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A TECHNICAL AND ECONOMIC EVALUATION OF A SMALL-SCALE COCONUT OIL EXPELLER OPERATIONS IN THE COOK ISLANDS *

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Abstract

Small-scale processing of copra was demonstrated to be technically feasible and potentially very profitable in the Cook Islands using equipment comprising a copra chopper, a screw press and a filter press. At throughputs close to 65 kg per hour, yields of clarified oil and copra cake were around 55 per cent and 40 per cent respectively, on a weight basis. A consumer survey indicated that coconut oil could be marketed as a cooking oil to substitute for imported vegetable oils; potential use in soap manufacture was also identified, while copra cake was readily marketed for animal feeding. For an initial establishment cost of just under NZ$ 100,000 the financial internal rate of return for investment in small-scale copra processing in the Cook Islands, provided that all output can be marketed, is calculated as 49 per cent, which is very attractive. Prospects for the success of similar ventures at locations elsewhere in the Pacific are promising.

INTRODUCTION

Coconut cultivation and production of copra for export are major economic activities for many island communities in the Pacific Ocean. However, the value of the copra to the exporting country is invariably reduced by international transport costs. Edible oil and livestock feed are imported, usually at a high price due to further transport costs and traders' margins.

Footnote: More details on the test operations of the small-capacity coconut oil expeller unit carried out in Rarotonga, the Cook Islands, have been laid down in the UNIDO document IO.R. 45 which will be made available by UNIDO on request.

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 local consumption to replace these expensive imports. Moreover, employment opportunities would be created and value added to agricultural production.

Although studies on the small scale processing of oilseeds in general have been numerous, published work specifically dealing with copra is limited (1-3).

The Tropical Development and Research Institute (TDRI) has worked for some years on small-scale oilseed processing (4) and has collaborated with a UK engineering company in the development of a small powered screw press with a capacity in the region of 25-50 kg/hr. Previous work (5) 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 Central Africa.

More recent work at TDRI in the UK has shown that the screw press, together with certain items of ancillary equipment, also operates efficiently on copra. With copra of an appropriate quality, the coconut oil produced would be suitable for human consumption. An opportunity arose, through a project funded by UNIDO, to investigate the potential for such small-scale processing in the Cook Islands.

EQUIPMENT REQUIREMENTS

The basic equipment necessary to produce coconut oil from copra comprises a chopper to break down the copra pieces into suitably sized fragments and a screw press to continuously expel oil, giving copra cake as the residue.

Since the efficiency of oil extraction is influenced by the moisture content, a heating stage may be necessary to further dry the copra. For small-scale ventures, where steam raising cannot be carried out economically, equipment fired by bottled gas, fuel oil, or firewood is suitable.

Freshly produced crude oil has a dark cloudy appearance due to the presence of finely divided particulate matter. With some oils, eg sunflowerseed, this material will settle out when the oil is allowed to stand undisturbed for a day or so, but with coconut oil a sufficiently clear oil cannot usually be obtained in this manner, and it is then necessary to pass it through a filter press.

The equipment used in these trials (see footnote) comprised:-

(a) Copra Chopper: Condux Cutting Mill Type CS150/100-2, fitted with a 10mm screen.

(b) Seed Heater: Hander Seed Scorcher Type L, heated by a butane gas burner.

(c) Screw Press: Simon Rosedowns Mini 40 expeller, powered by a 6.7KW Petter PH1 Diesel Engine, and fitted with an electrically driven vibratory feeder. This expeller comprises a wormshaft which rotates inside a closely fitting barrel composed of separate rings spaced apart by shim washers (see Figure 1).

(d) Filter Press: Edwards and Jones 406 mm x 406 mm Plate and Frame Press, with 6 filtration chambers (1.14 m^2 filtration area), fitted with a Mono-pump MD 22 providing a flow rate of about 3 litres of oil a minute.

The equipment was sited in Avarua, Rarotonga, inside a warehouse with good ventilation, a large outside door for easy access, and a small room utilised as an office and store. Installation required the provision of electricity supplies to each unit, the construction of a hearth for the seed heater, a concrete plinth for the screw press, and bolting the chopper and filter press to the floor.

Equipment Performance

(a) Copra Chopper: A steady throughput of about 160 kg per hour was easily achieved, provided the larger pieces were broken by hand before feeding to the mill. Over 90% of the copra was reduced to less than 0.5 cm^3 in size.

(b) Seed Heater: Approximately 0.75 kg of butane gas was required to heat the furnace to 65°C. Heating 1 tonne of copra to 65°C required about 12 kg of gas. The most convenient mode of operation was to heat the copra in 25 kg batches. This took about 15 to 20 minutes, and enabled the production of heated copra to match

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Footnote: Mention of a particular company does not imply a recommendation by TDRI of that company or its products to the exclusion of others which may be available.

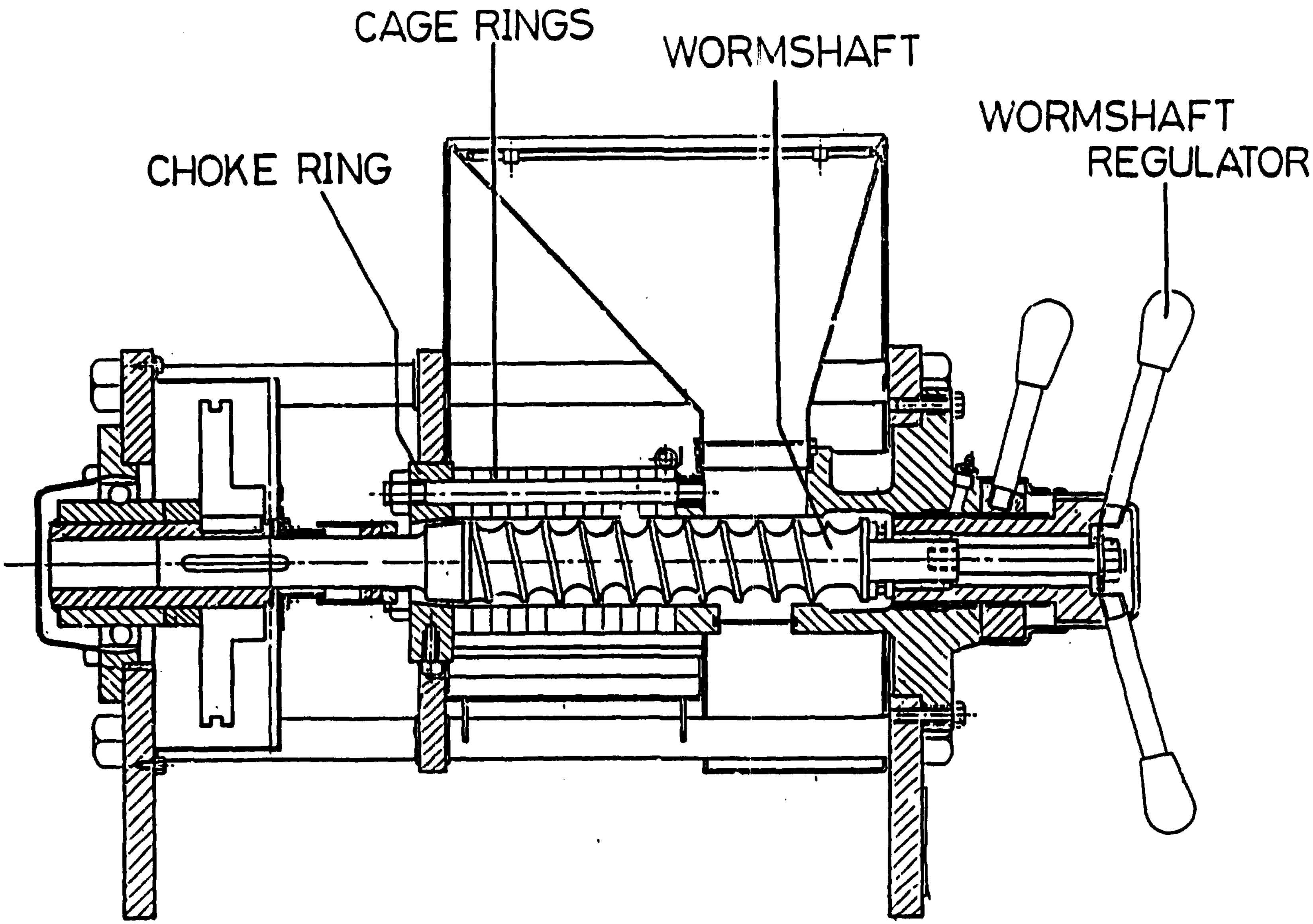


Figure 1 MINI 40 EXPELLER

the requirements of the screw press. Heating reduced the moisture content of the chopped copra from 5.3 per cent to 3.7 per cent.

(c) Screw Press: Ten month old copra was utilised for commissioning purposes and preliminary determinations of performance. Fresh copra was used for the remainder of the trials, including the commissioning of the seed heater and preparing oil for the consumer survey.

Table 1 Typical operational data for screw press

	A	B	C
Copra processed	592 kg	255 kg	750 kg
Throughput	61.7 kg/hr	70.8 kg/hr	71.4 kg/hr
Crude oil expelled	357 kg	148 kg	433 kg
Copra Cake residue	225 kg	99 kg	280 kg
Process/Moisture loss	10 kg	8 kg	37 kg
Crude Oil Extraction Rate	60.3%	58.0%	57.7%
Projected Yields from 1 tonne copra			
Crude Oil	603 kg	580 kg	577 kg
Oil Cake	380 kg	388 kg	373 kg

Notes

A: 10 month old copra, moisture content 4.3%, unheated.
B: Fresh copra, moisture content 5.3%, unheated.
C: As B, copra heated to 65°C for 10-15 mins before expelling.

Table 1 shows typical operational data for the screw press, with both old and fresh copra, and the effect of heating the fresh copra before expelling. As can be seen, old copra provides a slightly better yield of oil than fresh, and no gain in oil extraction efficiency appears to be achieved by using the seed heater. However, both old and fresh copra had reasonably low moisture contents, 4.3 per cent and 5.3 per cent respectively. One of the purposes of heating copra prior to expelling is adjustment of moisture content. When a batch of copra of moisture content 9.2 per cent was processed, the extraction efficiency was reduced from 58 per cent to 37 per cent. Thus in circumstances where copra moisture content is higher than 6-7 per cent it is probable that heating would be of benefit. However, it should be noted that copra with a moisture content of less than 2 per cent has proved difficult to process using the Mini 40 expeller.

The optimum choke setting for the screw press gave an oil cake thickness of about 1 mm. Narrower choke settings resulted either in blockages or in excessive amounts of solid material (fines) being expelled with the oil, whilst wider settings led to lower oil yields.

A number of spacer settings were tested during the trials and the most efficient, (in thousandths of an inch), close enough to inhibit production of fines yet providing good drainage of oil from the barrel, was found to be:

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

The screw press operated smoothly at wormshaft rotational speeds of 80 and 100 RPM, but at 110 RPM excessive vibration from the diesel engine became apparent and the level of vibration experienced above 110 RPM made operation at higher speed impractical. The rate of copra throughput varied according to wormshaft RPM, with hourly rates of 53 kg, 63 kg and 67 kg at 80 RPM, 100 RPM and 110 RPM, respectively.

Since similar yields of crude coconut oil per 100 kg of copra were obtained at all these speeds 100 RPM was selected as the optimum speed, consistent with vibration-free running and the fastest practical copra throughput per hour. Diesel fuel consumption of the screw press averaged 11.7 litres per tonne of copra processed.

Double pressing

The expeller processed ground oilcake (ie the cake was re-expelled after passing through the chopper) at approximately 45 kg per hr to give a 19 per cent yield of crude oil. However, using oilcake the screw press was difficult to control, requiring constant adjustment of the choke to avoid blockages and to maintain a steady throughput. The screw press was also under such stress that one of the barrel rings fractured whilst processing oilcake. In contrast, no barrel rings failed during the processing of chopped copra.

Table 2 compares the single and double pressing operations and shows that although 7 per cent more crude oil is produced per unit weight of copra (and consequently 7 per cent less oilcake) the double pressing operation has a 35 per cent lower overall throughput.

In view of this much lower throughput, the increased difficulty in operating the screwpress, its likely higher rate of wear and stress, and the ready market that exists for single press oilcake, it was concluded that double pressing was not a worthwhile operation in the Cook Islands.

Table 2 Comparison of throughputs and yields of typical single and double pressing operations

	Single Pressing	Double Pressing
First Press		
Copra processed	65 kg	65 'g
Time taken	1 hour	1 hour
Crude oil produced	39 kg	39 kg
Oilcake produced	24.7 kg	24.7 kg
Second Press		
Oilcake processed	-	24.7 kg
Time taken	-	33 minutes
Crude oil produced	-	4.7 kg
Oilcake produced	-	20 kg
Overall Performance		
Copra processed in 6 hr. operating day	390 kg	252 kg
Oil produced	234 kg	169 kg
Oilcake produced	148 kg	77 kg
Yield of crude oil	60%	67.1%
Yield of oilcake	38%	31%

(d) Filter Press: One day's production of about 200 kg of crude oil, produced from unheated copra, typically contained about 14 kg of solids in suspension but attempts to filter this oil immediately after expelling resulted in unacceptably low filtration rates of about 0.5 litres per minute. If, however, the crude oil was allowed to stand overnight, about 9 kg of the suspended material settled out. The remainder, 5 kg, could then be readily removed by the filter press with a flow rate initially at 3 litres of oil per minute, although slowly decreasing to 1 litre per minute as material accumulated on the filter cloths.

Thus in clarifying the oil, two types of solid material were obtained, sediment from the overnight standing, and filter cake, the former containing about 80 per cent oil, the latter 42 per cent.

The sediment can be recycled through the screw press without difficulty, admixing it with the copra feedstock. However, a similar procedure for filter cake was less satisfactory. Finely divided solid materials, of which the filter cake is composed, reappeared in the expelled oil and adversely affected filter press performance. The most advantageous method of disposal for the filter cake appeared to be blending it uniformly with oilcake for sale as livestock feed.

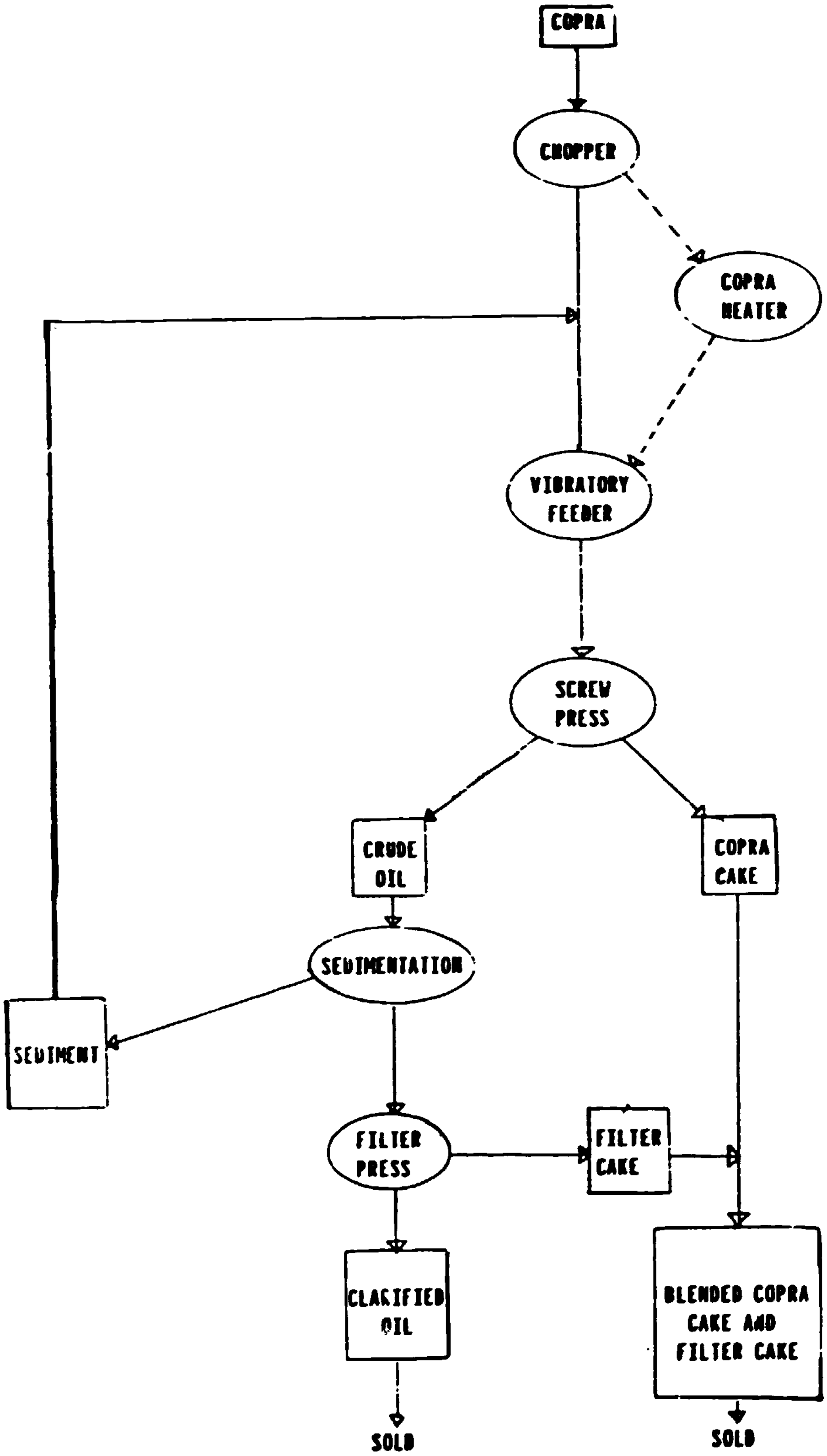
However recycling of sediment should be approached with caution, particularly when edible use of the coconut oil is envisaged, since free fatty acid levels in sediment can rise rapidly if reprocessing is not carried out within a day or so.

Summary of operational procedures and technical performance

The flow chart for small scale copra processing with the equipment specified earlier is shown in Figure 2.

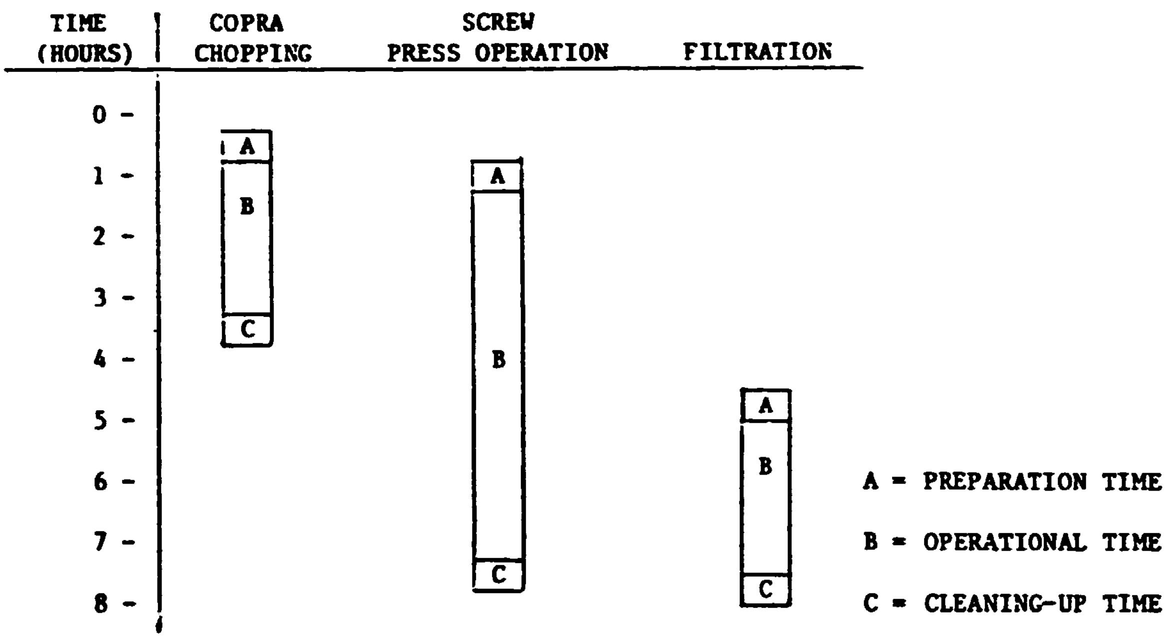
The individual items of equipment used proved to be well matched with respect to relative capacity. The copra chopper could prepare sufficient for a day's requirements in about 2½ hours. Although the seed heater performed satisfactorily its use was found to be unnecessary for Cook Island copra, similar yields of oil being obtained from both heated and unheated batches. Oil clarification was most satisfactorily achieved by allowing the larger particles to settle overnight (to produce a sediment that could be reprocessed with the copra through the screw press) and using the filter press to remove the finer particles still in suspension. A day's partially clarified crude oil could be filtered the following day in about 2½ hours.

Figure 2 Flow chart for small-scale Copra Processing.



An 8 hour working day was operated along the lines shown in Figure 3 using a team consisting of one semi-skilled supervisor responsible for overall production, and two general labourers.

Figure 3 Schedule for Working Day



Yields and throughputs of such a system will clearly vary depending on copra quality, equipment maintenance and operator skill and care. The summary performance data presented in Table 3 are derived from the extensive series of trials carried out during the project and are used in the later financial analysis.

Table 3 Yield and Throughput Summary

	Copra Processed	Clarified Oil Marketed	Oilcake Marketed
per hour	63 kg	34 kg	26 kg
per day (see Figure 3)	378 kg	206 kg (=227 litres)	155 kg
per tonne copra	1000 kg	545 kg (=600 litres)	410 kg
per year (250 working days)	94.5 tonnes	56,700 litres	38.7 tonnes

Note: Assumes recycling of sediment through the expeller but disposal of filter cake by blending with oilcake.

Raw material requirements

As shown in Table 3, the screw press can handle just under 100 tonnes per year. This volume of raw material is readily available in the Cook Islands, where production of copra has averaged about 1,000 tonnes per year in the 1980s, and is likely to be available also in many other Pacific islands.

Copra must be of a good quality for this type of project, particularly for edible oil production. In large scale processing, coconut oil is normally refined and deodorised before use for edible purposes. In the small-scale process described here, there is no refining stage and therefore quality requirements for the copra are stringent. Fresh copra that has been dried without delay to a moisture content below 6 per cent yields an oil with a fine coconut flavour, a pleasant aroma and low acidity (typically below 0.4 per cent). Oil from old copra tends to have a stale flavour and higher acidity levels. Mouldy copra should be avoided.

Copra which is not of sufficiently good quality for making edible oil, perhaps owing to some minor mould covering or the age of the copra, may be suitable for cosmetic oil production. Copra of even lower grade can usually be used for the production of oil for soap making.

In the Cook Islands normal export-quality copra was hand-selected for premium-grade copra for edible oil production. Other Pacific islands should have no particular difficulty in producing copra of an appropriate quality. Where, as in the Cook Islands, there is no grading of copra, it may be worthwhile to consider introducing a scheme to pay a premium price for higher quality copra, which would yield a better quality edible coconut oil.

The marketing of coconut oil

(a) Coconut oil for edible uses

The aim of the project was to produce coconut oil for edible use, as a substitute for imports of cooking oil. This end-use should yield much more revenue than using the oil for soap-production.

Many Cook Islanders keep pigs and commonly prepare their own lard for use in cooking. Imported vegetable cooking oils, principally soya bean oil, are also widely used; imports are estimated to be in the region of 45,000 litres per year. There is no traditional use of coconut oil in cooking, although the taste of coconut is basic to Polynesian cooking: many types of food are prepared by cooking in home-prepared fresh coconut cream and coconut sauces are often added to foods after cooking. In other parts of the world coconut oil is highly acceptable as a cooking oil, so one of the aims of the present project was to investigate the scope for marketing coconut oil as a cooking oil in the Cook Islands.

A batch of coconut oil which had an acidity of about 0.35 per cent was prepared using the small-scale screw press. This oil was used in a consumer survey carried out covering 104 households, representing a 5 per cent sample of the households on Rarotonga. Each household was given two litres of coconut oil for domestic cooking over a one week period. Consumers filled in a daily diary recording how they used the oil and their observations on its acceptability. At the end of the week, an interviewer visited each household and filled in a more detailed questionnaire in cooperation with the householder.

The main result of the survey concerned the degree to which consumers would change to purchasing coconut oil instead of their present cooking oil, if coconut oil was available in the Cook Islands at a price slightly below that of imported soya bean oil. On one hand, 48 per cent of respondents indicated that they would buy coconut oil in preference to their present oil, including 35 per cent who would still continue to buy some of their present oil. On the other hand, 32 per cent would mainly buy their present oil but would purchase also some coconut oil. Only 20 per cent said they would not buy coconut oil at all. In round figures, it would appear that approximately 50 per cent of present consumption of imported cooking oil in the Cook Islands can be substituted by locally produced coconut oil, if priced competitively.

The acceptability of unrefined coconut oil as a cooking oil in other Pacific islands where there is similarly no tradition of consuming this particular product thus appears reasonably promising. Market penetration in the long run cannot be assessed alone on the basis of the type of exercise described above. Tastes in a population can change considerably over time, particularly as consumers become accustomed to a particular product, and consumption patterns can be affected by advertising and other forms of promotion.

(b) Coconut oil for soap manufacture

Assuming a potential for 50 per cent substitution of current imports of cooking oil by locally produced coconut oil, the market in the Cook Islands for coconut cooking oil (22,500 litres per year) would not be sufficient to absorb the output of the small-scale screw press (56,700 litres per year) at full throughput. This partly reflects the small population in the Cook Islands - in many other Pacific Islands where similar ventures could be considered, this situation would probably not arise. However, it is necessary to look at alternatives to marketing the coconut oil for edible uses, and the major option is for soap manufacture.

Coconut oil is very uitable for soap manufacture, making a soap which characteristically foams well (even in salt water), and has a very strong cleansing action. This is ideal as a laundry soap, and coconut oil also makes an acceptable toilet soap. Up to 30 per cent coconut oil can also be used with tallow or lard, to give a milder toilet bar formulation.

The Cook Islands, in common with many other Pacific islands, import large quantities of soap each year, which in principle could be substituted by soap manufactured locally wholly or partly from coconut oil. The Cook Islands import about 70 tonnes of soap (excluding detergents) each year, of which about one half is laundry soap in 400 g retail bars, and the other half is toilet soap in smaller bars. There is also a requirement for guest soaps (20 g bars) in the hotels.

At the outset of the field work for this project, soap was not being manufactured on a significant scale in the Cook Islands. By the end of the visit a local entrepreneur had set up simple facilities for the production of soap in 70 kg batches using a simple 'cold' process (6).

(c) Coconut oil for other uses

The use of coconut oil as a hair and body oil is traditional in the Cook Islands, and there is also a market for sun tan oils for sale to tourists. In the Cook Islands, total sales in this category probably amount to about 1,000 litres per year, which is small in comparison with the potential market for coconut oil as a cooking oil or for soap manufacture, and small in comparison with the annual output of the small-scale screw press. Nevertheless, this may be a significant part of the overall market for coconut oil, given the potentially high prices for cosmetic oils.

The Cook Islands import in the region of 800,000 litres of diesel per year. From a technical viewpoint, fuels could be produced from coconut oil as a substitute for diesel. However, the current landed price for diesel is less than 25 per cent of the minimum price necessary to make small-scale coconut oil production viable, so that this option can be dismissed on financial grounds.

The marketing of copra cake

Imports of animal feeds and ingredients are significant for many Pacific islands; the Cook Islands imported 352 tonnes of feeds and ingredients in 1982 and 981 tonnes in 1983 (the latest available statistics). Most of these feeds are used for pig production and copra cake can be incorporated in pig rations up to 40 per cent of the feed, provided it is blended with other feedstuffs to provide a properly balanced diet.

At full throughput, the small-scale screw press will produce about 39 tonnes of copra cake per year, which could be easily absorbed by the local livestock industry. Cake produced during the demonstration trials in the Cook Islands was sold to farmers in 25 kg sacks at a price of 28 NZ cents per kg, compared with a landed price for imported pig feed pellets at 64 NZ cents per kg. All copra cake produced was sold as soon as it became available, and farmers were very pleased with the product.

Financial evaluation of small-scale copra expelling

The financial profitability of small-scale copra processing has been investigated by an analysis based largely on the actual costs and production data relating to the plant set up and operated in the Cook Islands. Detailed tables and notes relating to the financial analysis are provided in Appendix 1. The analysis is based upon prices and exchange rates in autumn 1986.

(i) Establishment costs

The fixed capital costs for setting up a small-scale screw press unit total just under NZ$100,000, as shown in Table A.1. Of this total, approximately 50 per cent is accounted for by the landed cost of the equipment. The allowance for land and buildings, estimated at NZ$35,000, would be higher if actual purchase of land were involved, as opposed to leasing, which is the normal situation in the Cook Islands. The establishment costs of the project are reduced significantly where the copra processing equipment can be set up in an existing building, and the effect of this option of financial performance is discussed later. The project has been costed excluding a seed heater, as this item of equipment proved unnecessary in the Cook Islands. At locations where copra has a high moisture content, a copra heater may prove advantageous.

(ii) Working capital

Table A.2 gives a breakdown of the working capital requirements for the project, which are about NZ$12,500 to cover salaries, utilities and other consumables, plus money tied up in working stocks of copra, coconut oil and copra cake. This is low in relation to the annual turnover of the project, as working stocks of raw material and products will not need to be large for a small project serving local markets.

(iii) Operating costs

Total operating costs are just under NZ$85,000 per year.

Fixed operating costs (Table A.3), ie those which are independent of the level of throughput on the equipment, amount to just over NZ$27,000 per year, mainly represented by staff costs. Day-to-day operation of the plant requires three workers, one of whom would be semi-skilled and responsible for overall production. Some higher level management will be necessary, but not as a full-time post. For the present analysis, it is assumed that someone of middle-management calibre would be providing an input averaging one day per week.

Throughput-dependent operating costs (Table A.4) amount to just over NZ$57,000 per year at a throughput of 94.5 tonnes per year. Most of this is represented by purchase of copra, totalling NZ$47,250 per year at a price of NZ$500 per tonne. In the Cook Islands, copra price is stabilised through the operation of a stabilisation fund. The price of NZ$500 per tonne is higher than the official price, to incorporate a premium to encourage supply of higher grade raw material.

(iv) Revenue

At full capacity (six hours per day screw press operation), it is estimated that the plant will produce 56,700 litres of coconut oil and 38.7 tonnes of copra cake per year. Revenue from sale of coconut oil will depend on the proportions of output which are sold as cooking oil and for soap manufacture, and the prices that can be obtained for each type of product. The analysis presented here is based on the specific situation in the Cook Islands, which will not necessarily be applicable on other Pacific islands.

Sales of coconut oil for cooking purposes are estimated at 22,500 litres per year, representing 50 per cent substitution of present imports of vegetable oils, and just under 40 per cent of the output of the small-scale screw press. It is assumed that the oil is sold wholesale at a price of NZ$2.25 per litre, excluding bottling costs. This is significantly below the present landed price for imported oils.

The balance of coconut oil, some 60 per cent of the output of the screw press, is assumed to be sold for soap manufacture, for which a price of NZ$1.75 per litre is estimated. At this price, a laundry soap could be produced for a price lower than the present landed cost of imported soap.

Copra cake is assumed to be sold at a price of NZ$280 per tonne. At this price level, copra cake produced during the field trials in the Cook Islands sold easily to pig farmers.

With these specific assumptions, the project would generate an annual revenue of NZ$121,324 per year, as shown in Table A.5.

(v) Discounted cash flow analysis

Table A.6 presents a cash flow for the project, assuming a ten year life for the equipment, and allowing for replacement of the diesel engine in years 4 and 7 of the project. After the first year, 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) of the project is 49 per cent, and at a discount rate of 10 per cent the project has a net present value of NZ$131,633.

This analysis shows that small scale copra processing should be a very profitable activity, if carried out under the specific circumstances assumed to exist in the above model of the project.

<u>Sensitivity analysis</u>

Many of the assumptions and estimates used above will not be directly applicable at other potential locations for small-scale copra processing. It is therefore important to identify those cost and revenue items which are most critical to the financial performance of the project.

Revenue variation is probably the most important item to be considered, and will depend on the average price at which the coconut oil is sold, and the total volume of sales. Average price will depend on the relative sales of oil for cooking purposes versus soap manufacture. The size of the domestic market and the degree of penetration by coconut oil will determine the level of output at which the equipment can be operated; equally, throughput could possibly be reduced or increased for technical reasons.

Table A.7 shows the effect on the project IRR of varying the average price at which the coconut oil is sold, in relation to varying the throughput on the equipment. The financial performance of the project appears fairly robust. In the basic project model presented above, the average selling price for coconut oil is about NZ$1.95 per litre, and in this price range the project could tolerate 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, other assumptions remaining unchanged.

If all of the output could be sold as cooking oil, at a price near to NZ$2.20 per litre, small-scale processing is viable even when throughput is reduced by 40 per cent. Table A.7 also shows that even if no oil is sold for cooking purposes, the project is viable producing coconut oil for soap manufacture alone, providing the plant is operated close to full capacity.

Capital costs are likely to vary from place to place, particularly in relation to the cost of land and a building. Where the processing equipment can be set up in an existing building such that land and building costs are not incurred, the profitability of the venture improves considerably, as land and building account for almost 37 per cent of the capital costs in the basic project model presented above. General variation in capital costs is likely through exchange rate variations (for the imported items), differences in location and other factors. Even with a 20 per cent increase in capital costs, the project remains profitable.

The operating costs most likely to vary to an extent that would affect the project's viability are the cost of copra and staff costs; the project remains viable even with a 20 per cent increase in either of these items.

While the project as modelled on the Cook Islands appears very attractive and financially sound, circumstances in other locations may be appreciably different. The analysis presented in this paper provides a framework for the assessment of similar projects at other locations.

Economic analysis

The main economic benefits to Pacific islands like Rarotonga of small-scale copra processing are as follows:

(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. Additional foreign exchange benefits may result from local soap manufacture.

(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.

(iii) Consumers benefit through the availability of cooking oil and/or soap at a lower price than current imports.

(iv) Employment generation includes not only those directly involved in the copra processing operation, but also those employed in providing services to the project, and downstream industry (such as soap manufacture).

(v) Availability of copra cake at a lower price than imported animal feed ingredients should stimulate the livestock sector.

Summary

The small-scale processing of copra has been demonstrated and evaluated in the Cook Islands, with a view to examining the potential transfer of this technology elsewhere.

The oil extraction equipment, comprising a knifemill for chopping the copra, a seed heater, a continuous screw press, and a filter press, processed copra very satisfactorily, with few technical difficulties. The seed heater was found to be unnecessary, since the locally available copra (moisture contents 4.3 per cent and 5.3 per cent) did not need heat pretreatment for the particular model of screw press employed. Throughputs in the range of 60 to 70 kg of copra per hour were consistently achieved, with yields of clarified oil and copra cake around 55 per cent and 40 per cent respectively, on a weight basis. Operating along commercial lines, with a full time staff of three, this set of equipment could process 94.5 tonnes of copra per year (250 working days on a single 8 hour shift basis) to produce about 57,000 litres of clarified coconut oil and 38 tonnes of copra cake.

Potential markets for coconut oil and copra cake were also assessed, and a consumer survey carried out on Rarotonga indicated that the oil was widely acceptable for cooking purposes. It was estimated that locally produced coconut oil could substitute for approximately 50 per cent of current imports of cooking oil if marketed at a slightly lower price. An additional potential market was identified in "cold process" soap manufacture. The production of trial batches of soap led to an entrepreneur taking steps to establish a soap production venture. The copra cake sold readily to local pig farmers.

A basic economic model was developed using the production and cost data obtained during the project and assumed that sufficiently large markets for the outputs of the equipment could be developed to permit full capacity utilisation. This showed an internal rate of return of 49.0 per cent, with a payback 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.

The overall conclusion is that small-scale copra processing is highly feasible from a technical viewpoint, using the equipment tested in the Cook Islands. Provided the output from the project can be marketed, as appears promising on the basis of this study, this type of project can be a highly profitable venture on a Pacific island such as Rarotonga. The analysis presented in this paper is based specifically on the circumstances prevailing in the Cook Islands in late 1986, but the project appears to remain financially worthwhile even with pessimistic assumptions about revenue, or when cost projections are increased within plausible limits. The potential appears promising for identifying other locations where this type of project would be viable.

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APPENDIX: Tables relating to the financial analysis

TABLE A.1 FIXED CAPITAL COSTS (1)

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

Notes

(1) Except where otherwise specified, costs are based on actual costs (in late 1986) for the equipment as installed in the Cook Islands.

(2) In the Cook Islands, the system of land tenure is complicated. For this analysis, lease of land is assumed rather than purchase. 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 A.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 A.3.

(2) See Table A.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 A.3 FIXED OPERATING COSTS

(a) STAFF COSTS	NZ$ per man-year	Annual Requirement (man-years)	Annual Cost NZ$	Note
Management overheads...	15000	0.2	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	

(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

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 A.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, etc.

TABLE A.4 THROUGHPUT-DEPENDENT OPERATING COSTS

(a) RAW MATERIAL COSTS

	Landed Rarotonga (per tonne) NZ$	Annual cost NZ$	Notes
Copra......	500	47,250	(1)

(b) UTILITIES

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

(c) REPLACEMENT OF WEARING PARTS

	Cost per part/set cif Rarotonga NZ $	Replacement rate T copra per part	Parts per year	Annual cost NZ $	
Worm shaft on expeller...	1134	20	5	5358	
Barrel-rings on expeller................	781	20	5	3691	
Filter cloths (set of 7)..............	252	94.5	1	252	
TOTAL...					9301 (3)

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

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 A.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	

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 A.6 DISCOUNTED CASH FLOW ANALYSIS

PROJECT YEAR	1	2	3	4	5	6	7	8	9	10
Fixed capital costs (1)	(95449)			(4133)			(4133)			13000
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 A.1. 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, 50 per cent of the initial cost of the building is recovered.
(2) See Table A.2. All working capital is recovered in the final year of the project.
(3) See Tables A.3 and A.4. Assumed constant throughout the project life.
(4) See Table A.5. Assumed constant throughout the project life.

TABLE A.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.
Figures in brackets are negative and - indicates a negative IRR outside the calculation range of the computer program used.