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PHILIPPINES PHARMACEUTICAL INDUSTRY DEVELOPMENT

DP/PHI/87/019

PRE-FEASIBILITY STUDY ON PROCESSING CINCHONA FOR QUININE IN THE PHILIPPINES

Contract No. 89/42

Prepared for the Government of the Philippines on behalf of the United Nations Industrial Development Organisation acting as executing agency for the United Nations Development Programme.

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August 1989

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ACKNOWLEDGEMENTS

It is wished to acknowledge and extend thanks to the officials of the Department of Health and the Department of Environment and Natural Resources for the assistance given and arrangements made to facilitate this study.

Special recognition is given to:

Mr. Rhais M. Gamboa	Under Secretary, Department of Health
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It is also wished to record indebtedness to the following for their interest and local assistance:-

Mr. Ernest Tabias	Governor of Bukidnon, Malaybalay
Mr. Teddy Pajaro	Mayor of Lantapan

Final appreciation is extended for support to:-

Mr. Christian Newman	SIDFA, UNIDO, Manila, Republic of the Philippines

SUMMARY

A well established Cinchona Reforestration Project exists at Kaatoan, Lantapan, Bukidnon, Mindanao, Republic of the Philippines.

The principle product of Cinchona is quinine which is not only an essential antimalarial drug but also widely used as a bittering agent in drinks and as a raw material for another important drug, quinidine.

Although it has been determined that a sustained supply of some 450 metric tonnes of dry Cinchona bark could be provided for processing, the quality of the overall stand is too low for economic processing.

A supply of some 100 metric tonnes of good quality Cinchona bark is thought to be available on a sustained basis by 1990, but this is insufficient volume for economic processing.

By 1993/4 a sustainable quantity of good quality Cinchona bark amounting to 160 metric tonnes per annum, should be available and this would be sufficient to maintain a profitable processing operation. At this time the "Wealth of Kaatoan" could begin to be realised.

It is recommended that only planting of high quality Cinchona should be made in the future and subsequently the use of meristem tissue culture of plants be considered. An analytical survey of quality and quantity of bark should be initiated to confirm the potential and to attract investors in a processing operation.

GLOSSARY AND GENERAL INFORMATION

The following are terms and abbreviations encountered in the field of Cinchona and quinine processing. Some, but not all, will be encountered in the text. Formulae, molecular weights and conversion factors are also listed.

		Formula	Mol.Wt.
TAA	= total alkaloid anhydrous		
QAA	= quinine alkaloid anhydrous	$C_{20}H_{24}N_2O_2$	324
C^DAA	= cinchonidine alkaloid anhydrons	$C_{19}H_{22}N_2O$	294
C^NAA	= cinchonidine alkaloid anhydrous	$C_{19}H_{22}N_2O$	294
Q^DAA	= quinidine alkaloid anydrous	$C_{20}H_{24}N_2O_2$	324
Q^N	= quinine (abbreviation)	-	-
Q^D	= quinidine (abbreviation)	-	-
SQ_2	= quinine sulphate dihydrate	$(C_{20}H_{24}N_2O_2)_2H_2SO_4.2H_2O$	783
SQ_7	= quinine sulphate heptahydrate	$2(C_{20}H_{24}N_2O_2)_2H_2SO_4.7H_2O$	873

SQ_2 is the nomenclature which represents quinine sulphate dihydrate (alternative Q^NSO_4) the form in which quinine appears in current pharmacopoeias and in which it is sold. It is also used to describe or define the content of quinine in bark.

SQ_7 is the form previously used to describe the content in bark and also the form in which quinine sulphate was formerly sold. It is rarely used today, although the Indonesians do still use it to describe bark content as may some older traders.

Quinine and quinidine are optical isomers as also are cinchonine and cinchonidine.
Quinine and cinchonidine have similar optical orientation.
Quinidine and cinchonine have similar optical orientation.

Conversion factors

$SQ_7 = 1.1151 \times SQ_2$
$SQ_2 = 1.2067 \times QAA$

Marketed forms of quinine

		Common abbreviation	Formula
*	Quinine alkaloid	- Q^N	$C_{20}H_{24}N_2O_2.xH_2O$ (x=0-3)
	Quinine sulphate	- Q^NSO_4	$(C_{20}H_{24}N_2O_2)2H_2SO_4.2H_2O$
	Quinine bisulphate	- Q^NBSO_4	$C_{20}H_{24}N_2O_2.H_2SO_4.7H_2O$
	Quinine hydrochloride	- $Q^NHCl.$	$C_{20}H_{24}N_2O_2.HCl.2H_2O$
	Quinine dihydrochloride	- $Q^NDHCl.$	$C_{20}H_{24}N_2O_2.2HCl.$
*	Quinine ethylcarbonate	- QEC	$C_{23}H_{28}N_2O_4$

* These products not listed in current Pharmacopoeias, but were in former NF (National Formulary, USA).

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COMFAR

1. EXECUTIVE SUMMARY

1.1 Project

This pre-feasibility study was initiated by the Department of Health, Government of the Philippines as a result of recommendations made in the report of the "Development Study of the Philippine Pharmaceutical Industry" carried out in 1988 by UNIDO experts, and funded by UNDP under DP/PH1/87/019.

This study has been funded under the umbrella of the same project, where funds of up to US $50,000 were available.

1.2 Project orientation

The project is raw material orientated, there having been in existence since 1929 an experimental forestry project entitled "Cinchona Reforestation Project of the Philippines".

The health aspect was also a factor of consideration as quinine isolated from Cinchona bark is a most important anti-malarial drug and malaria is endemic in the Philippines.

1.2.1 Market orientation

The project, in spite of a need for quinine as an anti-malarial, can only be considered as export orientated.

The consumption of quinine in the Philippines is almost entirely as an anti-malarial, but the quantity scheduled for current use is only in the order of 300kgs per annum. Even if more extensively used, demand would be unlikely to exceed 750kgs per annum, and this would not be sufficient to support a viable project, nor would there by any significant saving of foreign exchange. Demand is controlled by physicians as quinine is only administered under hospital conditions, on account of possible side affects, and should only be used for severe attacks.

Whereas the world market for quinine as an anti-malarial is only in the order of 10MT and for all medicinal uses less than 50MT, large markets exist for use in tonic and soft drinks (200MT or 40% market) and as a raw material for production of quinidine, a heart drug (250MT or 50% market).

1.2.2 Project background

Establishment of growth of Cinchona in the Philippines was achieved in 1929 with an official Government Policy to set up an on-going project. This was initially envisaged to provide quinine as an anti-malarial drug to combat the seriousness of this endemic disease prevalent in the Philippines.

In fact, since its inception only during the Second World War was this benefit realised. At that time lives of many Filipino guerrillas and American forces were preserved by utilising the Cinchona from Kaatoan. Otherwise only infrequent harvestings in 1951 (71MT), 1956 (173MT), 1966/67 (781MT) and 1971/72(40MT) were recorded. These harvestings were presumably sold in the world market to quinine producers, but no clear records of sales were generally available.

The information which is most lacking is the level of quinine contents in the barks, and this is the most important feature. Only one reliable set of analyses for Cinchona ledgeriana could be located for the 1971 harvest. At that time the average quality of this specie at 7.34% SQ_2 was quite acceptable.

What is needed is regular annual harvesting and preferably processing in the Philippines, provided the quality, quantity and continuity of supply can warrant it. This must also be supported by a continuous planting programme to maintain supplies and quality.

Such a production could be a first most important step in the initiation of a truly basic pharmaceutical chemical industry in the Philippines.

In view of the experience of the Reforestration project team in rearing Cinchona, and that one of the most important factors in persuading investors to set up a Cinchona processing factory would be the reliability and security of supply of raw material, it would appear most attractive to consider an integrated unit for both processing and growing Cinchona. Such an integrated unit also benefits from some economic advantages, such as being able to hold lower Cinchona bark stocks (the best storage is on the living tree until such time as needed for processing, for although in a mature tree the level of quinine content may have reached a maximum, the weight growth increases). Also pre-analysis of bark prior to extraction may be eliminated.

It is not considered particularly desirable to hand over the growing of Cinchona to private planters, because of lack of experience, if improved and sustained high quality plantations are to be established.

One aspect which must be considered is provision of better access to the forest areas. Proposals for this have already been submitted by DENR.

1.3 Market and plant capacity

Capacity has to be determined, certainly for the first seven/eight years by the level of sustainable availability of the Cinchona bark raw material. This has been determined from facts available by computer analysis at between 450-540MT per annum after a first year crop of 300MT. This initial lower level is acceptable as the first year production level is set low to allow for training and gaining experience.

Throughput of Cinchona bark is the base-line to determine production capacity, but is only one aspect of production. The quality of the Cinchona bark governs the output of quinine salts.

The total current market for quinine is in the order of 500MT per annum with a possible average growth rate of 2-3% per annum due to the increasing markets for soft drinks and raw material for quinidine production.

The sales level to be realised from a throughput of 450-540MT Cinchona bark per annum would have to be a minimum of 19-23MT per annum (corresponding to 5% SQ_2 content) for below this level profitability would be very low.

This sales level represents about 3.8-4.6% of the world market, and is a level at which sales could be readily achieved without any serious resistance from existing competitors. The major market (60%) is in the USA, Europe (23%) and the Rest of the World (17%). The largest markets for quinine as an anti-malarial exist in Vietnam, Laos and Africa.

The price of quinine throughout the years has tended to follow cyclical patterns and has reached very high levels in the past (mid 1960's and mid 1970's) due to a combination of increased demand and shortage of raw material. The price currently stands in the range US $70-$80 per kilogram and is in a mild trough situation. No severe price changes, as in the past, are anticipated but a gentle increase is possible to a high of US$90-$100 per kilogram during the next 10 years. For evaluation purposes, a constant US $70 per kilogram has been used.

Based on availability a production programme has been proposed:-

Year 1: 300MT based partly on availability but also to facilitate commissioning, training and familiarisation with production and shift working.

Years 2 to 5: 450MT determined by availability of Cinchona bark.

Years 6 onwards: 540MT, the higher level being possible by the build up of stock of branch bark. This level will be subject to acceptance of 3-shift working which is necessary above a level of 480MT per annum.

During the processing programme it is also necessary to carry out planting programmes and in order to produce a high quality stand in a reasonable time, it is suggested that meristem tissue culture should be employed. This technique would develop high quality trees and these would both increase output without any increase in plant capacity and also significantly increase profitability.

It is proposed that the domestic conversion of quinine to quinidine should not be considered until any quinine production was well established and that such production might in any case be appropriate for a multi-purpose chemical plant.

1.4 Material and inputs

Apart from the main raw material, Cinchona bark, all other chemicals used are currently available in the Philippines, although most are imported. Exceptions are sulphuric acid and lime where locally produced materials should be acceptable.

Although there is some local manufacture of hydrochloric acid, the quality at present could not be acceptable.

It has been suggested that the use of bunker fuel for firing the steam generator might be economically replaced by wood fuel which is a by-product of the Cinchona tree.

Spent marc (extracted wood) could also possibly be considered as fuel and would regenerate lime which could probably replace fresh lime. These two considerations need checking practically and have not been used in financial analyses. Alternatively, the waste marc can be used for land in-filling and can be useful for breaking down clay soils.

The main by-product from the isolation of pure quinine salts could be a cheap source of Cinchona alkaloids, which might be acceptable as a cheap and effective anti-malarial.

1.4.1 Material inputs

Most supplies, with the exception of lime, will need to be shipped to Cagayan de Oro City, Mindanao, and be delivered by local transport to the processing plant.

Material inputs are based on throughput of Cinchona bark and also the quality of Cinchona bark. Assuming a 5% SQ_2 content, the following main inputs would apply based on 1000kgs Cinchona bark.

Toluene	45 LTS
Lime	300 KGS
Sodium hydroxide	87.50 KGS
Sulphuric acid tech	30.00 LTS
Sulphuric acid pure	3.75 LTS
Ammonia	9.15 LTS
Hydrochloric acid	9.10 LTS
Carbon	9.25 KGS
Dicalite	6.50 KGS

1.4.2 Utilities requirements are not high and will be available at the selected site (although the site might not actually be serviced).

At the highest proposed throughput (540MT p.a.) the following installations and consumptions will apply.

Electricity:	single and 3 phase supplies.	
	Installed capacity	100-125KVA
	Annual consumption	53,040KWH
Fuel:	Bunker fuel	162,000LTS
	(for 2500KG/HR boiler; 120 psi)	
Gas:	Calor gas for laboratory as required	
Water:	Usage (cooling)	32,400 m^3
	(process)	1,862 m^3
	Actual Consumption	5,102 m^3

1.5 Location and site

The site should be relatively close to the plantation area to minimise transport costs, but must also be served by a satisfactory infrastructure including labour availability and service provisions. It has been proposed that a site at Malaybalay, the Provincial Capital, which is some 37Km from the Kaatoan plantation would be most suitable. A precise site was not selected but as an area of only one hectare is required several would be available.

1.6 Project Engineering

1.6.1 The factory unit would comprise three buildings

(1) a raw material store
(2) the processing area and integral utilities
(3) offices and laboratories for chemical analysis and tissue culture work.

The total covered area totals 980m^2, the processing area comprising some 576m^2. The buildings should be free standing and plant supported on its own structures. The grinding and extraction sections would have three floors, the remainder single storey. The only special requirements are a small flameproof area for the extraction section where inflammable solvent is used, and drainage for the other wet processing areas. Chemical resistant floors are needed in the wet process areas.

Site works would include servicing with electricity and water, drainage, effluent tank and hard standing for a cooling tower and storage. An underground tank should be sunk for storage of inflammable solvent. The one hectare site would be served with internal service roads and fenced. A nursery area for growing Cinchona plants would occupy some 768m^2 of the site.

1.6.2 Technology

Processes selected are ones which have been well tried and proven comprising:-

1. Pre-treatment of dried bark by milling to close limits, alkalising and screw conveying to extractors.
2. Extraction by hot solvent in Soxhlet type batch extractor, capacity 650MT p.a.
3. Alkaloid isolation by acid extraction batchwise.
4. Primary separation by pH adjustment, detailed procedures sometimes variable with bark quality.
5. Salts formation for sulphate and hydrochloride has been proposed from 95-98% pure quinine bisulphate. The proportions of salts can be altered widely.
6. Air drying and sifting for packaging in bulk.

Technology is available, but from very limited sources, particularly with commercial experience. Leads to developments for possible economic improvements are also available.

1.6.3 Equipment list

Some non-pressure tanks, vessels and cyclones could be fabricated in the Philippines, but most major items would need to be imported.

For main equipment items foreign costs are estimated at about 92% and local 8%. For installation of plant and services, the foreign element is estimated at 61.7% and local 38.3%. For installed plant: foreign 77.7%, local 22.3%.

Principal items

Mill and feed	500kgs/hr
Mixer and conveyor	4cu.m and 7,500kgs/hr
Extractor	3cu.m
Condensers	-
Contractor	3cu.m
Agitated tanks and pumps	1-2cu.m
Storage tanks and pumps	1-5cu.m
Conveyors and trucks	7,500kgs/hr
Reactors, agitated	various
Pans, agitated	various
Filters, vacuum	-
Filter presses	-
Crystallisation bowls	-
Air driers	-
Sieve	-
Boiler, steam	2,500kgs/hr
Cooling tower	-
Chilled water unit	5 Tonnes
Electrical panel	-
Spares (2 years)	-

1.6.4 Civil Engineering

When specific sites are considered, it will be necessary to survey the ground to determine what foundations are needed or if a raft structure is more appropriate. Consideration must be given to access and availability of tying into local services of electricity, water, telecommunications and drainage/sewerage as appropriate. A level terrain should be selected and will be serviced with roads. No special building requirements are needed, free standing structures with light roofing being satisfactory. Consideration has to be taken of the special flameproof area and its adequate isolation from adjoining areas. Floor specifications need close attention from points of view of chemical resistance and drainage in wet processing areas and loading for any heavy equipment. Reinforced concrete and steel are suitable construction materials. Special attention should be given to provision of well proportioned entry points (for easy equipment entry).

Some co-ordination of equipment installation and civil works, particularly in the extraction and mixing section, may be necessary where it may be most satisfactory to install large units through the roof.

Building costs have been based at this stage on appropriate m^2 rates for the types of units.

Site development 1 hectare

Buildings:

A. Production/processing area $576m^2$ comprising:			
1. Grinding and mixing	$36m^2$	3 floors	Height 13m
2. Flameproof/extraction	$60m^2$	3 floors	Height 10m
3. Other processing and utility rooms	$480m^2$	1 floor	Height 4.5m
B. Office and laboratory	$360m^2$	1 floor	Height 3m
C. Bark and raw material store	$108m^2$	1 floor	Height 4m

1.7 Plant Organisation and Overhead Costs

Cost centres are proposed for:

1. Planting programme expenses (as site development) comprising raw materials (chemicals), utility costs (electricity and heating), disposables and labour (with surcharges), including laboratory (tissue culture).

2. Factory or production expenses comprising, for the integrated unit, raw material harvesting costs, chemical additives and solvents, labour (with surcharges) and works overhead expenses. The overhead costs cover such items as supervision, maintenance labour and materials, fuel oil (or alternative) utilities costs, laboratory salaries and expenses (chemical) and general manufacturing expenses (which for this operation include costs relating to sales

and distribution in form of packaging, transport and insurance). Plant depreciation is also included.

3. Administration overheads which are deemed to cover any directors/general manager and office salaries, building maintenance and depreciation, rates, insurance, vehicle expenses, post, telephone, stationery, audit, financial charges and legal and professional fees.

4. Marketing expenses are covered in the form of commission on sales.

Such a basic structure should be satisfactory for this relatively simple organisation.

1.8 Manpower

For the processing factory manpower requirements are summarised below.

Labour - comprising unskilled labourers, skilled operators, mechanics and maintenance workers, driver and security guards will total from 20-24. Including tissue culture, the numbers at the factory would rise to 28-32 on engagement of planters. The plantation labour force should remain as at present but additional casual labour for harvesting, concentrated over a 3 month period will be additional.

Labour will be engaged locally.

Staff - comprising technical, management and office staff.

Senior staff should be technically orientated in disciplines of chemistry, engineering or chemical engineering.

Technical staff will be required for analysis and assisting in process control and for tissue culture work.

Office staff will comprise secretarial, clerking and warehouse.

All staff should be engagable locally in Malaybalay, or perhaps Cagayan de Oro City for the more technically qualified. Total staff will number 8 for processing and 11 including tissue culture.

Training

Most training will be done "on-site", both "off-the-job" and "on-the-job".

Most initial training will be done by foreign expatriate experts, but later Filipino managerial and technical staff will also contribute.

Certain senior personnel will be employed during the pre-production periods. Training will probably all be executed within the Philippines.

There is little likelihood of the availability of "on-the-job" training at any operating extraction and refinery plants overseas.

Foreign expatriate

Foreign expatriate assistance during construction and erection will be required and is included in the contract price.

Additionally foreign expatriate presence for training and commissioning assistance is also included.

Costs

Labour and salary expenses will be allocated to appropriate costs centres.

The totals estimated (including surcharges) are:

Production labour (direct)	P456,891p.a.
Works overheads (labour)	P643,223p.a.
Administration (labour)	P210,180p.a.

Pre-production labour expenses comprise P135,067 for local labour and US $19,000 (including expenses) for foreign training expatriate.

Salary levels have taken into account the recent (July 1989) wage increases.

1.9 Implementation scheduling

Implementation periods are given relative to the time of award of contract.

Buildings erected, site works complete	11 months
Plant erected and installation complete	17 months
Commissioning and test runs	18 months
Complete handover	20 months
Main training to commence at	13 months

1.10 Financial and economic evaluation

Four scenarios were examined in the financial and economic analyses, the scenarios differing in terms of the quality of the bark, the mode of operation (integrated vs processing alone) and the scale of operation. The UNIDO Computer Model for Feasibility Analysis and Reports (COMFAR) has been used to conduct the cash flow analyses.

The first scenario was based on the first set of bark analyses performed on the small sample of harvested barks and averaging only 3% SQ_2. Annual throughputs varied from 300MT (year 1), 450MT (years 2-5) and the including branch bark 540MT for the remaining years. An integrated operation was considered and the establishment of a high quality Cinchona stand for the future included.

Partial benefit would be realised by year 8 when the average bark content would have increased to 6.5% SQ_2 but full benefit would not be realised until year 16 which is outside of the analysis. An input of 9% SQ_2 would be expected at this time.

The second scenario is similar to the first except that an initial content of 5% SQ_2 is assumed. This level was assumed pending the second analysis being performed of mature living trees.

The third and fourth scenarios examined the cases where a processing unit operates independently of the plantation and Cinchona bark raw material is purchased at proposed world market prices. As a 3% SQ_2 content could not be profitable a constant 5% SQ_2 content without improvement was considered.

In the third scenario, after an initial annual input of 300MT, a throughput of 450MT was assumed throughout the life of the analysis.

In the fourth scenario the throughput was assumed to be increased after year 5 to 540MT corresponding to use of branch bark.

Inputs applied correspond to:

Total investment costs	Foreign US $	Local US$	Total US$
Land	-	25,300	25,300
Site prep & development	-	50,690	50,690
Structure & civil engineering	-	203,170	203,170
Auxiliary and services	668,800	374,000	1,042,800
Incorporated fixed assets	109,500	-	109,500
Technology, plant, machinery, equipment installed	1,021,694	154,995	1,176,689
Pre-production capital costs	40,800	25,296	66,096
Total initial investment costs	1,840,794	833,451	2,674,245
Current investment			
Working capital (year 1)	20,752	62,765	83,517
Site development (forestry)	171,319	73,423	244,742
Total investment costs	2,032,865	9,570,263	3,002,504

Project financing (assumed)

No detailed financing package has been proposed and it has been assumed that funds will be supplied in the form of ordinary equity and bank overdraft for working capital.

Total production costs (at 450MT annual capacity)

	$3\%SQ_2$ US $	$5\%SQ_2$ US $
Factory costs	284,726	321,487
Administration overheads	88,000	88,000
Sales and distribution	26,000	72,000
Operating costs	398,726	481,487
+ Depreciation	295,668	295,668
Total	694,394	777,155
Foreign	43.638%	46,217%
Labour (total)	61,000	61,000
Output SQ_2	6,980kgs	19,125kgs

1.10.1 Recent assessment

Evaluations, although not in depth, have been made on the basis of using only C. ledgeriana bark of good quality.

These investigations indicated that a level of 160 metric tonnes of bark at 6.8% SQ_2 are needed to provide a potentially interesting project.

Although this is not currently available consistent supply at this level could be available from 1993/4 upwards. Processing at this level, assuming current costs, could provide a rate of return on equity of 15%, and 13.2% on investment for an integrated unit, and rising fairly rapidly with any increase in throughput or quality. A rate of return with SER adjustment has not been determined, but would inevitably be at a high level due to the export orientation. Such a project is quite small needing an investment in the order of US $2m, of which 30% would be local. net annual foreign exchange benefit would amount to US $647,000-672,000 with annual local purchases of P300,000. Direct labour utilisation would only start at 24, but some increased numbers would be possibly needed at the plantation and regular seasonal work would be created for some 100/120 local workers.

1.11 CONCLUSIONS

1.11.1 Initial evaluations indicate the need for a minimal supply of 450 metric tonnes of Cinchona bark per annum of 5% SQ_2 content processed in an integrated unit before any potentially interesting proposition can be put forward.

Although the quantity is available it is of lower quality than necessary.

1.11.2 Consideration of a small operation suggests that 160 metric tonnes of bark per annum, having a 6.8% SQ_2 content, is necessary as a minimum for further consideration. This quantity is not realisable by 1990.

1.11.3 Delaying any harvesting and processing until at least 1993/4 could result in the provision of a sustained supply of 160 metric tonnes bark per annum at 6.8% SQ_2 C. Ledgeriana bark. It is possible some small additional quantity of other acceptable bark from some other species might also be located to further improve the situation. A possibility of implementation could then be seen. Such timing also allows for systematic assessment and development.

1.12 <u>RECOMMENDATIONS</u>

1. Planting of all Cinchona species other than C. Ledgeriana could be stopped immediately.

   Maximum seed collection and propagation from C. ledgeriana should be aimed at to plant out, if possible commencing 1990, an area of 240 hectares at 2m x 2m spacing.

   Planting should preferably be made at an elevation of 1500m probably in the proposed new planting area.

2. It is necessary to perform a reasonably extensive analysis of the stands to support the validity of the potential supply and quality of Cinchona bark. The main concentration should be on C. Ledgeriana but a more limited analysis of other species, with the exception of C. Succirubra and C. Calisaya, being included.

3. Chemical analysis for this purpose should be carried out by the fluorimetric method. This could either be organised by employing the services of PIPAC whose charges for 400 samples would probably amount to about US $3000. The only advantage of this is that this facility is already available. The alternative would be to consider setting up a laboratory, preferably in Bukidnon and probably in Malaybalay.

4. During the screening study the C. Ledgeriana trees should also have their growth characteristics recorded in order to isolate potential source materials for tissue culture work. The sampling and recording should be organised by DENR personnel after appropriate training.

5. Work should be commenced on learning the techniques of meristem tissue culture for propagation of Cinchona.

   Although some initial work could be performed in existing laboratories it would be desirable to set up a unit in Malaybalay and preferably associated with the chemical analysis unit.

6. Agencies should be approached for funding of this project which can be considered of definite development orientation and in view of the fact that chemical analysis is an integral part, funding of this should be included. Training assistance funding could also be sought.

7. Agronomic research under the Cinchona Reforestration Project should also be pursued with particular reference to effects of fertilisers and minerals with assessment of achievements including chemical analysis.

8. With the support of a satisfactory assessment of the potential quantity and quality of Cinchona at Kaatoan facts can be presented to potential investors. This might be cone even at this stage with the hope that the investor might be sufficiently interested in funding the necessary preliminary evaluation.

Technical assistance

Assistance could be supplied in all aspects from technical assistance in drawing up work programmes, equipping, analytical methods, training assistance, analysis of results, technology transfer, project engineering or turnkey operation.

2. Project Background and History

2.1 Project Sponsors

This pre-feasibility study is being financed by the United Nations Development Programme (UNDP) under funding from project DP/PHI/87/019 - Philippine Pharmaceutical Development Study

2.2 Project History

This report entitled a "Pre-feasibility Study on the Utilisation of Cinchona" has originated from the Philippine Government Health Policy and the request from the Government of the Philippines for a UNIDO study entitled "Philippine Pharmacutical Development Study".

As a result, an extensive technical assistance study was carried out by the United Nations Industrial Development Organisation (UNIDO) employing International Experts together with National Experts. The study was carried out during 1988 being funded by UNDP as project DP/PHI/87/019.

As a result of proposals in the report and especially propounded at a Validation meeting of independent International Experts held at UNIDO Headquarters in Vienna, Austria on 27-28 October 1988 the recommendation for a pre-feasibility on the utilisation of Cinchona was endorsed.

A project document was subsequently prepared and submitted for UNIDF financing and funding was allocated up to US$50,000 under DP/PHI/87/019.

2.3 Costs of Previous Studies

Costs of previous studies and investigations already performed cannot be identified, comprising only a very small element of the original project.

2.4 Other Investment

The principle investments which have, in fact, already been made with relationship to this Cinchona project are those invested in the Philippine Cinchona Reforestation Project initiated in 1929 and now under the management of the Forest Management Bureau of the Department of Environment and National Resources.

The total investment and returns could not be evaluated over the long period of the project.

2.5 The Project

The ultimate object of the study is to evaluate the feasibility and economics of installation of a processing plant in the Philippines for the isolation of quinine and other Cinchona alkaloids from the bark of the Cinchona tree.

Such an ultimate production has to be divided into several parts.

The first step consists of the plantation work, divided into nursery production of young plants followed by the field work in which the young plants are grown to harvesting maturity. This is then followed by harvesting which can be performed after 7 years growth although an older age may be more economical overall. Harvesting consists of cutting the tree, stripping off bark and drying it. The future supply of trees may be satisfied partly by coppicing cut trees (i.e. allowing to throw out shoots) and partly by fresh plantings of seedlings.

The plantation side may be either a separate or integral part of the whole Cinchona processing concept. What needs to be considered is the level of availability of supply of Cinchona and continuity of supply as these govern the size of chemical production plant which can be sustained. Appropriate planting programmes have to be specified for the future continuity or increase of production.

The second step is the actual specifying of the chemical processing or extraction and refining plant and its location. This is unlikely to be situated in the actual plantation area but closest proximity is desirable.

Finally, the financial and economic aspects of production have to be considered. Apart from considerations of infrastructure, labour, prices and availability of chemicals, the most critical aspect is the quality of the feed stock Cinchona bark and especially its level of quinine content.

The throughput of the production unit is determined by the volume of Cinchona bark available, whereas the profitability and output of quinine salts is governed by the quality of the bark.

2.5.1 Cinchona - Historical

The Cinchona tree is indigenous to certain areas of South America, especially the Andes and the surrounding countries of Columbia, Equador, Peru and Bolivia. It grows usually at altitudes of about 1200 meters to 2150 meters above sea level. The natural distribution of the major species, out of about 40, is recorded as

Bolivia	- C. Calisaya
	- C. Ledgeriana
Columbia	- C. Lancifolia
Equador	- C. Officinalis
Peru	- C. Officinalis
	- C. Succirubra
	- C. Micrantha

Various Hybrids have subsequently been developed especially from C. Officinalis or C. Succirubra with C. Calisaya or C. Ledgeriana. One such is the hybrid C. Robusta Howard (a hybrid of C. Officinalis with C. Succirubra) which having a higher cinchonidine content than quinine was first mentioned in a Pharmacopoeia as a suitable source of Totaquina.

The Cinchona tree was later artificially introduced into many countries, essentially subtropical. The main supplies were established by the Dutch in Java and they were fortunate in processing seeds from Bolivia which produced trees with relatively high quinine contents. In the second half of the nineteenth century others were established in India and Ceylon from which India emerged as a producer. In the late 1920's experimental plantations were established in the Philippines, the Belgian Congo, Soviet Russia and Tanganika (Tanzania), while in the 1930's cultivation was established in Guatemala. By the beginning of the second World War well over 90% of the worlds supply came from Indonesia and the disadvantage in war periods of relying on a single source of supply for an essential commodity became evident when Java was invaded by the Japanese in 1942. At this time Indian output reached its peak.

Activity in the 1940's was intensified in Central and South America and pioneering plantations were set up in Costa Rica by Merck & Co. who had established the Guatemalan plantations.

During the Japanese occupation of Indonesia large scale felling of the Cinchona plantations took place without any replanting and the decline continued further into the 1950's particularly after the expropriation of the Dutch owned plantation. Zaire then emerged as an important supplier of bark with smaller contributions from Guatemala and some other South America Countries.

In the early 1960's a sudden resurgence in the use of quinine as an antimalarial by the US Army in Vietnam encouraged the setting up of plantations in Kenya and extension of activities in Tanzania. Currently the Indonesians have re-established the supplies in their plantations and are again becoming forerunners in the supply of Cinchona alkaloids.

2.5.1.1 Cinchona Production in the Philippines

The earliest attempted introduction of Cinchona into the Philippines was made in 1893 by the Spaniards on Mt. Banahaw, Quezon and Munay, Antipolo, Rizal but no indication of success was recorded.

The Bureau of Forestry plantings in 1912 in Baguio, Mt. Province and Los Banos, Laguna also failed as did plantings made with seeds of Cinchona Ledgeriana obtained by a missionary institution "Igorot Exchange" at Sagada, Mt. Province.

From 1922 Arthur F. Fischer, Director of Forestry determined to establish Cinchona plantations in the Philippines and initiated several trials in lower regions of Bukidnon. More serious cultivation started after the Philippine Legislature passed a Reforestation Act (Act No. 3283) in 1926 which was approved by the President of USA on Feb. 10, 1927. Sites selected earlier in Bukidnon did not thrive and others were planted at Lantapan, Alanib, Mirayon and Kaatoan using seeds of .C. Ledgeriana, C. Succirubra and C. Sp. Hybrid obtained from Java. Of all the sites only Kaatoan ultimately produced good results.

The Cinchona Reforestation project was established in 1929, administered at that time by the now defunct Bureau of Forestry, and is located on the Southern slopes of the highest landmark in Central Mindanao, Mt Kitanglad. It is situated in a rugged mountainous barrio of Kaatoan, Municipality of Lantapan, Bukidnon at an altitude of from 1000 meters to 1500 meters and currently covering some 1994 hectares.

In April 1942, after the fall of Bataan to the Japanese, Colonel F. Fischer left Bukidnon for Australia taking 10 liters of seeds from promising trees. These subsequently produced some 2.5 million seedlings when planted in the American Cinchona Plantation in Costa Rica where Fischer had become an executive Officer. It has been claimed that trees having a total alkaloid content of 18% have been observed indicating the potential of seeds from Bukidnon at the time.

Records have been located for continued planting programmes from 1969 through to 1988 although the areas prior to 1981 are not defined.

Several harvestings have sporadically been made since inception of the plantation. The first recorded prior to 1941 comprised some 23,000 kgs bark originating from early Kaatoan plantings and also from plantings in the areas of Impalutar. Various harvestings were collected between 1941 and June 1945 amounting to a total of 54,880 kgs. Almost all of this material derived from salvage of trees rogued out due to disease or signs of serious physical injury. Of this 54,880 kgs some 36,522 kgs were taken by the USAFIP between 1942 and 1944 and 15,000 kgs of this shipped to Australia by submarine. The remainder was distributed to guerilla forces in Mindanao and some parts of Visayas and Luzon. Other quantities were taken in 1942 by USAFFE, in 1943 by the provincial Government of Free Bukidnon, in 1945 by a Commander Parsons and the balance during the occupation by the Japanese.

Up to this time no regular harvesting has been done on selected and well matured trees.

Records have been located of shipments of 71,707 Kgs from 1951 harvesting and further 173.711 Kgs from 1956 harvesting.

The next harvest, carried out in 1966/67 was substantial amounting to 781,000 Kgs of which 725,000 Kgs was reputed to be shipped to Europe. The fate of the 56,000 Kgs balance was not clear.

In 1971 a further 40,000 kgs was sold for shipment to the UK. This was the only material for which a chemical analysis could be located.

Currently a small stock of dried Cinchona bark is held in the store at a Kaatoan having been collected from a few diseased trees. Samples have been taken for analysis.

The Cinchona Reforestation Programme is now administered by the Department of and Environment and National Resources (DENR) and regular plantings are being maintained.

2.5.1.2 Current Situation and Impressions

The plantation area at Kaatoan was visited for a period of four days on three of which extensive treks were made through the plantation areas. A comprehensive and good impression of the different areas, plantation locations and ages of trees were observed as well as the nursery bed management.

In general the Cinchona is grown under a canopy of Albizia Falcataria of varying densities.

The Cinchona, as could be expected under such conditions, was found to be variable but very many trees of excellent growth were observed both in terms of girth and height. Areas where variation of growth could be observed would, in part, be due to replanting programmes and also to varying degrees of cover. The lower level plantation areas at about 1000 meters are at the minimum height above sea level suitable for growing Cinchona. Good growth and fertility (as observed by the existence of an abundance of self seeded plants) could be observed in the areas sited at 1500 meters. This could be of great significance for the future as it is proposed to extend the planting area by some 8,600 hectares which are all essentially sited at 1500 meters in the same vicinity of the particularly fertile area.

The general plantation management was observed to be very professional with planted areas clearly defined. Similarly the management of the seed beds was impressive.

There was evidence of cross breeding of some species which can be expected where clear segregation has not been applied and in view of the fact that the Cinchona tree is an outbreeder.

The method of planting out seedlings into the field was different to techniques normally applied. The uprooted seedlings have their roots trimmed and can then be dibbled into the ground at a high planting rate which seems to be successful in the Philippines. The reason for trimming the roots is not clear and most planters prefer to transfer seedlings together with the soil and without root disturbance. The original harvesting technique of uprooting the whole tree, which is not a preferred method as re-planting from seed must be applied for replacement, has now been discontinued. The practise of coppicing has now been applied. It should be realised that the survival rate from such propagation does successively result in a lower survival rate and normally only two coppicings can be applied after which the tree should be uprooted.

Programmes of the DENR to investigate and improve the quality and species of Cinchona have been well organised and planned but the emphasis throughout has been to improve bark yield and no information has been gained on the content of quinine in the bark due to lack of knowledge and facilities for analysis.

In fact three aspects have to be taken into account in developing the most desirable Cinchona tree:

1.) Quinine Content - The higher the content, the more economical to process and more valuable

2.) Bark weight per tree - Coupled with high quinine Content improves the plantation return

3.) Disease free species - Though disease is not a serious problem it can be always threaten a tree

In view of the fact that much cross-pollination may have already taken place an extensive programme of analysis of Cinchona trees could be desirable and consideration for the future might be given to the application of tissue culture for propagation of high quality plants.

2.5.2 Composition and Use of Cinchona Alkaloids - Historical

Cinchona bark contains some 25 alkaloids of which only quinine and quinidine are of any significant commercial value. Quality of these products is closely controlled by Pharmacopoeia Standards but they always contain small amounts of their corresponding dihydro-derivatives.

The other alkaloids occurring at significant level in Cinchona barks are cinchonidine and cinchonine. These are only rarely isolated by manufacturers in pure form and have little commercial value. Cinchonidine is the component which makes the isolation of pure quinine a complicated process. All other minor alkaloids are readily removable from the major components to an acceptable level.

Quinine was isolated in 1820 by Pelletier and Caventou and they showed that the alkaloids of Cinchona were responsible for its febrifuge (ability to depress fever) activity. The structure was not established until 1918 by Rabe.[1]

Confirmation of the structure was proved when quinine was chemically synthesised by Woodward and Doering in 1945.[2] Later syntheses were published by Uskokovic and Gutzwiller of Hoffman la Roche in 1970[3] and a later partial synthesis in 1973.[4] Several other syntheses have also been published but it is certain that none will ever have any commercial significance.

Medicinally, Cinchona alkaloids have formed one of the most important groups of compounds derived from plants.

They have been administered in the form of extract, tincture, alkaloids mixture, and isolated, purified alkaloids usually as salts conforming to the latest pharmacopoeia standards.

The drug was administered in the form of decoction of powdered Cinchona bark until alkaloids in it were first isolated in 1820. Soon after the discovery of quinine the sulphate of the alkaloid began to be used and use of the decoction and tincture largely fell out of fashion. Initially plantings in the Far East were made with C. Succirubra and the total alkaloids of the bark were used under the name "Quinetum". With the development in India of Cinchona hybrids for improvement of quinine content the Quinetum was gradually replaced by "Cinchona Febrifuge" which consisted on residual alkaloids left after removal of quinine[5]. This product, variable in composition was used as a cheap drug for malaria treatment[6]. The Malaria Commission of the League of Nations (1931) redefined "Quinetum" as a mixture of equal parts quinine, cinchonine and cinchonidine and introduced a new product "Totaquina" which was defined in the British Pharmacopoeia 1932 and the US Pharmacopoeia XIII. This product was defined as containing a minimum of 70% crystallizable alkaloids not less than 15% of which was quinine.

For medicinal use the most important application, particularly of quinine, is as an anti-malarial although there is some increase in use in analgesic preparations for the treatment of common colds, cough, influenza, varicose veins other fevers and night cramps. Although claims have been made for such, quinine cannot be classed as a true abortifactant being unreliable and potentially toxic to mothers and foetus. Use as a contraceptive is also unreliable.

Additionally very substantial quantities are used particularly in more developed countries, in the manufacture of tonic and soft drinks. Both the hydrochloride and sulphate are quoted in the Food Chemicals Codex.

Salts of quinine have also been added to anti-smoking tablets, hair oils, sunburn lotions, moth repellants, insecticides. It is also used vulcanisation accelerators in the rubber industry, in polaroid lenses and pickling agents in the metal industry.

The final, increasing, use of quinine is as the source material for chemical conversion to quinidine. Quinidine exists naturally as one of the Cinchona alkaloids but its content is generally low and isolation from Cinchona is not particularly economically attractive. Virtually all quinidine is produced synthetically.

Quinidine is used for Cardiac ailments, particularly auricular fibrillation, paroxysmal tachycardia and various arrthythmias following Coronary thrombosis. Also, by virtue of its effects on skeletal muscle quinidine has been found useful in some cases of intractable hiccough and, because of its atropine like effects, can prevent cardiac standstill in hyperactive carotid sinus reflexes.

Totaquina was manufactured in Tanzania and, by a rather unusual procedure, in Russia. Here Cinchona was grown as a biennial crop, the young plants being harvested in the second year of growth and worked up for total alkaloids. An average yield of 1.25% totaquina was achieved and the product known locally as "Sovchinet".

Many papers were written on the use of mixtures of Cinchona alkaloids as an anti-malarial including extensive research performed in the Philippines[7] by Dr. J. Maranon of the Bureau of Health and Prisons. Extensive clinical studies of Totaquina on malaria cases proved the preparation to be just as effective as quinine sulphate. Interestingly, even at that time, it was believed that the other alkaloids counteracted the adverse effect quinine might have on the heart. Very recently papers have been published on a re-investigation of mixtures of Cinchona alkaloids for use against Plasmodium Falcipatrium particularly where it is becoming less susceptible to quinine[8]

Nowadays little demand exists for crude mixtures of Cinchona alkaloids and quinine manufacturers are now mostly interested in the isolation of the maximum amount of pure quinine from Cinchona bark. Nevertheless in the context of the Philippines,the position and possible utilisation of Cinchona alkaloid mixture will be examined.

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[1] Rabe P. Kinder k Be 51 466 (1918)
[2] Woodward R.B. C. Doering W.E. J.A.C.S. 67 860 (1945)
[3] Uskokovic MR and Gutzwiller J J.A.C.S. 92 203 (1970)
[4] Uskokovic MR et al Helv. Chim Acta 56 1485 & 1494 (1973)
[5] Gage: Trans Roy Soc. Trop Med & Hyg 1925 18 348
[6] Howard & Henry: Quart J. Pharm 1930 3 238
[7] Maranon, Perez and Russell: Philippines J. Sci 1935 56 229
[8] P. Druihe et al: Anti-microbial agent and chemotheraphy Feb 1988 p 250-254

2.5.2.1 Current situation and consideration

Quinine manufacturers are mostly interested in the isolation of the maximum amount of pure quinine from Cinchona bark as it commands a reasonable price. Also, in contrast to the early days of use of Cinchona alkaloids as antimalarials, nowadays such crude materials no longer feature in modern pharmacopoeias and the only use is in products such as Vermouth.

One of the first considerations when investigating utilisation of Cinchona grown in the Philippines was whether it would be appropriate to produce a crude mixture of alkaloids at a low price to satisfy the needs of poor, malaria suffering, population of the Philippines. As such this could not be an economical production of interest to private investors.

Such a meritorious wish might still be realised for when processing Cinchona bark to isolate pure quinine, mixtures of residual alkaloids composing quinine, cinchonidine, cinchonine and quinidine are also be produced. To process such further to remove the low quantities of quinine present is tedious and expensive. This residual mixture could be a source of a cheap but effective, antimalarial product for domestic use. Sufficient material would probably be produced to completely satisfy any need in the Philippines.

Quinine is still such an important drug that it should only be used for severe cases and not indiscriminately for fear of development of resistance as has been recorded, particularly in Thailand.

Using a similar dosage to that of pure quinine in terms of Cinchona alkaloids one metric ton of such alkaloids could be sufficient to treat about 18,500 cases.

According to discussion with the Head of the Malaria Control Programme some 150,000 cases of malaria are forecast for 1989 (260 per 100,000 population). The usual ratio of radical to presumptive cases is about 1:10 which would indicate some 13,636 cases could be suitable for treatment with quinine. A normal single regimen of tablets consists of 60 tablets x 0.3 g alkaloids = 18 g. As three attacks is the average a total treatment dose per case would be 3 x 18 g = 54 g. For 13,636 cases a total of 736 kg would be needed.

The acceptance of the use of such a crude mixture would have to be established but certainly an adequate supply could be produced and, indeed an excess of some tons over a years production at any reasonable rate. An export market might just be possible to other endemic areas in Asia where consumptions of quinine as an anti-malarial are much higher than the Philippines. Such areas are particularly Vietnam whose forecast consumption of quinine for 1989 was estimated at 3.3 MT and Laos where 3.6 kg was the estimated consumption in 1989.

2.6 Project Papers on Utilisation of Cinchona

Three separate Project proposals have been prepared recently relating to the utilisation of Cinchona grown at Kaatoan.

	Project proposal	Agency
1.	Proposal for Financial Assistance of a Health Research Project	Department of Industrial Pharmacy, College of Pharmacy, UP Manila Originator, Prof. L.B. Gutierrez Chairman
2.	Project title: Production and Processing of Cinchona Barks and Other Medicinal Plants for the Manufacture of Quinine	Eco Systems R & D Sector of DENR X, Cagayan de Oro City in association with: 1) DOH Region X, Cagayan 2) Cinchona Reforestration Project, Lantapan, Bukidnon Originator: Dr. M.L. Generalao
3.	Processing and Manufacturing Laboratory for Quinine and Cinchona and Other Herbal Medicines	Regional Health Office No. 10, Carmen, Cagayan de Oro City Originator: Dr. C.R. Tan, Jr.

Project 1. relates to isolation of Cinchona alkaloids and separation of quinine and does include for determination of quinine yields in differing species with a view to selection. It is, perhaps, not appreciated that for commercial utilisation that such selection must also be coupled with tree growth in respect of yield and also resistance to disease.

Although the basic method suggested for extraction is reasonably valid control factors have to be observed. The isolation of "pure" quinine by the proposed method is not to be recommended for it is tedious and does not necessarily lead to pharmacopoeia standard of quinine quality. Different total alkaloid contents will lead to different quality products except by repeated purifications whereby yields would not be acceptable.

Analytical methods are available which will give the necessary information and also provide adequate information on the presence, identification and levels of other Cinchona alkaloids with out having to repeat past work on individual isolation and characterisation.

In fact quinine alkaloid itself is not included in the pharmacopoedias only salts, and the proposal to formulate alkaloid is not clear.

In view of the fact that products from varying barks, if isolated in acceptable yields, would not be consistent then any dosage and clinical testing of such would contain variables that would in effect invalidate results. However, provided analytical standards and ranges were set, the different purities could be tested.

If the intention, as the proposal suggests, is to only clinically test quinine of Pharmacopoeia standard it is suggested that such work has been extensively covered and proven and does not need to be repeated. The investigation of varying dosage forms has also undoubtedly been extensively covered.

The proposal does not include for the necessary follow up of isolation and purification on larger scale where different conditions need to be applied.

Proposals 2 and 3 are really exactly the same proposals but undoubtedly submitted to different panels. They may be dealt with together.

Although the submission by the Regional Health Office No. 10 includes for processing of other herbal medicines other than Cinchona the proposal programme really only covers Cinchona.

The idea of a collaboration between DENR and RHO is laudable for both forestry and processing need to be blended for any commercial operation.

The proposals cover the 'other side of the coin' in the philosophy of use of the Cinchona alkaloids if the proposal is correctly understood. The proposal is to harvest and dry Cinchona bark, mill, granulate and compact into tablets.

It is suggested that what has not been taken into account is that for effective treatment the level of Cinchona alkaloids (if not quinine) should be in the order of that employed using pure quinine. Tablets, for fully effective use, would therefore have to be in the order of a minimum 14 times the size of normal tablets.

It was stated in the project paper that Bukidnon Cinchona trees yield "high alkaloid content or high grade sulphate content." Insufficient analyses could be located to really support this statement.

A processing plant of capacity 171 metric tonnes Cinchona bark was proposed but with no rationale.

Such a quantity of bark would contain in the order of 12 metric tonnes total alkaloids. This could (assuming the dose level of total Cinchona alkaloids being the same as quinine at 300 mgs per tablet), supply sufficient anti-malarial to treat 222,222 cases (each assuming to average 3 attacks per year). Such a figure is in excess of the 1989 forecast of 150,000 cases for the Philippines and probably only 10% of these should qualify as radical cases needing treatment with quinine alkaloids.

On the basis of the size of tablet alone it is respectfully suggested that this is not an appropriate approach.

An intermediate approach might be more appropriate of considering the use of a total extracted alkaloid mixture. This is in effect used to be the form of many early preparations for malaria treatment. In view of recent work such might well be more effective than pure quinine alone. Much work was performed on clinical testing of such products in the Philippines by a Dr. Joaquin Maranon in the 1930's and reported fully on "The Philippines Journal of Science".[7]

Whether such mixtures would be accepted nowadays would need to be considered, and since the potential output available is considerably in excess of domestic Filipino needs, export potential would also need to be considered. Consequently acceptance of use would not only be a concern of the Philippines Bureau of Food and Drug but would also require acceptance by other government authorities and WHO.

Small scale production for Philippine consumption only would not be a commercial venture.

Full scale commercial production suffers from the marketing problems mentioned above for there is no essential current market for totaquina or total alkaloid extracts unless of very high quinine content.

Also with respect to the use of quinine itself as an anti-malarial the forecast consumption for the whole world (WHO), is only 9 metric tonnes.

A processing plant for producing this whole world consumption in terms of total alkaloids would only need to extract 128 MT Cinchona bark a year and could not be feasible even taking into account all investment costs of growing bark were written off and the bark supplied free.

Conclusions

None of the proposals as presented can be considered worthwhile for funding. If there is a possibility of the processing of Cinchona in the Philippines, then one aspect of proposal 1 would be essential. This refers to the screening of the Cinchona trees for quality.

It is suggested that this would be best achieved by utilising facilities already existing, rather than buying new equipment. Two options could be considered:

(1) analysis could be performed in the UK, but this suffers from the disadvantage of distance and cost of analysis (possibly in the order of US $100 per sample.)

(2) analysis could be performed in the Philippines by PIPAC in Manila, who, it has been established, have appropriate equipment available to perform any analyses decided upon involving either fluorimetry or HPLC. Indicative costs were obtained and for fluorimetric analysis, the cost could be in the order of P62,000 for 400 samples taking 1 month or P60,000 (+ cost of column) by HPLC analysis for 200 samples in 1 month. Assistance could be given to PIPAC with respect to methods and reference samples.

It is suggested that this second alternative is the preferred solution.

A detailed programme would need to be set up for selection of trees to be analysed so that an overall and meaningful assessment of the plantation was realised. Something in the order of 500-600 analyses could be sufficient.

3. Market Analysis

3.1 Market Situation

For the past 40 years the World demand for quinine has fluctuated between 375-500 tonnes per annum and bark processed from 5,000-10,000 MT per annum. However the use of quinine has changed. Whereas there has been some reduction at times in the use as an anti-malarial,and usage is currently probably somewhat less than 10,000 Kgs per annum according to WHO reports, the consumption by the tonic and soft drinks industry (particularly in developed countries) has increased steadily. The largest, and increasing proportion, now well over 50%, is used for chemical conversion to quinidine. This market is still expanding. Factors which are likely to bring about further growth are (1) the possibility of increase in soft drink franchises in currently underdeveloped countries as their economies improve and (2) a widening in the prescribing practices for quinidine. Although sales are considerable they are largely confined to the United States and Australia. Quinine is also likely to maintain an important position as an anti-malarial either alone or in combination with other agents and consumption may even increase marginally for some time if this practise of combination drugs is extended.

Soft drinks and mixer drinks market

This market is becoming very dominated by the organisation of Cadbury-Schweppes plc which currently consumes about 25% (50 m.t.) of quinine used in soft and mixer drinks. The best known product is Indian Tonic water, followed by Bitter Lemon. These are marketed in both the original formulation and also in Slim-line versions which are becoming increasingly popular. Although initially quinine was excluded from Soda-stream concentrates, the alkaloid has now been added as the original concentrate was not acceptable to the public. Cadbury-Schweppes plc operate under a variety of associate Companies in different countries through joint ventures or simply purchase of smaller operations. In the United Kingdom, operations are run by Coca-Cola & Schweppes Beverages Limited and Sodastream Limited; in North America by Cadbury Schweppes Holding and the acquired Canada Dry. Operations are split into geographical areas of United Kingdom, European Continent, North America and International. This latter covers 80 countries currently including Australia, new Zealand, South Africa, Kenya, Ghana, Zambia and Malaysia where operating companies exist.

Statistics are difficult to obtain or abstract in this field and as Cadbury-Schweppes are the major customer and user of quinine for drinks information obtained from them may only be used as a guideline to present and future trends. Apart from the total annual consumption of quinine hydrochloride which has been quoted currently at 50 m.t. per annum, no meaningful quantitative figures are available.

General trends in the soft drinks field world-wide can be listed. These represent the market of soft drinks in total and not specifically drinks containing quinine, although these have been mentioned as market leaders in terms of percentage growth in several cases.

The following figures mentioned relate particularly to trade during 1988.

In the United Kingdom, sales of tonic water alone grew by 5 per cent in volume. In Europe, sales increased by 9 per cent and Slim-line tonic was introduced at this time in both Spain and France. Substantial increases were recorded in the United States of America. In the International market, special mention has been made of Japan where sales in general have increased more than 100 per cent during the period 1984/1988 while steady growth is recorded in Latin America. Steady growth is also being seen in Australia.

In view of the difficulty in abstracting detailed figures, what is considered to be a very conservative estimate of growth in this area has been proposed at 3 per cent, maintained for at least four years, and then reduced for evaluation purposes to 1.2 per cent, although the higher level might well be maintained as new markets also are developed.

3.1.1 Future Growth

As previously indicated, the market for quinine (although still considered an important and essential drug) as an anti-malarial accounts for only about 2% of production. The total use for all medicinal purposes, including cold and particularly night cramp preparations, is believed to be only in the order of 10% maximum.

There is no reason to expect any significant growth in this area, even if combination therapy of quinine and antibiotics is more extensively used. The total consumption for medical use is expected to remain static for the foreseeable future.

Although the tonic and soft drinks area can be seasonal and effected by climatic conditions and trends, there is likely to be a moderate growth rate continuing over the next fifteen years and beyond. Although there is an apparent large potential growth by granting of franchises in currently lesser developed countries, such potential may, in fact, be limited for in such countries there often does not appear to be such a pronounced taste for more bitter drinks as exists in the more developed Western Countries. There is, however, some consumption in Eastern Mediterranean areas and this might gradually spread in time eastwards through the Near East and Arab countries.

The larger consumptions may be more related, however, to population increases in existing markets and aggressive marketing.

A continuing average current growth rate of 3.0% per annum is considered realistic as a mean for 4 years, then reducing to 1.2%.

A positive growth rate is forecast for the use of quinine as the raw material for the production of quinidine, the drug used for heart conditions.

Growth rate over recent years has averaged about 3.5% per annum for quinidine (which corresponds to a rate of 4.13% in terms of quinine) following a rather higher average over 1976-82 of 4.8% per annum. It is thought that this rate may reduce to a conservative 1.0% per annum (in terms of quinine) and remain at this level for the next fifteen years.

The individual and combined growth rates are shown graphically and indicate that total consumption of quinine could rise to 655MT by year 2005, comprising 345MT for quinidine, 260MT for soft drinks, and 50MT for pharmaceutical use.(figure 1)

The consumptions and forecasts are based on abstracted figures from statistics and opinions of dealers in the markets. Manufacturers' information is not readily available.

Growth rates are not likely to be constant, but subject to annual fluctuations.

3.1.2 Influence of Indonesian supplies and policy

As mentioned earlier, there is intelligence that the Indonesian company, Kimia Farma, are wishing to install new production facilities for the production of 150 m.t. SQ_2. Of this it is planned to domestically consume 50 m.t. for conversion to quinidine and salts in a new plant, leaving the remaining 100 m.t. for sale as quinine and salts. The current production level is believed to be about 130 m.t. and the investment is considered to be a necessity for replacing old plant and domestic utilisation of quinine for quinidine production rather than any substantial expansion programme.

The level of production has no doubt partly been determined by the availability in the future of adequacy of supplied of cinchona bark. Their currently cultivated hectarage covers about 2,500 hectares supplemented by small supplies by low testing bark from small holders.

If this new unit is installed, as indeed seems a necessity as far as some units are concerned within the next 5/8 years, the production cost in Indonesia must rise for some years until new plant is depreciated, although some cost improvements by better organisation and possible purchase of technology are no doubt contemplated.

Indonesia will always be a strong competitor in the field of quinine because of their history and experience and more newly developed contacts with customers. Nonetheless, even with a new production unit, as plans are not especially to increase production but to improve and diversity, they cannot be considered to be any greater threat as a competitor than at the present time.

3.1.1

HISTORICAL TRENDS AND FUTURE TRENDS ESTIMATES FOR QUININE CONSUMPION.

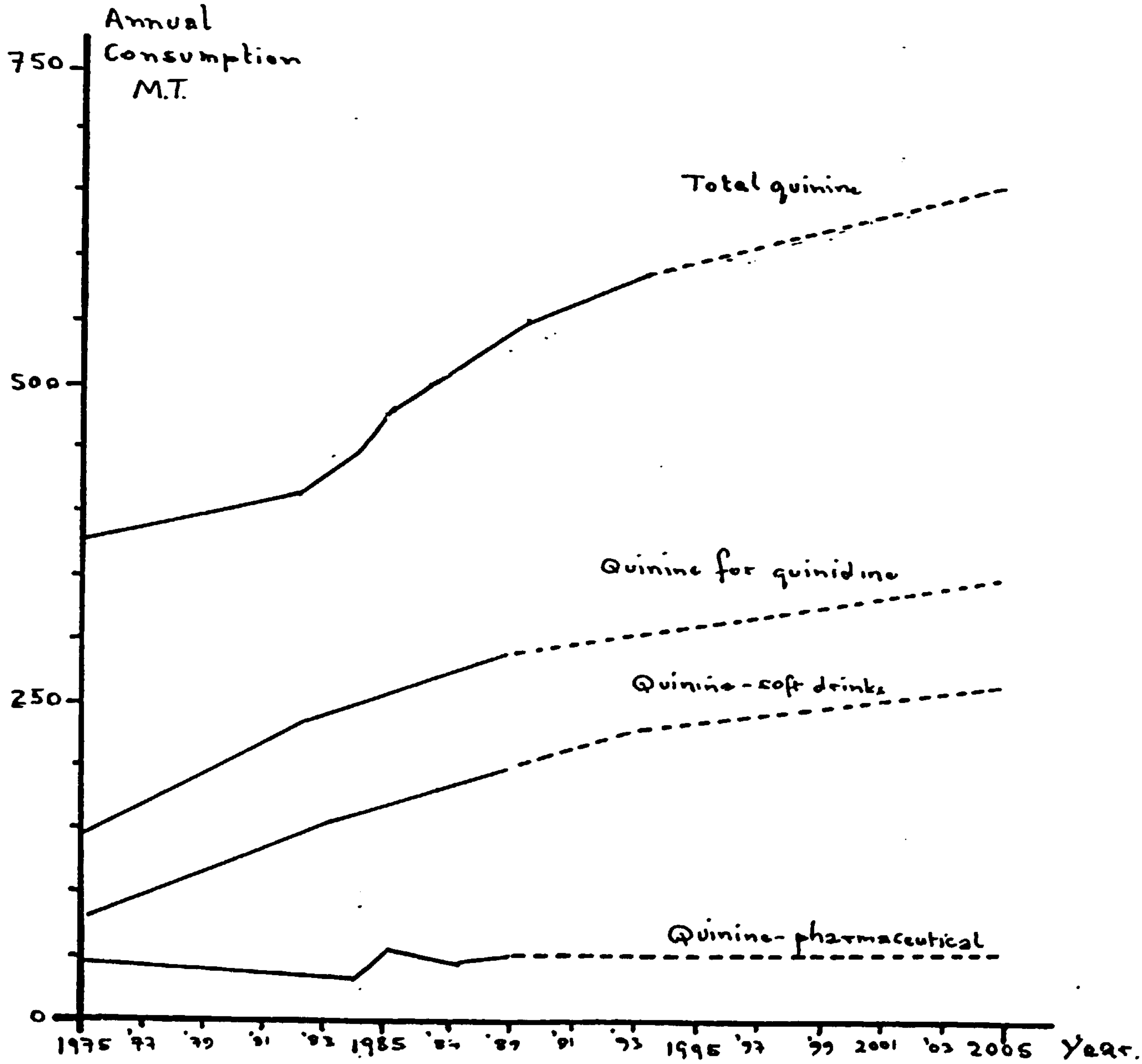


Figure 1

3.2 Market Prices

3.2.1 Current

Quinine and Quinidine prices are usually quoted in US $.

Prices do vary in different markets. Prices paid in the USA are generally the highest and are currently quoted (cif) at $82 per kilogram for quinine sulphate and $84 per kilogram for quinine hydrochloride. These prices are exactly the same as one year ago. Quinidine sulphate was reported as high as $140 per kilogram early this year, 1989, but probably related to small purchases for this is really too high. The appropriate price should be about $115-120 and a private communication confirms this as the correct level. No current prices could be obtained for quinidine gluconate which is a premium product.

The European domestic market is currently buying quinine sulphate at $77 per kilogram (cif). The Indonesians are currently offering quinine sulphate (BP88) at $68 per kilogram (f.o.b.) and quinine hydrochloride at $71 per kilogram. They are very aggressive in selling and have captured recently the bulk of the Schweppes market, where centralised buying from the USA now operates. This may cause some reaction from the European manufacturers who formerly largely satisfied this market, and might create some temporary price instability.

3.2.2 Past prices and future forecasts

Historical prices for quinine salts have been obtained from reports in the Chemical Marketing Reporter and, although these relate only to US prices, they serve to give an overall picture of variation through the years. It is difficult to collate prices over the years from other countries.

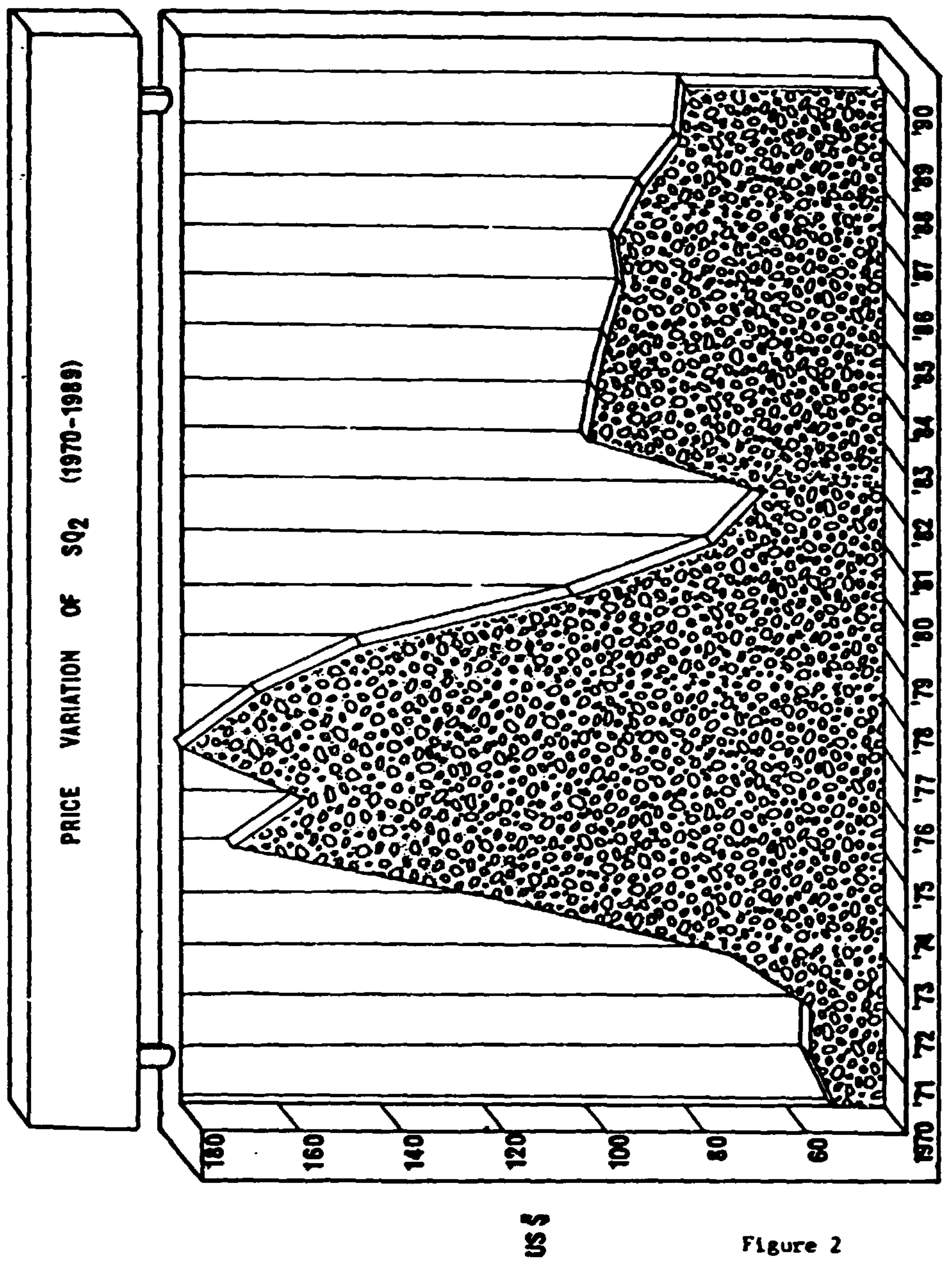

PRICE VARIATION OF SO2 (1970-1989)
180
160
140
120
100
80
60
1970 '71 '72 '73 '74 '75 '76 '77 '78 '79 '80 '81 '82 '83 '84 '85 '86 '87 '88 '89 '90
YEAR
US $

Figure 2

The graph (figure 2) presents the general trend in prices. It has tended to be a historical fact that quinine prices pass through peak prices over, roughly, a seven year period, followed by troughs. Previous to the 20 year period reported, a previous high occurred in 1964/65 at about $130 per kilogram, and fell by 1968 to a relatively stable price of $50 with revival being observed in 1973. The peak prices probably correspond to relative shortage of bark. However, although a 7-cycle is apparent, there does not seem to be a certain correlation with the fact that it takes 7 years for the Cinchona trees to mature. Prices peaked again in 1984 and have declined marginally since, producing a shallow trough.

It is expected that peaks and troughs may well be observed over the coming years, but much less pronounced. An average price of $70 per kilogram has been taken as the gross selling price for the evaluation and assumed constant for 15 years.

It is expected that a trough price will persist for another 3/4 years, after which a modest rise towards $90/$100 might be observed. These forecasts are simply based on historical facts and experience in the industry.

The projected future price prediction is depicted in figure 3.

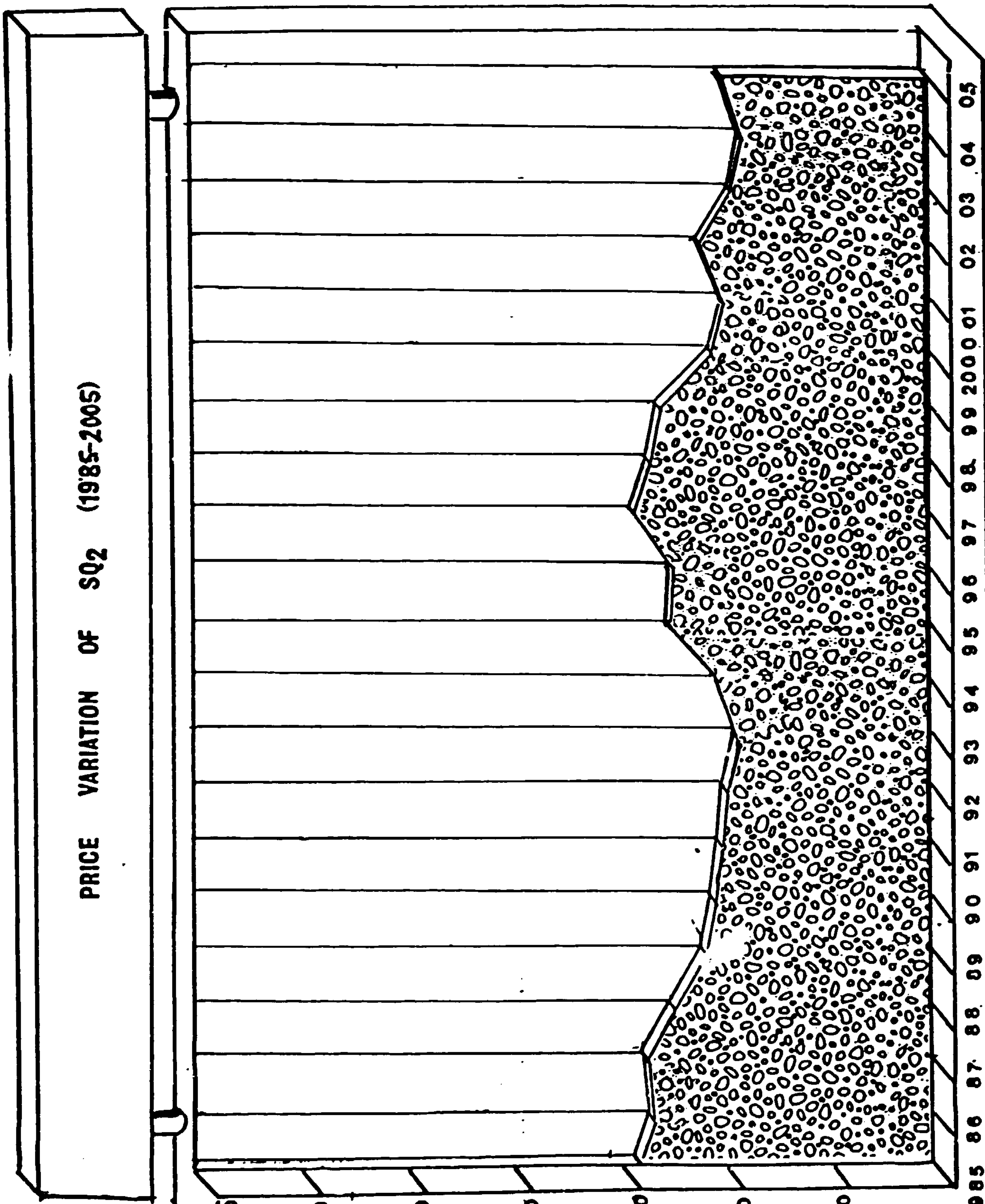

PRICE VARIATION OF SO2 (1985-2005)
180
160
140
120
100
80
60
1985
86
87
88
89
90
91
92
93
94
95
96
97
98
99
2000
01
02
03
04
05
US$

Figure 3

3.2.2.1 Philippine Importations and Prices

An analysis has been made for importations of quinine into the Philippines during the present decade. The price paid in 1989 is difficult to understand for, even considering the small quantity, it is way above the general market price.

Philippine purchases have been made from Germany, Hong Kong, Indonesia and Singapore.

Year	1981	1982	1983	1984	1985	1986	1987	1989 (3 mths)
Quantity(kg)	478	758	472	460	250	70	450	10
Price(fob) '000's$	38	63	32	32	20	5	34	1.47
Ave price	79.5	83.1	67.8	69.6	80.0	71.4	76.1	147.0

3.2.3 Duty

In the main European and American markets no import duty is currently applied. India, and presumably Indonesia, do impose import duties for protection of their industry.

3.3 Market Supply

Although there is probably sufficient capacity amongst current manufacturers (so far as extraction capacity is concerned) to meet the demand it is known that some plants are now very old and are really needing to be refurbished. Although Indonesia and Zaire are believed to have maintained their Cinchona plantations there are indications that some of the others in parts of Africa were cut severely in 1980/81 and not replanted . Maintenance of plantations in India is also believed to be restricted.

The market place is satisfied by two kinds of producer, (1) the fully producing countries and (2) those producing from imported Cinchona bark. The market is completed by the entirely importing countries.

The approximate market proportions are

USA	60%	(300 MT p.a.)
Europe	23%	(115 MT p.a.)
Rest of the World	17%	(85 MT p.a.)

These cannot be precise, nor do they necessarily indicate drug consumption. In Europe much quinine is converted to quinidine and exported. Most of the quinine used by the Schweppes organisation is now centrally purchased through the USA. Much of this, however, probably does not feature in the US imports as it will usually be shipped directly by the supplier to the end user in various countries, and be recorded in import statistics of the recipient country. With respect to the USA market, consumption has been taken as the composite of quinine and quinidine. The actual weight ratios are in the order 33% quinine and 66% is quinidine. For each kilogram of quinidine approximately 1.18kg quinine is needed. The European market comprises mainly quinine in terms of imports, but both quinine and quinidine as exports.

Demands for importation of quinine into China have dropped considerably since the mid/late 1970's, probably mainly due to the use currently by the Chinese of an alternative natural anti-malarial isolated from Artemesia annua and known by the local name Qinghaosu. This has not made any impact outside of China as the formulation is not yet very satisfactory. It has to be administered by injection and as the preparation usually contains some suspended matters, this can be rather painful.

Quinine and quinidine are marketed in several salt forms and smaller quantities of free alkaloids. Alkaloids are usually used for in situ preparation of salts while formulating, although some producers use quinine alkaloid as starting material for synthesis of quinidine.

The most common salts of quinine are the sulphate (dihydrate) and the hydrochloride. The former may be a starting material for quinidine synthesis or for tabletting as an anti-malarial, or compounding into cold or analgesic preparations. The hydrochloride is the form mostly used in the tonic and soft drinks industries. Other salts such as bisulphate may be used by some companies (eg Astra, Sweden) to satisfy a specific formulation. The dihydrochloride has become more increasingly used as an anti-malarial being suitable for injection by which route response is more rapid.

In the case of quinidine the range of salts is more restricted, being principally the sulphate for tablets or gluconate for injection. This latter product commands a premium price. A small quantity of quinidine alkaloid is marketed as such and a Swedish company use quinidine bisulphate.

3.3.1 Producing Countries

Cinchona bark is commercially grown in a number of countries in Africa, Asia, Central and South America. The principal producers are Indonesia and Zaire although others of significance have included Tanzania, Kenya, Burundi, India, Guatemala, Peru, Ecuador, Bolivia, Rwanda, Sri Lanka, Columbia and Costa Rica. Of these countries, only in Indonesia and India is Cinchona fully processed to finished quinine salts to any substantial extent. Very small productions have been reported in South American countries, namely Bolivia, Equador and Columbia but there is no present intelligence on the current situation.

In Zaire the Cinchona bark is extracted to produce an alkaloid extract which is then shipped to Germany for refining.

Production in India, at plants both in West Bengal and Madras (Tamil Nadu), is operating at low capacity and the plants are very old. India produces only quinine salts (and some natural quinidine). Available capacity at West Bengal is reported to be 25 MT per annum and at Tamil Nadu at 10 MT per annum.

Indonesia started Cinchona operations in 1898 and installed the present extractors in 1940, further improving facilities in 1975 with the introduction of centrifuges. The plant, operated by Kimia Farma, is largely requiring re-tooling and active consideration has been given to doing this over the past few years. This is likely to increase the costs substantially. Subsequent to the reduction in production after the war and in subsequent years due to the lack of restocking plantations Indonesia are once again the forerunners in quinine production and their marketing is very aggressive. Indonesia do not produce quinidine but again are investigating the possibility of doing so on a substantial scale. Indonesian plans are to produce some 150 MT of SQ_2 and introduce quinidine production at a level of 50 MT per annum.

The recent tendency for obvious economic reasons, has been for producers to consider setting up production facilities in the region where the source of Cinchona is grown. Lake and Cruickshank Ltd in 1981 had planned to transfer its extraction unit to Kenya but, due to political reasons rather than economic ones, shut down all operations. Subsequently, Isochem of France. attempted to set up extraction facilities in Rwanda but the project never became operational.

3.3.2 Import Producing

The few remaining significant quinine producers are situated in Europe, in West Germany and Holland.

ACF (Amstedamische Chemiefarma N.V.) of Holland and Boehringer Mannheim of Germany are the largest European manufacturers although Boehringer extract largely at a plant in Bukavu in Zaire and only import bark of highest quinine content for extraction in Germany. ACF have capacity to produce about 100 MT and Boehringer Mannheim about 125 MT per annum of quinine salts.

Boehringer Mannheim also produce quinidine whereas ACF are only believed to do so through a subsidiary company.

Buchler of Ausweig, Germany are a smaller, but active producer, having a capacity of 50T quinine per year. They probably have the most modern plant for quinine processing having re-tooled refinery operations in 1985 and extraction recently.

Other former producers who principally operated on a custom production basis, such as Isochem, (France) Plantex, (Israel) and Omnichem, (Belgium) are no longer believed to operate to any significant degree.

3.3.3 Principal producers

India	West Bengal Cinchona, Darjeeling Tamil Nadir, Madras
Indonesia	Kimia Farma P.T. P.O. Box 12 Bandung
Holland	Amstedamische Chemifabrik, N.V. P.O. Box 5 Maarsen
W. Germany	Boehringer Mannheim GmbH. Dandhofer Strasse 116 6800 Mannheim 31
	Buchler GmbH & Co. P.O. Box 1829 3300 Braunsweig

3.4 Marketing and Distribution

3.4.1 Domestic Market

The market in the Philippines for quinine is very limited and confined essentially to the pharmaceutical industry. The main customer is likely to be the Department of Health requiring quinine for the Anti-Malaria Programme. The bulk of quinine still appears to be used in tablet form as quinine sulphate, and only small quantities as injectable quinine dihydrochloride. The demand will probably remain relatively steady for this purpose at 300-450kgs per annum, but there might be a change from sulphate to dihydrochloride. Although only manufacture of sulphate and hydrochloride has been proposed, the dihydrochloride in small quantities could be produced. However, it might not be possible or economic to procure custom formulation of this material as the number of units would be small. At present only about 13,000 vials are being used annually. With a domestic manufacture of quinine, it is possible that some of the local pharmaceutical houses might consider use of quinine in other pharmaceutical preparations other than anti-malarials, although no specific preparations appear to be used. For this, use could only be expected in the low hundreds of kilograms.

Use as a bittering agent in the Philippines was not located and it is not possible to forecast any real consumption in this area.

Distribution within the Philippines presents no problems, since the material would be supplied in bulk as at present to one main customer, the D.O.H. They would then tender for formulation and the distribution would be the responsibility of the D.O.H.

If other pharmaceutical houses should become customers, bulk distribution only to Manila by air shipment would be involved.

3.4.2 Export Market

The market for use of quinine in pharmaceutical products is world wide. The principal market is in the USA followed by Europe. With respect to the anti-malarial market, which is probably only 2% of the total world market, the bulk is consumed in developing countries. Principal consumers and market size are tabulated below.

Anti-malarial use

Region	Principal Users	Volume p.a.
African	Angola, Burkano Faso Rwanda Comoros	1000kgs
Eastern Mediterranean	Pakistan	300kgs
South East Asia	India	180kgs (all domestic)
Western Pacific	Vietnam	3,300kgs
	Laos	3,600kgs

In this area the most interesting must be the Western Pacific markets of Vietnam and Laos. Attempts could be made to penetrate these markets but obviously strong competition must exist from Indonesia. It was not established whether Vietnam or Laos import bulk quinine salts or formulated products. If the latter applies, the market could probably be penetrated more readily by utilising capacity at the Philippine pharmaceutical houses and at the same time attaching greater added value.

In the case of the food and drinks outlets, the most significant purchaser is Schweppes and now that most is purchased through the Central office in the USA this would be a very difficult market to penetrate, although it appears Indonesia has managed to capture such a market from the Europeans. Some smaller consumers still exist but many former ones have been absorbed under the Schweppes umbrella.

The widest market is probably that where quinine is used for conversion to quinidine. Most of the operations in this field operate in Europe, and especially Italy, apart from the production by major quinine manufacturers.

Proposals to set up a unit in Costa Rica or the Virgin Islands by a major pharmaceutical house in the early 1980's for the manufacture of quinidine does not seem to have materialised.

The major markets for quinine are in Europe and the USA and it is recommended that to penetrate these, at least for some years, would be best to do so using the expertise of existing chemical trading houses which have experience and contacts in the Cinchona alkaloids field. Alternatively, there could be some personnel available, previously expert in marketing in this field who would be prepared to act as agent or consultant. It is suggested that European Services might be most appropriate to cover not only the

Western Countries, but also the Far East, where in many cases, they now have strong connections, especially through Japan.

With time direct enquiries will inevitably develop and marketing strategy could change with direct marketing from the domestic producer, dependent only on any previous marketing agreements entered into.

3.4.3 Distribution

As distribution relates only to the bulk products to other manufacturers and not to diverse wholesale and retail outlets, no great problem exists. Even if using an agent, products in most cases could be dispatched directly from the Philippine production unit to the ultimate customer, whether in Africa, Far East, Middle East, America or Europe. In some cases it might be necessary to consider providing the agent with materials on a consignment basis for him to distribute.

In all instances, however, almost invariably for this relatively high value, low volume production, quinine is transported by air shipment and only rarely by sea for large consignments. The only requirement then for efficient distribution is a reliable and good freight and forwarding agent.

3.5 Alternative Products

3.5.1 Anti-malarials

Quinine was used for very many years as the most reliable remedy available for malaria treatment but was gradually replaced as synthetics became available which appeared to be less toxic and more effective particularly for prophylaxis. There was resurgence in use of quinine in the early 1960's partly due to side effects of some synthetics, such as paludrine and mepacrine, and demand due to the Vietnam War. There was also some later resurgence as a result of resistance to some of the synthetic drugs by Plasmodium falciparum when quinine again became a preferred drug for initial treatment of malaria caused by strains resistant to chloroquine. There is some evidence that quinine dihydrochloride given by slow intravenous injection is becoming a preferred treatment. The use of quinine in combination with tetracyclines is also become favoured.

Many thousands of compounds have been screened for anti-malarial activity, several have been employed clinically, but several have subsequently been removed from the market. The use of quinine persists.

The other currently used anti-malarials all can to some extent be considered competitive products but are not likely to effect the current level of use of quinine.

The 4-aminoquinolines represented by chloroquine, amodiaquine and mefloquin are the main competitive drugs being used especially for treatment and prophylaxis of malaria in areas where Plasmodium falciparum resistance occurs. These are currently the most widely used drugs.

Only one 8-aminoquinoline, primaquine is now used particularly for Plasmodium Vivax and not really competitive with quinine.

Dihydrofolate reductase (DHFR) drugs are represented principally by pyrimethamine which is used in combination with long acting sulphonamides, such as sulphadoxine for chloroquine resistant falciparum malaria. This combination is widely used, China being the largest consumer and accounting for 80% of the market.

Sulphonamides and sulphones represented by sulfadoxine (mainly), sulfalene and dapsone are generally used in combination with pyrimethamine for P. falciparum failing to respond satisfactorily to chloroquine or amodiaquine. Although the above mentioned drugs are competitors to quinine, the pattern of use established does not suggest that they will depress the use of quinine and indeed the opposite might well be true.

There has been some evidence of the increase of quinine resistant P. falciparum, although not very extensive. A new drug mixture is being tested for treatment of such malaria but in fact is composed of a mixture of cinchona alkaloids represented by quinine, quinidine and cinchonine in equal proportions.

Another drug under investigation for treatment of multiple resistant P. falciparum is Clindamycin (7-chloro-7-deoxy-lincomycin). Tests using this have been performed in the Philippines. However, it appears that as with tetracyclines and erythromycin, it may be necessary to use a drug combination with, possibly, quinine. It is considered this combination may have an advantage over tetracyclines in requiring a shorter course of therapy. This drug, therefore, is not likely to depress the use of quinine but could help to maintain or increase the usage level.

The main possible competition to quinine could come from the Chinese drug Ginghatsuo, a natural product isolated for Artemesia annua. This is being used in China and has largely replaced the use of quinine there. The product is not generally accepted or used outside of China. It does appear to be effective but the preparation is currently unsatisfactory not only for being administered as an injection, but particularly as the preparation apparently contains suspended particles which must make injection difficult and painful. It is possible with time that this product will become a serious competitor to quinine and other anti-malarials. Finally the question of a vaccine has to be considered but it is thought that such treatment must still be many years ahead.

Overall it is felt that quinine consumption as an anti-malarial is likely to remain fairly steady at the present level for the foreseeable future.

3.5.2 Bittering agents

The principle competition is probably quassia, another wood extract. Quassia is said to be 50 times more bitter than quinine. This product has been known for many years and is not now likely to replace quinine to any further extent.

Competition from synthetic bittering agents is not taken too seriously as natural products are usually preferred in the food industry.

The taste of quinine is very specific and well accepted by a large public and would be difficult to replace. Some years ago the pharmaceutical and food industry did investigate the replacement of quinine (due to a toxicity scare raised in the press) by other cinchona alkaloids. Fear of legislation to ban the use of quinine was ill-founded and the use of quinine continued to be accepted.

3.5.3 Anti-arrhythmic drugs

Quinidine as an anti-arrhythmic drug competes with lidocaine, procainamide hydrochloride, digitalis and several other drugs acting on the circulatory system.

Quinidine has an advantage in being specific in action and is used to increase the pulse rate in many cardiac and cardiovascular disorders. It is very much in demand in North America and expanding use is observed in Australia. Although European physicians tend to prefer other treatments, a general growth market should continue to exist particularly as the pace of life increases and cardiovascular problems become more prevalent throughout the world.

Although there is always the possibility of the development of new competitive drugs, such development takes a minimum of 10 years and more likely over 15 years, and there is no intelligence of any particularly interesting products at the present time.

3.6 Sales price, programme and distribution costs

Programme of sales. At this stage of the study, it is not possible to put forward a planned sales programme as the output available for sale can only be determined by the quantity and quality of input Cinchona bark available. It is proposed, at any level, that the whole output of production can be sold.

Sales price. A constant price for the sale of quinine salts based on SQ_2 value irrespective of the salt sold has been taken for the whole period of production considered.

Sales value: US$ 70.000 per kilogram SQ_2, delivered or f.o.b. price.

The programme of production (and sales as it is assumed all sold) in terms of volume and value is tabulated below for the various production programmes considered.

Programme 1

SQINT 1/2

Throughput	Year		Volume production	Sales value US$
300 m.t./3.0%	1992		4.653 m.t.	326,025
450 m.t./3.0%	1993/96	@	6.980 m.t.	489,038
540 m.t./3.0%	1997/99	@	8.375 m.t.	586,845
540 m.t./6.5%	2000/06	@	29.840 m.t.	2,088,450

Programme 2

SQINT 3/6

Throughput	Year		Volume production	Sales value US$
300 m.t./5.0%	1992		12.750 m.t.	892,500
450 m.t./5.0%	1993/96	@	19.125 m.t.	1,338,750
540 m.t./5.0%	1997/99	@	22.950 m.t.	1,606,500
540 m.t./6.5%	2000/06	@	29.840 m.t.	2,088,450

N.B. In above tables note 3% bark only yields 51.7% salts on input, while 5% & 6.5% will yield 85.0% yield.

Programme 3

SQPRC 1/2

Throughput	Year	Volume production	Sales value US$
300 m.t./5.0%	1992	12.750 m.t.	892,500
450 m.t./5.0%	1993/2006	19.125 m.t.	1,338,750

Programme 4

SQPRC 3/4

Throughput	Year	Volume production	Sales value US$
300 m.t./5.0%	1992	12.750 m.t.	892,500
450 m.t./5.0%	1993/96	19.125 m.t.	1,338,750
540 m.t./5.0%	1997/2006	22.950 m.t.	1,606,500

3.6.1 Sales and distribution costs

In view of the proposal to market through an agent only indirect sales and distribution cost has been included as input to COMFAR schedules.

Sales and distribution costs have simply been taken as 5.4 per cent of sales value.

The following inputs result:

Throughput bark	Sales and distribution cost US$
300 m.t./3.0%	18,000
450 m.t./3.0%	26,000
540 m.t./3.0%	32,000
300 m.t./5.0%	48,000
450 m.t./5.0%	72,000
540 m.t./5.0%	86,000
540 m.t./6.5%	111,000

All sales are assumed to be sold f.o.b. nearest airport. The transportation costs, which would be works transport are charged against works overheads rather than as a separate item. The cost is minimal and would not be more than US $114 per metric ton even if hired transportation was used to transfer to Cagayan de Oro City.

4. Raw Materials, Inputs and Plant Capacity

4.1 Cinchona Bark Supply - Plantation Aspects

4.1.1 Climatic and Soil Requirements

Experience elsewhere has shown that the optimum conditions for the successful culture of cinchona are as follows:

Temperature: Average daily maximum 21 C, minimum 13.5 C
Not regularly outside the range 7 - 26 C and frost free.

Relative humidity: Average daily maximum 97%, minimum 68%

Mean daily 83%

Rainfall: 3500mm annually if there is a well marked dry season. 2000mm is adequate if more or less evenly distributed.

Soil: Deep, friable, well drained and aerated. High humus content, pH 4.6 - 6.5 with high levels of cations especially calcium.

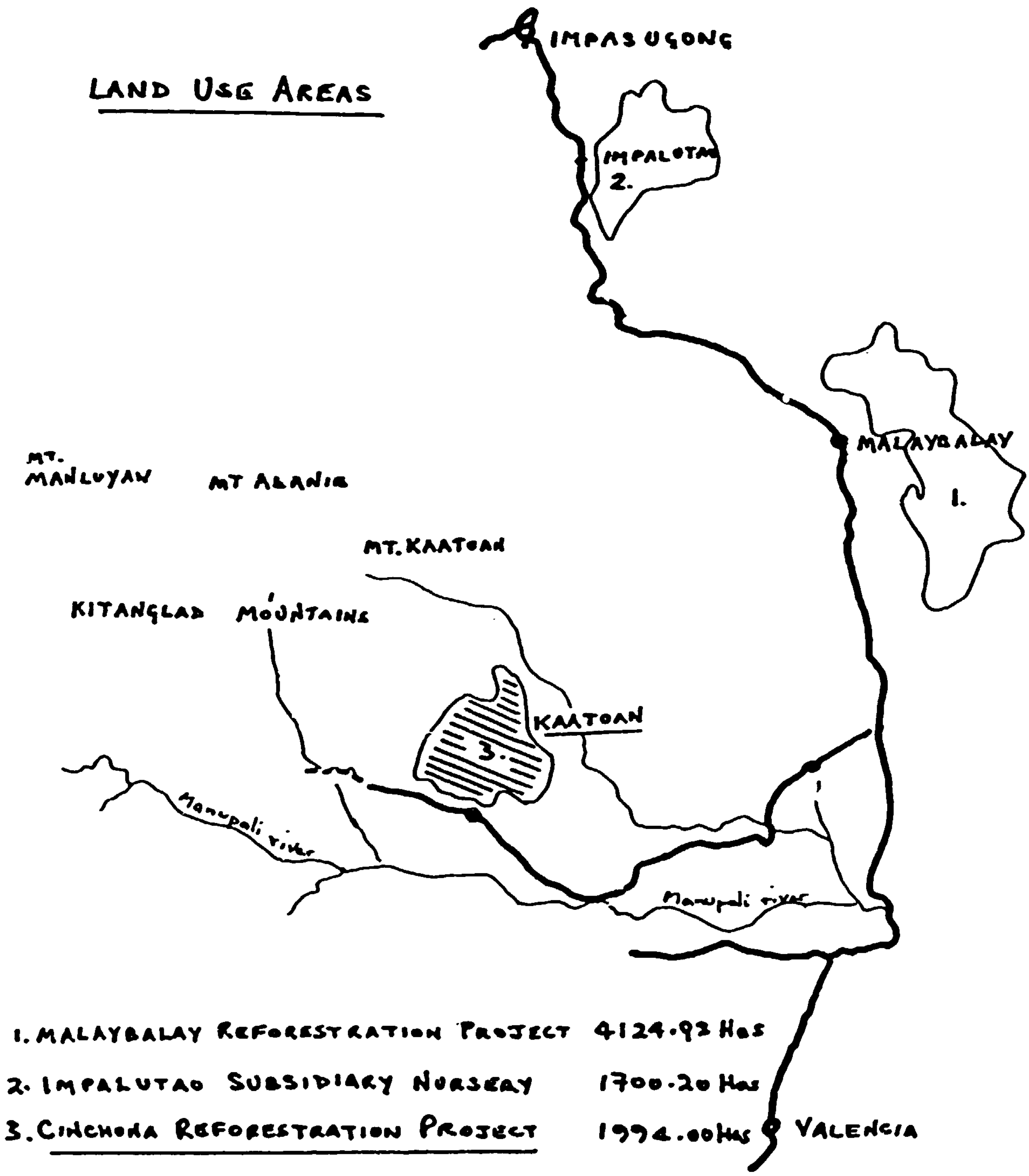
Within the near equatorial latitudes of the Philippines these climatic conditions are likely to be found at altitudes of 1500 - 2200m.

4.1.2 Location of the Cinchona plantations in the Philippines

The cinchona plantation area lies on the southern slopes of Mount Kaatoan in the Municipality of Lantapan, Bukidnon. It is under the management of the Forest Management sector of the Department of Environmental and Natural Resources.

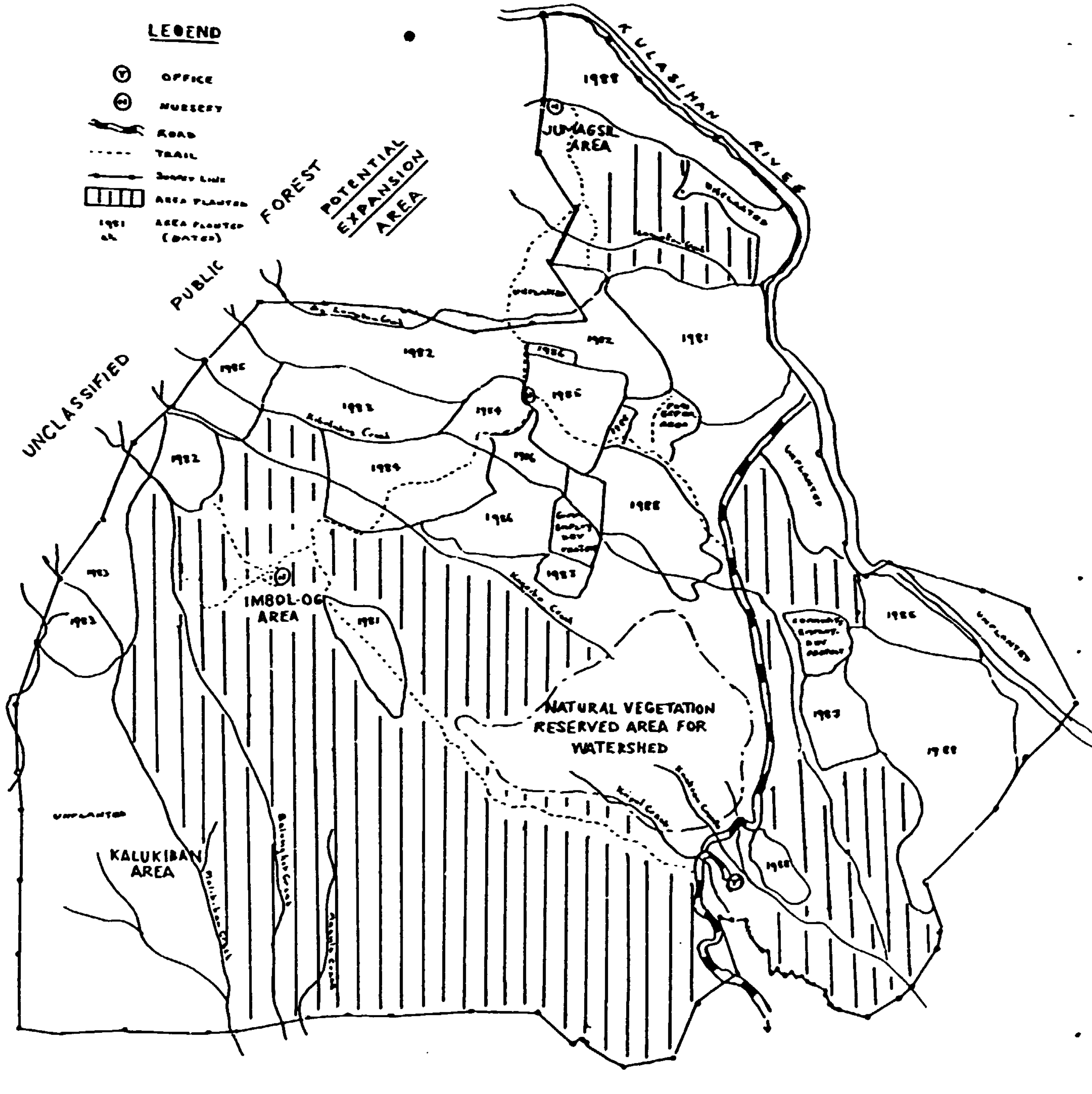
The location and site are illustrated in figure 4 and 5.

The total area encompassed by the project is 1994 ha., altitude 1,100 - 1,500 m. Thus it is already on the margin of altitude for successful cinchona production experienced elsewhere. The soil is fairly heavy and clayey, not ideal for cinchona, but is probably on the whole reasonably well drained by virtue of the underlying rocky material and the network of steep valleys and streams. Humus levels and pH are satisfactory, at least in newly cleared forest areas. No information was available regarding calcium status.



LAND USE AREAS
IMPASUGONG
IMPALUTAO
2.
MALAYBALAY
1.
MT. MANLUYAN
MT ALANIB
MT. KAATOAN
KITANGLAD MOUNTAINS
KAATOAN
3.
Manupali river
Manupali river
VALENCIA
1. MALAYBALAY REFORESTRATION PROJECT 4124.93 Has
2. IMPALUTAO SUBSIDIARY NURSERY 1700.20 Has
3. CINCHONA REFORESTRATION PROJECT 1994.00 Has

Figure 4



NOTE: PROPOSED ACCESS ROAD ESSENTIALLY TO FOLLOW TRAIL.

Figure 5

4.1.3 Status of the Plantation

4.1.3.1 Genetic Stock

There are stated to be 7 species under cultivation but two of these are referred to as named cultivars of Cinchona Ledgeriana.

These seven types are:

C. ledgeriana, C. ledgeriana v. kartamanah, C. ledgeriana v. tjinjiroena, C. officinalis, C. calisaya, C. succirubra, C. hybrida.

Propagation is by seed and unfortunately there are no isolated stands of the different species dating back to the origins of the plantations in the 1930s. Without these to serve as sources of seed there are likely to be difficulties in maintaining the genetic stability of the different species. Cinchona species are not generally self-fertile and require cross-pollination. Consequently there is a strong probability that some of the seed now being used results from interspecific pollination and that the stock includes complex hybrids.

Morphological characteristics of the different species are apparent both in the mature plantations and the nursery beds. However there are a good many specimens with indeterminate or intermediate character. For example dark red pigmentation of the leaves, considered to be a characteristic of C. officinalis was noted in odd specimens of other species. There were some obvious variations within the beds of young seedlings attributed to particular species and no indication that atypical specimens might be discarded before planting out.

The C.succirubra stock differed considerably from many specimens previously seen in India and East Africa. In these latter locations the leaves commonly had several well defined lobes. All specimens seen at Kaatoan had broad oval shaped leaves with a single lobe.

4.1.3.2 Husbandry

Seed is collected from identified trees and sown in drills in raised shaded beds. After several months seedlings are transplanted into open secondary beds and grown on for about 1 year before planting in the field. This operation involves lifting the seedlings, removing most of the soil and peripheral roots and planting into small holes with minimal preparation and without addition of any fertiliser etc. This technique allows rapid planting of large areas with minimum labour but seems unlikely to give the best chance of survival and rapid/vigorous growth. (In Kenya, by contrast, seedlings were grown in polythene sleeves and planted out with minimal root disturbance, into relatively large individually dug planting holes with fertiliser being placed in the planting hole).

Planting generally takes place during the wet season from May - December. All undergrowth is first cleared but the major trees are left to provide a shade canopy. Research has shown that survival is better with the benefit of shade from the canopy rather than in a completely open situation. Subjective observation however suggests that the shade should not be too dense for good growth. Trees under heavy shade often appeared stunted or spindly while, where the light is a little better, nearby trees, planted at the same time, appear strong and vigorous.

Again Kenya provides a contrast. There no shade was used and good survival rates were achieved. However the plantations are at higher altitudes and hence lower surface temperatures are experienced.

Planting density is normally 2m x 2m or 2500 trees/ha, but numbers are often less than this by virtue of the large trees and vagaries of the terrain. Some areas of much closer planting were also seen. These appeared to be very vigorous and healthy.

Maintenance in the first few years consists simply of weeding. Fertilisers are not generally applied. This is also contrary to practice elsewhere. It has been clearly demonstrated that both N & P fertilisers improve not only the weight of bark produced but also the quinine content of that bark.

A further factor is the calcium level of the soil and addition of lime is often beneficial and may influence the level of quinine by as much as 60%

The combined affects of N, P and Ca may increase yield of quinine/ha by more than 100%. On the other hand addition of K is not usually desirable since it antagonises uptake of Ca.

4.1.3.3 Pests and Diseases

The most common disease encountered in cinchona plantation is Phytophthorus cinnamoni or stripe canker. This, or a very similar fungal disease is present at Kaatoan. Although fairly widespread it does not appear, as yet, to be a very severe problem. Local forestry staff have estimated that only a few % of the trees are affected. It may however be a significant factor influencing the rather poor survival rate of young trees.

Control of this disease by chemical methods has not proved to be very successful elsewhere. Probably the best approach is one of containment by adopting cultural practices to minimise its impact.

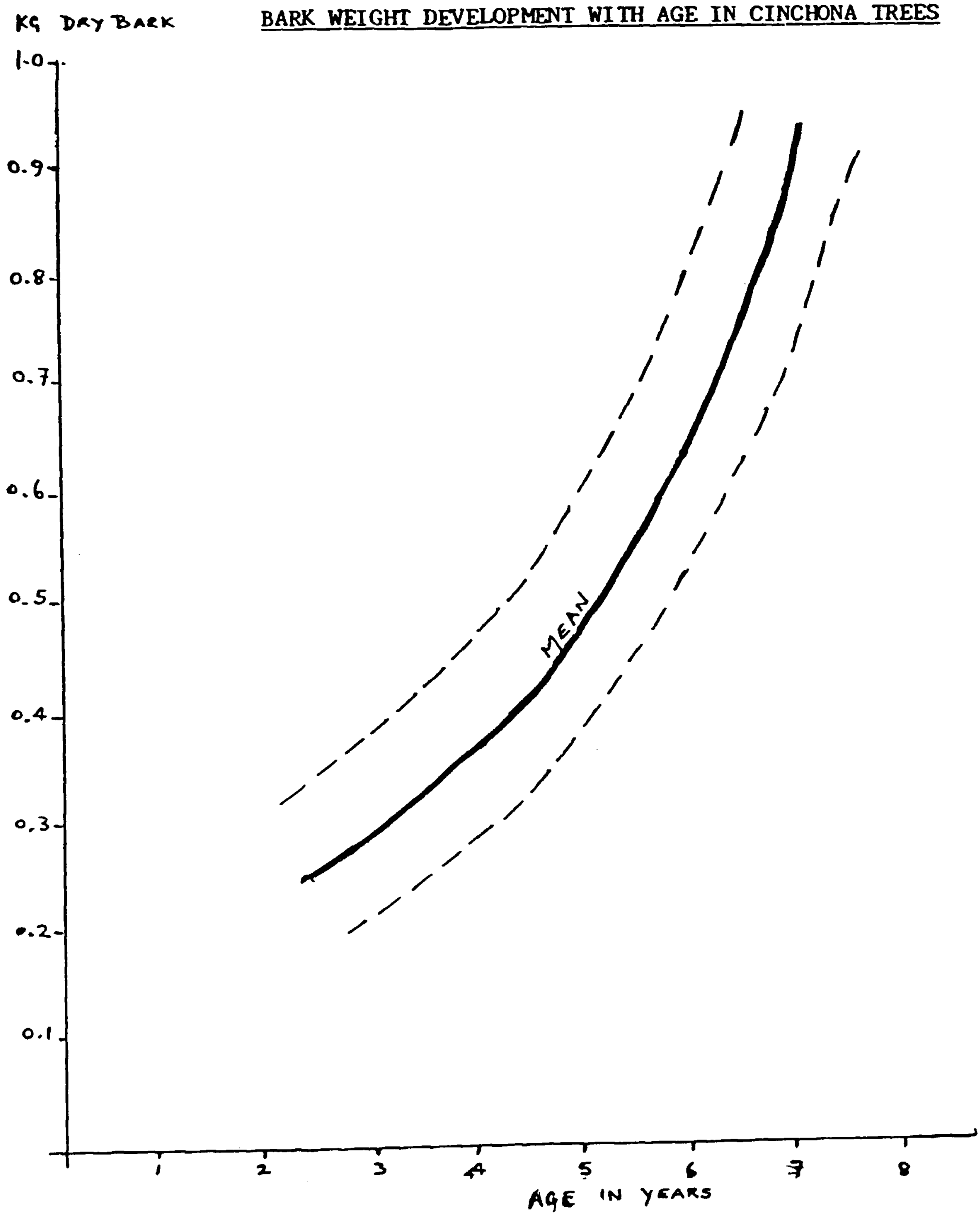

KG DRY BARK
BARK WEIGHT DEVELOPMENT WITH AGE IN CINCHONA TREES
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
MEAN
1
2
3
4
5
6
7
8
AGE IN YEARS

Figure 6

4.1.3.4 Harvesting

(1) Effect of age of trees. (See figure 6)

The alkaloid content of the bark, in particular the quinine level increases quite rapidly during the first 7 years of growth and subsequently only changes slowly. However the total quantity of bark continues to increase fairly rapidly for at least 12 - 15 years. Thus the quinine content of the tree increases rapidly during that period. Elsewhere the economic age of harvesting has been considered to be 7 years. This should however probably be regarded as an absolute minimum and may vary both with growing conditions and the market situation.

Other than collections of bark from dead or diseased trees virtually no harvesting has taken place since 1970. For the present, therefore, there are plenty of fully mature trees to harvest.

(2) Harvesting at Kaatoan.

If regular harvesting is to be established it will probably be best to confine it to the driest period, say January - April. This would allow the bark to be sun-dried fairly rapidly. The importance of thorough drying needs to be emphasised (apparent from the high moisture content of the samples taken from the bark store).

Harvesting and collection of the bark from the plantations would at present be fairly difficult and labour intensive.

Construction of an access road which would encircle a large part of the present area has been proposed. This should be implemented at an early stage and would further assist with development of the proposed extension area (see figure 5).

4.2 Estimates of available bark

Older areas (pre 1970) are very variable with some very large trees 15 - 20 m in height and diameter in excess of 25 cm, while others, under heavy shade, are rather spindly There are no really reliable and useful data on these older areas and there appears to be some difference of opinion on numbers of trees and expected yield of bark. Because of the obviously heterogeneous nature of this stock, coupled with planting of 7 species having rather different growth characteristics, it is impossible to make any sort of independent estimate without undertaking a fully detailed inventory. We will therefore base our projections on the more conservative of the estimates provided to us.

Subsequent to 1970 there are detailed records of planting by area, tree numbers and species. Inspection of many of these again reveals considerable heterogeneity particularly in the older areas, but in the more recent plantings (post 1979) there are some excellent stands of healthy vigorous trees and we see no reason at all to doubt most of the figures provided.

It must be stressed however that in general the number of trees planted has been given and survival rates assumed may, in some cases, be optimistic. Research has however shown different survival rates for each species (see figure 7) and different rates of bark production. These factors have been used to compute the amount of bark available now and for the succeeding 12 years.

It is also assumed that harvesting will be by coppicing and a subsequent survival rate of 70% for a 2nd harvest will be achieved. No account of a possible 3rd cycle has been included.

It can be estimated that by restricting the offtake of bark to 450 tonnes/annum (300 tonnes in year 1, taken as 1990) then the proposed production plant can operate at this level for the foreseeable future provided that there is a relatively modest increase in the present rate of planting.

The calculations made to determine the quantities of Cinchona bark available are given in table 1. The harvesting programme to give a regular level of off take is detailed in table 2.

Figure 7

Survival rates (ref. Report Constante B Serna, Forest Research Institute)

C. Ledgeriana	53.1%
C. Ledger var Tjinjiroena	51.8%
C. Ledger var Kartamanah	44.4%
C. Officianalis	45.6%
C. Calisaya	65.0%
C. Succirubra	53.7%
C. Hybrid	52.5%

Bark production

These figures may be located in Table 1 covering trees from 7 years to 19 years old for the different species.

TABLE 1

Year	1970	1971	1972	1973	1974	1975	1976
Planted: (Nos.)							
C.Ledg		48740	59700	14000	17200	6500	310
C.LvT		1000	28800	10415	0	600	310
C.LvK		7650	18420	12700	3240	1300	310
C.Off		0	5800	6000	5048	0	310
C.Cal		0	2300	1080	0	0	0
C.Suc		0	3000	4700	0	0	310
C.Hy		3000	27900	30715	6900	5480	310
Total No	115530	60390	145920	79610	32424	13880	1860
Survived:	1977	1978	1979	1980	1981	1982	1983
C.Ledg		25881	31701	7434	9133	3452	165
C.LvT		518	14918	5395	0	311	161
C.LvK		3397	8178	5639	1439	577	138
C.Off		0	2645	2736	2318	0	141
C.Cal		0	1495	702	0	0	0
C.Suc		0	1611	2524	0	0	166
C.Hy		1575	14648	16125	3623	2877	163
Total No	61462	31371	75196	40555	16513	7217	933
Bark/tree (Kgs.)							
C.Ledg	3.01	2.84	2.68	2.53	2.39	2.25	2.08
C.LvT	2.35	2.26	2.17	2.09	2.01	1.93	1.81
C.LvK	3.73	3.45	3.19	2.95	2.73	2.53	2.30
C.Off	3.35	3.10	2.87	2.66	2.46	2.28	2.07
C.Cal	2.43	2.29	2.16	2.04	1.92	1.81	1.68
C.Suc	2.82	2.69	2.56	2.44	2.33	2.21	2.03
C.Hy	2.86	2.70	2.55	2.41	2.27	2.14	1.97
Mean	2.94	2.76	2.60	2.45	2.30	2.16	1.99
1990 bark (MT.)							
C.Ledg		74	85	19	22	8	
C.LvT		1	32	11	0	1	
C.LvK		12	26	17	4	1	
C.Off		0	8	7	6	0	
C.Cal		0	3	1	0	0	
C.Suc		0	4	6	0	0	
C.Hy		4	37	39	8	6	
Total	181	91	195	100	40	16	2

TABLE 1

	1977	1978	1979	1980	1981	1982	1983
Planted:							
C.Ledg	25570	28350	101825	15600	23380	72875	75500
C.LvT	14600	16900	76860	28103	31720	34925	73000
C.LvK	19377	13700	16400	23938	46874	43950	27800
C.Off	11598	17225	57495	17400	0	16408	0
C.Cal	9000	10600	6750	2050	0	13842	26650
C.Suc	12519	61663	91690	3000	52220	0	21800
C.Hy	7185	6600	23000	0	19630	0	2500
	99849	155038	374020	90091	173824	182000	227250
Survived:	1984	1985	1986	1987	1988	1989	1990
C.Ledg	13578	15054	54069	8284	12415	38697	40091
C.LvT	7563	8754	39813	14557	16431	18091	37814
C.LvK	8603	6083	7282	10628	20812	19514	12343
C.Off	5289	7855	26218	7934	0	7482	0
C.Cal	5850	6890	4388	1333	0	8997	17323
C.Suc	6723	33113	49238	1611	28042	0	11707
C.Hy	3772	3465	12075	0	10306	0	1313
Total No	51377	81213	193082	44347	88006	92781	120589
Bark/tree (Kgs.)							
C.Ledg	1.93	1.79	1.66	1.54	1.40	1.27	1.15
C.LvT	1.70	1.60	1.50	1.41	1.31	1.21	1.12
C.LvK	2.09	1.90	1.73	1.57	1.43	1.30	1.18
C.Off	1.88	1.71	1.55	1.41	1.28	1.16	1.05
C.Cal	1.56	1.44	1.33	1.23	1.12	1.02	0.93
C.Suc	1.86	1.71	1.57	1.44	1.33	1.23	1.14
C.Hy	1.82	1.68	1.55	1.43	1.30	1.18	1.07
Mean	1.83	1.69	1.56	1.43	1.31	1.20	1.09
1990 Bark (MT.)							
C.Ledg	26	27	90	13	17	49	46
C.LvT	13	14	60	21	22	22	42
C.LvK	18	12	13	17	30	25	15
C.Off	10	13	41	11	0	9	0
C.Cal	9	10	6	2	0	9	16
C.Suc	13	57	77	2	37	0	13
C.Hy	7	6	19	0	13	0	1
	96	139	306	66	119	114	133

TABLE 1

	1984	1985	1986	1987	1988
Planted:					
C.Ledg	15872	115431	100040	41043	53547
C.LvT	6335	71921	62331	25572	61974
C.LvK	14198	86486	74954	30751	70258
C.Off	12220	21213	18315	7543	27040
C.Cal	23312	29910	25922	10636	17257
C.Suc	16916	56105	48624	19949	20588
C.Hy	10486	38695	33535	13758	62353
	99339	419761	363791	149252	313017
Survived:	1991	1992	1993	1994	1995
C.Ledg	8428	61294	53121	21794	28433
C.LvT	3282	37255	32287	13246	32103
C.LvK	6304	38400	33280	13653	31195
C.Off	5572	9673	8384	3440	12330
C.Cal	15153	19442	16849	6913	11217
C.Suc	9084	30128	26111	10713	11056
C.Hy	5505	20315	17606	7223	32735
Total No	53328	216507	187638	769082	159069
Bark/ Tree (Kgs.)					
C.Ledg	1.15				
C.LvT	1.12				
C.LvK	1.18				
C.Off	1.05				
C.Cal	0.93				
C.Suc	1.14				
C.Hy	1.07				
Mean	1.09				
Bark,yr:(MT.)	1990	1991	1992	1993	1994
C.Ledg	10	70	61	25	33
C.LvT	4	42	36	15	36
C.LvK	7	45	39	16	37
C.Off	6	10	9	4	13
C.Cal	14	18	16	6	10
C.Suc	10	34	30	12	13
C.Hy	6	22	19	8	35
Total	57	241	210	86	277

Table 2 Harvest schedule tonnes 1990to 1993

Yr plantec	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1960	1981	1982
No trees	61462	31371	75196	46555	16513	7217	933	51377	81213	193082	44347	88006	92781
1990 avail.	181	91	195	100	40	16	2	96	139	306	66	119	114
1990 harvest	181	91	26										
1990 cumul.	181	272	300										
remainder	0	0	167										
1991 avail.			177	106	42	17	2	104	151	332	72	131	125
1991 harvest			177	106	43	17	2	104	1				
1991 cumul.				283	326	343	345	449	450				
remainder				0	0	0	0	0	150				
1992 avail.									163	360	78	142	138
1992 harvest									163	287			
1992 cumul.										450			
remainder										73			
1993 avail.										79	84	154	150
1993 harvest										79	84	154	133
1993 cumul.											163	317	450
remainder											0	0	17
Survive coppicing:	43023	21560	52637	28389	11559	5052	653	35964	56849	135157	31043	61604	64947
2nd cycle													
1997 bark	47	24	8										
(total 79)													
1998 bark			49	31	13	6	1	39					
(total 139)													
1999 bark									62	117			
(total 179)													
2000 bark										30	34	67	63
(total 194)													

Table 2 Harvest schedule tonnes 1994to 2000 No.trees needed to survive

Yr plantes / No trees	1982 (balance)	1983 120589	1984 53328	1985 216507	1986 187638	1987 76982	1988 159069	1989 220000	1990 270000	1991 280000	1992 245000	1993 220000
1990 avail.		133										
1991 avail.		146	57									
1992 avail.		161	63	241								
1993 avail.		177	69	265	210							
1994 avail.	16	192	76	292	231	86						
1994 harvest	18	192	76	164								
1994 cumul.		210	286	450								
remainder		0	0	128								
1995 avail.				140	254	95	177					
1995 harvest				140	254	56						
1995 cumul.					394	450						
remainder					0	39						
1996 avail.						42	195	250				
1996 harvest						42	195	213				
1996 cumul							237	450				
remainder							0	37				
	2nd cycle											
1997 avail.	79							41	330			
1997 harvest	79							41	330			
1997 cumul								120	450			
remainder								0	0			
1998 avail.	139									320		
1998 harvest	139									311		
1998 cumul.										450		
remainder										9		
1999 avail.	179									10	280	
1999 harvest	179									10	271	
1999 cumul.											450	
remainder											9	
2000 avail.	194										10	250
2000 harvest	194										10	246
2000 cumul.												450
remainder												4

4.2.1 Quality of Bark and Planting Material

In order to maximise the value of the cinchona bark extracts it is highly desirable to be able to isolate a proportion of pure quinine which is a potentially valuable export while, at the same time, preparing a mixed alkaloid extract for use as an anti-malarial.

Thus the bark should have as high as possible level of total alkaloids and a sufficiently high proportion of quinine to allow easy isolation.

The composition of the bark has a very critical influence on the economics of processing. Generally C.ledgeriana is preferred for the isolation of quinine. Good quality ledgeriana bark may have quinine as high as 9 - 10% (expressed as quinine sulphate, $2.H_2O$ or SQ2) with a total alkaloid content of 10-12% The alkaloid content is a characteristic of genotype or even the individual tree. Trees with quinine levels as high as 18% have been reported. Alkaloid content is also influenced by the environment, the age of the tree and soil and nutrient levels as mentioned above.

All ledgeriana stocks are not necessarily equally favourable in their alkaloid contents and other species generally have much less favourable levels. For example, C.succirubra typically may have only 2-3% SQ2 and a total alkaloid content of 4-5% (see figure 8 comparing different species).

FIGURE 8

COMPARISON OF QUALITY RANGES OF DIFFERENT CINCHONA SPECIES

The analysis of different species of Cinchona fall within typical ranges of contents shown below (Source:Trease, Pharmacognasy). All figures are recorded as percentages on dry basis.

Species	TAA	QAA	C_DAA	Q_DAA	CNA	Amorphons alkaloids
C.Ledgeriana	5.0-14.0	3.0-13.0	0.0-2.5	0.0-0.5	0.0-1.5	0.2-2.0
C.Calisaya	3.0-7.0	0.0-4.0	0.0-2.0	0.0-3.0	0.3-2.0	0.2-2.0
C.Succimbra	4.5-8.5	1.0-3.0	1.0-5.0	0.0-0.3	1.0-2.5	0.3-2.0
C.Officinalis	5.0-8.0	2.0-7.5	0.0-3.0	0.0-0.3	0.0-3.0	0.0-1.5
C.Hybrid (Ledger&Succ)	6.0-12.0	3.0-9.0	0.0-3.0	0.0-0.0	0.5-1.5	1.0-2.5
C.Robusta (Offic&Succ)	6.0-8.5	1.0-8.0	2.5-6.5	0.0-TR.	0.0-1.0	1.0-2.0

Previous Analyses

The greatest problem with the survey was the lack of information regarding the quality of the Cinchona trees grown at Kaatoan. The few analyses which could be located are reported below, although only of historical interest. The bark analysed for sale in 1971/72 almost certainly originated from C. Ledgeriana. The analysis indicates that a very acceptable quality of the specie existed at that period of time.

Five analyses reported indicated a rather consistent quality and good ratio of quinine to cinchonidine.

Water content	8.12	8.17	10.12	9.96	10.64
TAA	8.45	8.45	7.60	7.87	7.87
QAA	6.24	6.09	6.03	6.04	6.01
C_DAA	0.84	0.87	0.66	0.60	0.60
SQ_2	7.53	7.35	7.27	7.29	7.26

A further series of analyses were also located, but the results generally appeared to be rather poor. It is noticeable that most of the samples were very wet when analysed (dried samples should contain about 12% water).

The TAA contents are particularly observed to be very low and it may be that the results are quoted on wet bark rather than is normal practice on dry bark. If so, it could indicate some presence of reasonable quality C. Hybrid. The date of sampling and analysis were not reported.

Species	Plant part	Water content	TAA	QAA	C_DAA	SQ_2
Ledger	Roots 2.5	29.85	5.47	2.01	0.91	2.42
CL ?	Roots 5.0	36.34	5.21	3.28	0.58	3.95
	Stem	20.07	3.96	2.72	0.29	3.28
	Branch	11.03	4.47	3.02	0.18	3.64
Ledger	Roots	36.97	5.74	1.85	0.75	2.24
CLVK	Stem	27.63	4.27	1.89	0.38	2.28
	Branch	12.47	2.41	0.76	0.26	0.92
Hybrid	Root	10.37	9.38	1.69	3.01	2.04
CH	Stem 2.5	22.68	5.97	3.46	0.48	4.17
	Stem 7.5	28.93	5.66	5.17	1.29	6.24
	Branch	12.01	2.40	0.37	0.41	0.45
Officinalis	Roots	10.97	8.06	4.31	1.00	5.20
CO	Stem	23.73	5.04	2.19	1.42	2.64
	Branch	10.64	2.33	0.32	0.77	0.39

Irrespective of whether calculations are correct or not, it is concluded that the C. Ledger Variety Kartamanah does not appear to be a high testing species.

Recent Analyses

Samples of bark of each species were made available from existing stocks held at Kaataon. These were analysed by the traditional, commercially accepted, procedure in U.K. with the following results:

Species	Total alkaloid TAA%	Quinine SQ2%	Cinchonidine CdAA%
C. Ledgeriana	8.91	4.15	2.04
C. Calisaya	6.96	2.18	1.67
C. Officinalis	7.24	2.45	2.98
C. Ledgeriana, v. kartamanah	7.61	3.39	1.62
C. Ledgeriana, v. tjinjiroena	7.43	2.12	1.3
C. Succirubra	8.75	2.7	2.63
C. Hybrida	8.14	2.25	2.23
C. Ledgeriana, (small twigs)	9.03	1.56	2.68

These results were most disappointing. It was noted that the moisture content was very high in the region of 30% and the possibility was considered that some deterioration might have taken place because of inadequate drying. Further it was understood that this bark was primarily from dead or diseased trees of indeterminate ages. Therefore further samples, freshly taken from trees of known ages, were obtained.

Results available thus far are as follows:

Species	Age(yrs)	TAA	CdAA	SQ2
C. Ledgeriana	8	8.9	2.3	6.8
C. Ledgeriana Kartamanah	11	7.35	1.6	2.8
C. Succirubra	11	8.90	3.4	1.75

While the results for C.Ledgeriana represent a significant improvement on the earlier samples the other results are broadly similar.

Thus the present indications are that only C.Ledgeriana is likely to be economically viable for processing. This reduces, very substantially, the size of plant which can be sustained. Considering only C. Ledgeriana bark the projections are summarised in Table 3.

Table 3 Bark and harvest schedules(C.Ledg.)

Year	1970	1971	1972	1973	1974	1975	1976
Planted:							
C.Ledg	28880 (est.)	48740	59700	14000	17200	6500	310
Survived:	1977	1978	1979	1980	1981	1982	1983
C.Ledg	15360	25881	31701	7434	9133	3452	165
Bark/tree							
C.Ledg	3.01	2.84	2.68	2.53	2.39	2.25	2.08
1990 bark							
available	46	74	85	19	22	8	0
harvested	46	54					
1991 bark							
available		21	90	20	23	8	0
harvested		21	79				
1992 bark							
available			12	21	24	9	0
harvested			12	21	24	9	
1993 bark							
available							0
harvested							0
Survive							
coppicing	10752	18117	22190	5204	6393	2416	115
2nd cycle							
1997 bark (total 27)	12	15					
1998 bark (total 27)		5	22				
1999 bark (total 31)			3	6	7	3	0

Table 3 Bark and harvest schedules(C.Ledg)

Year	1977	1978	1979	1980	1981	1982	1983
Planted: C.Ledg	25570	28350	101825	15600	23380	72875	75500
Survived:	1984	1985	1986	1987	1988	1989	1990
	13578	15054	54069	8284	12415	38697	40091
Bark/tree C.Ledg	1.93	1.79	1.66	1.54	1.40	1.27	1.15
1990 bark available harvested	26	27	90	13	17	49	46
1991 bark available harvested	28	29	97	14	19	54	51
1992 bark available	31	34	104	15	21	60	56
harvested	31	3					
1993 bark available		33	112	16	22	64	62
harvested		33	67				
1994 bark available			49	17	24	69	67
harvested			49	17	24	10	
1995 bark available						64	72
harvested						64	36
1996 bark available							39
harvested							39
Survived coppicing 2nd cycle	9504	10538	37848	5799	8690	27088	28063
1999 bark (total 31)	11	[illegible]					
2000 bark (total 37)		11	26				
2001 bark (total 39)			18	7	10	4	

Table 3 Bark and harvest schedules(C.Ledg.)

	1984	1985	1986	1987	1988
Planted:					
C.Ledg	15872	115431	100040	41043	53547
Survived:	1991	1992	1993	1994	1995
	8428	61294	53121	21794	28433
Bark/tree					
C.Ledg	1.15	1.15	1.15	1.15	1.15
1991 bark					
available	10				
harvested					
1992 bark					
available	11	70			
harvested					
1993 bark					
available	12	78	61		
harvested					
1994 bark					
available	13	86	67	25	
harvested					
1995 bark					
available	14	94	74	28	33
harvested					
1996 bark					
available	15	102	82	31	36
harvested	15	46			
1997 bark					
available		60	88	34	40
2nd cycle		27			
harvested		87	13		
1998 bark					
available			81	36	44
2nd cycle			27		
harvested			100		
1999 bark					
available			9	39	47
2nd cycle				31	
harvested			9	70	21
2000 bark					
available					51
2nd cycle					37
harvested					88

This indicates that an offtake of at least 100 tonnes/annum can be sustained and considerably more would be possible by 1997 given a satisfactory planting programme. A further immediate consequence is that only C. Ledgeriana should be planted at least until a more detailed analytical survey has been completed. It is not clear whether seed supply might become a limiting factor in the short term. In the longer term a programme of selection and reproduction by meristem culture should be undertaken

4.3. Expansion of Plantation Area

4.3.1 Land Availability

A proposed area of 8625 ha has been earmarked for future expansion. This is located on the plateau above the present plantation at more than 1500m.

The edge of this area was visited and it does appear to be highly suitable for cinchona, in that there was a profusion of wind-blown natural seedlings on the forest floor and even on rotting logs and stumps. Young 'wild' seedlings are often collected and added to the nursery stock. This practice, of course, increases the probability of using genetically poorly defined planting material.

There is also interest in establishing small-holders and it was stated that up to 100 growers might be expected to plant 2-3 hectares each of cinchona. Clearly there is no shortage of land for the establishment of a viable cinchona plantation and processing operation.

4.3.2 Planting Material

Present Situation

As indicated previously the commercial quality of the bark is determined by its quinine content and the ratio of quinine to other alkaloids. This in turn is determined by the species and ultimately by the genetic make-up of the individual trees.

The indication from the limited amount of analysis so far carried out are that only C. Ledgeriana is of significant commercial value. This is precisely in line with experience elsewhere.

Therefore it is strongly recommended that future planting be confined to C. Ledgeriana only, at least until a more detailed analytical survey has been completed.

4.4 Future Development

4.4.1 Analysis of bark

The first priority should be to carry out a much more detailed survey of the quality of bark currently available. This requires setting up suitable analytical procedures.

There are three analytical procedures to be considered:-

(i) The traditional 'wet' chemistry procedure involving solvent extraction of the bark, measurement of total alkaloids by filtration, isolation of quinine and cinchonidine as tartrates and determination of the ratio of these two alkaloids by optical rotation. This gives precise results for quinine and cinchonidine and is the recognised method used commercially to determine the value of bark. It is however inconvenient, time consuming and requires a skilled and patient analyst. It also requires a minimum of about 20g of dry bark. While it would be desirable to have this capability in the laboratory associated with any proposed processing factory, it is not really suitable for a screening programme involving a large number of small samples.

(ii) High performance liquid chromatography (HPLC).

This gives quantitative data for each individual alkaloid and is therefore the most comprehensive and useful procedure. The equipment however, is rather costly.

(iii) Fluorimetry

This is a relatively quick and easy procedure involving measurement of quinine plus quinidine fluorimetrically in an extract.

This is an ideal procedure for screening a large number of trees. The ratio of quinine to quinidine is more or less constant within a particular species. Thus a factor can be established by one of the other procedures and fluorimetry used for rapid analysis of a large number of small samples.

4.4.2 Clonal Selection

The objective would be to find individual trees with high quinine yield potential. Screening procedures, based on estimates of bark weight and quinine content of bark samples have been worked out in detail elsewhere.

4.4.3 Propagation

The usual pr dures of vegetative propagation using stem or leaf cuttings are not generally very successful with C. Ledgeriana. A further problem is that only a limited number of suitable cuttings can be taken from a selected tree at any one time. Thus either a large number of selected trees have to be available or a very long timescale must elapse before plants can be produced in commercially useful quantities.

Grafting of good Ledgeriana scions onto vigorous Succicubra rootstock has been used successfully on a commercial scale, particularly in Indonesia. While this technique might ultimately prove to be valuable at Kaatoan especially as a means of regenerating older areas planted with unwanted species the same limitation of availability of sufficient high quality material in a reasonable time remain.

To overcome this problem the technique of meristem culture can be adopted. This technology has been successfully demonstrated for cinchona. In principle a single meristem, given appropriate tissue culture techniques, can give rise to up to 250,000 plants per annum. The first plants are ready for field planting about 9 months after commencement of the operation. Thus it is possible to obtain virtually unlimited supplies of plants from a single selected clone. Although not so far used commercially with cinchona similar procedures have proved highly successful with a number of other crops.

Tissue culture facilities already exist at a number of establishments in the Philippines. However it would be virtually essential to set up a facility specifically for cinchona reasonably close to the plantation. Only in this way would it be practicable to establish a reliable supply of plants on a large scale.

4.5. Summary of recommendations for Future Development of the Plantation

4.5.1 Planting Material

(1) Immediately limit new planting to C.Ledgeriana only

(2) Establish methods for routine analyses of large numbers of bark samples from individual trees

(3) Undertake a screening programme to select from the existing C.Ledgeriana stock a series of clones with high quinine content and high bark yield

(4) Establish a tissue culture facility, preferably at Malaybalay and develop meristem culture as [illegible] for the large scale propagation of selected clones

(5) Undertake planting/development programme based principally on selected clones

(6) Undertake a long term breeding programme to improve the stock with respect to yield, vigour, disease resistance and quinine content

(7) Establish and maintain a complete germplasm collection of all species, variants and cultivars available to serve long term breeding needs

4.5.2 Agronomic Research

(1) Assess benefit of more costly methods of raising and planting procedures

(2) Assess benefit of fertiliser application at all stages of growth relating this both to bark yield and quinine content

(3) Define conditions and cultural practices to minimise the impact of fungal diseases

(4) Establish economically optimum age of harvesting under Kaatoan conditions

4.5.3 Technical Assistance

If required technical assistance and training can be provided to support any of the foregoing proposals.

4.6 Use of other domestic raw materials

Consideration is given here to the possible use of other domestic raw material and by-product which would contribute towards cost savings in processing.

(a) Utilisation of wood fuel for steam generation

It is possible that the waste wood from the Cinchona trees could be utilised in the place of bunker fuel to fire the steam boiler.

A ratio of 8:1 in respect of wood to bark is found in mature Cinchona trees. Consequently for each 1,000kgs of bark harvested there is available 8,000kgs of fuel wood. Assuming this is sun dried to 18% moisture and the calorific value is estimated at 3,850 Kcals/kg[1] then heat availability = 8,000 x 3,850 = 30.8 x 10^6Kcals for every 1,000kgs bark processed.

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1. This figure has not been determined but is a conservative estimate which may be compared with other potential fuel woods such as Agoho (Casuarina Spp) rated at 4,950Kcals/kg, Kakawate (Gliricidia sepium) at 4,900Kcals/kg and Kamachile (Pithecollobium dulce) at 5,200/5,600Kcals/kg.

Both of the above suggestions for possible savings have not been proved in practice and this would need to be done. The possibilities have been ignored in financial calculations.

HEAT BALANCE FOR PROCESSING OF 1,000 KGS. CINCHONA BARK.

Units in millions kilocalories.

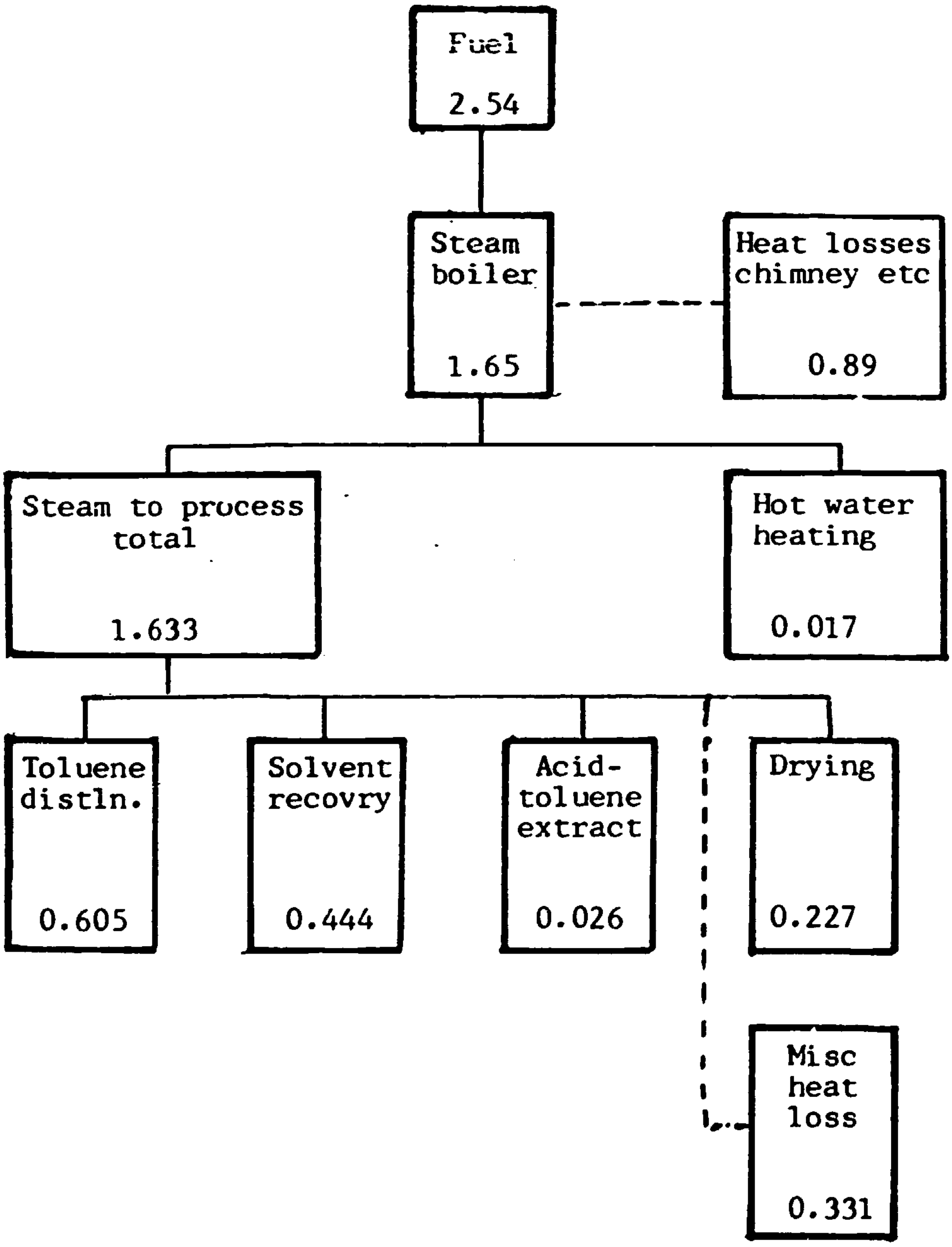


Figure 9

Comparing with the heat balance (figure 9) determined for processing (a requirement of 2.54 x 10^6Kcals per 1000kgs bark) it can be seen that only 8.25% of the wood would satisfy the need, leaving excess for possible sale as fuel wood or for other purposes. Even if it was decided to still use bunker fuel at the processing plant, the wood might in entirety be a source of income as fuel wood. No actual value could be put on the wood as fuel, the only reference being bundles of firewood (of unspecified weight) selling at P5 per bundle locally in the Lantapan area, each bundle comprising 10 pieces, each 24 inches in length. Obviously a value could be determined locally.

This wood, if suitable for fuel, could contribute to the considered need for fuel wood in the region (see Farmers Digest, Bukidnon, April 1989, article by Dr Maximino Generalao, DENR).

(b) Utilisation of spent bark (marc) as fuel and lime source

Calculations indicate a further possibility that the spent marc from extraction could also be sun dried to 18% moisture and also used as boiler fuel satisfying 50% of the fuel needs.

Additionally, the lime could be recovered in the ash and possibly also be re-used. Again this is only a speculative suggestion and the actual heat availability has only been estimated.

4.7 Inputs

This section deals with the input of
(1) Cinchona bark and use of meristem tissue culture
(2) Energy and utilities requirements
(3) Chemical additives

Labour inputs are dealt with in section 8.

4.7.1 Cinchona bark value and cost

As an input Cinchona bark is considered differently for the two situations to be investigated in financial projections.

For a processing only unit, it is assumed that the bark will be sold to the processing unit at the price it would normally be expected to command on the open market. This price depends on the quinine (SQ_2) content and the relationship of quinine to cinchonidine. From experience scales of charges fair to the processor and the grower can be suggested although most experience is with good quality barks and where the quinine level is low the value drops dramatically. There is, of course, a point where processing becomes entirely uneconomic. For the conditions of processing in the Philippines such a breakeven point will be calculated and reported later.

These prices relate to the grower selling to a processor. In the case of an integrated growing/production company either internal prices can be used or supplied at cost.

Suggested Scale of Payments to Growers based on SQ2 content of Barks (for non-integrated processing operation or on open market)

%SQ2 content of bark	% of market price of pure SQ2 (set price)	P Value of bark at SQ2 prices	
		P1520 US$ 70	P1763 US$ 80
<3.0%	not normally acceptable	0	0
3.0%	30	13.68	15.62
4.0%	31	18.85	21.53
5.0%	32	24.32	27.78
6.0%	34	31.01	35.42
7.0%	35	37.24	42.53
8.0%	37	45.00	51.39
9.0%	38	51.98	59.37
10.0%	40	60.80	69.44
11.0%	41	68.55	78.29
12.0%	43	80.26	91.66
13.0%	44	86.94	99.29

These are also represented in graphical form (figure 10). It will be observed that the curve is not entirely smooth but some what stepwise. This is to take into account to some extent known ratios of other alkaloids at various SQ2 levels. It cannot cover all eventualities and occasionally the value of an individual bark of unusual analysis might need separate evaluation.

The value of the bark should also be calculated from the aspect of cost of growing to reach an economic minimum from the growers point of view. Such is difficult to calculate for much of the initial croppings which would be used to feed the processing unit in the early years.
To evaluate the quality of a consignment of bark for sale it is necessary to sample the lots.

Bark sampling

It should be emphasized that the individual species of barks should be stored separately for analysis and even stem, branch and root preferably separated.

If the bark is to be sold to the processor it will always be necessary to execute an independent sampling by an experienced sampler and such samples need to be independently analysed.

It is general practice for the grower and purchaser to receive and analyse themselves such samples. If agreement is not observed than the sample held by the arbitrator should be analysed by an independent international analytical organisation on which, assuming the bark quality is generally satisfactory and acceptable, the final analysis is accepted by both parties. The seller may also request that even the purchasers sample be analysed by international analyst.

This procedure is rather expensive, but essential if bark is to be shipped long distances overseas.

In fact the best place to analyse the bark content is in the final acid extract (together with a check that the extracted bark contains no essential level of unextracted alkaloids). Such a process could certainly be applied in an integrated company and perhaps, even by mutual trust in case of close proximity of the buyer to seller. This method overcomes the very difficult problem of sampling the saleable material.

Processing plant only - Cinchona bark price

Pending further information on the quality of the Cinchona trees actually available from Kaatoan, assumptions were made in order to make financial projections.

Firstly, an assumption was made that the average SQ_2 of bark might reach 5%. This figure was also influenced by the fact that in other processing plants quality lower than this is rarely processed except in times of exceptionally high selling prices.

The price used for financial projections SQPRC was P24.32 per kilogram bark. On receiving the analyses performed on existing samples at Kaatoan (see section 4.2.1) a rough average content of the stand was calculated at 3% SQ_2. This figure was not used in financial projections for a processing only unit as it is clearly known to be unprofitable.

4.7.1.1 Comments on bark valuations

In reviewing various documents it became clear that some misinterpretations in the valuing of cinchona bark, and hence the value of the stand, have been recorded. This is probably due to the fact that it is not clearly understood that the value of bark depends on the quinine content and general quality of bark. Although a price per kilogram dry bark may be quoted it is usually a derived figure from the value of the quinine content or certainly relating to this.

One report recorded a price of US $25 per kilogram bark. This was derived from the 1971 sale to Lake and Cruickshank Limited which referred to the price per kilogram SQ_2 content. The bark price corresponding was US $1.75.

A more recent estimate provided indicated a sales value of P100 ($4.61) per kilogram for current harvestable bark. This again is clearly too high even for high quality bark.

In fact most of the bark might not command any sales value due to low quality.

In yet another report a price of P300 ($13.82) per kilogram was applied in projections.

Figure 10 will be helpful in assessing the likely value of any quality cinchona bark, although it is only a guideline and if selling bark the ultimate price is a subject of negotiation.

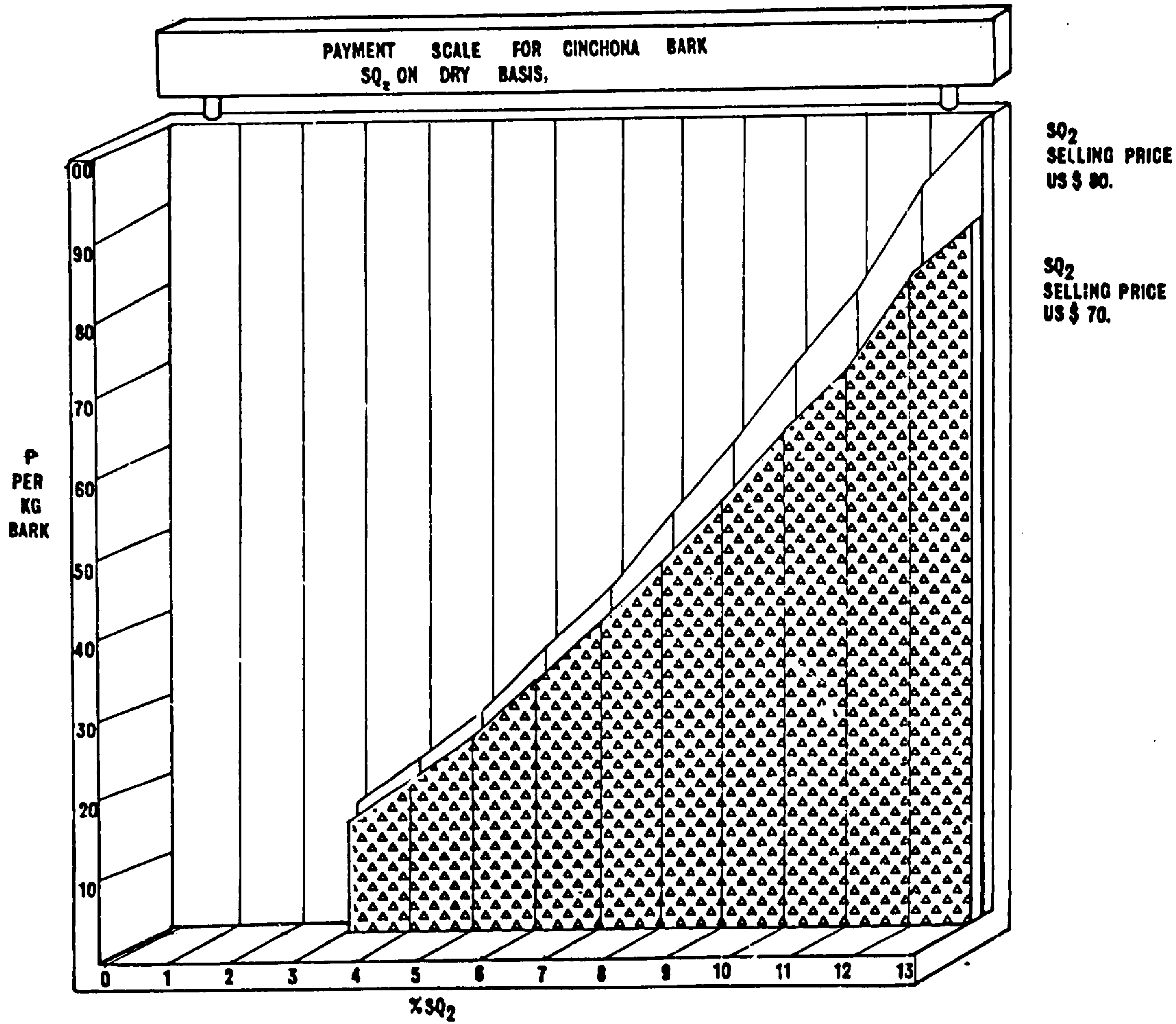
4.7.1.2 Raw material input costs for processing only unit (SQPRC 1/4)

Only 5.0% SQ_2 bark has been considered for a processing only unit.

The cost price (delivered) has been taken from figure 10, indicating a price of P 24.32 per kilogram of bark (the figure corresponding to a selling price of US $70 per kilogram for salts).

Raw material input cost for:

300 m.t. 5.0% SQ_2 bark p.a.	=	US$ 336,000
450 m.t. 5.0% SQ_2 bark p.a.	=	US$ 504,000
540 m.t. 5.0% SQ_2 bark p.a.	=	US$ 604,000



PAYMENT SCALE FOR CINCHONA BARK
SQ2 ON DRY BASIS,
SQ2
SELLING PRICE
US $ 80.
SQ2
SELLING PRICE
US $ 70.
¢
PER
KG
BARK
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
13
% SQ2

Figure 10

4.7.2 Integrated unit

In effect here the bark input is considered as the investment of the plantation and the harvesting costs and subsequent investment and overheads are charged to the integrated unit. Harvesting is essentially charged as the input cost being variable with input weight.

Re-investment in new plantation stands are treated as site development covering plant production, nursery, planting out and including plantation labour. Propagation is proposed by Meristem Tissue Culture. Under projection SQINT1 bark input is taken as 3% SQ_2 for SQINT1 and at 5% SQ_2 for SQINT2. The same plan for site development is used in both cases.

4.7.2.1 Raw material input - Integrated unit

The raw material cost, as mentioned above, for the integrated unit is considered to be the 'Harvesting cost' of the bark and delivery.

This cost includes harvesting labour, packing and drying materials, handling and delivery to the processing factory.

A cost of P 5,000 per metric ton was determined as appropriate after consulting various sources. The cost is directly related to the weight of dried bark harvested and processed and irrespective of quality.

Cost of raw material inputs for integrated unit (SQINT 1/6)

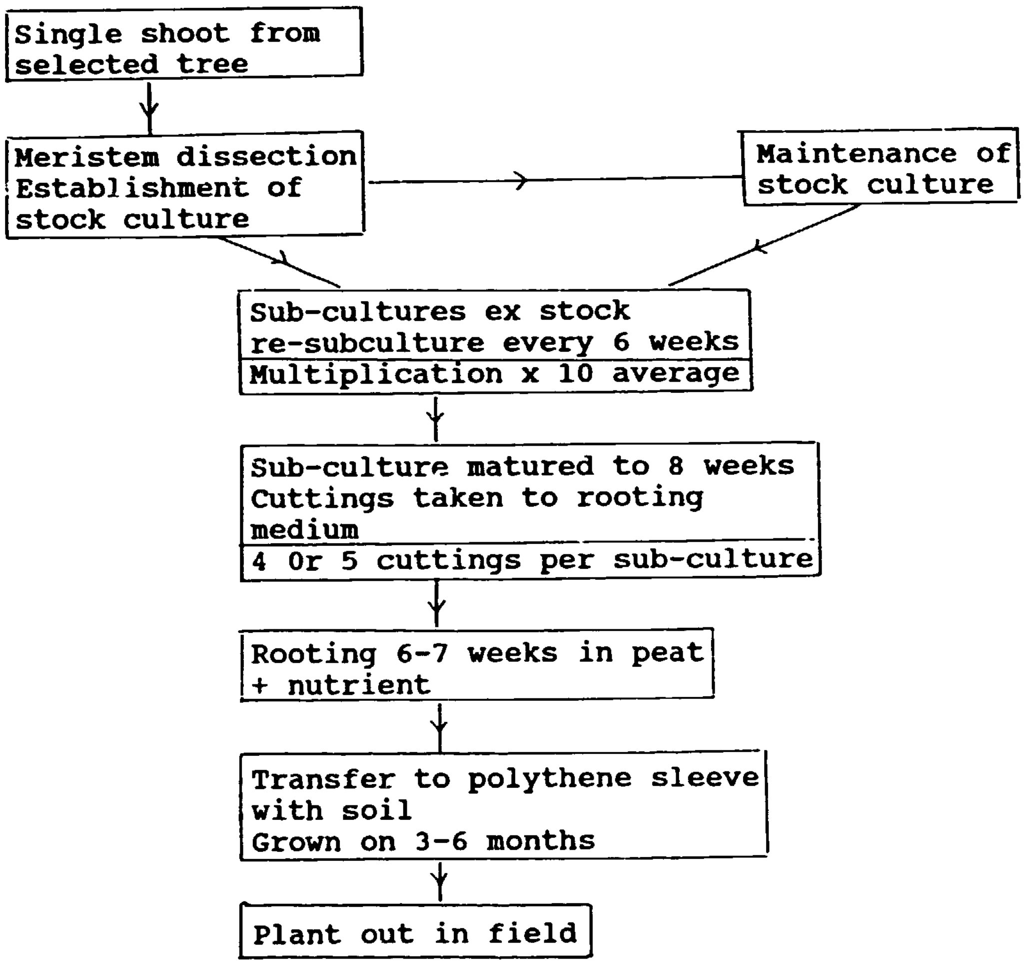
Processed volume	Input cost P	(US$)
300 m.t. p.a.	1,500,000	(69,000)
450 m.t. p.a.	2,250,000	(104,000)
540 m.t. p.a.	2,700,000	(125,000)

4.7.3 Meristem Tissue Culture

This technique will provide the most rapid means of establishing a high quality stand in the shortest possible time. In the meantime, until established planting with C. Ledgeriana seeds only should be continued.

FIGURE 11

PROPAGATION OF CINCHONA BY MERISTEM CULTURE



As a prelude to any successful tissue culture work, a programme of clonal selection will be necessary. This selection will involve not only chemical analysis but also determination of the vigour of the trees in order to select a few trees of highest quality.

Current chemical analyses results suggest also that a more extensive chemical screening of existing trees is needed before any firm commitment to processing could be considered, and both these analysis needs could be combined in one programme. In both cases analysis of about 500 trees should be adequate.

Basis of Meristem Tissue Culture

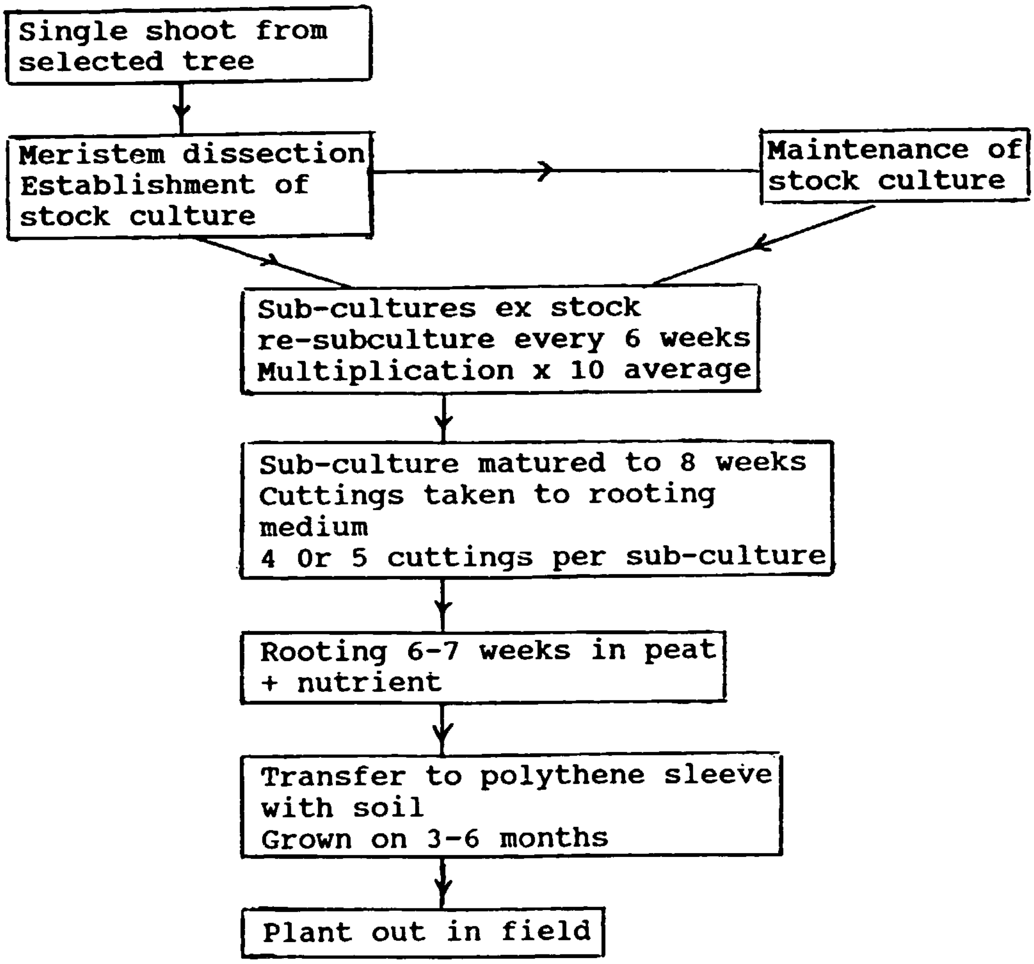
The outline is illustrated in figure 11. A small number of stock cultures are established under sterile conditions by dissection of meristems from top quality selected trees using a stereoscopic dissecting microscope and culturing in a special medium.

These cultures are then progressively sub-cultured still under sterile conditions and all growth performed in a temperature controlled room. Eight week old mature explants in the form of miniature plants with several side shoots, after removal from the medium, have several small cutting taken from each. After hormone rooting treatment, these are grown out in peat treated with a nutrient. Rooting is achieved under humidity and temperature control in a covered outside area.

After successful rooting the plants are potted up in local soil and transferred to grow on in a nursery for 3-6 months before planting in the field. Although original clones can be preserved, it would be anticipated that ongoing development for continued improvement would be carried out.

FIGURE 11

PROPAGATION OF CINCHONA BY MERISTEM CULTURE



4.7.4 Energy and Utilities Requirements

Fuel and Power

1. Electricity

Estimated installed capacity	100 KVA
Consumption per 1000 Kg bark processed	96 KWH
Consumption for other non extracting days and rest days (per day)	40 KWH

Annual Consumption :

300 MT per annum = (96 x 300) + (40 x 90) = 32,400 KWH
450 MT per annum = (96 x 450) + (40 x 75) = 46,200 KWH
540 MT per annum = (96 x 540) + (40 x 30) = 53,040 KWH

2. Fuel

a) Wood 2 m^3 per 1000 Kg bark

or

b) Bunker fuel 300 lts per 1000 Kg bark

3. Gas

Calor gas for laboratory as required

4. Water

Process water	2,526 lts per 1000 Kgs bark
Cooling water (net) (re-circulating)	60,000 lts per 1000 Kgs bark
Purified water	922 lts per 1000 Kgs bark (5%) SQ_2)

Annual Consumption Water

	300 MT	450 MT	540 MT
Cooling Water	18,000 M^3	27,000 M^3	32,400 M^3
Cooling Water (net)	1,800 M^3	2,700 M^3	3,240 M^3
Process Water	757 M^3	1,137 M^3	1,364 M^3
Purified Water	277 M^3	415 M^3	498 M^3
Total Annual Consumption	2,834 M^3	4,252 M^3	5,102 M^3
Ave. Daily Consumption	11.3 M^3	17.0 M^3	20.4 M^3

4.7.4.1 Costs of Energy and Utilities

1. Electricity

Costs : Demand charge P18 per KVA per month
Energy charge P1.3 KWH

Annual Costs

	300 MT	450 MT	540 MT
Demand	₱21,600	₱21,600	₱21,600
Energy	₱42,120	₱60,060	₱68,952
Total	₱63,720	₱81,660	₱90,552
or	$2,936	$3,763	$4,173

2. Fuels

Costs (1) Wood $18.4 per 1000 Kg bark (carriage only)
(2) Bunker fuel $36.4 per 1000 Kg bark

Annual Costs

	300 MT	450 MT	540 MT
(1) Wood	$ 5,520	$ 8,280	$ 9,936
(2) Bunker Fuel	$10,920	$16,380	$19,656

3. Gas

Calor Gas (Laboratory) - estimated $ 400

Total Fuel and Energy

Throughput	Annual cost (max)
300 MT	$14,256
450 MT	$20,543
540 MT	$24,229

4. Water

Costs

Fixed	₱	26,100
Variable	₱	2.2 per per M^3

Annual Costs

	300 MT	450 MT	540 MT
Consumed Water	₱ 32,335 $1,490	₱ 35,454 $1,634	₱ 37,324 $1.760

5. Chi led Water

	300 MT	450 MT	540 MT
Estimated cost for production	$ 759	$ 1138	$ 1326

6. Effluent Disposal

No costs for disposal established. Treatment to be performed on site and costs included in general manufacture

Total Costs US$

Energy & Fuel

	300 MT	450 MT	540 MT
Electricity	2,936	3,763	4,173
Fuel	10,920	16,380	19,656
Gas	400	400	400
	14,256	20,543	24,229
(Using Wood Free)	(8,856)	(12,443)	(14,509)

Utilities

	300 MT	450 MT	540 MT
Water/Chilled water	2,249	2,772	3,086

4.7.5. Chemical Inputs

Chemical inputs are devided into two groups and have to be extended in relation to the processing inputs.

One group of chemicals vary directly with the Cinchona bark throughput, while a second group vary with the alkaloid and quinine content.

4.7.5.1 Unit Chemical Costs

	Unit		Delivered price Malaybalay	
		P	US $	
Toluene	lt	16.40	0.7558	Imp
Lime	Kg	2.71	0.1248	Loc
Sulphuric Acid tech	Lt	14.80	0.6820	Loc
Sulphuric Acid Pure	Lt	16.20	0.7470	Loc
Carbon	Kg	45.80	2.1100	Imp
Dicalite	Kg	13.71	0.6220	Imp
Sodium Hydroxide	Kg	15.05	0.6936	Imp
Ammonia	Lt	7.50	0.3460	Imp
Hydrochloric Acid	Lt	37.20	1.7140	Imp

All chemicals are currently inported into the Philippines (with the exception of lime and sulphuric acid) and prices include duty and tax paid plus freight charges to Cagayan do Oro City.

Delivered prices include road transport to Malaybalay.

4.7.5.2 Chemical Costs - relative to throughput and quality

1. Per 1000 Kgs Bark,

Origin	Chemical	Quantity	Unit Cost US$	Total Cost Delivered Malaybalay Unit Price US$	
Import	Toluene	45 lts	0.7558	34.01	
Import	Sodium Hydroxide	70 Kgs	0.69360	48.55	
Import	Charcoal	6 Kgs	2.1100	12.66	
				95.22	sub
Local	Lime	300 Kgs	0.1248	37.44	
Local	Sulphuric Acid tech	30 Lts	0.6820	20.46	
				57.90	Sub
	Total		(62.0% foreign)	153.12	

2. Per 1000 Kgs SO_2

Import	Ammonia	183 lts	0.3460	63.30	
Import	Carbon	65 Kgs	2.0950	136.20	
Import	Dicalite	130 Kgs	0.6320	82.10	
Import	*Sodium hydroxide	350 Kgs	0.6976	242.80	
Import	*Hydrochloric Acid	182 Kgs	1.7140	312.00	
				836.40	Sub
Local pure	Sulphuric Acid	75 lts	0.7470	56.00	Sub
	Total	(93.4%	Foreign)	892.40	

* Although local material available quality is not satisfactory

Calculations are based on the chemical unit costs quoted under 4.7.5.1

Chemical production costs for different levels and qualities of bark

Chemicals input cost is based on 2 functions:-

(1) actual bark weight input, and
(2) quantity of intermediate bisulphate isolated for processing to salts.

In this latter case, the quality of intermediate bisulphate is essentially consistent at this stage of processing and the yield of finished salts from it constant. Thus for calculation purposes and ease, costs have been recorded (as above) relative to the finished salts output.

The losses which are mainly experienced relate to the first stage. Here output of intermediate bisulphate does not always relate directly to the percentage quinine content. For cinchona barks with 5 per cent SQ_2 or more output will be roughly in line with percentage content, but below 3 per cent SQ_2 the levels of other alkaloids is found generally to be relatively high and this dramatically will reduce the percentage output of intermediate quinine.

For 3 % SQ_2 bark the overall yield of salts which can be isolated corresponding to SQ_2 charged will only be 51.7% by weight

Chemical input for processing 300 m.t. of 3% SQ_2 bark yielding 4.654 m.t. SQ_2 as salts :-

1)	300 m.t. x US$ 153.12/m.t. =	US$ 45,936
2)	4.653 m.t. x US$ 892.40/m.t. =	US$ 4,153
	Total chemical input cost	US$ 50,089 (64% foreign)

Proportionately:-

Input 3% SQ_2 bark	Output SQ_2	Chemical input cost
450 m.t.	6.980 m.t.	US$ 75,134
540 m.t.	8.375 m.t.	US$ 90,159

For 5% SQ_2 bark the overall yield of salts which can be isolated corresponding to SQ_2 charged will be 85.0% by weight

Using the same calculation the chemical inputs are recorded as :-

Input 3% SQ_2 bark	Output SQ_2	Chemical input cost
300 m.t.	12.750 m.t.	US$ 57,314 (68% foreign)
450 m.t.	19.126 m.t.	US$ 85,972
540 m.t.	22.950 m.t.	US$103,166

4.8 Plant capacity

4.8.1 Extraction Plant Capacity

In the previous section the immediate and sustainable levels of raw material have been determined. The most pessimistic out-turns have been determined and will be used for economic evaluation purposes. The yields from branches have been included in the evaluationin later years (6 onwards) of processing, and could amount to an additional 15-20% weight of supply.
Thus an input for the first year of processing has been set at 300 metric tons, the subsequent 4 years at 450 metric tons each year, and then increasing to 540 metric tons per annum. Subsequent processing could be increased to 650 tons per year without any additional equipment needing to be installed. It must be pointed out that the throughout or capacity of an extraction plant is controlled by the weight of bark to be processed. The output of the plant on the other hand, is determined by the alkaloids content of the bark, and the yield of isolated quinine on the level of quinine content and its relationship to the levels of other alkaloids, especially the ratio of quinine to cinchonidine. The size of extraction plant selected is one capable of processing a maximum of 650 metric tons/700 metric tons per annum on a 250 day per year, 3 shift basis.

Although the most economical situation, it would not be proposed in the first years to operate on a full 3 shift basis, but on a 16 hours, 2 shift day. Apart from the possibility of increasing bark through put by operating on a 3 shift basis the design of the extraction building has been determined such that a second extractor, together with associated condensing system could be readily installed at minimal expenditure, but for any level above 450-500 metric tons per annum an early decision would need to be taken regarding the Cinchona planting program.

4.8.1.1 Extraction yields

As previously indicated, production level is described as throughput of bark but output is governed by the quality of the bark. The output is determined by the quinine content of the bark and the yields of (1) extraction, (2) isolation and refining, and (3) salts production.

The extraction yield is considered here being variable with both total alkaloid content of the bark and the quinine content of the bark. This is due to the fact that within finite time all alkaloids cannot be extracted from the bark and an essentially constant weight of residual alkaloids remains in the marc for each charge. This residue contains essentially the same ratio of alkaloids as the original bark. The effect on the quinine yield is illustrated in the table below based on some typical bark analyses and the overall picture is depicted in the graph (figure 12) reported in terms of SQ_2 which is the content of economic importance.

Effect of different bark contents on extraction yield

Bark content		Extraction					
TAA content	SQ_2 content	TAA in charge	TAA loss	TAA yield %	QAA in charge	QAA loss	QAA (or yield % SQ_2)
13.5%	12%	135	2	98.5	99.4	1.78	98.2
8.7%	6%	77	2	97.4	49.7	1.56	97.2
5.0%	3%	55	2	96.4	24.9	1.09	95.2

N.B. These figures are based only on C. Ledgeriana barks where the ratios of other alkaloids are relatively low. In the case, for example, of C Succirubra which might have a content of TAA 8.75%$SQ_2$2.63% the actual extraction efficiency relative quinine would be higher at 97.7% because most material left behind would be other alkaloids. The large losses occur at the next stage.

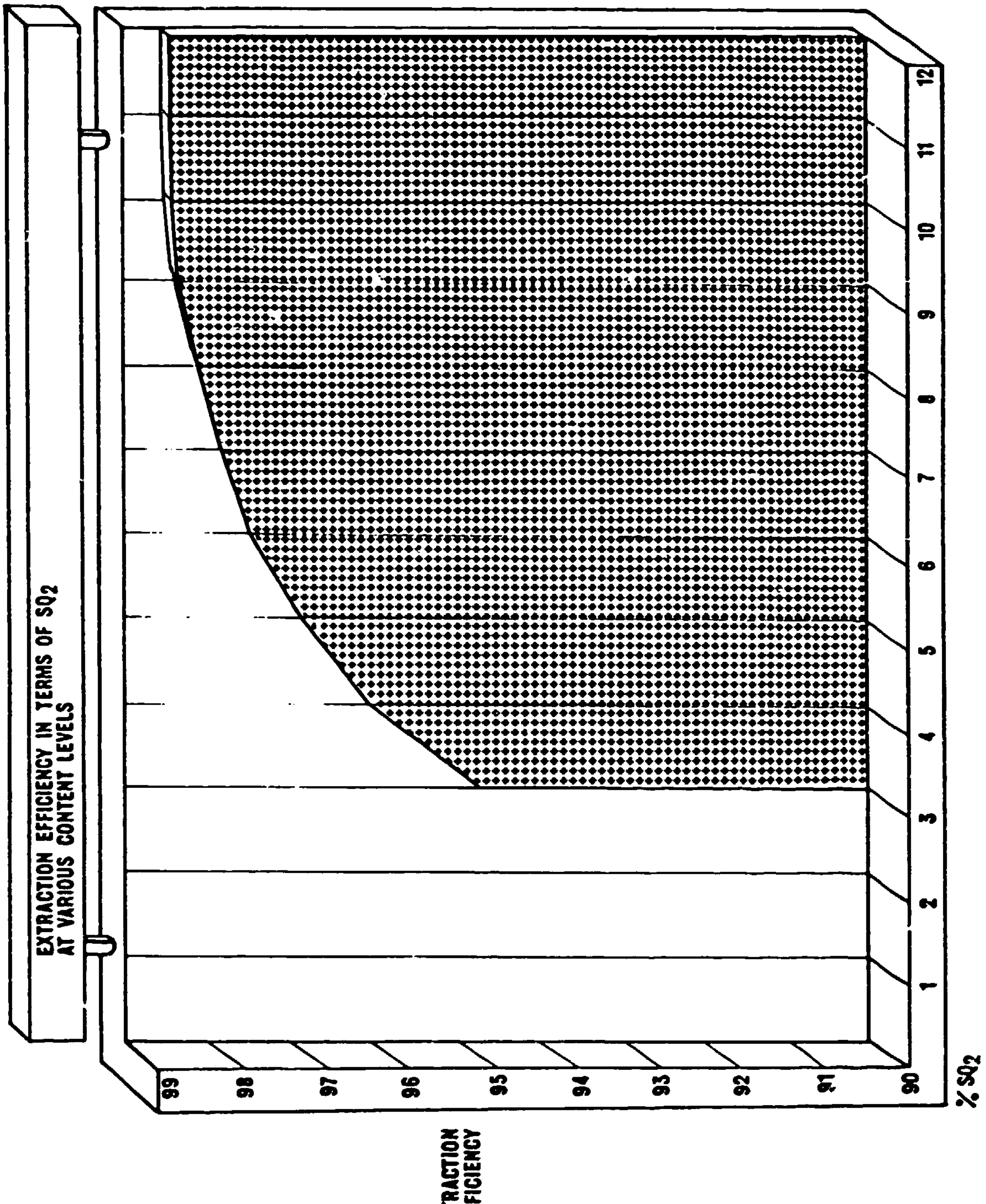

EXTRACTION EFFICIENCY IN TERMS OF SO_2
AT VARIOUS CONTENT LEVELS
EXTRACTION EFFICIENCY
99
98
97
96
95
94
93
92
91
90
1
2
3
4
5
6
7
8
9
10
11
12
% SO_2

Figure 12

4.8.2 Refining Plant Capacity

The refining section of the processing plant is determined partly by the level of total alkaloids in the bark, partly by the level of quinine in the bark and finally the actual mode of refining employed for isolation of pure quinine. A level of flexibility can be built into the plant design as is necessary for a possible variable input feed.

The first intention will be to isolate a large proportion of essentially pure quinine together with a lower quality mixture of Cinchona alkaloids.

Quinine is marketed normally as quinine sulphate (40%), quinine hydrochloride (40%), quinine alkaloid (10%) and others, principally quinine bisulphate, quinine dihydrochloride and small quantities of quinine ethyl carbonate ("tasteless quinine") excluding any as raw material for quinidine production. This can be in the form of "technical" quinine bisulphate, quinine sulphate or quinine alkaloid depending on the manufacturers choice. For in house production undried technical quinine bisulphate is the input material of choice but is inappropriate as a sales product.

It is not recommended to prepare a full spectrum of quinine salts, certainly until a higher level of quinine production materialises

The choice is to produce a high quality quinine bisulphate and a pure (BP, USP) quinine sulphate. and quinine hydrochloride. Dihydrochloride could be incorporated for domestic injectable material if desired as levels forecast for use in the malarial program are not high.

In addition some production will result of mixture of quinine, cinchonine, cinchonidine and quinidine which may be considered of essentially no value. Consideration could be given to utilisation of this as a "poor man's quinine" to alleviate suffering in the very poor, if indeed any shortage does exist.

4.8.2.1 Refining and salts yields

The final yield of quinine salts is determined by three individual yields.

1) Acid extraction efficiency yield
2) Yield of isolated processable quinine bisulphate
3) Yield of salts from quinine bisulphate

1) The acid extraction yield is essentially 100%. Some acid extract will always be entrained in the toluene layer but this toluene is re-used for extraction of a subsequent charge and recovered in this manner.

2) This is the most crucial stage and that at which most "losses" occur. The overall isolated yield is dependent on the quality of the input bark, especially the relationship of quinine to cinchonidine. The larger the quantity of cinchonidine the lower is the isolated yield of quinine which may be realised. There is no easy formula available to determine what yield is achievable, but experience indicates that for barks of 5%SQ_2 or more the realisable yield of quinine bisulphate will be in the order of 85-88%, when the ratio of quinine:cinchonidine does not exceed about 4:1. In contrast, a bark of only 3%SQ_2 and ratio of quinine to cinchonidine of 2:1 might only produce isolated quinine in a yield of 51.7%. Quality is very crucial.

3) The yield of salts from intermediate bisulphate is consistent subject to the quality of the intermediate and records at 98% calculated in terms of SQ_2. In the case of quinine sulphate this is a direct yield, but in the case of quinine hydrochloride involves a re-cycle of alkaloid, the direct yield being in the order of 70%.

4.8.3 Future processing of quinine

4.8.3.1 Pharmaceutical preparations

The proposal considers only the production of bulk quinine salts. Processing could be taken further by either making pharmaceutical preparations of quinine as tablets or injectable solutions, or by chemical conversion to quinidine. The former has not been included, as firstly the volume is not high and it is debatable whether it would be worth the investment involved. In any event, there is an adequate capacity, certainly for tabletting and also probably for the volume of injectables which might be considered, available at existing pharmaceutical houses in the Philippines. Finished preparations could be made on a custom basis.

4.8.3.2 Quinidine

Although the main area of expansion for the sale or utilisation of Quinine is in the field of chemically processing quinine to quinidine it is not recommended that such should be considered in the initial phase of utilising Cinchona bark. In the first place the level of available quinine suitable for conversion would be rather low to justify the investment and technology cost. Secondly, experience in the field of processing Cinchona should be done in a progressive manner so as not to overextend the capabilities of the plant personnel who will be quite new to this technology. It might, in fact, be best not to set up a dedicated unit for this conversion but to consider it as a production for a multipurpose chemical plant.

4.9 Production Programme

Production programmes are based principally on the throughput of Cinchona bark and this is governed by availability. The detailed work programme in the refining section depends upon the quinine content of the bark and that for salts production is drawn up on the basis of the quantity of quinine bisulphate isolated and suitable for processing.

The actual procedure adopted for the isolation of the quinine bisulphate is partly determined by the levels of the various Cinchona alkaloids.

For the first year a bark input of 300 metric tons is programmed.

No. of batches of 1.0 metric tons	=	300
Normal cycle per 2 batch	=	16 hours
From cold start for 1 batch	=	9 hours
No of working days per annum	=	240 days

For training and gaining experience it is proposed 1 batch per day be processed for a approximately 24 weeks and then start 2 shift working to process two batches per day.

During the second year a production level of 450 is proposed as appropriate to the raw material supply and could occupy the plant, on 2 shift working of 225 days.

Above 480 metric tonnes per annum it is necessary to introduce the third shift.

If resistance to 3 shift working existed then the installation of the second extractor would have to be considered for higher throughputs, but would, of course, reduce profitability as well as disrupting production during installation.

4.9.1 PRODUCTION PROGRAMME SCHEDULE

FIRST YEAR PRODUCTION SCHEDULED AT 300 MT

WEEKS	THROUGHOUT	REMARKS
1-24	120 MT	Day Shift 1 MT (1 batch) per day New Crew Start Training Week 18
25-26	Rest Period	
27-44	180 MT	2 Shift 2 MT (2 batches) per day
45-52	Rest/Training/ Additional production period	Additional production possible if branch bark harvested

Total Scheduled Annual Production 300 MT is used in Financial Calculations

SECOND YEAR PRODUCTION SCHEDULED AT 450 MT

WEEK	THROUGHOUT	REMARKS
1-24	240 MT	2 shift 2 MT (2 batches) per day
25-26	Rest Period	
27-47	210 MT	2 shift 2 MT (2 batches) per day
48-52	Rest/maintenance/ additional production	Additional production possible if branch bark harvested up to to total 480 MT.

Total Scheduled Annual Production 450 MT is used in Financial Calculations.

SUBSEQUENT PRODUCTION LEVELS

Increase of production level proposed for later years at 540 metric tonnes (indeed, anything in excess of 480 metric tonnes) per annum would involve the employment of a third shift (24 hour working).

It is considered that the level of 540 metric tonnes per annum for planning purposes might be best considered in the sixth year of production. If the branch barks were stripped and stored from the beginning of harvesting the level could probably be increased to 600 metric tonnes per annum in the 9th year but this latter variable has not been included in the financial projections.

5. Location and Site for Processing Plant

The selection of a site may be partly determined on the basis of evaluation of financial factors such as land costs, transportation costs and infrastructure costs. However, other factors have to be taken into consideration which are more of a question of judgement. Such are staff availability, attraction to the area for managerial and technical staff and housing. All such factors must be taken into account to make the most satisfactory selection.

There is, in any event, always a strong case for erection of the processing plant as close as possible to, though rarely at, the plantation site for the most significant transport costs usually relate to that of delivering the Cinchona bank.

These is an additional advantage in that necessary laboratory facilities at the processing plant can be employed for analysis work important in improving plant specie selection and development and possibly also housing any high technology tissue culture laboratories which might be considered.

A variety of possible sites for a processing plant were briefly visited, or located, from Kaatoan until Cagayan de Oro City. Installation of a processing plant at the plantation must be excluded largely in view of service and road infrastructure and the possibility of the processing unit being an independent venture from the plantation aspect.

The sites under consideration are in the vicinity of Lantapan, Malaybalay and Cagayan de Oro City the respective distances from Kaatoan being indicated in the table below.

Road mileages between potential sites and towns (in Kms)
(see location map figure 13)

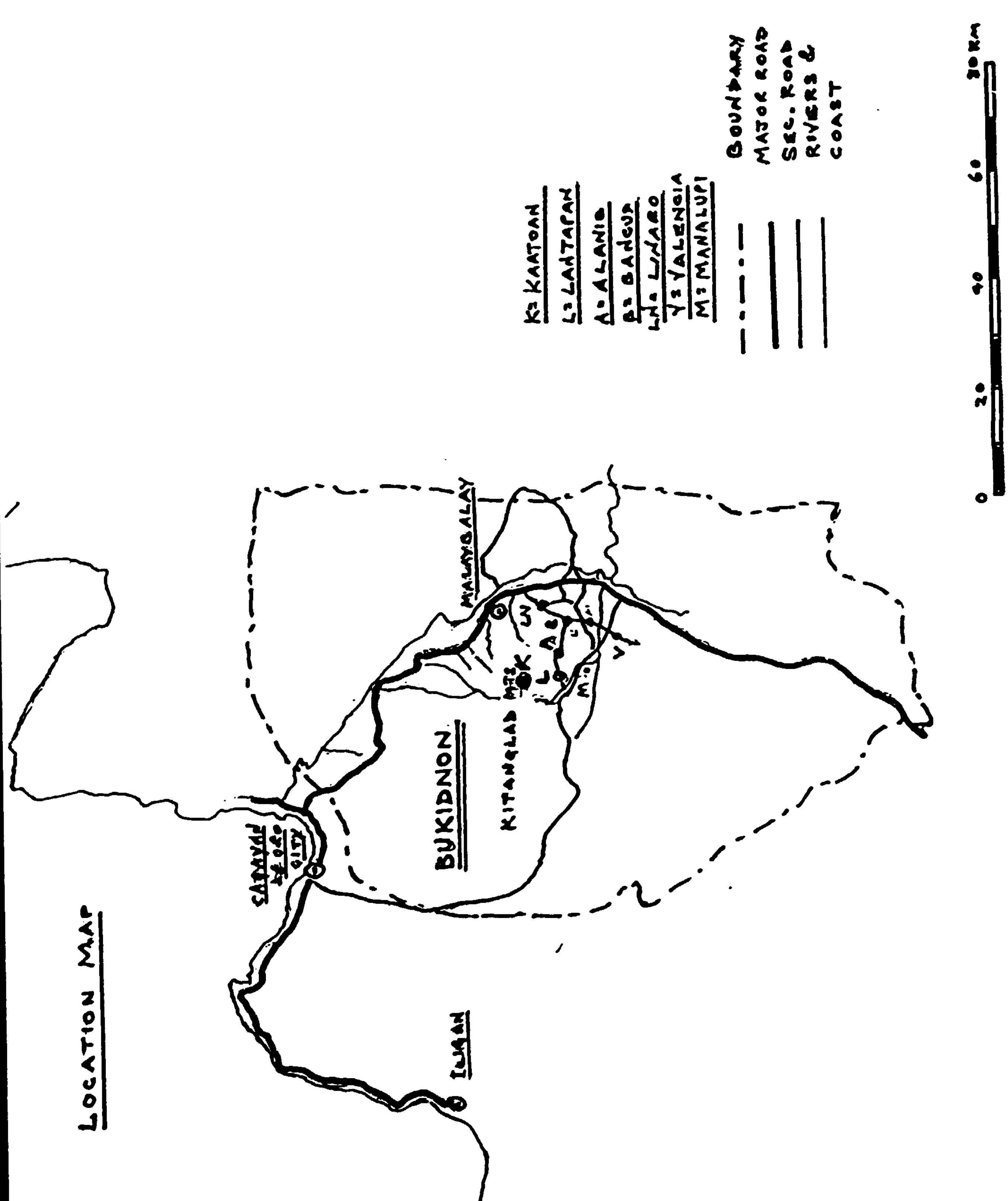

LOCATION MAP
ILIGAN
CAGAYAN DE ORO CITY
BUKIDNON
KITANGLAD MTS
MALAYBALAY
K: KAATOAN
L: LANTAPAN
A: ALANIB
B: BANGUD
L.M: LINABO
V: VALENCIA
M: MANALUPI
BOUNDARY
MAJOR ROAD
SEC. ROAD
RIVERS &
COAST
0
20
40
60
80 KM

Figure 13

	Kaatoan	Lantapan Town	Lantapan Manulupi	Lantapan Bancud	Malaybaly	Cagayan de Oro
Kaatoan	x	10	22	30	37	136
Lantapan Town	10	x	12	27	27	126
Lantapan(Manalupi)	22	12	x	13	15	117
Lantapan(Bancud)	30	27	13	x	18	117
Malaybalay	37	27	15	18	x	99
Cagayan de Oro	136	126	117	117	99	x

Note: Three (3) proposed sites in Cagayan de Oro City at (1) Cuguan (2) Baloy and (3) Agusan all in essentially same vicinity along highway. Only the areas available and land prices vary.

The distances between areas are significant for determination of transportation costs and also for possible commuting of senior and technical staff who may prefer to reside in a larger community.

Populations of the areas are: Cagayan de Oro City (320,000), Malaybalay (60,000) and Lantapan (24,000).

5.1 Factors to be taken into account in site selection.

5.1.1 Local Services and Infrastructure

Electricity is available at all sites although care would have to be taken in specification of electrical equipment as some areas are quoting a 60 cycle supply whereas Cagayan de Oro claim 50 cycles.(This is believed to be a printing error)

Water supply, although variable, exists at, or relatively close to all sites. In the Lantapan areas use of river cooling water would be considered. In any event water re-circulation and recovery equipment are included in factory equipment lists and water requirements are quite modest.

Telecommunication might be difficult at some sites but is not a serious drawback.

Road access to all sites is essentially good except that for the Lantapan sites some short access roads would need to be laid.

5.1.2 Effluent disposal

This will be dealt with in more detail under Project Engineering but the design of the plant would be such that effluent disposal should not be a problem at any of the sites considered. (see 6.9)

5.1.3 Labour availability

Labour covers a range of skills from guards, general labourers to plant operators with a reasonable education and intelligence. The latter, in particular, might be more available in the larger towns of Malaybalay and Cagayan de Oro City. The numbers required are not large and as, in any event, good training must be given in-house, such staff could be available in the Lantapan districts.

5.1.4 Managerial and technical staff

Managerial and technical staff would certainly only be available from the larger towns of Malaybalay and especially Cagayan de Oro City. Commuting from Cagayan de Oro City to sites outside of this area would not be realistic. However, commuting from Malaybalay to the Lantapan sites could be quite acceptable if such staff preferred to reside in the larger community (20-30 minutes by car)

5.1.5 Transport costs

The effect of location on transportation costs can be calculated. Those which require to be considered are:

(a) cost of bark and wood transportation from plantation to processing plant.

(b) cost of delivery of chemical raw materials and solvents

(c) cost of transportation of bulk or finished goods

(d) cost of delivery of planting out seedlings (if tissue culture established at processing unit.)

These can be summarised in the table below. (P)

	Manalupi	Bancud	Malaybalay	Cagayan de Oro Cit
Bark	107,015	170,251	180,000	661,547
Wood Fuel	70,323	111,872	118,266	434,706
Lime	34,172	83,531	94925	470,812
Chem and Solvent	231,857	235,906	196,258	-
Product	52,650	52,650	44,540	-
Total	496,017	654,210	633,989	1,567,065

Clearly with respect to transport costs siting of any unit at Cagayan de Oro suffers considerable cost disadvantage.

From this analysis Manalupi bears least cost but other factors have also to be taken into account in final site selection.

Note: For bark and wood transportation a rate of P 11 MT/KM was quoted

Delivery of chemicals and solvents are determined from the import site, Cagayan de Oro City. Product is also deemed to be delivered to Cagayan de Oro City.

Delivery of seedling is excluded from this analysis as it would be performed by factory transport.

The cost of tonnage transport was given as ₱20/ton/km. For chemicals the rate has been estimated at ₱25/ton/km and for some corrosives at P /30/ton/Km.

The material quantities are based on the annual usages of major chemicals.

Cinchona bark	450T
Cinchona wood fuel	315T
Lime	135T
Caustic Soda	12T
Toluene	18T
Sulphuric acid	30T
Ammonia	7T
Finished products	18T

*Local lime-source assumed Lantapan Town

5.1.6 <u>Site factors affecting Capital Costs</u>

There are three main factors involved here:

(1) the cost of land (and the availability for outright purchase)

(2) location relative to main roads and necessity to construct service roads (there might be some local authority assistance)

(3) costs of transporting construction materials and equipment to the site and possibly housing of construction and erection labour.

Of these considerations the cost of land can be quantified, being highest at Cagayan de Oro City at ₱100/200 per m2, ₱40/50 at Malaybalay and less at Lantapan, though here only only a lease price was obtained at ₱1,000 per hectare (20 years) p.a.

5.1.7 Local infrastructure

Sites nearer the towns, and in relationship to their sizes and development, will generally provide enhanced benefit from the points of view of local services, maintenance problems and other facilities. This can apply to general processing materials, spare parts and fabrications, transport problems and even labour and staff replacement when needed.

5.1.8 Local interest in project

This can be a significant factor in contributing to the smooth and expeditions implementation of the project.

Such interest is especially evident in the Lantapan area where the Mayor shows special interest. There is great support in general for Bukidnon by the Provincial Governor.

5.1.9 Tax advantages

This project should be eligible to be BOI(Board of Investment) registered under the Omnibus Investment Code of 1987 (Executive Order 226) and be eligible for the incentives within this order. Such incentives include from six to eight years income tax holiday, tax and duty free importation of capital equipment (until August 1992), Tax Credit on Domestic Capital Equipment (also until August 1992) and others as detailed in the order.

Additionally as the whole of Mindanao is classed as a lees developed area additional incentive to infrastructure improvement is available. Although possibly not of great significant for this project.

Such incentives should, however, really be considered only as additional benefits and any project should be a viable one excluding these if it is to be of interest to a private investor.

5.2 Site selection

Taking into account all of the factors considered, and to principally satisfy the desire for reasonable proximity to the plantation area, and at the same time the best infra structure for servicing and availability of all levels of manpower, it is proposed that the most suitable location would be in the environs of Malaybalay.

No specific sites were examined, but the requirement for one hectare will not be difficult to satisfy.

6. Technology and Project Engineering

6.1 Selection of technology

The technology is best separated into several distinct sections comprising the following groups:

(A) Production of Cinchona stands

(B) Extraction; alkaloid isolation; primary purification and salts formation.

6.1.1.

(A) Cinchona stand development

The technology of development of high quality Cinchona stands by Meristem tissue culture has been described in section 4.3.

This is the preferred technology for producing Cinchona stands of high and consistent quality and which can be attained ready for possible harvesting in the relatively short time of eight years.

The alternative methods of clonal development by seed selection or of grafting techniques suffer from inadequate availability of high quality strains and take several decades to produce any substantial high quality stands.

Although there is no knowledge of cinchona plantations already developed in this way, all the development work has been satisfactorily completed and such technology is available. Other crops propagated in this manner have been satisfactorily completed and such technology is available. Other crops propagated in this manner have been satisfactorily exploited commercially.

For financial evaluation it has been considered most appropriate to consider this aspect of Cinchona tree plantation establishment as a current investment under the heading of site development.

Capital expenditure for incorporating this unit and activity is detailed in a later section (refer 6.10.6 & 6.10.7) but amounts in total to US $153,136. This comprises US $87,040 in capital equipment and US $66,096 in pre-production costs.

The equipment items involved are listed in 6.2. This initial capital expenditure has been depreciated as part of the total initial expenditure.

The current investment listed under site development has been determined by calculation of the production cost relating to the production of the tissue culture plants and then growing on in the plantation to the point of harvesting (but as mentioned above excluding the depreciation specifically relating to the operation).

Production cost

	Foreign	Local	
	US$	P	(US$)
Variable costs			
Materials (chemicals etc.)	138,258		
Fuel, power, water - specifically for tissue culture	-	66,186	(3,050)
Transportation costs	-	43,400	(2,000)
Plantation labour costs - (refer 8.5.2)	-	1,103,922	(50,872)
Sub-total	138,258	1,213,508	(55,922)
Fixed costs			
Wages & salaries (refer 8.5.1)	-	350,228	(16,140)
Maintenance (4% cap.)	-	75,559	(3,482)
Sundries, insurance	-	147,560	(6,800)
Sub-total	-	573,347	(26,422)
Total production cost	138,258	1,786,855	(82,344)
Total (in US$)	220,602		

The above presents the basic production cost for plant production and planting out 320 hectares.

In the first year an additional expense is to be included for training.

For each of the first 5 years of planting a Royalty is imposed on the production cost.

Total inputs under 'Current investments' - site development may be summarised (costs in US$) :-

Year:	Year 1 (1992)	Years 2-5 (1993-1996)	Years 6-8 (1997-1999)
Production costs	220,602	220,602	220,602
Training expert	8,000	-	-
Royalty	16,140	16,140	-
Total charged:	244,742	236,742	220,602

Note: For the purposes of the evaluation inputs of planting annual new hectarages each of 320 has. have been only applied for the 8 years from 1992-1999 since only such bark will be processed in the production plant within the 15 year production evaluation.

6.1.2 Extraction

Four types of equipment are potentially available for the extraction of Cinchona bark.

(1) Tumbler Extractor

A rotating tumbler extractor where bark is charged to a horizontal/cylindrical vessel which slowly rotates about its horizontal axis. Such extractors have been used, usually utilising mineral oils as extractant at elevated temperature but well below boiling point. The disadvantage of this method is that very high volume of solvent to solids ratio is used resulting in very large units, requiring large electric motors, and high corresponding power consumption being necessary for processing. Thus for extraction of 1000kg bark, an extractor of capacity of some 60,000 litres may be appropriate.

Also using such a system there is considerable difficulty, in recovery of the extraction solvent. This involves considerable capital expenditure as well as locking up capital due to high volumes of solvent in process.

For the reasons stated this system is not considered appropriate especially as no greatly advantageous supply of cheap mineral oil exists in the Philippines.

(2) Continuous Rotary Extractor

The continuous solvent extractor system may also be considered. In this system treated bark is fed continuously into the extractor whereby it is carried in a series of sectorial compartments which rotate about a vertical axis. The bottom of each cell is either fitted with a hinged drainage screen which can open to discharge extracted marc or alternatively moves over a fixed screen with sections cut out for discharge. Solvent passes through the bark collecting in separate chambers from which it is pumped back onto the material being extracted in such a way that the bark is repeatedly washed/soaked and extracted counter currently with miscella of diminishing strengths and finally washed with clean solvent. Extraction is normally performed at an elevated temperature but below boiling point. Extraction time can be adjusted to suit the material being extracted by variation of the rotational speed and the position of miscella wash can also be adjusted. Extracted marc is similarly discharged continuously from the extractor and passes through a vertical desoventiser where solvent is steam stripped before final discharge. The miscella may be concentrated as necessary in vacuum operated rising and falling film evaporators before further processing or used directly.

Such a system was investigated in the laboratory of at least one manufacturer for the extraction of Cinchona bark. With some modification of the pre-treatment it was concluded that the continuous extraction technique could be applied. A very recent check indicates, however, that no such continuous plant has, in fact, been sold for processing of Cinchona bark.

As the same time a budget quotation was obtained for the smallest unit (Ø2 meter) including all pre-treatment equipment and solvent recovery from extracted marc but no after treatment of the extract. An installed cost of US$1,000,000 was indicated. In view of the fact that a continuous plant is designed for 24 hour operation, 7 days a week for maximum economics, the higher capital cost and, most importantly, that such has not been used commercially for this purpose it is proposed that such is not appropriate for any installation in the Philippines.

(3) Supercritical Gas Extraction

A third potential method has been muted for the extraction of Cinchona bark employing the technique of supercritical (high pressure) gas extraction using carbon dioxide or nitrous oxide as solvent. Such a technique, in theory, has the advantages of no environmental problems, simple recovery of solvent, favourable solvent recovery with regard to energy and, of benefit to some natural products and foodstuffs, extraction under gentle treatment and low temperature.

Such plants are operated in preparing hop extracts for use in brewing in various parts of the world and for decaffination of coffee. It has potential in making extracts of herbs, spices and essential oils. However, it is not so easily adapted to, or efficient for, extraction of alkaloids containing hydroxyl groups although there is a patent claim for its use with Cinchona. Major manufacturers were approached in Germany and Japan but they have no experience, either experimentally or commercially of the use for processing Cinchona bark.

Because of lack of information only a very rough budget estimate of the cost of such a unit could be obtained. Excluding any pre-treatment or after-treatment a typical extraction plant could cost between US$ 2.0-2.5 million.

Additionally to operate such a plant would require increased skills of operators and maintenance staff.

Such an extraction procedure is clearly excluded on high cost, and lack of commercial exploitation experience

(4) Soxhlet Type Extractor

The principle of this type of extractor is that hot solvent percolates through a bed of pre-treated bark and collects in an evaporation chamber where it is boiled and the vapour condensed to provide pure fresh hot solvent for further continuous extraction to completion. The overall process is, however, discontinuous and the extraction is a batch process.

Although this method utilises more steam energy it has the advantage of using a low charge of solvent. Often also latent heat of condensation of the solvent, toluene being preferred, can be utilised to heat other systems such as driers or spray driers.

With this system the solvent remaining in the marc at the end of extraction, after draining, is recovered in situ by steam distillation. It may also be noted that using this system it is easy to increase production capacity by adding further extraction units. Preparation of the bark for extraction both at the grinding and alkalising stages is very important but can vary for different types of extractor. For example when performing tests on the rotary extractor it was found that the technique used for the batch extractor had to be modified. In the case of the batch extractor extensive work has been performed in optimising pre-treatment and it has been exploited commercially.

The capital expenditure for a batch, extraction unit is also considerably less than for the previous extractors considered. The comparable price for the extraction section can be abstracted from the costs detailed later at some US$ 720,000. To install a second extractor (at 1989 prices) would cost an additional US$ 500,000.

This form of extraction plant is recommended for the Philippine project in view of the capital cost and more particularly the extent of know-how available in optimalizing the use of such a unit. It is also a relatively simple plant to operate and requires very little maintenance.

6.1.3 Alkalcid Isolation

There are two procedures which can be used for the isolation of total alkaloids from the toluene extract.

(1) The toluene extract is partially concentrated by distillation and the residual toluene then completely removed by steam distillation. Such a process has been employed commercially but has the disadvantage of prolonged heating at high temperature and possibility of localised overheating as alkaloids and impurities separate from the resulting aqueous medium and there is danger of loss by degradation.

The slurry has then to be dropped into sulphuric acid to dissolve the alkaloids. Insoluble impurities may be filtered off. Additionally if filtration of small particles of bark, which almost inevitably pass through into the toluene extract, is not efficient the action of the sulphuric acid on them produces undesirable, very coloured impurities.

(2) The second method, and by far superior, is to extract the alkaloids directly from warm toluene. The process is rapid and efficient. Separations are good providing too much energy is not employed. Again it is important to remove any bark particles which could contribute to some separation difficulties. This is a greater problem, perhaps, than the likelihood of leaching out colour.

This is the method of choice and can be operated on either a batch or continuous process.

A system is available for continuous extraction but in the initial years particularly the input of bark quality is likely to be rather variable and it is therefore proposed that a batch extraction with acid should be employed when analytical control of the extract output can be more readily achieved.

6.1.4 Primary purification

The precise procedure may have to be varied if low quality bark is processed.

The object is to isolate quinine at a purity of 95-98% which involves stripping off the other alkaloids, cinchonidine, cinchonine and quinidine representing the bulk.

Equipment to be installed can lend itself to both batch isolation which would be proposed initially, or adapted to a semi-continuous process which might be preferable at a later stage, particularly with higher quality bark.

Essentially pure quinine is isolated in the form of quinine bisulphate, separation being proposed by rotary vacuum filters.

6.1.4.1 Residual alkaloids

A residual mixture of Cinchona alkaloids may be produced from the primary isolation stage. Such residues contain quinine and, although it is possible to isolate further quantities, it is rarely economical to do so.

Similarly, other alkaloids can be isolated in essentially pure form but no market exists for them or only very rarely.

6.1.5. Salts formation

Equipment has been installed to produce the two main salts, quinine sulphate dihydrate and quinine hydrochloride. The proportions may be varied. It would also be feasible to produce pure quinine alkaloid or quinine dihydrochloride if desired.

Quinine sulphate is prepared directly from quinine bisulphate incorporating purification and clarification processes.

Quinine hydrochloride is produced from an intermediate alkaloid prepared from the quinine bisulphate. Most care is required in removal of traces of sulphate and colour.

Centrifuging is proposed for separation of the solid products.

6.1.5.1 Drying of products

Products may be dried using various equipments. Consideration was given to spray drying, but this is only really appropriate to producing a crude dry alkaloid mixture and it is an unnecessary operation when the object is to produce final salts.

Static air driers or fluidized bed driers have both been used for drying and either are suitable. Drying is not exhaustive, but to specific moisture limits.

Sieving may be used prior to, or after drying.

6.2 Major Capital Equipment Items

(A) Tissue culture

Laboratory equipment:-	Use
Stereoscopic dissecting microscope, laminar flow hoods, autoclaves, balances, sterilising unit, ovens, water treatment, heat pumps, trolleys and racks.	Preparation of stock cultures, sub-culturing & rooting.

Nursery equipment:-	
Polythene tunnels, humidity control equipment, pumps & shading	Growing on for planting out.

(B) Process Equipments

Operation	Equipment	Use
1. Grinding Bark	Hammer mill 500 Kg/hr.	Grinding to specified limits
2. Mixing	Ribbon mixer 4 cu.m.	Alkalising and granulating bark
3. Extraction	Hot percolation 3 cu.m.	Removal of alkaloids by solvent
4. Solvent recycle and recovery	Condenser and Separator	Recovery and solvent recycle
5. Acid Extraction	Agitated vessel 3 cu.m.	Liquid-liquid extraction
6. Water and reactants supply	Tanks, agitators 1-2 cu.m.	Alkalising feed and water system
7. Extract storage	Tanks and pumps 1 cu.m.	Acid storage
8. Solvent Handling System	Tank and pump 2.5 cu.m.	Holding and feed for re-cycle deidic toluene
9. Bulk solvent storage and supply	Tank and pump 5 cu.m.	Bulk storage and supply
10. Waste bark disposal	Conveyor system 7,500 Kg/hr.	Discharge of spent marc.
11. Primary refining	2 reactors 2 Vaccuum Filters 2 filter presses 2 dissolvers 2 rubber tanks	Separator of 95/98% pure quinine salts and residue

12. Salts Formation	2 reactors 2 agitated pans 2 filter presses crystalline pans centrifuge	Preparation of pure quinine sulphate intermediate alkaloid and pure quinine hydrochloride
13. Drying and finishing	Air Drier Sieve	Drying Sieving to size

6.3 Service Equipment - Auxiliary Capital Equipment

14. Water treatment/circ	Filters, Columns, Cooling tower and tower treating water.	
15. Boiler and steam supply	Boiler Steam 100psi/120psi 2500 Kg steam/hr.	
16. Chilled Water Supply	Package unit 5 Tonnes	Batch crystallisation

6.4 Spares: repairs and maintenance: replacement

Facilities for a maintenance workshop and stores have been included in the building plan amounting to some $40m^2$.

Tools for pipe fitting will be required and also welding equipment. No necessity for a lathe is initially envisaged but tools such as vices, pipe threading and general spanners etc. are needed for fitting out. Electrical test equipment will be included. A blanket figure for these has been included at US$4,000

Laboratory equipment

Astute selection of any analytical instrument is of paramount importance with respect to reliability and maintenance service.

6.4.1 Spares

Spares should be standardised as far as design allows to minimise the necessary inventory, particularly in the case of pump and motor elements.

Spares will principally cover the following items:-

Grinder, mill	- knife replacements, filter elements
Pumps	- seal replacements, rotors, stators etc.
Motors	- brushes, replacement units
Mixers, vacuum filters, screw feeds	- bearings, seals

Spares for two years operation have been included in the initial purchases at an investment of US $68,000 subject to a ten per cent contingency (total US $74,800) (refer 6.10.4).

Assuming good planned maintenance, and regularly implemented, spares requirements over the years have been assumed to be essentially consistent. No allowance is included for years 1 and 2 of production (1992 and 1993) but thereafter from years 3 (1994) to 15 (2006) an annual input of US $26,000 has been applied.

All spares assumed as foreign purchases.

6.4.2 Repairs and maintenance and costs

Regular planned maintenance should be performed and following this procedure no overall serious, individual unexpected costs should be experienced over the production years. Although starting with newly installed units, some element is included for the first year of production under the heading of 'repairs' mainly for correction or improvement of operation. With ageing of the installation an increased level of repairs and maintenance will be necessary. The following levels are proposed:-

Year	Foreign US$	Local in US$	Total US$
1 (1992)	8,000	1,000	9,000
2 - 5 (1993-1996)	12,500	1,500	14,000
6 - 15 (1997-2006)	15,000	2,000	17,000

These figures essentially represent materials for plant, service items and buildings and any element for casual labour. Permanent maintenance labour is included within the direct labour element of production costs.

6.4.3 Replacement equipment

All major items of equipment have a normal working life in excess of 15 years and no capital replacement costs have therefore been included in the evaluation.

Allowance is made for replacement of the works vehicle every three years at a cost of US $27,000 (including contingency cost). The first vehicle is purchased during the construction period in year 1991 and subsequently replaced in years 1994, 1997, 2000 and 2003.

6.5 Plant arrangement

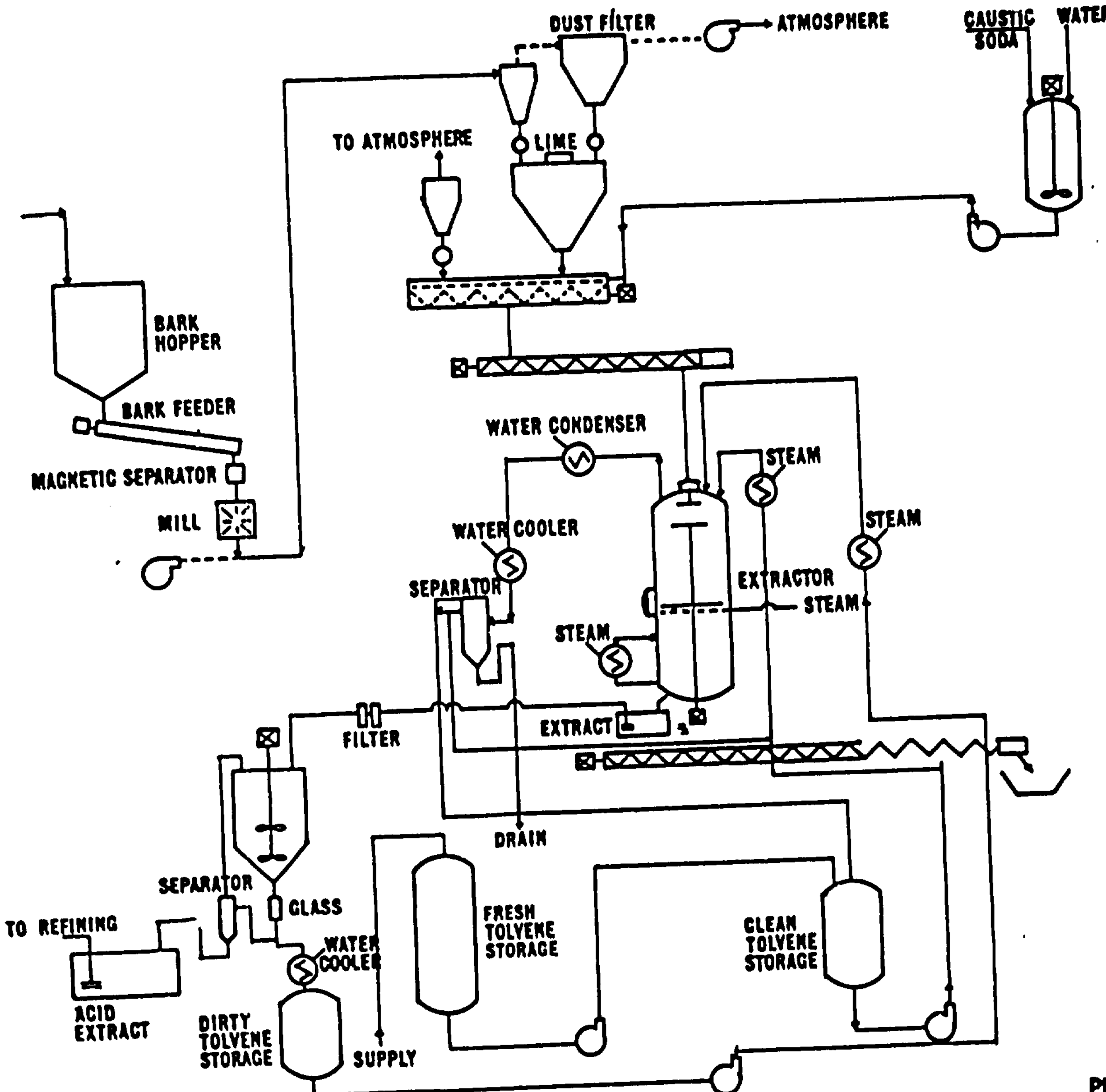
The plant arrangement suggested is based on optimal material flow and processing experience.

Bark is transferred to the 2nd floor of the milling room and milled bark transferred by vacuum to the mixer. After the mixer, material is transferred through the sealed wall by screw conveyor to the extractors in the flameproof area.

Solvent is transferred by pumping and after solvent extraction and acid extraction, the acid extract is stored. Waste marc, after steam stripping, is screw conveyed out of the building.

The acid extract is then pumped to the isolation shop. Here solutions are transferred by pumping and gravity, while solid products may be discharged by knives into mobile containers and manually transported to the salts refining shop. In this shop transfers are made by a combination of manual operations, pumping and gravity as appropriate. Purified salts are transferred to the drying, sieving and packing room where products are handled manually. Finally products are put into store.

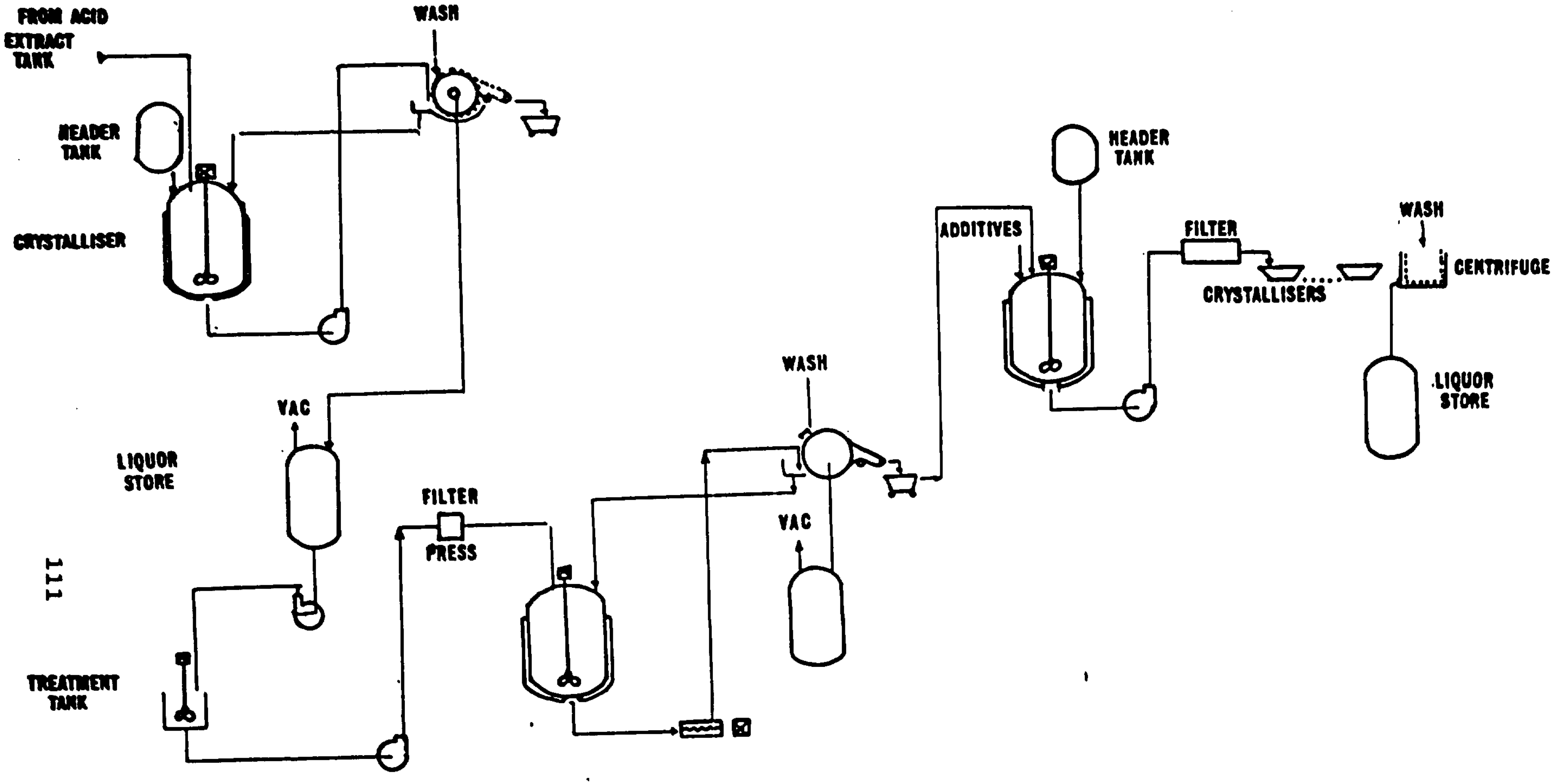
Schematic drawings indicating the major items of equipment are given in figure 14 (milling, solvent extraction, acid extraction), figure 15 (bisulphate isolation),and figure 16 (salts production).



PROCESS SCHEMATIC

QUININE EXTRACTION

Figure 14



SCHEMATIC

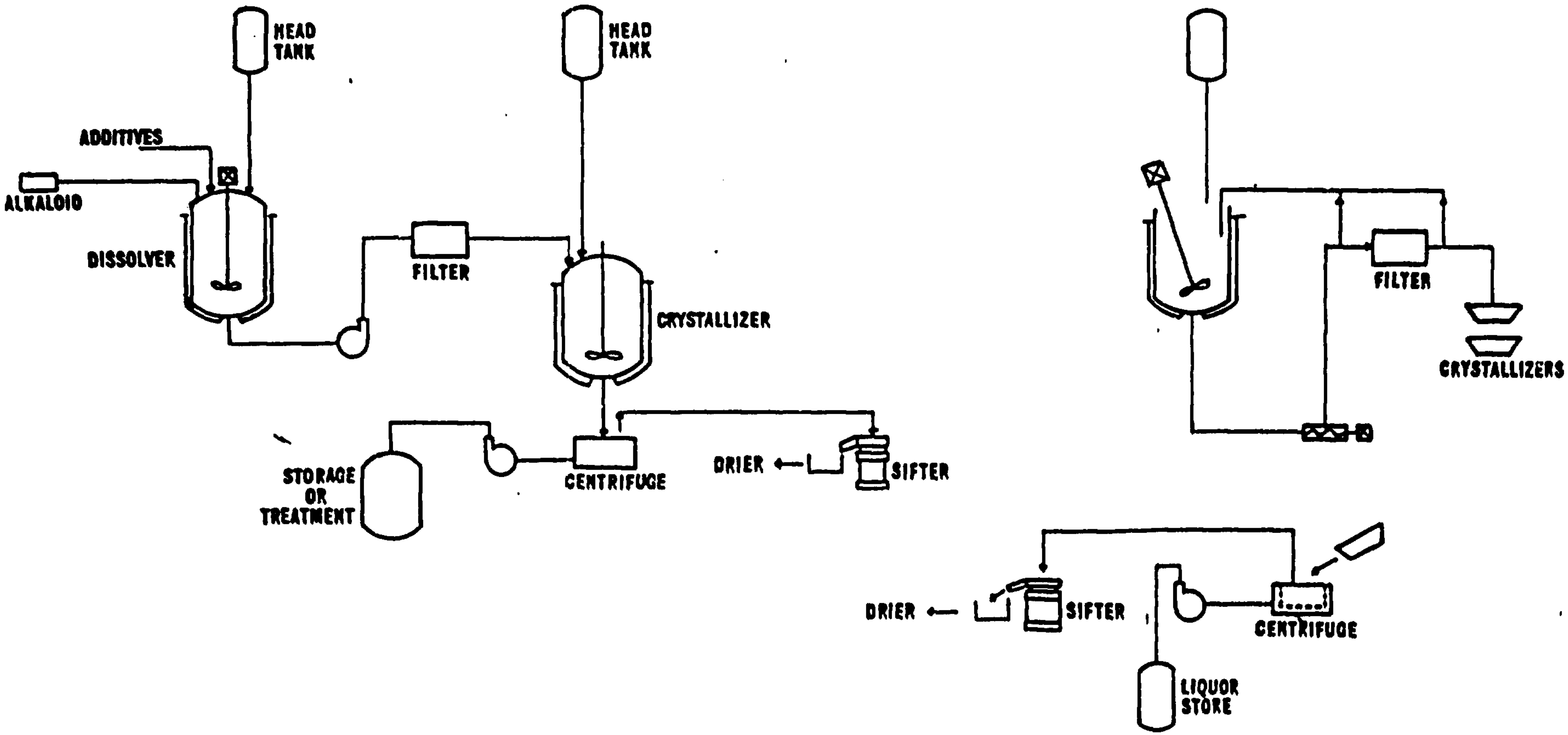
PROCESS FLOW SHEET

PRIMARY REFINING

N.B; FLOWS OF MATERIALS MAY VARY ACCORDING TO MATERIAL QUALITY.

SOME PUMPS MAY BE ELIMINATED IN DETAILED LAYOUT USING GRAVITY FLOW.

Figure 15



SCHEMATIC

<u>PROCESS FLOW SHEET</u>

<u>SALT REFINING</u>

PRINCIPALLY FOR QUININE SULPHATE
AND QUININE HYDROCHLORIDE

Figure 16

6.6 Plant layout

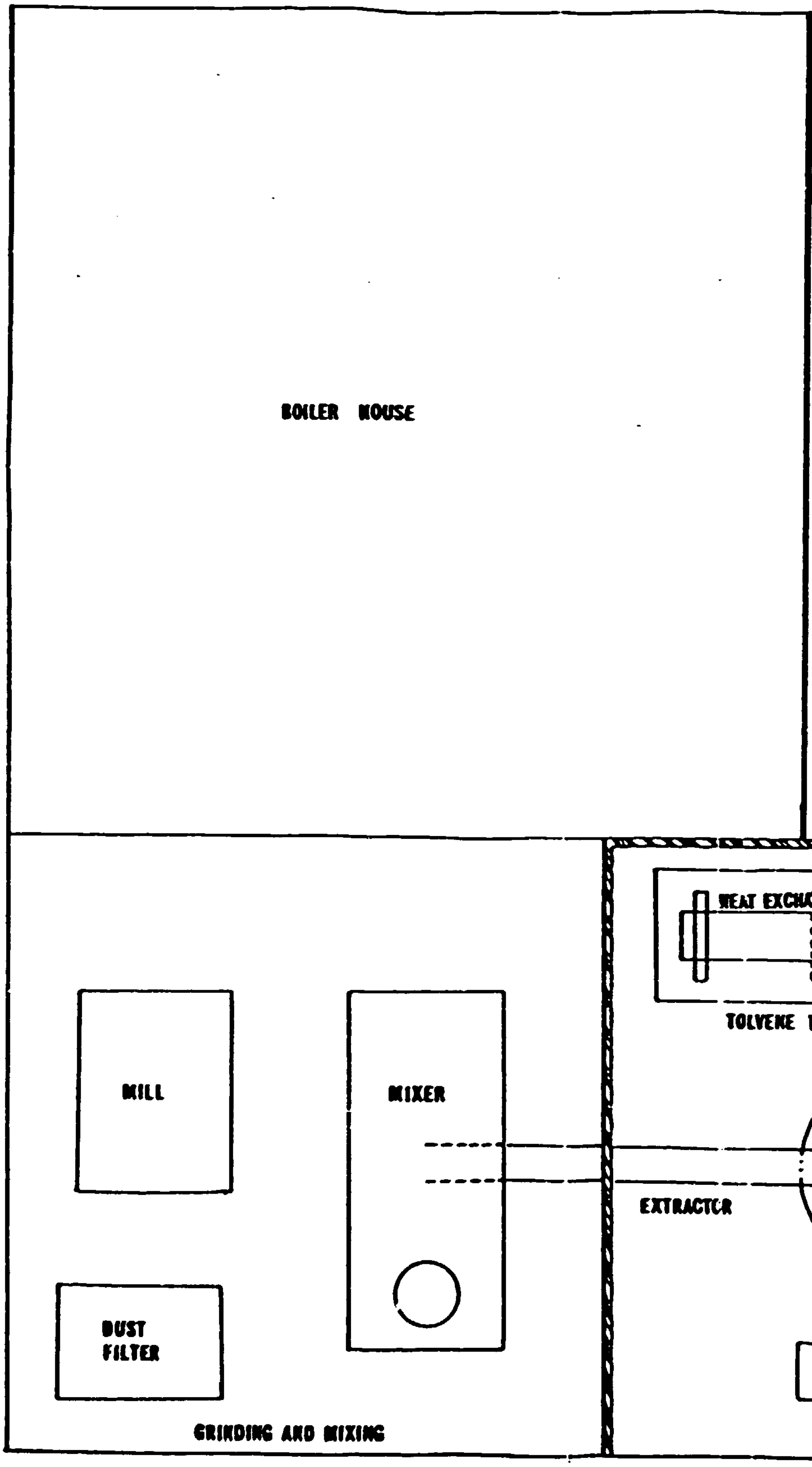
The plant layout based on the previously described flow of materials is illustrated in the plan drawings included as figures 17 and 18. The provision for installation of a second extractor in the future is included in the flameproof area.

LAY-OUT
GRINDING,
MIXING,
EXTRACTION
AND
PRIMARY REFINING
(PRINCIPAL ITEMS ONLY)

NOTE:

GRINDING/MIXING AND EXTRACTION AREAS ON 3 FLOOR LEVELS.
TANK, VESSELS, ETC. SITUATED ON DIFFERENT LEVELS BUT NOT INDICATED IN PLAN.

APPROX. SCALE:
1cm. = .6 METER



SECTION 1

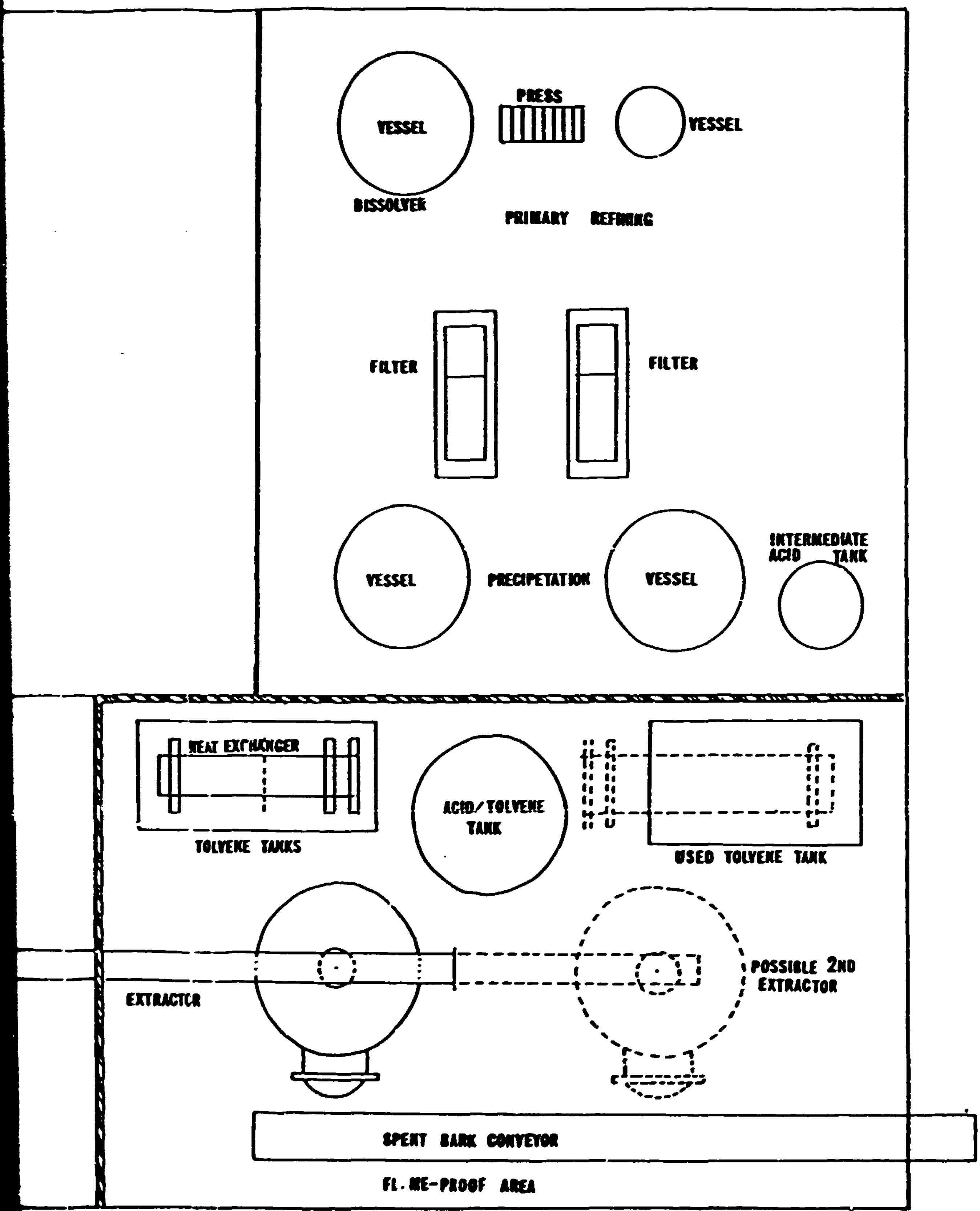
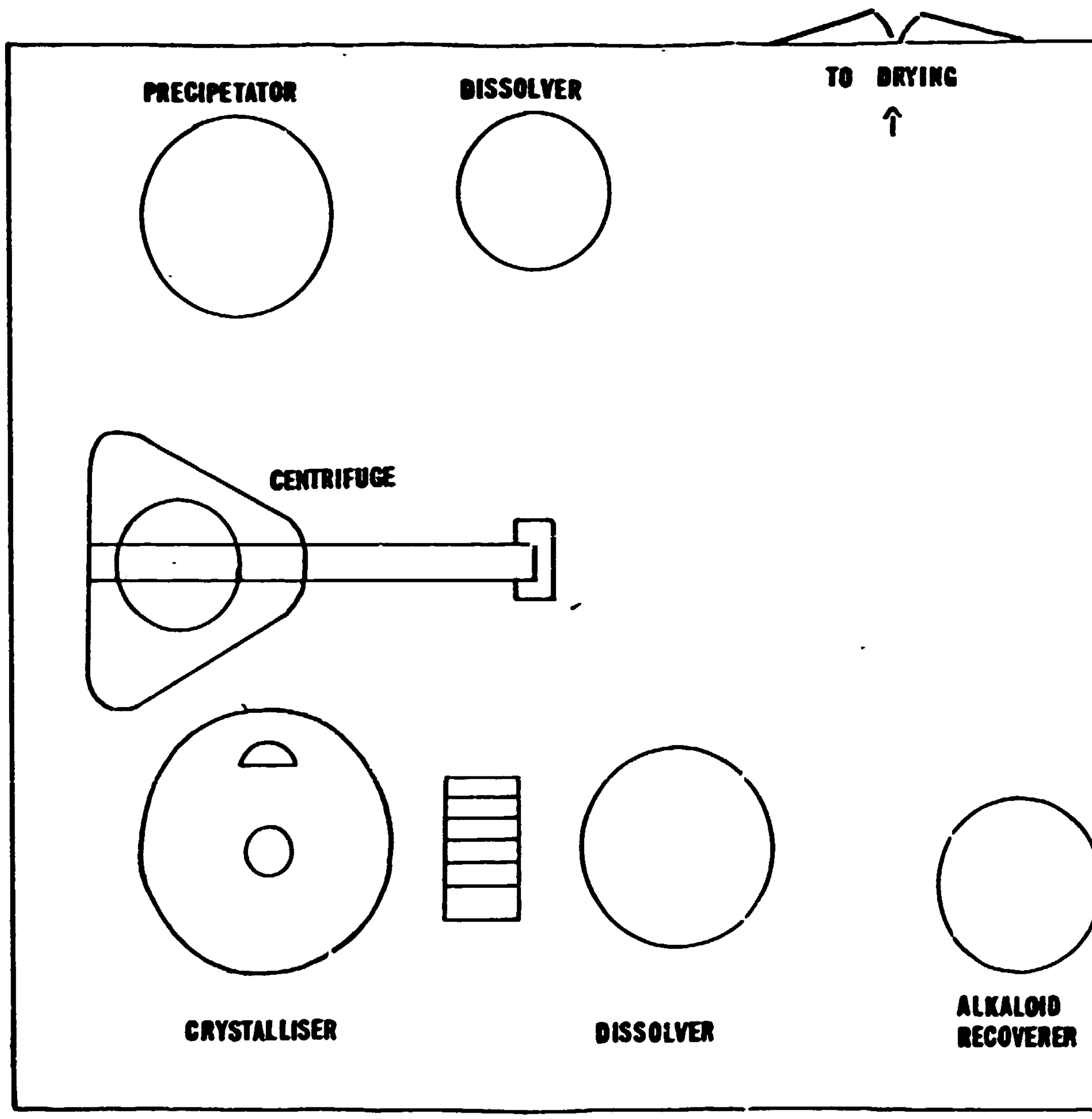


Figure 17

SECTION 2

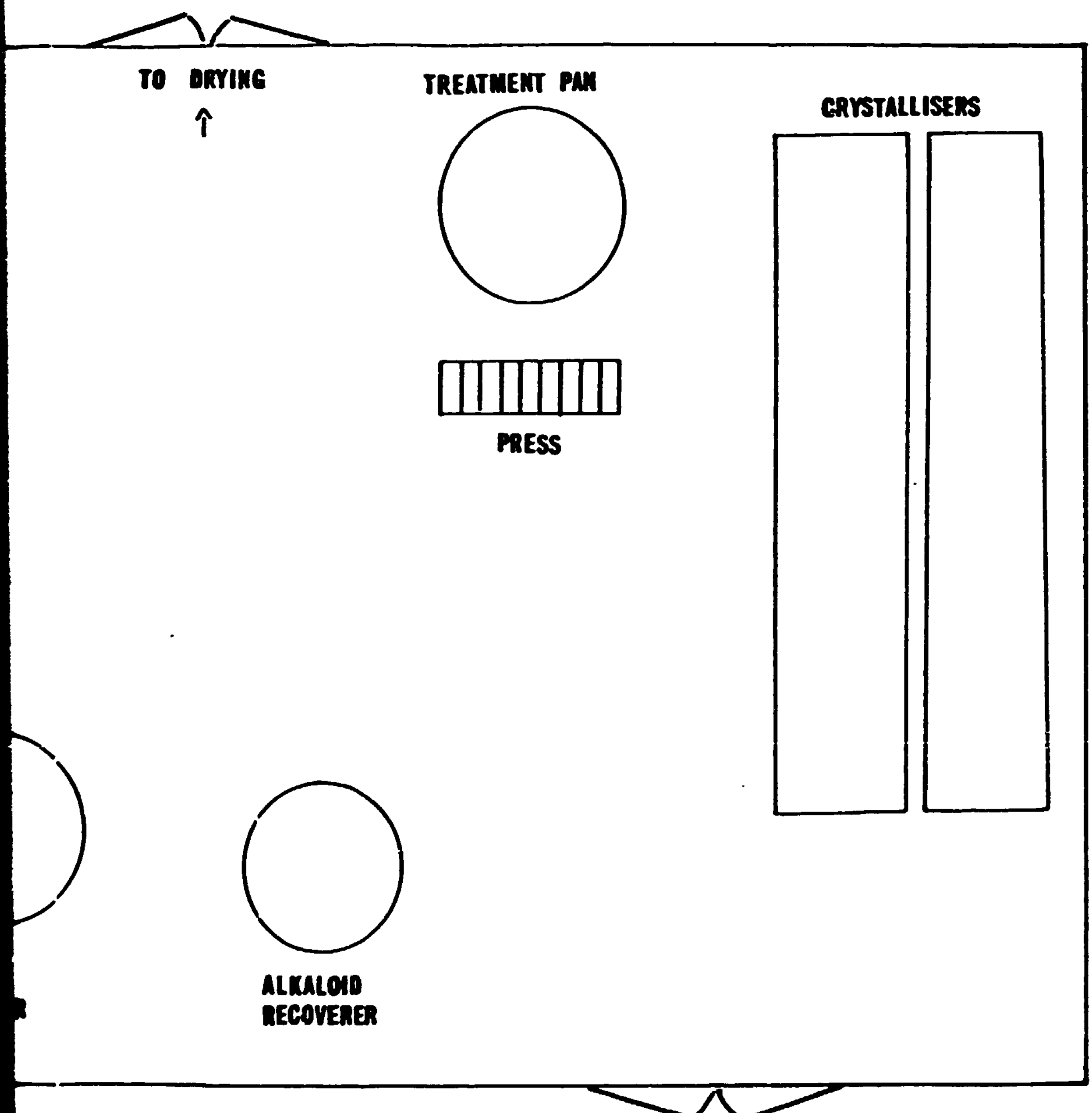
<u>REFINERY LAY-OUT</u>



SECTION 1

APPROX. SCALE: 1 cm.=.5 METER

REFINERY LAY-OUT



OX. SCALE: 1 cm. = .5 METER

SECTION 2

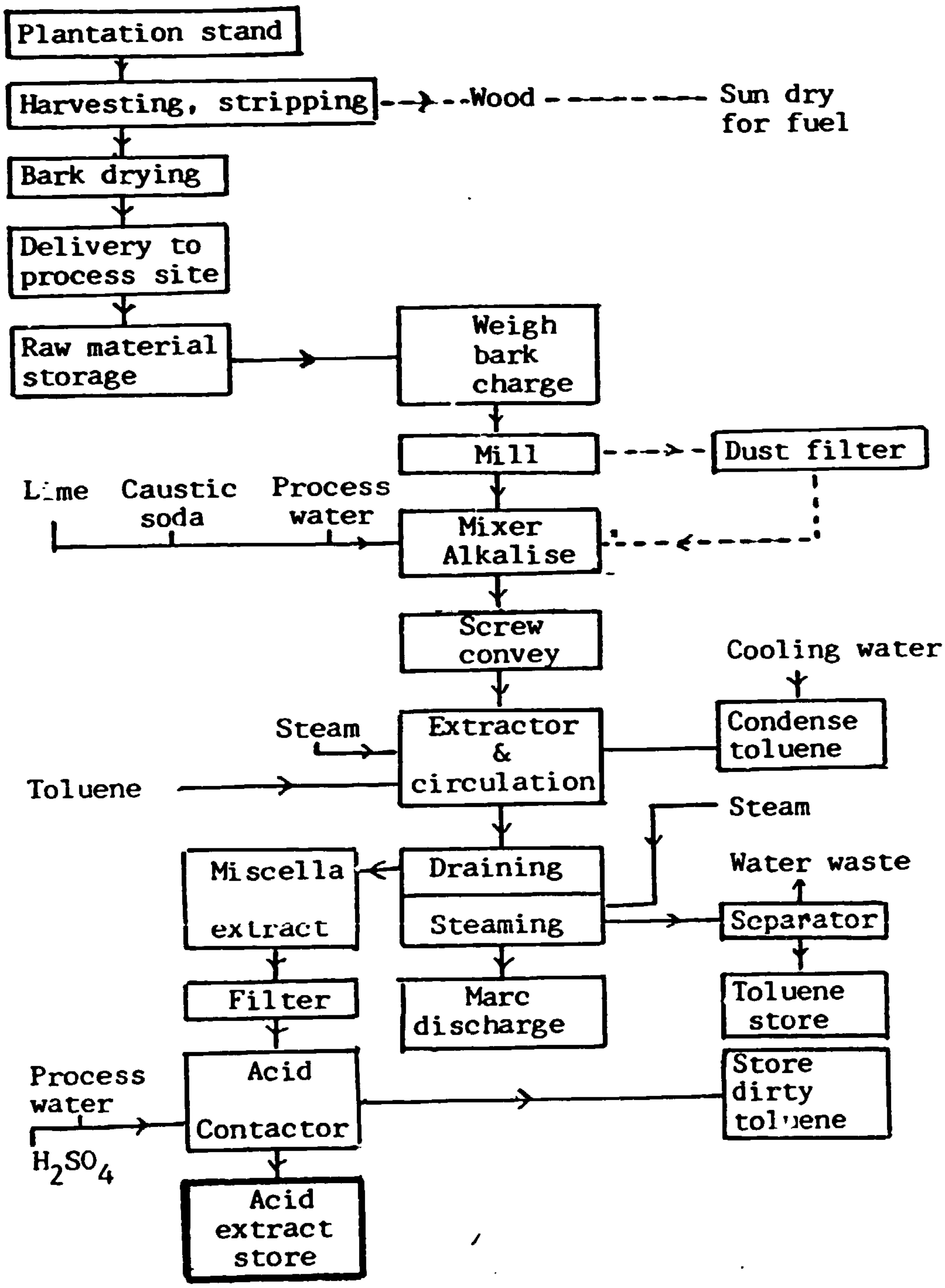
Figure 18

6.7 Process flow and material flow

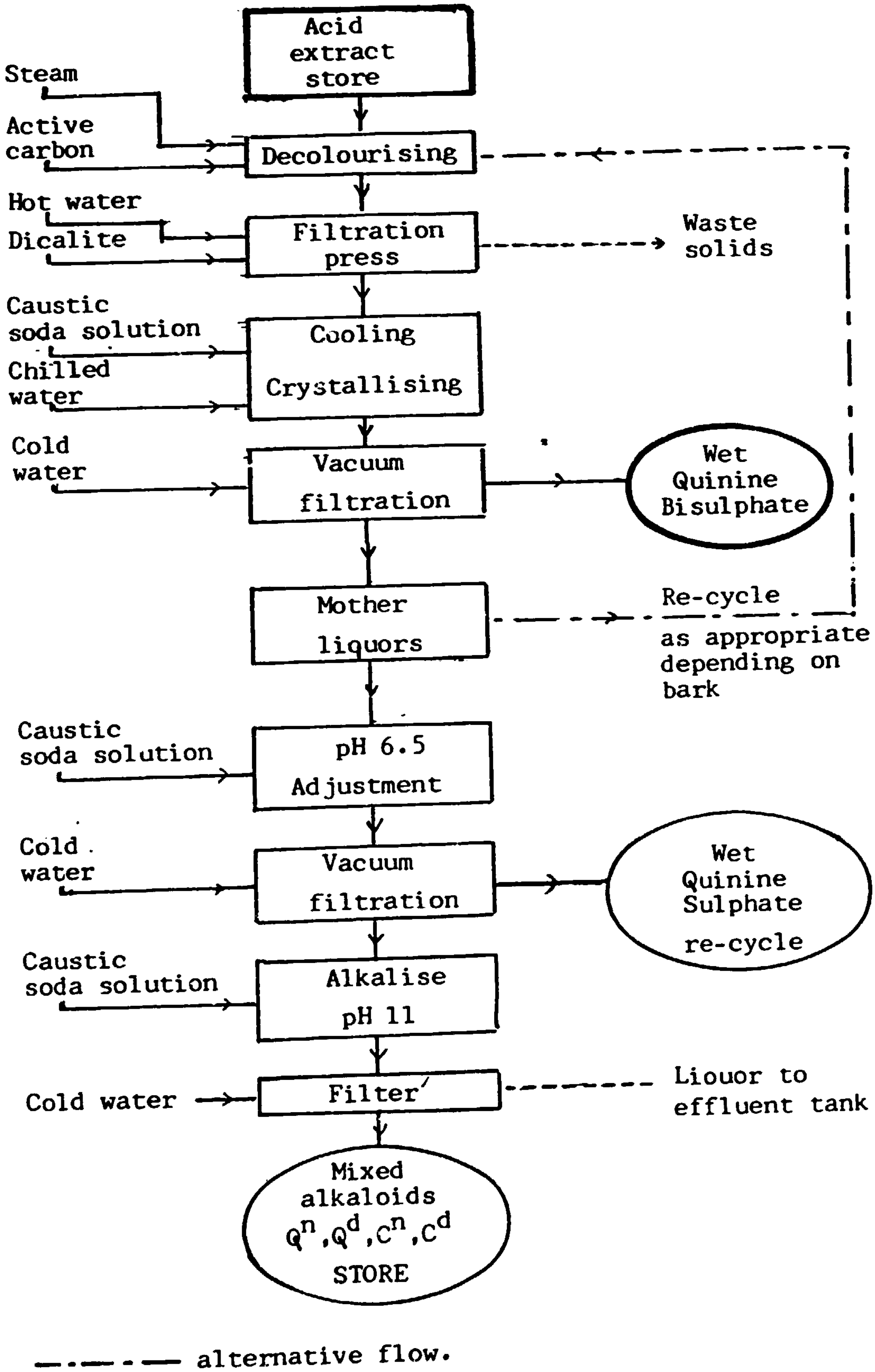
Outline process and material flow sheets are presented in the following sections followed by mass balance sheets. In the case of the latter, only those for the extraction and salt refining are given and the latter is in terms of an alkaloid balance.

The balance for isolation has been excluded because of the great variations that can occur dependent on the nature and quality of the bark extracted. The isolated yield of quinine bisulphate may vary from 55% to 92% of the quinine extracted from the bark (on SQ_2 to SQ_2 basis). The quinine representing the difference is not actually lost but builds up in residues of mixed alkaloids which are not economic to work further and produce the materials which might have some use as a cheap anti-malarial.

6.7.1 Process & material flow sheet for extraction.

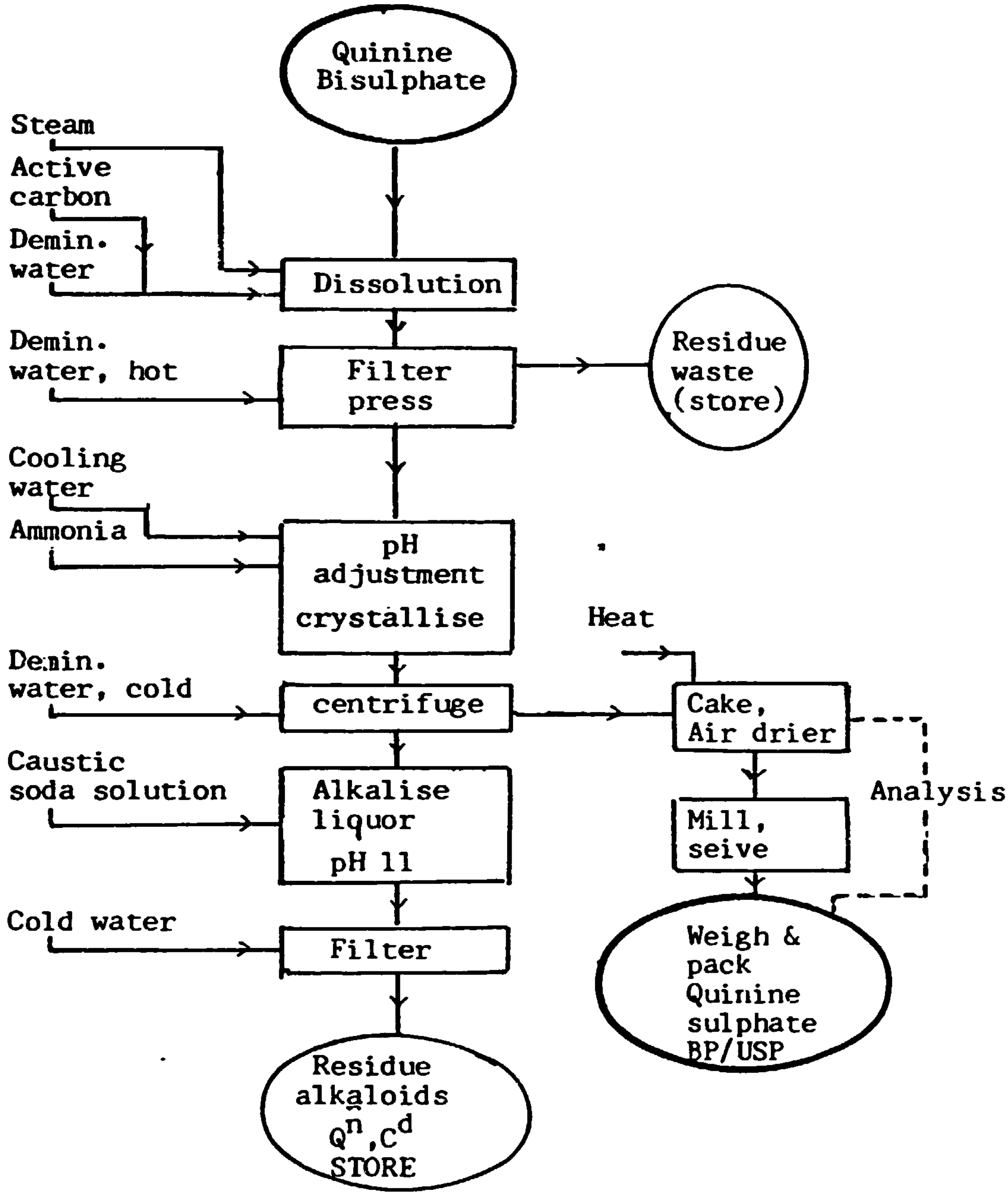


6.7.2 Process & material flow sheet for isolation.

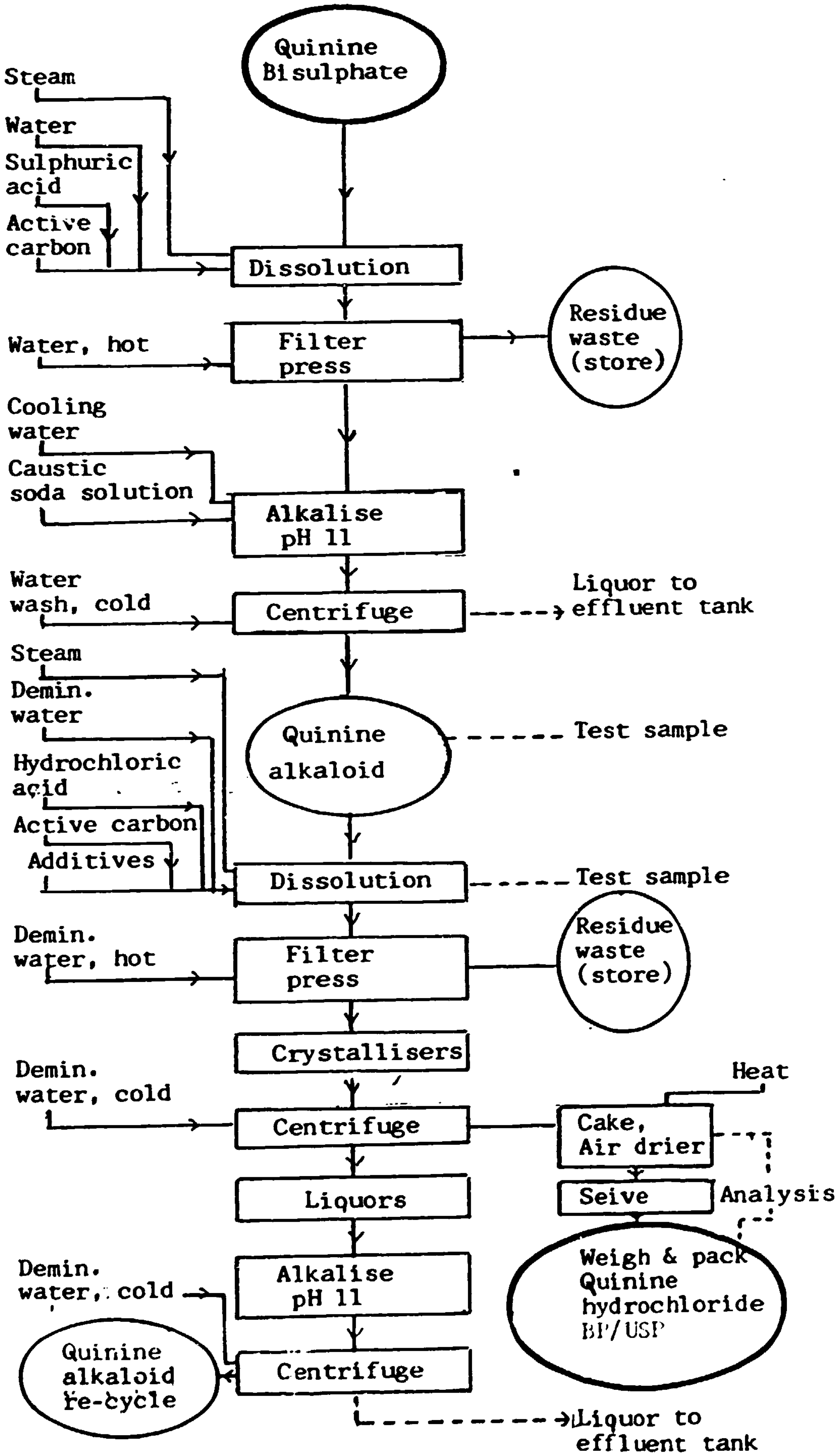


6.7.3 Process & material flow sheet for salts preparation.

(A) Quinine sulphate

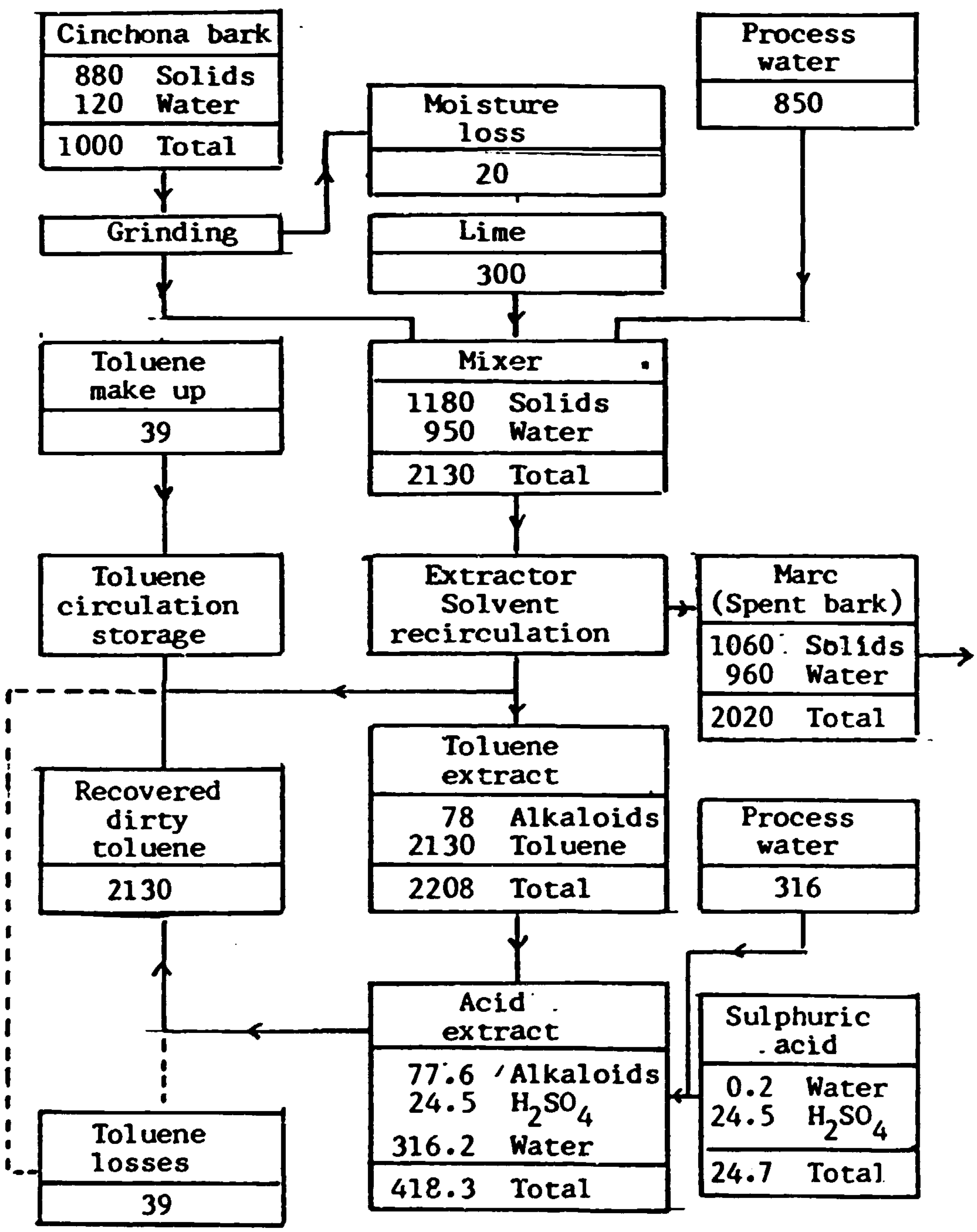


(B) Quinine hydrochloride.



6.7.4 Mass balance for extraction process.

This is an indicative mass balance for a typical bark of 8% total alkaloid content & 5% SO_2 content. In practise some quantity adjustments may be made for the dependant on the bark used. All quantities in Kg.



QUININE ALKALOID BALANCE.

Quinine alkaloid in bark	41.4
Quinine loss in marc	1.2
Quinine in toluene extract	40.2
Quinine in acid extract (ultimate)	40.1
Quinine circulating in dirty toluene	1.0

6.7.5 Mass balance for production of Quinine salts from intermediate Quinine bisulphate.

The mass balances for Quinine sulphate and Quinine hydrochloride are presented in simple form considering principally the alkaloids and ignoring in these tables the salt by-products formed in the liquors.

(A) Quinine sulphate.

Quinine bisulphate	
51.07	Quinine
2.65	Other alk.
16.25	H_2SO_4
30.00	Water
100.00	Total

Quinine sulphate	
48.67	Quinine
-	Other alk.
7.36	H_2SO_4
24.67	Water
80.04	Total

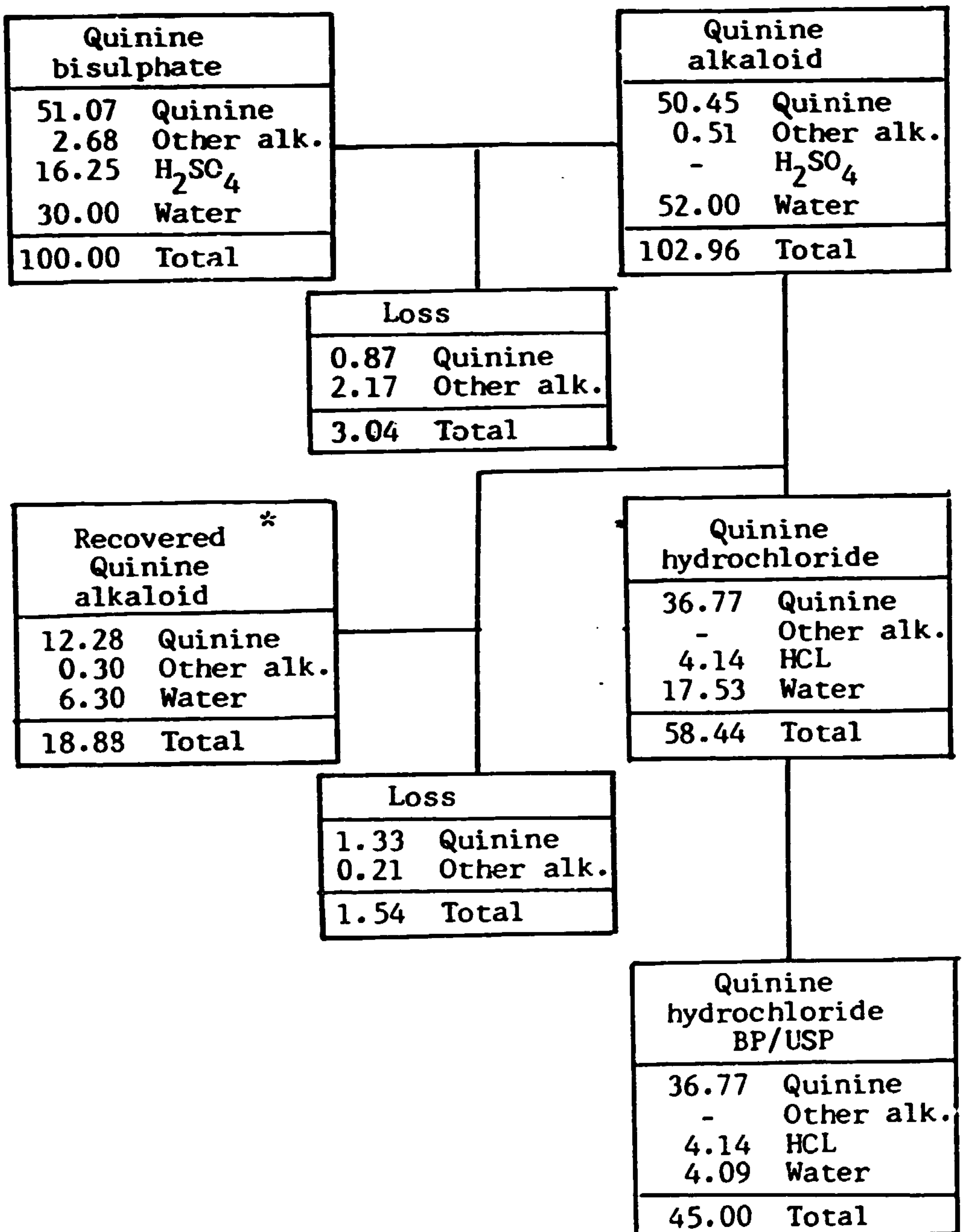
Loss	
1.33	Quinine
1.34	Other alk.
2.67	Total

Recovered alkaloids	
1.07	Quinine
1.31	Other alk.
-	H_2SO_4
3.60	Water
5.98	Total

Quinine sulphate BP/USP	
48.67	Quinine
-	Other alk.
7.36	H_2SO_4
2.70	Water
58.73	Total

OVERALL YIELD (in terms Quinine) 95.30%

(B) Quinine hydrochloride.



* Re-cycled (sometimes liquor re-cycled)

OVERALL YIELD (in terms Quinine)

Direct yield	72.00%
Overall yield	95.80%

6.8 Civil Engineering

6.8.1 General

In surveying potential sites normal soil bearing properties and water tables will need to be determined in order to specify suitable foundations. It would also be advisable to assess the possible availability of well water.

Consideration should be given to access to the site and the ease of tying in to local services of electricity, water and drainage/sewerage. A level terrain should be selected and will be serviced with internal roadways.

No special building requirements are needed and free standing structures with light weight roofs will be satisfactory.

Consideration has to be given to the extraction area which must be satisfactorily isolated from adjacent areas being of flame proof classification.

Floor specifications need close attention in view of chemical resistance in the wet processing areas and also here good drainage channels must be installed. In the dry packing area attention should be given to smooth, easily cleaned flooring.

The other aspect of flooring which needs to be considered is the load bearing for heavier pieces of equipment. Weight is not the sole criteria here, but also special attention needed for motorised units and particularly centrfuges. Clearly close liaison between the project engineering aspect and civil engineering activities is most important.

For building materials reinforced concrete and steel are suitable building materials, with either brickwork or panels for walls. Roofs of lightweight construction are preferred. Special attention should be given to the provision of large and well proportioned entry points for ingress of equipment. Also, from the point of view of installation of equipment, co-ordination of civil work and equipment installation should be well planned, as some large items may be best installed through the roof of the building. This may particularly apply in the grinding, mixing and extraction areas.

Attention must be given to lighting and ventilation.

Separate buildings are proposed for the administration, laboratories, processing unit and raw material stores and are strategically located within the site.

Site works will comprise servicing the site with electricity, water, drainage and telecommunication. The site area of one hectare should be completely fenced for security and suitable internal roads built for safe movement of chemicals, solvents and materials.

The installation of an underground solvent storage tank is proposed and also a sunken effluent treatment tank with appropriate drain connections. External plinths will be required for water storage and associated cooling tower.

6.8.2 Building specifications

1. Raw material store
A basic warehouse of $108m^2$, one storey, height 4m.

2. Office and laboratories of $360m^2$, one storey, height 3m. Apart from offices will contain chemical laboratory with store and tissue culture laboratory (4 sub-divisions, one temperature controlled). At this stage detailed layout has not been specified.

3. Processing area of $576m^2$ sub-divided into sections for different functions.

These principally comprise
(a) Grinding and mixing area of $36m^2$, 3 floors, height 13m.
(b) Extraction (flameproof) of $60m^2$, 3 floors, height 10m.
(c) Other processing and utility rooms comprising $480m^2$, one storey, height 4.5m.

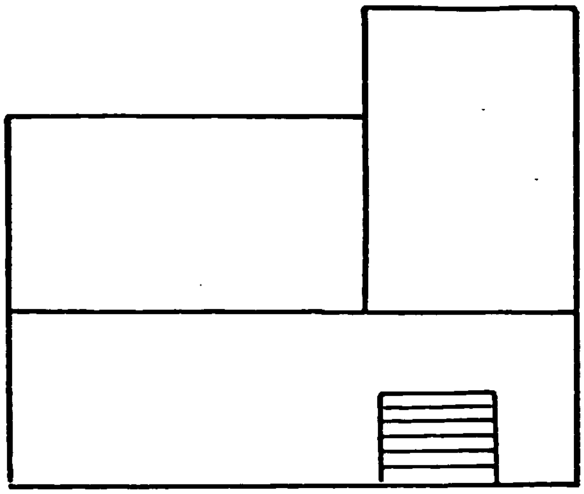
The basic building design and layout of the processing unit is shown on drawing "Extraction and Process Building" figure 19.

6.8.3 Site Layout

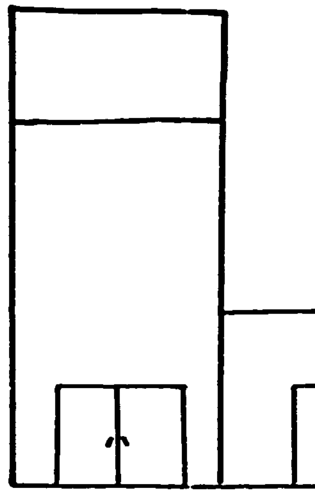
The size of site selected is based on the amount of covered area and experience of segregation of buildings for the type of industry. Some land is utilised also for nursery beds. For satisfactory delivery of raw materials and chemicals and general handling, reasonable grade metalled roadways are proposed.

The layout of the factory unit is indicated on drawing, figure 20.

EXTRACTION AND PROCESS BUI



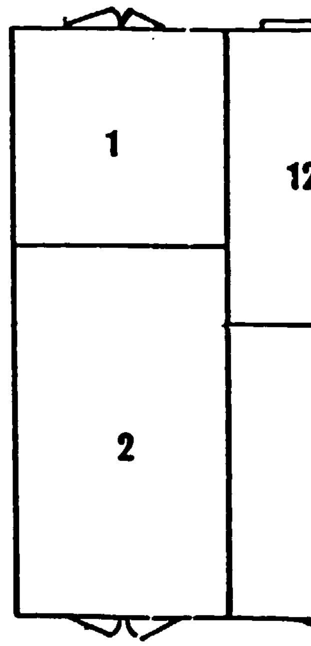
ELEVATION A



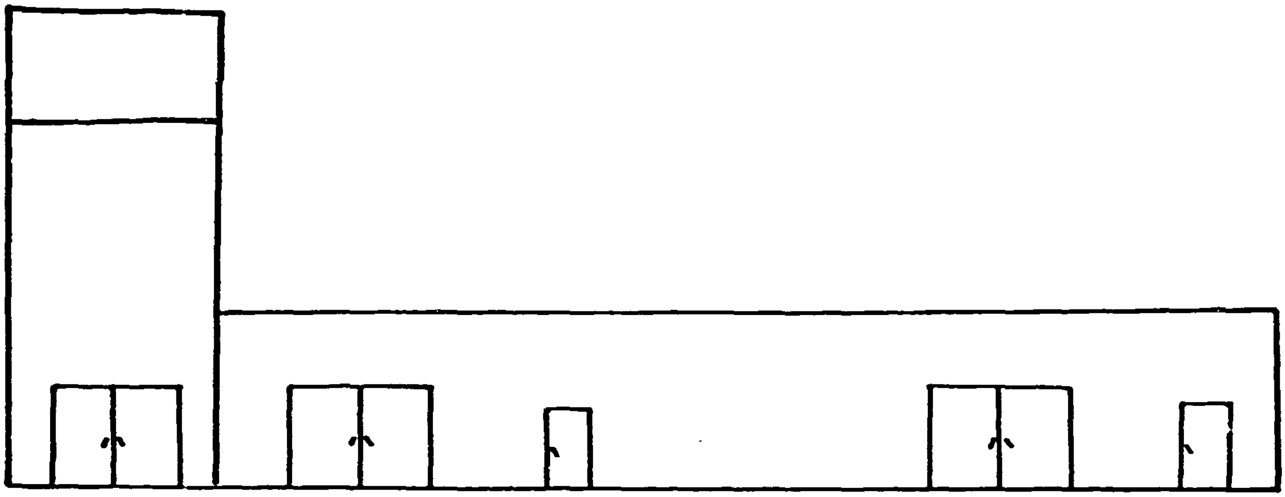
LEGEND:

1 GRINDING
2 EXTRACTION
3 PRIMARY REFINING
4 WASH/SHOWER/CHANGING ROOM
5 CONNECTING PASSAGE
6 SALTS REFINING
7 MESS ROOM
8 FINISHED GOOD STORE
9 DRYING, PACKING
10 MAINTENANCE SHOP AND CHILLER
11 SWITCH ROOM
12 BOILER HOUSE

APPROX SCALE: 1cm. = 2 METERS

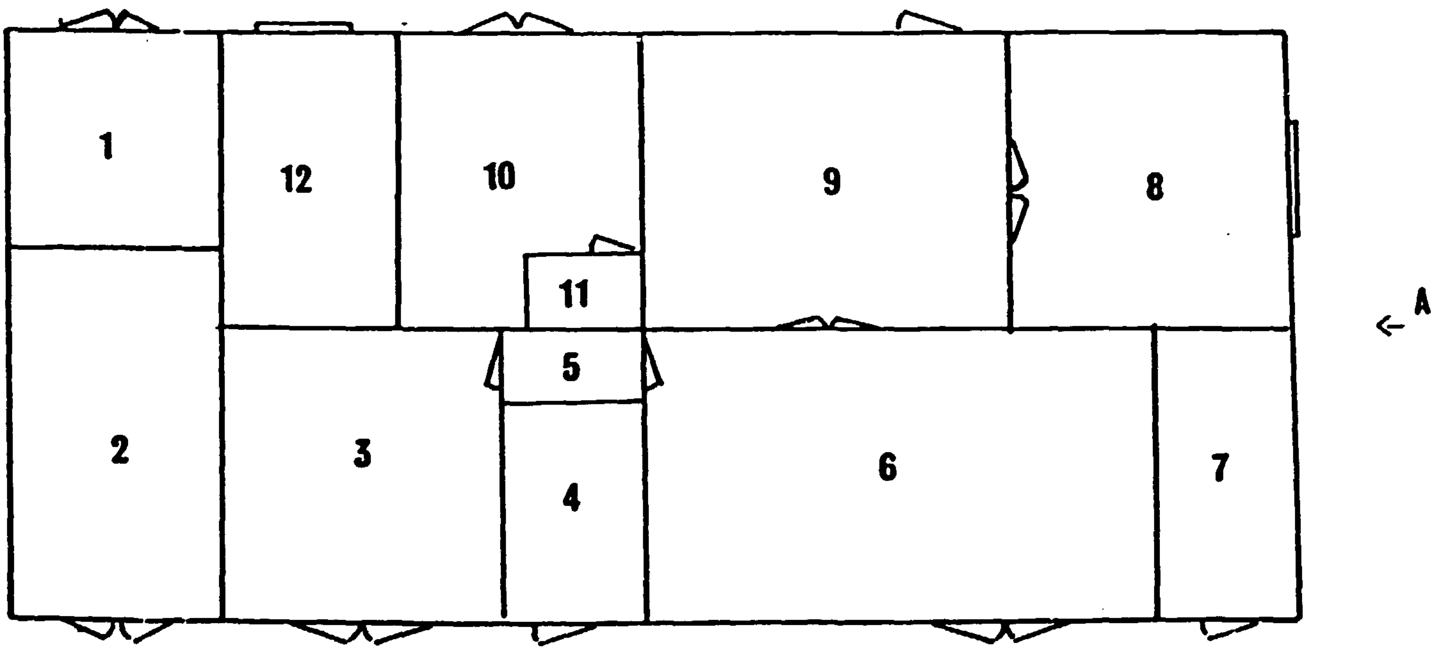


SECTION 1



ELEVATION B

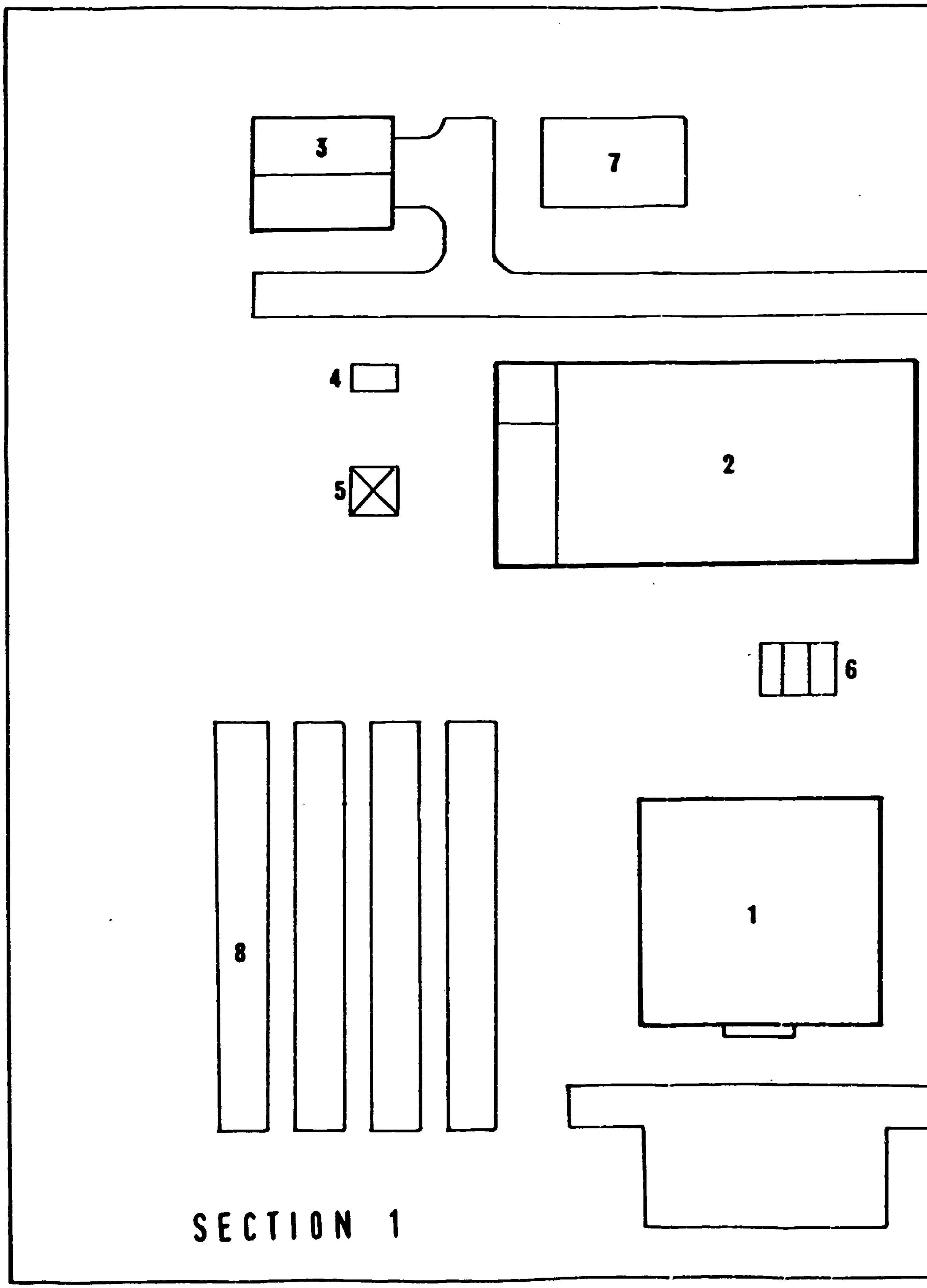
SECTION 2



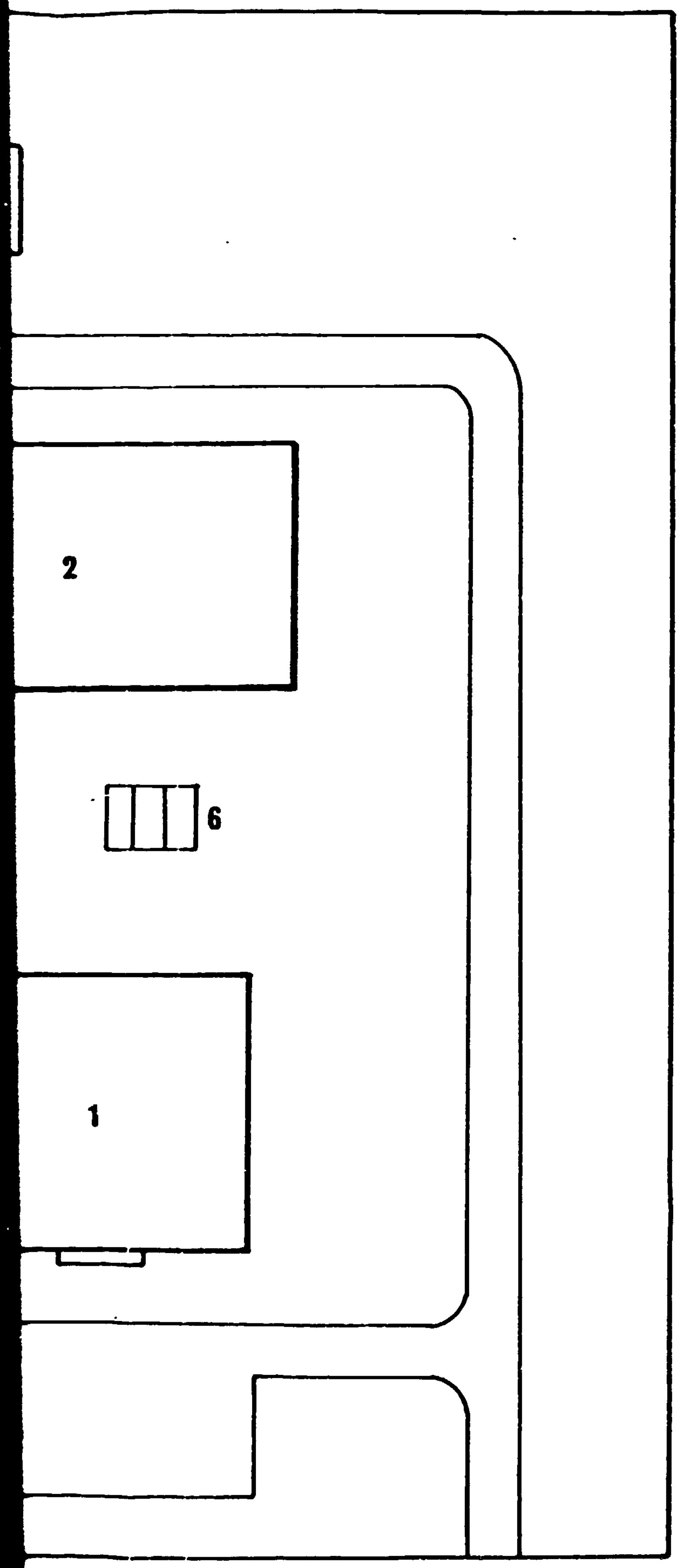
PLAN

Figure 19

SITE PLAN



LAN



LEGEND:

BUILDINGS:

1 OFFICE, LABORATORIES
2 EXTRACTION/PROCESS PLANT
3 BARK STORE AND R.M.

OUTSIDE AREAS:

4 SOLVENT STORAGE
5 COOLING TOWER
6 EFFLUENT TREATMENT
7 WOOD STORE AREA
8 PLANT BEDS

APPROX. SCALE: 1cm = 4 METERS

SECTION 2

Figure 20

6.9 Effluents and wastes

1. Liquid Wastes

The volumes of liquid wastes are minimal, principally being water distilled from the input treated bark, water used for washing down purposes and some process water.

An effluent treatment tank is nonetheless included in the civil works serving two purposes: (1) to rescue any inadvertent discharge of solvent and (2) to separate out any entrained solvent, remove suspended solids and allow for the need of pH, adjustment. Control of the quality of any effluent can thus be achieved. (See also 6.9.3.)

2. Solid Wastes

A volume of solid waste in the form of wet extracted bark (marc) will be produced. It will normally contain some 50% water.

This material could be used as a land-infilling as in other countries.

Alternatively spent bark after sun drying could possibly be also used as boiler fuel and the wood ash would contain recovered lime which might be re-utilized. (See also 4.1.3)

As this procedure has not been commercially utilised it is not included in any calculations although rough calculations indicate some 50% of the steam generation required could possibly be produced.

6.9.1 Air Pollution

No air pollution in outside areas should exist providing that the steam boiler is operating correctly. A wood fired boiler might give rise to more problems.

The only chemicals used for which air pollution levels are posted comprise:-

Ammonia	400mg/scm
Hydrogen chloride	200mg/scm (as chlorine)
Sulphuric acid	1500mg/scm (as SO_3)

Only in the case of accidental spillage might a problem arise, but would be localised and readily controlled by neutralisation.

There are also regulations controlling working areas and the maximum permissible concentrations are as below.

Ammonia	0.2mg/scm
Hydrogen chloride	0.2mg/scm
Sulphuric acid	0.03mg/scm

These levels must be controlled by careful handling and appropriate ventilation. Breathing masks should be available for workers.

6.9.2 Noise levels

Permissible noise levels vary with location. The most likely for the factory situation could be expected to be:-

Night	65db.
Morning/evening	70db.
Day	75db.

The only equipment which might cause a problem could be the mill and this can be controlled with appropriate simple sound proofing.

6.9.3 Aqueous effluents

These are the most produced effluents. The total volume produced annually will be in the order of $1200m^3$ +/- 20% or $4.8m^3$ +/- 20% average per day.

About 12% of the effluent might contain traces of organic solvent, whereas the balance consists only of salts bearing water.

All effluent will pass through a simple effluent treatment tank and provision should be made to contain any accidental spillage of toluene.

Otherwise, the main parameters which will need to be controlled are temperature, pH, clarity solution (suspended solids) and level of various dissolved solids. The level of organics will generally be low.

All liquors discharged are alkaline liquors and pH adjustment will be the main treatment.

An estimate has been made of the possible annual composition of effluent.

$SO_4^=$	1.98 g/l
Na^+	0.78 g/l
NH_4^+	0.18 g/l
OH^-	0.14 g/l
Ba^+	Trace
Cl^-	0.21 g/l
$SO_3^=$	Trace
Organics	0.56 g/l

Effluent should meet the following requirements, although for industrial operations sometimes levels may be increased by agreement.

Abstract Effluent Regulation of 1982: DENR
(Ministry, Bureau, and Office Administrative Orders and Regulations)

	Industrial Waste	Strong Industrial Wastes
Colour (Pt/Co test)	100	150
pH	6-8.5	6-9
Temp. °C	40	40
Suspended solid mg/l	75	100
BOD mg/l	80	150
Barium mg/l	2	2
Oil/grease mg/l	10	10

6.10 Estimated Costs for setting up Cinchona extraction and Refining Plant

The capital cost element for setting up a Cinchona processing plant having a capacity of up to 650 MT per annum, are considered in this section.

6.10.1 Land

A total covered area of 980 m^2 is required to house the necessary facilities. To allow for proper spacing of buildings, access roads and accommodation of solvent storages, cooling towers, effluent tanks etc a factor of 7 is appropriate leading to a land requirement of 6,860 m^2.

Allowing for inclusion of a planting out area if tissue culture work is included (768 m^2) a land area of 10,000 m^2 or 1 hectare is appropriate.

A suggested site plan is appended. (Section 6.8.3 - figure 20)

The area selected for a production unit is that in the vicinity of Malaybalay where purchase land costs in the order of ₱40 - ₱50 per m^2 can be expected.

Cost of 1 hectare	P 500,000	(US$ 23,000)
+ 10% contingency cost	P 50,000	(US$ 2,300)
Total cost	P 550,000	(US$ 25,300)

6.10.2 Site preparation & initial development

	Foreign	Local P	(US$)
Site development including fenced site, internal roads, effluent, drainage & cables.	-	1,000,000	(46,082)
+ 10% contingency		100,000	(4,608)
Total		1,100,000	(50,690)

6.10.3 Estimate of building costs

Building Areas

There are three buildings proposed and each having a different construction and unit (m^2) cost. Furthermore, the production building is divided into several sections requiring individual considerations because of ceiling height, numbers of floors and a special area which must comply with flame-proof regulations. There are also special drainage needs in some sections of the production building.

The structures and areas are defined belows.

A. Production area

1.	Grinding and mixing area	36 m^2	3 floors	Height 13 m
2.	Flameproof	60 m^2	3 floors	Height 10 m
3.	All other rooms (incl. services)	480 m^2	1 floor	Height 4.5 m

B. Office and laboratory building

Offices, rest rooms, cupboards, corridors and 2 laboratories	360 m^2	1 floor	Height 3 m

C. Bark and Raw Material Store

Raw material warehouse	108 m^2	1 floor	Height 4 m

Additional civil works will cover internal access roads, drainage, effluent and fencing.

Estimated building costs

Building costs for a variety of structures were obtained from several building firms and especial note observed of rates quoted for Malaybalay and Bukidnon.

Building cost estimates

A. Production building

	Area x rate/m^2	Local P	(US$)
1. Grinding	36 x P5,500	198,000	(9,124)
2. Extraction	60 x P6,000	360,000	(16,590)
3. Refinery & service	480 x P4,000	1,920,000	(88,479)
Total production building		2,478,000	(114,193)

B. Office & laboratory: warehouse

	Area x rate/m^2	Local P	(US$)
1. Office & laboratory	360 x P3,500	1,260,000	(58,065)
2. Warehouse	180 x P2,500	270,000	(12,442)

TOTAL BUILDING COSTS

	Local P	(US$)
Production building	2,478,000	(114,193)
Office & laboratory	1,260,000	(58,065)
Warehouse	270,000	(12,442)
Total	4,008,000	(184,700)
+ 10% contingency	400,800	(18,470)
Total building costs	4,408,800	(203,170)

6.10.4 Auxiliaries and services

Items	Foreign US$	Local P	Local (US$)
Steam generation - boiler	40,000	75,950	(3,500)
Water circ/treatment - tower	11,000	-	-
Chilled water plant	16,000	10,850	(500)
Supporting steel structure	-	1,844,500	(85,000)
Electrical panels & equipment	28,000	1,345,400	(62,000)
Mechanical installation mat.	40,000	1,736,000	(80,000)
Labour mechanical installn.	-	1,302,000	(60,000)
Electrical installation mat.	20,000	347,200	(16,000)
Power to site		108,500	(5,000)
Design costs, procurement	300,000	-	-
Spares	68,000	-	-
Technical adviser	59,000	-	-
Foreign expert-training	19,000	-	-
Local trainees	-	141,050	(6,500)
Total	608,000	7,378,000	(340,000)
+ 10% contingency	60,800	737,800	(34,000)
Total Auxiliaries & services	668,000	8,115,800	(374,000)

6.10.5 Incorporated fixed assets (gross, including contingency)

	Foreign US$	Local P	Local (US$)
Transport (4 wheel drive)	27,000	-	-
Technology	82,500	-	-
Total incorporated fixed assets	109,500		

6.10.6 Plant and Equipment

Unit Operation	Major Items	Imported US$	Local ₱	(US$)
1 Grinding	Mill & Feed	39,000	97,650	(4,500)
2 Mixing	Mixer & Conveyor	46,000	-	-
3 Extraction	Extractor Percolator	270,000	43,400	(2,000)
4 Toluene re-cycl/sec	Condensers	46,000		
5 Acid extraction	Contactor	5,000	325,000	(15,000)
6 Base-supply	Tanks, pump, agitators	5,500	86,800	(4,000)
7 Inter storage	Tanks, pumps	2,500	162,750	(7,500)
8 Solvent Handling	Tanks, pumps	2,500	217,000	(10,000)
9 Bulk Storage	Tanks, pumps	2,500	217,000	(10,000)
10 Marc discharge	Conveyor, trucks	-	477,400	(22,000)
11 Primary isolation	Reactors, vac filters pan reactors	198,000		
12 Salt refining	Reactors filters, presses	187,340		
13 Drying, seiving	Airdriers, sieves	37,600		
14 Laboratory, chemical	Equipment	30,000	-	-
	Furnishing, etc.	-	173,600	(8,000)
15 Laboratory, tissue culture	Equipment	56,873	-	-
	Nursery	-	482,924	(22,255)
16 Sundry items	General utilities	-	600,000	(27,650)
	Workshop tools	-	86,800	(4,000)
	Miscellaneous tools	-	43,400	(2,000)
	Office furnishings etc	-	43,400	(2,000)
Total		928,813	3,057,624	(140,881)
+ 10% contingency		92,881	305,762	(14,088)
Total Plant & Equipment		1,021,694	3,363,386	(154,995)

6.10.7 Pre-production expenditure (gross, including contingency)

	Foreign US$	Local P	(US$)
Technical assistance & training for tissue culture	40,800	548,923	(25,296)

6.11 Summary Capital Costs for Setting up

Total initial capital investments to set up integrated production unit.

This sections summarises the costs detailed in the preceding sections, including contingency cover where appropriate.

Section	Item	Foreign US$	Local in US$	Total US$
6.10.1	Land	-	25,300	25,300
6.10.2	Site preparation	-	50,690	50,690
6.10.3	Structure & Civil engineering	-	203,170	203,170
6.10.4	Auxiliary & services	668,000	374,000	1,042,800
6.10.5	Incorporated fixed assets	109,000	-	109,500
6.10.6	Plant, machinery & equipment	1,021,694	154,995	1,176,689
6.10.7	Pre-production expenditure	40,800	25,296	66,096
Total initial investment costs for integrated unit		1,833,644	840,601	2,674,245

Total initial capital investments to set up processing unit.

In the case of a 'processing only' unit, the following elements of investment cost are not incurred due to the elimination of the tissue culture and nursery unit.

Reductions	Foreign US$	Local in US$	Total US$
Item			
6.10.6 (no.15)	62,560	24,480	87,040
6.10.7	40,800	25,296	66,096
Total reductions	103,360	49,776	153,136
Total initial investment costs for processing only unit	1,731,084	790,825	[illegible],521,109

7. Plant Organisation

7.1 Cost Organisation

From an organisation point of view, the operation proposed of a Cinchona processing plant, even incorporating tissue culture development of plants for reforestration, is a relatively simple operation.

Where all processing from Cinchona bark to finished salts is accomplished at one site, there is no necessity for cost purposes to split up intermediate operations, although for work-in-process assessments intermediate materials can be separated in values for bark in progress, intermediate bisulphate, recovered sulphates and final salts. All products, in whatever state of refinement, are reported in the common term of SQ_2 and these values used for yield calculations.

The cost centres normally considered would be:

(1) Works or factory costs
(2) Administration overheads
(3) Distribution costs
(4) Selling costs
(5) Cinchona stand development

7.1.1 Works or factory costs consist of both direct costs and overhead costs.

Direct labour is charged in total according to wages including surcharges. Over or underabsorption may be determined with reference to budget forecasts. In the case of an integrated unit charges against bark raw material relate to harvesting and transport costs. (In the case of processing only the cost of bark would apply.) Chemicals and additives are charged according to usage.

Works overheads which are part of works costs are considered to comprise the following:

(1) Supervising labour
(2) Maintenance labour and materials
(3) Fuel costs
(4) Utilities: water, electricity and gas
(5) Works vehicle expenses
(6) General manufacturing expenses (filter bags, protective clothing, expendables, etc.)
(7) Laboratory salaries and expenses
(8) Plant depreciation (straight line 10 years)

7.1.2 Administrative or General Overheads

This cost centre covers items such as:

(1) Director, office salaries and security
(2) Rent and rates (as applicable)
(3) Insurances

(4) Post and telephone
(5) Printing and stationery
(6) Travel
(7) General charges (laundry, cleaning materials, etc.)
(8) Audit fees
(9) Legal and professional charges
(10) Bank charges
(11) Depreciation buildings (straight line 10 years) and vehicles (3 years)

7.1.3 Distribution costs would normally include warehouse salaries and expenses, packing materials, carriage and fob charges, overseas freight and related insurance. For the purchase of the analysis in the study, these items have been including partly under works overheads and partly administrative.

7.1.4 Selling costs

As it is proposed in this study to execute all sales through an agent, this cost centre principally relates to commission payments, charges and communication costs.

7.1.5 Cinchona Stand Development

A cost centre would need to be set up for this operation. In the financial evaluation this has been allocated to site development under current investments.

7.1.6 Allocation of costs

Several items require to be allocated to various cost centres and the table below illustrates some of these.

	Works overheads	Administrative overheads	Selling costs	Cinchona stand development
Salaries	x	x		x
Wages	x	x		x
Fuel	x			x
Utilities	x			x
Post, telephone		x	x	
Lab. salaries & materials	x			x

7.1.7 Composition of estimated administration overheads

	US$	
Director salary	8,000	
Office salary	-	(included under factory)
Maintenance	3,000	(est)
Rates	8,000	(est)
Insurance	57,768	(3.5% P+M; building&vehicle)
Legal & prof.	2,000	(est)
Audit	1,000	(est)
Stationery, travel, etc.	4,232	(est)
Post & telephone	2,000	(est)
General charges	2,000	(est)
	88,000	

NB: Building depreciation which might be included here has been entered under separate depreciation heading together with plant depreciation.

Composition of factory overheads

Several of the items considered normally as factory overheads are entered into COMFAR inputs as individual items, energy & utilities (fuel, electricity, water, etc.).

Also supervisory salaries, maintenance labour have been entered under labour direct, although strictly should come under factory overheads. Warehouse salaries were treated similarly. Depreciation of plant is entered under the same separate heading which also includes vehicle depreciation.

Items remaining which fall under the description of factory overheads are laboratory expenses and materials, works vehicle expenses and general manufacturing expenses, including filter and centrifuge clothes, protective clothing, cleaning materials, intermediate packaging, disposable materials. In fact, for simplicity, final packaging materials have also been included in this heading.

The figure covering these items was estimated for evaluation purposes to be essentially directly variable with both bark throughput and volume of SQ_2 being processed and particularly with the volume isolated.

For 3% SQ_2 bark a figure of $33.3 per MT bark processed was used increasing to US$90.0 per MT 5% SQ_2 bark processed.

		US$
For	300MT 3% bark factory overheads =	10,000
	300MT 5% bark factory overheads =	27,000
	450MT 3% bark factory overheads =	15,000
	450MT 5% bark factory overheads =	41,000
	540MT 3% bark factory overheads =	18,000
	540MT 5% bark factory overheads =	49,000
	540MT 6.5% bark factory overheads =	64,000

7.1.8 Depreciation

For COMFAR input purposes depreciation is considered as a separate input rather than allocated to works and administrative overheads.

Depreciation of two aspects has to be considered:

(1) initial fixed assets, and
(2) current fixed investment costs.

The following depreciation rates and scrap (or salvage) values applicable to the different assets are summarised in the table below.

Initial fixed assets

Item	Initial fixed assets values US$	% dep.	% scrap	yrs. dep.
Land	25,300	0.0	100.0	0.0
Site	50,690	10.0	15.0	10.0
Structures	203,170	10.0	15.0	10.0
Incorporated fixed assets:				
(a) works vehicle	27,000	33.3	0.0	3.0
(b) technology	82,500	10.0	0.0	10.0
Plant & machinery	1,176,689	10.0	10.0	10.0
Auxiliary & service	1,042,800	10.0	10.0	10.0
Pre-production	66,096	10.0	0.0	10.0

Current fixed assets

In view of the fact that it has been projected that no major replacements of plant and equipment, buildings, nor new items will need to be installed during the 15 years of production scheduled in the evaluation, this section covers two items:

(1) Works vehicle
(2) Cinchona stand production under 'site development'.

(1) Works vehicle

The works vehicle is scheduled to be replaced every three years, first replacement in 1994 and subsequently in 1997, 2000 and 2003 at a set cost of US $27,000.

As above, this will be depreciated at 33.3% straight line over three years and allocated zero scrap value.

(2) Site development - Cinchona stands

This is a more complex subject to consider from the angle of depreciation, but a simple input is proposed after considering various approaches.

(a) The lifetime of a Cinchona tree to reach maturity for harvesting is a minimum of seven years.

Consideration was therefore given to simply depreciating over seven years, straight line, with no scrap value.

This would only by valid if trees were uprooted after seven years and used in entirety. This is not the case for after a first harvesting the trees are allowed to produce a further crop in later years.

(b) As indicated above, after planting out trees are grown for a minimum of seven years and then harvested and processed. The asset might be thought to be consumed. In fact after the first harvest the trees are allowed to coppice, i.e. throw out new shoots. These shoots grow to produce a further valuable harvest after another seven years. The yield of this second harvest is normally in the order of 30-33 per cent of the first harvesting.

Further coppicing may also be applied to produce a third harvesting after yet another seven years. At this time the whole tree will probably be uprooted when the asset will at last be dissipated. The yield from the third harvest will be about 15-17 per cent of the first.

For the purposes of the evaluation any value associated with a third harvesting is being ignored as such would not be processed until well outside the evaluation period.

At the first harvest, in effect, it can be assumed that about 70-75 per cent of the ultimate output of the tree is consumed and that the remaining 25 per cent will start to be processed in the 16th year of production. Twenty-five per cent is suggested as scrap value.

As a compromise to represent the residual value of the asset, the following proposal is made for current fixed assets:

<u>Current fixed assets - depreciation</u>:

Item	% dep.	% scrap	yrs. dep.
Works vehicle	33.3	0.0	3.0
Site development	10.0	25.0	10.0

In practice, the best method of depreciation might be to adopt an annual revaluation system which could also adjust for potential market value or relative value to selling price of quinine salts. Such a procedure is not appropriate for evaluation in this report.

It will be clear that without the period of production in this evaluation it will later be necessary to apply a further depreciation as the second and third harvests are taken

8. Manpower

Manpower covers a variety of levels and skills and will be needed both in the plantation operation and the processing operation.

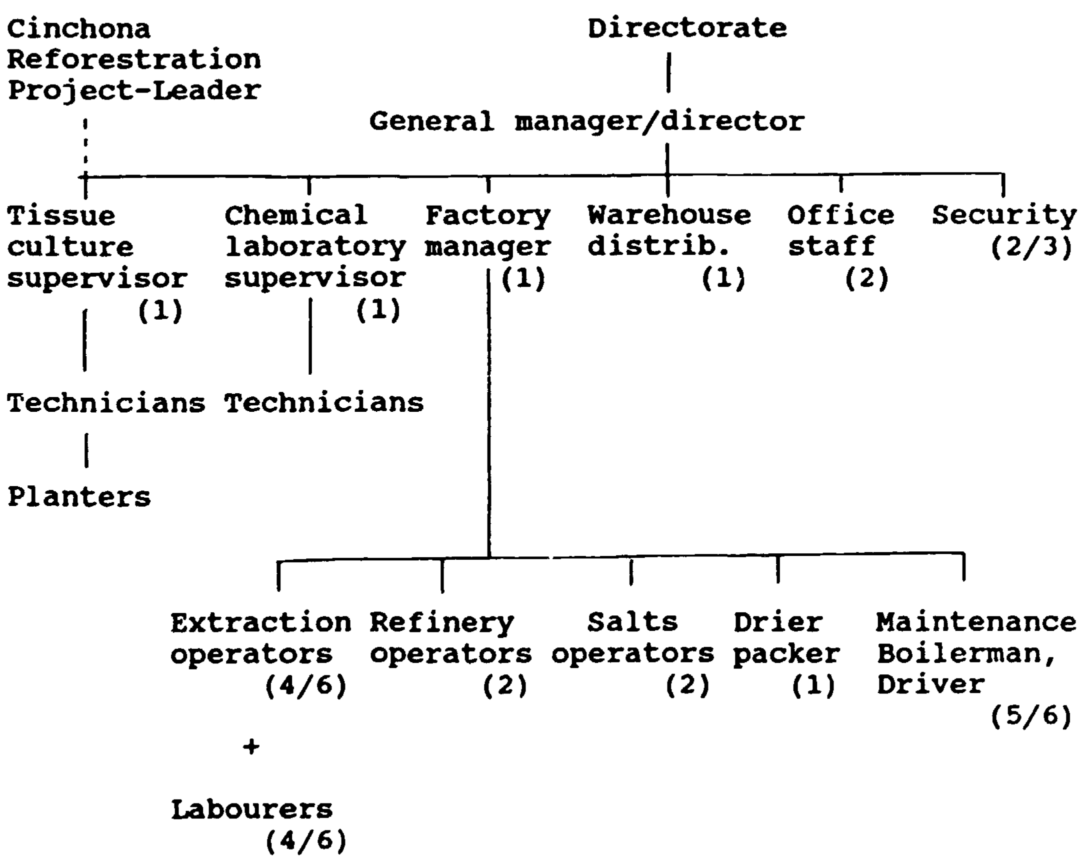
With regards the plantation, foresters and planters are needed for sustaining planting and maintaining stands. Such experienced staff are already available. The numbers required are not expected to increase substantially, although a small increase can be expected with expansion of the annual planting area to establish high quality stands.

Harvesting may be performed by trained casual labour and may well be operated on a family basis. This would provide some welcome additional and regular employment for annual harvesting would be effected.

The processing unit is a different proposition as there is no history in the area of similar employment. A variety of staff and labour will be required and the different levels are discussed later.

8.1 Manpower Organisation and Responsibilities

A typical manpower organisation for the processing unit is proposed.



General Manager (possibly an executive director) responsible to Directorate (non-executive) for all aspects of marketing, production, maintenance and utilities, planning of extraction and refining, warehouse distribution, training, office administration and security.

Factory Manager - responsible to General Manager for the smooth and efficient operation of factory functions and production. Will oversee the extraction, isolation, refinery and drying sections of production as well as services and utilities. Also responsible for satisfactory effluent levels and training of workers. Will ensure good maintenance of equipment.

Tissue Culture Supervisor - operating at the production site would be responsible to the General manager, but also work intimately with Cinchona Reforestration project leader. Would be involved in practical work. Train and supervise technicians and planters.

Chemical Laboratory Supervisor - responsible to General manager for analysis of raw materials, production samples and final products. Also for analysis of tree selection samples and tissue culture samples. Would also be engaged in bench work and advise on production control tests. Train technicians and assist in operator training.

Extraction operators assisted by labourers will carry out the day-to-day execution of bark extraction and waste disposal. Responsible for maintenance of equipment. Labourers will particularly operate milling equipment and assist as necessary. Production records to be maintained.

Refinery operators (primary and salts) responsible for day-to-day operations of isolating quinine and production of salts. Responsible for good maintenance of equipment. Maintain production records.

Drier/packer responsible for product drying as available and packaging of bulk products.

Warehouse/distribution responsible to General Manager for despatch of products, paperwork and records.

Office staff responsible to General Manager for general office duties, secretarial, typing, accounting, wages, invoices, etc.

8.2 Manpower Selection and Training

8.2.1 Labour - selection, availability and quality of local manpower.

The procedures of extraction of Cinchona, isolation and purification of quinine salts will be quite new to the area. The number of people required is not too large so procurement of suitable, trainable people should not pose a problem if care is taken in recruitment.

Unskilled and skilled positions may be filled by workers with some general education. Ability to read, understand simple instructions, and to add and subtract is important for weighing and reporting is necessary. Skilled workers will learn to operate valves, motors and pumps, read gauges and general mechanical skills. They will be expected to react to situations, give instructions, keep simple records and possibly perform simple chemical tests.

Mechanics and maintenance men with some experience should be available in the Malaybalay area.

Training - labour.

Both unskilled and skilled operators will need to be trained "in-house", both "off-the-job" and more particularly "on-the-job". The former will start just prior to commissioning and the latter during commissioning under the auspices of the proposed technical adviser.

In the case of mechanics and maintenance staff training and familiarisation should take place during the plant installation period. Often these staff are recruited from the installation crew, but could be specifically recruited. During the installation period they should be trained by the technical adviser overseeing installation. Training of these personnel is made easier for installation and mai tenance manuals of suppliers should be available. Most of the plant maintenance will be preventative or involve replacement cf seals or valve seats or dealing with electrical failures.

Care would be taken in procurement to ensure a good and appropriate stock of spares when purchasing the main equipment. Standardisation should be applied in selection wherever possible.

8.2.2 Staff - technical and administrative

Staff include senior management which should be technically orientated, particularly in disciplines of chemistry and chemical engineering or engineering. Laboratory technical staff will cover disciplines of chemistry and tissue culture.

All technical staff should be college or University trained to at least B.S. standard and possibly higher for the senior positions. Considering the limited numbers there should be adequate choice from Malaybalay and Cagayan de Oro City to fill the positions.

Office staff duties will not differ much from any other manufacturing business and selection and procurement of services should present no problem.

Training - staff

Office staff will only need to be trained in any specific aspect of the business and in familiarisation with terminology. Such training will be done "in-house" by the General manager.

For laboratory technicians the detailed training in methods and procedures, particularly pertaining to Cinchona alkaloids should be readily absorbed by trained chemists. Some training and experience in analysis methods, especially for the senior QC analyst, could possibly be initiated prior to availability of factory facilities by renting bench space at a local college or University and the programme overseen by the technical adviser. Any special equipment needed could be purchased and shipped at an early stage and employed at the rented premises until completion of the factory facility. Training outside of the Philippines is not considered necessary.

In the case of technicians for meristem tissue culture, arrangements for the supervisor to train overseas in the UK could probably be made, although satisfactory training and experience could be arranged in the Philippines at the tissue culture unit at Los Banos, Laguna, Luzon. Alternatively, facilities might also be available in Mindanao. If necessary, an expert from the UK to perform training in the Philippines could also be provided and though, possibly not essential, would be advisable. An expenditure for such has been included in financial considerations.

Managerial staff of General Manager and particularly Factory Manager will require the most extensive training. The occupants of these positions should have a technical background covering chemistry or chemical engineering, as well as the ability to plan and exhibit managerial skills. In depth training with respect to both equipment and technological processes will be needed. Also an understanding of the basic principles governing the methods applied.

These positions should be filled at an early stage in the project. Such personnel, at the worst, should be involved in the immediate pre-production period, and preferably as early as commencement of installation of plant.

Involvement at the project formulation stage could be even more desirable.

Training of these personnel should again be done in the Philippines by visiting technical experts as there is virtually no possibility of visiting operating Cinchona processing factories to receive training.

Much training would be gained from assisting the technical supervisor responsible for overseeing installation and later from the adviser responsible for commissioning and training.

8.3 Training Schedule

An outline programme schedule is given below.

Training Schedule

Months	-18	16	14	12	10	8	6	4	2	Startup +2	4	6
General Manager							—	—	—	—		
Factory Manager							—	—	—	—		
Technician QC (supervisor)									—	—		
Technician TC (supervisor)									—			
Assistant Technicians										—		
Maintenance						…	…	…	…			
Operators									—	—	—	
Office									—			

8.4 Foreign expatriates

A foreign expatriate will be needed during the latter stages of the building programme (earlier supervised by local architect or agents) to check equipment and supervise erection and installation of plant and to give some training. Additional technical assistance to extend training and cover chemical commissioning will probably also be expected on site on completion of erection and for a period of 2 months.

Expatriate personnel will require suitable accommodation probably in the form of a residence with appropriate facilities and domestic assistance, as the alternative of hotel accommodation will probably not exist in the Malaybalay area.

Transportation will also be required for which the factory vehicle could be used. Financial provision for these will be negotiated within the contract price.

8.5 Staff and Labour Requirements with Costs

Type	Position	No.	Rate/Month (P)	Annual Outlay (P)	Type
Day	Director	1	12,000	144,000	Managerial
Day	Factory Mgr	1	9,000	108,000	Technical
Day	Q/C Technician	3	5,000	180,000	Technical
Day	Labourer/Drier	3	1,914	68,904	Unskilled
Day	Driver/Mechanic	1	2,500	30,000	Skilled
Day	Mechanic	2	2,450	58,800	Skilled
Day	Secretary	1	3,500	42,000	Skilled
Day	Clerk	1	3,000	36,000	Skilled
Day	Typist	1	3,000	36,000	Skilled
Shift	Extraction Operator	4(2x2)	3,000	144,000	Skilled
Shift	Labourers	4(2x2)	2,488	119,424	Unskilled
Shift	Boiler Attendant	2(1x2)	2,488	59,712	Unskilled
Shift	Refining Operator	2(1x2)	3,000	72,000	Skilled
Shift	Security	2(1x2)	2,488	59,712	Unskilled
				1,158,552	
SSS	3%			34,756	
Other Costs	10% (includes 13th month)			115,855	
Total Salary/Wage Bill				1,309,163	

Shift rate = 1.3 x basic included

These figures apply for processing up to 450 metric tonnes bark per annum. At a higher throughput additional staff wou;d be needed and 24 hours, 3 shift working would have to be operated with the installed equipment in the extraction section. This is the most economical method of operation.

The Additional Staff would comprise:

	No.	Rate/Month	Annual Outlay (P)	
Extraction Operators	2	3,000	72,000	Skilled
Labourers	2	2,488	59,712	Unskilled
Boiler Attendant	1	2,488	29,856	Unskilled
			161,568	
Additional Shift Premium 7.35% (night work average)			11,875	
			173,443	
SSS 3%			5,203	
Other Costs 10% (includes 13th month)			17,344	
			195,990	

Staffing for possible inclusion of meri-stem tissue culture is given separately below, but still operating under the factory management.

Allocation of Manpower Costs

Allocation of the labour costs may be made to the following cost centres.

Annual costs (year 1)	P
Factory labour (direct)	
3 day workers	68,904
4 shift extraction workers	144,000
4 shift labourers	119,424
2 shift refinery	72,000
Total	404,328
Total with 13% surcharge	456,890
Works overheads (labour costs)	
1 Factory manager	108,000
3 QC technicians	180,000
2 Mechanics	58,800
1 Driver/mechanic	30,000
2 Boiler attendants	59,712
1 Clerk/warehouse	36,000
2 Security	59,712
1 Typist	36,000
Total	568,224
Total with 13% surcharge	642,093

Administration overheads (labour)

1 General manager	154,000
1 Secretary	42,000
Total	196,000
Total with 13% surcharge	221,480

In the financial evaluation, the cost centres were not strictly adhered to, only the General manager salary being allocated to the administration cost centre and the balance charged to the production cost centre.

Total direct labour charges are allocated with surcharges to production irrespective of throughput. In practice, under or over absorption would then be reported.

8.5.1 Direct labour input

The actual allocations submitted for COMFAR projections represent:-

Bark throughout level 300 M.T. and 450 M.T. p.a.

Direct labour comprising:

	P		
Production direct labour	456,890		
Overheads 'indirect' labour	642,093		
Secretary (42,000 x 1.13)	47,460		
Total direct labour input	1,146,443	=	US $53,000

Bark throughput level greater than 480 M.T. p.a.

Additional direct labour is incurred due to increased labour force and operation of 3 shift working carrying premiums.

Normal direct labour input	1,146,443		
Additional costs	195,999		
Total direct labour input (for 540 M.T.)	1,342,442	=	US $61,000

Production training

During the first two months of production in the first year it is proposed that foreign technical advisers (2) will be engaged and the salaries and expenses relating to this provision are also charged under 'direct labour'.

Cost of provision of expert technical assistance for production US $33,000

DIRECT LABOUR INPUTS

Year	Level	Input US$
1 (1992)	300 M.T.	86,000
2/5 (1993/1996)	450 M.T.	53,000
6/15 (1997/2006)	540 M.T.	61,000

8.5.2 Administration Salaries

Insofar as COMFAR input is concerned, only the salary of the Director/General manager has been included and this forms part of the Administration overheads input.

The contribution is:

Director/General manager salary P 174,020 = US $8,000

8.6 Advisory and training payments

Several items relating to this aspect have been included under 'Auxiliaries & services' when performed during the construction and installation period (refer 6.10.4).

Under this heading the following are covered:-

1) Technical adviser principally supervising the construction, installation, co-ordination and some training.

2) Technical expert for pre-production training of local personnel.

3) Local personnel.

The local personnel would be employed to receive training during the installation period and within the last semester of installation (semester 1991.2). They would consist of the positions listed below at the salaries or wages indicated. These levels of payment have been set somewhat lower than those which will operate when production commences.

Expenditures incurred are presented as:-

	Training period	P
Director/General Manager	6 months	60,000
Factory Manager	6 months	45,000
Maintenance (2)	1 month	5,250
OC analyst	1 month	5,300
Plant operators (2)	1 month	4,000
Office	1 month	5,300
	Total	124,850
+ 13% surcharge		16,230
		141,080=US $6,500

Total charged to Auxiliary & services:

	Foreign US$	Local US$
1) Technical adviser	59,000	-
2) Technical expert	19,000	-
3) Local personnel	-	6,500

8.7 Staffing for Meri-Stem Culture

	No	Rate/Month	Annual Outlay (P)	
Technicians	2	5,000	120,000	Technical
Skilled Labourers	5	2,400	144,000	Skilled
General Labourers	2	1,914	45,936	Unskilled
			309,936	
SSS 3%			9,298	
Other Outlays 10% (includes13th month)			30,994	
Total			350,228	US$ 16,140

In the financial evaluation these labour costs have beem included under the item of site development. (refer 6.1.1)

It should be noted that salary/wages levels have taken into account the recent agreement for a ₱25 per day increase in (operating from 1 July 1989) minimum wage and consequential increases in other levels.

Particularly for technical staff generous levels have been proposed as it would be important to select top quality personnel and pay the premium.

8.8 Plantation Labour

Labour will also be needed at the plantation for land preparation, growing on and planting out trees. Weeding, in-filling and maintenance of the stands and general security will be needed. An estimate for this work has been made, based on the annual report of the reforestation programme of 1988 and included in the site development item. Allowance has been made for the current wage increases.

Harvesting costs have been also charged to the integrated project under the heading of "raw material".

Plantation costs

Plantation costs for growing on of plants derived from tissue culture were estimated by abstraction of recorded costs in the Cinchona Reforestration Project Annual Report of 1988. These were escalated by 23% to cover future wage increase adjustments and a 50% plantation overheads contribution.

Plantation costs for growing-on, planting out and maintenance of 320 hectares p.a.	US $50,872

This figure was used for costing input to production of Cinchona trees by tissue culture (refer 6.1.1).

9. Implementation Schedule

An implementation schedule is proposed which is determined from the point of final decision to proceed and award of contract.

Prior to this point various other aspects have to be completed, including -

- evaluation,
- financial arrangement,
- site selection,
- use of land and general permission for industrial building,
- investment approval, and
- tendering.

The time schedules are presented in simple bar chart form in figure 21 and indicate a period of 18 months from the granting of the contract(s) until start of production. The time intervals are based on current, well scheduled plant delivery times and realistic building schedule.

On acceptance of a tender it is assumed that the construction period will commence at the beginning of the second semester (half year) of 1991.

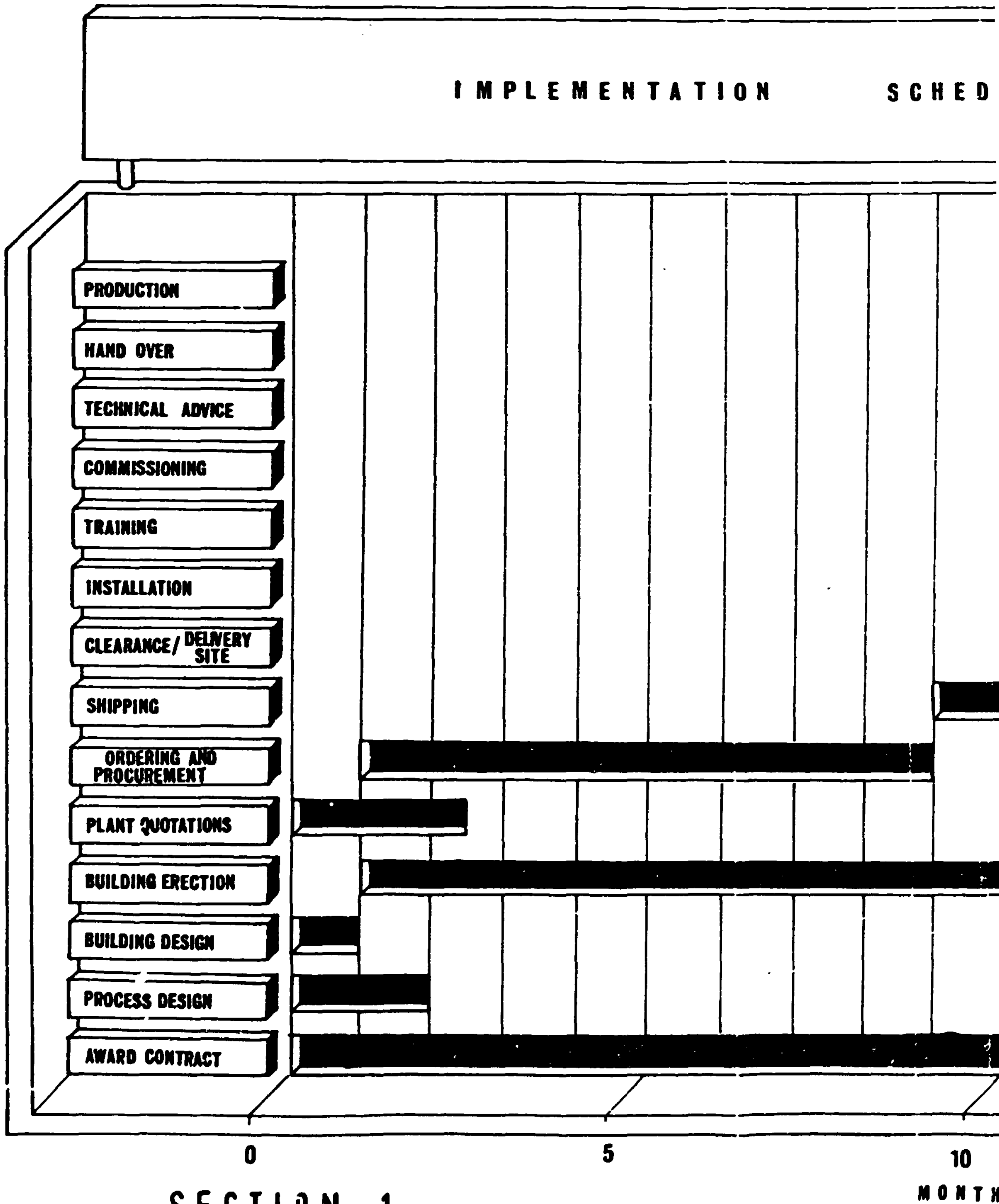
For this pre-feasibility study only a brief implementation schedule is presented. On signing of the tender immediate work would start on site and civil plans and designs (to be completed in one month) and at the same time on project design (scheduled for two months).

Ordering of longer delivery plant items will take place as soon as possible, being given preference for tendering. Site and building works should start one month after start date, and be essentially complete within ten months. At this time all plant and installation material should be on site and it is likely that some large items may need to be installed before final completion of the roof in the extraction section.

Installation of plant is expected to take six months during which period much basic training will also be carried out. Production, at about 50 per cent of the plant capacity, is expected to commence 18 months after granting of contract after some preliminary commissioning.

Major activities and scheduling are represented in the table below and in the figure 21.

Activity	Time schedule	Duration
Commence implementing		
Contract granted	1 July 1990	
Process design	1 July 1990 - 31 August 1990	2 m.
Civil design & site	1 July 1990 - 31 July 1990	1 m.
Building erection/site	1 Aug. 1990 - 31 May 1991	10 m.
Plant quotations	1 July 1990 - 14 Sept. 1990	2.5 m.
Order/procure plant	1 Aug. 1990 - 31 March 1991	8 m.
Ship plant	1 Apr. 1991 - 31 May 1991	2 m.
Clearance/delivery	1 June 1991 - 30 June 1991	1 m.
Installation plant	1 July 1991 - 30 Nov. 1991	5 m.
Technical advisers	1 July 1991 - 31 Dec. 1991	6 m.
Training	1 July 1991 - 31 Dec. 1991	6 m.
Commissioning	1 Dec. 1991 - 31 Dec. 1991	1 m.
Official completion	31 Dec. 1991	
Production commences	1 Jan. 1992	


IMPLEMENTATION SCHED
PRODUCTION
HAND OVER
TECHNICAL ADVICE
COMMISSIONING
TRAINING
INSTALLATION
CLEARANCE/ DELIVERY SITE
SHIPPING
ORDERING AND PROCUREMENT
PLANT QUOTATIONS
BUILDING ERECTION
BUILDING DESIGN
PROCESS DESIGN
AWARD CONTRACT
0
5
10
MONTH

SECTION 1

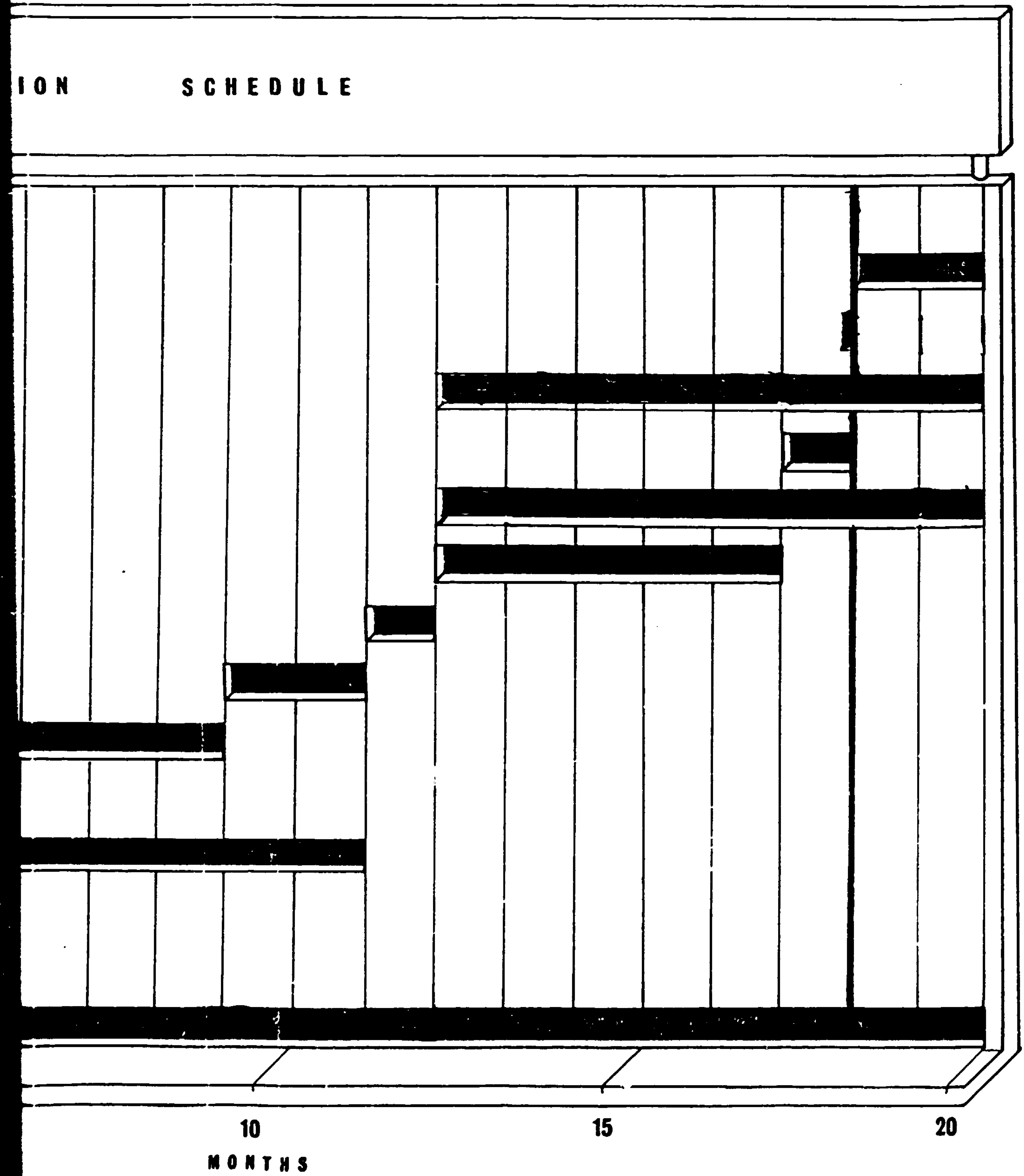


Figure 21

SECTION 2

Project implementation costs

The costs under this heading are allocated elsewhere under (1) auxiliary and service costs and (2) pre-production costs.

These which are relevant to implementation scheduling may be considered to be :-

(1) Under auxiliary and service (refer 6.10.4).

	Foreign	Local	
	US$	P	(US$)
Local trainees & management	-	141,050	(6,500)
Design costs (by foreign experts, travel, staff, fees, etc.)	300,000	-	-
Technical adviser, construction supervision & training	59,500	-	-
Foreign expert (training)	19,000	-	-
	378,500	141,050	(6,500)
= 10% contingency	37,850	14,105	(650)
	416,350	155,155	(7,150)

(2) Under pre-production expenses the following have been posted - especially with respect to tissue culture work (refer 6.10.7).

	Foreign	Local	
	US$	P	(US$)
Technical assistance & training for tissue culture (including contingency)	40,800	548,923	(25,296)
Total relevant to implementation scheduling	457,150	704,078	(32,446)
Total (in US$ only)	489,596		

10. **Financial and economic evaluations**

COMFAR, the UNIDO Computer Model for Feasibility and Analysis Reports was employed for the Financial and Economic projections.

The inputs supplied to compute the schedules and which originate from the various earlier sections in the study are now summarised.

10.1 Capital investment costs for setting up

Total initial capital investments for setting up an integrated production unit.

Section	Item	Foreign US$	Local in US$	Total US$
6.10.1	Land	-	25,300	25,300
6.10.2	Site Preparation	-	50,690	50,690
6.10.3	Structure & Civil engineering	-	203,170	203,170
6.10.4	Auxiliary & services	668,000	374,000	1,042,800
6.10.5	Incorporated fixed assets	109,500	-	109,500
6.10.6	Plant, machinery & equipment	1,021,694	154,995	1,176,689
6.10.7	Pre-production expenditure	40,800	25,296	66,096
Total initial investment costs for integrated unit		1,833,644	840,601	2,674,245

Total initial capital investments to set up processing unit.

In the case of a 'processing only' unit, the following elements of investment cost are not incurred due to the elimination of the tissue culture and nursery unit.

Reductions:	Foreign US%	Local in US$	Total US$
Item			
6.10.6 (No.15)	62,560	24,480	87,040
6.10.7	40,800	25,296	66,096
Total reductions	103,360	49,776	153,136

Total initial investment costs for processing only unit	1,731,084	790,825	2,521,109

Time schedule of expenditure during construction
(for integrated unit; percentage allocation similar for processing only)

Item	1st semester	2nd semester	3rd semester
Land & site prep.	100%	-	-
Structure & civil	36%	32%	32%
Auxiliary & service	36%	32%	32%
Incorporated fixed assets	27%	24%	49%
Plant, machinery & equipment	36%	32%	32%
Pre-production	-	50%	50%

Integrated unit - actual expenditure during construction

Item	1st semester (1190.2)	2nd semester (1991.1)	3rd semester (1991.2)
	US$	US$	US$
Land & site prep.	75,990	0.000	0.000
Structure & civil	73,100	65,015	65,015
Auxiliary & service	375,408	333,696	333,696
Incorp. fixed assets	29,700	26,400	26,400
Plant, machinery etc.	423,605	376,542	376,542
Total initial investment	977,843	834,701	861,701

Working capital

The following parameters were fed to COMFAR for calculation of working capital.

Current assets	Days coverage
Accounts receivable	30
Inventory raw material (a)	30
Inventory raw material (b)	30
Inventory energy	30
Inventory spare parts	60
Inventory work in progress	30
Inventory finished products	30

Current liabilities

Accounts payable	30

Working capital in COMFAR for year 1 (1992) is US $83,517.

10.2 Total production costs

In this study several production situations are investigated. Principal interest is in an integrated production unit, but inputs are also covered for a 'processing only' unit.

Raw materials 1 (refer 4.7.2.1.) - Integrated unit.

The input costs are represented by the harvesting costs of the Cinchona bark which include packing, handling and delivery to the production factory.

Costs are directly related to the volume of bark and irrespective of quality.

Raw material cost:

Production year	Volume processed	Foreign US$	Local in US$	Total US$
1 (1992)	300 m.t.	-	(69,000)	(69,000)
2/5 (1993/6)	450 m.t.	-	(104,000)	(104,000)
6/15 (1997/2006)	540 m.t.	-	(125,000)	(125,000)

Raw materials 1 (refer 4.7.1.2.) - Processing only.

In this case an arbitary world price, representing the price at which bark could be bought or sold, may be used. Price is very dependent on the quality of the bark and is also related to the selling price of quinine salts at the time.

Financial scenarios have only been projected for 'processing only' using five per cent SQ_2 bark as it is not normally considered profitable to process bark as low as three per cent bark (except for blending with higher quality bark in times of shortage).

The input price of five per cent bark is entered at P. 24.32/kilogram (US $1.1207/kilogram.

Production year	Volume processed	Foreign US$	Local in US$	Total US$
1 (1992)	300 m.t.	-	336,000	336,000
2/5 (1993/6)	450 m.t.	-	504,000	504,000
6/15 (1997/2006)	540 m.t.	·	604,000	604,000

b. Other raw materials (refer 4.7.5.2)

Chemical additives and reagents are covered here. The cost is determined by both quantity of bark processed and the quality.

For 3.0% SQ_2 bark (see SQINT 1)

Production year	Volume	Foreign US$	Local in US$	Total US$
1 (1992)	300 m.t.	32,371	17,718	50,089
2/5 (1993/6)	450 m.t.	48,556	26,655	[illegible]
6/8 (1997/9)	540 m.t.	58,268	31,891	[illegible]
9/15 (2000/06)	540 m.t.	74,333	34,980	[illegible],314

* The input changes here because with the integrated unit the tissue culture stands provide their first harvest and the average bark quality increases to 6.5% SQ_2.

For 5.0% SQ_2 bark (see SQINT 3)

Production year	Volume	Foreign US$	Local in US$	Total US$
1 (1992)	300 m.t.	38,974	18,340	57,314
2/5 (1993/6)	450 m.t.	58,960	27,012	85,972
6/8 (1997/9)	540 m.t.	70,153	33,013	103,166
9/15 (2000/06)	540 m.t.	74,333	34,980	*109,314

* Average 6.5% SQ_2

c. Utilities and Energy (refer 4.7.4.1)

Consumption is essentially governed by throughput of bark.

The inputs indicated are applicable to both SQINT and SQPRC schedules relative to particular throughput.

Throughput	Utilities			Energy		
	Foreign US$	Local in US$	Total US$	Foreign US$	Local in US$	Total US$
300 m.t.	-	2,249	2,249	10,920	2,936	14,256
450 m.t.	-	2,772	2,772	16,380	3,763	20,543
540 m.t.	-	3,086	3,086	19,656	4,173	24,229

d. Direct labour (refer 8.5 & 8.5.1)

Direct labour is not directly relatable to the throughput of bark.

In the evaluations, two levels of direct labour are applied, depending on whether 2 shift or 3 shift working is necessary.

Also for convenience normal works overhead indirect labour has been included under the mantle of 'direct labour'.

Such covers supervisory wages, laboratory service, maintenance service, warehouse and a secretary as with this unit virtually all work relates to production.

Direct labour cost up to throughput 480 m.t. p.a.=US $53,000
Direct labour costs 480/650 m.t. p.a. =US $61,000

During the initial two months of production in year 1 (1992) the remuneration and expenses for services of a foreign training expert have additionally been charged to 'direct labour'.

Summarised inputs are:

Production year	Throughput	Foreign US$	Local in US$	Total US$
1 (1992)	300 m.t.	33,000	53,000	86,000
2/5 (1993/6)	450 m.t.	-	53,000	53,000
6/15 (1997/2006)	540 m.t.	-	61,000	61,000

e. Repairs & maintenance (refer 6.4.2)

Under planned maintenance, no great fluctuations of expense are forecast, only increasing gradually with plant age.

Production year	Foreign US$	Local in US$	Total US$
1 (1992)	8,000	1,000	9,000
2/5 (1993/6)	12,500	1,500	14,000
6/15 (1997/2006)	15,000	2,000	17,000

f. Spares (refer 6.4.1)

The first two years are covered as plant and equipment initial investment.

A regular expenditure and consumption is assumed starting with year 3 of production. This is applicable to all SQINT and SQPRC schedules.

Spares

Production year	Foreign US$	Local in US$	Total US$
3/15 (1994/2006)	26,000	-	26,000

g. Works overheads (refer 7.1.7)

These would normally be expected to cover:-

I. Supervisory labour
Laboratory service labour
Maintenance service labour

II. Fuel & energy costs
Utilities cost

III. Plant depreciation

IV. Maintenance materials
Laboratory materials
Works vehicle expenses
General manufacturing expenses
Protective clothing
Cleaning materials
Intermediate packing
Disposable.

Of these subsections I-IV, it has already been indicated that as those of group I have already been allocated to 'direct labour'.

Groups II and III to suit COMFAR input requirements are dealt with as separate inputs. Group II has already been covered and Group III will be dealt with later.

The remaining Group IV represents the works overheads cost submitted in this report and have been considered to be essentially directly variable with the SQ_2 output of production.

<u>3.0% SQ_2 bark</u> (SQINT 1/2)

Production year		Throughput	Foreign US$	Local in US$	Total US$
1	(1992)	300 m.t.	4,800	5,200	10,000
2/5	(1993/6)	450 m.t.	7,200	7,800	15,000
6/8	(1997/99)	540 m.t.	8,640	9,360	18,000
9/15	(2000/06)	540 m.t.	30,720	33,280	64,000*

* Due to increase to 6.5% SQ_2 and high salts output.

<u>5.0% SQ_2 bark</u> (SQINT 3/6)

Production year		Throughput	Foreign US$	Local in US$	Total US$
1	(1992)	300 m.t.	12,960	14,040	27,000
2/5	(1993/6)	450 m.t.	19,680	21,320	41,000
6/8	(1997/99)	540 m.t.	23,520	25,480	49,000
9/15	(2000/06)	540 m.t.	30,720	33,280	64,000*

h. <u>Administration overheads</u> (refer 7.1.7)

At this level of evaluation the administration overheads have been considered to be constant irrespective of throughput or output.

Only the salary of the Director/General Manager has been included within the administration overheads heading.

Production year	Foreign US$	Local in US$	Total US$
1/15 (1992/2006)	-	88,000	88,000

Applicable to all SQINT and SQPRC schedules.

i. <u>Sales and distribution</u> (refer 3.6.1)

Only indirect sales and distribution sales costs have been applied for evaluation.

These costs relate directly to the quantity of finished salts marketed and are applicable to all SQINT and SQPRC schedules.

Indirect sales and distribution costs

Throughput bark	Foreign US$	Local in US$	Total US$
300 m.t./3.0% SQ_2	18,000	-	18,000
450 m.t./3.0% SQ_2	26,000	-	26,000
540 m.t./3.0% SQ_2	32,000	-	32,000
300 m.t./5.0% SQ_2	48,000	-	48,000
450 m.t./5.0% SQ_2	72,000	-	72,000
540 m.t./5.0% SQ_2	86,000	-	86,000
540 m.t./6.5% SQ_2	111,000	-	111,000

j. Depreciation (refer 7.1.8)

Depreciation of all assets is entered under COMFAR as a single item coverirg initial fixed assets and current fixed assets.

Initial fixed assets depreciation is determined from the following rates and periods of depreciation and relevant salvage (or scrap) values allocated.

Initial fixed assets

Item	Initial fixed assets values US$	% dep.	% scrap	yrs. dep.
Land	25,300	0.0	100	0.0
Site	50,690	10.0	15	10.0
Structures	203,170	10.0	15	10.0
Incorporated fixed assets:				
(a) works vehicle	27,000	33.3	nil	3.0
(b) technology	82,500	10.0	nil	10.0
Plant & machinery	1,176,689	10.0	10	10.0
Auxiliary & service	1,042,800	10.0	10	10.0
Pre-production	66,096	10.0	nil	10.0

Current fixed assets

In view of the fact that it has been projected that no major replacement of capital plant and equipment or buildings, nor any new items, will need to be installed during the fifteen years of production scheduled in the evaluation, this section covers only two items. Depreciation of these is determined from the following parameters.

Item	% dep.	% scrap	yrs. dep.
Works vehicle	33.3	nil	3.0
Site development (Cinchona)	10.0	25	10.0

10.3 Sales price (refer 3.6)

All sales are made in terms of SQ_2 and the price recorded on this basis as f.o.b. nearest airport.

A constant sales price has been entered throughout the whole evaluation period.

Sales price: US $70.0 per kilogram SQ_2

10.4 Financial Scenarios and Inputs

In view of the fact that the quality of the Cinchona bark input was not fully available during the study, several scenarios were examined.

The first scenario was based on a preliminary set of analyses performed on available bark samples, albeit from undefined, diseased trees. Analysis of these showed an average SQ_2 content of 3%. Although from experience it was considered that such a low level would not be economic as a standard level over the years, the situation was examined in depth from the viewpoint of upgrading the quality of the cinchona stand over future years as quickly as possible. This scenario, therefore, examined an input of bark at 3% with a first year throughput of 300MT, followed by 4 years at 450MT per annum, and then increasing to 540MT per annum. These are levels of bark calculated as being available over the years. The Cinchona stand improvement programme was integrated in the analysis. Schedules were produced using the UNIDO Computer Model for Feasibility and Analysis Reports (COMFAR).

For the first scenario referred to as SQINT1, a full set of schedules have been attached, including a summary sheet with SER (Shadow Exchange Rate) adjustments.

The second scenario was investigated to show the situation if the quality of the stand was rather better than the initial analysis suggested. An arbitrary content of 5%SQ_2 was chosen as not being unrealistic in view of the fact that three C. Ledger species (usually containing highest quinine contents) are planted and together comprise over 54% of the mature stands and 62.5% of the immature stands.

For this scenario, referred to as SQINT2, similar schedules with the exception of the projected balance sheet and net income statement, have been presented. Investment and working capital costs are the same as SQINT1. A summary sheet considering a 6 year tax holiday, for which this project could qualify, has also been presented.

Two further scenarios are also considered where again the bark quality was assumed to be 5%SQ_2, and that this quality would remain constant throughout the analysis period. In these cases an independent processing unit purchasing the bark at suggested world market price, and having no involvement in establishment of future plantations, was considered. The only difference in the scenarios is that one employs a constant throughput of 450MT per annum, while the latter incorporates an increase in throughput from the 6th year on to 540MT per annum.

The third scenario (SQPRC1 & 2 entitled "Processing only 450MT") and the fourth scenario (SQPRC3 & 4 entitled "Processing only 540MT") each present two summary sheets, the second in each case with SER adjustment.

Only schedules for total investment costs, total production costs, cash flows, cash flow discounting and net income statements have been presented.

The inputs on which the analyses have been based have been itemised in sections 10.1, 10.2 and 10.3

10.5 Financial Evaluation

A separate summary of the financial and Economic analyses resulting from the COMFAR presentations is to be given later and will cover such indicators as the Net present Values (NPV) and Internal Rates of Return (IRR). Other aspects of interest which will be considered below cover the payback periods, breakeven points and sensitivity.

10.6 Payback periods

These are derived from the COMFAR schedules and summarised below. The figures quoted are relative to commencement of production, from commencement of contract 1.5 years should be added.

Profile	Payback period (years)
SQINT1	12.0
SQINT2	5.5
SQPRC1	11.8
SQPRC2	10.3

10.7 Breakeven analysis

These are based on the 3%SQ_2 and 5%SQ_2 integrated profiles and the following situations are covered.

1. Production levels
2. Sales price levels
3. SQ_2 level
4. Isolation yield level

10.7.1 Production levels

(a) Throughput level for 3% SO_2

This has been determined graphically as the analysis is complicated by the fact that the level of fixed costs changes at different throughput level brackets according to shift utilisation and possible further plant investment.

Breakeven analysis depicted in figure 22 shows that it would be necessary to install a second extractor and process a level of 1,060MT 3% bark per annum. Such a level is not feasible without installation of a second extractor and this level of bark is not available.

(b) Throughput level of 5% SO_2

This is presented graphically in figure 23 and a breakeven throughput level of 200MT per annum is indicated.

This may also be confirmed mathematically. Variable costs include all items relating to throughput of bark including sales commission and is calculated at $634.4 per MT.
X = MT at breakeven.

Production Volume x unit price=fixed costs + variable costs

$$\frac{5}{100} \times X \times 0.85 \times 70{,}000 = 467{,}194 + 634.4X$$

$$2{,}340.6X = 467{,}194$$

$$X = 199.6MT$$

Breakeven (calc) = 199.6MT or 44.35% scheduled throughput

This can equally be interpreted as sales breakeven point at 44.35% of sales.

3% SQ₂ INTEGRATED - CONSTANT QUALITY

BREAKEVEN THROUGHPUT.

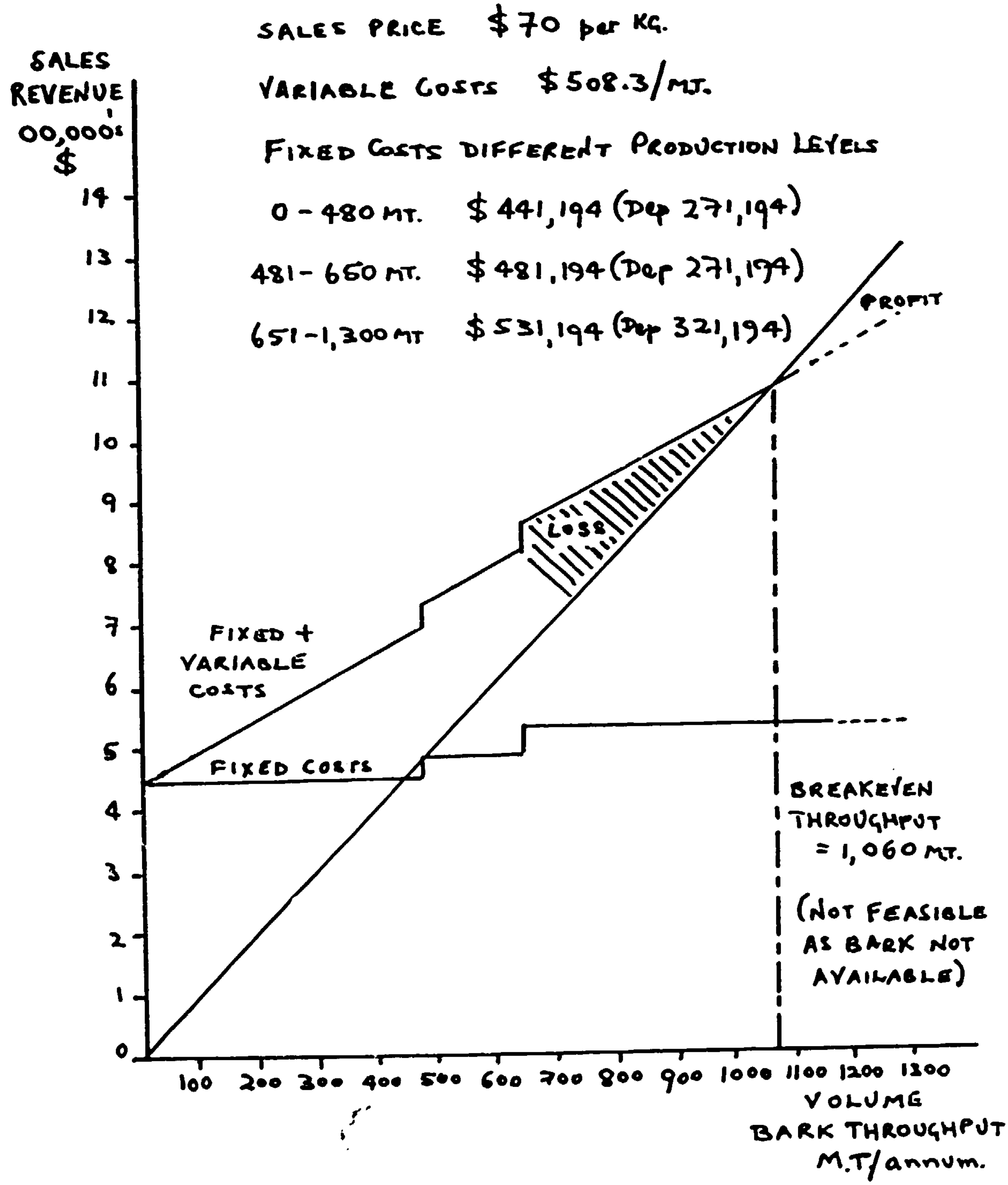


Figure 22

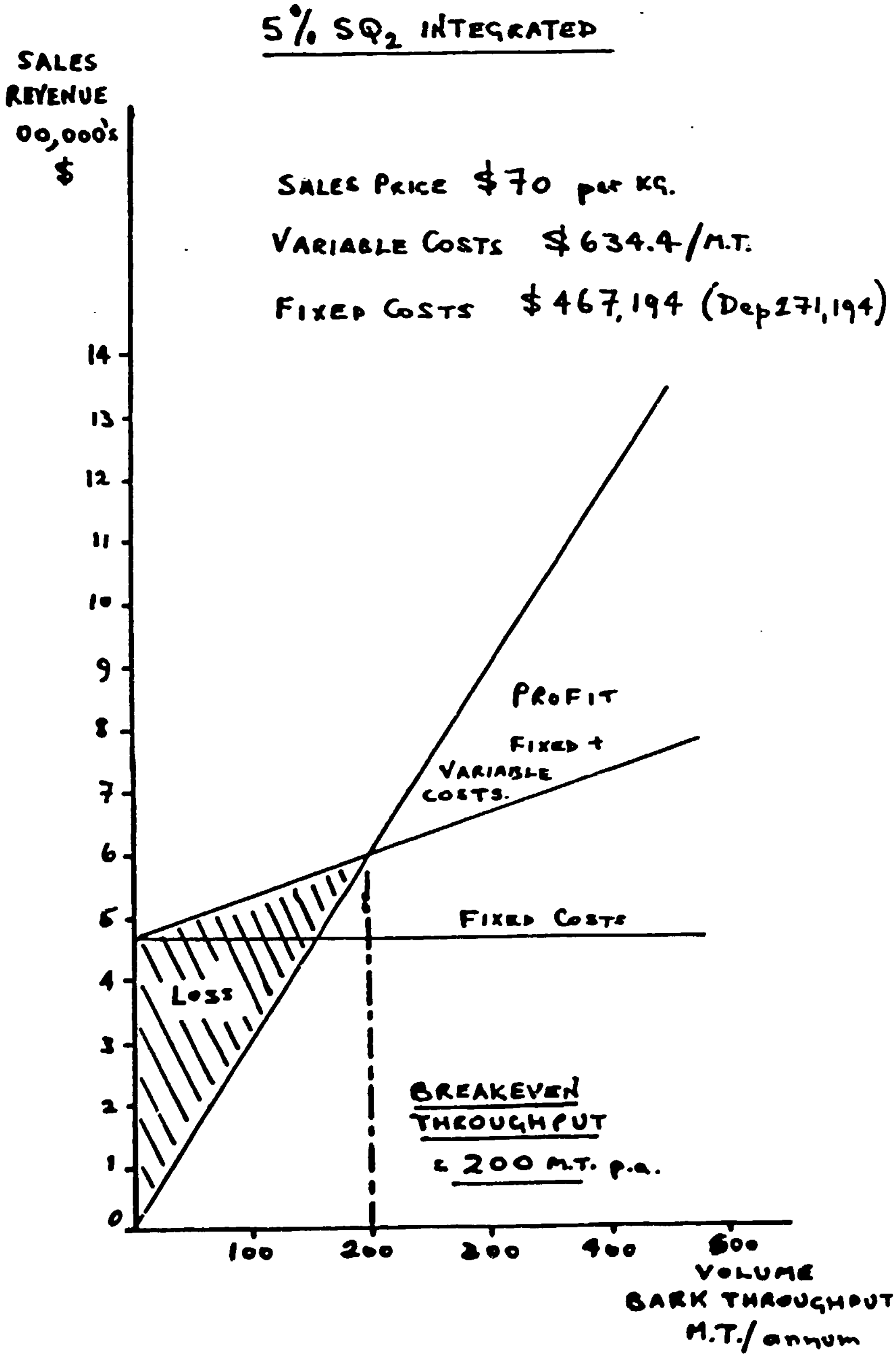

5% SO2 INTEGRATED
SALES REVENUE 00,000's $
SALES PRICE $70 per KG.
VARIABLE COSTS $634.4/M.T.
FIXED COSTS $467,194 (Dep 271,194)
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
PROFIT
FIXED + VARIABLE COSTS.
FIXED COSTS
LOSS
BREAKEVEN THROUGHPUT ≈ 200 M.T. p.a.
100
200
300
400
500
VOLUME
BARK THROUGHPUT
M.T./annum

Figure 23

10.7.2 Sales Prices

(a) For 3%SQ_2 content, 450MT per annum

Output 6,980kgsSQ_2
Production cost \$642,920 (fixed) + 6980 x $\frac{5.3X}{100}$

where X = US\$ price per kg
Then 6980 X = 643,920 + 370x
X = 97.4
Breakeven will be met at a sales price of \$97.4 per kgSQ_2

(b) For 5%SQ_2 content, 450MT per annum

Output 19,125kgsSQ_2
Production costs \$680,674 + 19,125 x $\frac{5.3X}{100}$

Then 19,125X = 680,674 + 1014X
X = 37.6
Breakeven will be met at a sales price of \$37.6 per kgSQ_2

10.7.3 Bark SQ_2 content

Breakeven level for SQ_2 content of bark at fixed throughput of 450MT per annum.

Variable costs relate here to refining chemical costs, general overheads and sales commission with respect of output production and can be calculated at \$5557 per 1000kgSQ_2. output yield 85% (assumed).

Fixed costs, relating to bark throughput are \$608,751.
Then X = %SQ_2 level for breakeven.

$$\frac{X}{100} \times 450 \times 0.85 \times 70,000 = 608,751 + \frac{X}{100} \times 450 \times 5557$$

$$X = 2.51$$

This result is, however, misleading. In the calculation it has been assumed that an overall isolation yield of 85% would be achieved. This would not be achieved from a bark of content 2.51%. Inevitably such a bark (unless from a high quality immature C. Ledgeriana tree) would contain other alkaloids in sufficiently high content to depress the isolatable yield to as low as 50%. The calculation can be repeated incorporating the yield set for 3%SQ_2 in scenario one which was 51.7%. This reduces the variable costs per 1000kgsSQ_2 to \$4320.
Then

$$\frac{X}{100} \times 450 \times 0.517 \times 70,000 = 608,751 + \frac{X}{100} \times 450 \times 4320$$

$$143,415X = 608,751$$

$$X = 4.79$$

The real breakeven point will lie somewhere between 2.51% and 4.79% SQ_2 but as no direct correlation exists between content and yield it is not possible to be more accurate.

10.7.4 Isolation yield levels

(a) Breakeven isolation yield for 3%SO_2 bark

This value can be readily calculated and can be useful in assessment of individual bark qualities. In this case it is not possible to incorporate the sales commission in the variable costs as such without knowing the isolatable yield. The sales commission is therefore allowed for in the revenue side of the equation. Variable cost per kilogram SO_2 in bark for this calculation is $3128. An assumption has to be made that the chemical consumption cost does not appreciably change with yield and in fact this would not be substantial as most chemical cost relates to the bark processing and initial isolation.

Then where X = isolatable yield %

$$0.947 \times \frac{3}{100} \times 450 \times \frac{X}{100} \times 70{,}000 = 622{,}559 + \frac{3}{100} \times 450 \times 3128$$

$$8949X = 664{,}787$$

$$X = 74.3$$

Breakeven isolation yield = 74.3%

(b) Breakeven isolation yield for 5%SO_2 bark

This may be calculated in an analogous manner.

The result is:-
Breakeven isolation yield = 46.5%

This in effect indicates the scope of inefficiency in isolation which could be tolerated before losses are made.

10.8 Sensitivity Analysis

This analysis has been applied to the case of integrated processing of 5% SO_2 bark for which the reference levels are :-

Sales Revenue	US$	1,338,750
Fixed Production Costs	US$	467,194
Variable Production Costs	US$	285,478
Depreciation	US$	271,194

Analysis has considered the effect of variation of unit sales price, variable production costs and fixed production costs. Levels of +/- 20% have been chosen and calculations based on

$$BEP = \frac{\text{fixed production costs}}{\text{sales revenue - variable production costs}} \times 100$$

(a) sales revenue +/- 20% ; fixed and variable costs constant

At + 20% BEP = 35.4%

At - 20% BEP = 59.5%

These correspond to sales levels of 6.77 MT SQ_2 (+20%) to 10.77 MT SQ_2 (-20%).

Alternatively they may be interpreted as a safety margin of 64.6% at +20% or 43.7% at -20%.

(b) Variable costs +/- 20% ; fixed costs and sales revenue constant.

At + 20% BEP = 47.12%

At - 20% BEP = 42.26%

(c) Fixed costs (excluding depreciation) +/- 20%, variable costs, depreciation and sales revenue constant.

At + 20% BEP = 48.1%

At - 20% BEP = 40.6%

10.9 Summary of Financial and Economic Analyses

General Considerations

Four scenarios were examined in the financial and economic analyses, the scenarios differing in terms of the quality of the bark, the mode of operation (integrated vs. processing alone), and the scale of operation (450 MT vs. 540 MT of bark). The UNIDO Computer Model for Feasibility Analysis and Reports (COMFAR) was used to conduct the cash flow analyses. However, certain common assumptions were adopted in the delineation of the cash flows from both the investors' and the economy's viewpoints:

(a) All financial flows are in US dollars at constant June 1989 prices, with the exchange rate placed at P21.70/$1. Relative prices are assumed to remain the same throughout the project life (15 years for analytical purposes).

(b) Construction is assumed to start on the second semester of 1990, running over three semesters, so that production starts in 1992. Only 300 MT of bark will be processed on the first year, rising to 450 MT by the second year.

(c) The build-up of working capital is assumed to start on the first year of operation, with 60 days' coverage for spares and 30 days' coverage for all other accounts (including receivables and payables).

Scenario A

The first scenario considers a 3% yield on the bark, which was what the initial test results showed. Because of this low yield, the quinine plant would be worth establishing only if a cinchona replanting program would be started to produce trees with higher yield. The analysis for Scenario A thus covers an integrated cinchona plantation and quinine processing plant.

The capital cost of the quinine plant itself is $2521.11 thousand, but the laboratory and nursery facilities add on $153.14 thousand to the initial investment. Developing the plantation also means incurring current investment costs of $244.74 thousand for 1992 (the first year of production, declining to $220.60 thousand by 1999 (the eighth year of production). Since the analysis covers only 15 years of operating life, new planting is assumed to last only up to 1999. The planting expenses are considered as current investment rather than production cost, as the trees do not mature until after seven years.

The schedule of throughput is 300 MT of bark in year 1, 450 MT for years 2 to 5, and 540 MT for year 6 onwards. However, if the present stock of trees yields only 3% quinine, the increase in yield will be felt only by year 9, when average yield rises to 6.5% quinine.

The resulting analysis shows a financial internal rate of return (IRR) on total investment of only 9.08%, before the corporate income tax. The application of income taxes will of course reduce the profitability. Even with a six-year tax holiday as allowed for by the Omnibus Investment Code, financial profitability will not be enhanced, as profits are not realised until after 1999, when revenues rise significantly.

From the economy's viewpoint, the cash flow adjustment made was simply the application of the shadow exchange rate (SER) to all inflows and outflows involving foreign exchange. The ratio of the SER to the Official Exchange Rate used is 1.2, which is the official Philippine government estimate. Since the project is export producing, the resulting economic IRR is higher than the financial IRR at 10.81%, but still much lower than the 15% social opportunity cost of capital officially adopted by the Philippine government.

Scenario B

Further testing of bark samples will be conducted to verify whether the 3% yield is indeed representative of the whole plantation. The second scenario looks at what would happen to profitability if the new tests should show a higher yield at, say, 5% quinine. The financial IRR before the corporate income tax rises significantly to 23.67% in this case. With the six year tax holiday, investor profitability is still high at 20.89%; in fact, even with no tax incentives, the project yields a financial return of 17.40%. The economic IRR also looks good under this scenario, at 26.60%.

Scenario C

The third scenario examines the case where only processing is involved, with the investors buying the bark at world market prices. The quinine content is assumed constant at 5%, with production throughput at 300 MT on year 1 and 450 MY from year 2 onwards. (The 3% case in this arrangement is not profitable.) The financial IRR in this scenario is only 12.52% before tax, while the economic IRR is 15.08%.

Scenario D

The fourth scenario differs from the third only in the assumption that from year 6 onwards, the throughput rises to 540 MT. As expected, the financial IRR rises to 14.50%, while the economic IRR rises to 17.00% with the higher capacity utilisation.

SUMMARY OF COMFAR RESULTS

		Investment		Indicators	
File	Description	Foreign	Total	NPV 15%	IRR
SQINT1)A	3%-3%-6.5% w/o tax	68.83%	2674.25	-1360.53	9.08%
SQINT2)	3%-3%-6.5% w/ SER	72.61%	3042.40	-1118.53	10.81%
SQINT3)	5%-5%-6.5% w/o tax	68.83%	2674.25	1585.73	23.67%
SQINT4)B	5%-5%-6.5% w/ SER	72.61%	3042.40	2438.06	26.60%
SQINT5)	5%-5%-6.5% w/ tax	68.83%	2674.25	398.30	17.40%
SQINT6)	5%-5%-6.5% w/ hldy	68.83%	2674.25	926.92	20.89%
SQPRC1)C	5%--450 MT w/o tax	68.92%	2521.11	-300.59	12.52%
SQPRC2)	5%--450 MT w/ SER	72.68%	2868.60	11.48	15.08%
SQPRC3)D	5%--540 MT w/o tax	68.92%	2521.11	-65.78	14.50%
SQPRC4)	5%--540 MT w/ SER	72.68%	2868.60	304.50	17.00%

10.10 FURTHER CONSIDERATIONS BASED ON C. LEDGERIANA ALONE

The recent analysis results indicate so far that only C. Ledgeriana can be considered of suitable quality for extraction processing. Clearly this is much lower than the throughput required for viable production in the size of production unit evaluated.

Although all analysis of latest samples have not yet been completed, there is sufficient information to suggest that the average bark content must be below 4% and with a relatively high cinchonidine content. This also is unsatisfactory.

It was considered necessary before dismissing the project out of hand to investigate the possibility of utilising the good quality Cinchona bark alone.

The quantity of C. Ledgeriana available for a sustained programme has been determined at 100MT per annum (see Table 3) and analysis indicates a content of 6.8% SQ_2. The consistency of this level and quality would need to be checked by a wider analysis screening.

The level of 100MT has been demonstrated to be too low a throughput for the size of plant having a throughput of up to 650MT per annum and consideration must be given to a smaller production unit. There is evidence of small units having been operated in Colombia, Equador and Bolivia, though not necessarily profitably.

Consideration is therefore given to a production unit which could process between 100MT and 325MT per annum, which is 50% of the size of the original proposal. To consider less capacity than this is not advisable for the reduction in capital costs and operating costs would be low.

Processing of 100MT C. Ledgeriana bark with 6.8% SQ_2 content

It is proposed:-

1. That a processing plant of capacity 300/325MT per annum should be most appropriate which would process 100MT per annum working on one day shift. Capacity would be available for later expansion. The smaller the equipment the more relatively expensive it will be.

2. Changing the buildings

(a) Reducing the size of the bark and raw material store.
(b) Maintaining the design of the processing building except that the function of the rooms should be modified to incorporate offices and laboratory.
(c) The office and laboratory block would not be built.

3. That a site of 1 hectare should still be considered to allow for later extension. Costs would be reduced to some extent in site works by only fencing the operating area and internal service roads would be limited.

Again different scenarios will be considered for comparison, looking briefly at a processing plant only and an integrated unit.

For this exercise the estimates may be less accurate as plant and equipment costs are determined by a rule of thumb factor.

Normally a factor of 1.6 is applied when doubling the size of a plant; the converse is used here.

1. PROCESSING ONLY

Inputs Initial investment	US$
Land cost	25,300
Site preparation and development	40,000
Structure and civil engineering	126,000
Auxiliary and services	651,750
Installed plant and machinery	639,806
Incorporated fixed assets	109,500
Pre-production costs	29,812
Technology	75,000
Total initial investment	1,697,168
Current investment	
Working capital	44,557
Total investment costs	1,771,725(70.7%foreign)

Production cost inputs

Raw material

Purchasing bark of 6.8% SO_2 at P35.9 ($1.654) per kg.
Cost for 100MT = US $165,400

Labour and Salaries

	P	
Director/Manager	144,000	Allocate
Secretary/typist	42,000	to Admin.
Security	36,000	overheads
	222,000 x 1.0833 = US $11,082	
QC(2)	120,000	
Mech/Driver(2)	58,800	Allocate
Boilerman	29,856	to Factory
Warehouse/clerk	36,000	overheads
	244,656 x 1.0833 = US $12,213	
Extraction operators(2)	60,000	Allocate
Labourers(2)	49,760	to Direct
Refinery(4)	91,872	labour
	201,632 x 1.0833 = US $10,066	

Pre-production (foreign) US $27,000

Pre-production labour (local)

Director/Manager	43,200	
Mechanics(2)	4,000	
QC	5,000	
Operators	3,828	Pre-production
Office	5,000	
	61,028 x 1.0833 = US $ 3,047	

Utilities and fuel (for 100MT) US$ 5,226
Repairs and maintenance US$ 3,111 (est)

Factory overheads (excludes depreciation P & M)

	US$	
Indirect labours	12,213	
Maintenance materials	3,111	(est)
Laboratory expenses	500	(est)
Gen. manufacturing	8,500	(est)
Works vehicle	1,000	(est)
	25,324	

Admin. overheads (excludes building depreciation)

Salaries	11,082	
Maintenance	1,500	(est)
Rates	4,000	(est)
Insurance (3.5%)	36,105	
Legal & Professional	1,500	(est)
Audit	700	(est)
Stat. travel	1,200	(est)
Post & telephone	1,000	
General charges	1,000	(est)
	58,087	

Chemical additives

Bark processing	15,300
Salts processing	5,676
	20,976

Depreciation -	Plant & machinery	10 years
	Buildings	20 years
	Vehicle	3 years

Total depreciation US $158,886

Production costs (Processing unit

Raw material	165,400
Other chemicals	20,976
Utilities	616
Energy	4,610
Labour - direct	10,006
Repair, maintenance	3,111
Factory overhead	25,324
Factory costs	230,043
Admin. overheads	58,087
Depreciation	158,886
Sales Comm. & royalty	12,138
Total costs	459,154

PROCESSING ONLY

Net Income Statement

	US$
Total sales	404,600
Production costs	459,154
Operational margin	-54,554
Gross & net profit	-54,554
Gross profit % sales	-13.483
Net profit % sales	-13.483
ROE, Net profit, % equity	- 3.214
ROI, Net profit, % investment	- 3.132

Conclusion

As illustrated in figure 24, a throughput of 130MT of 6.8% SO_2 bark is necessary before reaching the breakeven point. Even at full capacity the return on equity is only 16.5%. The substantial increase in fixed overheads at 200MT throughput is due to increased depreciation resulting from the necessary building at this level of a separate office/laboratory building, costs estimate US $90,000.

This scenario only begins to look attractive at full capacity throughput.

2. INTEGRATED UNIT WITH IMPROVEMENT OF PLANTATION

Cost of cinchona bark raw material is replaced by the harvesting costs.

Purchase price of 100MT bark	US $165,400
Harvesting cost	US $ 23,111
Reduction in production costs	US $142,289

Additional costs for establishment of high quality cinchona stand (increase quality and volume to 300MT per annum planting 240 hectares)

(a) Initial investment - tissue culture laboratory

Single storey 200m^2	US $ 40,000	
Equipment	US $ 87,000	
Pre-production expenses	US $ 40,800	
Total initial investment	US $1,864,968	(70.8% foreign)

(b) Current investment	
Additional working capital	US $ 26,200
Site development cost for planting 240 hectares	US $ 185,556
Total investment costs (yr 1)	US $2,121,281

Production costs	US $ 459,154
Less RM reduction	142,289
	316,865
+ depreciation increase	18,555
Total production costs	335,420

Net income statement

	US$
Total sales	404,600
Production costs	335,420
Operational margin	69,180
Gross & net profit	69,180
Gross profit % sales	17.10%
Net profit % sales	17.10%
ROE, Net profit, % equity	3.71%
ROI, Net profit, % investment	3.57%

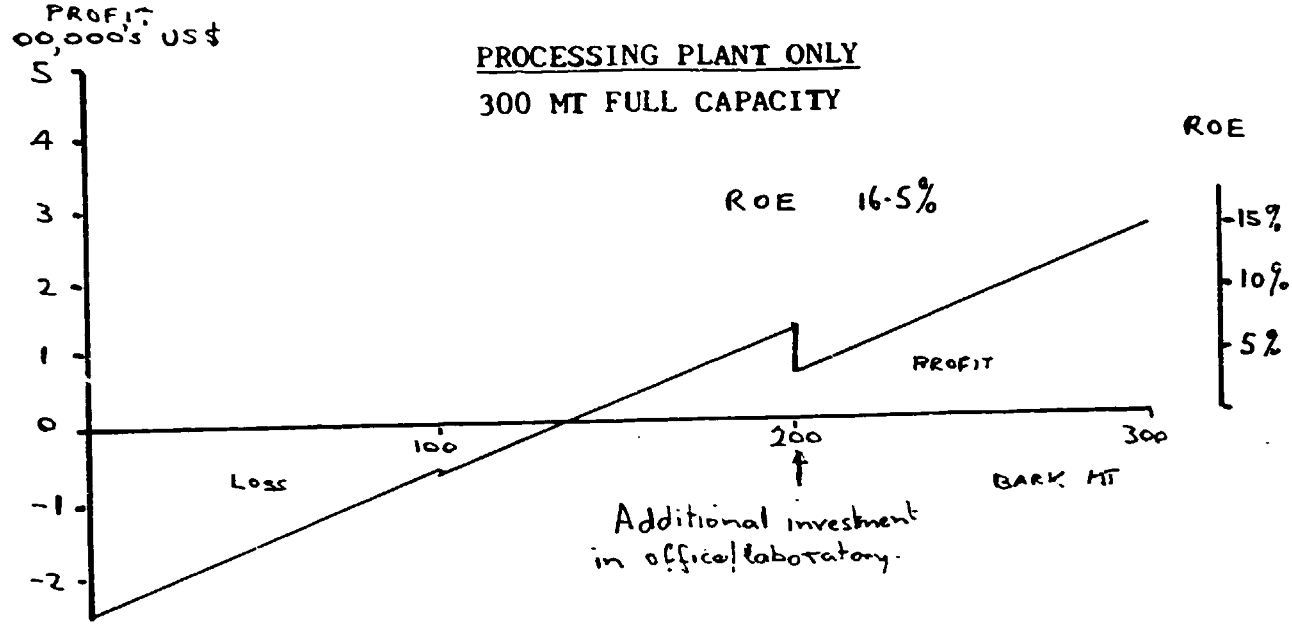
Conclusions

Figure 25 indicates a breakeven point at 80MT per annum. The scenario is not attractive at the level of estimated current availability of bark of 6.8% SQ_2 but would start to be attractive from 160-200MT per annum on the basis of this simple analysis.

After about eight years when the new stands would be mature the throughput of 300MT per annum would be available of improved quality. The project would then be very profitable.

PROCESSING PLANT ONLY

300 MT FULL CAPACITY



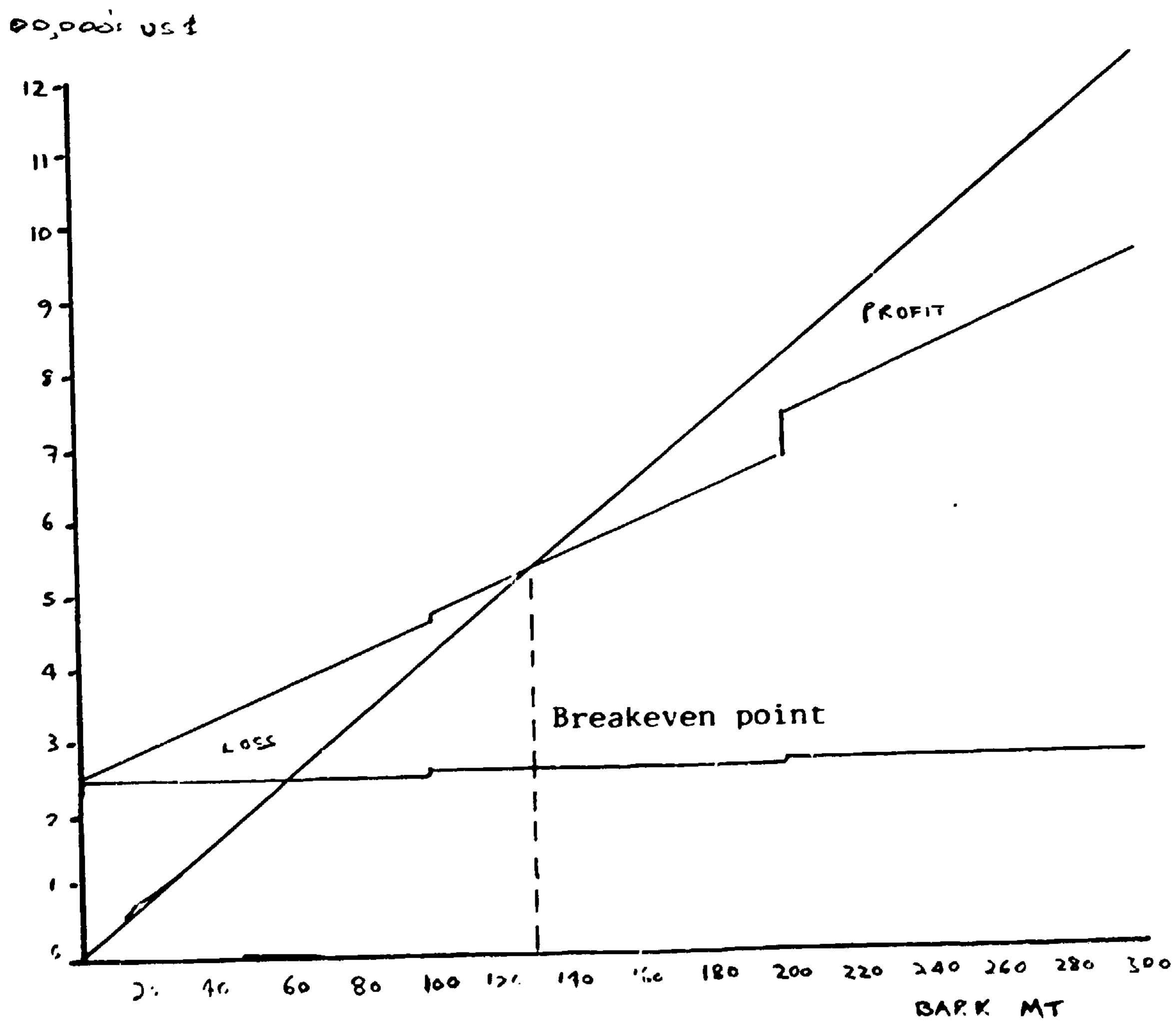


Figure 24

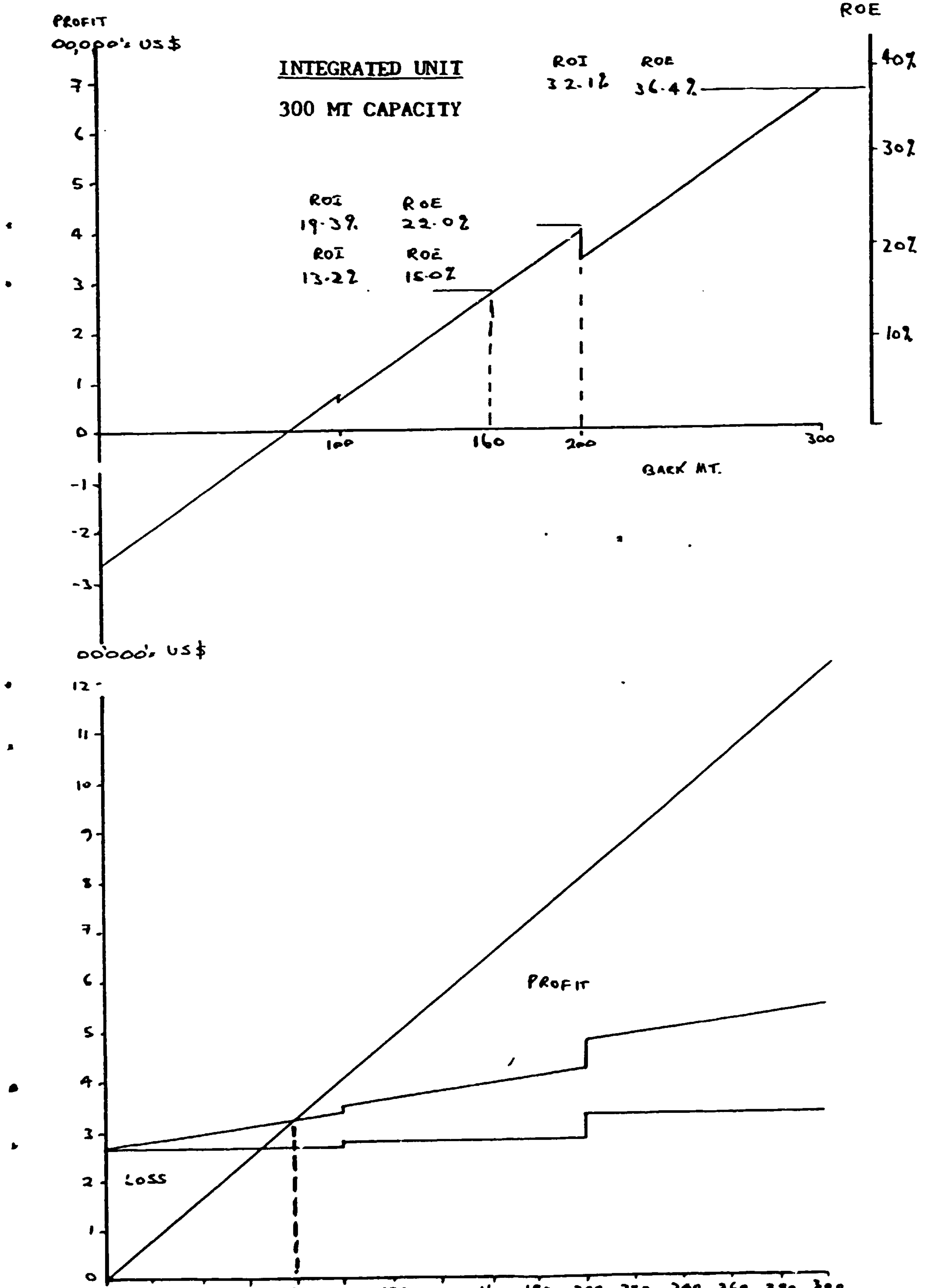

PROFIT
00,000's US$
INTEGRATED UNIT
300 MT CAPACITY
ROE
ROI 32.1% ROE 36.4%
ROI 19.39% ROE 22.0%
ROI 13.22 ROE 15.0%
40%
30%
20%
10%
7
6
5
4
3
2
1
0
-1
-2
-3
100
160
200
300
BARK MT.
00000's US$
12
11
10
9
8
7
6
5
4
3
2
1
0
PROFIT
LOSS
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
BARK M.T.

Figure 25

In view of the fact that current assessment suggests that no more than 100MT per annum of high testing bark is available the financial analysis will not be taken further at this point, but consideration given to the supply position.

Sufficient possibilities can be seen to justify carrying out a more detailed and extensive analysis of existing stands. It is thought that estimates have been determined conservatively and it is possible that some reasonable quality barks may exist amongst the C. Officinalis and C. Hybrid to supplement the level of available bark suitable for extraction.

An estimate has also been made to determine the effect of delaying harvesting until later years during which time quinine will be accumulating on the trees. These projections are indicated in table 4 when it is found that delaying any harvesting until at least 1993 an off-take of C. Ledgeriana amounting to 160MT per annum, covering processing from 1993/4 to 1999/2000, could be realised.

For processing after 1999/2000 it would be necessary to start planting a minimum of 160 hectares (2m x 2m) with C. Ledgeriana seeds in 1990 and continuation at this level until plants from tissue culture become available.

Planting should preferably be performed in the new areas at 1500m level and apart from the more preferred situation will be well separated from other species currently planted. To preserve an adequate supply of good quality seeds, it may be necessary to remove any other species in the immediate vicinity of good quality trees to avoid subsequent cross pollination. This appears to be a realistic approach with a good possibility of success and, apart from the immediate necessity to start collection and planting of C. Ledgeriana seed and plants, gives the time to fully assess the potential and quality of the stands while giving in-depth attention to the planning of processing and development.

Financial and economic evaluation cannot be covered in detail, but figures shown do indicate financial possibilities. From the economic point of view considerations can be given to basic economic advantages with regards to foreign exchange, local purchases and labour utilisation.

TABLE 4

CALCULATION OF C. LEDGERIANA AVAILABILITY WITH DELAYED HARVESTING

Year:	1970	1971	1972	1973	1974	1975	1976
1993 bark available	55	88	101	22	25	11	-
Harvest	55	88	17				
	-	-	84				
1994 bark available			89	23	27	12	-
Harvest			89	23	27	12	
			-	-	-	-	

Year:	1977	1978	1979	1980	1981	1982	1983
1994 bark	33	34	113	17	21	61	58
Harvest	9						
	24						
1995 bark	25	36	120	18	22	65	51
Harvest	25	36	99				
			21				
1996 bark			22	19	23	69	65
Harvest			22	19	23	69	27
			-	-	-	-	38

Year:	1983	1984	1985	1986	1987	1988
1997 bark	40	16	106	83	31	37
Harvest	40	16	104			
	-	-	2			
1998 bark			2	88	33	39
Harvest			2	88	33	37
			-	-	-	-

1999 Harvest - from plantings 1992 or ealier.

Foreign exchange

Under operating conditions three areas are considered:-

1. Saving of foreign exchange; domestic supply of currently and possible future importation of finished quinine is limited and estimated to amount to	US $25/50,000 p.a.
2. Earning of foreign exchange from export sales	US $647,000min.p.a.
3. Additional foreign exchange outlays on chemicals	US $20,000
Net benefit	US $652/677,000p.a.

Local purchases

Chemicals, utilities and miscellaneous materials min P300,000p.a.

Labour

Although not substantial covers both technical and manual labour initially amount to 17 persons. However, there will be also some increase in plantation labour and creation of regular, though seasonal, additional labour for local residents during the harvest season and possibly employing some 100/120 persons.

Technology

Albeit small in stature, this project does create the development of chemical and extraction technology and initiation of a basic bulk pharmaceutical production.

The basic parameters of the plan could also lend itself to utilisation for extraction of other natural products in the unlikely situation that the market or raw material supply would fail.

10.11 Land utilisation and Cinchona supply

Recent information (30.8.1989) confirms that the 8,600 hectare of land indicated for Cinchona cultivation has only been identified by DENR 10 as a potential expansion area for contract reforestration, or industrial tree plantation. It does not fall within the Cinchona Forest Reservation nor is it proposed that it should do so.

Development of the land could be by contract growing by small holders or as an industrial tree plantation. Such development would not preclude involvement by DENR or supply from the Cinchona Forest Reservation.

Although not detailed in the report, these situations could well be incorporated into the integrated unit, or otherwise, all planting and funding costs having been included. The costs might need reallocation. Lease of forest land was not specifically included as it was not able to establish the possible cost. The price would be expected to be considerably less than the figure quoted in the Lantapan area of P1000 per hectare for agricultural or industrial land and should have little significance in the total growing cost.

If necessary, in the case of not being under direct control of the production company, a protection of the supply position could be secured by a Government imposition of a ban on exportation of Cinchona bark.

10.12 Plantation costs and returns

Costs of planting, maintenance and harvesting are exactly the same for all qualities of trees. For this reason alone only high quality stands should be cultivated.

The costs of growing need closer examination for variations have been observed in figures presented by different sources. The highest figure just received from the Director, DENR, Manila is P 15,000 per hectare average for planting and three years' maintenance of denuded forest.

Harvesting costs also bear closer examination. Generally figures of P 5,000 per hectare maximum were reported, but in a paper later received from the Forest Management Bureau a figure of P 5,113,898 (including administration, road maintenance and transportation costs to Cagayan de Oro City) for 600 m.t. dry bark were estimated. This corresponds to P 8,523 per hectare.

Estimation of plant returns

Assumptions:

Planting 1 hectare, 2m x 2m	= 2,500 seedlings
Survival rate 53%; mature trees	= 1,325 trees
Yield for 7 year old C. Ledgeriana	= 1.15kg per tree
Total yield per hectare	= 1,523kg dry bark
Cost of planting 1 hectare at P 15,000 per hectare (assuming all cost incurred first year although in practice some is in later years	= P 15,000
Assuming investment borrowed at 12% p.a. interest over 7 years, interest	= <u>P 18,160</u>
Sub-total	= P 33,160
+ Harvesting cost	= <u>P 8,523</u>
Total cost	= P 41,683

The situation of margin may be compared for different bark qualities assuming valuation is at the 'World prices' suggested within the report.

These are:

SQ_2 content:		5.0%	6.8%	7.5%	9.0%
Value per kg:	(P)	24.32	35.99	41.12	51.98

Operating margins:

SQ_2	5.0%	6.8%	7.5%	9.0%	9.0%(MS)
Sales value (P)	37,039	54,813	62,626	79,166	79,166
Costs	41,683	41,683	41,683	41,683	46,673
Margin	-4,644	13,131	20,943	37,483	32,493
ROI	-11.0%	31.5%	50.2%	89.9%	69.5%

The final column has been included because, in practice, it would be very difficult to establish a consistent stand of 9.0% SQ_2 by methods other than meristem tissue culture.

For tissue culture the production costs are somewhat higher and are estimated at P 46,673 in the first year, gradually reducing in later years. The result indicates clearly that the additional expenditure is justified.

The profit margins are good, but there could be further scope for improvement. Investment in the use of fertilisers and other methods to improve quinine contents and bark yields, although incurring additional expenditure, should be investigated for they are likely to improve the rate of return even further.

The so called 'world prices' are acceptable to manufacturers with substantial throughput. Margins increase quite rapidly with increase in throughput. For the sizes of operations considered for the Philippines (even the higher level of 450/540 m.t. per annum) the prices are really higher than can be easily borne. The growing margins are sufficient to probably negotiate lower domestic prices if a 'processing only' operation should be considered.

The 'world price' is somewhat arbitary and it has always been suspected that the larger manufacturers who also control their own plantations enter into purchases from outside sources to keep the price of generally available bark high for their competitors. By averaging out they can maintain a further distinct advantage over any non-growing manufacturers. This has no doubt contributed to the demise of several producers in the past.

It can be seen that very attractive returns can be realised by growing Cinchona bark, but it is absolutely essential to grow high SQ_2 content trees. It is for this reason that almost entirely C. Ledgeriana is found as the preferred species.

RESTRICTED ANNEXES ORIGINAL : ENGLISH

18500 (2 of 2)

PHILIPPINES PHARMACEUTICAL INDUSTRY DEVELOPMENT

DP/PHI/87/019

PRE-FEASIBILITY STUDY ON PROCESSING CINCHONA FOR QUININE IN THE PHILIPPINES

Contract No. 89/42

Prepared for the Government of the Philippines on behalf of the United Nations Industrial Development Organisation acting as executing agency for the United Nations Development Programme.

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Scotland, U.K.

August 1989

ANNEXES

COMFAR

INTEGRATED QUININE PLANT (SQINT1)
JULY 5, 1989
3% CONTENT WITH IMPROVEMENTS

1½ year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: THOUSAND U.S. DOLLARS

Total initial investment during construction phase

fixed assets:	2674.25	68.834 % foreign
current assets:	0.00	0.000 % foreign
total assets:	2674.25	68.834 % foreign

Source of funds during construction phase

equity & grants:	2674.25	68.834 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	2674.25	68.834 % foreign

Cashflow from operations

Year:	1	6	9
operating costs:	346.79	484.47	628.63
depreciation :	271.19	390.36	431.62
interest :	0.00	0.00	0.00
production costs	617.99	874.84	1060.25
thereof foreign	46.18 %	48.96 %	53.80 %
total sales :	326.02	586.85	2088.45
gross income :	-291.96	-287.99	1028.20
net income :	-291.96	-287.99	1028.20
cash balance :	-349.03	-159.14	1409.95
net cashflow :	-349.03	-159.14	1409.95

Net Present Value at: 15.00 % = -1360.53
Internal Rate of Return: 9.08 %
Return on equity1: 6.31 %
Return on equity2: 9.08 %

Index of Schedules produced by COMFAR

Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

INTEGRATED QUININE PLANT (SQINT2)
JULY 5, 1989
3% CONTENT WITH SER ADJUSTMENT

1½ year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.2000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: THOUSAND U.S. DOLLARS

Total initial investment during construction phase

fixed assets:	3042.40	72.606 % foreign
current assets:	0.00	0.000 % foreign
total assets:	3042.40	72.606 % foreign

Source of funds during construction phase

equity & grants:	3042.41	72.606 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	3042.41	72.606 % foreign

Cashflow from operations

Year:	1	6	9
operating costs:	365.80	511.78	675.33
depreciation :	309.27	448.73	499.00
interest :	0.00	0.00	0.00
production costs	675.07	960.51	1174.32
thereof foreign	50.73 %	53.51 %	58.28 %
total sales :	391.23	704.21	2506.14
gross income :	-283.84	-256.29	1331.82
net income :	-283.84	-256.29	1331.82
cash balance :	-348.83	-112.25	1773.33
net cashflow :	-348.83	-112.25	1773.33

Net Present Value at: 15.00 % = -1118.53
Internal Rate of Return: 10.81 %
Return on equity1: 8.23 %
Return on equity2: 10.81 %

Index of Schedules produced by COMFAR

Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

Total Initial Investment in THOUSAND U.S. DOLLARS

Year	1990.1	1990.2	1991.1	1991.2
Fixed investment costs				
Land, site preparation, development	0.000	75.536	0.000	0.000
Buildings and civil works	0.000	73.146	65.015	65.015
Auxiliary and service facilities	0.[illegible]	375.4[illegible]8	[illegible].696	[illegible].596
Incorporated fixed assets	0.000	29.700	26.400	53.400
Plant machinery and equipment	0.000	4[illegible]	276.542	276.542
Total fixed investment costs	0.000	977.843	801.653	628.653
Pre-production capital expenditures.	0.000	0.000	33.048	33.048
Net working capital	0.000	0.000	0.000	0.000
Total initial investment costs	0.000	977.843	834.701	861.701
Of it foreign, in %	0.000	65.274	70.416	71.342

INTEGRATED QUININE PLANT (SOINTI) --- JULY 5, 1989

Total Current Investment in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995-96	1997
Fixed investment costs					
Land, site preparation, development	244.742	236.742	236.742	236.742	220.602
Buildings and civil works	0.000	0.000	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000	0.000	0.000
Incorporated fixed assets	0.000	0.000	27.000	0.000	27.000
Plant, machinery and equipment	0.000	0.000	0.000	0.000	0.000
Total fixed investment costs	244.742	236.742	263.742	236.742	247.602
Preproduction capitals expenditures.	0.000	0.000	0.000	0.000	0.000
Working capital	83.517	11.606	10.833	0.000	13.912
Total current investment costs	328.259	248.350	274.575	236.742	261.514
Of it foreign, %	70.070	80.341	87.077	85.012	82.529

COMFAR 2.1 - NATIONAL ECONOMIC & DEV. AUTHORITY, MANILA

Total Current Investment in THOUSAND U.S. DOLLARS

Year	1996-99	2000	2001- 2	2003
Fixed investment costs				
Land, site preparation, development	220.602	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000	0.000
Incorporated fixed assets	0.000	27.000	0.000	27.000
Plant, machinery and equipment	0.000	[illegible]	0.000	0.000
Total fixed investment costs	[illegible]	[illegible]	0.000	27.000
Preproduction capitals expenditures.	0.000	0.000	0.000	0.000
Working capital	[illegible]	[illegible]	0.000	0.000
Total current investment costs	220.602	[illegible]	0.000	27.000
Of it foreign, %	83.516	[illegible]	0.000	100.000

Total Production Costs in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	69.000	104.000	104.000	104.000	104.000
Other raw materials	50.089	75.211	75.211	75.211	75.211
Utilities	2.249	2.772	2.772	2.772	2.772
Energy	14.456	20.743	20.743	20.743	20.743
Labour, direct	86.000	53.000	53.000	53.000	53.000
Repair, maintenance	9.000	14.000	14.000	14.000	14.000
Spares	0.006	0.000	26.000	26.000	26.000
Factory overheads	10.000	15.000	15.000	15.000	15.000
Factory costs	240.754	284.726	310.726	310.726	310.726
Administrative overheads	88.000	88.000	88.000	88.006	88.000
Indir. costs, sales and distribution	18.000	26.000	26.000	26.000	26.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.006	0.000
Depreciation	271.194	295.666	319.342	343.016	366.690
Financial costs	0.000	0.000	0.000	0.000	0.000
Total production costs	617.988	694.392	744.068	767.742	791.416
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	46.180	43.536	46.924	48.098	49.202
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	94.000	61.000	61.000	61.000	61.000

Total Production Costs in THOUSAND U.S. DOLLARS

Year	1997	1998	1999	2000	2001
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	125.000	125.000	125.000	125.000	125.000
Other raw materials	90.159	90.159	90.159	109.314	109.314
Utilities	3.086	3.086	3.086	3.086	3.086
Energy	24.229	24.229	24.229	24.229	24.229
Labour, direct	61.000	61.000	61.000	61.000	61.000
Repair, maintenance	17.000	17.000	17.000	17.000	17.000
Spares	26.000	26.000	26.000	26.000	26.000
Factory overheads	18.000	18.000	18.000	64.000	64.000
Factory costs	364.474	364.474	364.474	429.629	429.629
Administrative overheads	88.000	88.000	88.000	88.000	88.000
Indir. costs, sales and distribution	32.000	32.000	32.000	111.000	111.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	390.364	412.424	434.484	431.621	172.901
Financial costs	0.000	0.000	0.000	0.000	0.000
Total production costs	874.838	896.898	918.958	1060.250	801.530
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	48.963	49.822	50.641	53.796	47.509
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	69.000	69.000	69.000	69.000	69.000

Total Production Costs in THOUSAND U.S. DOLLARS

Year	2002	2003	2004	2005	2006
% of nom. capacity (single product)	0.000	0.000	0.000	0.000	0.000
Raw material 1	125.000	125.000	125.000	125.000	125.000
Other raw materials	109.314	109.314	109.314	109.314	109.314
Utilities	3.086	3.086	3.086	3.086	3.086
Energy	24.229	24.229	24.229	24.229	24.229
Labour, direct	61.000	61.000	61.000	61.000	61.000
Repair, maintenance	17.000	17.000	17.000	17.000	17.000
Spares	26.000	26.000	26.000	26.000	26.000
Factory overheads	64.000	64.000	64.000	64.000	64.000
Factory costs	429.629	429.629	429.629	429.629	429.629
Administrative overheads	88.000	88.000	88.000	88.000	88.000
Indir. costs, sales and distribution	111.000	111.000	111.000	111.000	111.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	134.367	110.693	87.019	64.152	42.093
Financial costs	0.000	0.000	0.000	0.000	0.000
Total production costs	762.996	739.322	715.648	692.781	670.722
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	45.654	44.394	43.050	41.682	40.293
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	69.000	69.000	69.000	69.000	69.000

Net Working Capital in THOUSAND U.S. DOLLARS

Year	mdc	coto	1992	1993	1994	1995-96	1997
Coverage	mdc	coto					
Current assets &							
Accounts receivable	30	12.0	28.899	33.227	35.394	35.394	40.373
Inventory and materials	30	12.2	9.915	14.942	14.942	14.942	17.938
Energy	30	12.0	1.205	1.729	1.729	1.729	2.019
Spares	60	6.0	0.000	0.000	4.333	4.333	4.333
Work in progress	30	12.0	20.066	23.727	25.894	25.894	30.373
Finished products	30	12.0	27.395	31.061	33.227	33.227	37.706
Cash in hand	30	12.0	16.083	14.167	16.333	16.333	17.500
Total current assets			103.563	118.852	131.852	131.852	150.243
Current liabilities and							
Accounts payable	30	12.0	20.066	23.727	25.894	25.894	30.373
Net working capital			83.517	95.125	105.958	105.958	119.870
Increase in working capital			83.517	11.608	10.833	0.000	13.912
Net working capital, local			62.765	76.530	76.530	76.530	86.736
Net working capital, foreign			20.752	18.595	29.428	29.428	33.134

Note: mdc = minimum days of coverage ; coto = coefficient of turnover .

COMFAR 2.1 - NATIONAL ECONOMIC & DEV. AUTHORITY, MANILA

Net Working Capital in THOUSAND U.S. DOLLARS

Year	mdc	coto	1998-99	2000	2001- 6
Coverage	mdc	coto			
Current assets &					
Accounts receivable	30	12.0	40.373	52.386	52.386
Inventory and materials	30	12.2	17.938	19.535	19.535
Energy	30	12.0	2.019	2.019	2.019
Spares	60	6.0	4.333	4.333	4.333
Work in progress	30	12.0	30.373	35.802	35.802
Finished products	30	12.0	37.706	43.136	43.136
Cash in hand	30	12.0	17.500	21.333	21.333
Total current assets			150.243	178.544	178.544
Current liabilities and					
Accounts payable	30	12.0	30.373	35.802	35.802
Net working capital			119.870	142.742	142.742
Increase in working capital			0.000	22.872	0.000
Net working capital, local			86.736	98.537	98.537
Net working capital, foreign			33.134	44.205	44.205

Note: mdc = minimum days of coverage ; coto = coefficient of turnover .

Source of Finance, construction in THOUSAND U.S. DOLLARS

Year	1990.1	1990.2	1991.1	1991.2
Equity, ordinary ..	0.000	977.850	834.700	861.700
Equity, preference.	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000
Loan A, foreign .	0.000	0.000	0.000	0.000
Loan B, foreign..	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000
Loan A, local....	0.000	0.000	0.000	0.000
Loan B, local....	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000
Total loan	0.000	0.000	0.000	0.000
Current liabilities	0.000	0.000	0.000	0.000
Bank overdraft	0.000	0.000	0.000	0.000
Total funds	0.000	977.850	834.700	861.700

Source of Finance, production in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995-96	1997	1998-99
Equity, ordinary ..	0.000	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan B, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	0.000	0.000	0.000	0.000	0.000	0.000
Current liabilities	20.066	3.661	2.167	0.000	4.479	0.000
Bank overdraft	349.023	158.038	210.264	172.431	159.143	118.231
Total funds	369.090	161.699	212.430	172.431	163.622	118.231

INTEGRATED QUININE PLANT (SQINTI) --- JULY 5, 1989

COMFAR 2.1 - NATIONAL ECONOMIC & DEV. AUTHORITY, MANILA

Source of Finance, production in THOUSAND U.S. DOLLARS

Year	2000	2001
Equity, ordinary ..	0.000	0.000
Equity, preference.	0.000	0.000
Subsidies, grants .	0.000	0.000
Loan A, foreign .	0.000	0.000
Loan B, foreign..	0.000	0.000
Loan C, foreign .	0.000	0.000
Loan A, local....	0.000	0.000
Loan B, local....	0.000	0.000
Loan C, local....	0.000	0.000
Total loan	0.000	0.000
Current liabilities	5.430	0.000
Bank overdraft	-1409.949	-47.842
Total funds	-1404.519	-47.842

INTEGRATED QUININE PLANT (SQINTI) --- JULY 5, 1989

Cashflow Tables, construction in THOUSAND U.S. DOLLARS

Year	1990.1	1990.2	1991.1	1991.2
Total cash inflow . .	0.000	977.850	834.700	861.700
Financial resources .	0.000	977.850	834.700	861.700
Sales, net of tax . .	0.000	0.000	0.000	0.000
Total cash outflow . .	0.000	977.843	834.701	861.701
Total assets	0.000	977.842	834.701	861.701
Operating costs . . .	0.000	0.000	0.000	0.000
Cost of finance . . .	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000
Corporate tax . . .	0.000	0.000	0.000	0.000
Dividends paid . . .	0.000	0.006	0.000	0.006
Surplus (deficit) .	0.000	0.007	-0.001	-0.001
Cumulated cash balance	0.000	0.007	0.006	0.005
Inflow, local	0.000	339.570	246.940	246.940
Outflow, local	0.000	339.567	246.942	246.942
Surplus (deficit) .	0.000	0.003	-0.002	-0.002
Inflow, foreign . . .	0.000	638.280	587.760	614.760
Outflow, foreign . . .	0.000	638.276	587.759	614.759
Surplus (deficit) .	0.000	0.004	0.001	0.001
Net cashflow	0.000	-977.843	-834.701	-861.701
Cumulated net cashflow	0.000	-977.843	-1812.544	-2674.245

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996	1997
Total cash inflow . .	346.091	493.640	491.204	489.038	489.038	591.324
Financial resources .	20.066	4.602	2.167	0.000	0.000	4.479
Sales, net of tax . .	326.025	489.038	489.038	489.038	489.038	586.845
Total cash outflow . .	695.120	651.678	701.468	661.468	661.468	750.467
Total assets	348.326	257.011	276.742	236.742	236.742	265.993
Operating costs . . .	346.794	396.726	424.726	424.726	424.726	484.474
Cost of finance . . .	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.941	0.000	0.000	0.000	0.000
Corporate tax . . .	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	-349.028	-158.038	-210.264	-172.431	-172.431	-159.143
Cumulated cash balance	-349.023	-507.061	-717.325	-889.756	-1062.186	-1221.329
Inflow, local	13.649	4.602	0.000	0.000	0.000	3.410
Outflow, local	363.682	360.863	342.496	342.496	342.496	397.039
Surplus (deficit) .	-350.033	-356.261	-342.496	-342.496	-342.496	-393.628
Inflow, foreign . . .	332.442	489.038	491.204	489.038	489.038	587.914
Outflow, foreign . . .	331.437	290.815	358.972	318.972	318.972	353.428
Surplus (deficit) .	1.005	198.223	132.232	170.066	170.066	234.486
Net cashflow	-349.028	-158.038	-210.264	-172.430	-172.430	-159.143
Cumulated net cashflow	-3023.273	-3181.312	-3391.575	-3564.006	-3736.436	-3895.579

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	1998	1999	2000	2001	2002	2003
Total cash inflow	586.845	586.845	2093.880	2088.450	2068.450	2088.450
Financial resources	0.000	0.000	5.430	0.000	0.000	0.000
Sales, net of tax	586.845	586.845	2088.450	2088.450	2088.450	2088.450
Total cash outflow	705.076	705.076	683.931	628.629	628.629	655.629
Total assets	220.602	220.602	55.302	0.000	0.000	27.000
Operating costs	484.474	484.474	628.629	628.629	628.629	628.629
Cost of finance	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	-118.231	-118.231	1409.949	1459.821	1459.821	1432.821
Cumulated cash balance	-1339.560	-1457.791	-47.842	1411.979	2871.800	4304.620
Inflow, local	0.000	0.000	[illegible]	0.000	0.000	0.000
Outflow, local	383.422	383.422	410.876	395.142	395.142	395.142
Surplus (deficit)	-383.422	[illegible]	-406.943	-395.142	-395.142	-395.142
Inflow, foreign	586.845	586.845	2089.346	2088.450	2098.450	2088.450
Outflow, foreign	321.654	321.654	[illegible]	233.487	233.487	260.487
Surplus (deficit)	265.191	265.191	1816.691	1854.963	1854.963	1827.963
Net cashflow	-118.231	-118.231	1409.949	1459.821	1459.821	1432.821
Cumulated net cashflow	-4013.610	-4132.041	-2722.092	-1262.271	197.549	1630.370

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	2004	2005	2006
Total cash inflow . .	2088.450	2088.450	2088.450
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	2088.450	2088.450	2088.450
Total cash outflow . .	628.629	628.629	628.629
Total assets	0.000	0.000	0.000
Operating costs . . .	628.629	628.629	628.629
Cost of finance . . .	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax . . .	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	1459.821	1459.821	1459.821
Cumulated cash balance	5764.441	7224.262	8684.082
Inflow, local	0.000	0.000	0.000
Outflow, local	395.142	395.142	395.142
Surplus (deficit) .	-395.142	-395.142	-395.142
Inflow, foreign . . .	2088.450	2088.450	2088.450
Outflow, foreign . . .	233.487	233.487	233.487
Surplus (deficit) .	1854.963	1854.963	1854.963
Net cashflow	1459.821	1459.821	1459.821
Cumulated net cashflow	3090.191	4550.012	6009.833

Cashflow Discounting:

a) Equity paid versus Net income flow:
    Net present value .... -1856.57 at 15.00 %
    Internal Rate of Return (IRRE1) .. -6.31 %
b) Net Worth versus Net cash return:
    Net present value .... -1360.53 at 15.00 %
    Internal Rate of Return (IRRE2) .. 9.08 %
c) Internal Rate of Return on total investment:
    Net present value .... -1360.53 at 15.00 %
    Internal Rate of Return (IRR) .. 9.08 %
Net Worth = Equity paid plus reserves

Net Income Statement in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996
Total sales, incl. sales tax	326.025	489.038	489.038	489.038	489.038
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	326.025	489.038	489.038	489.038	489.038
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	617.988	694.394	744.068	767.742	791.416
Operational margin	-291.963	-205.357	-255.030	-278.705	-302.379
As % of total sales	-89.552	-41.992	-52.149	-56.990	-61.831
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	-291.963	-205.357	-255.030	-278.705	-302.379
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-291.963	-205.357	-255.030	-278.705	-302.379
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	-291.963	-205.357	-255.030	-278.705	-302.379
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-291.963	-205.357	-255.030	-278.705	-302.379
Accumulated undistributed profit	-291.963	-497.320	-752.350	-1031.055	-1333.433
Gross profit, % of total sales	-89.552	-41.992	-52.149	-56.990	-61.831
Net profit, % of total sales	-89.552	-41.992	-52.149	-56.990	-61.831
ROE, Net profit, % of equity	-10.918	-7.679	-9.537	-10.422	-11.307
ROI, Net profit+interest, % of invest.	-9.724	-6.317	-7.234	-7.408	-7.562

Net Income Statement in THOUSAND U.S. DOLLARS

Year	1997	1998	1999	2000	2001
Total sales, incl. sales tax	586.845	586.845	586.845	2088.450	2088.450
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	586.845	586.845	586.845	2088.450	2088.450
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	874.838	896.898	918.958	1060.250	801.530
Operational margin	-287.993	-310.053	-332.113	1028.200	1286.920
As % of total sales	-49.075	-52.834	-56.593	49.233	61.621
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	-287.993	-310.053	-332.113	1028.200	1286.920
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-287.993	-310.053	-332.113	1028.200	1286.920
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	-287.993	-310.053	-332.113	1028.200	1286.920
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-287.993	-310.053	-332.113	1028.200	1286.920
Accumulated undistributed profit	-1621.426	-1931.479	-2263.592	-1235.392	51.528
Gross profit, % of total sales	-49.075	-52.834	-56.593	49.233	61.621
Net profit, % of total sales	-49.075	-52.834	-56.593	49.233	61.621
ROE, Net profit, % of equity	-10.769	[illegible]	[illegible]	38.446	48.123
ROI, Net profit+interest, % of invest.	-6.760	-6.919	-7.064	21.639	27.084

INTEGRATED QUININE PLANT ([illegible]) --- JULY 5, 199[illegible]

Net Income Statement in THOUSANDS U.S. DOLLARS

Year	2002	2003	2004	2005	2006
Total sales, incl. sales tax	2088.450	2088.450	2088.450	2088.450	2088.450
Less: variable costs, incl. sales tax	0.000	0.000	0.000	0.000	0.000
Variable margin	2088.450	2088.450	2088.450	2088.450	2088.450
As % of total sales	100.000	100.000	[illegible]	100.000	100.000
Non-variable costs, incl. depreciation	762.996	739.322	715.648	692.781	670.722
Operational margin	1325.454	1349.128	1372.802	1395.669	1417.728
As % of total sales	63.466	64.599	65.733	66.828	67.884
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	1325.454	1349.128	1372.802	1395.669	1417.728
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	1325.454	1349.128	1372.802	1395.669	1417.728
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	1325.454	1349.128	1372.802	1395.669	1417.728
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	1325.454	1349.128	1372.802	1395.669	1417.728
Accumulated undistributed profit	1376.981	2726.109	4098.911	5494.580	6912.308
Gross profit, % of total sales	63.466	64.599	65.733	66.828	67.884
Net profit, % of total sales	63.466	64.599	65.733	66.828	67.884
ROE, Net profit, % of equity	49.564	50.449	51.334	52.16[illegible]	53.014
ROI, Net profit+interest, % of invest.	27.835	28.233	28.729	29.2[illegible]	29.665

INTEGRATED QUININE PLANT (SOINTS) --- JULY 5, 198[illegible]

Projected Balance Sheets, construction in THOUSAND U.S. DOLLARS

Year	1990.1	1990.2	1991.1	1991.2
Total assets	0.000	977.850	1812.550	2674.250
Fixed assets, net of depreciation	0.000	0.000	977.843	1812.544
Construction in progress	0.000	977.843	834.701	861.701
Current assets	0.000	0.000	0.000	0.000
Cash, bank	0.000	0.000	0.000	0.000
Cash surplus, finance available	0.000	0.000	0.000	0.000
Loss carried forward	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000
Total liabilities	0.000	977.850	1812.550	2674.250
Equity capital	0.000	977.850	1812.550	2674.250
Reserves, retained profit	0.000	0.000	0.000	0.000
Profit	0.000	0.000	0.000	0.000
Long and medium term debt	0.000	0.000	0.000	0.000
Current liabilities	0.000	0.000	0.000	0.000
Bank overdraft, finance required.	0.000	0.000	0.000	0.000
Total debt	0.000	0.000	0.000	0.000
Equity, % of liabilities	0.000	100.000	100.000	100.000

INTEGRATED QUININE PLANT (SDINT1) --- JULY 5, 1989

Projected Balance Sheets. Production in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996
Total assets	3043.340	3205.039	3417.469	3569.900	3762.330
Fixed assets, net of depreciation	2403.051	2352.125	2269.525	2190.251	2060.303
Construction in progress	244.742	236.742	263.742	236.742	236.742
Current assets	87.500	104.685	115.519	115.519	115.519
Cash, bank	16.083	14.167	16.333	16.333	15.333
Cash surplus, finance available	0.000	0.000	0.000	0.000	0.000
Loss carried forward	6.000	291.963	497.320	752.350	1031.055
Loss	291.963	205.357	255.030	278.705	302.379
Total liabilities	3043.340	3205.039	3417.469	3569.900	3762.330
Equity capital	2674.250	2674.250	2674.250	2674.250	2674.250
Reserves, retained profit	0.000	0.000	0.000	0.000	0.000
Profit	0.000	0.000	0.000	0.000	0.000
Long and medium term debt	0.000	0.000	0.000	0.000	0.000
Current liabilities	20.066	23.727	25.894	25.894	25.894
Bank overdraft, finance required.	349.023	507.662	717.325	889.756	1062.186
Total debt	369.090	530.789	743.219	915.650	1088.080
Equity, % of liabilities	87.872	83.439	78.252	74.494	71.060

INTEGRATED QUININE PLANT (SQINTI) --- JULY 5, 1989

CONFAR 2.1 - NATIONAL ECONOMIC & DEV. AUTHORITY, MANILA

Projected Balance Sheets, Production in THOUSAND U.S. DOLLARS

Year	1997	1998	1999	2000	2001
Total assets	3925.952	4044.183	4162.414	3766.694	3996.977
Fixed assets, net of depreciation	1906.581	1741.655	1577.377	1016.258	[illegible]
Construction in progress	247.602	230.402	220.6[illegible]	27.000	0.000
Current assets	127.743	127.743	127.743	[illegible]	[illegible]
Cash, bank	17.500	17.500	17.500	[illegible]	[illegible]
Cash surplus, finance available	0.000	0.000	[illegible]	0.000	[illegible]
Loss carried forward	1333.435	1671.476	1931.479	2267.592	[illegible]
Loss	337.993	310.053	[illegible]	0.000	0.000
Total liabilities	3925.952	4044.183	4162.414	3766.694	3996.977
Equity capital	2674.250	2674.250	2674.250	2674.250	2674.250
Reserves, retained profit	0.000	0.000	0.000	0.000	0.000
Profit	0.000	0.000	0.000	1028.200	1266.920
Long and medium term debt	0.000	0.000	0.000	0.000	0.000
Current liabilities	30.373	30.373	30.373	35.802	35.802
Bank overdraft, finance required.	1221.329	1339.560	1457.791	47.842	0.000
Total debt	1251.702	1369.933	1488.164	83.644	35.802
Equity, % of liabilities	68.117	66.176	64.248	70.633	66.907

Projected Balance Sheets, Production in THOUSAND U.S. DOLLARS

Year	2002	2003	2004	2005	2006
Total assets	4087.034	5436.162	6608.964	8204.633	9622.361
Fixed assets, net of depreciation	1035.690	925.597	865.978	801.626	759.733
Construction in progress	0.000	27.000	0.000	0.000	0.000
Current assets	157.211	157.211	157.211	157.211	157.211
Cash, bank	21.333	21.333	21.333	21.333	21.333
Cash surplus, finance available	2871.800	4304.671	5764.441	7224.463	8684.064
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	4087.034	5436.162	6608.963	8204.633	9622.361
Equity capital	2674.250	2674.250	2674.250	2674.250	2674.250
Reserves, retained profit	51.528	1376.981	2726.109	4098.911	5494.580
Profit	1325.454	1349.128	1372.802	1395.669	1417.728
Long and medium term debt	0.000	0.000	0.000	0.000	0.000
Current liabilities	35.802	35.802	35.802	35.802	35.802
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	35.802	35.802	35.802	35.802	35.802
Equity, % of liabilities	65.433	49.194	39.775	32.594	27.792

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value	-1896.52	at	15.00 %
Internal Rate of Return (IRRE1) ..	6.31 %		

b) Net Worth versus net cash return:

Net present value	-1360.53	at	15.00 %
Internal Rate of Return (IRRE2) ..	9.08 %		

c) Internal Rate of Return on total investment:

Net present value	-1360.53	at	15.00 %
Internal Rate of Return (IRR) ..	9.08 %		

Net Worth = Equity paid plus reserves

Net Income Statement in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996
Total sales, incl. sales tax	326.025	489.038	489.038	489.038	489.038
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	326.025	489.038	489.038	489.038	489.038
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	617.988	694.394	744.068	767.742	791.416
Operational margin	-291.963	-205.357	-255.030	-278.705	-302.379
As % of total sales	-89.552	-41.992	-52.149	-56.990	-61.831
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	-291.963	-205.357	-255.030	-278.705	-302.379
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-291.963	-205.357	-255.030	-278.705	-302.379
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	-291.963	-205.357	-255.030	-278.705	-302.379
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-291.963	-205.357	-255.030	-278.705	-302.379
Accumulated undistributed profit . . .	-291.963	-497.320	-752.350	-1031.055	-1333.433
Gross profit, % of total sales	-89.552	-41.992	-52.149	-56.990	-61.831
Net profit, % of total sales	-89.552	-41.992	-52.149	-56.990	-61.831
ROE, Net profit, % of equity	-10.918	-7.679	-9.537	-10.422	-11.307
ROI, Net profit+interest, % of invest.	-9.724	-6.317	-7.234	-7.408	-7.562

INTEGRATED QUININE PLANT (SJINT1) --- JULY 5, 1989

Net Income Statement in THOUSAND U.S. DOLLARS

Year	1997	1998	1999	2000	2001
Total sales, incl. sales tax	586.845	586.845	586.845	2088.450	2088.450
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	586.845	586.845	586.845	2088.450	2088.450
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	874.838	896.898	918.958	1060.250	801.530
Operational margin	-287.993	-310.053	-332.113	1028.200	1286.920
As % of total sales	-49.075	-52.834	-56.593	49.233	61.621
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	-287.993	-310.053	-332.113	1028.200	1286.920
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-287.993	-310.053	-332.113	1028.200	1286.920
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	-287.993	-310.053	-332.113	1028.200	1286.920
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-287.993	-310.053	-332.113	1028.200	1286.920
Accumulated undistributed profit	-1621.426	-1931.479	-2263.592	-1235.392	51.528
Gross profit, % of total sales	-49.075	-52.834	-56.593	49.233	61.621
Net profit, % of total sales	-49.075	-52.834	-56.593	49.233	61.621
ROE, Net profit, % of equity	-10.769	-11.594	-12.419	38.448	48.123
ROI, Net profit+interest, % of invest.	-6.760	-6.919	-7.064	21.639	27.084

INTEGRATED QUININE PLANT (SQINT1) --- JULY 5, 1989

Net Income Statement in THOUSAND U.S. DOLLARS

Year	2002	2003	2004	2005	2006
Total sales, incl. sales tax	2088.450	2088.450	2088.450	2088.450	2088.450
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	2088.450	2088.450	2088.450	2088.450	2088.450
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	762.996	739.322	715.648	692.781	670.722
Operational margin	1325.454	1349.128	1372.802	1395.669	1417.728
As % of total sales	63.466	64.599	65.733	66.828	67.884
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	1325.454	1349.128	1372.802	1395.669	1417.728
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	1325.454	1349.128	1372.802	1395.669	1417.728
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	1325.454	1349.128	1372.802	1395.669	1417.728
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	1325.454	1349.128	1372.802	1395.669	1417.728
Accumulated undistributed profit	1376.981	2726.109	4098.911	5494.580	6912.308
Gross profit, % of total sales	63.466	64.599	65.733	66.828	67.884
Net profit, % of total sales	63.466	64.599	65.733	66.828	67.884
ROE, Net profit, % of equity	49.564	50.449	51.334	52.169	53.014
ROI, Net profit+interest, % of invest.	27.835	28.233	28.729	29.207	29.669

Projected Balance Sheets, construction in THOUSAND U.S. DOLLARS

Year	1990.1	1990.2	1991.1	1991.2
Total assets	0.000	977.850	1812.550	2674.250
Fixed assets, net of depreciation	0.000	0.000	977.843	1812.544
Construction in progress	0.000	977.843	834.701	861.701
Current assets	0.000	0.000	0.000	0.000
Cash, bank	0.000	0.000	0.000	0.000
Cash surplus, finance available	0.000	0.007	0.006	0.005
Loss carried forward	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000
Total liabilities	0.000	977.850	1812.550	2674.250
Equity capital	0.000	977.850	1812.550	2674.250
Reserves, retained profit	0.000	0.000	0.000	0.000
Profit	0.000	0.000	0.000	0.000
Long and medium term debt	0.000	0.000	0.000	0.000
Current liabilities	0.000	0.000	0.000	0.000
Bank overdraft, finance required.	0.000	0.000	0.000	0.000
Total debt	0.000	0.000	0.000	0.000
Equity, % of liabilities	0.000	100.000	100.000	100.000

INTEGRATED QUININE PLANT (SOINTI) --- JULY 5, 1989

Projected Balance Sheets, Production in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996
Total assets	3043.340	3205.039	3417.469	3589.900	3762.330
Fixed assets, net of depreciation	2403.051	2352.125	2269.525	2190.251	2060.303
Construction in progress	244.742	236.742	263.742	236.742	236.742
Current assets	87.500	104.685	115.519	115.519	115.519
Cash, bank	16.083	14.167	16.333	16.333	16.333
Cash surplus, finance available	0.000	0.000	0.000	0.000	0.000
Loss carried forward	0.000	291.963	497.320	752.350	1031.055
Loss	291.963	205.357	255.030	278.705	302.379
Total liabilities	3043.340	3205.039	3417.469	3589.900	3762.330
Equity capital	2674.250	2674.250	2674.250	2674.250	2674.250
Reserves, retained profit	0.000	0.000	0.000	0.000	0.000
Profit	0.000	0.000	0.000	0.000	0.000
Long and medium term debt	0.000	0.000	0.000	0.000	0.000
Current liabilities	20.066	23.727	25.894	25.894	25.894
Bank overdraft, finance required.	349.023	507.062	717.325	889.756	1062.186
Total debt	369.090	530.789	743.219	915.650	1088.080
Equity, % of liabilities	87.872	83.439	78.252	74.494	71.080

COMFAR 2.1 - NATIONAL ECONOMIC & DEV. AUTHORITY, MANILA

Projected Balance Sheets, Production in THOUSAND U.S. DOLLARS

Year	1997	1998	1999	2000	2001
Total assets	3925.952	4044.183	4167.414	3786.094	3996.972
Fixed assets, net of depreciation	1906.681	1741.855	1577.977	1316.958	1171.057
Construction in progress	247.602	220.602	220.602	27.000	0.000
Current assets	137.743	137.743	137.743	157.211	157.211
Cash, bank	17.500	17.500	17.500	21.333	21.333
Cash surplus, finance available	0.000	0.000	0.000	0.000	1411.379
Loss carried forward	1333.433	1671.476	1931.479	2263.592	1235.392
Loss	287.993	310.053	332.113	0.000	0.000
Total liabilities	3925.952	4044.183	4167.414	3786.094	3996.972
Equity capital	2674.250	2674.250	2674.250	2674.250	2674.250
Reserves, retained profit	0.000	0.000	0.000	0.000	0.000
Profit	0.000	0.000	0.000	1028.200	1286.920
Long and medium term debt	0.000	0.000	0.000	0.000	0.000
Current liabilities	30.373	30.373	30.373	35.802	35.802
Bank overdraft, finance required.	1221.329	1339.560	1457.791	47.842	0.000
Total debt	1251.702	1369.933	1488.164	83.644	35.802
Equity, % of liabilities	68.117	66.126	64.248	70.633	66.907

Projected Balance Sheets, Production in THOUSAND U.S. DOLLARS

Year	2002	2003	2004	2005	2006
Total assets	4067.034	5436.162	6808.964	8204.633	9622.361
Fixed assets, net of depreciation	1036.690	925.997	865.978	801.826	759.733
Construction in progress	0.000	27.000	0.000	0.000	0.000
Current assets	157.211	157.211	157.211	157.211	157.211
Cash, bank	21.333	21.333	21.333	21.333	21.333
Cash surplus, finance available	2871.800	4304.621	5764.441	7224.263	8684.084
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	4067.034	5436.162	6808.963	8204.633	9622.361
Equity capital	2674.250	2674.250	2674.250	2674.250	2674.250
Reserves, retained profit	51.528	1376.981	2726.109	4058.911	5494.580
Profit	1325.454	1349.128	1372.802	1395.669	1417.728
Long and medium term debt	0.000	0.000	0.000	0.000	0.000
Current liabilities	35.802	35.802	35.802	35.802	35.802
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	35.802	35.802	35.802	35.802	35.802
Equity, % of liabilities	65.433	49.194	39.275	32.594	27.792

INTEGRATED QUININE PLANT (SQINT3)
JULY 5, 1989
5% CONTENT, WITHOUT TAX, 540 MT

1½ year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: THOUSAND U.S. DOLLARS

Total initial investment during construction phase

fixed assets:	2674.25	68.834 % foreign
current assets:	0.00	0.000 % foreign
total assets:	2674.25	68.834 % foreign

Source of funds during construction phase

equity & grants:	2674.25	68.834 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	2674.25	68.834 % foreign

Cashflow from operations

Year:	1	6	9
operating costs:	401.02	582.48	628.63
depreciation :	271.19	390.36	431.62
interest :	0.00	0.00	0.00
production costs	672.21	972.85	1060.25
thereof foreign	47.93 %	50.83 %	53.80 %
total sales :	892.50	1606.50	2088.45
gross income :	220.29	633.65	1028.20
net income :	220.29	633.65	1028.20
cash balance :	154.67	760.03	1425.45
net cashflow :	154.67	760.03	1425.45

Net Present Value at: 15.00 % = 1585.73
Internal Rate of Return: 23.67 %
Return on equity1: 21.19 %
Return on equity2: 23.67 %

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Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

INTEGRATED QUININE PLANT (SQINT4)
JULY 5, 1989
5% CONTENT, W/ SER ADJUSTMENT, 540 MT

1½ year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.2000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: THOUSAND U.S. DOLLARS

Total initial investment during construction phase

fixed assets:	3042.40	72.606 % foreign
current assets:	0.00	0.000 % foreign
total assets:	3042.40	72.606 % foreign

Source of funds during construction phase

equity & grants:	3042.41	72.606 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	3042.41	72.606 % foreign

Cashflow from operations

Year:	1	6	9
operating costs:	427.38	623.03	675.33
depreciation :	309.27	448.73	499.00
interest :	0.00	0.00	0.00
production costs	736.64	1071.75	1174.32
thereof foreign	52.48 %	55.37 %	58.28 %
total sales :	1071.00	1927.80	2506.14
gross income :	334.36	856.05	1331.82
net income :	334.36	856.05	1331.82
cash balance :	259.97	997.38	1790.34
net cashflow :	259.97	997.38	1790.34

Net Present Value at: 15.00 % = 2438.06
Internal Rate of Return: 26.60 %
Return on equity1: 24.38 %
Return on equity2: 26.60 %

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Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

INTEGRATED QUININE PLANT (SQINTS)
JULY 5, 1989
5% CONTENT, W/ CORP. INCOME TAX

1½ year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: THOUSAND U.S. DOLLARS

Total initial investment during construction phase

fixed assets:	2674.25	68.834 % foreign
current assets:	0.00	0.000 % foreign
total assets:	2674.25	68.834 % foreign

Source of funds during construction phase

equity & grants:	2674.25	68.834 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	2674.25	68.834 % foreign

Cashflow from operations

Year:	1	6	9
operating costs:	401.02	582.48	628.63.
depreciation :	271.19	390.36	431.62
interest :	0.00	0.00	0.00
production costs	672.2i	972.85	1060.25
thereof foreign	47.93 %	50.83 %	53.80 %
total sales :	892.50	1606.50	2088.45
gross income :	220.29	633.65	1028.20
net income :	143.19	411.88	668.33
cash balance :	77.56	538.25	1065.58
net cashflow :	77.56	538.25	1065.58

Net Present Value at: 15.00 % = 398.30
Internal Rate of Return: 17.40 %
Return on equity1: 14.13 %
Return on equity2: 17.40 %

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Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

INTEGRATED QUININE PLANT (SQINT6)
JULY 5, 1969
5% CONTENT, W/ 6-YR. TAX HOLIDAY

1½ year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = . 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: THOUSAND U.S. DOLLARS

Total initial investment during construction phase

fixed assets:	2674.25	68.834 % foreign
current assets:	0.00	0.000 % foreign
total assets:	2674.25	68.834 % foreign

Source of funds during construction phase

equity & grants:	2674.25	68.834 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	2674.25	68.834 % foreign

Cashflow from operations

Year:	1	6	9
operating costs:	401.02	582.48	628.63
depreciation :	271.19	390.36	431.62
interest :	0.00	0.00	0.00
production costs	672.21	972.85	1060.25
thereof foreign	47.93 %	50.83 %	53.80 %
total sales :	892.50	1606.50	2088.45
gross income :	220.29	633.65	1028.20
net income :	220.29	633.65	668.33
cash balance :	154.67	760.03	1065.58
net cashflow :	154.67	760.03	1065

Net Present Value at: 15.00 % = 926.92
Internal Rate of Return: 20.89 %
Return on equity1: 17.78 %
Return on equity2: 20.89 %

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Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

Total Production Costs in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	69.000	104.000	104.000	104.000	104.000
Other raw materials	57.314	85.972	85.972	85.972	85.972
Utilities	2.249	2.772	2.772	2.772	2.772
Energy	14.456	20.743	20.743	20.743	20.743
Labour, direct	86.000	53.000	53.000	53.000	53.000
Repair, maintenance	9.000	14.000	14.000	14.000	14.000
Spares	0.000	0.000	26.000	26.000	26.000
Factory overheads	77.000	41.000	41.000	41.000	41.000
Factory costs	265.019	321.467	347.487	347.487	347.487
Administrative overheads	88.000	88.000	88.000	88.000	88.000
Indir. costs, sales and distribution	48.000	72.000	72.000	72.000	72.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	271.194	295.688	319.342	343.016	366.690
Financial costs	0.000	0.000	0.000	0.000	0.000
Total production costs	672.213	777.155	826.829	850.503	874.177
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	47.925	46.217	49.019	50.021	50.968
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	94.000	61.000	61.000	61.000	61.000

INTEGRATED QUININE PLANT (SQINT3) --- JULY 5, 1989

Total Production Costs in THOUSAND U.S. DOLLARS

Year	1997	1998	1999	2000	2001
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	125.000	125.000	125.000	125.000	125.000
Other raw materials	103.166	103.166	103.166	109.314	109.314
Utilities	3.086	3.086	3.086	3.086	3.086
Energy	24.229	24.229	24.229	24.229	24.229
Labour, direct	61.000	61.000	61.000	61.000	61.000
Repair, maintenance	17.000	17.000	17.000	17.000	17.000
Spares	26.000	26.000	26.000	26.000	26.000
Factory overheads	49.000	49.000	49.000	64.000	64.000
Factory costs	408.481	408.481	408.481	429.629	429.629
Administrative overheads	88.000	86.000	88.000	88.000	88.000
Indir. costs, sales and distribution	86.000	86.000	86.000	111.000	111.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	390.364	412.424	434.484	431.621	172.901
Financial costs	0.000	0.000	0.000	0.000	0.000
Total production costs	972.845	994.905	1016.965	1060.250	801.530
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	50.834	51.567	52.269	53.796	47.509
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	69.000	69.000	69.000	69.000	69.000

Total Production Costs in THOUSAND U.S. DOLLARS

Year	2002	2003	2004	2005	2006
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	125.000	125.000	125.000	125.000	125.000
Other raw materials	109.314	109.314	109.314	109.314	109.314
Utilities	3.086	3.086	3.086	3.086	3.086
Energy	24.229	24.229	24.229	24.229	24.229
Labour, direct	61.000	61.000	61.000	61.000	61.000
Repair, maintenance	17.000	17.000	17.000	17.000	17.000
Spares	26.000	26.000	26.000	26.000	26.000
Factory overheads	64.000	64.000	64.000	64.000	64.000
Factory costs	429.629	429.629	429.629	429.629	429.629
Administrative overheads	88.000	88.000	88.000	88.000	88.000
Indir. costs, sales and distribution	111.000	111.000	111.000	111.000	111.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	134.367	110.693	87.019	64.152	42.093
Financial costs	0.000	0.000	0.000	0.000	0.000
Total production costs	762.996	739.322	715.648	692.781	670.722
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	45.654	44.354	43.050	41.682	40.293
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	69.000	69.000	69.000	69.000	69.000

INTEGRATED QUININE PLANT (SWINT3) --- JULY 5, 1989

Cashflow Tables, construction in THOUSAND U.S. DOLLARS

Year	1990.1	1990.2	1991.1	1991.2
Total cash inflow . .	0.000	977.850	834.700	861.700
Financial resources .	0.000	977.850	834.700	861.700
Sales, net of tax . .	0.000	0.000	0.000	0.000
Total cash outflow . .	0.000	977.843	834.701	861.701
Total assets	0.000	977.843	834.701	861.701
Operating costs . . .	0.000	0.000	0.000	0.000
Cost of finance . . .	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000
Corporate tax . . .	0.000	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000	0.000
Surplus (deficit) .	0.000	0.007	-0.001	-0.001
Cumulated cash balance	0.000	0.007	0.006	0.005
Inflow, local	0.000	339.570	246.940	246.940
Outflow, local	0.000	339.567	246.942	246.942
Surplus (deficit) .	0.000	0.003	-0.002	-0.002
Inflow, foreign . . .	0.000	638.280	587.760	614.760
Outflow, foreign . . .	0.000	638.276	587.759	614.759
Surplus (deficit) .	0.000	0.004	0.001	0.001
Net cashflow	0.000	-977.843	-834.701	-861.701
Cumulated net cashflow	0.000	-977.843	-1812.544	-2674.245

INTEGRATED QUININE PLANT (SQINT3) --- JULY 5, 1989

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996	1997
Total cash inflow	914.585	1344.115	1340.917	1338.750	1338.750	1611.583
Financial resources	22.085	5.365	2.167	0.000	0.000	5.083
Sales, net of tax	892.500	1338.750	1338.750	1338.750	1338.750	1606.500
Total cash outflow	759.920	739.669	784.229	744.229	744.229	851.556
Total assets	358.901	257.523	276.742	236.742	236.742	269.075
Operating costs	401.019	481.487	507.487	507.487	507.487	582.481
Cost of finance	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.659	0.000	0.000	0.000	0.000
Corporate tax	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	154.665	604.446	556.688	594.521	594.521	760.027
Cumulated cash balance	154.670	759.116	1315.804	1910.325	2504.846	3264.874
Inflow, local	15.103	5.365	0.000	0.000	0.000	3.845
Outflow, local	386.953	390.515	369.098	369.098	369.098	430.593
Surplus (deficit)	-371.850	-385.150	-369.098	-369.098	-369.098	-426.748
Inflow, foreign	899.482	1338.750	1340.917	1338.750	1338.750	1607.738
Outflow, foreign	372.967	349.154	415.131	375.131	375.131	420.963
Surplus (deficit)	526.515	989.596	925.786	963.619	963.619	1186.775
Net cashflow	154.665	604.446	556.688	594.521	594.521	760.027
Cumulated net cashflow	-2519.580	-1915.134	-1358.446	-763.925	-169.404	590.624

INTEGRATED QUININE PLANT (SQINT3) --- JULY 5, 1989

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	1998	1999	2000	2001	2002	2003
Total cash inflow . .	1606.500	1606.500	2090.212	2088.450	2088.450	2088.450
Financial resources .	0.000	0.000	1.762	0.000	0.000	0.000
Sales, net of tax . .	1606.500	1606.500	2088.450	2088.450	2088.450	2088.450
Total cash outflow . .	803.083	803.083	664.762	628.629	628.629	655.629
Total assets	220.602	220.602	36.133	0.000	0.000	27.000
Operating costs . . .	582.481	582.481	628.629	628.629	628.629	628.629
Cost of finance . . .	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax . . .	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	803.417	803.417	1425.451	1459.821	1459.821	1432.821
Cumulated cash balance	4068.291	4871.708	6297.158	7756.979	9216.800	10649.620
Inflow, local	0.000	0.000	1.282	0.000	0.000	0.000
Outflow, local	415.238	415.238	400.271	395.142	395.142	395.142
Surplus (deficit) .	-415.238	-415.238	-398.989	-395.142	-395.142	-395.142
Inflow, foreign . . .	1606.500	1606.500	2088.930	2088.450	2088.450	2088.450
Outflow, foreign . . .	387.845	387.845	264.491	233.487	233.487	260.487
Surplus (deficit) .	1218.655	1218.655	1824.439	1854.963	1854.963	1827.963
Net cashflow	803.417	803.417	1425.451	1459.821	1459.821	1432.821
Cumulated net cashflow	1394.041	2197.458	3622.908	5082.729	6542.550	7975.371

INTEGRATED QUININE PLANT (SQINT3) --- JULY 5, 1989

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	2004	2005	2006
Total cash inflow	2088.450	2088.450	2088.450
Financial resources	0.000	0.000	0.000
Sales, net of tax	2088.450	2088.450	2088.450
Total cash outflow	628.629	628.629	628.629
Total assets	0.000	0.000	0.000
Operating costs	628.629	628.629	628.629
Cost of finance	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000
Surplus (deficit)	1459.821	1459.821	1459.821
Cumulated cash balance	12109.440	13569.260	15029.080
Inflow, local	0.000	0.000	0.000
Outflow, local	395.142	395.142	395.142
Surplus (deficit)	-395.142	-395.142	-395.142
Inflow, foreign	2088.450	2088.450	2088.450
Outflow, foreign	233.487	233.487	233.487
Surplus (deficit)	1854.963	1854.963	1854.963
Net cashflow	1459.821	1459.821	1459.821
Cumulated net cashflow	9435.191	10895.010	12354.830

Cashflow Discounting:

a) Equity paid versus Net income flow:
    Net present value .... 1055.26 at 15.00 %
    Internal Rate of Return (IRRE1) .. 21.19 %
b) Net Worth versus Net cash return:
    Net present value .... 1585.73 at 15.00 %
    Internal Rate of Return (IRRE2) .. 23.67 %
c) Internal Rate of Return on total investment:
    Net present value .... 1585.73 at 15.00 %
    Internal Rate of Return (IRR) .. 23.67 %
Net Worth = Equity paid plus reserves

Net Income Statement in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996
Total sales, incl. sales tax	892.500	1338.750	1338.750	1338.750	1338.750
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	892.500	1338.750	1338.750	1338.750	1338.750
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	672.213	777.155	826.829	850.503	874.177
Operational margin	220.287	561.595	511.921	488.247	464.573
As % of total sales	24.682	41.949	38.239	36.470	34.702
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	220.287	561.595	511.921	488.247	464.573
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	220.287	561.595	511.921	488.247	464.573
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	220.287	561.595	511.921	488.247	464.573
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	220.287	561.595	511.921	488.247	464.573
Accumulated undistributed profit	220.287	781.882	1293.803	1782.050	2246.623
Gross profit, % of total sales	24.682	41.949	38.239	36.470	34.702
Net profit, % of total sales	24.682	41.949	38.239	36.470	34.702
ROE, Net profit, % of equity	-8.237	21.000	19.143	18.257	17.372
ROI, Net profit+interest, % of invest.	7.316	17.206	14.467	12.933	11.580

INTEGRATED QUININE PLANT (SQINT3) --- JULY 5, 1989

Net Income Statement in THOUSAND U.S. DOLLARS

Year	1997	1998	1999	2000	2001
Total sales, incl. sales tax	1606.500	1606.500	1606.500	2088.450	2088.450
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	1606.500	1606.500	1606.500	2088.450	2088.450
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	972.845	994.905	1016.965	1060.250	801.530
Operational margin	633.655	611.595	589.535	1028.200	1286.920
As % of total sales	39.443	38.070	36.697	49.233	61.621
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	633.655	611.595	589.535	1028.200	1286.920
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	633.655	611.595	589.535	1028.200	1286.920
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	633.655	611.595	589.535	1028.200	1286.920
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	633.655	611.595	589.535	1028.200	1286.920
Accumulated undistributed profit	2880.278	3491.873	4081.408	5109.608	6396.528
Gross profit, % of total sales	39.443	38.070	36.697	49.233	61.621
Net profit, % of total sales	39.443	38.070	36.697	49.233	61.621
ROE, Net profit, % of equity	23.695	22.870	22.045	38.448	48.123
ROI, Net profit+interest, % of invest.	14.819	13.601	12.498	21.639	27.084

INTEGRATED QUININE PLANT (SQINT3) --- JULY 5, 1989

Net Income Statement in THOUSAND U.S. DOLLARS

Year	2002	2003	2004	2005	2006
Total sales, incl. sales tax	2088.450	2088.450	2088.450	2088.450	2088.450
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	2088.450	2088.450	2088.450	2088.450	2088.450
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	762.996	739.322	715.648	692.781	670.722
Operational margin	1325.454	1349.128	1372.802	1395.669	1417.728
As % of total sales	63.466	64.599	65.733	66.828	67.884
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	1325.454	1349.128	1372.802	1395.669	1417.728
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	1325.454	1349.128	1372.802	1395.669	1417.728
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	1325.454	1349.128	1372.802	1395.669	1417.728
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	1325.454	1349.128	1372.802	1395.669	1417.728
Accumulated undistributed profit	7721.982	9071.110	10443.910	11839.580	13257.310
Gross profit, % of total sales	63.466	64.599	65.733	66.828	67.884
Net profit, % of total sales	63.466	64.599	65.733	66.828	67.884
ROE, Net profit, % of equity	49.564	50.449	51.334	52.169	53.014
ROI, Net profit+interest, % of invest.	27.895	28.233	28.729	29.207	29.669

COMFAR 2.1 UNIDO

QUININE PLANT, PROCESSING ONLY, 450 MT
JULY 5, 1989
5% CONTENT, W/O CORP. INCOME TAX

SQPRC 1

1½ year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: THOUSAND U.S. DOLLARS

Total initial investment during construction phase

fixed assets:	2521.11	68.915 % foreign
current assets:	0.00	0.000 % foreign
total assets:	2521.11	68.915 % foreign

Source of funds during construction phase

equity & grants:	2521.11	68.916 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	2521.11	68.916 % foreign

Cashflow from operations

Year:	1	6	9
operating costs:	668.02	907.49	907.49
depreciation :	255.88	255.88	243.19
interest :	0.00	0.00	0.00
production costs	923.90	1163.37	1150.67
thereof foreign	70.12 %	73.74 %	74.56 %
total sales :	892.50	1338.75	1338.75
gross income :	-31.40	175.38	188.08
net income :	-31.40	175.38	188.08
cash balance :	65.66	404.26	404.26
net cashflow :	65.66	404.26	404.26

Net Present Value at: 15.00 % = -300.59
Internal Rate of Return: 12.52 %
Return on equity1: 4.70 %
Return on equity2: 12.52 %

Index of Schedules produced by COMFAR

Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

QUININE PLANT. PROCESSING ONLY, 450 MT
JULY 5, 1989
5% CONTENT, W/ SER ADJUSTMENT

SQPRC 2

1½ year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.2000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: THOUSAND U.S. DOLLARS

Total initial investment during construction phase

fixed assets:	2868.60	72.681 % foreign
current assets:	0.00	0.000 % foreign
total assets:	2868.60	72.681 % foreign

Source of funds during construction phase

equity & grants:	2868.60	72.681 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	2868.60	72.681 % foreign

Cashflow from operations

Year:	1	6	9
operating costs:	761.58	1043.06	1043.06
depreciation :	291.89	291.89	279.20
interest :	0.00	0.00	0.00
production costs	1053.46	1334.95	1322.26
thereof foreign	73.79 %	77.12 %	77.66 %
total sales :	1071.00	1606.50	1606.50
gross income :	17.54	271.55	284.24
net income :	17.54	271.55	284.24
cash balance :	128.81	531.04	531.04
net cashflow :	128.81	531.04	531.04

Net Present Value at: 15.00 % = 11.48
Internal Rate of Return: 15.08 %
Return on equity1: 7.51 %
Return on equity2: 15.08 %

Index of Schedules produced by COMFAR

Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

Total Initial Investment in THOUSAND U.S. DOLLARS

Year	1990.1	1990.2	1991.1	1991.2
Fixed investment costs				
Land, site preparation, development	0.000	75.990	0.000	0.000
Buildings and civil works	0.000	73.140	65.015	65.015
Auxiliary and service facilities	0.000	375.400	333.696	333.696
Incorporated fixed assets	0.000	29.700	26.400	53.400
Plant machinery and equipment	0.000	392.273	348.688	348.688
Total fixed investment costs	0.000	946.511	773.799	800.799
Pre-production capital expenditures.	0.000	0.000	0.000	0.000
Net working capital	0.000	0.000	0.000	0.000
Total initial investment costs	0.000	946.511	773.799	800.799
Of it foreign, in %	0.000	65.055	70.734	71.721

QUININE PLANT, PROCESSING ONLY, 450 MT --- JULY 5, 1989

Total Production Costs in THOUSAND U.S. DOLLARS

Year	1992	1993	1994-99	2000	2001
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	336.000	504.000	504.000	504.000	504.000
Other raw materials	57.314	85.972	85.972	85.972	85.972
Utilities	2.249	2.772	2.772	2.772	2.772
Energy	14.456	20.743	20.743	20.743	20.743
Labour, direct	86.000	53.000	53.000	53.000	53.000
Repair, maintenance	9.000	14.000	14.000	14.000	14.000
Spares	0.000	0.000	26.000	26.000	26.000
Factory overheads	27.000	41.000	41.000	41.000	41.000
Factory costs	532.019	721.487	747.487	747.487	747.487
Administrative overheads	88.000	88.000	88.000	88.000	88.000
Indir. costs, sales and distribution	48.000	72.000	72.000	72.000	72.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	255.880	255.880	255.880	243.187	17.259
Financial costs	0.000	0.000	0.000	0.000	0.000
Total production costs	923.899	1137.367	1163.367	1150.674	924.746
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	70.118	73.144	73.744	74.558	75.169
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	94.000	61.000	61.000	61.000	61.000

Total Production Costs in THOUSAND U.S. DOLLARS

Year	2002- 6
% of nom. capacity (single product).	0.000
Raw material 1	504.000
Other raw materials	85.972
Utilities	2.772
Energy	20.743
Labour, direct	53.000
Repair, maintenance	14.000
Spares	26.000
Factory overheads	41.000
Factory costs	747.487
Administrative overheads	88.000
Indir. costs, sales and distribution	72.000
Direct costs, sales and distribution	0.000
Depreciation	9.000
Financial costs	0.000
Total production costs	916.487
Costs per unit (single product)	0.000
Of it foreign, %	74.946
Of it variable,%	0.000
Total labour	61.000

QUININE PLANT, PROCESSING ONLY. 450 MT --- JULY 5, 1989

Cashflow Tables, construction in THOUSAND U.S. DOLLARS

Year	1990.1	1990.2	1991.1	1991.2
Total cash inflow	0.000	946.515	773.795	800.799
Financial resources	0.000	946.515	773.795	800.799
Sales, net of tax	0.000	0.000	0.000	0.000
Total cash outflow	0.000	946.511	773.799	800.799
Total assets	0.000	946.511	773.799	800.799
Operating costs	0.000	0.000	0.000	0.000
Cost of finance	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000
Corporate tax	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000
Surplus (deficit)	0.000	0.004	-0.004	0.000
Cumulated cash balance	0.000	0.004	-0.000	-0.000
Inflow, local	0.000	330.755	226.455	226.459
Outflow, local	0.000	330.755	226.460	226.460
Surplus (deficit)	0.000	0.000	-0.005	-0.001
Inflow, foreign	0.000	615.760	547.340	574.340
Outflow, foreign	0.000	615.756	547.339	574.339
Surplus (deficit)	0.000	0.004	0.001	0.001
Net cashflow	0.000	-946.511	-773.799	-800.799
Cumulated net cashflow	0.000	-946.511	-1720.310	-2521.109

QUININE PLANT, PROCESSING ONLY, 450 MT --- JULY 5, 1989

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996	1997
Total cash inflow . .	936.835	1354.539	1340.917	1338.750	1338.750	1338.750
Financial resources .	44.335	15.789	2.167	0.000	0.000	0.000
Sales, net of tax . .	892.500	1338.750	1338.750	1338.750	1338.750	1338.750
Total cash outflow . .	871.178	946.601	947.487	907.487	907.487	934.487
Total assets	203.158	65.114	40.000	0.000	0.000	27.000
Operating costs . . .	668.019	881.487	907.487	907.487	907.487	907.487
Cost of finance . . .	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax . . .	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	65.657	407.938	393.430	431.263	431.263	404.263
Cumulated cash balance	65.657	473.595	867.025	1298.288	1729.551	2133.814
Inflow, local	9.353	2.448	0.000	0.000	0.000	0.000
Outflow, local	259.471	239.366	229.616	229.616	229.616	229.616
Surplus (deficit) .	-250.118	-236.918	-229.616	-229.616	-229.616	-229.616
Inflow, foreign . . .	927.482	1352.091	1340.917	1338.750	1338.750	1338.750
Outflow, foreign . . .	611.707	707.235	717.871	677.871	677.871	704.871
Surplus (deficit) .	315.775	644.856	623.046	660.879	660.879	633.879
Net cashflow	65.657	407.938	393.430	431.263	431.263	404.263
Cumulated net cashflow	-2455.452	-2047.513	-1654.084	-1222.821	-791.558	-387.295

QUININE PLANT, PROCESSING ONLY, 450 MT --- JULY 5, 1989

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	1998	1999	2000	2001	2002	2003
Total cash inflow . .	1338.750	1338.750	1338.750	1338.750	1338.750	1338.750
Financial resources .	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax . .	1338.750	1338.750	1338.750	1338.750	1338.750	1338.750
Total cash outflow . .	907.487	907.487	934.487	907.487	907.487	934.487
Total assets	0.000	0.000	27.000	0.000	0.000	27.000
Operating costs . . .	907.487	907.487	907.487	907.487	907.487	907.487
Cost of finance . . .	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax . . .	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	431.263	431.263	404.263	431.263	431.263	404.263
Cumulated cash balance	2565.077	2996.340	3400.604	3831.867	4263.130	4667.393
Inflow, local	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, local	229.616	229.616	229.616	229.616	229.616	229.616
Surplus (deficit) .	-229.616	-229.616	-229.616	-229.616	-229.616	-229.616
Inflow, foreign . . .	1338.750	1338.750	1338.750	1338.750	1338.750	1338.750
Outflow, foreign . . .	677.871	677.871	704.871	677.871	677.871	704.871
Surplus (deficit) .	660.879	660.879	633.879	660.879	660.879	633.879
Net cashflow	431.263	431.263	404.263	431.263	431.263	404.263
Cumulated net cashflow	43.969	475.232	879.495	1310.758	1742.021	2146.284

QUININE PLANT, PROCESSING ONLY, 450 MT --- JULY 5, 1989

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	1998	1999	2000	2001	2002	2003
Total cash inflow	1338.750	1338.750	1338.750	1338.750	1338.750	1338.750
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	1338.750	1338.750	1338.750	1338.750	1338.750	1338.750
Total cash outflow	907.487	907.487	934.487	907.487	907.487	934.487
Total assets	0.000	0.000	27.000	0.000	0.000	27.000
Operating costs	907.487	907.487	907.487	907.487	907.487	907.487
Cost of finance	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	431.263	431.263	404.263	431.263	431.263	404.263
Cumulated cash balance	2565.077	2996.340	3400.604	3831.867	4263.130	4667.393
Inflow, local	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, local	229.616	229.616	229.616	229.616	229.616	229.616
Surplus (deficit)	-229.616	-229.616	-229.616	-229.616	-229.616	-229.616
Inflow, foreign	1338.750	1338.750	1338.750	1338.750	1338.750	1338.750
Outflow, foreign	677.871	677.871	704.871	677.871	677.871	704.871
Surplus (deficit)	660.879	660.879	633.879	660.879	660.879	633.879
Net cashflow	431.263	431.263	404.263	431.263	431.263	404.263
Cumulated net cashflow	43.969	475.232	879.495	1310.758	1742.021	2146.284

QUININE PLANT, PROCESSING ONLY, 450 MT --- JULY 5, 1989

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	2004	2005	2006
Total cash inflow	1338.750	1338.750	1338.750
Financial resources	0.000	0.000	0.000
Sales, net of tax	1338.750	1338.750	1338.750
Total cash outflow	907.487	907.487	907.487
Total assets	0.000	0.000	0.000
Operating costs	907.487	907.487	907.487
Cost of finance	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000
Surplus (deficit)	431.263	431.263	431.263
Cumulated cash balance	5098.656	5529.919	5961.183
Inflow, local	0.000	0.000	0.000
Outflow, local	229.616	229.616	229.616
Surplus (deficit)	-229.616	-229.616	-229.616
Inflow, foreign	1338.750	1338.750	1338.750
Outflow, foreign	677.871	677.871	677.871
Surplus (deficit)	660.879	660.879	660.879
Net cashflow	431.263	431.263	431.263
Cumulated net cashflow	2577.547	3008.810	3440.073

QUININE PLANT, PROCESSING ONLY, 450 MT --- JULY 5, 1989

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value	-1220.03	at	15.00 %
Internal Rate of Return (IRRE1) ..	4.70 %		

b) Net Worth versus Net cash return:

Net present value	-300.59	at	15.00 %
Internal Rate of Return (IRRE2) ..	12.52 %		

c) Internal Rate of Return on total investment:

Net present value	-300.59	at	15.00 %
Internal Rate of Return (IRR) ..	12.52 %		

Net Worth = Equity paid plus reserves

Net Income Statement in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996
Total sales, incl. sales tax	892.500	1338.750	1338.750	1338.750	1338.750
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	892.500	1338.750	1338.750	1338.750	1338.750
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	923.899	1137.367	1163.367	1163.367	1163.367
Operational margin	-31.399	201.383	175.383	175.383	175.383
As % of total sales	-3.518	15.043	13.101	13.101	13.101
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	-31.399	201.383	175.383	175.383	175.383
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-31.399	201.383	175.383	175.383	175.383
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	-31.399	201.383	175.383	175.383	175.383
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-31.399	201.383	175.383	175.383	175.383
Accumulated undistributed profit	-31.399	169.984	345.367	520.750	696.133
Gross profit, % of total sales	-3.518	15.043	13.101	13.101	13.101
Net profit, % of total sales	-3.518	15.043	13.101	13.101	13.101
ROE, Net profit, % of equity	-1.245	7.988	6.957	6.957	6.957
ROI, Net profit+interest, % of invest.	-1.172	7.379	6.338	6.338	6.338

QUININE PLANT, PROCESSING ONLY, 450 MT --- JULY 5, 1989

Net Income Statement in THOUSAND U.S. DOLLARS

Year	1997	1998	1999	2000	2001
Total sales, incl. sales tax	1338.750	1338.750	1338.750	1338.750	1338.750
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	1338.750	1338.750	1338.750	1338.750	1338.750
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	1163.367	1163.367	1163.367	1150.674	924.746
Operational margin	175.383	175.383	175.383	188.076	414.004
As % of total sales	13.101	13.101	13.101	14.049	30.925
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	175.383	175.383	175.383	188.076	414.004
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	175.383	175.383	175.383	188.076	414.004
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	175.383	175.383	175.383	188.076	414.004
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	175.383	175.383	175.383	188.076	414.004
Accumulated undistributed profit	871.516	1046.899	1222.282	1410.359	1824.363
Gross profit, % of total sales	13.101	13.101	13.101	14.049	30.925
Net profit, % of total sales	13.101	13.101	13.101	14.049	30.925
ROE, Net profit, % of equity	6.957	6.957	6.957	7.460	16.422
ROI, Net profit+interest, % of invest.	6.277	6.277	6.277	6.667	14.675

QUININE PLANT, PROCESSING ONLY, 450 MT --- JULY 5, 1989

Net Income Statement in THOUSAND U.S. DOLLARS

Year	2002	2003	2004	2005	2006
Total sales, incl. sales tax	1338.750	1338.750	1338.750	1338.750	1338.750
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	1338.750	1338.750	1338.750	1338.750	1338.750
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	916.487	916.487	916.487	916.487	916.487
Operational margin	422.263	422.263	422.263	422.263	422.263
As % of total sales	31.542	31.542	31.542	31.542	31.542
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	422.263	422.263	422.263	422.263	422.263
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	422.263	422.263	422.263	422.263	422.263
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	422.263	422.263	422.263	422.263	422.263
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	422.263	422.263	422.263	422.263	422.263
Accumulated undistributed profit	2246.625	2668.889	3091.152	3513.415	3935.678
Gross profit, % of total sales	31.542	31.542	31.542	31.542	31.542
Net profit, % of total sales	31.542	31.542	31.542	31.542	31.542
ROE, Net profit, % of equity	16.749	16.749	16.749	16.749	16.749
ROI, Net profit+interest, % of invest.	14.966	14.626	14.826	14.826	14.826

QUININE PLANT, PROCESSING ONLY, 540 MT
JULY 5, 1989
5% CONTENT, W/ SER ADJUSTMENT

SQPRC 4

1½ year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.2000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: THOUSAND U.S. DOLLARS

Total initial investment during construction phase

fixed assets:	2868.60	72.681 % foreign
current assets:	0.00	0.000 % foreign
total assets:	2868.60	72.681 % foreign

Source of funds during construction phase

equity & grants:	2868.60	72.681 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	2368.60	72.681 % foreign

Cashflow from operations

Year:	1	6	9
operating costs:	761.58	1223.79	1223.79
depreciation :	291.89	291.89	279.20
interest :	0.00	0.00	0.00
production costs	1053.46	1515.67	1502.98
thereof foreign	73.79 %	78.19 %	78.85 %
total sales :	1071.00	1927.80	1927.80
gross income :	17.54	412.13	424.82
net income :	17.54	412.13	424.82
cash balance :	128.81	629.26	671.61
net cashflow :	128.81	629.26	671.61

Net Present Value at: 15.00 % = 304.50
Internal Rate of Return: 17.00 %
Return on equity1: 10.18 %
Return on equity2: 17.00 %

Index of Schedules produced by COMFAR

Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

QUININE PLANT, PROCESSING ONLY, 540 MT
JULY 5, 1989
5% CONTENT, W/O CORP. INCOME TAX

SQPRC 3

1½ year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: THOUSAND U.S. DOLLARS

Total initial investment during construction phase

fixed assets:	2521.11	68.915 % foreign
current assets:	0.00	0.000 % foreign
total assets:	2521.11	68.915 % foreign

Source of funds during construction phase

equity & grants:	2521.11	68.916 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	2521.11	68.916 % foreign

Cashflow from operations

Year:	1	6	9
operating costs:	668.02	1062.28	1062.28
depreciation :	255.88	255.88	243.19
interest :	0.00	0.00	0.00
production costs	923.90	1318.16	1305.47
thereof foreign	70.12 %	74.92 %	75.65 %
total sales :	892.50	1606.50	1606.50
gross income :	-31.40	288.34	301.03
net income :	-31.40	288.34	301.03
cash balance :	65.66	480.88	517.22
net cashflow :	65.66	480.88	517.22

Net Present Value at: 15.00 % = -65.78
Internal Rate of Return: 14.50 %
Return on equity1: 7.49 %
Return on equity2: 14.50 %

Index of Schedules produced by COMFAR

Total Initial Investment in THOUSAND U.S. DOLLARS

Year	1990.1	1990.2	1991.1	1991.2
Fixed investment costs				
Land, site preparation, development	0.000	75.990	0.000	0.000
Buildings and civil works	0.000	73.140	65.015	65.015
Auxiliary and service facilities	0.000	375.408	333.696	333.696
Incorporated fixed assets	0.000	29.700	26.400	53.400
Plant machinery and equipment	0.000	392.273	348.688	348.688
Total fixed investment costs	0.000	946.511	773.799	800.799
Pre-production capital expenditures.	0.000	0.000	0.000	0.000
Net working capital	0.000	0.000	0.000	0.000
Total initial investment costs	0.000	946.511	773.799	800.799
Of it foreign, in %	0.000	65.055	70.734	71.721

QUININE PLANT, PROCESSING ONLY, 540 MT --- JULY 5, 1989

Total Production Costs in THOUSAND U.S. DOLLARS

Year	1992	1993	1994-96	1997-99	2000
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	336.000	504.000	504.000	604.800	604.800
Other raw materials	57.314	85.972	85.972	103.166	103.166
Utilities	2.249	2.772	2.772	3.086	3.086
Energy	14.456	20.743	20.743	24.229	24.229
Labour, direct	86.000	53.000	53.000	61.000	61.000
Repair, maintenance	9.000	14.000	14.000	17.000	17.000
Spares	0.000	0.000	26.000	26.000	26.000
Factory overheads	27.000	41.000	41.000	49.000	49.000
Factory costs	532.019	721.487	747.487	888.281	888.281
Administrative overheads	88.000	88.000	88.000	88.000	88.000
Indir. costs, sales and distribution	48.000	72.000	72.000	86.000	86.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	255.880	255.880	255.880	255.880	243.187
Financial costs	0.000	0.000	0.000	0.000	0.000
Total production costs	923.899	1137.367	1163.367	1318.161	1305.468
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	70.118	73.144	73.744	74.920	75.649
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	94.000	61.000	61.000	69.000	69.000

QUININE PLANT, PROCESSING ONLY, 540 MT --- JULY 5, 1989

Total Production Costs in THOUSAND U.S. DOLLARS

Year	2001	2002- 6
% of nom. capacity (single product).	0.000	0.000
Raw material 1	604.800	604.800
Other raw materials	103.166	103.166
Utilities	3.086	3.086
Energy	24.229	24.229
Labour, direct	61.000	61.000
Repair, maintenance	17.000	17.000
Spares	26.000	26.000
Factory overheads	49.000	49.000
Factory costs	888.281	888.281
Administrative overheads	88.000	88.000
Indir. costs, sales and distribution	86.000	86.000
Direct costs, sales and distribution	0.000	0.000
Depreciation	17.259	9.000
Financial costs	0.000	0.000
Total production costs	1079.540	1071.281
Costs per unit (single product)	0.000	0.000
Of it foreign, %	76.401	76.219
Of it variable,%	0.000	0.000
Total labour	69.000	69.000

Cashflow Tables, construction in THOUSAND U.S. DOLLARS

Year	1990.1	1990.2	1991.1	1991.2
Total cash inflow	0.000	946.515	773.795	800.799
Financial resources	0.000	946.515	773.795	800.799
Sales, net of tax	0.000	0.000	0.000	0.000
Total cash outflow	0.000	946.511	773.799	800.799
Total assets	0.000	946.511	773.799	800.799
Operating costs	0.000	0.000	0.000	0.000
Cost of finance	0.000	0.000	0.000	0.
Repayment	0.000	0.000	0.000	0.000
Corporate tax	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000
Surplus (deficit)	0.000	0.004	-0.004	0.000
Cumulated cash balance	0.000	0.004	-0.000	-0.000
Inflow, local	0.000	330.755	226.455	226.459
Outflow, local	0.000	330.755	226.460	226.460
Surplus (deficit)	0.000	0.000	-0.005	-0.001
Inflow, foreign	0.000	615.760	547.340	574.340
Outflow, foreign	0.000	615.756	547.339	574.339
Surplus (deficit)	0.000	0.004	0.001	0.001
Net cashflow	0.000	-946.511	-773.799	-800.799
Cumulated net cashflow	0.000	-946.511	-1720.310	-2521.109

QUININE PLANT, PROCESSING ONLY, 540 MT --- JULY 5, 1989

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996	1997
Total cash inflow	936.835	1354.539	1340.917	1338.750	1338.750	1618.233
Financial resources	44.335	15.789	2.167	0.000	0.000	11.733
Sales, net of tax	892.500	1338.750	1338.750	1338.750	1338.750	1606.500
Total cash outflow	871.178	946.601	947.487	907.487	907.487	1137.354
Total assets	203.158	65.114	40.000	0.000	0.000	75.073
Operating costs	668.019	881.487	907.487	907.487	907.487	1062.281
Cost of finance	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	65.657	407.938	393.430	431.263	431.263	480.879
Cumulated cash balance	65.657	473.595	867.025	1298.288	1729.551	2210.430
Inflow, local	9.353	2.448	0.000	0.000	0.000	2.095
Outflow, local	259.471	239.366	229.616	229.616	229.616	263.111
Surplus (deficit)	-250.118	-236.918	-229.616	-229.616	-229.616	-261.016
Inflow, foreign	927.482	1352.091	1340.917	1338.750	1338.750	1616.138
Outflow, foreign	611.707	707.235	717.871	677.871	677.871	874.243
Surplus (deficit)	315.775	644.856	623.046	660.879	660.879	741.895
Net cashflow	65.657	407.938	393.430	431.263	431.263	480.879
Cumulated net cashflow	-2455.452	-2047.513	-1654.084	-1222.821	-791.558	-310.678

Cashflow tables, production in THOUSAND U.S. DOLLARS

Year	1998	1999	2000	2001	2002	2003
Total cash inflow	1606.500	1606.500	1606.500	1606.500	1606.500	1606.500
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	1606.500	1606.500	1606.500	1606.500	1606.500	1606.500
Total cash outflow	1062.281	1062.281	1089.281	1062.281	1062.281	1089.281
Total assets	0.000	0.000	27.000	0.000	0.000	27.000
Operating costs	1062.281	1062.281	1062.281	1062.281	1062.281	1062.281
Cost of finance	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	544.219	544.219	517.219	544.219	544.219	517.219
Cumulated cash balance	2754.649	3298.869	3816.088	4360.307	4904.526	5421.746
Inflow, local	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, local	254.756	254.756	254.756	254.756	254.756	254.756
Surplus (deficit)	-254.756	-254.756	-254.756	-254.756	-254.756	-254.756
Inflow, foreign	1606.500	1606.500	1606.500	1606.500	1606.500	1606.500
Outflow, foreign	807.525	807.525	834.525	807.525	807.525	834.525
Surplus (deficit)	798.975	798.975	771.975	798.975	798.975	771.975
Net cashflow	544.219	544.219	517.219	544.219	544.219	517.219
Cumulated net cashflow	233.541	777.760	1294.979	1839.198	2383.417	2900.636

Cashflow tables, pr ction in THOUSAND U.S. DOLLARS

Year	2004	2005	2006
Total cash inflow	1606.500	1606.500	1606.500
Financial resources	0.000	0.000	0.000
Sales, net of tax	1606.500	1606.500	1606.500
Total cash outflow	1062.281	1062.281	1062.281
Total assets	0.000	0.000	0.000
Operating costs	1062.281	1062.281	1062.281
Cost of finance	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000
Surplus (deficit)	544.219	544.219	544.219
Cumulated cash balance	5965.965	6510.184	7054.403
Inflow, local	0.000	0.000	0.000
Outflow, local	254.756	254.756	254.756
Surplus (deficit)	-254.756	-254.756	-254.756
Inflow, foreign	1606.500	1606.500	1606.500
Outflow, foreign	807.525	807.525	807.525
Surplus (deficit)	798.975	798.975	798.975
Net cashflow	544.219	544.219	544.219
Cumulated net cashflow	3444.855	3989.075	4533.294

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value	-974.94	at	15.00 %
Internal Rate of Return (IRRE1) ..	7.49 %		

b) Net Worth versus Net cash return:

Net present value	-65.79	at	15.00 %
Internal Rate of Return (IRRE2) ..	14.50 %		

c) Internal Rate of Return on total investment:

Net present value	-65.78	at	15.00 %
Internal Rate of Return (IRR) ..	14.50 %		

Net Worth = Equity paid plus reserves

Net Income Statement in THOUSAND U.S. DOLLARS

Year	1992	1993	1994	1995	1996
Total sales, incl. sales tax	892.500	1338.750	1338.750	1338.750	1338.750
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	892.500	1338.750	1338.750	1338.750	1338.750
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	923.899	1137.367	1163.367	1163.367	1163.367
Operational margin	-31.399	201.383	175.383	175.383	175.383
As % of total sales	-3.518	15.043	13.101	13.101	13.101
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	-31.399	201.383	175.383	175.383	175.383
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-31.399	201.383	175.383	175.383	175.383
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	-31.399	201.383	175.383	175.383	175.383
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-31.399	201.383	175.383	175.383	175.383
Accumulated undistributed profit	-31.399	169.984	345.367	520.750	696.133
Gross profit, % of total sales	-3.518	15.043	13.101	13.101	13.101
Net profit, % of total sales	-3.518	15.043	13.101	13.101	13.101
ROE, Net profit, % of equity	-1.245	7.988	6.957	6.957	6.957
ROI, Net profit+interest, % of invest.	-1.172	7.379	6.338	6.338	6.338

QUININE PLANT, PROCESSING ONLY, 540 MT --- JULY 5, 1989

Net Income Statement in THOUSAND U.S. DOLLARS

Year	1997	1996	1999	2000	2001
Total sales, incl. sales tax	1606.500	1606.500	1606.500	1606.500	1606.500
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	1606.500	1606.500	1606.500	1606.500	1606.500
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	1318.161	1318.161	1318.161	1305.468	1079.540
Operational margin	288.339	288.339	288.339	301.032	526.960
As % of total sales	17.948	17.948	17.948	18.738	32.802
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	288.339	288.339	288.339	301.032	526.960
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	288.339	288.339	288.339	301.032	526.960
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	288.339	288.339	288.339	301.032	526.960
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	288.339	288.339	288.339	301.032	526.960
Accumulated undistributed profit	984.472	1272.811	1561.150	1862.182	2389.142
Gross profit, % of total sales	17.948	17.948	17.948	18.738	32.802
Net profit, % of total sales	17.948	17.948	17.948	18.738	32.802
ROE, Net profit, % of equity	11.437	11.437	11.437	11.940	20.902
ROI, Net profit+interest, % of invest.	10.187	10.187	10.187	10.535	18.442

QUININE PLANT, PROCESSING ONLY, 540 MT --- JULY 5, 1989

Net Income Statement in THOUSAND U.S. DOLLARS

Year	2002	2003	2004	2005	2006
Total sales, incl. sales tax	1606.500	1606.500	1606.500	1606.500	1606.500
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	1606.500	1606.500	1606.500	1606.500	1606.500
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	1071.281	1071.281	1071.281	1071.281	1071.281
Operational margin	535.219	535.219	535.219	535.219	535.219
As % of total sales	33.316	33.316	33.316	33.316	33.316
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	535.219	535.219	535.219	535.219	535.219
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	535.219	535.219	535.219	535.219	535.219
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	535.219	535.219	535.219	535.219	535.219
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	535.219	535.219	535.219	535.219	535.219
Accumulated undistributed profit	2924.361	3459.580	3994.799	4530.018	5065.237
Gross profit, % of total sales	33.316	33.316	33.316	33.316	33.316
Net profit, % of total sales	33.316	33.316	33.316	33.316	33.316
ROE, Net profit, % of equity	21.230	21.230	21.230	21.230	21.230
ROI, Net profit+interest, % of invest.	18.731	18.555	18.555	18.555	18.555