attached which you are invited to complete and return to the writer if you consider that a suitable site for this exercise can be found in your country.

The site selected on the basis of the replies to this letter and questionnaire will be visited early next year when detailed proposals and arrangements will be finalised for the Operational Phase field trials and demonstration which is likely to take place during the latter part of 1985.

The counterpart organisation in the host country will be expected to be responsible for the necessary local needs including - transport of the processing unit from the harbour to the site; transportation of project officers during trials; provision of secure, undercover housing for the processing unit; purchase of copra and fuel; provision of storage facilities for copra, copra cake and oil; and the supply of a counterpart supervisor (who will be given training in the operation of the processing unit) and labourers.

We look forward to receiving your reaction to this proposal and the completed questionnaire in due course, preferably before 7 December 1984, at which time we hope to be in a position to commence planning the preparatory phase visit for the project.

Yours sincerely,

Dr. R. V. Harris
Head, Oilseed Section, TDRI

ANNEX 2

TDRI/UNIDO PROJECT

Technical and Economic potential of Small Scale Copra Expelling in the Pacific Region

Questionnaire:

The objective of this questionnaire is to enable TDRI to select a suitable site for the installation, commissioning and operation of a small copra expeller under field trial conditions to obtain performance and economic data on such a venture.

This questionnaire has been sent to a number of countries in the Pacific Region and on receipt and examination of the replies TDRI will make a selection, in liaison with UNIDO, of which they consider to be the most suitable precise location suggested. A preliminary visit, currently scheduled for January/February 1985, will be made by the TDRI Officer to the location to finalise the arrangements and draw up the necessary counterpart agreements for the Operational Phase field trials which it is hoped will take place in the last quarter of 1985.

Replies should be forwarded, as soon as possible, but preferably before 7 December, 1984, to the following address:

Dr R V Harris
Head, Oilseed Section
Tropical Development and Research Institute
Culham
Abingdon, Oxon, OX14 3DA
England

If some of the more general data, such as that required to complete Sections 1, 2 and 3 are difficult to obtain, please complete the questionnaire as far as is possible in order to return it by the above deadline date.

SECTION 1 - COPRA

(i) Annual Production, last 3 years, National.

(ii) Annual Production last 3 years, by District or Island.

(iii) Estimate of proportion of Copra produced by estates rather than by small holders.

(iv) Prices paid to copra producers, last 3 years.

(v) Estimate of proportion of harvested nuts used for purposes other than copra manufacture.

SECTION 2 - COCONUT OIL

A. Is copra crushed? if so:-

(i) How many operating factories?

(ii) For each factory, location, capacity and throughput, last 3 years.

(iii) For each factory, type of equipment installed.

B. Is edible oil refined? if so:-

(i) How many operating factories?

(ii) For each factory, location, capacity and throughput, last 3 years.

(iii) Are oils other than coconut oil refined? if so, which?

(iv) For each factory, type of equipment installed.

SECTION 3 - MARKETS

A. Domestic

(i) Is crude coconut oil consumed locally?
if so:- quantity sold and price, last 3 years.

(ii) Is refined coconut oil consumed locally?
if so:- quantity sold and price, last 3 years.

(iii) Are edible oils other than coconut consumed locally.
if so:- (a) type
(b) quantity
(c) prices, last 3 years

B. International

(i) Exports

(a) Copra Exports - quantity and prices, last 3 years.

(b) Coconut Oil Exports - quantity and prices, last 3 years.

(c) Copra Cake Exports - quantity and prices, last 3 years.

(ii) Imports

Type and quantities of imported edible oils, last 3 years.

C. Duties and Tariffs

Details of Import and Export Duties/Tariffs applied to copra, coconut oil, other edible oils and copra cake.

SECTION 4 - SUGGESTED SITE FOR TRIALS

Details of:-

(i) Name
(ii) Location
(iii) Main Function and Staff employed
(iv) Access to supplies of fresh copra
(v) Access to market for:
  (a) edible oil
  (b) livestock feed
(vi) Availability of Utilities and Power:
  (a) Electricity
  (b) Water
  (c) Diesel Fuel
(vii) Undercover, secure housing for processing equipment
(viii) Secure storage for copra, coconut oil and copra cake
(ix) Engineering Workshop Facilities. Details of equipment available
(x) Analytical Laboratory Facilities, if any. Details of equipment and instruments available
(xi) Accessability/infrastructure/communications
  (a) Road Access
  (b) Telephone/telex links
  (c) Distance from nearest town
  (d) Nearby accomodation for Project Officers (2)
(xii) Labour Availability, Project would need 1 skilled mechanic, to be trained in expeller operation, plus 3 general labourers

APPENDIX 3 Itinerary and List of Individuals Consulted

28 February/1 March, UNIDO Vienna

Mr. Horst Koenig, Senior Industrial Development Officer

11-17 March, Honiara, Solomon Islands

BRIAN C.G. SMITH, Undersecretary, Ministry of Agriculture and Lands

LEMUEL MAELATHA, Chief Field Officer, Ministry of Agriculture and Lands

FRANCES ALEXANDER, British High Commission

SOLOMON ILALA, General Manager, Solomon Islands Copra Board

ELFRIEDE JEDZINI, Director, Solomon Soaps Ltd.

JOHN ALLEN, UNIDO Adviser, Ministry of Trade, Commerce and Industry

TONY MAKABO, Principal Commercial Officer, Ministry of Trade, Commerce and Industry

LORENCE CHASE)
PETER LINTON) Do Do Greek Agricultural Research Station
CHRIS JOHNSON)

BRIAN WOODHEAD , General Manager, Solomon Islands Plantation Ltd.

21-29 March, Rarotonga, Cook Islands

Hon. PUPUKE ROBATI, Minister of Agriculture, Fisheries and Outer Island Affairs

Hon. TEARIKI MATENGA, Minister of Internal Affairs and Justice

WILLIAM J. HOSKING, Acting Secretary, Ministry of Agriculture

FRANCO MATEARIKI, Director of Advisory Services

GRAEME WATERS, New Zealand Government Representative

MICHAEL E. BENNS, Director, Kia Orana Food Corporation Ltd.

JOHN KORUTHA, UN Volunteer, Food Technologist, Kia Orana Food Corporation Ltd.

EMILE KAIRUA, Coordinator, Copra Producers Association

RICHARD N. MCDONALD, Director, Office of Audit and Inquiries

JOHN T. DAMM, Managing Director, South Pacific Import Network Co. Ltd. (SPINCO)

TAUEI SOLOMON, Solomon and Sons, Trading Company

JOHN ABBOTT, Director, Ariki Ltd, Costmetic Manufacturers

PAEPAEREI PAUKA, Government Printing Office

TANGATA TUARAE, Mechanical Engineer, Ministry of Works

CHARLIE BROTHERS, Pig Farmer and General Store owner

30 March/1 April, Suva, Fiji

IVAN F CONTRERAS, Senior Industrial Development Field Adviser, South Pacific Region

ANNEX B PERSONS CONTACTED AND ORGANISATIONS VISITED

Ministry of Agriculture, Government of the Cook Islands

Mr W Hosking,	Permanent Secretary
Mr T Raui,	Head, Agricultural Planning Unit
Mr E Winnen,	Adviser, Agricultural Planning Unit (Dutch)
Mr N Mataio,	Agricultural Economist, Agricultural Planning Unit
Mr T Marsters,	Chief Administrative Officer
Mr T Tamarau,	Senior Livestock Officer, Rarotonga
Mr J Campbell,	Director, Totokoitu Research Station
Mr U Tungata,	Chief Information Officer
Mr F Charlie,	Senior Agricultural Officer, Aitutaki
Mr J Jessie,	Agricultural Officer, Aitutaki

Kia Orana Food Corporation, Avarua, Rarotonga

Mr M Benns,	Managing Director
Mr D Tuaeu,	Counterpart Officer, Copra Processing Project

Northern Islands Copra Marketing Board

Mr R Tylor,	Manager
Mr B Toma,	Chairman
Mr E Kairua,	Board Member
Ms C Kea,	Accounting Clerk (Short and Tylor)

Statistics Department, Government of the Cook Islands

Mr A Turua,	Director
Mr S Waring,	Statistician

Ministry of Works, Rarotonga

Mr D Lavell,	Deputy Secretary, Civil Engineering
Mr W Parkinson,	Chief Draughtsman, Planning and Design Service

Ministry of Development, Government of the Cook Islands

Mr A Reisinger,	Research Economist

Public Service Commission, Government of the Cook Islands

Mr T McKay,	Head, Computer Centre
Ms V Taruia,	Programmer

Government Printing Office

Mr P Pauka, Manager

Mr J Jay, Design Office

Electric Power Supply, Government of the Cook Islands

Mr B French, Administrative Officer, Aitutaki

Ariki Industries Ltd, Avarua, Rarotonga (Perfume Manufacturers)

Mr J Abbott, Managing Director

Rarotonga Pig Farmers Club

Mr T Marsters, Treasurer

Foodlands Supermarket, Avarua

Mr J Wichman, Manager

Ms J Murray, Assistant Manager

Rarotonga Pharmacy, Cook Island Trading Corporation

Mr K Walters, Pharmacist

Cook Island Dairy Food (Frangi) Ltd, Nikao, Rarotonga (Orange juice and milk packing unit)

Mr N Willis, Managing Director

Mrs C Willis, Assistant Manager

Cook Islands Development Bank, Avarua

Mr P Solomona, Agricultural Projects Officer

New Zealand National Bank, Avarua

Mr B Eccleton, General Manager

Mr B Sole, Accountant

Cook Islands Trading Corporation

Mrs M Nganu, Manageress, Wholesale Division

Piggeries/pig farmers

Mr R Maki, Aitutaki

Haurua piggery, Rarotonga

Charlie Brothers Pig Farm, Rarotonga

Mr R George, Rarotonga

McKay Electrical, Avarua

Mr T Harrison

Portofino Restaurant

Mr and Mrs W Carruthers, Managers

Mr P Postlethwaite, Head Chef

Vaima Restaurant

Mr R Schedewie, Manager

ANNEX C EQUIPMENT DESCRIPTION

(i) Copra chopper

Comprising: Condux Cutting Mill Type CS150/100-2

Supplier Condux Werk
Herbert A. Merges KG
Industriegebiet Wolfgang
D-6450 Hanau 11
West Germany

Description

The mill consists of a hopper feeding vertically into a cylindrical chopping chamber equipped with 3 rotary cutting blades and two stationary cutting blades. Chopped copra is discharged through a 10 mm screen at the base of the chopping chamber.

Installation requirements

(a) Connection to electric supply
(b) Bolting to floor

(ii) Chopped copra heater unit

Comprising: (a) Hander seed scorcher, type L

Supplier Ce Co Co Chuo Boeki Goshi Kaisha
PO Box 8
9-29 Matsugamoto-cho
Ibaraki
Osaka 567
Japan

(b) Davies Wayne Ribbon Burner

Supplier R.H. Steer and Co Ltd
Combustion Works
Cwmcrachen Industrial Estate
Brynmawr
Gwent
UK

Description

The seed scorcher consists of an open circular pan, 300 mm deep by 1,200 mm in diameter. The pan is provided with an agitator that sweeps the base of the pan so that the chopped copra is kept continually mixed. The pan discharges through a hinged gate at one side. The agitator is powered by a 0.75 kilowatt, three phase electric motor. The pan is heated by a gas burner fuelled by butane gas, consisting of a 25 mm diameter ribbon pipe burner, overall length 1.5 metre, giving a heat release variable between 5 to 20 kilowatts.

Installation Requirements

(a) Construction of hearth
(b) Connection to electric supply

(iii) Screw Press Unit

Comprising: (a) Simon Rosedowns Mini 40 Screw Press

Supplier Simon Rosedowns Ltd
Cannon Street
Hull HU2 OAD
England

(b) Riley F-T01 Vibratory Feeder

Supplier Riley Vibratory Equipment
Sinfin Lane
Derby DE2 9GJ
England

Description

The screw press functions by means of a wormshaft which rotates inside a closely fitting 150 mm long drainage barrel comprised of 12 barrel rings spaced apart by shim washers. The chopped copra is metered to the wormshaft via the feed hopper by means of an electrically driven vibratory feeder (power requirement 0.5 amp at 240 volts).

The wormshaft rotational speed was adjustable downwards from a maximum practical speed of about 110 RPM.

The screw press is powered by a 6.7 kilowatt Petter PHi Diesel Engine.

Installation requirements

(a) Construction of concrete plinth
(b) Connection to electric supply

(iv) Filter Press Unit

Comprising: (a) Edwards and Jones 406 mm x 406 mm Plate and Frame Filter Press

Supplier Edwards and Jones Ltd
Whittle Road
Meir
Stoke on Trent
England

(b) Broady type A Surplus valve

Supplier Broady
English Street
Hull
Yorkshire
England

Description

The filter press was constructed of polypropylene plates and frames lired with terylene filter cloths which proved six filtration chambers with a total fil-

tration area of 1.14 square metres working to a maximum pressure of 7 bar.

The press is equipped with a Monopump type MJ22 which provided a flow rate of about 3 litres of coconut oil a minute. The monopump is driven by a 0.55 kilowatt, 3 phase electric motor. The pump was equipped with a flexible plastic feed pipe to enable filling to be carried out from a 200 litre oil drum. The filter press empties, via three ports at the fixed end, into a 200 litre oil drum.

The pressure at which the press operated is controlled by an adjustable Broady type 'A' S.G. iron surplus valve operating as a pressure relief valve. A pressure gauge is fitted to the filter press inlet port to enable the working pressure to be monitored. The filter press inlet was also provided with a compressed air inlet to enable air blowing.

Installation requirements

(a) Connection to electric supply
(b) Bolting to floor

NB The use of a specific item of equipment in this project does not necessarily imply that comparable equipment from other manufacturers would not be equally suitable but no guarantee of an equivalent performance can be given.

ANNEX D EXPERIMENTAL DATA

TABLE D1
NEW STOCK COPRA PROCESSED UNDER AMBIENT CONDITIONS

RUN NO	COPRA PROCESSED KG	TIME TAKEN MINS	COPRA THROUGH-PUT KG/HR	CRUDE OIL PRODUCED			CAKE PRODUCED		
				KG	PER CENT	KG/HR	KG	PER CENT	KG/HR
17	57	58	59	29.5	51.8	30.5	23.9	41.9	24.7
20	58.5	49	71.6	31.7	54.2	23.8	24.9	42.6	30.5
21	176.6	177	59.8	101.4	57.4	34.4	78.3	44.3	26.5
22	185	187	59.4	103.5	55.9	33.2	80.0	43.2	25.7
23	99	-	-	56	56.5	-	41.0	41.4	-
24	178.5	175	61.2	102	57.1	35.0	76.8	43.0	26.3
28	192.4	197	58.5	104.8	54.5	31.9	84.1	43.7	25.6
29	153.5	157	58.6	83.9	54.1	32.1	66.3	43.2	25.3
45+ 46	200	191	62.8	110	55.0	34.6	80.7	40.4	25.4
53	250	216	69	140.5	56.2	39.0	104.4	41.8	29.0
55	85	73	69.9	49.9	58.7	41.0	32.6	38.3	26.8
63	85	71	71.8	49	57.6	41.4	33.4	39.3	28.2
65	85	74	74.0	49.4	58.1	40.1	33.4	39.3	27.1

TABLE D2
OLD STOCK COPRA PROCESSED UNDER AMBIENT CONDITIONS: AVERAGE YIELDS

RUN NO	COPRA PROCESSED KG	TIME TAKEN MINS	THROUGH-PUT KG/HR	CRUDE OIL PRODUCED KG	CRUDE OIL PRODUCED PER CENT	CRUDE OIL PRODUCED KG/HR	CAKE PRODUCED KG	CAKE PRODUCED PER CENT	CAKE PRODUCED KG/HR
1	43.9	47	56	27.4	62.4	35.0	16.8	38.3	21.4
2	99.7	90	66.5	58.5	58.7	39.0	36.3	36.4	24.2
3	50.0	50	60	31.0	62.0	37.2	21.9	43.8	26.3
4	98.8	95	62.4	59.5	60.2	37.6	37.5	38.0	23.7
5	99.5	93	64.2	58.6	58.9	37.8	38.0	38.2	24.5
9	50	52	57.7	31.3	62.6	36.1	17.6	35.2	20.3
10	50	52	57.7	30.7	61.4	35.4	19.0	38.0	21.9
11	50	49	61.2	30.2	60.4	37.0	19.4	38.8	23.8
47	50	47	63.8	30.2	60.4	38.6	18.5	37.0	23.6

TABLE D3
NEW STOCK COPRA PROCESSED AT 65°C

RUN NO	COPRA PROCESSED KG	TIME TAKEN MINS	THROUGH-PUT KG/HR	CRUDE OIL PRODUCED			CAKE PRODUCED		
				KG	PER CENT	KG/HR	KG	PER CENT	KG/HR
27	40	32	75.0	23.4	58.5	43.9	14.9	37.3	27.9
39	75	66	68.2	45.8	61.1	41.6	27.4	36.5	24.9
48	450	377	71.6	255.7	56.8	40.7	172.3	38.3	27.4
51	85	69	73.9	49.2	57.9	42.8	29.5	34.7	25.7
60	100	83	72.3	59.1	59.1	42.7	35.7	35.7	25.8

TABLE D4
AVERAGE MASS BALANCE: NEW STOCK COPRA AMBIENT PROCESSING CONDITIONS

	COPRA INPUT	OIL CAKE PRODUCED	FILTER CAKE OBTAINED	SEDIMENT OBTAINED	FILTERED OIL	TOTAL	UNACCOUNTED FOR
KG	1000	421	16	25	519	981	19
PER CENT OIL	66.7	26.9	42.2	79.0	100		
KG OIL	667	113	7	20	519	659	
OIL DISTRIBUTION PER CENT OF PRODUCTS		17.1	1.1	3.0	78.8		

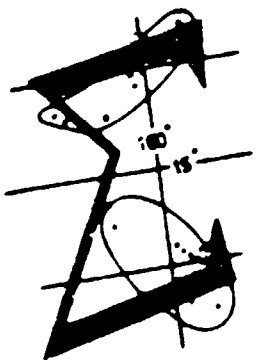
TABLE D5
AVERAGE MASS BALANCE: OLD STOCK COPRA AMBIENT PROCESSING CONDITIONS

	COPRA INPUT	OIL CAKE PRODUCED	FILTER CAKE	SEDIMENT OBTAINED	FILTERED OIL	TOTAL	UNACCOUNTED FOR
KG	1000	382	16	25	557	980	20
PER CENT OIL	67.4	19.7	(43.2)+	(79.5)+	100		
KG OIL	674	75	7	20	565	667	
OIL DISTRIBUTION PER CENT OF PRODUCTS		11.2	1.0	3.0	84.7		

+ ESTIMATED

ANNEX E

REPORT OF THE
CONSUMER SURVEY OF COOKING OIL
MADE FROM COOK ISLANDS COCONUTS



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STATISTICS OFFICE

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9 October 1986

COOK ISLANDS COCONUT OIL - CONSUMER SURVEY 1986

REPORT

The Ministry of Agriculture and the Statistics Office conducted a sample survey on consumer reactions to the use of Cook Islands Coconut Oil, in the week beginning the 22nd of September 1986. The survey covered Rarotonga only.

The objectives of the sample survey were:

a. to obtain from consumers information on the acceptability of the product in the household;

b. to obtain information regarding taste, flavour, likeness and allied information on the product;

c. to obtain information on how best the product could be marketed in terms of packaging.

A five percent sample of dwellings was selected, based on the list of dwellings used in the 1981 Census and subsequently updated in 1986. The survey covered all private dwellings irrespective of size and composition of the household and irrespective of the occupant's residential status.

The five percent sample produced 104 sample dwellings. Some of these dwellings proved to be vacant, in some cases the household was unable or unwilling to cooperate with the survey; as a result the final sample, on which the following tabulations are based, consisted of 98 dwellings.

Approximately one half of the selected dwellings were given 2 litres of coconut oil in a plastic bottle (the Kia Orana 2 litre bottle type) whilst the remainder of the selected dwellings were given 2 litres of coconut oil in a cardboard carton.(the Frangimilk type carton). The product was pure coconut oil, possessing an acidity level of 0.4% and containing no additives. Households were asked to try and use the coconut oil for cooking during the survey week and to record in the booklet provided, how they used the oil, the type of food prepared and whether they found the oil satisfactory or not. A copy of the household diary used in this survey forms appendix A of this report.

At the conclusion of the survey week householders were asked a series of questions on the acceptability of the product; information regarding taste, flavour, likeness and information on how best the product could be packaged. A copy of supplementary information booklet, which contains the questions on these topics forms appendix B to this report.

ANALYSIS OF SURVEY RESULTS

(a) Type of food prepared by preparation method by consumer assessment.

90% of meals prepared by consumers using the coconut oil provided were rated as at least acceptable. 34% of meals prepared were rated as very acceptable. Only 2% of meals were rated as very unacceptable. The balance (8%) were rated as not quite acceptable.

(b) Type of food prepared by consumer flavour assessment.

In commenting as to whether consumers noticed any flavour in the food which was due to the oil, 19% said the oil gave the food no flavour, 62% said the oil gave the food some flavour and 19% said the oil gave the food a strong flavour.

(c) Type of food prepared by consumer flavour reaction.

When asked to comment on their reaction to the flavour of the food cooked with the oil, 26% reported a very good reaction to the flavour, 61% a slightly good reaction, 9% a slightly bad reaction and 4% a very bad reaction.

(d) Type of food prepared by consumer assessment of smell during cooking.

In commenting on whether the oil gave off a strong smell during the cooking process, 33% reported a strong attractive smell, 43% reported a strong unattractive smell and 24% reported no strong smell during the cooking process.

(e) Household size by illness (if applicable)

90% of households reported no illness of ill effects resulting from the use of coconut oil for cooking. Of the 10% of households reporting illness or ill effects most often the report referred to one member of the household and not to the whole household.

(f) Household size by buying pattern.

When asked whether they would purchase the coconut oil if it were available in the shops at a price of approximately $6.50 for a two litre bottle, 20% said they would continue to buy their present oil and ignore the new product; 32% would mainly buy their present oil and a small amount of coconut oil; 35% would mainly buy coconut oil but continue to buy a small amount of their present oil; and the remaining 13% would switch completely to the new product.

(g) Packaging type by packaging size.

81% of consumers considered a plastic bottle to be the most suitable convenient and attractive packaging for this product. The 1 litre size container was preferred by 41% of consumers surveyed.

A M Turua
Statistics Officer
OCTOBER 1986

Statistics Office
P O Box 125
RAROTONGA, COOK ISLANDS

CONTENTS

Table 1: Number of Households by size by number of persons in full time employment.

SIZE OF HOUSEHOLD	NUMBER OF PERSONS IN FULL TIME PAID EMPLOYMENT							
	0	1	2	3	4	5	>5	TOTAL
1	-	-	-	-	-	-	-	-
2	-	2	1	-	-	-	-	3
3	1	2	4	1	-	-	-	8
4	-	8	7	1	1	-	-	17
5	-	4	6	3	-	-	-	13
6	-	7	6	3	3	2	-	21
7	1	2	4	3	1	-	-	11
8	-	1	5	1	4	1	1	13
9	-	1	1	1	-	-	-	3
10	-	-	-	-	-	1	1	2
>10	-	-	-	2	-	-	1	3
TOTAL	2	27	34	13	9	6	3	94

NOTE: 4 HOUSEHOLDS DID NOT ANSWER THESE SURVEY QUESTIONS.

Table 2: Type of food prepared by preparation method by consumer assessment.

PREPARATION METHOD	TYPE OF FOOD MEAT	FISH	EGGS	VEGETABLES	OTHER	TOTAL MEALS
	VERY ACCEPTABLE					
Shallow Frying	23	30	45	38	9	145
Deep Frying	8	11	1	10	3	33
Roasting	12	1	-	1	-	14
Baking	9	4	-	1	3	17
	ACCEPTABLE					
Shallow Frying	51	57	73	47	11	239
Deep Frying	22	14	7	9	6	58
Roasting	23	4	1	9	-	37
Baking	1	5	2	4	2	14
	NOT QUITE ACCEPTABLE					
Shallow Frying	6	7	10	8	1	32
Deep Frying	4	5	1	5	-	15
Roasting	2	-	-	-	-	2
Baking	-	1	-	-	-	1
	VERY UNACCEPTABLE					
Shallow Frying	2	-	1	2	3	8
Deep Frying	1	1	-	-	-	2
Rosting	-	-	-	-	-	-
Baking	-	-	-	-	-	-
	TOTAL RESPONSE					
Shallow Frying	82	94	129	95	24	424
Deep Frying	35	31	9	24	9	108
Roasting	37	5	1	10	-	53
Baking	10	10	2	5	5	32

Table 3: Type of food prepared by consumer flavour assessment

FLAVOUR ASSESSMENT	TYPE OF FOOD					
	IN ALL USES	MEAT	FISH	EGGS	VEGETABLES	OTHER
No Flavour	7	3	2	4	6	1
Some Flavour	34	15	9	9	6	1
Strong Flavour	12	3	3	3	1	-

NOTE : 2 HOUSEHOLDS DID NOT ANSWER THESE SURVEY QUESTIONS.

Table 4: Type of food prepared by consumer flavour reaction

FLAVOUR REACTION	TYPE OF FOOD					
	IN ALL USES	MEAT	FISH	EGGS	VEGETABLES	OTHER
Very Good	13	5	3	2	3	-
Slightly Good	24	12	10	9	4	1
Slightly Bad	5	1	-	1	1	1
Very Bad	3	-	-	-	1	-

NOTE: 13 HOUSEHOLDS DID NOT ANSWER THESE SURVEY QUESTIONS

Table 5: Type of food prepared by consumer assessment of smell during the cooking process.

SMELL DURING THE COOKING PROCESS	TYPE OF FOOD					
	IN ALL USES	MEAT	FISH	EGGS	VEGETABLES	OTHER
Attractive strong smell	18	3	4	4	7	1
Unattractive strong smell	12	8	6	7	5	1
No strong smell	8	7	4	5	3	-

NOTE: 6 HOUSEHOLDS DID NOT ANSWER THESE SURVEY QUESTIONS.

Table 6 : Household size by illness (if applicable) or ill effects

ILLNESS OR ILL EFFECT	SIZE OF HOUSEHOLD 1	2	3	4	5	6	7	8	9	10	>10	TOTAL
No illness or ill effect	-	3	7	15	11	16	9	14	2	1	3	81
Stomach ache	-	-	-	1	3	-	1	-	1	-	-	6
Head ache	-	-	-	1	-	-	-	-	-	-	-	1
Indigestion	-	-	-	-	1	-	-	-	-	-	-	1
Lost appetite	-	-	-	-	-	-	-	-	-	1	-	1

NOTE: (a) 8 HOUSEHOLDS DID NOT ANSWER THESE QUESTIONS.
(b) ILLNESS REPORTED MAY ONLY REFER TO ONE PERSON NOT NECESSARILY THE WHOLE HOUSEHOLD.

Table 7 : Hosuehold size by buying pattern

SIZE OF HOUSEHOLD	CONTINUE TO BUY THEIR PRESENT OIL AND IGNORE NEW PRODUCT	MAINLY BUY THESE PRESENT OIL AND A SMALL AMOUNT OF COCONUT OIL	MAINLY BUY COCONUT OIL, BUT CONTINUE TO BUY A SMALL AMOUNT OF THEIR PRESENT OIL	STOP BUYING THEIR NORMAL COOKING OIL AND SWITCH COMPLETELY TO COCONUT OIL
1	-	-	-	-
2	1	2	-	-
3	-	3	2	2
4	3	4	7	3
5	5	1	7	-
6	2	5	5	4
7	1	4	4	-
8	4	4	3	2
9	-	2	1	-
10	1	1	-	-
>10	-	1	1	-
TOTAL	17	27	30	11

NOTE: 13 HOUSEHOLDS DID NOT ANSWER THESE QUESTIONS.

Table 8: Packaging type by packaging size

TYPE OF PACKAGING	SIZE OF PACKAGING					
	5LITRES	2LITRES	1LITRE	500ml	250ml	TOTAL
Plastic Bottle	3	19	33	11	9	75
Cardboard carton	-	5	7	4	2	18
TOTAL	3	24	40	15	11	93

NOTE: 5 HOUSEHOLDS DID NOT ANSWER THESE QUESTIONS.

CONSUMER SURVEY OF

COOKING OIL MADE FROM COOK ISLANDS COCONUTS

Agricultural Planning Unit
Ministry of Agriculture
RAROTONGA
SEPTEMBER 1986

Statistics Office
RAROTONGA
SEPTEMBER 1986

The sample of oil provided with this booklet has been produced in Rarotonga at the Kia Orana Food Corporation. It has been made using copra from the Cook Islands by a new technology. The product is pure coconut oil and contains no other additives.

In other parts of the world coconut oil is already commonly used as a cooking oil. We are looking into the possibility of selling coconut oil in the Cook Islands, as a cooking oil. Your household has been specially selected to help us assess the quality of the product that we can produce here in Rarotonga.

Over the next week, please try using the coconut oil for cooking purposes - pan frying, deep frying, preparation of mayonnaise, in baking or in roasting. Use it as substitute for your usual cooking oil.

(NOTE: It is advisable not to mix coconut oil with other types of oil or fat when frying - such mixtures may have a tendency to foam and catch fire over an open flame. Used on its own, coconut oil is as safe as any other cooking oil.)

Each time you use the coconut oil, please record in this booklet what type of food you prepared, indicating how you used the oil, and whether you found it satisfactory or not. At the end of the week, your completed questionnaire will be collected from you.

Thank you for your cooperation in this survey.

HOUSEHOLD CODE NO.....

CONSUMER SURVEY: COOKING OIL FROM COCONUTS

PART 1: TO BE COMPLETED BY THE CONSUMER

1. Background information on your household:

   (a) How many people are living in your house? _____

   (b) How many people in your house have full time paid employment? _____

2. Record of your daily use of coconut oil

Each meal when you use the coconut oil, please record on this form the type of food prepared and how the oil was used. Please indicate whether you found the coconut oil acceptable as a cooking oil for each different way in which you use it. There is a space on the form for you to note any particular comments each time you use the oil. It is not essential that comments are recorded for every meal. If there is insufficient space on the form for your answers, please continue on a separate sheet and return with the booklet.

DAY ONE

(i) Type of food prepared: (Please tick)

Meat..... Fish..... Eggs..... Vegetables. .... Other.....
If other, please specify: .....

(ii) How it was prepared: (Please tick)

Shallow frying..... Deep frying..... Roasting..... Baking.....
Other, please specify: .....

(iii) What was your assessment of the coconut oil when used to cook this type of food? (Please tick)

Very acceptable.... Acceptable.... Not quite acceptable....
Very unacceptable.....

(iv) Please note any additional comments or observations:

.....

.....

.....

APPENDIX B

HOUSEHOLD CODE NO:.....

CONSUMER SURVEY: COOKING OIL FROM COCONUTS

PART 2: TO BE COMPLETED BY THE INTERVIEWER

1. How many days did the household have the coconut oil before this interview took place?

2. Approximately how much of the coconut oil provided to the household remained unused at the end of the survey?

3. Did the consumer notice any flavour in the food which was due to the oil? (Please tick)

   No flavour..... Some flavour..... Strong flavour....

4. Was this flavour noticed? (Please tick)

   (i) To a similar extent in all uses.....
   (ii) Only in cooking some types of food.....
   if (ii), please indicate which types of food.

   Meat..... Fish..... Eggs..... Vegetables.....
   Other(please specify).....

5. What was the consumer's reaction to this flavour?

   Very Good..... Slightly Good..... Slightly Bad..... Very Bad.....

6. Did the consumer notice any strong smell to the oil, particularly during the actual cooking process?

   Yes..... No.....

   If yes, was this smell Attractive..... Unattractive.....

7. Apart from taste and smell, did the consumer notice any other special characterists or effects of the oil? Please tick if any of the following are mentioned, but do not specifically ask the consumer.

   (i) Illness.....(e.g. diarrhoea, stomach ache)
   If so, note details .....

   (ii) Other .....
   If so, note details: .....

8. If this product was available in the shops at a price of approximately $6.50 for a two litre bottle, would the consumer (Please tick)

   (i) Continue to buy their present oil and ignore the new product.....

   (ii) Mainly buy their present oil and a small amount of coconut oil?
   .....

   (iii) Mainly buy coconut oil, but continue to buy a small amount of their present cooking oil? .....

   (iv) Stop buying their normal cooking oil and switch completely to coconut oil? .....

PART 2 (continued)

9. What type of packaging would the consumer consider most suitable, convenient and attractive for this product, if sold as a cooking oil in a shop: (Please tick)

A plastic bottle.....
(the Kia Orana 2 litre bottle type)

or

A cardboard carton .....
(the Frangimilk type carton)

10. If the product was available in different size bottles or cartons, which of the following would the consumer most commonly buy: (Please tick)

5 litres..... 2 litres..... 1 litre..... 500ml..... 250ml.....

SURVEY OFFICER

A M Turua	Statistics Officer	Survey Coodinators
C M Parker	" "	" "
T R Pokoati	Agriculture officer	" "
N Mataio	" "	" "

Ministry of Agriculture

Tapuni Parutua	Mrs Pupu Vogel
Joseph Kaveao	Mrs Rima Tutai
Ngatoko Ta	John Toa
Ngatokorua Takau	Teariki Rauru

Statistics Office

Ngamata Moo	Mrs Rua Raitia
Tetuanui Takai	Mrs Amelia Ngatokorua
Tanga Tuatai	Mrs Tutira

Treasury	Education
Mrs Moeroa Tamangaro	Teroo Naea
	William Richard Marsters
P.S.C.	Survey Department
Tinirau Andrew	Willie John

ANNEX F: MICROCOMPUTER SPREADSHEET FOR FINANCIAL ANALYSIS
COOK ISLANDS COPRA PROCESSING PROJECT
FILE : COOKREV4
DISK : SCALC JCB2

This spreadsheet was prepared by J C Barrett of the Marketing and Economics Department of the Tropical Development and Research Institute, London, using Supercalc 3 software on an Apricot microcomputer. The analyis has been carried out on behalf of the United Nations Industrial Development Organisation (UNIDO).

DATED : 13 May 1987.

Miscellaneous variables

Exchange rate.....	3 NZ$ per sterling
Working days per year.....	250
Contingency rate.....	10%

Table 9.1 FIXED CAPITAL COSTS

	Sterling	NZ$	Notes
Land (purchase of lease)...	1667	5000	(i)
Building.....	10000	30000	(ii)
Sub-total.....	11667	35000	
Expeller.....	3159	9477	
Ancillary equipment.....	800	2400	
Diesel engine.....	1089	3267	
Initial stock of spares....	1700	5100	
Sub-total.....	6748	20244	
Copra breaker.....	2100	6300	
Ancillary equipment.....	200	600	
Sub-total.....	2300	6900	
Filter press.....	4500	13500	
Stock of filter cloths.....	70	210	
Avery weighing scale.....	500	1500	
Office equipment.....	500	1500	
Tools and lab equipment....	500	1500	
Carriage and freight.....	2200	6600	
Installation.....	1000	3000	
Contingency allowance.....	1832	5495	
TOTAL FIXED CAPITAL COSTS..	31816	95449	

Replacement schedule for the diesel engine: 3 years
i.e. the diesel engine to be replaced in years 4 and 7.

Cost incurred in these years:	NZ$
Diesel engine fob UK.....	3267
Carriage and freight (estimated 15%).....	490
Contingency.....	376
TOTAL....	4133

Table 9.3 FIXED OPERATING COSTS

(a) STAFF COSTS	NZ$ per man-year	Ann. req. (man-years)	Ann. cost NZ$
Management overheads.....	15000	.2	3000
Foreman.....	9000	1.0	9000
Labourers.....	5000	2.0	10000
		Sub-total.....	22000
		Social overheads.....	2200 (10%)
TOTAL ANNUAL STAFF COSTS.....			24200
		(DAILY STAFF COST.....	97)

(b) OTHER FIXED COSTS	
Equipment servicing and maintenance.	1066
Building maintenance.....	900
Land rent.....	300
Insurance on building and equipment.	410
Miscellaneous expenses.....	500
Sub-total.....	3176

TOTAL FIXED OPERATING COSTS..... 27376 NZ$ per year
110 NZ$ per day

(WORKING TABLE: THROUGHPUT PARAMETERS)

Rate of processing of copra.....		63 kg per hour
Hours of expeller operation per day.		6 hours
Daily throughput of copra.....		378 kg
Annual throughput of copra.....		94500 kg
Yield of oil.....Per kg of copra...		60 % (vol/weight)
Per day.....		227 litres
Per year.....		56700 litres
Yield of oilcake..Per kg of copra...		41 % (weight/weight)
Per day.....		155 kg
Per year.....		38745 kg

Table 9.4 THROUGHPUT-DEPENDENT OPERATING COSTS

(a) RAW MATERIAL COSTS

	Producer price (per tonne) NZ$	Landed Rarotonga (per tonne) NZ$	Annual cost NZ$	Daily cost NZ$
Copra.....	350	500	47250	189

(b) UTILITIES	Cost per unit of utility	Units used per kg of copra	Total cost of utility per year	per day
Diesel fuel.....	.42 NZ$ per litre	.012	476	2
Electricity.....	.27 NZ$ per unit	.0174	444	2
Total.....			920	4

(c) REPLACEMENT WEAR PARTS	Cost per part/set			Replacement rate per part		
	fob UK Sterling	cif Raro Sterling	cif Raro NZ $	T copra per part	Parts per year	Cost per year
Worm shaft on expeller.....	315	378	1134	20	5	5358
O-rings on expeller.....	217	260	781	20	5	3691
Filter cloths (set of 7)...	70	84	252	94.5	1	252
TOTAL.....						9301

TOTAL THROUGHPUT-DEPENDENT OPERATING COSTS..... 57472 NZ$ per year
230 NZ$ per day

TOTAL OPERATING COST (FIXED PLUS THROUGHPUT-DEPENDENT)..... 84848 NZ$ per year

(Working table for working capital calculations)

Allowance for:	Salaries.....	2 months
	Raw material.....	10 days
	Utilities.....	3 months
	Coconut oil.....	10 days
	Copra cake.....	10 days
Price for:	Coconut oil.....	2.25 NZ$ per litre for edible use
		1.75 NZ$ per litre for soap manufacture
	Copra cake.....	.28 NZ$ per kg

	%	Litres
Coconut oil used for edible purposes.....	39.7	22500
Coconut oil used for soap.....	60.3	34200

Table 9.2 WORKING CAPITAL REQUIREMENTS

	NZ$
Fixed operating costs	4563
Utilities.....	230
Other consumables.....	1000
Raw material.....	1890
Coconut oil in stock.....	4419
Copra cake in stock.....	434
TOTAL.....	12536

Table 9.5 REVENUE PROJECTIONS

	NZ$ per year	
Coconut oil for edible consumption.....	50625	
Coconut oil for soap manufacture.....	59850	
Sub-total.....	110475	
Copra cake.....	10849	
TOTAL REVENUE.....	121324	NZ$ per year
i.e.	485	NZ$ per day

Table 9.6 DISCOUNTED CASH FLOW ANALYSIS

PROJECT YEAR.....	1	2	3	4	5	6	7	8	9	10
Fixed capital costs.....	(95449)			(4133)			(4133)			15000
Working capital costs.....	(12536)									12536
Total operating costs.....	(84848)	(84848)	(84848)	(84848)	(84848)	(84848)	(84848)	(84848)	(84848)	(84848)
Revenue.....	121324	121324	121324	121324	121324	121324	121324	121324	121324	121324
Annual net cash flow.....	(71509)	36476	36476	32343	36476	36476	32343	36476	36476	64012
Cumulative net cash flow...	(71509)	(35033)	1443	33786	70262	106738	139081	175557	212033	276045

Discount rate:	18%	16%	14%	12%	10
Net present value:	74245	85703	98868	114052	131633
Discount rate:	8%	6%	4%	2%	0
Net present value:	152076	175947	203950	236954	276045

Internal rate of return.... 49.0%

Average annual revenue..... 18561 NZ$ per year, calculated by dividing the NPV for the 10% discount rate
(at 10% interest rate) by 6.1446, the 10 year, 10% annuity factor.

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