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SMALL-SCALE CHARCOAL MANUFACTURE

UC/VAN/86/066

Republic of Vanuatu

Report on : Phase I Study

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

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SUMMARY

This study is an investigation of the potential for the production of charcoal from coconut shells in the Republic of Vanuatu. Santo and Malakula are identified as the best islands on which to initiate such production.

Production would be aimed at an export market to producers of activated carbon in Japan, USA and Europe. Some charcoal would also be available as a domestic fuel, but this market is inadequate by itself to support a major development project.

The design of a prototype charcoal kiln is given. The feed material to this kiln would be broken coconut shells. To produce these, it is necessary to modify the copra production process so that the nut is dehusked.

Proposals are outlined for further phases of this project. They include a detailed survey of world trade in shell charcoal, exploratory negotiations with appropriate activated carbon producers and construction of a prototype kiln. This kiln would be used to obtain data for a more detailed feasibility and cost study and to produce market samples, as well as serving as a demonstration and training unit.

Development of charcoal production and trade will create additional employment opportunities. No openings specifically for women were identifiable, most jobs being within the capabilities of both men and women.

1. INTRODUCTION

1.1. Objectives

1. To investigate the potential for the production of coconut shell charcoal.

   a) To augment the range of products from the coconut industry;
   b) To provide a fuel for domestic use;
   c) To provide an export product;

   and so to assist the government in its rural energy programme and generate employment opportunities

2. To develop an implementation plan for a demonstration charcoal production unit.

3. To maximise the involvement of women in industrial development.

1.2 Background

Copra has been Vanuatu's major domestic export for a number of years. In 1981-1985, it contributed 70-85% of the nation's domestic export income (Table 1). World market prices for copra have become unstable, in recent years declining severely. This has resulted in copra contributing only 47.5% of the export income in 1986. Diversification by the coconut industry into other related products would help ameliorate the effect of this downturn in prices and returns on the national economy.

If all coconut shell was converted to charcoal, the yields would be about 80% of the copra tonnage and could rival it in value at 1986 prices. The extreme position is constrained by high collection and internal freight costs, by competing uses for the shell, by problems of incorporating charcoal production in the present copra production process, and by marketing difficulties.

Charcoal production is a relatively simple process and a number of techniques and kiln designs are available. They are appropriate for application in small to medium scale operations compatible with the scale of copra production.

As a domestic fuel charcoal has the advantages of being cleaner burning than wood and cheaper than imported liquified petroleum gases (LPG). Its substitution for the latter would however require replacement of the cooking stove, but possibly only minor modification in the case of wood. Choice would probably be on the basis of a trade-off between cost and convenience, which factors would differ in significance in different communities.

1.3 Project output

The key product of this phase of this project is a development plan for Phase II. This, as detailed later in this report, includes a survey of potential markets for coconut shell charcoal and the building of a demonstration plant for its production. A draft project proposal for Phase II is given in the appendix.

The demonstration plant would serve as a prototype unit for the purpose of producing quantities of charcoal for market assessment, for conducting a series of trials to determine the optimum mode of operation, and for training operators for other plants to be installed in the subsequent phase of the development.

TABLE 1 : COPRA EXPORTS

	Quantity, Tonnes			Average Value
	Santo	Vila	Total	VT/t
1981	32684	14386	47070	22742
1982	26107	8691	34798	20398
1983	28549	9989	38538	33950
1984	35814	10867	46682	58583
1985	24362	10568	34930	39851
1986	30888	11405	42293	10895

	Copra Value '000 VT	Total Domestic Exports 000 VT	Copra/Total %
1981	1070460	1402100	76.3
1982	709794	1027266	69.1
1983	1308378	1781406	73.4
1984	2734762	3221106	84.9
1985	1391980	1980505	70.3
1986	460775	970184	47.5

Source: NPSO, Statistical bulletin

2. THE CURRENT SITUATION

2.1 Coconut production

For the purposes of this study, data for the production of copra for export can be taken as an indicator of coconut production and of potential arisings of coconut shell. Table 2 shows the distribution between local government regions of land used for coconut production as assessed in the 1983/84 Agricultural Census. Table 3 lists the export copra production on the same basis for 1981-85. Table 4 subdivides the 1985 production by type of source - plantation or small-holding.

These data give no indication of the household consumption of coconuts for human and animal consumption. Estimates from a sample survey in the 1983/84 Agricultural Census showed an average consumption of 15 nuts per household per day. The copra equivalent of this was assessed as 16,058 t in 1983, 35% of the total small-holding production for that year.

Table 5 is derived from Tables 2 and 4, together with census estimates of household use of coconuts. There has obviously been some reclassification of land-holdings, but the 1983 numbers are used nonetheless.

These tables show that not only are Santo/Malo and Malakula the dominant regions for coconut production. Malakula has on average the largest and most productive plantations and, apart from Epi, the most productive small-holdings. Approximately 24,000 t/y of coconut shells are potentially available in these regions.

These two regions were therefore selected for a study of the copra production process with a view to integrating it with charcoal production.

TABLE 2 : LAND IN USE FOR COCONUT PRODUCTION

LGC REGION	PLANTATIONS		SMALL-HOLDINGS	
	Area, ha	Number	Area, ha	Number
Banks/Torres	80	(1)	4373	(1111)
Aoba/Maewo	294	(7)	9854	(2203)
Santo/Malo	9608	(59)	11271	(3186)
Malakula	2997	(13)	14364	(3463)
Pentecost	1019	(8)	6886	(2177)
Ambrym	16	(2)	6040	(1338)
Paama	0	(0)	1353	(560)
Epi	1760	(12)	2589	(595)
Shepherds	0	(0)	3683	(933)
Efate	3065	(40)	4762	(1958)
Tafea	0	(0)	7277	(3877)
Total	18839	(142)	72452	(21401)
Average Size, ha	133		3.4	

Source : NPSO, Agricultural Census 1983/84

TABLE 3A : COPRA RECEIVED FOR EXPORT (TONNES)

LGC REGION	1981	1982	1983	1984	1985	Total 1981-85
Banks/Torres	922	737	1151	1618	2222	6650
Aoba/Maewo	5230	3913	5267	6135	3288	23833
Santo/Malo	13931	12247	9377	13137	9230	57922
Malakula	12296	10167	11185	12338	10852	56838
Pentecost	2352	1307	1772	3142	2086	10659
Ambrym	3405	2598	4119	4414	3457	17993
Paama	442	216	229	382	305	1574
Epi	1627	1274	1765	1849	1892	8407
Shepherds	1100	250	1013	1491	1312	5166
Efate	3792	825	1091	1846	2421	9975
Tafea	1377	722	934	1407	1758	6198
Unknown	2614	885	239	59	-	3797
TOTAL	49088	35141	38142	47818	38806	208995

TABLE 3B : COPRA RECEIVED FOR EXPORT (%)

LGC REGION	1981	1982	1983	1984	1985	average 1981-85
Banks/Torres	2.0	2.1	3.0	3.4	5.7	3.2
Aoba/Maewo	11.3	11.4	13.9	12.8	8.5	11.6
Santo/Malo	30.0	35.6	24.7	27.5	23.8	28.2
Malakula	26.5	29.6	29.5	25.8	28.0	27.7
Pentecost	5.1	3.8	4.7	6.6	5.3	5.2
Ambrym	7.3	7.6	10.9	9.2	8.9	8.6
Paama	0.9	0.6	0.6	0.8	0.8	0.8
Epi	3.5	3.7	4.6	3.9	4.9	4.1
Shepherds	2.4	0.7	2.7	[illegible].1	3.4	2.5
Efate	8.2	2.4	2.9	3.9	6.2	4.9
Tafea	3.0	2.1	2.5	2.9	4.5	3.0

TABLE 4 : COPRA PRODUCTION, 1985, BY SOURCE (TONNES)

LGC REGION	PLANTATIONS	SMALL-HOLDINGS	TOTAL
Banks/Torres	19	2203	2222
Aoba/Maewo	158	3103	3288
Santo/Malo	3901	5329	9230
Malakula	2174	8678	10852
Pentecost	212	1856	2068
Ambrym	184	3273	3457
Paama	0	305	305
Epi	71	1821	1892
Shepherds	56	1257	1313
Efate	725	1696	2421
Tafea	75	1683	1758
Total	7575	31231	38806
	19.5%	80.5%	

Source : NPSO, Copra Statistics, 1985

TABLE 5 : COPRA PRODUCTION, 1985, BY UNIT (TONNES/PRODUCTION UNIT)

LGC REGION	PLANTATIONS	SMALL-HOLDINGS		
		Export	Own-use	Total
Banks/Torres	19.0	1.98	0.60	2.58
Aoba/Maewo	22.6	1.41	0.80	2.21
Santo/Malo	66.1	1.67	0.55	2.22
Malakula	167.2	2.51	0.75	3.26
Pentecost	26.5	0.85	0.70	1.55
Ambrym	92.0	2.45	0.70	3.15
Paama	0	0.54	0.65	1.19
Epi	5.9	3.06	0.80	3.86
Shepherds	-	1.35	1.15	2.50
Efate	18.1	0.87	0.90	1.77
Tafea	-	0.43	0.65	1.08
Average, t/unit	53.3	1.46	0.75	2.21
t/ha	0.40	0.43	0.22	0.65

2.2 The Copra Production Process

In Vanuatu, mature coconuts are allowed to fall naturally. The nuts are gathered throughout the year. On small-holdings, they may be gathered as frequently as every 2 weeks. On one plantation visited, they were gathered only 3-4 times per year; twice in February - May after the main flush of production and again before the wet season in November. The nuts will therefore have had various lengths of time for seasoning and sun-drying. Lengthy periods between gathering the nuts increase the loss of nuts through germination.

Nuts are accumulated into convenient piles in the plantation. From here they may be collected with a truck or tractor/trailer unit and transported to a central location for splitting and removal of the kernel. Alternatively the nuts may be split at the small piles in the plantation and only the raw kernel taken to the central dryer. The husk and shell intact remain in the field where they eventually rot returning nutrients to the soil.

The practice adopted of course depends on the facilities available to the operator, and the fuel requirements and availability for the copra dryer. On plantations where livestock - cattle or pigs - are run among the coconut palms, shells and husks left lying on the ground restrict pasture production, encourage weed growth and provide breeding places for mosquitos. Even if burnt in their piles in the plantation, pasture is destroyed and supplanted by weeds. In terms of pasture management, it is highly desirable that the whole nuts be removed from the plantation. This is rarely done completely however because of the lack of transport equipment.

In most cases, the nuts are split and the copra cut in the field. The raw copra is packed in jute bags for taking to the dryer. If the copra dryer is fueled solely with husks and shells, 50 - 60% of the nuts are required for fuel and so must be taken to the dryer. The husks are bulky and inconvenient to transport particularly for a small-holder who may not have a truck or truck access into the plantation. Most dryers are therefore fueled with firewood and husks in various proportions depending on their relative availability.

Most operators have their own dryers. In the 1983/84 agricultural census, only 6% of producing households had co-operative ownership dryers. Dryers are all of the same basis design - a raised platform, approximately 2.5 m x 5 m, protected by a roof.

The platform is a series of joists covered with a woven steel mesh. The area below the platform is enclosed with cement-covered jute bags or old roofing iron. In the case of smoke dryers a fire is built here producing smoke and hot air which passes through the copra bed to dry it. In hot air dryers the fire is confined in a 750 mm dia x 3 mm thick horizontal steel drum extending the length of the dryer and with a flue at the far end. This heated drum creates a convection flow of smoke-free hot air to dry the copra.

Larger dryers as used on plantations generally consist of a side-by-side replication of these units, often on a concrete or concrete block structure.

Drying times quoted by various operators ranged from 16 hours to 2-3 days. The greater depth of copra in the dryer beds in the large plantation dryers would account for some of this variation. Dryers also varied somewhat in the area of openings available for in-flow of air.

Copra may be turned on the drying bed part way through the drying cycle. The dry copra is packed directly in 65-70 kg jute bags from the dryer, or in plantations at times of peak production may go into a bulk store for bagging out later when labour is available.

On small-holdings the work will be done by the farmer and his family. Their average production (based on 250 working days/year) is 65 nuts/day including those for their own use.

Plantations operate with teams of piece-workers, paid at rates set by the Vanuatu Commodities Marketing Board related to the support price for copra. Production by copra cutters, who are responsible for gathering nuts and delivering cut kernel to the dryers, ranged from averages of 350 - 900 nuts/day on the plantations visited. Other piece-workers are employed as smokers and dryer attendants, and casual labour is used for packing and warehousing operations.

All copra is traded through the Vanuatu Commodities Marketing Board (VCMB), a quasi-governmental authority responsible since 1982 for export trading in copra. The Board pays a standard price for each of the two grades of copra - grade 1 : sun or hot-air dried, and grade 2 : smoke dried. This price is adjusted from time to time as in Table 6 according to revenues received on the world market. Additionally transport subsidies of 3000 - 6500 VT/t are paid based on the distances of each of four zones from the VCMB depots in Vila and Luganville, Santo.

The VCMB has the statutory right to market all coconut product exports. Private operators may be licensed to export products other than copra. Such licences normally, have a time limit. There are currently no private licences extant, but such would be required for coconut charcoal export.

TABLE 6 : COPRA PRICES

Date of Changes	Domestic Support Price, VT/t Grade 1 Hot-air/Sun dried	Domestic Support Price, VT/t Grade 2 Smoke dried	Market Quotation Year average, $US/t
1982			
April	18 000	18 000	
November 15	15 000	13 000	
1983			
August 10	20 000	16 000	
October 21	23 000	19 000	
December 1	25 000	21 000	
1984			
February 10	30 000	26 000	
August 24	36 000	31 000	
November 21	41 000	36 000	
1985			386.00
September 11	35 000	30 000	
1986			197.50
March 19	25 000	20 000	
May 21	18 000	13 000	
1987			284.35*
July	23 000	18 000	
October 19	30 000	25 000	

* January - June only

Sources : VCMB, in Central Bank of Vanuatu, Quarterly Economic Review
Vanuatu Weekly, 17 October 1967

2.3 Domestic cooking

In urban area, in expatriate households and on some plantations, domestic cooking is generally done using imported bottled gas (LPG) on imported appliances. Occasionally kerosene-fueled cookers may be used.

In rural villages and small-holdings firewood and coconut husks are used as fuel on open fires for cooking. Firewood is readily available in most areas, but considerable effort may be expended in its collection. It is probably least available to workers on plantations who may be housed some distances from natural forests which provide the firewood.

There have been isolated instances where wood charcoal has been produced for use as a local cooking fuel. At Onesua, Efate, its still made occasionally using the pit or drum method, and simply cast concrete stoves have been made in which to use it efficiently.

It is understood that production on a similar basis in Tanna has now ceased. In both cases, firewood was being cut and converted to charcoal for local use. Use of the firewood already as the cooking fuel is probably more efficient, convenience of the charcoal stove is foregone.

There has been no trade in fuel charcoal. Firewood is traded in the Vila market at 200 - 300 Vatu per bundle by two or three sellers.

LPG imports in 1983 amounted to 646 t, valued at 33.7 million Vatu. Replacement of, say, half this with shell charcoal would require only about 500 t. Even at this very high level of substitution, this quantity is considered too small to warrant the development of a charcoal industry to satisfy this market alone.

The major potential sources of shell charcoal are Santo and Malakula, while the major LPG market is on Efate. This separation of source and market, and the need to retrain copra cutters for only a small production militate against the introduction of charcoal production for local consumption only. Domestic demands could be readily satisfied however in association with an export trade.

3. CHARCOAL PRODUCTION

3.1 The charcoal production process

Charcoal may be produced by either of two basic methods:-

(i) partial combustion, or
(ii) indirect-heated pyrolysis

The pit or drum methods are typical examples of partial combustion systems. The same procedures apply irrespective of the feedstock.

In the simplest form of the drum method, an open-topped oil drum with a number of small holes in the base is used. With the drum supported on a couple of pipes, a fire is established in the bottom of the drum. When this fire is burning freely, more of the material to be carbonised, in this case coconut shells, is put on the fire to stifle the flames. More fuel is added progressively whenever the fire is on the verge of breaking through to the top of the fuel bed.

When the drum is full, the pipes are removed from under the drum, thus sealing the air vents, and the drum is covered with a wet jute bag or banana leaves. The lid is then placed in position and weighted with soil or stones to seal the top of the drum.

The fire dies through lack of air while the heat in the fuel bed completes the carbonisation reactions converting the fuel to charcoal. After cooling, the drum may be unsealed and the charcoal removed. Before bagging, it should be spread thinly on clean matting to ensure that there is no tendency to burst into flame.

The yield of charcoal by this method is 25 - 35% of the feed material. Dry material would carbonise best, but increases the risk of too vigorous a fire developing. Therefore fresh coconut shells or moderately green wood is preferred.

In various variants of the drum method, the drum is fitted with a number of air vents up the height of the drum (or two drums joined end to end). These vents are progressively closed as the drum is filled and the fire moves up the drum.

For production of charcoal by the method of indirect-heated pyrolysis, the feedstock (coconut shells or wood) is placed in a closed drum and the drum is heated by an external fire. The drum must be vented to allow the escape of pyrolysis gases and tars, but no air is allowed to flow through the charge of material in the drum.

This method gives a higher yield of charcoal than do the partial combustion methods because there is no loss of carbon by combustion.

Any waste material may be used as fuel and only sufficient is needed to heat the drum or kiln to about 250°C. At this temperature the pyrolysis reactions are exothermic (generate heat) and the process should be self-sustaining. Ideally the vent for the pyrolysis gases should be arranged so that they pass into the fire, thereby supplementing the fuel and avoiding a smoke nuisance.

3.2 A conceptual system for charcoal production

Conceptually the most convenient basis on which to produce charcoal would be to associate a charcoal kiln with each copra dryer. A standard indirect-heated kiln or retort could be designed and the village small-holder would operate this whenever he had sufficient shells to produce a batch of charcoal, in the same way as he currently manages his copra dryer. The charcoal kiln could be attended in the idle periods between attending the copra dryer. The two processes could be run concurrently without necessarily extending the overall cycle time.

The biggest hurdle to be overcome before charcoal production can be undertaken is for the copra cutters to produce a clean shell, free from husk. Currently the nuts are split longitudinally with an axe or knife, and the kernel is then cut, with an appropriately curved knife, from each half nut. The nut with husk intact is readily gripped for easy removal of the kernel.

If the husk is removed before the nut is split, as is the practice in most places other than the Pacific Islands, it may be more difficult to cut the copra from the shell and copra cutters will need to modify their current techniques accordingly.

To remove the husk from the whole nut, four longitudinal cuts can be made through the husk and each quarter of the husk then cut from the nut, as is now done with the few nuts that are sold in the Vila market for instance.

Removal of husk from the shell after splitting and cutting of the kernel could be done in a similar manner, but possibly not as easily.

A mechanical dehusking device is reportedly used in the Ivory Coast, but no details are available. Such a device may be applicable in Vanuatu if manually actuated.

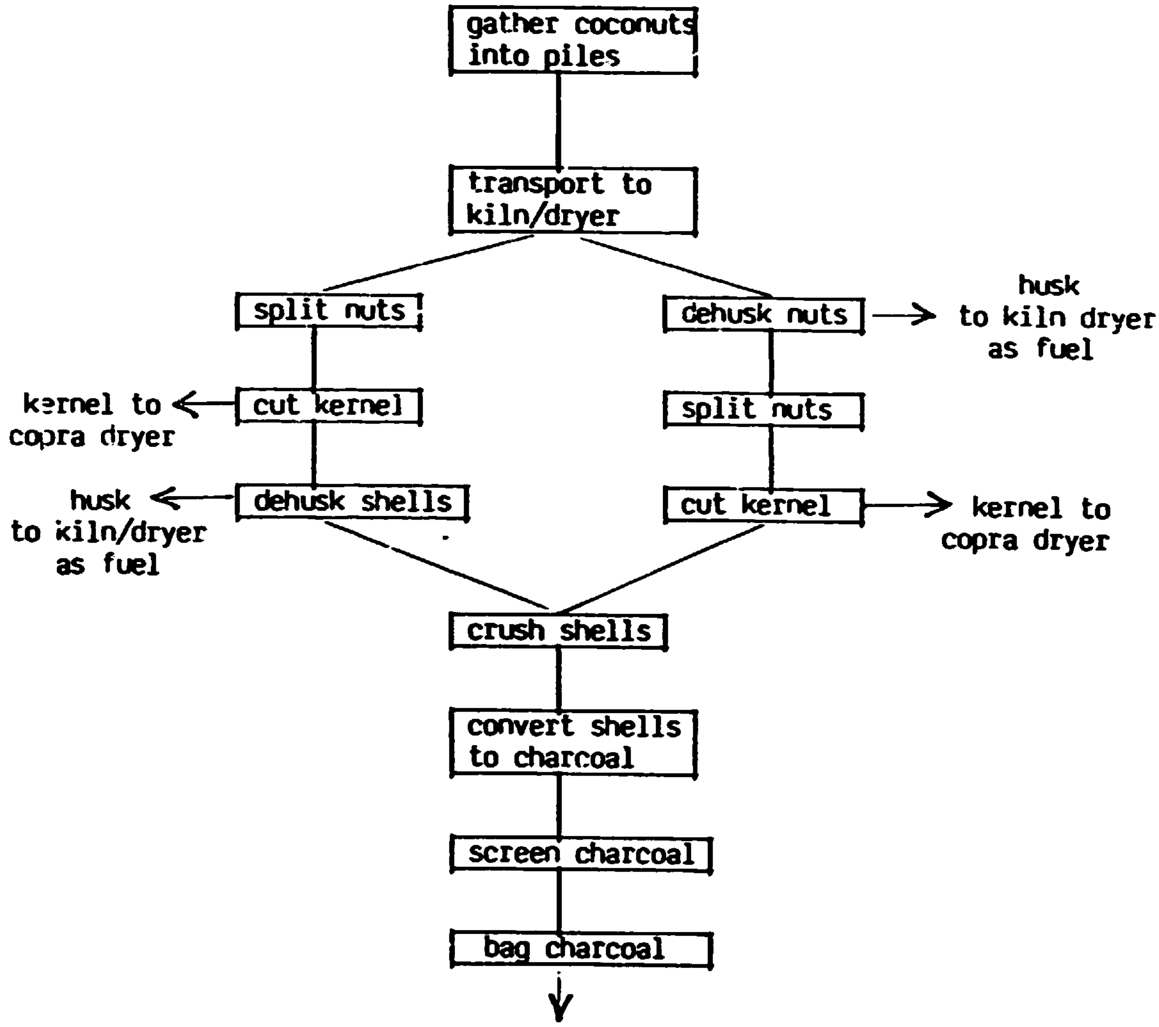
Dehusking of the shell, either before or after splitting, could be done in the field or at the location of the copra dryer. The latter is preferable for reasons noted earlier, but its feasibility depends on the ability of the operator to transport the volumes of materials involved.

If the dehusking occurs at the dryer the husk is immediately available to fuel the copra dryer and the charcoal kiln. Little or no firewood will be required as supplementary fuel if husk is available from all the nuts. Some firewood may be desirable to give an appropriate structure to the dryer fire.

On completion of the charcoal production cycle, and after sufficient time for cooling, the charcoal from the kiln would be passed over a 6 mm screen to separate dust and fine particles of charcoal before packing in jute bags. The screening or sieving process would also serve to remove by abrasion any charred husk still adherent to the shell.

This scheme is shown diagrammatically in Figure 1.

FIGURE 1 : PRODUCTION SCHEME



4. DEVELOPMENT CONTEXT

4.1 Infrastructure

In Vanuatu there is a well-established infrastructure for handling copra production from small-holders and plantations through to export markets under the direction of the VCMB. This same infrastructure should suffice for handling coconut charcoal in a similar manner.

There may be some constraint due to limited cargo space available on some inter-island routes. This should be investigated in a subsequent stage of this programme.

The engineering firm which fabricates copra dryer components is quite capable of building charcoal kilns also.

4.2 Market potential

The most desirable and highest valued market for coconut shell charcoal is as a feed material for the production of high quality activated carbon. This is essentially an export market. The most likely customers are in Japan, USA and Europe. An investigation of this market and preliminary negotiations with potential clients is proposed as part of the phase II programme.

The market of charcoal as a domestic cooking fuel is not seen as sufficient in itself to justify the widespread promotion of charcoal production. There will however inevitably be some domestic market if only for outdoor cooking (barbecues) in urban areas or as a cheaper alternative to bottled gas for those communities where firewood is difficult to obtain.

4.3 Technical and Management Abilities

The abilities of all those involved in copra production and marketing is demonstrated by the success of the current system. Those same skills will be required for charcoal production and marketing. If the market is right, there is no reason to doubt that they should succeed.

The wide variation in technical abilities and understanding of the drying process by both Ni-Vanuatu and expatriate operators was demonstrated by the range of drying times and dryer operating and firing conditions used to achieve the same objective. The methods although effective vary markedly in efficiency. They are no doubt based on tradition and past practice with little appreciation of technical aspects of the drying process.

Any charcoal production process must also be effective under this constraint and tolerant to a wide range of operating procedures and practices.

5. FEASIBILITY STUDY

5.1 Market Values

A world-wide survey of charcoal and activated carbon production (Palmer, 1976) showed that there was a significant trade in coconut shell charcoal for the production of activated carbon. This survey should be updated as part of the Phase II programme.

In the 1984 study by Bio-Carbon, shell charcoal was valued at $US250/t C.I.F. France. This will be used until revised values are available from the Phase II market survey.

Shipping costs to Europe are approximately $US 2000/container giving a F.O.B. value of $US 85/t assuming a 30m^3 container will hold 12t of charcoal. On the same basis, shipping to Japan costs $1084/container giving a F.O.B. value of $160/t. These costs are based on the rates for full container loads of scrap metal and include 26279 VT/container local stevedoring charges and 4200 VT export tax.

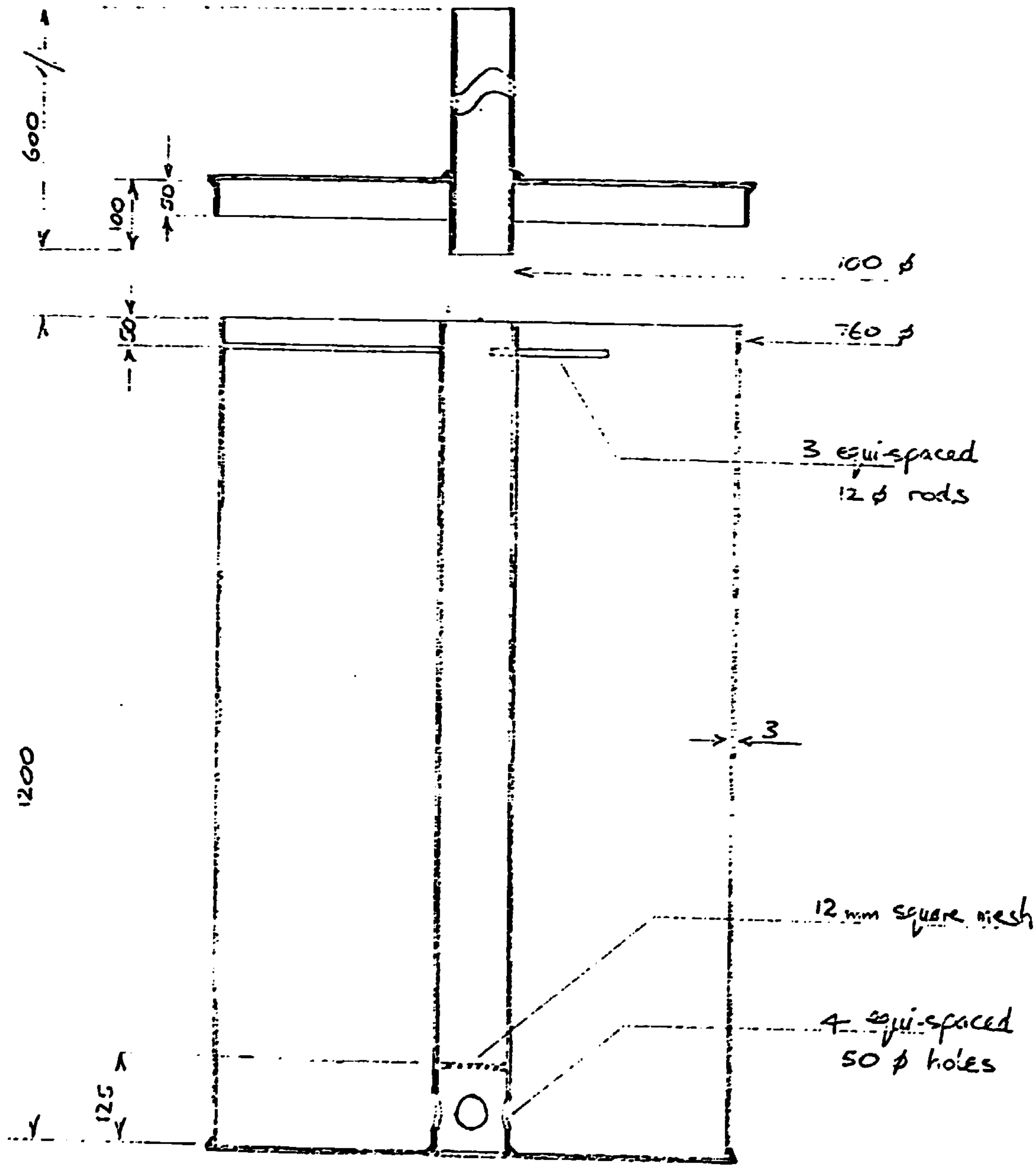
If shipped at the general cargo rate of $US 120/m^3 to Japan or $US 157.64/m^3 to Europe, the costs would exceed the charcoal value.

5.2 Plant design and operation

The prototype charcoal kiln illustrated in Figure 2 has been designed on the basis of fabrication from standard 1200 x 2400 x 3 mm mild steel plates. In the absence of any data on the bulk density of coconut shells, and of any dehusked shells on which to make measurements, the kiln capacity can be only crudely estimated.

On the assumption that coconuts comprise one third each of husk, shell and kernel by weight and yield 137 g of copra after a 50% loss of weight on drying, an average shell weighs 275g. If shells pack to about 1000 nuts/m^3, the kiln will have a capacity of about 500 nuts. One kiln charge of charcoal would

FIGURE 2 : PROTOTYPE CHARCOAL KILN



all dimensions in millimeters
material - 3 mm M.S.

therefore be processed for each bag of copra produced if all shells were available for conversion.

The kiln is of the indirect-heated type. Broken coconut shells are charged into the vessel until it is full. The lid, with flue, is placed securely on top, carefully engaging the mating sections of flue.

The whole kiln is set up on rocks or two lengths of pipe or channel and a fire of husks and wastewood lit beneath it. Only experience will show the required size and intensity of this fire. As the shells in the kiln are heated, firstly moisture is driven off and then combustible pyrolysis gases and tars. These emerge from the kiln through the holes in the base of the flue and are consumed in the fire.

If the flue emits smoke because of inadequate combustion of these pyrolysis products, some burning brands should be dropped down the flue to create a fire on the mesh in the flue and through which the gases must pass.

When the pyrolysis process has developed to a sufficient stage, the fire under the kiln may be let die, but the small fire in the flue should be maintained until pyrolysis is complete and no further gases are emitted from the kiln. The kiln must then be left to cool before it is opened and the charcoal tipped out.

The charcoal should be passed over a 6 mm screen to ensure that it is cool, to separate any dust and small particles, and to abrade off any char from residual husk adhering to the shell, before packing in jute bags.

It is expected that about 1 bag of char will be produced from each kiln batch, which, to ensure adequate cooling, should be regarded as a 20 - 24 hour cycle.

Precise estimates of yield and processing times must await the experimental operation of the prototype or demonstration plant in Phase II of the project.

Briquetting is not appropriate for the envisaged market.

5.3 Costs

The estimated cost for fabrication of the kiln in Figure 2 by Vate Industries, Vila, is 18,000 VT. To this must be added an allowance for delivery to its place of operation and the construction cost of any additional buildings to house the kiln or its product. In most cases the kiln and storage of the charcoal can probably be accommodated in the copra drying facilities or by a small extension thereto.

The steel components of hot-air copra dryers have a life of 5-8 years depending on usage. A charcoal kiln would have a similar life, and hence an annualised cost of about 3700 VT/y (over 6 years at 5% discount factor).

Other components of the operating costs cannot be assessed until Phase II B of this project.

6. FURTHER DEVELOPMENT AND DEMONSTRATION

There are two elements to the recommended Phase II development programme:

A) Market studies
B) Experimental operation and demonstration of a prototype charcoal production unit.

6.1 Market studies

A survey should be undertaken of production, export and import statistics for those countries which are possible producers of shell charcoal and for those countries, such as Japan, USA and in Europe, where there are major producers of activated carbon. This would be similar to that by Palmer (1976) and would identify the current world trade in coconut shell charcoal, its value, origins and destinations.

Concurrently with this, a letter should be sent to all major producers of activated carbon to ascertain the value they place on shell charcoal and their possible interest in sourcing it from Vanuatu. This survey would identify those manufacturers with whom it would be most worthwhile negotiating as potential contractors for the purchase of shell charcoal.

These studies are independent of the experimental prototype programme and could be readily carried out from New Zealand for instance, making use of the world-wide New Zealand Trade Commissioner network to access the country data.

6.2 Experimental prototype programme

This programme would involve an implementation of the conceptual system for charcoal production, based on the prototye charcoal kiln in Figure 2, as a demonstration unit. This could be established on the property of a co-operative plantation owner who desired to participate in, and make his labour available to assist in, trials of the proposed system, or at the Saraoutou Research Station on Santo where the operations could become part of their experimental programme.

A number of experiments and trials would be conducted with this facility:

i) to determine the optimum procedure for dehusking the coconut and producing the husk, shell and kernel as separate items, and

ii) to determine the productive capacity of the kiln and its optimum mode of operation.

In the course of the experiments appropriate measurements would be made to quantify such parameters as relative weights of coconut components, bulk density of shells and shell charcoal, fuel value of husks, fuel demand for kiln operation, kiln operating temperatures, and temperature/time cycle. These parameters, plus the labour requirements for dehusking and for kiln operation, are necessary for an accurate economic assessment of the charcoal production process.

After completion of the experimental programme, the kiln, its now-trained operator and a re-skilled copra cutter could travel with the expatriate supervisor and consultant to a number of centres of copra production on Santo, Malakula, Aoba, Maewo and Pentecost to demonstrate both the technique for dehusking coconuts and the process of producing a high quality shell charcoal.

It may however be prudent to defer such demonstration and promotion of charcoal production until there is an assured market for the product. The output from the experimental plant should therefore be used as samples in a marketing campaign and in negotiations with potential buyers.

Phase III of the project would consist of demonstration and training in charcoal production, and development of a network of producers to supply the negotiated contracts.

6.3 Phase III Development

The plan for Phase III will be predicated on the results of the market survey and subsequent negotiations with buyers. The purchasers are likely to demand significant quantities of charcoal from the outset, and the production system must be developed to satisfy these demands.

This could be done by first installing charcoal production facilities at the plantations on Santo and Malakula, followed by progressive introduction among the small-holders. If half the coconut shells were converted to charcoal, this plan would give an initial production of about 3000 t/y, building up to 10000 t/y.

Charcoal production on the plantations would not necessarily use a multiplicity of small kilns, the size of the prototype unit. A kiln of the same basic design and with a capacity of $5m^3$ has been producing wood charcoal in New Zealand for some time. Similarly sized units could be used on plantations. On such large units, skips and hoppers could be used for loading and discharging the kiln.

The initial production unit to be used as a demonstration plant and for training plant operators and copra cutters would be funded with develop assistance grants. Subsequent plants would be funded on a commercial basis.

6.4 Costs

Estimated costs for the next phase are : Phase II A $US 4000
Phase II B $US 25000

The Phase II A costs cover consultants' fees only. Phase II B costs are for consultant's fees and expenses, and the cost of prototype equipment. There will also be costs of local labour, but these should be contributed by local organisations.

Consultants' costs for Phase III would be similar, but a greater local contribution would be required.

These programmes are summarized in Table 7.

TABLE 7 : DEVELOPMENT PROGRAMME

Phase II A :	Market studies (8 weeks part-time)
	- survey of country statistics
	- survey of activated carbon producers
Phase II B :	Prototype development (8 weeks)
	- construction of prototype kiln
	- development of dehusking techniques
	- experimental operation of kiln
	- economic evaluation
	- market testing and negotiations
Phase III :	production demonstration
	- construction of production plant
	- demonstration of plant
	- training plant operators and copra cutters

7. WOMEN AND EMPLOYMENT

It is not possible at this stage to estimate the additional employment opportunities created by charcoal production. This must await Phase II B of the project.

Changes in the copra cutting process so as to produce clean shells, tending the charcoal kiln, and the additional volume of goods to be handled will all generate employment opportunities throughout the production and marketing chain.

Just as both men and women are engaged in copra production, there are no tasks in charcoal production which should be reserved exclusively for women.

The president of the National Council of Women declined to meet with the consultant, and so it was not possible to ascertain any specific concerns of that organisation.

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APPENDIX

DRAFT PROJECT PROPOSAL - PHASE II

PART A - BASIC DATA

Country/Region	:	Republic of Vanuatu
Project number	:	UC/VAN/86/066
Project title	:	Small scale charcoal manufacture
Scheduled start	:	
Scheduled completion	:	
Origin and date of official request	:	Follow-up to phase I
Government counterpart agency	:	Department of Industry
UNIDO contribution	:	US$25,000
Government contribution	:	
Other contribution	:	US$4000 (NZ government ODA to be negotiated for phase II A)
UNIDO backstopping section	:	IO/Chem

PART B - NARRATIVE

1. Objectives

a) Immediate objectives

Phase II A - to evaluate the world market for coconut shell charcoal

- to identify likely purchasers of the charcoal

Phase II B - to develop techniques for dehusking coconuts to give a clean shell suitable for charcoal production

- to construct a prototype charcoal kiln and determine its operating characteristics

- to demonstrate charcoal production on a limited basis

- to produce charcoal samples for evaluation by potential buyers

b) Development objectives

- to augment the range of products from the coconut industry

- to provide a fuel for domestic use

- to provide an export product

Thereby assisting the government in its rural energy programme and generating employment opportunities.

2. Background Information

Phase I of this project confirmed the potential for the production of charcoal from coconut shells. Santo and Malakula were identified as the best islands on which to initiate such production.

Production would be aimed at an export market to producers to activated carbon in Japan, USA and Europe. Some charcoal would also be available as a domestic fuel, but this market is inadequate by itself to support a major development project.

A prototype kiln has been designed to produce charcoal from broken coconut shells.

The Phase I report gave recommendations for further phases of the project. They included a detailed survey of world trade in shell charcoal, exploratory negotiations with appropriate activated carbon producers and construction of a prototype kiln. This kiln would be used to obtain data for a more detailed feasibility and cost study and to produce market samples, as well as serving as a demonstration and training unit.

3. Project output

Phase II A - a report identifying potential buyers of coconut shell charcoal and quantifying the market size and value.

Phase II B - a report detailing a recommended design for small-scale charcoal kilns, describing their method of operation and their performance characteristics. The report will also describe dehusking techniques developed to produce clean coconut shells and the training of copra cutters in these techniques and in kiln operation.

A further report will be required to summarise the responses from firms supplied with charcoal samples for market evaluation and to make firm recommendations for Phase III of this project.

4. Projects inputs

(a) Government - counterpart staff, office accommodation, secretarial assistance, local transport, wages for copra cutters and other workers assisting in method development.

(b) UNIDO - fees, SOAs and travel to field a consultant for 2 months for Phase II B.

(c) Other (to be negotiated) - funding of consultant for Phase II A by New Zealand Government overseas development assistance programme.

5. Workplan

Month 1)
2) Phase II A - market survey and reporting
3)

4)
5) Phase II B - field investigations, training
6) and report preparation

6. Envisaged follow-up (Phase III)

Contingent of the results from evaluation of market samples, installation of initial production facilities, training of further operators, assistance with establishment of additional production units and consolidation of the exporting system.