

THE GOVERNMENT OF MALAYSIA
THE STATE OF SARAWAK

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MIRI-BINTULU

REGIONAL PLANNING STUDY

SUPPORTING REPORT

No. 2

AGRICULTURE PART IV THE SELECTION AND MANAGEMENT OF CROPS FOR DEVELOPMENT

—1974—

HUNTING TECHNICAL
SERVICES LTD. LONDON

HOFF AND OVERGAARD
COPENHAGEN

THE GOVERNMENTS OF MALAYSIA AND THE
STATE OF SARAWAK

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MIRI BINTULU REGIONAL PLANNING STUDY

SUPPORTING REPORT

No. 2 ASPECTS ASSOCIATED WITH
AGRICULTURAL PLAN

AGRICULTURE

PART IV
THE SELECTION AND
MANAGEMENT OF CROPS
FOR DEVELOPMENT

— 1974 —

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C O N V E R S I O N S

Linear Measures:

1 inch	=	25.4 millimetres
	=	2.54 centimetres
1 foot (12 inches)	=	0.3048 metre
1 yard (3 feet)	=	0.9144 metre
1 chain (22 yards)	=	20.117 metres
1 mile (1 760 yards)	=	1.609 kilometres

Square Measures:

1 square inch	=	6.45 square centimetres
1 square foot	=	9.29 square decimetres
1 square yard	=	0.836 square metre
1 acre (4 840 sq. yards)	=	0.405 hectare
1 square mile (640 acres)	=	259.00 hectares

Weights:

1 ounce (16 drams)	=	28.350 grammes
1 pound (16 ounces)	=	0.454 kilogram
	=	12 tahils
1 tahlil	=	1.33 ounces
1 kati (16 tahils)	=	1.33 pounds
1 kilogram	=	1.65 katis
1 cwt (112 pounds)	=	50.8 kilograms
1 ton (20 cwt)	=	16.8 piculs
1 picul	=	100 katis

Measure of Capacity:

1 pint	=	0.568 litre
1 quart (2 pints)	=	1.137 litres
1 gallon (4 quarts)	=	4.546 litres
(or 1 gantang)		

INTRODUCTION

In this Part an explanation is given of the process whereby the agricultural activities recommended in the development plan have been selected. This is followed by an exposition of the market situation, agronomic and economic aspects of the main crops chosen. Livestock and fishery enterprises are only superficially dealt with here, they are treated more fully in Part V.

The agronomic details presented here are not necessarily recommendations on how the crops should be handled, rather they are assumptions, based on practical experience and current practices in Sarawak and Malaysia, of how the crops could be handled. These assumptions have been taken as the basis for calculating, for each crop, the associated costs and returns which have then been incorporated in the economic and financial analyses of the proposed agricultural plan presented in Part II.

It is possible that the assumptions costs and returns would be of assistance as an initial basis for compiling the Extension Manual considered necessary for the efficient operation of the Agricultural Development Unit (see Part III).

CHAPTER 1

DEVELOPMENT OPPORTUNITIES AND SELECTION OF AGRICULTURAL ACTIVITIES

1.1 INTRODUCTION

A number of economic and technical factors have been considered in the selection of agricultural activities for inclusion in the agricultural plan for the Study Area. Over a 20 year period technical innovation and changed market conditions may come-up, as they have in the past, which may require adjustments to the plan. The first approach to the problem of activity selection, which is outlined here, was to examine a wide range of potential activities and to screen these on the basis of various selection criteria to determine their suitability for inclusion in the agricultural development plan. To facilitate the screening process preliminary groupings of crops reflecting commercial production potential and location requirements were developed, and each activity was given a rating on the basis of currently available data. This preliminary screening was followed by a more rigorous evaluation of the more likely enterprises considered for inclusion in the development programme.

1.2 POTENTIAL AGRICULTURAL ACTIVITIES

Agriculturally there can be no large tracts of mechanised, arable farming based on annual crops in the Study Area. The future development envisaged is rather one of largely permanent or semi-permanent crops, including pasture and forest trees, growing on the steeper parts of undulating country, with relatively small areas of annual crops growing on the gently sloping land, and banded padi fields on the flatter areas subject to periodic inundation. The potential crops which could be grown considering environmental and agronomic conditions of the Study Area are given in Table 1.1. Also tentatively indicated is the slope range within which each should be restricted mainly because of the erosion described in Supporting Report 1, Part II.

Other enterprises for which the physical environment is suitable are beef, poultry and pig rearing, pond culture of fresh water fish, turtles and prawns, also, but on a much more limited scale, the culture in brackish water of crustacea.

1.3 PRELIMINARY GROUPING AND SCREENING OF ACTIVITIES

The object of this first screening of potential activities was to determine commercial prospects on the basis of the following factors or constraints:-

TABLE 1.1 POTENTIAL AGRICULTURAL ACTIVITIES

Slope range (degrees)	Annual	Semi-perennial	Perennial	Remarks
0 - 2	Swamp rice		Sago	
0 - 6	Groundnuts, Vegetables, Yam, Sweet potatoes, Pulses, Sorghum, Maize, Chillies, Ginger, Turmeric	Tapioca		If terraced, small patches could be grown on steeper land. Erosion control measures would be necessary on slopes above four degrees.
0 - 12		Sugar cane, Essential oil crops	Bananas, Papaya, Pineapple, Vanilla	
0 - 20			Cinnamon, Cardamon, Coconuts, Pasture, Anatto, Coffee, Cocoa, Citrus, Mango, Durian, Mangosteen, Rambutan, Oil palm	The tree and bush crops would need to be contour planted on slopes between four and 12 degrees. Terraces or platforms would be required on slopes above 12 degrees and complete ground cover necessary during establishment.
0 - 25			Rubber, Tea, Pepper, Cloves, Nutmeg, Cashew-nut	Terraces or platforms would be required above 12 degrees. Between four and 12 degrees contour planting would be necessary and complete ground cover necessary during establishment.

- environmental adaptation of the crop, livestock or aquaculture activity;
- availability of proven technical knowledge on the basis of which husbandry requirements might be established;
- availability of market outlets either internally or overseas.

This grouping indicated primarily those enterprises for which there were prospects for commercial development and on this basis possible opportunities were further examined within the overall development objectives.

Four production groups were defined as follows:-

- Group 1: activities known to be commercially viable for immediate development on a large scale.
- Group 2: activities known to be commercially viable and suitable for immediate development but on a restricted scale or only for internal or local consumption.
- Group 3: activities with promising commercial prospects but requiring an initial period of trial or limited research prior to recommendation for development on a large scale.
- Group 4: activities possibly suited to the local environment but requiring intensive research and field trial before they might be considered for commercial exploitation.

A second grouping was developed in order to deal with the particular problems of access and transportation encountered

in the Study Area, and to define the role of transport as a constraint to development planning. This grouping was therefore based on the location requirements of each activity for which three alternatives were derived, thus:-

- Group A: activities whose inputs and end-products would be easily transported and for which no special processing facilities would be envisaged. These activities were regarded as suitable for development in remote areas served by minor waterways or tracks.
- Group B: activities whose end-products would be bulky but reasonably durable or could be processed on the farm, requiring simple means of transport on larger rivers or rural roads. These activities were considered suitable for semi-remote areas.
- Group C: activities which due to the bulkiness or perishability of their product or need for specialised large scale processing of their products require good roads or waterways. These activities were considered suitable only where proximity to an all weather road network, navigable waterway, processing plant or urban market was satisfied.

On the basis of the above criteria a classification of potential agriculture activities was drawn up as shown in Table 1.2. There are of course gradations within the groups and it has not always been a clear-cut decision as to which group a particular activity should be placed. But the table shows that any short-term development programme would have to rely heavily on oil palm and rubber. Other enterprises which could be considered on a more restricted scale are:- maize for green cobs, single cropping of swamp rice, vegetables for fresh market, anatto, some essential oils, pepper, coffee (robusta), coconuts, certain fruits, sago, beef rearing, pig rearing for fresh meat, poultry, pond culture of fish and prawns.

1.4 PRELIMINARY EVALUATION OF AGRICULTURAL DEVELOPMENT OPPORTUNITIES

The criteria which have been employed as a basis for the preliminary evaluation of agricultural enterprises centred on three main elements, namely:-

- agronomic aspects;
- production economics; and
- market potential.

The results of these evaluations, summarised in Table 1.3 confirmed those mentioned in the previous section; that the choice of possible activities for immediate large scale development was limited to palm oil and rubber, and from the list of possible restricted enterprises coconuts, tapioca and sago

TABLE 1.2 CLASSIFICATION OF AGRICULTURAL ACTIVITIES BY
COMMERCIAL VIABILITY (PRODUCTION) AND LOCATION GROUPINGS

Activity	Production group	Location group
<u>Annual crops</u>		
Chillies (spice)	3	A
Legumes - beans, groundnuts, cowpea, soyabeans	4	B
Maize and sorghum for grain	4	B
Maize for green cobs	2	C
Swamp rice - single crop per annum (landas season)	2	A-C
Swamp rice - double crop	3	C
Tapioca for chips or feed	3	C
Vegetables for fresh markets	2	C
<u>Semi-perennial crops</u>		
Anatto	2	A
Bananas (for export)	4	C
Essential oils - lemon grass, patchouli	2	C
Essential oils - citronella grass, vetiver grass	3	C
Grasses and legumes for grazing (beef production)	3	C
Grasses and legumes for cut fodder (beef production)	3	C
Papaya for fruit or papain	4	C
Pepper	2	B-C
Spices - turmeric, cardamon	3	B-C
Spices - vanilla, ginger	4	B-C
Sugar cane	4	B-C
<u>Perennial crops</u>		
Cashew nuts	3-4	A
Coffee (robusta)	2-3	A-B
Cocoa	2	B-C
Coconuts	2	B-C
Fruit trees including durian, guava, rambutan and citrus for local markets	2	C
Fruits for processing	4	C
Oil palms	1	C
Rubber	1	B-C
Sago	2	C
Sago, cultivated plantation	4	C
Spices - cassia, cinnamon	4	B
Spices - cloves, nutmeg	3	B
Tea - lowland	3	C
<u>Livestock (commercial)</u>		
Beef, breeding and fattening for fresh meat	2-3	C
Pigs for fresh meat	2	C
Poultry - eggs, broilers and hatching eggs	2	C
Aquaculture schemes - fish, prawns	2	C
Aquaculture schemes - brackish water crustacia	3	C
Aquaculture schemes - turtles	3	C

were found unsatisfactory under conditions in the Study Area. On the basis of market potential and production economics the best prospects for large scale development in the Study Area in the near future appeared to lie in the direction of beef cattle and cocoa; both, however, would require careful introduction before wide-spread large scale enterprises could begin. All the other selected enterprises were selected and have been included to some degree in the recommendations in the agricultural plan presented in Part II. Oil palms have been made the major enterprise followed by rubber and, to a lesser extent, cocoa which has been recommended only on the most suitable land. Single cropping of swamp rice has been recommended on a reasonably limited scale. A commercially

TABLE 1.3 PRELIMINARY EVALUATION OF AGRICULTURAL ACTIVITIES IN GROUPS I, II AND III

Production group	Enterprise	Production organisation	Agronomic constraints	Production economics					Labour requirement	Remarks
				Estimated average yield	Gross value of production at farm gate	Gross margin including labour at \$5.40 per man day	Capital cost	Man days per acre		
			<ol style="list-style-type: none"> Slopes less than 20 degrees Fertility requirement on in-land soil types Inter-cropping on slopes less than 15 degrees Proven on basis of experiments and existing development 	9.0 tons f.f.b.	613	281	1 810	20		
	Oil palm	<p>Estate type management processing</p> <p>Small farmer management processing</p>	<ol style="list-style-type: none"> Slopes less than 25 degrees Availability of high yielding clones, planting material Dispersion and neglect of existing plantings 	<p>1 600 pounds</p> <p>1 500 pounds</p>	<p>487</p> <p>487</p>	<p>262</p> <p>227</p>	<p>1 850</p> <p>960</p>	<p>30</p> <p>45</p>		
	Rubber	<p>Estate including processing</p> <p>Small holder excluding processing carried out by estate</p>								
Market potential for Study Area products										
	Enterprise	Market constraints	Projected market limit over 20 years	Internal	Export	Area required to meet market projection acres	Projected price dollars			
	Oil palm	<ol style="list-style-type: none"> Demand for vegetable oils growing at 3.1 per cent per annum to 1990 Malaysia share of world market expanded to 50 per cent by 1990 Saravak would account for 10 per cent of Malaysia's production 	<p>Palm oil</p> <p>Palm kernels or kernel oil</p>	<p>Negligible</p> <p>Limited</p>	<p>186 000 tons palm oil</p>	<p>155 000</p>	<p>Palm oil \$330 per ton</p> <p>Palm kernels \$370 per ton</p>		<p>Study Area share assumes 66 000 acres of potential already developed or located outside the Area, including Lambir-Subis Development.</p>	
	Rubber	<ol style="list-style-type: none"> Demand for elastomers growing at 6 per cent per annum, diminishing share of increase captured by rubber Demand for rubber growing at 3 per cent per annum <p>Saravak share 2.9 per cent of world market</p>	<p>Smoked sheet or crumb rubber</p>		<p>32 000 tons</p>	<p>95 000</p>	<p>RSS1 or equivalent \$1 050 per ton</p>		<p>Saravak contribution to world market demand estimated at 151 000 tons. Split on basis of current high yielding rubber area, 20 per cent to Study Area = 75 000 to 95 000 acres at average yields of 800 to 1 000 pounds d.r.c. per acre.</p>	

TABLE 1.3 (cont'd)

Production group	Enterprise	Production organisation	Agronomic constraints	Production economics				
				Estimated average yield	Gross value of production at farm gate	Gross margin including labour at \$5.00 per man day	Capital cost	Labour requirement
				Per acre	Man days per acre			
	Rice, wet padi	Small holder	<ol style="list-style-type: none"> 1. Availability of suitable land 2. Development of cropping programmes to satisfy land usage constraints 	1.33 tons padi (= 3 000 lbs)	295	-31	550	58
	Essential oils (lemon grass, patchouli)	Small holder	<ol style="list-style-type: none"> 1. Availability of suitable land 2. Cropping patterns and husbandry techniques for maximum productivity, and persistence 	4.3 tons raw material	800	196	605	47
II	Pepper	Small holder	<ol style="list-style-type: none"> 1. Introduction of improved varieties 2. Disease problems 	25 piculs made pepper	3 730	2 417	3 535	124
	Vegetables	Small holder	<ol style="list-style-type: none"> 1. Land suitability, slope less than 6 degrees 2. Varieties adapted to local environment 3. Crop rotations 	10 tons fresh	1 700	495	1 500	115
	Poultry (layers broilers)	Small holder (1 000 bird unit)	<ol style="list-style-type: none"> 1. Feed costs and consumption rates relatively high 2. Diseases 		14 000 per unit	1 950 per unit	7 300 per unit	125 per unit
	Pigs (porkers)	Small holder (10 sows unit)	<ol style="list-style-type: none"> 1. Feed costs and consumption rates relatively high 2. Availability of breeding stock 		34 000 per unit	3 080 per unit	17 400 per unit	125

TABLE 1.3 (cont'd)

Production group	Enterprise	Market constraints	Market potential for Study Area products				Remarks	
			Projected market limit over 20 years			Area required to meet market projection acres**		Projected price dollars
			Product	Internal *	Export			
II	Rice, wet padi	<ol style="list-style-type: none"> Per capita consumption estimated at about 340 lb milled rice per annum Production projected to keep pace with internal demand subject to availability of suitable land 	Padi, rice	According* to population projections		1 acre per 6 persons in population	Padi \$320 per ton	Present hill padi areas unlikely to decrease appreciably, wet padi area intensified, two crops in three years resulting in doubling of cropped area on existing areas.
	Essential oils (lemon grass, patchouli)	<ol style="list-style-type: none"> Market for oils related to demand for luxury goods, projected steady growth Relatively small Saravak production easily sold to buyers in Europe or Singapore 	Crude oils	Limited	No data available	2 500	Various prices for products	Enquiries from Singapore buyers indicate future possibilities for quality products at competitive prices. Quality standards necessary for successful crude oil marketing.
	Pepper	<ol style="list-style-type: none"> Demand for pepper increasing at 2 per cent per annum Saravak share of market projected to remain at present 29 per cent or slowly increase Quality and type of pepper produced improved 	Black and white pepper		8 000 tons	3 500	White \$2 100 Black \$1 680 per ton	Possible competition from Indian hybrid production. Scope for producing more pungent type of black pepper. Essential to ensure quality of produce matches market requirements. Attention to marketing and grading organisations required.
	Vegetables	<ol style="list-style-type: none"> Demand for fresh vegetables increasing with population Pattern of settlement determines degree of commercial production 	Fresh vegetables	50 000 tons	Negligible	5 000 acres	Various	Production for urban population located in market gardens on periphery of town areas.
	Poultry (layers, broilers)	<ol style="list-style-type: none"> Consumption per capita increasing to 120 eggs and 9 lb meat per annum by 1990 Commercial production to supply urban areas 	Eggs Meat	42 m eggs* 1 280 tons		584 000 birds in commercial units, 656 000 birds in rural areas	\$12.00 per 100 \$1.80 per kati	As for above. Feed costs are major elements of production costs and determinant of local prices.
	Pigs	<ol style="list-style-type: none"> Consumption increasing to 32 lb per capita by 1990 Commercial production to supply urban population Production costs limit export prospects 	Pork meat	4 300 tons*		300 commercial 10 sow units	\$3.50 per kati for lean meat	Long term prospects for some processing in conjunction with abattoir development. Feed costs are major determinant of local price structure.

Notes * Study Area and rest of Saravak

** Study Area share of Saravak

TABLE 1.3 (cont'd)

Production group	Enterprise	Production organisation	Agronomic constraints	Production economics					
				Estimated average yield	Gross value of production at farm gate	Gross margin including labour at \$5.40 per man day	Capital cost	Labour requirement	
									Dollars per acre
Per acre									
	Cocoa	Small holder/estate	<ol style="list-style-type: none"> 1. Land suitability and adaptation to Study Area soils below 1 000 feet 2. Rainfall and temperature condition favourable 3. Availability of seed of proven hybrids 	1 500 lb dried beans equivalent				35	
	Tea	Estate	<ol style="list-style-type: none"> 1. Land suitability and adaptation to soils of Study Area 2. Rainfall distribution and soil moisture relations favourable 3. Provides good erosion protection 	1 000 lb dried tea leaf	1 120	195	3 400	150	
III	Tapioca	Small holder/estate	<ol style="list-style-type: none"> 1. Production techniques for local soils and slopes not yet established 2. Selection of varieties and availability planting material 3. Processing techniques require investigation 	12 tons fresh roots	300	50	450	20	
	Annual spices (turmeric, chillies)	Small holder	<ol style="list-style-type: none"> 1. Production techniques and varieties for local conditions 2. Crop rotations not yet established 	8 tons dried produce	1 090	585	740	70	
	Perennial spices (cloves, nutmeg)	Small holder	<ol style="list-style-type: none"> 1. Adaptation to local environment 2. Production techniques 3. Availability of planting material of proven high yielding strains 	345 lb dried produce	700	190	1 365	104	
	Beef, breeding weaners	Commercial ranch	<ol style="list-style-type: none"> 1. Land suitability 2. Pasture production techniques not established 3. Availability of suitable breeding animals 	NA	227	106	880	2.5 - 5.0	
	Beef, fattening	Small holder	<ol style="list-style-type: none"> 1. Land suitability 2. Pasture production 3. Availability of animals from breeding 4. Integration with crops 	NA	356	85	550	9	

TABLE 1.3 (cont'd)

Production group	Enterprise	Market constraints	Market potential for Study Area products				Remarks	
			Projected market limit over 20 years		Area required to meet market projection acres	Projected price dollars		
			product	Internal *				Export
Cocoa		<ol style="list-style-type: none"> World supply and demand in balance to 1980's Relatively small output from Sarawak unlikely to upset market balance Attention to quality and type of bean essential 	Dried beans	Negligible	2 700 tons	12 000 acres	\$1 200 per ton	Expansion in other areas of Sarawak may extend to 20 000 acres. Estimated 12 000 acres in Study Area on basis of management requirements and related unit size.
	Tea	<ol style="list-style-type: none"> World market over supplied, declining price trend projected for future Sarawak and West Malaysia import low quality tea, potential import substitution 	Black tea	350 tons	100 tons	1 000 acres	\$1.50 per lb	Export prospects limited to West Malaysian requirements for bulking or blending purposes at competitive prices. Estate type development essential for management and technical reasons.
	Tapioca	<ol style="list-style-type: none"> Good local and export demand prospects for animal feeds Local market, based on feed mixing requirements, estimated at 5 000 tons increasing to 20 000 tons by 1990 Competitive price essential 	Dried flakes	20 000 tons	Not assessed	6 000 acres	\$200 per ton	Successful producing basis must be established by commercial trials prior to expansion. Inter-cropping with oil palm possible.
Annual spices (turmeric, chillies)		<ol style="list-style-type: none"> Steady increase in demand forecast but unstable production situation on year to year basis Prices likely to fluctuate with changes in supply position Grading and maintenance of quality standards essential 	Dried spices	100 tons	2 500 tons	3 100 acres	\$1 600 per ton	Sarawak projected to capture 5 per cent world export market. Further market studies are necessary. Development of any scale would require effective control of grading and quality for exported produce c.f. pepper. Oleoresin and flavouring market requires investigation.
	Perennial spices (cloves, nutmeg)	As above but relatively more stable market situation with stiffer competition	Dried spices	Negligible	300 tons	1 800 acres	\$5 175 per ton	
	Beef, breeding weaners	<ol style="list-style-type: none"> Demand for fresh meat increasing with population and income growth World market likely to be under supplied to 1980's (foot and mouth) pre-requisite for export development 	Weaners or fattening animals	6 000 to 20 000 weaners/fatteners		33 000 acres	\$180 to \$195 for weaners	Major urban markets could be supplied from Fourth Division. Slaughtering and marketing facilities require attention. Commercial trial integrated with expansion phase.
Beef, fattening	As above	Slaughter animals	6 000 to 12 000 slaughter animals	8 000 slaughter animals	33 000 acres	\$3.30 to \$3.50 for best cuts of meat	Based on breeding of weaners/fatteners on commercial ranch, small holder fattening and finishing of animals.	

Note * Study Area and/or Sarawak

orientated beef breeding ranch has been recommended but further extension of beef rearing should await the outcome of specific trials (see Part V). Many of the other enterprises have been recommended for inclusion in the farming patterns, generally on a restricted scale, in accordance with the particular circumstances of each development area. A few enterprises have been recommended for further research only. In this category (Group 4) are a range of annual crops such as maize for grain, groundnuts and vegetables for processing, in addition to fruits for processing, bananas for export, plantation grown sago and highly valued spices such as vanilla. One problem associated with the annual crops is that they tend to require specific soils and terrain conditions, particularly relatively flat, well-drained land, which does not exist on any scale in the Study Area. Another production problem, particularly of grain crops, is the risk due to unpredictable weather which, in a bad year, might cause complete failure resulting in severe financial losses although in a favourable year they might be comparatively profitable. As explained earlier erosion hazards generally rule out mechanised cultivation. Thus strip cropping techniques or zero cultivation methods using herbicides and covercrops would need to be developed if large scale arable cropping at some future date, is found to be particularly desirable.

1.5 ECONOMIC EVALUATION OF THE SELECTED AGRICULTURAL ACTIVITIES

The main activities selected for inclusion in the development programme were examined in detail with particular reference to markets, production and economics. Details of the market prospects, husbandry requirements and production costings for the crops are given in the following Chapters of this Report, livestock and aquaculture are presented in Part V. To establish a basis for economic comparisons of the activities in addition to the marketing aspects dealt with later, cash flows were computed for standard production units of each crop and a series of economic achievements or criteria were derived for each as follows:

- (a) Commercial rate of return over 25 years for which all inputs and outputs were included at their market values.
- (b) Internal rate of return over 25 years for which social prices were attributed to inputs and output. For other calculations labour was valued at the shadow wage rate of \$3 per day and all taxes and duties were excluded from the cost of inputs and the value of output.
- (c) Returns to labour, calculated as the annual equivalent of returns to labour at the social rate of discount, (10 per cent) divided by the annual equivalent labour requirement in man days.
- (d) Returns to land, calculated as the net present value of output net of all factors, including capital, at social prices reduced to an annual equivalent per acre.

- (e) Employment generated at maturity measured in terms of the full time jobs created per hundred acres.
- (f) Employment generated at maturity measured in terms of the full time jobs created per thousand dollars capital invested.

The achievements calculated for the selected agricultural activities are given in Table 1.4. The following observations may be made on the results of this analysis.

- (a) Oil palm appears to be the most attractive crop for large scale development in terms of returns to commercial and social investments as well as land and labour resources. Employment generated per area planted, however, is considerably lower than for rubber for example.
- (b) Aquaculture schemes generally give the highest returns to investment and basic resources but are very capital intensive and can only be applied on a relatively small-scale due to market limitations. Similar remarks apply to pepper and here the risk of failure due to disease attack in conjunction with the high capital investments required, combine to make this activity an undertaking best suited to relatively small-scale operations.
- (c) Cocoa compares very favourably with any undertaking, either small or large-scale, in all respects but particularly in terms of returns to investments and land resources. An expansion of this activity on suitable land would appear to be well worth while.
- (d) Beef, as an initial breeding scheme, does not compare with other large-scale undertakings but in an expansion scheme it would be comparable with most alternatives. But beef enterprises have a very low capacity for generating new employment. Small-holder growing out of steers for beef appears relatively attractive, but due to low returns to land a fairly large undertaking would be required to produce an acceptable level of family income if it is the only enterprise. It appears from the data that livestock might be profitably developed on land which is marginal for other activities or as a supplementary enterprise on small-holdings.
- (e) Rice does not compare favourably with any other activity except in terms of employment. Its role would appear to be mainly one of satisfying local demand for food, and as such would perform an essential function in the development process.

TABLE 1.4 ECONOMIC ACHIEVEMENTS OF SELECTED AGRICULTURAL ACTIVITIES

Activity	Commercial rate of return (market prices) per cent	Internal rate of return (social prices) per cent	Returns to resources		Employment generated Full time workers per 100 acres at maturity	Investment required	
			Labour \$/man day	Land \$ per acre/annum		Cumulative undiscounted deficit cash flows \$ per acre	Cumulative deficit cash flow including interest at 7 per cent \$ per acre
Oil palm							
Estate: based on 60 ton per hour mill	14	23	14.1	148	6.5	1 356	1 713
Small-holder farmer	15	23	10.0	155	6.7	1 147	1 430
Rubber							
Estate: based on 10 ton per day factory:							
Large lumps field material } without stimulation material	3	9	2.3	Negative	18.6	2 213	3 291
Latex field material }	6	11	3.6	20	18.1	2 195	3 056
Latex field material with stimulation	8	12	4.2	45	21.1	2 201	3 063
Small-holder: delivering to central factory:							
Large lumps material } without stimulation material	3	11	3.3	11	16.1	1 650	2 492
Latex field material }	8	14	4.5	55	17.7	1 635	2 331
Pepper							
Small-holder farmer:							
Average yield situation	23	38	7.6	925	82.5	4 127	4 666
Low yield situation	11	26	5.6	463	73.7	4 127	4 666
Cocoa							
Small-holder farmer	20	25	9.6	201	9.3	1 167	1 450
Rice							
Small-holder farmer	3	14	3.7	35	15.4	1 098	1 316
Beef							
Ranch (5 000 acres)							
Initial breeding scheme	9	12	11.0	40	1.1	1 630	2 202
Expansion scheme	12	13	10.1	35	1.1	1 062	1 434
Small-holder farmer growing-out steers	15	18	9.6	46	2.1	559	717
Aquaculture schemes:							
Small-holder farmer							
1 acre Chinese carp	50	50	33.2	1 795	18.0	4 431	4 741
1/2 acre Chinese carp	38	45	17.8	1 182	24.0	4 380	4 686
1/10 acre local fish	31	42	9.6	792	24.0	3 710	3 970
1/2 acre prawns and local fish	39	46	18.0	1 151	24.0	4 310	4 612
Turtles (11/100 acre)	13	37	5.0	869	140.0	4 327	4 864

CHAPTER 2

OIL PALMS

2.1 INTRODUCTION

Oil palm with rubber is the main tree crop grown in Malaysia which is rapidly becoming the major supplier of palm oil on the world market. The effect of this expansion on the market balance is not easy to determine because of the wider range of competing products in the edible-industrial oil group. Future technological advances are also likely to play a role in determining the overall balance by increasing the substitutability between the various types of fats and oils.

Recent plantings of oil palms in Sarawak together with trials started in 1961/62 at Kabuloh Research Station in the Study Area have proved the technical feasibility for growing the crop and in general the climate is ideal for oil palms.

The economic studies indicate the importance of large-scale operations particularly with regard to processing. Large capacity mills are needed in order to achieve economies of scale. Unit costs of virtually all production items are generally higher in Sarawak than elsewhere and only by operating efficiently and on a large scale will it be possible to create an industry that would be competitive on the world market. Nevertheless the selection processes described in Chapter 1 showed oil palms to be the enterprise with the best prospects for large-scale development in the Study Area. The plantings already undertaken show that expansion can be achieved fairly rapidly, but until very recently Sarawak has lagged behind other parts of Malaysia. This imbalance should now be righted.

In the agricultural plan (see Part II) the recommended cropping pattern has been designed, within the limits of proper land use and the need for crop diversification, to create concentrations of oil palms close around a large processing mill, thus enabling modern production and transportation techniques to be undertaken. The plans have been aimed at quite rapid establishment of at least 30 000 acres of oil palms within a radius of roughly 20 miles of a mill which would be developed by stages to a final capacity of about 60 or 70 tons of fresh fruit bunches per hour.

Palm oil bulking, storage and ship loading facilities are presently being installed at Miri, but these are likely to be of sufficient capacity to handle production only up to about 1980. In the agricultural plan it has been assumed that oil and kernel handling facilities will be established near Bintulu where there are possibilities, presently being investigated, of constructing a deep-water port. If this does not materialise the whole problem of palm oil exportation will have to be reviewed.

22 THE MARKET FOR OIL PALM PRODUCTS

Oil palm fruit is processed to produce palm oil and palm kernels and the latter are crushed to yield palm kernel oil. These two products are edible industrial oils which belong to a group of 15 or more fats and oils entering the world fats and oils market. The vegetable and animal fats and oils market forms an important part of the world agricultural economy.

Long term predictions of the oil and fats market are complex due to the range of competing products and technological, natural, economic and political factors which may favour or operate against particular products. The increasing possibilities for substitution between various oils, in conjunction with economic factors, is undoubtedly likely to influence the future market structure and hence production and trade patterns. A feature of the future market could be decreasing price differences between particular types of oils and fats.

2.21 General Review of Uses, Production and Trade in Fats and Oils

Generally the classes into which fats and oils are grouped is determined by their end uses and this in turn depends on their component fatty acids. All fats and oils contain more or less the same range of fatty acids, but in different proportions. The differences between them arise from the extent of the "saturation" of their carbon atoms which causes variations in the nature of the oil or fat and the degree to which they can be used for specific purposes. Those oils with higher saturation melt at higher temperatures and have a more limited range of uses. While the oils with a high proportion of unsaturated fatty acids have low melting points and can be altered through hydrogenation to serve a wider range of end uses. The four classes of oils which are generally distinguished are the following:-

- (a) Industrial oils - castor and linseed oil which have highly specific end uses.
- (b) Soft or fluid edible oils - have both specific demands and can be altered by hydrogenation to serve a wider range of end uses. Soya bean, sunflower, groundnut and fish oils are the most important in this class.
- (c) Lauric oils - have a relatively strong specific demand both in industrial and edible uses. Coconut and palm kernel are the two main oils in this class.
- (d) Hard or edible industrial oils, these generally contain high proportions of saturated fatty acids and have the least specific demand. Palm oil, marine oils and tallow are the more important members of this group.

The position of oil palm products may therefore be summarised as follows:-

- (a) Palm oil as a relatively highly saturated oil has a low

specificity of demand. Other fats and oils can easily be substituted for it should price trends be favourable while technical constraints greatly restrict its ability to replace other oils.

- (b) Palm kernel oil has a far greater specificity in end use as a cooking oil and in margarines.

World production of the major types of fats and oils is given in Table 2.1. These statistics indicate that there has been steady growth in the output of vegetable oils and animal derived fats while supplies of marine oils have declined. Historically, climatic factors have had a major effect on supplies of all classes of oils and have generally caused the year to year fluctuations shown in the table. Other factors have also played a part, for instance, whale oil has declined due to overcatching of particular whale species. A notable feature of the supply situation of vegetable oils is the increase of soya beans, rapeseed, palm oil and palm kernel oil, which have contributed to the overall steady growth in fats and oils production.

TABLE 2.1 WORLD PRODUCTION OF OILS AND FATS
(THOUSAND TONS)

Commodity	1955-57	1967	1968	1969	1970	1971	1972*
<u>Vegetable Oils</u>							
<u>Edible</u>							
Groundnut	2 169	2 970	3 038	2 715	2 904	2 954	3 000
Soya bean	2 489	4 976	5 121	5 502	6 716	6 789	6 934
Cottonseed	2 052	2 103	2 127	2 315	2 247	2 247	2 383
Rapeseed	919	1 618	1 946	1 844	1 760	2 377	2 535
Sunflower	1 294	3 275	3 412	3 307	3 268	3 157	3 220
Sesame	N.A.	544	573	555	650	677	654
Olive	957	1 357	1 446	1 489	1 320	1 507	1 551
<u>Total</u>	9 880	16 843	17 663	17 727	18 865	19 708	20 277
<u>Edible-industrial</u>							
Coconut	2 627	1 976	2 047	2 056	2 087	2 368	2 460
Palm kernel	440	299	313	329	404	428	450
Palm	1 233	717	813	886	1 062	1 285	1 450
<u>Total</u>	4 300	2 992	3 173	3 271	3 553	4 081	4 360
<u>Industrial Oils</u>							
Linseed	N.A.	973	826	890	1 019	1 217	849
Castor	N.A.	334	352	365	374	370	378
Tung	N.A.	121	114	108	102	113	117
<u>Total</u>		1 428	1 292	1 363	1 495	1 700	1 344
<u>Marine Oils</u>							
Fish	481	1 024	1 008	848	959	1 065*	N.A.
Whale	488	100	90	74	68	69*	N.A.
<u>Total</u>	969	1 124	1 098	922	1 027	1 134	
<u>Animal Fats</u>							
Butter	N.A.	4 740*	4 910*	4 880*	N.A.	N.A.	N.A.
Lard/Tallow	N.A.	4 900*	4 870*	4 750*	N.A.	N.A.	N.A.
<u>Total</u>	6 829	9 640*	9 780*	9 630*			

Note * Estimated figures

Trade in fats and oils displays a similar pattern to production and a summary of the available statistics is given in Table 2.2. The total quantities entering world trade have risen from nine mn tons in 1960 to over 13 mn tons in 1970. The increase in fish, soya bean and rapeseed oils exports overshadow that of palm oil while palm kernel and groundnut oil exports have declined. On the basis of these statistics traded quantities have grown at four per cent per annum with the major share of the increase attributed to the edible oils and animal fats. Palm oils share of the market has tended to remain static or decline over the last decade making up 1.7 per cent of total exports in 1960 and 6.4 per cent in 1970. Palm kernel oil declined over the same period from 4.9 per cent to 2.8 per cent. This trend appears to stem from the early 1950's when palm oil made up over 15 per cent of world exports of fats and oils.

TABLE 2.2 WORLD EXPORTS OF OILSEEDS, OIL AND FATS (FAT OR OIL EQUIVALENT)
(THOUSAND SHORT TONS)

Commodity	1960	1962	1964	1966	1968	1970
<u>Vegetable Oils</u>						
<u>Edible</u>						
Cottonseed	318	328	429	292	203	375
Groundnut	858	1 084	1 111	1 198	1 268	940
Soya bean	1 577	1 654	1 895	1 940	2 233	3 475
Sunflower	268	399	427	836	1 321	1 150
Rapeseed	101	152	145	386	434	500
Sesame	87	98	98	95	101	100
Olive	76	96	125	76	90	100
Other(1)	49	65	77	80	57	50
<u>Total</u>	3 334	3 876	4 307	4 903	5 707	6 690
<u>Edible-industrial</u>						
Coconut	1 304	1 374	1 469	1 531	1 380	1 250
Palm kernel	443	401	407	415	348	375
Palm oil	645	560	629	691	736	850
<u>Total</u>	2 392	2 345	2 505	2 643	2 474	2 480
<u>Industrial Oils</u>						
Linseed	468	496	492	491	390	500
Other(2)	251	242	281	247	305	290
<u>Total</u>	719	738	773	738	695	790
<u>Animal Fats</u>						
Butter (fat content)	470	465	562	525	530	520
Lard	470	415	522	334	461	465
Tallow and greases	1 100	1 133	1 549	1 505	1 569	1 475
<u>Total</u>	2 040	2 013	2 633	2 364	2 560	2 460
<u>Marine Oils</u>						
Whale	350	262	220	189	140	135
Fish	251	404	395	559	796	700
<u>Total</u>	601	666	615	748	936	835
<u>Grand total</u>	9 086	9 638	10 833	11 396	12 372	13 255

Notes (1) Corn, Safflower.
(2) Castor, Oiticica, Tung.

2.22 The Future Prospects for Fats and Oils

Production projections made by the FAO (1965) shown in Table 2.3 assessed possible 1975 output of fats and oils at about 45.6 mn tons with the major share in the increase being contributed by edible oils. Recent statistics show that production of these oils has already reached the levels predicted for them.

TABLE 2.3 WORLD PRODUCTION OF FATS AND OILS - AVERAGE 1961-63 AND PROJECTIONS FOR 1975 (MILLION TONS)

Oil or Fat	Average 1961-63				1975			
	World	Developed countries	Centrally planned countries	Developing countries (1)	World	Developed countries	Centrally planned countries	Developing countries (1)
<u>Soft Oils</u>								
Groundnut oil	2.56	0.10	0.35	2.11	4.02	0.15	0.51	3.36
Soya-bean oil	3.83	2.99	0.81	0.04	6.51	5.14	1.11	0.27
Cottonseed oil	2.21	0.95	0.54	0.71	2.91	1.10	0.80	1.01
Rapeseed oil	1.29	0.27	0.48	0.54	1.88	0.53	0.63	0.72
Sunflowerseed oil	1.98	0.05	1.74	0.19	3.29	0.09	2.97	0.23
Olive oil	1.30	1.13	0.01	0.16	1.49	1.25	0.01	0.23
<u>Total</u>	13.17	5.49	3.93	3.75	20.10	8.25	6.02	5.83
<u>Lauric Oils</u>								
Coconut oil	2.08	0.18		1.90	2.62	0.22		2.40
Palm kernel oil	0.48			0.48	0.61			0.61
<u>Total</u>	2.56	0.18		2.38	3.23	0.22		3.01
<u>Hard Oils</u>								
Marine oils	1.02	0.53	0.04	0.45	0.81	0.48	0.05	0.28
Palm oil	1.17			1.17	1.78			1.78
Tallow	3.55	2.73	0.35	0.47	4.80	3.73	0.48	0.60
<u>Total</u>	5.74	3.26	0.39	2.09	7.39	4.21	0.53	2.66
<u>Animal Fats</u>								
Butter	4.51	2.55	1.09	0.88	5.95	3.36	1.54	1.05
Lard	4.94	2.26	2.34	0.34	6.42	2.74	3.18	0.49
Industrial oils (2)	1.29	0.43	0.19	0.67	1.44	0.35	0.23	0.86
Other fats and oils (3)	0.83	0.23	0.15	0.44	1.13	0.34	0.18	0.62
<u>Grand total</u>	33.04	14.40	8.09	10.55	45.65	19.46	11.63	14.51

Notes (1) Including Antarctic.

(2) Linseed, Castorseed and Tung oils.

(3) Includes all oils of minor importance not shown separately above.

Demand for fats and oils is largely a function of population growth and increase in real incomes or per capita consumption levels. Various studies of demand indicate the following:-

- (a) Over the last decade increases in production have generally been absorbed by a corresponding increase in demand although at times short-term imbalances have occurred for instance 1968-69.
- (b) About two thirds of the increase in overall demand is accounted for by population growth and one third by the

increase in per capita consumption. In the developed countries per capita consumption is reaching saturation point while in the developing countries there is scope for increasing per capita consumption levels and this combined with their high population growth rates accounts for a large proportion of the potential increase in world demand.

- (c) The balance between the uses of fats and oils shows that about 75 per cent of consumption is in edible uses and 25 per cent in industrial uses. The trend is towards an increase in the proportion used for edible uses. Industrial uses are not increasing particularly owing to competition from synthetic substitutes (FAO 1970).

The overall demand for fats and oils is estimated to be growing at about 3.5 per cent per annum. A recent study by the United States Department of Agriculture (1971) estimates that the growth in demand for vegetable fats and oils will be 3.1 per cent per annum to 1980 when total world demand is projected to reach 29.7 mn tons. The same study projects production growth of vegetable oils at 3.5 per cent per annum to reach 31.7 mn tons by 1980 and marine and animal oils and fats at 1.9 per cent. The latter products are not therefore expected to compete with vegetable oils any more than they have in the past.

2.23 Prices of Fats and Oils

The average prices at which the major fats and oils have been traded on the European market are shown in Table 2.4. These data show that over the last decade the pattern of price fluctuations has been quite erratic and there appears to be no visible trend, changes upward or downward are generally explained by fluctuations in supply.

The degree to which vegetable oil prices have moved together is a good indication of their substitutability. There are two exceptions namely:

- (a) Lauric oils (coconut and palm kernel oils) prices are closely related to each other but bear no significant relationship to other vegetable oils. This is due to their distinct qualities and specificity of uses.
- (b) Olive oil similarly has tended to follow its own price pattern in response to supply and demand changes.

2.24 The Prospects for Oil Palm Products

The future of palm oil and palm kernels has to be viewed in the context of the overall fats and oils situation and in

TABLE 2.4 IMPORT PRICES OF SELECTED OILS AND FATS 1955-1968
(US\$ PER METRIC TON (C.F. EUROPEAN PORTS))

Item	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
<u>Vegetable oils</u>														
Peanut oil	287	369	358	275	300	326	329	274	269	313	323	296	287	269
Cottonseed oil	265	335	323	291	252	235	305	266	243	250	276	333	276	269(1)
Soya-bean oil	295	344	320	261	233	225	283	218	215	228	265	259	216	178
Sunflowerseed oil	293	355	345	268	269	244	316	241	236	254	292	262	212	194
Rapeseed oil	308	377	358	261	221	219	280	221	215	252	263	244	206	161
Coconut oil	260	264	271	316	376	317	254	252	283	296	360	311	332	393
Palm kernel oil	259	262	267	296	358	305	253	249	279	294	350	292	256	330(1)
Olive oil	608	952	769	644	589	624	567	651	923	585	663	660	689	681
Palm oil	240	258	252	229	238	224	228	210	218	234	269	233	226(2)	140(2)
Linseed oil	247	329	271	266	226	254	280	254	213	237	213	191	202	234
<u>Other oils and fats</u>														
Butter	970	882	772	948	948	853	706	820	900	930	911	838	761	768
Lard			364	345	269	253	244	217	213	251	292	262	205	170
Fish oil	199	218	214	185	171	155	138	99	164	204	217	192	127	99
Whale oil	242	249	249	214	215	206	192	132	195	225	239	233	167	127

Notes (1) Estimate.

(2) Malaysian, five per cent bulk.

Source: USDA, 1971.

particular that of the vegetable and animal oils with which they compete.

2.2.4.1 Palm Oil

The data presented in Table 2.1 indicate that world palm oil production increased only slightly between 1960 and 1969 but since then has grown considerably to 1.45 mn tons in 1972. This increase has been the result of plantings undertaken during the 1960's and the trend is expected to continue over the next 20 years. As a result of this trend the quantities of palm oil entering the world market will expand rapidly and may reach 1.8 mn tons by 1975. Thus palm oil production is likely to expand at a much higher rate than the overall production or demand for oils and fats.

By far the largest importers of palm oil are Western Europe and the United States which together accounted for an estimated 93 per cent of world imports in 1971. Available statistics are given in Table 2.5. The main end uses for palm oil are as follows:-

- (a) Edible uses mainly in margarine and shortening but also in ice cream, chocolates and animal feeds.
- (b) Non edible uses are in metallurgy, textiles, candles, cosmetics, mining, soap and chemical manufacturing.

TABLE 2.5 IMPORTS OF PALM OIL BY MAJOR COUNTRIES
(Thousand tons)

Country	1970	1971	Per cent of total in 1971
United Kingdom	159.9	219.2	28
E.E.C. Countries	309.7	410.5	50
Canada	11.9	12.7	2
United States	62.9	101.3	12
Japan	39.7	40.3	5
Portugal	19.0	19.3	3
Total	603.1	803.3	100

Source: Commonwealth Secretariate 1972.

The relative importance of these end uses in Western Europe based on trade estimates (Sorca 1971) is given below and shows the overall importance of edible uses.

	Per cent used
Edible uses, margarine	34
shortenings	17
other edible uses	24
Non-edible uses, metallurgy	10
soap	4
other non-edible uses	10

In the United States it is estimated that 50 per cent is used in metallurgy.

Prices for oils and fats reached a high level initially in 1969 when supplies were at a low level. Since then they have stayed at high levels despite increasing shipments of edible oils during 1970. For the reasons outlined above the position of palm oil in the overall market is somewhat weak and given the projected increase in supply is expected to be in the forefront of any decline. Several factors are likely to be of importance in determining the future position of Malaysian palm oil, they include the following:-

- (a) the rate at which new plantings are established in the near future and the stage at which replanting becomes necessary.
- (b) trends in consumer preferences and technological developments which might widen the end uses of palm oil.
- (c) the extent to which prices drop and which might induce increased use of palm oil in soap and detergent manufacture.
- (d) the production of other vegetable oils many of which are produced from annual crops and some of which are a by-product, the seeds from them are extracted being crushed to provide cake for livestock feed as well as oil.

The FAO Indicative World Plan shows that if Malaysia plants on an average 30 000 acres of oil palms per annum in the 1970 to 1975 period and 35 000 to 50 000 acres per annum during 1975 to 1985, production will be at least 1.5 mn tons in 1985. This would amount to about 40 per cent of projected world palm oil production of 3.7 to 4.0 mn tons. This would mean a growth in world output of 5.5 per cent per annum over the 1970 to 1985 period and should be compared to the predicted growth in demand for fats and oils of about 3.5 (see Section 2.2.2). The average prices realised for Malaysian palm oil are given in Table 2.6. These have followed the general pattern of world prices discussed in Section 2.2.3 and Table 2.4.

TABLE 2.6 MALAYSIAN PALM OIL EXPORTS AND PRICES 1961-1971

Year	Quantity 000 tons	Value \$ mn	Average price \$ per ton
1961	93.4	61.2	655
1962	105.7	65.1	675
1963	114.9	69.0	600
1964	123.3	80.6	653
1965	139.2	106.0	761
1966	178.4	118.1	662
1967	177.2	110.7	625
1968	263.7	116.8	442
1969	325.6	142.8	438
1970	367.4	246.2	670
1971	522.6	354.8	675

In the absence of a dramatic change in the supply - demand situation for palm oil it is anticipated that its price will reflect the influence on the overall market of the increase in supply, and will follow a downward trend in the long-term as follows:-

<u>Year</u>	<u>Price per ton fob Sarawak</u> (Dollars)
1975	520
1980	432
1985	398
1990	398
1995	398

22.4.2 Palm Kernels

Palm kernel oil, as noted earlier, has a much greater specificity of demand than palm oil and, with coconut oil, is favoured for a number of uses particularly as a cooking oil in tropical Asia and Africa, in soap and detergent manufacture and high quality margarine. Table 2.1 and 2.3 show that output and exports of palm kernel have tended to change only

marginally over the last decade with exports tending to decline due to increasing domestic consumption in producing countries. Future projections of palm kernel supplies do not show the same dramatic increases as palm oil due to a decreasing extraction rate of kernels as more and more genetically improved oil palms come into production.

Supplies of the major competing oil, coconut, have shown little change in production or exports, over the last decade, but during 1970 and 1971 there was an increase in supplies as rehabilitation programmes in the Phillipines, the world's largest supplier, began to have effect.

A steady growth in demand for palm kernel oil is anticipated and the price of both kernels and oil is expected to be less effected by any general fall in prices than palm oil.

Exports and average prices realised by Malaysian palm kernels over the last decade are given in Table 2.7. The projected price of palm kernels over the next 20 years is as follows:-

<u>Year</u>	<u>Price per ton fob Sarawak</u> (Dollars)
1975	365
1980	315
1985	290
1990	290
1995	290

TABLE 2.7 MALAYSIAN PALM KERNEL EXPORTS AND PRICES 1961-1971

<u>Year</u>	<u>Quantity</u> 000 tons	<u>Value</u> \$ mn	<u>Average price</u> \$ per ton
1961	21.2	7.2	339
1962	20.3	6.8	335
1963	19.5	7.3	374
1964	18.0	7.1	394
1965	18.7	8.7	465
1966	22.5	9.1	403
1967	23.3	8.7	373
1968	32.1	14.2	442
1969	33.5	11.9	354
1970	22.5	8.9	395
1971	15.7	5.6	357

23 THE ASSUMED AGRONOMIC ASPECTS ASSOCIATED WITH OIL PALMS IN THE AGRICULTURAL PLAN

Land clearing and preparations have been included in this section for convenience, and have been set as a standard against which to compare the particular needs of other crops.

The assumptions given in this section have been used to estimate the costs and returns from oil palms presented in Chapter 8.

Operation	Assumptions	Remarks
LAND PREPARATION		
Land selection	Only land assessed as suitable for oil palm would be developed. The general slope range 0 - 20 degrees; land with slopes 20 - 25 degrees would also be included provided large contiguous areas would not be involved; soil depth more than 20 inches. Land subject to prolonged flooding and requiring special drainage or flood control would not be selected for oil palm.	The 20 degree limit has been imposed because of the harvesting difficulties envisaged on steeper slopes and the close correlation between steep slopes and shallow soil.
Land clearing	Land divided into 500 acre blocks; labour for surveying and trace cutting and access roads 0.5 man day per acre. For road based improvement schemes, the maximum distance of oil palm from the road, 200 yards. All land clearing operations (underbrushing, felling, burning, stacking and reburning) carried out by SLDB or contractors using their own labour and machines. Underbrushing; (hand cutting of bush and trees upto three inch diameter) 2.5 man days per acre. Felling, (cutting of trees larger than three inch diameter by motor driven chain-saws) 2.5 man days per acre. Labour ratio one chain-saw operator to three axe men. Stacking of cut tree trunks (the large trees stumps are not removed) done by D6 bulldozer with two drivers and chain-saw and axe men. The stacks are then burned, restacked and burned again. Labour five man days per acre. One D6 power-shift bulldozer averages 100 acres per month during clearing period = 900 to 1 000 acres per year.	This is standard practice. Planned development envisages that most of the large sound trees will have been removed for processing in the industrial timber complexes.
Lining, platforming, digging drainage ditches and clearing natural drainage lines	Undertaken by SLDB or contractors using their own labour. Platforms made on all slopes over 12 degrees (estimated at 33 per cent of area). Labour requirement 20 man days per acre.	Platforming is current SLDB practice.
Road construction	Undertaken by SLDB or contractors using their own machinery and labour. First constructing rough tracks for four wheel driven vehicles and tractors. Subsequent improvement (in third year) to roads suitable for lorry transport. Road requirements may vary from 1.0 to 1.5 chains per acre depending on local topography and block configuration.	Roads remain unsurfaced for first three years, stone surfaced thereafter. Only the major timber extraction roads are assumed to become part of the final road system.
Selective weeding	Undertaken by SLDB or contractor using their own labour, performed immediately following terracing and platforming. <i>Mimosa</i> spp., <i>Imperata cylindrica</i> (lallang) and <i>Eupatorium</i> (Siam Weed) would be the main weeds eradicated. Most grasses would be left. Spray used; 100 gallons solution per acre of Sodium Chlorate 150 ounces, MSMA five pints, 2,4-D Amine one pint. Large areas of lallang sprayed with Dalapon at 10 ounces in four gallons of water per acre. Spray and manual operation; labour one man day per acre.	Operation necessary to eradicate noxious plant growth occurring prior to planting cover crops.
Cover crop establishment	Undertaken by SLDB or contractor using their own labour; performed immediately after selective weeding. Scarified legume seed obtained from commercial growers. A mixture of three pounds <i>Pueraria</i> to three pounds <i>Centrosema</i> per acre planted in hand made drills six to eight feet apart. Five pounds of Christmas Island Rock Phosphate (CIRP) per acre at planting. Labour one man day per acre.	This is standard SLDB practice.
Subsequent cover crop fertilizer	CIRP applied in two doses one month and three months after germination of the seed. Total fertilizer 190 to 220 pounds per acre. Labour 0.3 man days per acre.	This is standard SLDB practice.
Cover crop maintenance	Spot spraying of noxious weeds as required using same cocktail spray as for selective weeding; assumed total of two sprayings necessary over four months from germination. Total labour, 0.25 man days per acre.	Spot spraying is standard practice by SLDB. This is in addition to circle spraying around planted palms.
Opening-up of harvesting lines	Not necessary until just before first harvest, roughly 30 months after field planting when many of the tree trunks and stumps will have rotted. Work done by hand using chain-saws where necessary. Cover crop in paths killed by herbicide spray. Labour requirement; 11 chains per man per day = one man day per acre.	Operation consists of clearing a path between alternative rows of planted palms.

Operation	Assumption	Remarks																																
THE NURSERY																																		
Seed supply	Pre-germinated Dura x Pecifera hybrid seed used. Obtained from Research stations in Peninsular Malaysia. 70 seeds required per acre.																																	
Nursery preparation	80 acres of cleared nursery area for every 5 000 acres of planted palms. One nursery site established centrally in each development unit with two chain wide fire break all round. Site selection done during semi-detailed soil surveys. Labour required for clean clearing, stumping, top-soil movement and levelling, nursery-bed, lining and soil preparation; 300 man days over eight months; done by SLDB or contractor using their own labour and machinery. Construction of store, road system, two sprinkler systems, drains and labour lines undertaken by SLDB or contractor using their own labour and machinery.																																	
Nursery procedure	<p>Germinated seed planted into poly-bags. Either the one or two bag system used at managers discretion. Similarly the provision of shade over the bags during germination will be at the managers discretion.</p> <p>Labour: bag filling, 150 bags per man day.</p> <p>Seed planting, 1 500 seeds per man per day.</p> <p>Watering, by overhead sprinklers; operated daily whenever the rainfall is less than 0.5 inch. Two separate sprinkler units each covering 40 acres. Labour team for each unit, four labourers and pump attendant. Maximum labour for watering 1 800 man days.</p> <p>Setting out bags into growing beds; labour, using wheel-barrow 500 seedlings per day.</p> <p>Weeding, at monthly intervals after first month = seven rounds. Bag weeding, 2 500 bags per day. Between bag weeding, 800 bags per day.</p> <p>Fertiliser application; commencing one month after planting; applied at weekly intervals for three months; total 12 fertiliser applications. 6.5 ounces Nitrophoska Yellow or ammonium phosphate in five gallons of water at four fluid ounces per seedling (200 seedlings per five gallons).</p> <p>Labour one man day per 40 000 seedlings per round.</p> <p>Subsequent fertiliser application per seedling, applied at monthly intervals after weeding; four applications.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Month</th> <th colspan="2">Nitrophoska Blue</th> <th>Kieserite</th> </tr> <tr> <td></td> <th colspan="3">Ounces</th> </tr> </thead> <tbody> <tr> <td>5th</td> <td>0.25</td> <td>plus</td> <td>0.25</td> </tr> <tr> <td>6th</td> <td>0.25</td> <td>plus</td> <td>0.25</td> </tr> <tr> <td>7th</td> <td>0.5</td> <td>plus</td> <td>0.5</td> </tr> <tr> <td>8th</td> <td>0.75</td> <td>plus</td> <td>0.75</td> </tr> <tr> <td></td> <td>1.75</td> <td></td> <td>1.75</td> </tr> <tr> <td></td> <td>*****</td> <td></td> <td>*****</td> </tr> </tbody> </table> <p>Labour: 1 700 bags per man day.</p> <p>Consolidation of loose seedlings, weekly rounds.</p> <p>Labour; two man days per week.</p> <p>Pest and disease control, applied as required using a knapsack sprayer.</p> <p>Culling of seedlings; 7.5 per cent during nursery stage. Loss on planting out five per cent.</p> <p>Seedlings from nursery planted out at seven to eight months old.</p>	Month	Nitrophoska Blue		Kieserite		Ounces			5th	0.25	plus	0.25	6th	0.25	plus	0.25	7th	0.5	plus	0.5	8th	0.75	plus	0.75		1.75		1.75		*****		*****	<p>Shading of germination seedlings can be done at the managers discretion. The practice has been shown not to be necessary in Peninsular Malaysia.</p> <p>The fertiliser application is based on recommendations by Harrison's and Cranfield Oil Palm Research Station, Banting, Selangor, Malaysia.</p> <p>Planting out of seedlings after eight months in the nursery is standard SLDB practice and has proved successful.</p>
Month	Nitrophoska Blue		Kieserite																															
	Ounces																																	
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7th	0.5	plus	0.5																															
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	1.75		1.75																															
	*****		*****																															

ASSUMED OIL PALM YIELDS

TABLE OF 10 ROWS ACRES PER YEAR

Operation	Assumptions	Remarks																																						
FIELD PLANTING AND MAINTENANCE	Planting distance 29 by 29 feet triangular = 60 plants per acre Transport of seedlings; by tractor and trailer or lorry carrying 200 seedlings per load. Labour: loading seedlings on to vehicle, 450 seedlings per man day; offloading seedlings in the field, 600 seedlings per man day; carrying seedlings to planting points, 100 seedlings per man day; holing and planting; two man teams each planting 80 seedlings per day. Fertiliser application at planting, 0.5 pound CIRP per seedling in the planting hole = 30 pounds per acre.	This planting distance is standard, SLOB practice. This is standard SLOB practice.																																						
Subsequent fertiliser application	The fertiliser requirement would be based on leaf analysis. For calculation purposes the following has been assumed; three applications each year applied as a dry mixture on the soil surface within the root-spread of the plant.	Quantities taken from recommendations in the ICI Fertiliser Hand-book referring to 'inland sedimentary soils derived from shale and sandstone'. There is no experimental evidence in Sarawak showing that three applications are better than one or two. However, under the high rainfall conditions and quite steeply undulating terrain it would seem advisable to split the applications into three rather than two.																																						
	<table border="1"> <thead> <tr> <th>Time</th> <th>Fertiliser type and quantity per palm (pounds)</th> <th>Total quantities of fertiliser lbs/acre</th> </tr> </thead> <tbody> <tr> <td rowspan="3">First year</td> <td>(a) 0.25 ammonium nitrate (Nitro 26)</td> <td>15</td> </tr> <tr> <td>(b) 2 compound fertiliser (14% N, 13% P₂O₅, 9% K₂O, 2% MgO)</td> <td>120</td> </tr> <tr> <td>(c) 1 compound fertiliser (15% N, 7% P₂O₅, 18% K₂O, 2% MgO)</td> <td>60</td> </tr> <tr> <td rowspan="3">Second year</td> <td>(a) 0.5 Kieserite</td> <td>30</td> </tr> <tr> <td>(b) 2.25 compound fertiliser as (c) above</td> <td>135</td> </tr> <tr> <td>(c) a repeat of (b)</td> <td>135</td> </tr> <tr> <td rowspan="3">Third year</td> <td>(a) 3.25 compound fertiliser (12% N, 6% P₂O₅, 22% K₂O, 3% MgO)</td> <td>195</td> </tr> <tr> <td>(b) 1.5 Muriate of potash</td> <td>90</td> </tr> <tr> <td>(c) a repeat of (a)</td> <td>195</td> </tr> <tr> <td rowspan="3">Fourth year</td> <td>(a) 4.25 compound fertiliser as for third year</td> <td>255</td> </tr> <tr> <td>(b) 1.5 Muriate of potash</td> <td>90</td> </tr> <tr> <td>(c) 1.25 a repeat of (a)</td> <td>255</td> </tr> <tr> <td rowspan="3">Fifth year and thereafter</td> <td>(a) 5 compound fertiliser (as above)</td> <td>300</td> </tr> <tr> <td>(b) 2 Muriate of potash</td> <td>120</td> </tr> <tr> <td>(c) a repeat of (a)</td> <td>300</td> </tr> </tbody> </table>	Time	Fertiliser type and quantity per palm (pounds)	Total quantities of fertiliser lbs/acre	First year	(a) 0.25 ammonium nitrate (Nitro 26)	15	(b) 2 compound fertiliser (14% N, 13% P ₂ O ₅ , 9% K ₂ O, 2% MgO)	120	(c) 1 compound fertiliser (15% N, 7% P ₂ O ₅ , 18% K ₂ O, 2% MgO)	60	Second year	(a) 0.5 Kieserite	30	(b) 2.25 compound fertiliser as (c) above	135	(c) a repeat of (b)	135	Third year	(a) 3.25 compound fertiliser (12% N, 6% P ₂ O ₅ , 22% K ₂ O, 3% MgO)	195	(b) 1.5 Muriate of potash	90	(c) a repeat of (a)	195	Fourth year	(a) 4.25 compound fertiliser as for third year	255	(b) 1.5 Muriate of potash	90	(c) 1.25 a repeat of (a)	255	Fifth year and thereafter	(a) 5 compound fertiliser (as above)	300	(b) 2 Muriate of potash	120	(c) a repeat of (a)	300	
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	Labour required: One man per 180 palms = three acres per man day. Three applications = one man day per acre per year.																																							
Circle weeding	Clean weeding of planting circles commencing one month after field planting. Alternate hand and spray control. Labour: manual one man day per acre; spray one man day per six acres. Repeated at monthly intervals for years one and two; after field planting; seven man days per acre per year. Repeated at two monthly intervals for year three; 3.5 man days per acre per year. Repeated at three monthly intervals for years four and five; 2.3 man days per acre per year. Repeated when required thereafter. Assumed once a year; one man day per acre per year. Spray mixture used is the same as for selective weeding.	The spray mixture used would be the same as for selective weeding.																																						

Operation	Assumptions	Remarks																																
Assisted pollination	<p><u>Pollen collection.</u> Ripe pollen collected, dried and stored. It would be necessary to build up a two month reserve of pollen. Flower production varies with the age of the palms, therefore quantity collection per man day would also vary. Assumption as follows.</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="3">Age of palms (years)</th> </tr> <tr> <th>2½-3</th> <th>4-5</th> <th>6+</th> </tr> </thead> <tbody> <tr> <td colspan="3" style="text-align: center;">(grams)</td> </tr> <tr> <td>Quantity of pollen collected per man day</td> <td>120</td> <td>225 720</td> </tr> </tbody> </table> <p><u>Pollination.</u> Applications every three to four days, pollen diluted at a ratio of one pollen to eight talc and applied at 1.5 grams per palm. Work is easy and can be performed by youths or women. Labour required varies with the age of the palm.</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Age of palm (years)</th> <th>Acres per worker day</th> <th>Worker days per acre per round</th> <th>Number of rounds per year</th> <th>Worker days per acre per year</th> </tr> </thead> <tbody> <tr> <td>2½ - 3</td> <td>10</td> <td>.1</td> <td>100</td> <td>10.0</td> </tr> <tr> <td>4 - 5</td> <td>15</td> <td>.067</td> <td>120</td> <td>8.0</td> </tr> <tr> <td>6 - 8</td> <td>20</td> <td>.05</td> <td>110</td> <td>5.5</td> </tr> </tbody> </table>	Age of palms (years)			2½-3	4-5	6+	(grams)			Quantity of pollen collected per man day	120	225 720	Age of palm (years)	Acres per worker day	Worker days per acre per round	Number of rounds per year	Worker days per acre per year	2½ - 3	10	.1	100	10.0	4 - 5	15	.067	120	8.0	6 - 8	20	.05	110	5.5	
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4 - 5	15	.067	120	8.0																														
6 - 8	20	.05	110	5.5																														
Pruning	<p>First pruning necessary immediately prior to first harvest, that is, at 30 months and thereafter once a year. Labour requirement would vary with the age of the palms as follows.</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Age of palm (years)</th> <th>Palms per man day</th> <th>Man days per acre per year</th> </tr> </thead> <tbody> <tr> <td>Initial pruning</td> <td>30</td> <td>2.0</td> </tr> <tr> <td>5 - 8</td> <td>35</td> <td>1.7</td> </tr> <tr> <td>9 - 16</td> <td>25</td> <td>2.4</td> </tr> <tr> <td>17</td> <td>20</td> <td>3.0</td> </tr> </tbody> </table> <p>Commences about 30 months after planting out. Operation carried out every 7 to 10 days. For calculations 50 times per year.</p>	Age of palm (years)	Palms per man day	Man days per acre per year	Initial pruning	30	2.0	5 - 8	35	1.7	9 - 16	25	2.4	17	20	3.0																		
Age of palm (years)	Palms per man day	Man days per acre per year																																
Initial pruning	30	2.0																																
5 - 8	35	1.7																																
9 - 16	25	2.4																																
17	20	3.0																																
Harvesting	<p>Harvesting done in teams of two men, one cutting one carrying. Baskets or nets would be used to carry fruit bunches from the rows to the road where they would be placed into large nets. The ffb would then be loaded by self-loading tipper lorries and transported directly to bulk holding containers at the factory site.</p> <p>Labour requirement would be affected by the number and weight of bunches per acre, age of palms and ease of access to bunches as follows:</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Age of palm (years)</th> <th>Acreage per day per team of 2</th> <th>Man days* per acre per year</th> </tr> </thead> <tbody> <tr> <td>3 - 4</td> <td>12</td> <td>8.3</td> </tr> <tr> <td>5 - 8</td> <td>10</td> <td>10.0</td> </tr> <tr> <td>9 - 16</td> <td>9</td> <td>11.1</td> </tr> <tr> <td>17 - 25</td> <td>8</td> <td>12.5</td> </tr> </tbody> </table> <p>* Assuming 50 harvesting rounds per annum.</p>	Age of palm (years)	Acreage per day per team of 2	Man days* per acre per year	3 - 4	12	8.3	5 - 8	10	10.0	9 - 16	9	11.1	17 - 25	8	12.5	Method chosen from evidence given in the paper, "Mechanised Loading of ffb and Transportation from Field to Palm Oil Mill" by Price, J.G.M. and Kidd, D.D., which was presented at the International Oil Palm Conference 1972.																	
Age of palm (years)	Acreage per day per team of 2	Man days* per acre per year																																
3 - 4	12	8.3																																
5 - 8	10	10.0																																
9 - 16	9	11.1																																
17 - 25	8	12.5																																
Yields	See Figure 2.1 (average weight of ffb, five to eight pounds when palms are young, rising to 40 to 50 pounds by seven years.																																	
Economic life of an oil palm plantation	25 years of bearing life, that is, 25 years from planting-out.																																	
Extraction rate of oil from ffb	20 per cent average for all palm ages. The kernels would equal about four per cent of the ffb by weight, and the oil in the kernel equals 45 per cent.	Extraction rate is thought to vary with the age of the palms but the evidence is inconclusive.																																
Timing of operations	These are shown diagrammatically in Figure 2.2.	Information obtained from SLDB.																																

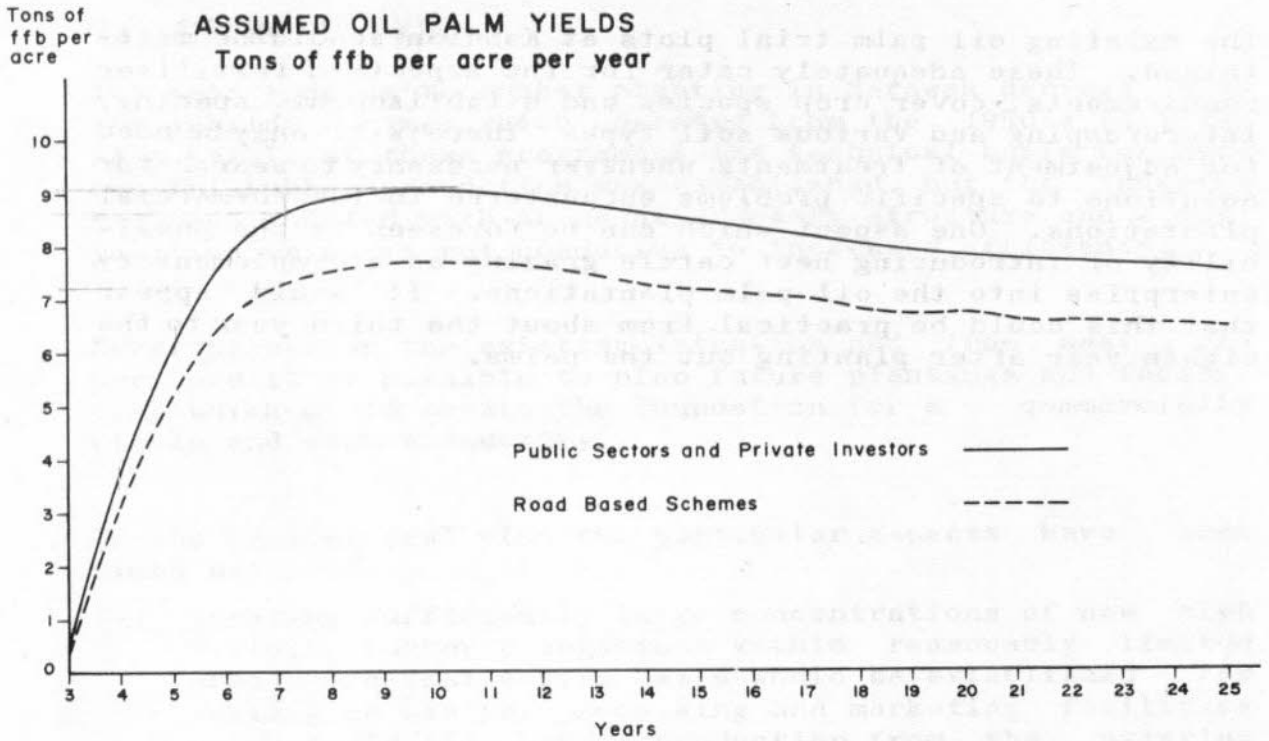


FIGURE 2.2

TIMING OF OPERATIONS FOR OIL PALM

	PREPLANTING PERIOD												YEAR 1												YEAR 2	
	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F			
NURSERY																										
NURSERY SITE SELECTION	█																									
NURSERY SITE LAND CLEARING	█		█																							
NURSERY PREPARATION					█																					
BAG FILLING & SEED PLANTING							█																			
NURSERY MAINTENANCE							█																			
MAIN PERIOD																										
UNDERBRUSHING									█																	
FELLING									█																	
BURNING									█																	
STACKING - REBURNING									█																	
MAIN ROAD & LATER SECONDARY ROAD CONSTRUCTION									█																	
LINING, PLATFORMING, DRAINAGE & CLEARING DRAINAGE LINES									█																	
CLEAN WEEDING									█																	
SOWING COVERS									█																	
MAINTENANCE OF COVERS									█				█													
FIELD PLANTING OF PALMS									█				█													
FIELD MAINTENANCE OF PALMS									█				█													

24 FUTURE INVESTIGATIONS

The existing oil palm trial plots at Kabuloh should be maintained. These adequately cater for the aspects of fertiliser requirements, cover crop species and establishment, spacing, intercropping and various soil types. There will only be need for adjustment of treatments whenever necessary to search for solutions to specific problems encountered in the commercial plantations. One aspect which can be foreseen is the possibility of introducing beef cattle grazing as a complementary enterprise into the oil palm plantations. It would appear that this could be practical from about the third year to the eighth year after planting out the palms.

TIMING OF OPERATIONS FOR OIL PALM

YEAR	YEAR	PERIOD	OPERATION
1	1	1-12	Planting
1	2	1-12	Planting
1	3	1-12	Planting
1	4	1-12	Planting
1	5	1-12	Planting
1	6	1-12	Planting
1	7	1-12	Planting
1	8	1-12	Planting
1	9	1-12	Planting
1	10	1-12	Planting
1	11	1-12	Planting
1	12	1-12	Planting
2	1	1-12	Planting
2	2	1-12	Planting
2	3	1-12	Planting
2	4	1-12	Planting
2	5	1-12	Planting
2	6	1-12	Planting
2	7	1-12	Planting
2	8	1-12	Planting
2	9	1-12	Planting
2	10	1-12	Planting
2	11	1-12	Planting
2	12	1-12	Planting
3	1	1-12	Planting
3	2	1-12	Planting
3	3	1-12	Planting
3	4	1-12	Planting
3	5	1-12	Planting
3	6	1-12	Planting
3	7	1-12	Planting
3	8	1-12	Planting
3	9	1-12	Planting
3	10	1-12	Planting
3	11	1-12	Planting
3	12	1-12	Planting
4	1	1-12	Planting
4	2	1-12	Planting
4	3	1-12	Planting
4	4	1-12	Planting
4	5	1-12	Planting
4	6	1-12	Planting
4	7	1-12	Planting
4	8	1-12	Planting
4	9	1-12	Planting
4	10	1-12	Planting
4	11	1-12	Planting
4	12	1-12	Planting
5	1	1-12	Planting
5	2	1-12	Planting
5	3	1-12	Planting
5	4	1-12	Planting
5	5	1-12	Planting
5	6	1-12	Planting
5	7	1-12	Planting
5	8	1-12	Planting
5	9	1-12	Planting
5	10	1-12	Planting
5	11	1-12	Planting
5	12	1-12	Planting
6	1	1-12	Planting
6	2	1-12	Planting
6	3	1-12	Planting
6	4	1-12	Planting
6	5	1-12	Planting
6	6	1-12	Planting
6	7	1-12	Planting
6	8	1-12	Planting
6	9	1-12	Planting
6	10	1-12	Planting
6	11	1-12	Planting
6	12	1-12	Planting
7	1	1-12	Planting
7	2	1-12	Planting
7	3	1-12	Planting
7	4	1-12	Planting
7	5	1-12	Planting
7	6	1-12	Planting
7	7	1-12	Planting
7	8	1-12	Planting
7	9	1-12	Planting
7	10	1-12	Planting
7	11	1-12	Planting
7	12	1-12	Planting
8	1	1-12	Planting
8	2	1-12	Planting
8	3	1-12	Planting
8	4	1-12	Planting
8	5	1-12	Planting
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8	7	1-12	Planting
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9	12	1-12	Planting
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11	11	1-12	Planting
11	12	1-12	Planting
12	1	1-12	Planting
12	2	1-12	Planting
12	3	1-12	Planting
12	4	1-12	Planting
12	5	1-12	Planting
12	6	1-12	Planting
12	7	1-12	Planting
12	8	1-12	Planting
12	9	1-12	Planting
12	10	1-12	Planting
12	11	1-12	Planting
12	12	1-12	Planting

CHAPTER 3

RUBBER

3.1 INTRODUCTION

The main impetus to rubber planting in Sarawak derived from the subsidy schemes which operated from the 1950's to 1972. As a result of these programmes the technical basis for successful rubber production was established, but the industry has been saddled with an unsatisfactory structure and a disposition which is not conducive to increased efficiency.

Nevertheless on the existing situation and from past experience it is possible to plan future plantings and facilities which could create the foundation for a commercially viable and stable industry.

In the agricultural plan two particular aspects have been aimed at:

- (a) creating sufficiently large concentrations of new high yielding rubber plantations within reasonably limited areas such that a firm basis would be established for setting up central processing and marketing facilities which could also handle production from the existing rubber plots in the surrounding areas. Even within the areas where oil palm schemes are planned there are blocks of land which, due to terrain and soil factors, are not suitable for oil palms but on which rubber could be successfully established. To do this has been recommended in the plan.
- (b) maintaining Sarawak's standing as a rubber producer but to ensure in future that the industry is capable of consistent production in terms of both quality and quantity of product.

Thus it is desirable that the area of productive plantations should be maintained and that the structure of the industry should be related to the need for economic viability at projected price levels: This would, in addition to the planned future planting, require careful consideration of the economic viability of existing plantings. Where necessary old plantations should be replaced by carefully planned development served by the processing and marketing facilities already mentioned. Thus the overall production costs could be reduced and labour productivity and potential earnings increased.

Synthetic rubbers are of two main types; Styrene/butadiene (SBR) which is the most widely produced comes from the by-products of petro-chemical processing and is the cheapest, but it lacks the resilience of NR: Polyisoprene rubber is the synthetic most like NR but it is only manufactured on a relatively small scale due to the difficulty of obtaining certain raw materials, and the high cost factors.

TABLE 3.1 WORLD PRODUCTION OF NATURAL RUBBER
(Thousand Metric Tons)

Year	1953	1963	1965	1966	1967	1968	1969	1970	1971
World Total	1 755	2 100	2 380	2 435	2 490	2 635	2 885	2 895	3 000
Major Producers:									
Indonesia	706	582	717	716	760*	750*	790	780*	834*
Malaysia	623	865	949	998	998	1 100	1 268	1 270	1 324
Thailand	97	180	216	207	214	259	282	287	316
Sri Lanka	100	104	118	131	143	143	148	151	141

* Estimated.

Source: International Rubber Study Group.

TABLE 3.2 WORLD CONSUMPTION OF ELASTOMERS
(Thousand Metric Tons)

Category	1953-55	1965-57	1961-63	1965-67	1968	1969	1970	1971	Annual growth rates	
									1964-68	1968-71
Natural	1 746	1 860	2 135	2 340	2 130	2 235	2 295	2 375	%	%
Synthetic	1 292	1 420	2 704	3 960	3 865	4 300	4 470	4 820	3.0	2.2
									10.0	4.2
Total	3 038	3 280	4 839	6 300	5 995	6 535	6 765	7 195	6.5	4.0

TABLE 3.3 TRENDS IN MARKET SHARES OF NATURAL AND SYNTHETIC RUBBER

Category	1954	1956	1962	1966	1968	1970	1971
Natural	58	57	44	37	37	34	33
Synthetic	42	43	56	63	63	66	67

Trends in the production and use of natural and synthetic rubbers over the past two decades are shown in Tables 3.1 and 3.2. Historically total consumption of all elastomers is shown to have increased by six to seven per cent per annum. Natural rubber consumption has grown by three per cent while synthetics have grown at about 10 per cent per annum. As a result the overall share of the market held by natural rubber has fallen steadily as is shown in Table 3.3.

Some relationships and factors relevant to the market penetration by synthetics can be deduced from reports on studies of the world rubber market:-

- (a) the historical pattern of supplies of natural rubber are perhaps the most important factor responsible for its decreasing share of the market. Perhaps the major single reason was that for a period after World War II there was a shortage of natural rubber. In the years just preceding and during the War little or no planting took place and many plantations were ravaged. During the post war period planters concentrated on rehabilitating old plantings.

- (b) new technological developments giving impetus to the development and improvement of techniques of synthetic rubber production to which is coupled the fact that major rubber users are frequently also producers of the synthetic products;
- (c) users of rubber frequently have individual requirements and synthetics have often been able to meet these more readily than natural rubber. Moreover the synthetic products have had a more consistent quality than the natural product;
- (d) the cost structure of synthetic manufacturing processes involves heavy capital outlays and low marginal production costs. Thus once a processing unit has been installed its capacity is likely to be used regardless of the price of natural rubber;
- (e) strategic reasons stemming from the reluctance of use countries to be too heavily reliant on supplies from any one area of the world.

3.2 THE MARKET FOR RUBBER

Market prospects for natural rubber have been overshadowed by competition from synthetic rubber. However in the present context of crude oil supplies, and their effect on supplies and prices of synthetic elastomer, there appear to be good reasons to adopt a more optimistic view of the market than has been taken in the past. This is not to say that the current upsurge in rubber prices can be attributed to this cause alone, undoubtedly a balance between supply and demand has yet to be reached. A thorough understanding of the elastomer market is essential if full advantage is to be taken of the present situation. Moreover it should be borne in mind that any new plantings will not come into production for several years by which time conditions may have changed.

3.2.1 Review of the Elastomer Market

There are two main types of elastomer, natural rubber (NR) and synthetic rubber (SR) the latter is produced mainly from by-products of petroleum refining. Elastomers are used for a wide variety of purposes, but by far the most important is for tyres for all types of automobiles and vehicles. Other uses include footwear, hoses, piping, belting, wire and cable insulation, flooring, carpeting and foam products.

3.2.2 The Future Prospects for Natural Rubber

The FAO in its indicative World Plan for Agriculture has projected that the overall demand for elastomers might be 18.5

million tons by 1985, this would be equivalent to a growth rate of slightly under six per cent per annum, slightly below the rate attained in the recent past. Natural rubber usage was expected to continue to grow at three per cent and to command an overall share of 24 per cent of the market by 1985. Demand for synthetics was predicted to grow more slowly than in the past, at 7.5 per cent per annum. On this basis the demand for natural rubber would be 4.5 mn tons by 1985. However, since the huge increases in the price of oil considerable uncertainty is attached to these figures. The market share of natural rubber could increase or decrease, and a range of possible figures is as follows:-

<u>Market share</u> (per cent)		<u>Quantity demanded</u> (mn tons)
High	32	5.950
Low	17	3.130
Average	24	4.452

These estimates show that natural rubber should be used in increasing quantities if it is available at a competitive price.

Production

Production projections are extremely difficult to make because production has been so affected by changing prices and for this reason the statistics are unreliable in gauging future production. But the situation in Malaysia was reviewed by the Rubber Research Institute of Malaysia (Thomas, 1970) as follows:-

- (a) recent annual increases in production have been as high as 15 per cent due largely to increases in yield per acre as high yielding clones in new plantings have reached maturity. The average growth rate over the past decade was 5.5 per cent,
- (b) the future rate of increase in production is likely to slow down due to a decrease in the rate of new plantings and failure to re-establish rubber plantations,
- (c) production is projected to reach 2.1 mn tons by 1980.

These projections are summarised in Table 3.4 and clearly show the emergence of small-holders as the major producers. The estimates exclude the possible increase in production due to the use of new ethylene based stimulants. By including this it is estimated that production could increase by 100 mn tons by 1980. Continuing the rate of growth to 1985 Malaysian production might reach 2.6 to 2.8 mn tons, about 60 per cent of world usage projected by FAO. Whether such output could be absorbed by the market will depend on a number of factors, amongst which are:-

- the demand for oil supplies for other uses combined with the high crude oil prices which are likely to induce caution in the rate of investment in synthetic rubber installations;

TABLE 3.4 MALAYSIAN RUBBER PRODUCTION 1960-1980
(Thousand Tons)

Year	Peninsular Malaysia		Sabah and Sarawak	Total
	Estates	Small-holdings		
1960	413	272	67	752
1961	428	278	67	773
1962	438	277	56	771
1963	458	295	65	818
1964	477	314	66	857
1965	491	348	64	903
1966	514	386	57	957
1967	526	397	51	974
1968	563	472	48	1 083
1969	603	587	68	1 258
<u>Projections</u>				
1970	638	635	75	1 348
1973	724	846	81	1 651
1975	751	929	85	1 765
1977	775	1 013	91	1 879
1980	800	1 200	100	2 100

Source: Thomas, 1970

- increasing fuel prices causing a decline in the demand for vehicle tyres combined with technical changes in the type of materials used for tyres;
- accelerated expansion of uses for natural rubber due to an increasing number of specialised forms of output catering for specific user needs.

From the available information it appears that a critical time in the future could be from 1980 onwards when supplies from Malaysia are likely to have built up and similar increases may be expected from other major producing countries.

Prices

The prices at which rubber has been sold in the past and predictions of future price levels are of major significance in determining future trends of investments in rubber. Historically the price of rubber has fluctuated widely and has steadily declined from about \$1.00 per pound fob Singapore in the decade 1950 to 1960 to about 45 or 50 cents per pound in 1970 to 1972.

Average prices realised on the Singapore and Malaysian Rubber Exchange from 1962 to 1973 are given in Table 3.5.

Several studies of future price trends indicate that natural rubber prices will be related to the cost of the synthetic

rubber. However, there is evidence to suggest that an imbalance in the supply of either natural or synthetic products is likely to have an effect on the natural rubber price. The current world oil situation appears to favour natural rubber but it is difficult to judge the overall effect of increasing fuel costs on the demand for rubber. A possible decline in rubber demand could cause an over supply situation to arise. However, lower natural rubber prices below that for synthetics would probably favour an increase in the share of the elastomer market captured by natural rubber.

TABLE 3.5 AVERAGE PRICES OF RIBBED SMOKED SHEET RUBBER
(¢/lb fob)

Year	Singapore and Malaysian Rubber Exchange	Kuching
1962	78.20	-
1963	72.42	-
1964	68.14	-
1965	70.02	57.18
1966	65.38	54.29
1967	54.08	44.07
1968	53.12	44.15
1969	69.82	56.50
1970	56.42	46.59
1971	46.10	35.77
1972	42.63	33.17

Source: Department of Statistics, Kuala Lumpur.
Agricultural Statistics of Sarawak 1972.

In view of the uncertainty of the situation a basic price of 57 cents fob Singapore has been used in calculating the returns to rubber. This price would be equivalent to 47 cents fob Sarawak. For sensitivity analyses a price 20 per cent higher has been taken. (See Chapter 8)

33 THE ASSUMED AGRONOMIC ASPECTS ASSOCIATED WITH RUBBER IN THE AGRICULTURAL PLAN

Operation	Assumption	Remarks		
LAND PREPARATION				
Land selection	Only land assessed as suitable for rubber would be developed. Where rubber is a secondary enterprise in a cropping pattern it would be confined to the steeper slopes but with an upper limit of 25 degrees.			
Land clearing	As for oil palms.			
Lining, terracing, digging drainage ditches and clearing natural drainage lines	Would be done by SLDB or contractors using their own labour. On slopes steeper than 12 degrees contour terraces would be made four feet wide 30 feet apart. Planting points eight feet apart. On slopes less than 12 degrees, there would be no terracing but planting would be on the contours with the same spacing. Holes two by two by two feet dug at planting points. Fertiliser at planting four ounces CIRP per hole equals 50 pounds per acre.	This terrace spacing would give 22 chains of terracing per acre. The plant spacing would give about 180 trees per acre. Subsequent losses and culling of unproductive trees would reduce the final stand to densities of between 120 and 125 trees per acre. Present practice in Sarawak aims at 120 trees per acre.		
Selective weeding	As for oil palms.			
Cover crop establishment	As for oil palms.			
Subsequent cover crop maintenance	As for oil palms.			
Roads	Construction would be undertaken by SLDB or contractors using their own machinery. First constructing rough tracks for four wheel drive vehicles with subsequent improvement taking place in the seventh year to a standard suitable for tractor and trailer or lorry transport. Road requirement would vary from 0.3 to 0.6 chains per acre according to the terrain, for present calculations 0.4 chains per acre has been used.	Roads would remain unsurfaced for the first seven years, stone surfaced thereafter. Major and secondary timber extraction roads have been assumed to become part of the final road system.		
FIELD ESTABLISHMENT				
	The intention would be to create plantations of budded trees of selected clones.			
Seed supply	Seed would be collected locally from selected budded plantations.			
Germination field planting	Seed would be germinated in sawdust in a central nursery and the pre-germinated seed planted into the field; three seeds per planting point.	This is only one method used in Sarawak. Another method of establishment is by budded seedlings raised in a nursery; i.e. budded stumps, or the larger stumped buddings.		
Subsequent maintenance	Circle weeding, as for oil palms. Pruning; would consist of removal of adventitious shoots from the growing seedling until it is ready for budding. Pest and disease control: spraying would be carried out as required using a knapsack sprayer. Two complete rounds per year using commercial insecticides and fungicides has been assumed. Fertiliser application would vary with age of the seedling as follows:-	Main pests expected would be white ants. Main diseases expected would be Pink Disease (<i>Corticium salmonicolor</i>) White root disease (<i>Fomes pignosis</i>) and Mouldy rot (<i>Ceratostomella fibriata</i>) Routine controls are known for all these.		
	<u>Quantity per application</u>			
Time after planting	Compound fertiliser	Per tree (ounces)	Per acre (pounds)	No. of trees per acre
1 month	10% N, 16% P ₂ O ₅ 9% K ₂ O, 2½% MgO	3	34	180
5 months	"	3	34	180
9 months	"	5	56	180
13 months	"	5	56	180
17 months	"	6	60	160
21 months	"	8	80	160
Year 3	"	8	210	140
		3 applications		
Year 4	14% N, 13% P ₂ O ₅ 9% K ₂ O, 2½% MgO	10	260	140
		3 applications		
Year 5	"	12	290	130
		3 applications		
Year 6	14% N, 13% P ₂ O ₅ 9% K ₂ O, 2½% MgO	12	290	130
		3 applications		
First 5 years of tapping	"	24	375	125
		3 applications		
6th year of tapping and onwards	15% N, 7% P ₂ O ₅ 18% K ₂ O, 2% MgO	24	360	120
		2 applications		

Operation	Assumption	Remarks																																
	<p>Timing of fertiliser applications after tapping has commenced would be as follows:-</p> <p>First round; about March at the time of wintering, just prior to refoliation.</p> <p>Second round; between May and September (July), prior to the leaves becoming senescent prior to wintering.</p> <p>Labour; would vary with the total quantities that would have to be applied. On average two man days per acre per application.</p> <table border="0"> <tr> <td>First year</td> <td>10 man days per acre</td> </tr> <tr> <td>2nd - 6th year</td> <td>6 man days per acre</td> </tr> <tr> <td>Subsequent years</td> <td>4 man days per acre</td> </tr> </table>	First year	10 man days per acre	2nd - 6th year	6 man days per acre	Subsequent years	4 man days per acre																											
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2nd - 6th year	6 man days per acre																																	
Subsequent years	4 man days per acre																																	
Budding	This would be carried out at any time of the year one year after seed germination. Budwood would be obtained from existing Government budwood nurseries or selected plantations. Generally, budwood material of the RRIM 600 clonal series would be used but also material of more recent clones if recommended by the Rubber Research Institute.																																	
Thinning out	Once a successful budding has been obtained at a planting point all unbudded seedlings would be removed. Subsequent thinning would consist of cutting out poorly growing trees.																																	
Tapping	<p>Tapping would commence seven years after seed planting. A spiral cut on a half circumference, alternate daily tapping at 100 per cent.</p> <p>Labour requirements for tapping would vary with the type of product aimed at. The following have been assumed:</p> <ul style="list-style-type: none"> - for polybag coagulum, 850 trees per man day equals 6.75 acres per man day - for fresh latex and bucket lump coagulum 500 trees per man day equals four acres per man day. 																																	
Processing	Central factory processing has been assumed.																																	
Product	Generally new plantings would be aimed at producing poly-bag or lump coagulum for manufacture into crumb rubber. There would be no deliberate policy of diverting the latex supply from successful factories producing Ribbed Smoked Sheet Rubber and new plantings close to such factories may well feed into them.																																	
Yields	<p>Assumed yields are:-</p> <table border="1"> <thead> <tr> <th rowspan="2">Year from planting</th> <th colspan="2">Pounds of dry rubber per acre</th> </tr> <tr> <th>Public sector and private investors</th> <th>Road based schemes</th> </tr> </thead> <tbody> <tr> <td>7</td> <td>620</td> <td>530</td> </tr> <tr> <td>8</td> <td>1 010</td> <td>860</td> </tr> <tr> <td>9</td> <td>1 260</td> <td>1 070</td> </tr> <tr> <td>10</td> <td>1 420</td> <td>1 200</td> </tr> <tr> <td>11</td> <td>1 500</td> <td>1 250</td> </tr> <tr> <td>12</td> <td>1 600</td> <td>1 350</td> </tr> <tr> <td>13</td> <td>1 700</td> <td>1 450</td> </tr> <tr> <td>14</td> <td>1 800</td> <td>1 520</td> </tr> <tr> <td>and onwards</td> <td>1 800</td> <td>1 520</td> </tr> </tbody> </table>	Year from planting	Pounds of dry rubber per acre		Public sector and private investors	Road based schemes	7	620	530	8	1 010	860	9	1 260	1 070	10	1 420	1 200	11	1 500	1 250	12	1 600	1 350	13	1 700	1 450	14	1 800	1 520	and onwards	1 800	1 520	It is considered the Study Area is suitable for rubber and high yields should be obtainable. Training programmes for management staff and for extension staff have been planned so that the standard and density at which they would be applied should be sufficiently high to avoid loss of yield due to poor cultural practices.
Year from planting	Pounds of dry rubber per acre																																	
	Public sector and private investors	Road based schemes																																
7	620	530																																
8	1 010	860																																
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12	1 600	1 350																																
13	1 700	1 450																																
14	1 800	1 520																																
and onwards	1 800	1 520																																
Ethrel stimulation	Would not be used until about 17 years of after planting, then it would be used every two months and tapping changed to every day.																																	
Timing of operations	These are shown diagrammatically in Figure 3.1.																																	

34 INVESTIGATIONS

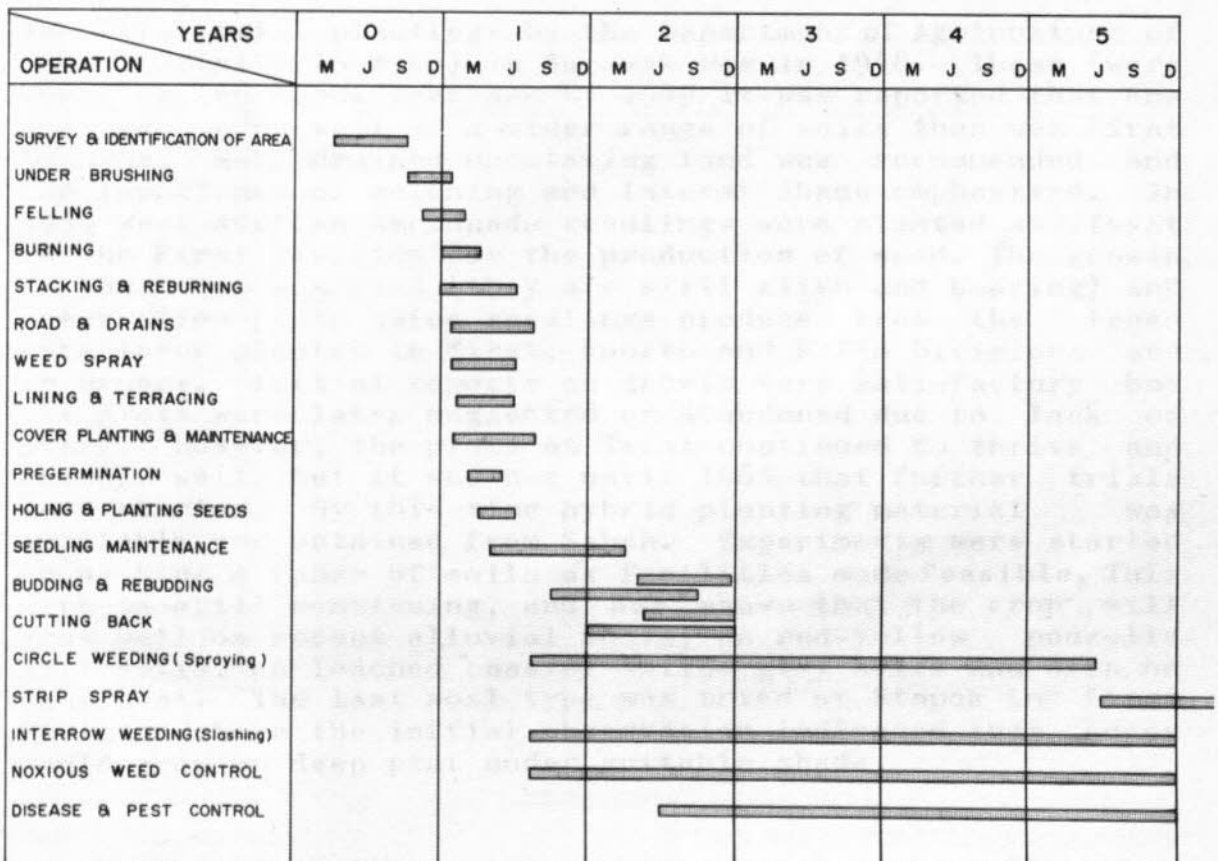
Research concerned with rubber is adequately handled at the Rubber Research Institute in Peninsular Malaysia, and there is no need for research to be undertaken in the Study Area or in Sarawak.

What is needed, however, in the Study Area is a campaign to improve the tapping and processing techniques. The present standards on the majority of the small, scattered plots is appallingly low, and if it is not improved on the plantings planned for the future then the yields predicted will not be achieved.

It is recommended that a plantation of about 10 acres of rubber is established at the Kabuloh Research Station or at the Kabuloh Training Centre, (see Part III) where Agricultural Development Unit staff could be taught correct tapping. They would then be able to pass on their knowledge and skill to the farmers associated with the new plantings of high yielding rubber.

FIGURE 3.1

RUBBER OPERATIONS CHART - FIELD BUDDED SEEDLINGS



CHAPTER 4

COCOA

4.1 INTRODUCTION

Cocoa is a relatively new crop to Sarawak and is currently being established under coconuts in many parts of the State. It has not yet been grown on any scale on inland soils under a system which permits commercial evaluation.

Nevertheless experimental evidence in Sarawak and experience in Sabah under similar conditions indicate that the crop could be successfully grown in the Study Area. Accordingly new plantings are recommended in the agricultural plan, but on a reasonably limited scale and under the most favourable conditions. Total planting recommended amounts to about 9 000 acres by 1980. Provided these prove successful larger acreages could be established in the Study Area by 1990.

Because the proposed plantings would be the first commercial ones on inland soils in Sarawak it is considered necessary to give an account of the evidence and reasoning behind the recommendations.

4.1.1 Trial Plantings

The first trial plantings by the Department of Agriculture of cocoa (Trinitario type) in Sarawak was in 1948. These were under varied conditions and by 1949 it was reported that cocoa might grow well on a wider range of soils than was first thought. Well drained undulating land was recommended and the importance of mulching and lateral shade emphasised. In 1950 West African Amelonado seedlings were planted at Tarat in the First Division for the production of seed. The growth of the trees was good (they are still alive and bearing) and observation plots using seedlings produced from the trees were later planted in First, Fourth and Fifth Divisions and in Brunei. Initial reports on growth were satisfactory but all plots were later neglected or abandoned due to lack of staff. However, the plots at Tarat continued to thrive and produce well, but it was not until 1965 that further trials were started. By this time hybrid planting material was available and obtained from Sabah. Experiments were started on as wide a range of soils as facilities made feasible. This work is still continuing, and has shown that the crop will grow well on recent alluvial soils, on red-yellow podzolic hill soils, on leached coastal saline gley soils and even on deep peat. The last soil type was tried at Stapok in First Division where the initial observation indicated that cocoa could grow on deep peat under suitable shade.

Most of the work has been confined to the First Division and it has produced sufficient evidence to show that cocoa will thrive under First Division conditions. So much so in fact that a cocoa planting subsidy scheme has been started. This is confined to interplanting in coconut plantations which are generally planted on recent alluvial and muck soils.

Recent plantings in the Fourth Division include 250 acres in the coastal gley soils south of Bintulu, 20 acres on alluvial soil in the Baram District and two small trials on the Kabuloh Experimental Station in well drained hill soils. These latter plots have grown well and commenced bearing in their second year. A fungus attacked the bark at the base of the stem of about 20 per cent of the trees in the trial planted under thinned jungle. The disease has however been controlled by removal of the affected bark and application of a fungicide.

All the evidence in Sarawak confirms the findings in other parts of the world which show that cocoa is not particularly sensitive with regard to soil type. For example Ochse et al (1961) say the following about soils for cocoa "it thrives on a wide diversity of soil types. Plantations are located on soils ranging from badly eroded heavy clays to recently formed volcanic sands and loams. They vary in soil reaction from pH 4.0 to pH 7.4 in the upper layers and pH 4.0 to pH 8.3 in the subsoil. In studies made all over the world, no correlation has been found between soil fertility and growth and productiveness of cocoa provided the soils were rich in organic matter". In Sarawak, Dunsmore and Ngui (1969) state that the sandy loams to sandy clay loams of the red-yellow podzolic soils would be suitable though the best conditions are to be found in drained, saline gley soils. For Sabah conditions Wyrley-Birch in the cocoa Planting Manual (1973) writes "Soils normally described as loams, sandy loams, silt loams and sandy clay loams are considered to be the most suitable for cocoa cultivation, particularly when they occur on the flat areas adjacent to rivers. These riverine alluvial soils are usually quite fertile and cocoa will do well without fertiliser. Nevertheless the application of fertiliser is still advisable for maximum yield and growth. Since these riverine areas are often subject to flooding in the wet season and also rainfall does not run off, or runs off slowly drainage is necessary to prevent the soils from becoming waterlogged. The amount of drainage required will vary from one area to another, but as a general rule approximately two chains per acre of drains four feet deep, and 13 to 18 chains of drains one to two feet deep will be required. Drainage has been emphasised because cocoa does best on freely drained well aerated soils". There is little doubt that suitable soils for cocoa exist in the Study Area

The long period over which cocoa has been tried in Sarawak shows that the climate is suitable. Experimental yields of over 2 000 pounds of dried beans per acre have been recorded at Tarat in the First Division from hybrid trees in their

third year of bearing. Yet the climate in the First Division could be considered as on the wet side for cocoa, whereas that of the Study Area appears more suitable. Ochse et al say that "the crop is cultivated in areas where some rain falls every month in the year and the more evenly distributed the better. An annual precipitation of at least 60 to 80 inches is necessary". The rainfall in the Study Area varies between 70 and 120 inches and there is no distinct dry period. First Division rainfall averages about 150 inches. It is evident that climatically the Study Area is suitable for cocoa.

From the foregoing summary of the history of cocoa in Sarawak and of the growing conditions required for cocoa it has been considered reasonable to recommend that a moderate area of the crop is included in the cropping pattern for the Study Area. The crop is ideal for small-holders and, provided it is planted in sufficient concentration to enable good extension work and good pest control to be undertaken and processing and marketing organised, there is a good chance that it can be successfully and economically grown.

A first year (1975) planting of at least 100 acres has been recommended. This acreage should give, even in the early production years, an annual production of dried beans of over 25 tons which is the minimum desirable export package. This rate of planting could easily be increased in subsequent years. Present world market indications are that the production from about 6 000 acres in the Study Area could be safely absorbed up to 1990. It is envisaged that about half of this acreage might be established in the period 1975 to 1980 at which stage the cocoa situation could be reviewed and subsequent plans adjusted accordingly.

Chocolate manufacture is already undertaken in Peninsular Malaysia by Van Houton and Cadbury; each firm working with their established recipes, techniques and marketing knowledge. This sophisticated processing should be left to them or other similar companies. But the production of cocoa butter and cocoa powder may be economically practicable in Sarawak when local production of dried beans has reached sufficient quantities.

Cocoa butter has its main use in chocolate manufacture but also has uses in pharmaceutical products and cosmetics. Cocoa powder requires further specialised treatment before retail sale but other by-products are obtained from the shell which accounts for 10 to 12 per cent of the dried bean. Theobromine can be extracted and used medicinally or for the preparation of caffeine. The shell can be used as fertiliser and soil conditioner and also as an animal feed supplement. The theobromine represents a good source of vitamin D and total digestible nutrients in the shell are 47 per cent although digestible protein is low at 4.2 per cent. Cocoa pods are also potentially useful animal feeds.

The report on Agro-based and Food Industries Potential in Sarawak by Majumdar and Chua (1971) mentions a factory capable of handling 900 tons per year output, taking in 1 040 tons of cocoa beans. There would seem to be possibilities for establishing such a factory in the Study Area when assured production reaches that level.

42 THE MARKET FOR COCOA

Historically cocoa production expanded very rapidly in the period late 1950's to the mid-1960's as a result of row plantings and improved management particularly in African producing countries. During this period, consumption increased, but at a slower rate than production, with the result that prices declined considerably to the mid-1960's. Since then production increases have been relatively small with virtually no change over the past three years, and prices have generally recovered reflecting a balance being reached between supply and demand.

A feature of the cocoa market is its price instability with rapid changes from month to month and year to year. This has led to concerted action by both producers and consumers to negotiate an International Cocoa Agreement. Final ratification of the agreement has yet to be achieved but reactions to it have generally been favourable.

42.1 Review of Cocoa Production and Trade

World cocoa output fluctuates from year to year, mainly due to variations in weather conditions and the incidence of diseases. Total world output and utilisation over the last decade is shown in Table 4.1. About 73 per cent of world production comes from Africa and 23 per cent from Latin America. Ghana is the largest single producer at a general level of over 400 000 tons with Nigeria increasing production to around 250 000 tons. The Ivory Coast and Brazil are also major producers each accounting for some 200 000 tons, while Cameroon produces about 110 000 tons annually.

Cocoa enters world trade as dry beans, cocoa powder, cocoa butter and chocolates. About 80 per cent of the total is traded as dry beans with the remainder, about 400 000 tons, being ground in the producing countries and exported as cocoa butter, paste, powder or cake.

The main grades of raw dried beans are recognised - ordinary and fine, with the former representing about 90 per cent of output. The West African countries and Brazil produce most

TABLE 4.1 TOTAL WORLD PRODUCTION, GRINDINGS AND EXPORTS
OF COCOA 1960/61 - 1972/73
(Thousand tons dry bean equivalent)

Year	Production	Grindings	Exports
Average 1960/61 to 1962/63	1 144	-	-
Average 1963/64 to 1965/66	1 296	-	-
1964/65	1 515	1 320	1 285
1965/66	1 205	1 370	1 094
1966/67	1 331	1 366	1 066
1967/68	1 335	1 392	1 039
1968/69	1 221	1 333	982
1969/70	1 420	1 336	1 094
1970/71	1 480	1 418	1 170*
1971/72	1 548*	1 529*	N.A
1972/73	1 494*	1 540*	N.A

NA = not available

* Estimated or forecast figures.

of the ordinary grades and Trinidad, Ecuador and Venezuela contribute the majority of fine grades.

Trade in raw cocoa beans has been falling in recent years, partly because of increasing grindings in the producing countries and partly because the importing countries are starting to use extenders and substitutes for cocoa butter. This is a trend brought about by recent high prices of beans and advancing edible oil technology.

The main importing countries are the USA, West Germany, USSR, Holland and the UK in that order. A feature of the market in recent years has been the increases in USSR imports and this country was ranking just behind West Germany in 1971.

4.2.2 Prices of Raw Cocoa Beans

As production fluctuates so does price as shown in Table 4.2. A peak spot price was reached in 1958 when it was US44.3 cents per pound of dried beans falling sharply to US17.3 cents in 1965 when production was at its peak. Since then the price increased to US45.7 cents per pound in 1969 before falling again to US26.8 cents in 1971, and then rose steadily through 1972 reaching US37.7 cents per pound in December 1972. On the London market the average spot price in December 1972 was £333 per ton compared with the 1969 average price of £415 per ton. These figures underline the wide short-term fluctuations in

TABLE 4.2 AVERAGE PRICES OF RAW COCOA*

Year	New York (US cents per pound)		London (£ per metric ton)
	Spot price	3 months future-price**	Spot price
1961	22.6)	Average 1961-63 22.5	177
1962	21.0)		167
1963	25.3)		205
1964	23.4)	Average 1964-66 20.5	188
1965	17.3)		138
1966	24.4)		193
1967	29.1	26.3	238
1968	34.4	31.5	320
1969	45.7	39.6	415
1970	34.2	30.6	306
1971	26.8	N.A.	232
1972	32.3	N.A.	270

N.A. = not available.

* Ghana grade 1 - main crop.

** World indicator price as defined in the draft International Cocoa Agreement.

Sources: Gill and Duffus, 1973.

prices which characterise the cocoa market and which prompted the United Nations Cocoa Conference to be convened in 1972 under the auspices of UNCTAD. As a result of these discussions an International Cocoa Agreement has been drafted but not yet adopted pending negotiation on several points of which the major question is the minimum price level at which restrictions on exports would be removed.

4.2.3 The Future Prospects of Cocoa

Food and Agricultural Organisation (FAO) 1967, 1971 commodity projections suggest that at constant (1962) prices world demand would increase at an overall rate of 3.5 per cent with the developed countries increasing their demand at the rate of 2.6 per cent per year and developing countries at 4.0 per cent. Total projected supply and demand is expected to be more or less in balance by 1985. However, a note of caution was sounded by the FAO reports; that there could be over production by 1985 if the potential which exists for increasing production in a number of countries is utilised.

Assuming a supply-demand balance occurs the effect could be a slow downward drift in prices of raw cocoa particularly since the high prices in the late 1960s stimulated rehabilitation

and planting programmes in some of the major producing countries. Past experience indicates that due to the relatively low price elasticity of demand in the main importing countries, consumption is sensitive to price changes which may result from relatively small fluctuations in supply, and any tendency towards continuously high prices could result in curtailed consumption. Conversely consumption is stimulated by periods of low prices. The prices forecast which have been used in the costs and returns calculations in Chapter 8 are given in Table 4.3.

TABLE 4.3 PRICE FORECAST FOR DRIED COCOA BEANS

Year	US future-price (US cents per lb)	Fob price Sarawak (Malaysian cents per lb)
1975	31	60
1980	29	55
1985	27	50
1990	27	50
1995	27	50

43 THE ASSUMED AGRONOMIC ASPECTS ASSOCIATED WITH COCOA IN THE AGRICULTURAL PLAN

It is often wrongly believed that cocoa is a difficult crop to grow and that to do so requires much skill. Cocoa does require more regular attention than either rubber or oil palm for example, but no particular skills are involved as in the case of pepper pruning for instance. The greatest difficulties with cocoa are experienced in the early stages after the land has been cleared. The planting, firstly of shade and subsequently of the cocoa seedlings, must be properly timed. Also the young cocoa must be given regular attention for the first 12 to 18 months after planting. The assumed cultural and organisational steps for cocoa growing are as follows.

Operation	Assumption	Remarks
Site selection	Until more experience has been gained with cocoa under local conditions it is obviously desirable to make the initial plantings under the most favourable conditions; therefore, reasonably large areas of gently sloping, deep well drained soils which are not subject to flooding, or are subject to only infrequent floods of short duration would be selected.	
Land development	On public sector schemes would be done by contractors or SLDB using their own labour and machines. Clearing of logged forest would be to a higher standard than for either oil palm or rubber. All but the very largest logs and stumps would be burned.	This is the normal practice in Sabah where the planting of cocoa under thinned out jungle is not now recommended.
Planting material	Hybrid seed would be used and any one plantation would consist of several hybrids.	Sufficient evidence has already been gained in Sarawak to enable the following hybrids to be recommended. PA ₃₅ x NA ₃₂ PA ₇ x NA ₃₂ PA ₃₅ x NA ₃₁ AML x NA ₃₄ AML x PA ₇ AML x NA ₃₂ There are other hybrids of Triniteric x NA and x PA which have also yielded well, but the true parentage on the Triniteric side is not known. Seeds of all these and other hybrids are available from the Quoin Hill Cocoa Research Station, Sabah, and the Commonwealth Development Corporation, Borneo Abaca Ltd., Estate, Tawau, Sabah.
Nursery	Central nurseries would be established by SLDB reasonably close to the selected planting areas. Seedlings would be raised in polythene bags and planted out at about four months old. The bags would be the same as those used in Sabah: 12 by 17 inches when flat; 140 seed planted for every 100 seedlings required, 609 seeds per acre to be planted; 0.5 ounce of a complete compound fertiliser plus 0.5 ounce of lime per bag. Pest and disease control would be undertaken as required.	Central cocoa nurseries are not a present feature of cocoa development in Sarawak but they are for oil palm and rubber.
Field planting	In all types of schemes (public sector, road based and private investors) would be in contiguous blocks as opposed to scattered isolated plot plantings. Plant spacing would be 10 feet by 10 feet giving an initial stand of 435 trees per acre.	Reasonably large block plantings would facilitate the organisation of preventative measures against diseases and pests (rats and squirrels as well as insects). Block planting would also facilitate the organisation of central fermentation and drying. Experience and economic calculations indicate that about 50 acres is the smallest viable unit for a fermentation and drying unit. 20 acres, planted within a reasonably small area, is the least acreage for which the Sarawak Department of Agriculture recommends loans for the construction of Samoan-type dryer and fermentation boxes. In the agriculture plan (see Part II) block plantings larger than 50 acres are recommended in the public sector development, for private investors and road based development 20 acres blocks would be the minimum aimed at.
Shade	Would be established immediately after completion of land clearing and at least six months before planting out of the cocoa seedlings. A leguminous cover crop would also be established on undulating land. a) Temporary shade; planted in the same row and at the same spacing as cocoa; pure stands, or mixed stands of <u>Gliricidia maculata</u> and <u>Albizia falcata</u> or <u>Albizia Chinensis</u> . Approximate number of shade trees required per acre would be <u>Gliricidia</u> 420, <u>Albizia</u> 20. Pruning-up and gradual thinning of the temporary shade would be undertaken such that by the time the cocoa is two years old most of the temporary shade would have been removed and the permanent shade taking over. Removal of the shade trees would be done using a 245T selection (one part to 20 parts water) painted around the bore of the stem using two ounces per tree. Cover crop would be destroyed just prior to planting cocoa, using a gramoxone spray solution, (two pints to 20 gallons of water). b) Permanent shades; planted at the same time as the temporary shade at a spacing of about 40 feet by 40 feet. Recommended species; durian (<u>Durio zibethinus</u>) and <u>Parkia javanica</u> .	Experience in Sarawak has shown that partial shade is beneficial, possibly even essential, for the first two years after planting-out of cocoa seedlings. Tall bananas (Eban and Keling varieties), could be used in specific cases where the fruit would be useful in providing an early cash return or family food requirements. Details of shade management are given in the Sabah Agricultural Departments' pamphlet "Cocoa Planting Manual" (Wyrley-Birch 1973)

The cocoa hybrid plants at Sabah should be given the same treatment as the cocoa plants at Sarawak. The cocoa plants at Sarawak are well established and the results of the investigation are as follows:-

Operation	Assumption	Remarks												
Fertilising	<p>An application at planting time would be given of 12 ounces of CIRP in each planting hole. In year two an application of 1 000 pounds per acre of lime plus five ounces per cocoa tree of a complete compound fertiliser (10% N, 16% P₂O₅, 9% K₂O, 2% MgO). In year three and onwards an application of 200 pounds per acre of lime plus increasing amounts of compound fertiliser as follows:-</p> <table border="1" data-bbox="464 674 828 821"> <thead> <tr> <th>Year</th> <th>lbs per acre of compound fertiliser</th> </tr> </thead> <tbody> <tr> <td>3</td> <td>200</td> </tr> <tr> <td>4</td> <td>300</td> </tr> <tr> <td>5</td> <td>600</td> </tr> <tr> <td>6</td> <td>800</td> </tr> <tr> <td>and onwards</td> <td></td> </tr> </tbody> </table>	Year	lbs per acre of compound fertiliser	3	200	4	300	5	600	6	800	and onwards		<p>Recommendation of the cocoa Agronomist at the Agricultural Research Station, Semongok, Sarawak.</p>
Year	lbs per acre of compound fertiliser													
3	200													
4	300													
5	600													
6	800													
and onwards														
Pest control	<p>Attacks by insects such as capsid bugs, lead-eating beetles, bag worms, aphids, mealy bugs, trunk borers and termites would be controlled by spraying using a knapsack sprayer as and when required.</p> <p>Two rounds of spot spraying using Dieldax 15 at six fluid ounces per acre per round have been assumed. Labour requirement one man day per acre per round. Rats and squirrels would be important pests and the block planting system would be adopted principally as a means of obtaining group control measures against them. Poisoning and trapping of rats can be expected to be reasonably effective, but squirrels become bait-shy quickly and are not easily trapped. Moreover they are known to travel long distances for feeding. Thus killing a few in the plantation would not deter others from coming. Squirrel damage would be reduced by patrolling the area during the main cocoa harvest season and accepting a certain amount of damage during the off-season. Labour requirement one man day per 10 acres for nine months.</p>	<p>Recommendation of the Agricultural Department, Sarawak.</p>												
Disease control	<p>Regular pruning and spot spraying with a fungicide, using a knapsack sprayer to control pink disease (<i>Corticium salmonicolor</i>) which is expected to be the most prevalent disease. Four rounds of pruning and spot spraying have been assumed using nine ounces of "Perenex" or "Coprantol" per acre per round. Labour requirement one man day per acre per round.</p>	<p>Other disease which have occurred in Sarawak but have not caused serious outbreaks are: white root disease (<i>Fomes lignosus</i>), black thread blight (<i>Marasmius scandens</i>), black thread blight (<i>Marasmius equicrinis</i>) and brown pod (<i>Botryodiplodia theobromae</i>).</p>												
Harvesting	<p>Because several hybrids would be used there would be prolonged harvest periods with a short off-season in September/early October and late January/March. During the harvest period picking would take place every ten days. The ripe pods would be opened in the field and the wet beans transported the same day to the central fermentation and drying plant. Labour requirement one fifth man day per acre per picking.</p>	<p>Picking tasks on estates in Sabah vary from 5 to 10 acres per man day depending on the quantity of ripe pods. The task includes opening the pods and extracting the beans.</p>												
Fermentation drying and marketing	<p>Done centrally using fermentation boxes and Samoan type dryers under the control of the managing agency (SLDB, ADUs or FDs). Each farmer would sell his wet beans to the agency who would then take care of the next step in the marketing chain aimed initially at the export of dried beans.</p>	<p>Correct processing is essential for producing good, uniform quality, dried beans.</p>												
Yields	<p>The first worthwhile harvest would be expected in the third year after planting out; yield would average 500 pounds of dried beans per acre; the next year 1 000 pounds and thereafter annual yield would average 1 500 pounds dried beans per acre.</p>	<p>These yields have been exceeded by considerable margins in hybrid trials in Sarawak.</p>												

44 INVESTIGATIONS

The cocoa hybrid plots at Kabuloh should be greatly extended to include more crosses as well as different soil types. The starting point for these trials should be proven husbandry techniques and shade species, and the objective should be to determine as quickly as possible the most suitable varieties and the fertiliser regimes for the Study Area.

It would be important to increase the acreage of cocoa at the station sufficient to warrant building fermentation boxes and erecting a samoan-type dryer of the type that would be needed to handle the production from the planned plantings in the development of the Area.

CHAPTER 5

RICE

5.1 INTRODUCTION

Rice is the staple food of all races in Sarawak. Production of a staple crop almost always plays an important role in the planning of agricultural development in any country and in Sarawak there is the additional factor that, amongst certain races, cultivation of rice assumes the proportion of a religion. Recently declared intentions of the Government are that Sarawak should become self-sufficient (or even become an exporter) in rice.

Production is by two basic methods; hill rice and wet or swamp rice. The Government has a stated policy to discourage hill rice and to increase swamp rice production. It has operated this policy since 1967 and would appear to have achieved some success and the area of hill rice has decreased. It is conceivable that it will fall even further but is unlikely to disappear within a generation or two.

There is known to be a reserve of wet land immediately available for swamp padi cultivation because many farmers with suitable land only farm a proportion each year, this proportion may be as low as 20 per cent of an individual farm although the overall cropping intensity is unknown. In a farm survey of 103 randomly selected farmers throughout the Study Area 80 of them stated they cultivated wet rice. The average size of wet padi holdings in this survey was three acres (see Part II Appendix VI).

The wet rice lands are normally flat, swampy, flood prone areas often with a layer of peat or muck overlaying the alluvial soil. The presently cultivated areas have been mostly opened up by the local people themselves often under the Assistance to Padi Planters scheme but generally neither irrigation nor effective drainage have been carried out. The only areas of significance so far tackled by the Drainage and Irrigation Department in the Study Area are:-

- (a) Paya Selanyau near Bekenu, a scheme which eventually will extend to about 1 300 acres. Drains have already been constructed and gravity irrigation installed. The area is partly an old, traditionally cultivated swamp rice area and partly a new and as yet unworked swamp area. Some 20 acres in the old cultivated area have been developed as a rice experimental station where variety and double cropping trials were started in 1972.
- (b) Pujut-Lopeng near Miri where drainage works are being carried out in a large swamp area part of which has been previously cultivated and partially drained. The newly drained area is being developed as a Youth Settlement Scheme.

5.2 PRESENT CULTIVATION METHODS

5.2.1 Hill Rice

This is the traditional method of rice growing practised by the Ibans, Kedayans and Kenyahs. The traditions, cult and undesirable land use associated with hill rice cultivation have been described in many publications and need not be repeated here. But it is important to appreciate that even today the planting of a patch of hill rice is, to these people, a social tradition, even an obligation, and may have little or no economic justification. In the Study Area, it is generally true to say that most groups practising hill rice cultivation still have sufficient land on which to rotate their plantings so that serious soil exhaustion and erosion is not a current problem.

The timing of hill rice cultural operations in the Study Area varies slightly from year to year, depending on the rainfall, and varies with location, the inland areas are normally earlier than the coastal areas, but a generalisation is as follows:-

- jungle felling and burning; June, July and August;
- planting; August, September (long-term varieties 150 to 180 days are used);
- harvesting; February, March.

Yields are low and vary from year to year. From available statistics and crop cutting trials it appears that average yields are between 800 and 1 000 pounds of padi per acre. The yields in the Fourth Division appear higher than the average for most other parts of Sarawak.

5.2.2 Wet or Swamp Rice

The intensity at which these lands are worked varies from farmer to farmer and from place to place. For example at Paya Selanyau it is normal for the farmers to take one crop of rice off their holdings each year; that is 100 per cent intensity; but the Ibans who often cultivate the patches of flat swamp land in the small valleys in hilly country commonly cultivate the same plot for several years before moving to another part of their holding.

The cultural operations in these areas are simple, no turning or puddling of the soil is undertaken nor is double cropping of any sort practised, some bunding is done but levelling of the fields is uncommon. The weed growth, which grows up during the off-season or during the fallow period is merely cut down and burned. Transplanting of seedlings raised in a separate nursery follows immediately. Very little fertiliser is used because the tall, long-term varieties (150 to 180 days) generally lodge when fertilised. Weeding and harvesting is done by hand. The timing of the operations is similar to

those for hill rice, but yields are higher. Recent crop cutting trials indicated yields of between 1 400 to 1 900 pounds of unmilled rice per acre though yields of over a ton were recorded. Generally though the statistical records show average yields of about 1 200 pounds.

5.3 FUTURE CULTIVATION OF RICE

The return to labour for traditional growing of both hill and wet rice is low and any efforts or encouragement to increase production over and above subsistence requirements should be confined to the more accessible areas where organised, efficient marketing of the surplus is feasible.

5.3.1 Hill Rice

Undoubtedly the growing of hill rice will continue for many years in the region though the acreages involved are likely to decrease gradually as a result of the Governments' Assistance to Padi Planters Scheme. This scheme which encourages and assists farmers to open up and maintain swamp padi areas should be continued, as should the present policy to provide subsidised fertiliser (ammophos) to hill rice cultivators.

In the agricultural plan hill rice is envisaged only in two circumstances in the intensive development areas:-

- (a) in road-based improvement schemes in Native Customary Land, hill rice could be used as a nurse-crop in the first establishment year of some permanent crop, oil palm, rubber, cashew-nut or fruit trees.
- (b) if beef cattle enterprises are to be extended to smallholders there would be a need to investigate methods of maintaining the productivity of planted pastures. Re-establishing them after a number of years may be found necessary. Hill rice as a nurse-crop could possibly be an attractive method of achieving this.

If high yielding rice varieties and fertilisers were to be used under these circumstances yields could average around 1 500 pounds of unmilled rice per acre.

5.3.2 Wet or Swamp Rice

This would be the main method of rice growing in the intensive development area. The object would be to produce rice, mainly as a food crop not as a cash earning crop (though it must be economically produced), and to organise its culture

so that it interferes as little as possible with the production of more profitable crops. It is envisaged that the flat, swampy flood-prone lands which are not covered in deep peat would be developed for wet rice cultivation. The aim would be to grow a crop of rice during the normal rice season and a short-term dry-land crop wherever possible in the off-season. In public sector development schemes it is envisaged that particularly selected valley land would be cleared and developed by SLDB before it is handed over in one acre plots to small-holder farmers.

In road-based improvement schemes selected areas would be developed by the local inhabitants with the guidance and assistance of the Agricultural Development Unit.

Important development aspects under both conditions would be:-

- (a) combined drainage and flood control; the works would be designed so that flood water could be drained away reasonably quickly (within a week) or retained on the land at a required depth of up to about nine inches. The provision of irrigation would be of secondary importance and only carried out where the works could be simply and cheaply constructed.
- (b) good land clearing; it would be necessary to remove all logs and stumps because mechanical land preparation would be introduced wherever possible. Research so far has shown that yields from "no-cultivation" systems are generally significantly lower than systems involving some cultivation.
- (c) land levelling and bunding; this would be necessary to ensure water distribution and to obtain fields large enough for mechanical operation.

The agricultural plan provides for a complete package input of cultural operations. This would include:

- (i) for rice in the "landas" season, organised group mechanical land preparation, the application of fertilisers, pesticides and weedicides together with the introduction of short or medium term, high yielding varieties which will respond to the fertilisers without lodging;
- (ii) in the off-season, wherever practical, the cultivation of short-term crops such as maize (for green cobs), soya beans, groundnuts and numerous vegetables. At present the growing of an off-season crop is not widely practised. Research has shown that there are practical problems. For example, at the Paya Paloh Padi Testing Station the conclusions from the 1970 off-season trials were summarised as follows:

"Because of its puddled nature, the padi soil settled down to a homogenous mass losing its structure and inhibiting water retention and soil aeration. The soil formed solid masses during dry spells, restricting root penetration and hence plant growth. Unless there was

sufficient rainfall or irrigation water to keep the top-soil wet, plant growth in the padi fields, as encountered at Paya Paloh, will meet with variable results".

However, research to investigate the feasibility of a no-cultivation system using herbicides to kill pre-planting weeds should be continued because yields are already reasonable and any cheap labour saving method which would maintain, or improve them would be worthwhile.

With the envisaged package inputs future wet rice yields could be expected to average between 2 500 and 3 000 pounds of unmilled rice per acre. Harvesting would be done by hand as at present though attempts should be made to introduce sickles by means of which several heads or handfuls of stalks can be cut simultaneously in place of single stalk method employed at present. Some simple form of mechanical threshing should also be introduced. The objective would be to reduce the amount of labour required for harvesting.

The introduction of mechanical land preparation would reduce the labour required for this operation as well as facilitate increasing the cropping intensity and possibly even permitting double cropping. Well prepared land would enable higher yields to be obtained.

Mechanical cultivation could be achieved by using either conventional tractors and rotovators or by power tillers. Both systems would require that the equipment be owned and worked by a central organisation; for example a Farmers Association, and work would be on credit to the individual farmers. Conventional tractors (of the Ford 5 000 type) fitted with cage-wheel extensions and operating a heavy duty Rotovator could be used for every 200 to 300 acres of land available within a reasonable radius of the works centre, say three to five miles. The farmers would need to co-operate among themselves to arrange efficient use of the machines. Land preparation would have to take place in blocks so that when a mechanical unit went to an area all the work there could be completed before the unit returned to the centre. Such units could handle weeds or unharvested rice straw.

Power-tillers appear a better type of machinery to use where the land available is in small isolated patches or the total area is less than 200 acres within a radius of three to five miles of the works centre. Block preparation of land would again be necessary to prevent unnecessary road travel by the unit. It is unlikely that the power-tillers could handle weed growth or unharvested rice straw. Thus hand clearing of these growths would be necessary where such machinery is used.

The timing of operations would be:-

- planting of rice nurseries; August, September.
- land preparation for rice; September, October.
- transplanting; late September, October (medium term variety 135 to 140 days).
- harvesting; February, March.
- land preparation for off-season crop; March, April, May.
- planting; April, May (four month crop).
- harvesting; July, August.

5.4 THE MARKET FOR RICE

Overall consumption of rice in Sarawak has increased with population growth and local production has generally kept pace with the increased demand. Thus while imports have been necessary to supply total demand, the proportion of imports has tended to fall over the last decade from around 50 per cent in the early 1960's to under 40 per cent in the early 1970's.

The most significant contribution to increasing local supplies is attributed to wet padi production which has grown by about 70 per cent over the past decade. Overall production increased by 50 per cent over the same period.

5.4.1 Present Rice Production and Consumption in Sarawak

Over the decade 1961 padi production in Sarawak increased from an estimated 95.8 thousand tons to 154.4 thousand tons; as shown in Table 5.1, largely due to increased areas and yields of wet padi.

Consumption of rice, as measured by adding together the figures for local production and imports of rice, similarly rose from 120 000 tons in 1961 to about 159 300 tons in 1971 as shown in Table 5.2. The per capita consumption levels assessed on the basis of these statistics are also given in Table 5.2 and show no specific trend, but averaging about 340 pounds of milled rice equivalent per annum. The variation in consumption from year to year is probably due to the high proportion of rice which is grown entirely for home consumption and which is largely dependent on weather conditions. In a poor crop year subsistence farmers go short of rice and imports would not balance the deficit because the farmers in remote areas do not buy traditional supplies in the market.

TABLE 5.1 ESTIMATED RICE PRODUCTION IN SARAWAK 1960/61 TO 1971/72

Season	Swamp rice			Hill rice			Total		
	Acreage Thous.	Yield lbs/acre	Production '000 tons	Acreage Thous.	Yield lbs/acre	Production '000 tons	Acreage Thous.	Yield lbs/acre	Production '000 tons
1960/61	101.3	1 034	46.7	181.9	604	49.1	283.3	758	95.8
1961/62	103.4	1 034	56.7	177.4	653	51.7	280.8	865	108.4
1962/63	106.7	1 228	53.2	177.1	612	48.4	283.8	802	101.6
1963/64	112.1	1 116	47.3	183.5	610	50.0	295.6	737	97.3
1964/65	118.9	946	72.0	183.1	550	45.0	302.0	868	117.0
1965/66	115.6	1 251	64.6	148.9	717	47.7	264.5	950	112.2
1966/67	110.8	1 015	50.2	174.9	472	36.8	285.7	682	87.0
1967/68	128.1	1 187	67.9	209.6	570	53.4	337.7	804	121.3
1968/69	135.8	1 406	85.3	214.3	672	64.3	350.0	957	149.6
1969/70	127.3	1 362	77.4	187.2	798	66.7	314.5	1 026	144.1
1970/71	152.0	1 408	95.6	180.9	728	58.8	32.9	1 039	154.4
1971/72	148.3	1 499	99.2	211.4	635	60.0	359.7	980	157.4

TABLE 5.2 ESTIMATED RICE CONSUMPTION IN SARAWAK 1961 TO 1972

Year	Rice equivalent '000 tons					Population '000	Average consumption per capita (lbs)
	Sarawak production			Imported rice	Total rice available		
	Swamp(1)	Hill(2)	Total				
1961	29.4	33.4	62.8	57.3	120.1	760.4	352
1962	35.7	35.2	70.9	51.3	122.2	778.5	349
1963	33.5	32.9	66.4	63.8	130.2	799.2	363
1964	29.8	34.0	63.8	59.1	122.9	818.1	336
1965	45.4	30.6	76.0	58.8	134.8	838.0	358
1966	40.7	32.4	73.1	59.9	133.0	862.4	345
1967	31.6	25.0	56.6	61.0	117.6	902.8	291
1968	42.8	36.3	79.1	44.3	123.4	923.5	298
1969	53.7	43.7	97.4	54.7	152.1	945.1	358
1970	48.8	45.4	94.2	58.7	152.9	975.9	349
1971	60.2	40.0	100.2	59.1	159.3	1 003.2	354
1972	62.5	40.8	103.3	62.7	166.0	1 031.3	358

Notes (1) Conversion rate - 0.62 of padi
(2) Conversion rate - 0.68 of padi

5.4.2 Future Rice Production and Consumption in Sarawak

Demand for rice is largely a function of population growth and, to a much lesser extent, income changes. For projection purposes the population of Sarawak has been assumed to grow at 2.8 per cent per annum and per capita incomes at three per

cent per annum. The income elasticity of demand for rice at a real income growth rate of three per cent is likely to be either zero or negative, - 0.2. On the basis of these assumptions, two possible levels of per capita consumption of rice over the next 20 years have been calculated. The results are shown in Table 5.3 in which the negative elasticity demand has been taken as - 0.2. On these assumptions two projections of the possible overall demand for rice in Sarawak to 1990 are given in Table 5.4.

TABLE 5.3 ESTIMATED FUTURE PER CAPITA RICE CONSUMPTION LEVEL (pounds of rice per year)

Year	Average consumption per capita at two demand levels of income elasticity	
	A	B
	0	- 0.2
Basic level	340	340
1975	340	330
1980	340	320
1985	340	310
1990	340	301

TABLE 5.4 ESTIMATED DEMAND FOR RICE IN SARAWAK 1975-1990

Year	Population '000	Projected demand at per capita level 'A' '000 tons rice	Projected demand at per capita level 'B' '000 tons rice
1975	1 120.5	170.1	165.1
1980	1 286.3	195.2	183.8
1985	1 476.8	224.2	204.4
1990	1 695.5	257.4	227.8

Future rice production in Sarawak is projected to 1990 in Table 5.5 on the basis of the following assumptions:-

- the total area of swamp rice would increase on average by 3 400 acres per annum or 52 000 acres over the 20 year period.
- the total area of hill rice would remain static at 186 000 acres.
- average yields of swamp rice would increase to 2 265 pounds padi by 1990 while hill rice yields would remain static at 640 pounds padi per acre.

On the basis of these estimates local production would be unlikely to supply the total Sarawak demand for rice by 1990, but the country would be 74 per cent self-sufficient. Two

TABLE 5.5 PROJECTED SARAWAK RICE PRODUCTION 1975 - 1990

Year	Acreages			Yields of padi		Total production		
	Swamp rice	Hill rice	Total	Swamp rice	Hill rice	Swamp rice(1)	Hill rice(1)	Total
	Thousand acres			lbs per acre		Thousand tons rice		
1975	158	186	344	1 625	640	72.2	36.1	108.3
1980	175	186	361	1 840	640	90.6	36.1	126.7
1985	192	186	378	2 052	640	110.8	36.1	146.9
1990	209	186	395	2 265	640	133.1	36.1	169.2
1990 Alternative I	209	200	409	2 750	800	161.6	48.6	210.2
1990 Alternative II	260	186	446	2 750	800	201.1	48.6	249.7

Note (1) Conversion rates of padi to milled rice equivalent on following basis:

Swamp rice - 63 per cent

Hill rice - 68 per cent

alternative solutions were computed for the 1990 situation, thus:-

Alternative I: assumes there would be a slight increase in the area under hill rice, and yields would increase to 2 750 and 800 pounds for swamp and hill rice respectively. Under these assumptions the country would still not be self-sufficient.

Alternative II: assumes the area of swamp rice would increase by 6 800 acres per annum, and yields increase to the levels proposed for Alternative I. Total production would then possibly meet local demand; the production total would be between the projected total demands given in Table 5.4.

5.43 Rice Production and Consumption in the Agricultural Plan

Estimates of rice production and consumption in the Study Area are necessarily limited by the availability of statistics. However, the situation for the whole of the Fourth Division is somewhat better and the available data on production is summarised in Table 5.6. These figures indicate that production has increased by some 88 per cent over the last decade largely due to expanding areas of swamp rice cultivation and increasing yields.

The Study Area situation was examined for the 1969/70 season because this was the year for which the most reliable statistics were available. Production data for this year are summarised in Table 5.7. Yields are estimated on the basis of the 1969 to 1970 crop cutting survey carried out by the Statistics Department.

TABLE 5.6 ESTIMATED RICE PRODUCTION IN 4TH DIVISION 1960/61 TO 1971/72

Season	Swamp rice			Hill rice			Total		
	Acreage Thous.	Yield lbs/acre	Production '000 tons	Acreage Thous.	Yield lbs/acre	Production '000 tons	Acreage Thous.	Yield lbs/acre	Production '000 tons
1960/61	9.7	772	3.1	31.4	550	7.7	41.1	591	10.9
1961/62	9.8	3 347	14.6	31.6	57	0.8	41.4	833	15.4
1962/63	10.5	470	2.2	32.5	460	6.7	43.0	463	8.9
1963/64	18.5	795	6.6	25.8	650	7.5	44.3	711	14.1
1964/65	23.2	1 163	12.0	24.3	802	8.7	47.5	978	20.7
1965/66	23.1	1 049	10.8	24.2	744	8.0	47.4	893	18.9
1966/67	23.3	1 119	11.6	24.6	803	8.8	47.9	956	20.4
1967/68	22.4	1 253	12.6	25.2	829	9.3	47.6	1 029	21.9
1968/69	23.3	1 310	13.6	26.0	767	8.9	49.3	1 024	22.5
1969/70	23.4	635	7.2	27.3	907	11.1	50.7	804	18.2
1970/71	20.7	957	8.8	27.0	913	11.0	47.7	932	19.9
1971/72	22.2	1 309	13.0	30.1	1 040	14.0	52.3	1 154	27.0

TABLE 5.7 ESTIMATED RICE PRODUCTION IN THE STUDY AREA 1969/70

	Area planted (acres)	Padi Yield ⁺ (lbs per acre)	Total production (tons)	
			Padi	Rice* equivalent
Hill rice	22 000	1 270	12 470	8 480
Swamp rice	16 500	1 620	11 935	7 520
Total	38 500	1 420	24 405	16 000

Note + Yields estimated from the 1969/70 crop cutting survey data for Miri, Bintulu and Baram Districts. Survey gross yield estimate less 10 per cent for losses during harvesting and storage.

* Conversion from Padi to rice equivalent estimated at the following rates:

Hill rice	68 per cent
Swamp rice	63 per cent

Imports into, and exports from, the Study Area during 1970 are thought to have more or less balanced each other. Thus, the overall per capita consumption of rice has been estimated at 310 pounds which agrees closely with the national figure. Assuming this estimate then the future demand in the Study Area would be about 33 600 tons of rice by 1990 or 51 600 tons padi as shown in Table 5.8.

TABLE 5.8 PROJECTED DEMAND FOR RICE IN THE STUDY AREA
1975-1990

Year	Average per capita consumption lbs rice ⁺	Estimated population (thousand)	Total demand (tons)	
			Milled rice equivalent	Padi*
1975	301	118	15 800	24 300
1980	291	170	21 900	33 700
1985	283	217	27 300	42 100
1990	275	275	33 600	51 600

Note + Estimated assuming three per cent per annum income growth rate and income elasticity of demand of - 0.2.

* Padi/rice conversion estimated at 65 per cent.

If the yields from existing areas remain at their present levels and there is no increase in the area under hill rice the increase in consumption might be supplied from 37 600 acres of wet rice at current yields or 22 000 acres at increased yields (2 750 pounds per acre). If yields on existing wet rice areas also increase to the higher level about 15 000 acres of new rice land would be required to supply the total demand of the Study Area.

5.44 Prices

The average cif price of imported whole milled rice over the last six years has been about \$470 per ton which at a 67 per cent conversion rate is equivalent to \$317 per ton of padi. Recently rice export prices have hardened considerably due to crop failures and world shortages, however, for the long term, the above price appears reasonable for evaluation purposes in this Study (see Chapter 8). The price also is in agreement with the view expressed in the FAO Commodity Review for 1969 namely that the introduction of new high yielding varieties will cause considerable improvement in the rice supply/demand situation particularly in importing countries. A factor that has tended to cause fluctuating prices is that only a very small proportion of rice production enters world trade - about 6.5 mn tons out of 284 mn tons.

The present Sarawak Government support price is \$16 per picul (\$269 per ton) for padi, but the little surplus padi entering the local market seldom sells at this price. Marketing chain surveys undertaken in the Study Area during 1973 indicated a seasonal variation with lowest prices of around \$17 per picul being paid during the harvesting period. Later in the year the price increases to about \$24 and \$30 per picul. In 1973 the price for hill grown padi rose to about \$33 per picul, but this is exceptional and the current average over the year

is about \$19 per picul. Slightly higher prices are paid for hill grown padi reflecting its higher milling recovery rate and also enhanced palatability compared to swamp grown padi.

55 DOUBLE CROPPING OF RICE

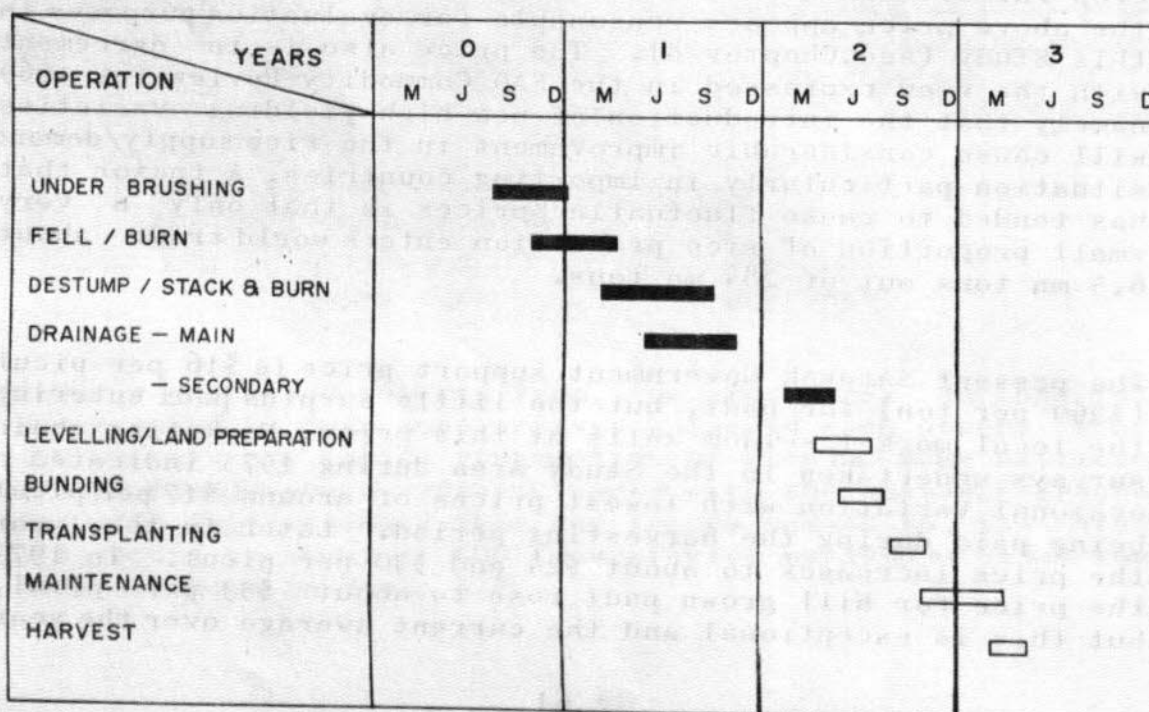
Although experiments on double cropping of rice have been conducted in Sarawak for several years there is very little actual double cropping currently taking place. However, in Sabah, under rather similar climatic conditions to those found in the Study Area, double cropping has been successfully carried out on an ever increasing scale for about five years. In 1973 there were roughly 17 000 acres double cropped under the guidance and assistance of the Sabah Padi Board. Essential features of their success are:-

- (a) irrigation, drainage, land levelling and flood control, a combination necessary to ensure timely land preparation and planting of successive crops. Also irrigation is necessary to ensure success of the off-season rice crop.
- (b) mechanised land preparation; over 95 per cent of the double cropped area has the land mechanically prepared. Conventional tractors operating rotovators are used.
- (c) land preparation is in blocks to facilitate mechanisation as well as irrigation and drainage control.
- (d) all other cultural operations are done by hand. Hand harvesting in particular is important because by tradition the farmers are used to harvesting and drying their grain under the local conditions which can be wet during the harvest period. Any attempt to mechanise harvesting will have to be accompanied by artificial drying aids.

SMALL HOLDER RICE DEVELOPMENT

FIGURE 5.1

1. Development Programme



Contractor Operations/SLDB █

ADU/Farmer Operations □

Operation	Assumption	Remarks
LAND DEVELOPMENT	On public sector schemes would be done by the SLDB. Complete clearing of logged forest, all logs and stumps removed. Drainage and flood protection works undertaken as well as irrigation where practicable and the land levelled.	This type of development is not done in Sarawak at present but it is common in Sabah.
LAND PREPARATION Land cultivation and pre-cultivation weed control	Would be undertaken mechanically before planting both the rice crop and the off-season dry-land crop. Units used would be either:- a) Conventional tractor with cage-wheel extensions and heavy duty rotator; two passes necessary if no off-season crop is planted otherwise only one pass for each preparation. Rate of operation one hour per acre per pass. b) Power tiller; a hand slashing, or an application of herbicides would be used to control weed growth or rice stubble before cultivation. Where only single cropping of rice is undertaken a single knapsack application of Gramoxone at 1.75 to 2.8 pints per acre before land preparation is assumed. In the case of double cropping where a dry land crop follows rice a similar application to the rice stubble would be given but no application following the dry land crop. The number of passes the same as for the conventional tractor. The rate of operation eight hours per acre per pass.	Pre-cultivation of weed growth is necessary because the power tillers are not able to handle tall, vegetative growth.
Fertiliser	Applied by hand, 30 pounds Nitro + 12 pounds P ₂ O ₅ per acre (120 pounds Nitro 26 + 25 pounds triple super-phosphate).	This is the only fertiliser applied to the field. Experiments have shown that an additional top dressing of nitrogen does not significantly increase yields (Department of Agriculture, 1970).
Relevelling of land and bund making	Would be done by hand immediately after land preparation. Labour required, three man days per acre.	
NURSERY Land preparation	Would be done by hand about one month before land preparation on the main fields. 150 square yards of nursery required for every acre of field to be planted. Labour required; three man days to prepare a nursery sufficient for an acre of field planting, plus a further three days (spread over one month) for nursery maintenance.	The preparation of nurseries is normal current practice among swamp rice cultivators.
Fertiliser	Six pounds of ammophos per 150 square yards.	A Department of Agriculture recommendation.
Seed	Would be supplied by the Agricultural Development Unit on credit or a one for one recovery basis. Selected short or medium term, high yielding varieties would be used. Seed would be centrally stored and treated with a mercury seed dressing (Agrosan 5). 12 ounces per 1 000 pounds of seed. Seed requirement, 20 pounds per acre.	At present farmers select and keep their own seed. No seed dressing is currently used. It is required as a precaution against Blast disease (<i>Piricularia oryzae</i>) and brown spot disease (<i>Helminthosporium oryzae</i>).
TRANSPLANTING	Would be done by hand, as soon after land preparation as possible. Labour requirement eight man days per acre.	This is normal practice.
WEED CONTROL	Herbicide spray would be used three to four weeks after transplanting. One pass using a knapsack sprayer applying MCPA at the rate of three pints per acre. Labour requirement 0.5 man day per acre. Hand weeding of resistant weeds; two after spraying. Labour requirement, three man days per acre.	Department of Agriculture recommendations.
PEST CONTROL	Pesticides would be applied as required by knapsack sprayer. Assumed two passes applying Agrocide 26 dispersible powder at rate of one pound per acre. Labour requirement, 0.5 man day per acre pass.	
BIRD SCARING	One person per five acres for one month.	Will be necessary in most areas. Can be undertaken by children and women.
HARVESTING THRESHING	Would be done by hand, each holding harvested separately. Two possible methods:- a) collecting heads only, threshing by human trampling, drying in the sun in individual homesteads. Labour requirements: 16 man days per acre.	This is the traditional method and is well adapted to local conditions where rain can occur during the harvest period.
DRYING	b) using a sickle to cut a good length of straw with the head, threshing by foot or motor driven thresher, drying in the sun in individual homesteads. Labour requirement: eight man days per acre.	This method is very uncommon at present in Sarawak.
STORAGE AND MARKETING	Each family would continue to store in the traditional manner the quantity required for their own use. The remainder would be sold through the ADU which would supply the bags and provide the transport, storage and if necessary marketing facilities.	
TIMING AND OPERATIONS	These are shown diagrammatically in Figure 5.1.	

5.7 INVESTIGATIONS

The rice double cropping investigations at Paya Selanyau are meeting with success in that the local farmers surrounding the Research Station have already started adopting the techniques. Clearly this research work should continue as should the variety and fertiliser trials.

Additional work should now be started, both at Paya Selanyau and Kabuloh, to investigate the possibilities and techniques required for the growing of short-term off-season crops such as maize (for the production of green cobs), soya beans, groundnuts, green beans and many other vegetables.

Aspects of hill rice cultivation which should be investigated are the planting of an improved variety, together with fertiliser applications, to provide food as well as acting as a nurse crop in;

- (a) the first years of establishment of permanent tree crops;
- (b) establishment and renovation of pastures.

Such techniques would be particularly important in the work connected with road-based improvement schemes in Native Customary Land and, later, on those holdings where beef growing out and fattening is undertaken. The work should be done at Kabuloh and at the Livestock Production and Animal Husbandry Training Centre. (See Part III)

CHAPTER 6

PEPPER

6.1 INTRODUCTION

Pepper in Sarawak is of major importance. In 1972, for example roughly 25 500 tons of pepper were exported at a total value of about \$58 mn. Virtually the entire crop is grown by small-holder farmers who in the past have been mainly Chinese, but recently an increasing number of native peoples have planted up gardens in many parts of the country. Due to the widely dispersed nature of the pepper holdings there are few reliable data on recent plantings, and it appears that much of the information contained in the 1965 survey (Leonard 1965) is now of little more than historical significance.

Research programmes undertaken by the Department of Agriculture and farmer expertise, appear to have kept abreast of most technical problems facing the industry although measures to control foot rot are still in their infancy.

At present Sarawak pepper is mainly sold through brokers and agents in Singapore who provide credit, storage, clearing and packing facilities as well as contact with overseas buyers. Marketing channels are, however, currently under review and a Pepper Marketing Board aimed at promoting direct sales to consuming countries and securing a larger share of the world market for the Malaysian product was established in 1973.

Market studies indicate that demand for pepper is very inelastic (FAO 1970), thus prices respond to any change in the supply situation and wide fluctuations have tended to occur in the past. International measures to devise a buffer-stock operation to reduce price fluctuations are currently being examined but little progress has been made so far towards establishing a system in the face of recent upward price trends.

On the demand side most pepper is consumed in its raw state and in the producing countries little progress has so far been made in discovering new uses or developing processing facilities. However, in the world market there is a considerable increase in the use of flavourings and oleoresins derived from black pepper. Generally the market is tending to favour more pungent types of pepper. Thus the suitability of local pepper for these uses may have an important bearing on its penetration of the market in future. Some very preliminary investigations into oleoresin extractions from berries of different stages of development (conducted during the Study in conjunction with Botanicus Limited, Singapore) indicated that the piperin content per weight of dried berry was highest when the berries were unripe.

During the period 1968-1970 Sarawak, on average, accounted for about 29 per cent of the world export market which is projected to grow at about two per cent per annum on past performance. Thus assuming that Sarawak were able to capture a larger share of the market, say one per cent of the annual increase, her total share of the market by 1990 would be 36 per cent. The quantitative implications of this and a less optimistic projection are shown in Table 6.1.

TABLE 6.1 WORLD PEPPER PRODUCTION 1961-1968
(Thousand tons)

Country	1961-63 Average	1964-66 Average	1967	1968
India	27.7	32.7	35.0	34.0
Indonesia	42.3	46.5	49.0	40.0
Malaysia	8.4	15.1	20.5	24.2
Sri Lanka	8.2	9.8	11.1	11.4
Khmer Republic	1.3	1.5	2.5	2.5
Other Asia	1.4	1.6	2.4	2.4
Brazil	5.0	8.4	10.3	9.9
Other America	0.1	0.4	0.4	0.4
Malagasy Republic	1.3	1.9	2.8	2.9
Other Africa	0.6	1.0	1.7	1.7
Total	96.3	118.9	135.7	129.4

Source: FAO 1969.

In the agricultural plan pepper has been included as an important supplementary crop grown by most farmers in the intensive development areas but generally on a small scale on each holding. Large individual plots of pepper have not been included in the cropping pattern because the labour requirements and establishment costs of the crop are very high and although it is often very profitable there is a considerable element of risk, diseases and pests can seriously reduce yields and root rot can rapidly wipe out a garden. Constant vigilance is necessary.

62 THE MARKET FOR PEPPER

Pepper is one of some 40 products which, in various forms, have condiment or flavouring properties and are known as spices. In terms of quantity and value it is one of the major trade commodities in the group.

A feature of pepper production and trade is that it is produced in a limited number of countries from which it is exported throughout the world. Variations in supply tend to

cause fluctuating prices and contribute to competition between various exporting countries. This situation has led to proposals for international study groups and the establishment of communities involving groups of producing countries.

6.2.1 Review of Production and Trade

World pepper production fluctuates from year to year due mainly to varying climatic conditions and disease factors. Statistics of production are generally incomplete but the available data is summarised in Table 6.1 in which the producing countries are listed in order of the magnitude of their production. The table shows that annual world production is currently about 130 000 tons.

Export trade generally follows production trends but there is a re-ordering of countries contributing to exports compared to production. Exports from the major producing countries are shown in Table 6.2. World exports are currently estimated at 80 to 85 thousand tons per annum having dropped from the peak of over 90 thousand achieved in 1967 and 1968. The main exporting countries are, Malaysia (mainly Sarawak), Indonesia, India and Brazil with Sarawak contributing over 30 per cent in 1971. Brazil has recently increased its share of the market while both Indonesia and India exports have tended to decline.

The main importing countries are the United States, USSR, West Germany, France, United Kingdom, Italy, Canada, Morocco and Japan which account in all for about 75 per cent of the total.

Virtually all pepper is traded as peppercorns, either white or black, and further processing, mainly grinding and oleoresin extraction, is carried out in the importing countries. The pattern of final use varies from one country to another, but generally domestic house-holders and food industries account for about 80 per cent of consumption.

TABLE 6.2 PEPPER EXPORTS FROM MAJOR PRODUCING COUNTRIES
(Thousand tons)

Country	Average 1960-64	1965	1966	1967	1968	1969	1970	1971
India	19.0	22.3	24.5	20.5	24.4	17.1	19.4	16.6
Indonesia	24.6	12.2	20.7	36.7	27.5	15.0	2.4	23.2
Malaysia	10.0	17.6	13.1	19.5	22.8	28.6	24.0	26.5
Brazil	2.8	7.3	6.3	9.5	9.6	14.3	8.9	17.1
Malagasy Republic	1.2	1.5	1.1	1.4	3.0	3.4	2.1	1.3
Khmer Republic	1.0	1.8	1.5	1.7	1.6	1.7	0.9	0.9
Sri Lanka	0.3	0.7	0.3	0.1	0.8	0.9	0.5	0.5
Total	58.9	63.4	67.5	89.4	89.7	81.0	58.2	86.1

Source: WDA 1973.

6.2.2 Prices

The pattern of pepper prices generally follows that of supply - as shown in Table 6.3. Prices have declined from the very high levels reached in the early 1950's and during the last decade have fluctuated between 30 and 60 US cents per pound averaging around 40 cents per pound on the US market. The London prices have similarly ranged around the £350 to £450 per ton mark.

International measures to reduce price fluctuation are currently being examined but have made little progress in the face of recent upward price movements.

TABLE 6.3 AVERAGE PEPPER PRICES ON MAJOR MARKETS

Centre	Unit	Average 1961-63	Average 1964-66	1967	1968	1969	1970	1971
<u>Singapore</u>								
Muntok White	\$ per picul	171	178	145	120	152	N.A	N.A
<u>London</u>								
Sarawak White	£ per ton	351	364	323	316	402	N.A	N.A
<u>New York</u>								
Lamong Black	US cents per lb	39	43	38	38	46	57	50

N.A = not available.

6.2.3 The Future Prospects for Pepper

World demand for pepper is estimated to be growing at between 1.5 and two per cent per annum. A large proportion of this increase is likely to be accounted for by increased applications in industrial uses related to food processing and catering requirements. This trend is largely due to the demand for "convenience" foods many of which are highly spiced. A considerable increase in the use of flavourings and oleoresins derived from black pepper is likely. Thus demand is likely to favour the more pungent varieties with high pepperin contents.

Based on the average level of consumption during 1968 to 1970 the future world demand for pepper, assuming a two per cent growth rate, would be as follows:-

<u>Year</u>	<u>Thousand tons</u>
1975	93.8
1980	103.6
1985	114.4
1990	126.3

6.2.4 The Future Position of Sarawak Pepper

Sarawak production and exports, as shown in Table 6.4 have been increasing over the past decade mainly due to increased plantings. A record level was reached in 1969 when over 28 600 tons were produced and shipped from the country. Export values have similarly increased and generally higher prices, have resulted in export earnings continuing to rise year by year even when quantities were smaller.

The actual acreage under pepper is not known accurately because holdings are generally small and widely scattered. Estimates derived from a survey carried out by the Department of Agriculture in 1965 indicated that some 17 000 acres were planted in 1970 and since then new plantings have been undertaken at the rate of 1 000 acres per annum. Thus the current acreage may be between 18 000 and 20 000 acres.

TABLE 6.4 EXPORTS OF PEPPER FROM SARAWAK 1962-1972
(Value in \$ '000)

Year	WHITE		BLACK	
	Tons	Value	Tons	Value
1962	7 082	16 100	4 496	7 787
1963	8 326	17 664	3 115	4 726
1964	7 732	16 288	4 382	7 376
1965	7 119	19 193	10 495	22 539
1966	7 094	20 422	5 960	12 574
1967	10 777	22 488	8 724	12 980
1968	10 826	19 089	11 978	15 575
1969	11 879	27 604	16 753	25 283
1970	9 230	25 102	14 791	31 103
1971	8 829	24 634	17 660	38 173
1972	10 094	28 790	15 671	29 288

Source: Annual Reports Department of Statistics, Sarawak.

Over the period 1968 to 1970 Sarawak, on average, accounted for 29 per cent of world exports and it is of interest to examine the potential growth in this market on the basis of world consumption. The world demand for pepper was projected in Section 6.2.3 on the basis of a two per cent growth rate. In Table 6.5 Sarawak's possible share of this market is shown on the basis of two assumptions; either retaining a constant share, or assuming that a larger share of the total market were captured, say one per cent of the annual increase. The lower set of figures imply a 50 per cent increase in production while the more optimistic figure results in 86 per cent increase accounting for 36 per cent of estimated world trade by 1990.

The proportion of green berry production made into white and black pepper is largely a function of price. Estimation of

TABLE 6.5 SARAWAK'S POSSIBLE SHARE OF THE WORLD PEPPER MARKET 1970-1990

Year	World demand assuming a two per cent annual increase	Sarawak Exports			
		Assuming constant share		Assuming share increases	
		Thousand tons	% of world	Thousand tons	% of world
1970	85.0	24.5	29	24.5	29
1975	93.8	27.2	29	27.6	29.5
1980	103.6	30.0	29	32.0	31
1985	114.4	33.2	29	37.9	33
1990	126.3	36.6	29	45.7	36

future prices is difficult in the light of the rather wide variations that may occur, but for the cost and return analysis presented in Chapter 8 the 1964 average prices have been used.

\$125 per picul for white pepper and
\$100 per picul for black pepper

63 THE ASSUMED AGRONOMIC ASPECTS ASSOCIATED WITH PEPPER IN THE AGRICULTURAL PLAN

Operation	Assumption	Remarks
Land selection	Only land assessed as suitable for pepper would developed. The slope would be range 0 to 25 degrees, soil depth more than 24 inches; land well drained.	
Land preparation	<p>After felling, stacking and reburning of primary or secondary jungle all logs and stumps would be burned or removed by hand. Labour 20 man days per acre.</p> <p>On slopes steeper than 12 degrees terraces approximately 3 feet wide and 10 feet apart would be constructed by hand and a legume cover would be established between the vines immediately after construction of the terraces. Labour, 50 feet of terrace per day equals 90 man days per acre.</p> <p>On slopes of less than 12 degrees intercropping with groundnuts, soya bean, chillies etc., could be done during the first two years. Storm-water contour ditches, three feet by two feet every 30 feet constructed on slopes seven to 12 degrees. Labour, 40 yards of ditch per day equals 12 man days per acre.</p> <p>On slopes of less than seven degrees inter-cropping as above. Drainage ditches, three feet by two feet constructed for control of ground water-table. Labour, 12 man days per acre.</p>	<p>This is not normal practice but the legumes could help over come 'back affect' of terracing and help control erosion. There is no long term experimental data concerning the effect of cover crops on pepper yield, but field observations indicate that severe erosion takes place under clean cultivation as practiced at present.</p> <p>Interplanting is common practice among the Chinese but construction of ditches for soil conservation is not practiced.</p> <p>This is a Department of Agriculture recommendation.</p>
Nursery	Cuttings, selected from disease free vines one to two years old, planted out in nursery beds under shade until well rooted.	This is common practice though sometimes unrooted cuttings are planted directly into the field.
Planting out	<p>The planting distances would vary with slopes:- 0 to 12 degrees eight feet by eight feet equals 680 vines per acre; 12 to 25 degrees eight feet apart on terraces 10 feet apart equals 550 vines per acre; 615 vines per acre have been assumed for calculations; Erecting posts (12 feet long, three feet buried in the ground) 25 points per day equals 24 man days per acre.</p> <p>Mound making, planting cuttings and erecting temporary shade (grass or bracken). Labour, 40 points per day equals 15 man days per acre.</p>	

Operation	Assumption	Remarks																																				
Pruning and training	<p>Vines would be pruned three times in first 20 to 24 months to encourage branching and suitable growth habit.</p> <p>Pruned at three feet, six feet and nine feet heights. Flowers would be removed during this period to prevent early fruiting.</p> <p>Labour, 200 vines per day equals three man days per pound per acre equals nine man days per acre in the first year.</p> <p>Thereafter annual pruning would be done to remove excess top and side growth and remove old leaves on the main stem. Labour, 100 vines per day equals six man days per acre per year.</p>																																					
Weeding	<p>Eight rounds per year. Labour, 120 vines per day equals five man days per round equals 40 man days per acre per year.</p>	<p>Weeding would consist of hand control of legume cover on land steeper than 12 degrees, and clean weeding on less steep land.</p>																																				
Re-mounding	<p>Annual replacing of earth on the plant mounds commencing in third year, three to four baskets of earth per vine. Labour, 60 vines per day equals 10 man days per acre per year.</p>																																					
Fertilising	<p>At planting an application of two pounds per vine of Dolomite equals 1 200 pounds per acre. Thereafter three applications per year the quantity varying with age as follows:-</p> <table border="1"> <thead> <tr> <th>Age after planting</th> <th>Fertiliser</th> <th>Quantity per vine per application (ozs)</th> <th>Quantity per acre per year (lbs)</th> </tr> </thead> <tbody> <tr> <td></td> <td>Compound (13% N, 6% P, 18% K, 4% MgO)</td> <td>8</td> <td>900</td> </tr> <tr> <td rowspan="2">First year</td> <td>Frittered trace elements (FTE)</td> <td>0.33</td> <td>38</td> </tr> <tr> <td>Lime</td> <td>5.3</td> <td>600</td> </tr> <tr> <td rowspan="3">Second year</td> <td>Compound (as above)</td> <td>16.0</td> <td>1 800</td> </tr> <tr> <td>FTE</td> <td>0.33</td> <td>38</td> </tr> <tr> <td>Lime</td> <td>5.3</td> <td>600</td> </tr> <tr> <td rowspan="2">Third and subsequent years</td> <td>Compound (as above)</td> <td>24.0</td> <td>2 700</td> </tr> <tr> <td>FTE</td> <td>0.33</td> <td>38</td> </tr> <tr> <td></td> <td>Lime</td> <td>5.3</td> <td>600</td> </tr> </tbody> </table> <p>Labour: 150 vines per day equals two man days per acre per round equals 14 man days per acre per year. This is not heavy work and can be undertaken by women or youths.</p>	Age after planting	Fertiliser	Quantity per vine per application (ozs)	Quantity per acre per year (lbs)		Compound (13% N, 6% P, 18% K, 4% MgO)	8	900	First year	Frittered trace elements (FTE)	0.33	38	Lime	5.3	600	Second year	Compound (as above)	16.0	1 800	FTE	0.33	38	Lime	5.3	600	Third and subsequent years	Compound (as above)	24.0	2 700	FTE	0.33	38		Lime	5.3	600	<p>The quantities are Department of Agriculture recommendations but applied in three doses instead of four to be more in line with practice as undertaken by the local Chinese farmers.</p>
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Pest and disease	<p>Spraying of vines would undertaken when required using knapsack sprayers. Main pests requiring control would be: Pepper Tingid Bug, Green Pepper Bug, Scale insects, Aphids, Tree Hoppers and caterpillars.</p> <p>Three spray rounds a year.</p> <p>Chemicals used; Malathion 50 per cent emulsion at 1.5 fluid ounce in five gallons of water per 30 vines equals 1.5 gallons per acre per round equals 4.5 gallons per year.</p> <p>Or Agroicide 25 dispersable powder at 1.5 ounces in five gallons of water per 30 vines equals two pounds per acre per round equals six pounds per year.</p> <p>Main diseases requiring spray control are Pink Disease and Thread Blight. Two routine prophylactic sprays during October to January.</p> <p>Chemical used; Perenox at one ounce in four gallons of water per 24 vines equals 1.5 pounds per acre per round equals three pounds per acre per year.</p> <p>Labour; 250 vines per day equals 2.5 man days per acre per round equals five man days per acre per year.</p>	<p>Assumptions made from Department of Agriculture.</p>																																				
Harvesting	<p>First harvest would be 30 to 36 months after planting; harvesting period February to June; interval between picking two weeks i.e. two pickings per month. Work could be undertaken by mixed groups of men, women and youths. Men would be needed to handle the picking ladders and pick the crop from the high part of the vines.</p> <p>Labour 1.4 Pikula (185 lbs) green berries per man day. .7 Pikula (60 lbs) dry black berries per man day. .38 Pikula (50 lbs) dry white berries per man day.</p>	<p>This is normal practice among local pepper growers.</p>																																				

Operation	Assumption	Remarks																																																																			
Processing	<p>For making "white pepper", berries would be harvested when one berry per spike turns red.</p> <p>Conversion rate of fresh berries to dry white pepper equals 27 per cent by weight. Picked berries soaked in clean water for seven to 10 days, then washed to remove stalks and skins, soaked again for one to two days, washed again then dried for two to three days.</p> <p>Labour; three man hours per pikul of green berries equals 11 man hours per pikul of dried white pepper.</p> <p>For making "black pepper", berries would be harvested when one berry per spike turns yellow and all berries are full. 24 hours after picking the berries are trampled and sieved to remove dirt and stalks. Conversion rate of fresh berries to dry black pepper equal 33 per cent by weight.</p> <p>Labour; five man hours per pikul of green berries equal 15 man hours per pikul of dried black pepper.</p> <p>Percentage of final pepper product in the whole harvest equals 60 per cent black and 40 per cent white.</p>	<p>From Leonard P., 1965.</p> <p>From Leonard P., 1965.</p>																																																																			
Yields	<p>Yields would vary with the age of the vine.</p> <p style="text-align: center;"><u>Assumed average pepper yields per acre</u></p> <table border="1"> <thead> <tr> <th rowspan="2">Year</th> <th rowspan="2">Average yield assumption at lbs/vines</th> <th rowspan="2">Total per acre green berries (Tons)</th> <th colspan="2">Made pepper</th> </tr> <tr> <th>40% White (Tons)</th> <th>50% Black (Tons)</th> </tr> </thead> <tbody> <tr><td>1</td><td></td><td></td><td></td><td></td></tr> <tr><td>2</td><td></td><td></td><td></td><td></td></tr> <tr><td>3</td><td>17</td><td>4.58</td><td>0.49</td><td>0.90</td></tr> <tr><td>4</td><td>29</td><td>7.48</td><td>0.86</td><td>1.57</td></tr> <tr><td>5</td><td>33</td><td>9.16</td><td>0.98</td><td>1.81</td></tr> <tr><td>6</td><td>33</td><td>9.16</td><td>0.98</td><td>1.81</td></tr> <tr><td>7</td><td>30</td><td>8.15</td><td>0.88</td><td>1.61</td></tr> <tr><td>8</td><td>25</td><td>6.84</td><td>0.73</td><td>1.35</td></tr> <tr><td>9</td><td>22</td><td>5.89</td><td>0.63</td><td>1.16</td></tr> <tr><td>10</td><td>19</td><td>5.29</td><td>0.57</td><td>1.04</td></tr> <tr><td>11</td><td>18</td><td>4.82</td><td>0.52</td><td>0.95</td></tr> <tr><td>12</td><td>17</td><td>4.58</td><td>0.49</td><td>0.90</td></tr> </tbody> </table> <p>Conversion rates from green berries to made pepper:</p> <p>1 kati = 1.333 lbs. black 33 per cent; 1 pikul = 100 katis (133.3 lbs) white 27 per cent. 16.8 pikuls = 1 ton</p>	Year	Average yield assumption at lbs/vines	Total per acre green berries (Tons)	Made pepper		40% White (Tons)	50% Black (Tons)	1					2					3	17	4.58	0.49	0.90	4	29	7.48	0.86	1.57	5	33	9.16	0.98	1.81	6	33	9.16	0.98	1.81	7	30	8.15	0.88	1.61	8	25	6.84	0.73	1.35	9	22	5.89	0.63	1.16	10	19	5.29	0.57	1.04	11	18	4.82	0.52	0.95	12	17	4.58	0.49	0.90	
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64 INVESTIGATIONS

At Semongok Research Station near Kuching considerable re-search work on the control of foot rot and other diseases is already being undertaken. Breeding for resistant varieties is also carried out. This work need not be duplicated in the Study Area but the results of the work should be incorporated into trials at Kabuloh Research Station.

Soil conservation trials are urgently required in connection with the cultivation of pepper. The present practice of clean weeding pepper gardens, often without any terracing at all even on the steepest slopes, obviously leads to severe erosion. Trials to investigate different methods of soil conservation in pepper should be started as soon as possible. The work should include the following treatments:

- (a) clean weeded, no conservation measures;

- (b) clean weeded, terraced;
- (c) terraced with leguminous cover crop (Stylozanthus spp.) on the terrace faces;
- (d) unterraced with leguminous cover crop in bands across the slopes between the pepper rows.

The Pepper Agronomist at Semongok and the Director of the Pepper Marketing Board are both aware of the expanding world market for oleoresins derived from black pepper. They have started some preliminary marketing and agronomic investigations into ways in which Sarawak could more profitably enter this trade. These investigations should be continued. Two particular lines appear promising.

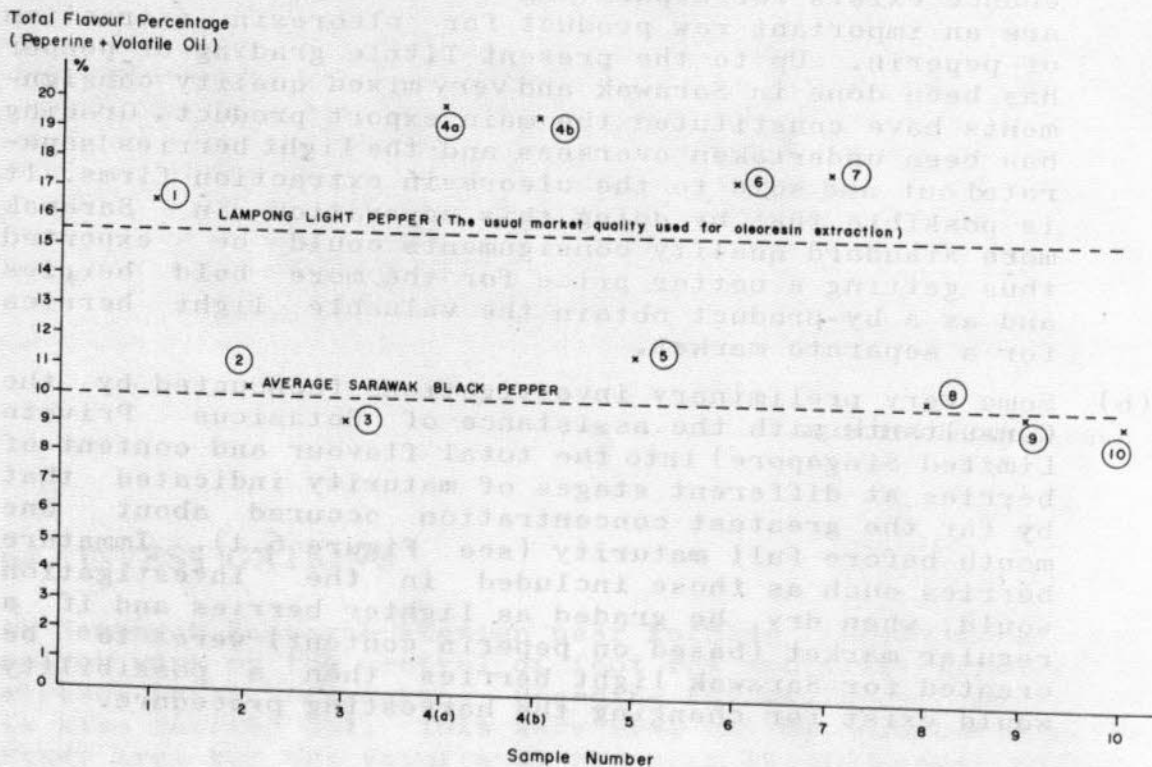
- (a) The Pepper Marketing Board intends to introduce compulsory grading of all pepper. In the grading process the chance exists for separating out the light berries which are an important raw product for oleoresin extraction of peperin. Up to the present little grading of pepper has been done in Sarawak and very mixed quality consignments have constituted the main export product. Grading has been undertaken overseas and the light berries separated out and sold to the oleoresin extraction firms. It is possible that by doing this separation in Sarawak more standard quality consignments could be exported thus getting a better price for the more bold berries and as a by-product obtain the valuable light berries for a separate market.
- (b) Some very preliminary investigations (conducted by the Consultants with the assistance of Botanicus Private Limited Singapore) into the total flavour and content of berries at different stages of maturity indicated that by far the greatest concentration occurred about one month before full maturity (see Figure 6.1). Immature berries such as those included in the investigation would, when dry, be graded as lighter berries and if a regular market (based on peperin content) were to be created for Sarawak light berries then a possibility would exist for changing the harvesting procedure.

The object would be to reduce the number of picking rounds and possibly the number of man days required without reducing significantly the returns from the harvest. Pepper vines do not ripen their berries evenly; on any one vine there is generally a wide maturity range of berries. Thus at present numerous harvesting rounds have to be undertaken selecting each time only the spikes containing mature berries. But if a good market existed for immature berries the harvesting of a pepper garden could be reduced to two or at the most three rounds. At each round all spikes ranging from fully mature to one and a half months immature could be picked. A harvester could be expected to pick a greater weight of berries per day because having moved to a vine there would be more spikes to pick and less selection to do. But only black pepper could be made from such pickings and a very mixed

quality consignment would leave the farm needing to be graded before entering the world market. Nevertheless all grades of black pepper would be in each farm consignment though there would be a higher percentage of light berries than at present, but if their value was based on their piperin content then the total net returns for the harvest could still be very high.

FIGURE 6.1

FLAVOUR CONTENT OF PEPPER SAMPLES FOR OLEORESIN EXTRACTION



CHAPTER 7

OTHER CROPS

7.1 INTRODUCTION

The crops discussed in this chapter are those which generally will grow in the Study Area and for which there are markets, but for one reason or another they cannot be recommended for large scale plantings. However, generally the products of these crops can be produced on a small scale, as subsidiary crops on small-holdings, and then gathered together from the numerous individual producers to make sufficiently large consignments to warrant local processing or to be exported.

Most of them can be produced almost anywhere geographically in the Study Area on small patches of suitable land, very often in the homestead plots of small-holders.

The strategy recommended is to concentrate the production of those crops requiring some processing (ginger, turmeric and essential oils for example) into selected areas while others like coffee, anatto, cashew nuts, cardamon and red peppers could be grown in widely scattered areas. The crops are not expected to make any one particular farmer rich but production from one or two of them could provide a useful addition - sometimes year round - to a family's house keeping money.

7.2 COFFEE

Coffee was one of Malaysia's first commercial crops and there is still considerable local demand for it. Estimates made in Peninsular Malaysia (Federal Agricultural Marketing Authority, 1973) indicate that there is an immediate local market for about 2 500 tons of coffee beans per year. At present this quantity is being imported. The market prospects in Sarawak are not clearly known but local production does not satisfy demand. In 1972 coffee in one form or another worth about \$1.46 mn was imported. Coffee planting is currently included in the Department of Agriculture's subsidy schemes. Two species are planted in Sarawak-robusta and liberica, but only robusta is included in the subsidy schemes. The recent acreages planted in the Study Area have been 77 acres in 1971 and 135 acres in 1972.

Experimental plantings have been established at Semongok since 1967 and although yields have not been high (600 to 700 pounds of fresh berries per acre) the growth and vigour of the trees has been encouraging. Similar results have been observed in trial plantings at Kabuloh where bananas and Gliricidia have been used as shade. Also robusta coffee has been planted by local farmers in scattered small sized plots in many parts of

the Study Area.

Observations of the plots at Kabuloh and of numerous small plots of the local farmers has revealed damage, often severe, by berry borers and sucking insects. These pests could well be the cause of the low yields recorded.

Robusta coffee is recommended for planting on a small-scale in the agricultural plan, aimed first at the Sarawak market but with the possibility of exporting to Peninsular Malaysia in mind. Robusta is not a "fine" coffee and consequently does not gain quality significantly by processes such as pulping and fermenting. Production should aim at dry ripe cherries which could be "husked" at a simple central processing plant.

Research should be undertaken into the control of the berry pests together with fertiliser investigations aimed at increasing yields. For these trials the plantings at Kabuloh should be extended.

7.3 COCONUTS

This crop has been grown in Sarawak for a very long time. In 1959 the Department of Agriculture started a Coconut Planting Scheme which was aimed at assisting people in the coastal regions to establish small-holdings of coconuts as a cash crop. The majority of the plantings have taken place in the low-lying delta lands in the First and Second Divisions. On the whole the scheme has not attained the success that was expected. Low percentage of productive acreage coupled with the low yield per acre, found in a Government survey resulted in the Department lowering the value of the subsidy and directing attention in the future to a more stringent selection of participants, a more intensive extension work on crop husbandry and an improvement in the quality of copra produced. The scheme is active in the Study Area and recent planted acreages were 385 in 1971 and 362 in 1972.

In order to increase the income from the coconut plantings a scheme has been recently started to encourage the inter-planting of cocoa. This appears to be proving successful and is being implemented on a small scale in the Fourth Division: 60 acres of cocoa were planted in coconut plantations south of Bintulu in 1973.

In the proposed agricultural plan for the Study Area no great effort is recommended for the coconut scheme, although coconuts could be planted for household supplies. A market analysis for coconuts, copra and coconut oil in Sarawak indicated that even with the low yields the acreage of coconuts

already planted together with new plantings planned for the Second Malaysia Plan, would produce more than enough for local consumption except for copra cake. A shortage of between 12 000 and 26 000 tons could exist of this product for the manufacture of livestock rations. Much of this deficit though could be supplied by palm kernel cake.

Research should be undertaken (but not necessarily at Kabuloh) into the growing in Sarawak of much higher yielding coconut varieties. When these have been established then further plantings in the Study Area could be profitably undertaken but at the same time a copra marketing organisation should be set up in the Area.

74 ANATTO

The seed of this small tree is covered by a red substance which has a value as a colouring agent in foods and cosmetics. Market demand has risen recently due to increased restrictions in the world on the use of synthetic food colourings.

The tree is a hardy, vigorous grower and is quite common in gardens in Sarawak. A field scale trial at Semongok Experimental Station showed that it can yield well (up to 800 pounds per acre) but under the conditions there the yield declined considerably in the fourth year. From observations in the Study Area the tree appears to do better here than in the First Division though no trials have yet been carried out in the Fourth Division. Several well established trees near Miri, all growing on sandy, terrace soils, have been observed during 1972 and 1973. All the trees have borne heavily and continuously. There has been no indication of the die-back and tree decline as reported from Semongok. One group of trees which grew too tall in a private garden were cut back severely but the trees coppiced and recommenced bearing within nine months. Seedlings planted at Tanjong Lobang commenced bearing in 16 months. A sample of seed collected from trees in Tanjong Lobang was sent to Botanicus Private Ltd., in Singapore for evaluation and was found to be perfectly satisfactory. Price on the market would be about \$1 per pound, giving a producer price of about \$0.75 to \$0.50.

The processing is particularly simple, merely harvesting groups of pods when one pod in the group starts turning from red to brown, opening the pods and drying the seeds in the sun. Protection from rats during drying would be necessary. For the Study Area as a whole a reliable, total annual production of about 500 tons of seed would be needed to establish an export industry. At average yields of 500 pounds per acre this would require a total planting of about 2 000 acres or about 600 000 trees. Production on this scale is unlikely to affect world market supplies.

75 CASHEW - NUTS

The export market for cashew products can be divided into three parts - the market for unshelled cashew-nuts, the market for cashew kernels and the market for cashew-nut shell liquid.

The Market for Cashew-nuts

India is the main purchaser of unshelled cashew-nuts: it imports between 150 000 and 200 000 tons of nuts a year to supply its processing factories, which re-export the extracted kernels and cashew-nut shell liquid. This operation is profitable because the processing is carried out by hand by an army of women workers who have developed the requisite skills over time and who represent an economic form of labour.

India imports three-quarters of her unshelled cashew-nut requirements, mainly from East Africa, but the export availability from this area is likely to diminish as an increasingly large proportion of unshelled nuts are diverted into the mechanical extraction plants which have been introduced into East Africa over the last ten years and are being developed on a wide scale. The Indians have planned to increase their domestic production to compensate for the probable decline in imports in the future, but no practical steps have been taken to achieve any significant increase in output. It seems likely that there will be a strong demand from India for unshelled cashew-nuts in the foreseeable future.

Shipments of unshelled nuts into India are invariably made to Cochin. All purchases of imported nuts are made by the Cashew Corporation of India.

A possible further market for unshelled cashew-nuts from Sarawak is Peninsular Malaysia, where cashew-nuts plantations and processing facilities are being established with Government support.

Brazilian processors enter the market for unshelled nuts occasionally, when their domestic crop falls below their processing capacity.

The price of unshelled nuts varies according to quality, but follows the general trend of cashew kernel prices. Prime quality nuts have risen in price between 1968 and 1970.

The Market for Cashew Kernels

The main consuming countries over the last five years have been the USA (taking on average over 50 per cent of world exports of cashew kernels), the USSR 20 per cent, Canada four per cent, the German Democratic Republic three per cent, the

UK three per cent and Australia two per cent. Significant and growing markets in South East Asia are Japan, Hong Kong, Peninsular Malaysia and Singapore.

The market situation for cashew kernels has been extremely favourable over the ten years: both output and prices have followed an upward trend as shown in Table 7.1. The prospects for further growth in demand in North America, Western Europe, Japan and Australia are good.

TABLE 7.1 THE MARKET FOR CASHEW NUTS

Year	Exports of Cashew Kernels ('000 metric tons)	Price of 450's whole kernels (£ per metric ton c and f UK)
1962	51.1	328
1963	54.8	352
1964	60.6	468
1965	56.3	458
1966	58.4	540
1967	62.3	472
1968	79.9	622
1969	81.2	595
1970	74.7	650
1971	74.4	631
		(up to July)

On the production side, it has been contended that the increase in output over the last decade has come from a greater exploitation of existing trees. If this is true, the rate of increase in output from East Africa and India may be rather slower than it was in the early and mid 1960's. Brazil, on the other hand has extended its acreage under cashews considerably and could increase its exports of kernels by 15 000 tons per annum in five years time. The market should be able to absorb this increase and a similar increase from the other producers.

The Market for Cashew Nut Shell Liquid (CNSL)

Over 90 per cent of exports of CNSL go to just three countries; the USA takes about 50 per cent, the UK in excess of 25 per cent and Japan around 15 per cent. A large proportion of the UK's imports are re-exported as refined products and the same may be true for the USA. Apparently the only important use for CNSL in the USA and the UK is as a friction modifying resin for use in brake linings. Demand for CNSL is, therefore, subject to the variations in fortune of the motor manufacturing trade.

In total, demand is insufficient to take up to the full potential output of CNSL. World production is rising as increasing tonnages of cashew nuts are being processed in East Africa

and Brazil by mechanical extraction plants, from which CNSL is an automatic by-product. But demand is expected to grow slowly and subject to brake lining technology.

The CNSL trade will prove difficult for new producers to break into. In a buyer's market, the large consumers are able to insist on strict quality specifications and to pick and choose their suppliers. They require a regular supply of oil consistently up to specification, often in bulk lots of 400 tons or more. Shipments from a new producer represent a quality risk and involve time and expense in testing.

Quite clearly cashew-nuts in Sarawak and the Study Area are an attractive proposition if they can be grown satisfactorily and production is aimed initially at the export of whole nuts.

Scattered trees have been in the country for a long time but none have ever been grown commercially. An experimental planting in the First Division has not been particularly promising. Pest damage to inflorescences and young fruit have been very severe ever since 1968. Harvests have been low, the maximum reaching 159 pounds per acre with an average of 74 pounds. However the growth of the trees has been satisfactory and other trials have been planted at Kabuloh and Lambir Rubber Planting Scheme in the Study Area as well as in other parts of the State. In the two trial plantings in the Study Area, each of about five acres, the trees are growing well but have not yet come into bearing.

Observations on some older trees at Tanjong Lobang and Riam Road areas of Miri indicate that cashew trees can bear heavily under local conditions. It appears that the severe pest damage to inflorescences and young fruits, reported from the trials in the First Division, will not be a limiting factor here.

Further field-scale plantings are recommended. These should be done in conjunction with the Livestock Production and Animal Husbandry Training Centre to investigate the feasibility of combined cashew-nut growing and beef cattle grazing. Plantings should be on several different soil types including the sandy terrace soils. Research into the practical use of these soils is required because they are generally not considered very productive. Usually after they have been opened up they have been subsequently abandoned and grasses and scrub have taken over. Trials of grasses (particularly Ischaemum magnum) and grass/legume mixtures are recommended to investigate their use as cover crops for cashew trees and for subsequent grazing of beef cattle. There are quite large areas of terrace soils identified in the Study Area particularly near the coast so that a mixed farming pattern of cashew-nuts and beef production would be well worth the investigation.

In the meantime the planting of cashew-nut trees should be encouraged among small-holders, a few trees for each family in their homestead plots. Production should be aimed at the export of unprocessed nuts. A total raw nut production of about 650 tons a year is required before it would be worth considering installing a cashew-nut decorticating plant in Sarawak.

76 SUGAR CANE

The vegetative growth of this crop is generally good in Sarawak but there are two factors against its adoption for large-scale planting in the Study Area:-

- (a) the lack of a dry season in which the cane could "ripen" and thus build up its sugar content.
- (b) the generally broken topography of the land together with the year round rainfall would make large-scale harvesting and transportation of cane to the mill very difficult and costly.

Planting of sugar cane in the intensive development areas is not recommended in the agricultural plan except for varieties suitable for chewing. Such planting should be on a very small scale and should be close to the homestead. However, there is a possibility of producing unrefined sugar, by a simple cane crushing and juice evaporating process which could be adapted to local conditions. There appears to be a market for this type of sugar (which would be of a similar quality to that of nipah palm sugar) among the poorer sections of the community and among the inland peoples where the transport costs make the imported refined sugar very expensive.

An important criterion needed for setting up a small industry for producing unrefined sugar is a sufficient concentration of sugar cane in an area where transport of the harvested cane to the crusher, or the crusher to the cane, would be easy. This can only occur along roads or along the larger rivers. Under the conditions in the Study Area it would appear that the most suitable location would be along the Baram River and its tributaries.

On the levees bordering these rivers sugar cane is already a common crop. It is possible that if increased plantings were encouraged a small unrefined sugar industry could be built up in this river system aimed at supplying sugar to the people living in the area and further inland.

The cane production could be in the form of numerous small plantings close to the rivers and the processing could be done on a specially converted trading launch travelling up

and down the rivers. But the entire enterprise requires further investigation and a careful planning of planting and marketing arrangements.

7.7 TAPIOCA

This crop is grown throughout Sarawak and is common in the shifting cultivation lands in the Study Area. It is grown mainly as a subsistence food crop; not much reaches the market and none is exported from the Study Area. Nor is there any local processing of the tubers.

However, there is a local (Sarawak) and export market for dried tapioca chips. But before plantings aimed at these markets can be recommended two major aspects require solving;

- (a) cultural techniques to maintain a steady production, either from arable fields where a rotation with other crops could be undertaken or from fields of permanent crops where tapioca would be interplanted as an early cash crop.
- (b) the harvesting and processing of the tubers into dried chips. The particular questions to which answers are required are whether the chipping should be done by small, mobile machines moving from farm to farm, or in centralised plants. The problems that require solving are;
 - (i) the transport of the fresh tubers to the chipping plant (the tubers are bulky, heavy and contain only about 25 to 30 per cent starch which is the commercial ingredient). Total yields of fresh tubers could be over 10 tons per acre. Thus a formidable farm labour problem is posed if human transportation is envisaged;
 - (ii) the need to wash the tubers before chipping. This could become a limiting factor for on-the-farm processing;
 - (iii) the drying of large quantities of chips; this problem would arise if centralised processing is undertaken. Fungus infection of undried chips can be rapid, and under the local climatic conditions this could pose a serious problem. Artificial drying may become necessary.

Investigations into these aspects could take place at Kabuloh, but until satisfactory answers are found no special plantings of tapioca are recommended. Its planting as a source of individual family food or for a particular pig rearing enterprise, for example, where the tubers would be used fresh should be encouraged.

78 SPICES AND ESSENTIAL OILS

There are several of these crops which will grow well in the Study Area but none of them can be recommended for large-scale plantings. If they are annuals or bi-annuals there is limited land suitable for such farming, and for the perennial crops in this group there is little concrete evidence on their performance or the quality of their product. However, if grown on an individually small-scale by numerous farmers then worth while group enterprises could be created. Some research would be necessary and it would need to cover two aspects:

- (a) the agronomy of the crops and the preparation of the primary product for despatch to the processing unit;
- (b) commercial evaluation of the primary product. The largest and fastest growing outlet for the products from many of these crops is the oleoresin extraction market.

The agronomy aspect could be adequately handled by the Research Scientist at Kabuloh with the help of the specialists at Semongok. However, particular technical know-how is required for the commercial evaluation and it is suggested that an existing institution or firm is contracted to provide this service, for example, Botanicus Private Limited, Singapore. This arrangement would ensure that the primary product is one which the extraction firms want and, at the same time, a market outlet to the particular co-operating firm could be established.

Field-scale plantings are recommended to be undertaken at Kabuloh of lemon grass, citronella grass and patchioli; while at the same station production trials of turmeric, ginger, chillies and vetiver grass should be planted.

Given below are notes on the more promising crops, spices are discussed first. In most cases the aim would be to produce products for sale to the oleoresin extraction industry.

Prepared oleoresins are the residues isolated by evaporation of solvent extracts of plant material, mostly used in flavour work. They can come from almost any spice or herb, but the commercially significant ones tend to be those extracted from the major spices.

Prepared oleoresins are not normally sold to the food industry as an extracted oleoresin, they are sold in the form of dispersed spice extracts i.e. spread on a variety of dry sterile bases; salt, dextrose, flour or rusk. The advantage is that it can be blended easily with other ingredients, whereas the oleoresin is too concentrated for simple blending. The food industry is content to pay premiums for the convenience of having the active ingredient supplied in the form of a dispersed spice extract. The oleoresins compete commercially with the dry spices because in the form of a dispersed

extract it is sold weight equivalent in strength to the dry spice: the advantages are:-

- (a) it avoids the high bacterial load carried by most major spices.
- (b) it is standardised in strength and quality to a greater extent than the dry spices.

Dispersed spice extracts have made, and continue to make, a large impact on the industrial market for spices. In USA they have replaced about 70 per cent of this market, in UK about 50 per cent and in Western Europe about 15 per cent, but the percentage is rising.

The prospective demand for oleoresins is therefore great and oleoresin extraction would appear to be a profitable business for the major spice-producing countries to enter. There is a large freight saving if oleoresins are exported rather than the whole spices. However, apart from the many technical problems involved in the extraction of oleoresins, there is the major problem that the food industries in the consuming countries demand their oleoresins in the form of dispersed spice extracts. If exporting countries were to disperse the oleoresins on a base prior to export the potential freight saving would be lost. The solution is therefore one of attempting to sell the oleoresins to the large essence houses in the consuming countries who can disperse them on a base and supply the food industries. But the large firms also extract their own oleoresins and it is not likely that they will be willing to lose this profitable part of their business. The solution for Sarawak would be to sell the dried spice to a nearby oleoresin extraction firm, in Singapore for example. The distance to Singapore is not great and therefore the freight charges would not be high. An established firm would have the technical know how and the markets. All that would be required of Sarawak would be to produce reasonably large, regular supplies of a standard product.

Turmeric (Curcuma longa)

In 1968 the world consumption of turmeric for oleoresin extraction was 500 tons. The turmeric plant is a perennial herb growing two to three feet high. It is cultivated throughout the tropics mostly as an annual and thrives in a hot moist climate under partial shade. It is propagated by rhizomes and a crop is produced in about nine months from planting. For oleoresin extraction the rhizomes, after washing, can be chipped and then sun dried. Yields can be as high as 3 000 pounds or more per acre.

A sample of turmeric roots prepared in this way at Semongok was sent for evaluation to a firm in Singapore and the quality was found to be comparable to the Indian product which is presently being bought for oleoresin extraction.

Ginger (Zingibes officinale)

The planting of this crop is being encouraged by the Department of Agriculture but so far no great acreage has been

planted. There is a limited local market for undried ginger.

The growing and processing of ginger for the oleoresin market would be the same as for turmeric, merely wash, chip and dry.

Capsicums (sweet and hot chillies)

This group is the most important oleoresin. Paprika - C. annum is valued for its flavour and its red colouring but is not likely to be of great promise in the Study Area because of the difficulty of drying the very fleshy fruits. However the small very hot chilli C. minimum should not present this problem. The drying of locally collected samples presented no problem, but evaluation for capsaicim content proved that the local variety is lacking in this ingredient and is not of commercial value.

Trials at Kabuloh are recommended to introduce a sufficiently "hot" variety. Seed of a commercial variety was obtained and passed to the Department of Agriculture in the Fourth Division. Other seed samples could be obtained from processing firms.

Nutmeg and Mace (Myristica fragrans)

Nutmeg is the seed of this tree crop and mace the covering which surrounds the shell containing the nutmeg. There is a limited market for these products.

Indications from trees growing at Semongok Research Station suggest that the trees can be grown and will bear successfully in Sarawak. The trees are dioecious (i.e. there are male and female trees) so that planting of isolated trees should not be encouraged but rather a concentration of trees in a selected village, for example. This would also be advantageous because the nuts require drying in so called smoke lofts where the temperature should not exceed 45 degrees Centigrade (higher temperatures melt the fat in the seed). The seeds cannot usually be dried in the sun. Trees start bearing eight to nine years after planting, bearing only a few fruit at first but increasing until about 30 years old when they average about 3 000 to 4 000 nuts per tree. The nuts are likely to become insect damaged if they are not gathered daily when ripe.

It is recommended that one or two of the new villages planned in the Regional Plan should be selected and nutmeg tree planting encouraged in the homestead plots.

Cloves (Eugenia caryophyllata)

There is a reasonable market for this crop in the world trade, but an interesting possibility would be to supply Indonesia. Although this country grows cloves itself the oil content is too high for inclusion in the cigarettes that are so popular

there. Indonesia imports large quantities of cloves from Zanzibar for the cigarettes. Cloves of the correct variety grown in Sarawak would be in a good geographical position to supply that market.

The fact that the crop grows well in Indonesia and in Sri Lanka suggests that it could be grown in Sarawak. A tree at Semongok is bearing well though others at Tarat, not far away, are stunted and appear to have been planted in an unfavourable site.

Trial plantings at Kabuloh on different soils and aspects are recommended. If growth is good then clove trees should be included in the planting material provided by the Department of Agriculture under the Diversification of Agriculture subsidy scheme. (See Part III)

Cardamom (Ellettaria cardamomum)

A herbaceous perennial with large, leafy basal shoots eight to 12 feet long and strong creeping rhizomes. A native of the wet tropical forests of Sri Lanka and South India.

In a recent trial planting at Tarat near Kuching the plants have grown well and flowering started in the second year, though the fruit set was poor.

This spice crop has several attractive aspects as the Study Area is concerned; it is a perennial and can be planted into partially cleared forest (it requires light shade); it can be propagated by division of rhizomes (or by seed); the plants, which would require some fertilising, grow into thick clumps and once well established would require very little weeding; although full bearing commences in the fourth year a small crop could be obtained in the second year; the harvest consists of the ovoid fruit capsules which are gathered before they are fully ripe and are dried and marketed in that form. The capsules contain numerous, small, brown, angular seeds which are the spice and have a powerful aromatic odour and flavour. Average yields of about 100 to 250 pounds per acre per year could be expected (plants spaced nine by 12 feet). 1973 prices for sundried capsules were around \$5 per pound.

The possibilities of planting this crop in thinned out secondary growth on shifting cultivation lands is obvious. It is recommended that trials are started at Kabuloh with the object of it being grown as a cash crop for the shifting cultivators.

Essential Oil Crops

As a group the processing requirements, either drying or distilling, of these crops necessitates that they should be grown

in reasonably concentrated areas.

Patchouli Oil (Pogostemon cablin)

There is a ready market in Singapore for the dried leaves and young stems of this herbaceous shrub. The harvested material requires merely drying and bailing.

Trial plantings at Kabuloh have shown good growth and easy propagation though attacks by eel worm and a rotting of the collar region indicates that further trials are needed before the crop is recommended for planting by farmers.

Citronella Oil (Cymbopogon nardus) and Lemon grass oil (C. citratus)

Both these grasses have grown and yielded well at Kabuloh. Oil samples sent to the Tropical Products Institute showed that commercial qualities can be produced. However, before farmers are encouraged to undertake plantings of these grasses it is recommended that distillation trials, using simple equipment are conducted at Kabuloh or Semongok to ensure that this process can be successfully accomplished on a production scale in a village, for example. Designs of simple distillation plants that could be made locally are available from the Tropical Products Institute, London.

Other essential oil crop and perfume which justify similar trials are:- Vetiver grass (Vetiveria zizanioides) and conanga (Conanga odorata). Plantings of these at Tarat have grown well and oil samples tested have proved of commercial value.

7.9 FRUITS

Many tropical fruits are already grown in the Study Area and when in season there is an abundant supply both in the rural areas and in the towns. This is particularly true of durian and rambutan which have been exported to Brunei until recently when such trade was stopped. Bananas too are plentiful though not all are of the high quality varieties such as Keling and Embun. Mangoes are generally from seedlings trees and very variable in quality though there are several gardens of budded trees. Pineapples are mainly of the large "Malaysian" and smooth cayenne type, often of excellent table quality. Similarly papaya are generally well flavoured.

The Department of Agriculture in its Diversification of Agriculture subsidy scheme encourages the planting of most fruits by the issue of packages of 30 trees to each participant in the scheme. This is an excellent programme and should be

continued. The aim should be to maintain fruit as a common and plentiful commodity among all the inhabitants of the Area. Particular efforts should be made to increase plantings close to Miri and Bintulu to supply the demand expected from the increasing population in these towns and the victualling of ships. Such concentrations of fruit could lead to the eventual establishment of canning or processing plants in these areas. Thus it will be important to encourage the planting of good varieties and to organise a marketing system.

One fruit which appears at present to be absent from the Study Area is the mangosteen. It is recommended that this is introduced.

7.10 ILLIPE NUTS

Illipe nuts are collected from the Dipterocarp forests of Sarawak solely for export, the total value varying from one year to the next. For instance between 1963 and 1972 exports were recorded only in 1968 and 1970 and the respective values were about \$12 700 and \$17 200. Being a jungle product, it does not entail any production cost at all. The tree species, apart from producing illipe nuts, also yield timbers like red meranti and dark red meranti.

Fats obtained from illipe nuts are manufactured into edible butter fat, an ingredient in chocolate making. It is also of importance in other foods because of its good spreadability characteristics. The residue, after the extraction of oil, is an ingredient in the manufacture of compound animal feeds.

Collection of illipe nuts is as sporadic as the fruiting of these forest trees. Though an increase in price which is linked to the price of cocoa will stimulate collection.

Illipe nuts from Sarawak have a bad reputation overseas because of their high percentage of deteriorated nuts due to high moisture contents which results in substantial conversion of oil into free fatty acids. Also insect infestation together with high moisture content causes phytosanitary hazards during shipping.

Illipe nuts are a valuable product and worth efforts to increase its importance to the Sarawak economy. There are two lines of approach to achieve this both of which should be followed.

- (a) improvement in the quality of the natural product. This should take the form of encouraging better drying; and export of a cleaner product. Subsidies to establish

drying kilns in certain centres would help and sampling for quality standards at the point of export. This should not be difficult because there are only a few exporters and all are either in Sibuluan or Kuching. Seven per cent moisture content should be aimed at;

- (b) investigations into the commercial planting possibilities of selected species. There is information (already passed to the Conservator of Forests, Kuching) that at Haverbentes, Java, Indonesia a plantation of a particular strain of illipe nut (Shorea stenoptera Burck in this case) has been under observation for several years. It is claimed to come into regular bearing in about three years. The plantations are said to cover about 1 000 acres. Seed from this strain or from local selections should be planted in trial plots possibly as part of the Forest Department's investigations into reforestation recommended in Supporting Report 3.

CHAPTER 8

COSTS AND RETURNS OF SELECTED AGRICULTURAL ACTIVITIES

8.1 INTRODUCTION

Detailed costs and returns and labour input requirements have been worked out for the main crops identified for inclusion in the agricultural plans for the Study Area. These costs and returns which are discussed in this Chapter have been used for the economic and financial analysis of the agricultural development recommended for implementation during the Action Programme period (1975 to 1980) as well as for farm budget studies. Detailed costs and returns and labour input requirements have been worked out for the main crops identified for inclusion in the agricultural plans for the Study Area.

The basis for the costings have been the physical inputs including labour indicated in the agronomic sections of the previous chapters at prices which prevailed in Sarawak during 1972 adjusted to relate to the Study Area. Wherever possible local records and case studies were used as a basis for these estimates but in some instances it was necessary to calculate them on the empirical basis.

As is usual in studies of this nature a constant prices assumption has been used in the estimates although it was realised that even during the course of the Study there were significant price developments for many materials, as well as supply situations, which affected the availability of many items. The most important item affected by these trends was fertilisers due to hardening prices and shortage of basic raw materials.

8.2 BASIS OF ESTIMATING THE COSTS AND RETURNS

8.2.1 Initial Development and Maintenance

For economic evaluation and comparison of the activities it was important that costs were established for the basic resources involved in production both from the overall economic and the management point of view. To satisfy these needs the costs have been divided into several categories thus:-

On-farm costs covering land development and crop production expenses;

Ex-farm costs covering loading and transport, distribution and processing.

The costs of production of tree crops established under road based schemes in Native Customary Land have been estimated on the basis of the following changes made to the public sector scheme costs:

- (a) land clearing reduced to account for clearing secondary jungle compared to logged mature jungle;
- (b) road development costs excluded; the road either already exists or would be constructed for purposes other than agriculture.
- (c) production materials costs were reduced by 10 per cent because it has been assumed that generally a lower standard of crop husbandry would be achieved on the road based schemes resulting in yields 15 per cent below those which would prevail on the public sector schemes or private investor undertakings.
- (d) processing costs were reduced by 15 per cent to account for the lower yields.

8.2.2 Crop Replanting Costs

The costs of replanting oil palms, rubber and cocoa have been estimated assuming that the same crops would be replanted at the end of the initial productive cycle. The same basis of calculation has been used as for initial establishment costs but labour and management costs have been included in the land development and production costs.

8.2.3 Labour Requirements

The labour inputs of each crop have been assessed on an annual basis according to the major operations performed in that year. The unit used has been a man day or its equivalent which is the work performed by an adult worker during a normal working day of about eight hours. Labour inputs for a crop on a public sector scheme and on a road based scheme have been assumed to be the same.

8.2.4 Management Costs

Management staff with suitable qualifications and experience would be essential to the successful development of the tree crop activities dealt with here. Costs of estate type management as provided on SLDB or private sector schemes are covered in this chapter but details of ADU management and costs are given in Part III.

8.2.5 Returns

The gross returns attributed to each crop have been estimated on the basis of the yield of the crop and the fob prices

projected for the crop in that year. For the farm budgets a common starting year has been assumed for all activities, other analyses have been related to the specific year of operation.

8.3 OIL PALMS

A great deal of information is available on the costs of oil palm production in Peninsular Malaysia from previous work including the Jengka Triangle, Johore Tenggara and Pahang Tenggara studies, as well as from published material mainly emanating from the Incorporated Society of Planters (ISP). This material has been drawn on and supplemented by local information obtained with the assistance of the SLDB and management in the Study Area.

8.3.1 Costs

The costs of production for the public sector, private investor and road-based situations are summarised in Tables 8.1 and 8.2. Further details of operation costings are given in Appendix I. The costings have been generally based on the assumption that skilled management would be available to supervise or advise on husbandry and production techniques which would generally follow the pattern of successful estate management practices for the crops established in Peninsular Malaysia.

On-Farm Costs

Under land development provision has been made for land clearing to oil palm standards (see Chapter 2) drainage and stream clearing to ensure freedom from flooding and road construction allowing 1.3 chains road length per acre of palms planted.

Production costs have included cover crops, platforming, planting, fertilising, weeding, pest and disease control, rodent protection, pollination, harvesting tools, small tools and leaf analysis to assess fertiliser input requirements.

Ex-Farm Costs

Loading and transport costs of ffb have been estimated at \$3.00 per ton on the basis of an average of 10.3 mile distance to the factory and assuming contractor haulage. Processing

TABLE 8.1 SUMMARISED OIL PALM COSTS AND LABOUR REQUIREMENTS FOR PUBLIC SECTOR AND PRIVATE INVESTORS SCHEMES

Year	On-farm costs (\$ per acre)				Ex-farm costs (\$ per acre)				Labour requirements (man days per acre)	
	Land development including labour	Production materials	Production labour at \$5	Total on-farm costs	Transport	Processing	Distribution	Total ex-farm costs	Development	Production
0	93		9	102					5.7	1.7
1	171	127	93	391					6.1	18.6
2	8	75	65	148					0.6	12.9
3	134	83	95	312	2	6	3	10	2.0	19.0
4	22	104	132	258	11	43	18	72		26.3
5	22	117	128	267	18	73	31	122		25.6
6	22	113	106	241	23	92	39	155		21.1
7		113	106	241	26	102	43	171		21.1
8		112	95	229	26	106	45	177		19.0
9		112	84	218	27	108	46	181		16.8
10			84	218	27	108	46	181		16.8
11					27	108	46	181		
12					27	107	45	179		
13					26	106	45	177		
14					26	103	44	173		
15					26	102	43	171		
16					25	100	42	167		
17			96	230	25	98	42	165		19.1
18			96	230	24	96	41	161		19.1
19					23	94	40	157		
20					23	94	40	157		
21						92	39	155		
22						92	39	155		
23						91	39	153		
24						91	39	153		
25						90	38	151		
Total	890	2 748	2 365	6 003	526	2 102	888	3 516	14.4	471.6
NPV at 10%	541	1 075	965	2 581	169	676	285	1 130	14.0	191.9

NPV = Net present value

Note: Figures have been rounded-up from the values given in the Appendix.

has been assumed to be undertaken in a 60 ton per hour mill operation at full capacity for which a charge of \$12 per ton ffb has been included. Distribution to a port near Bintulu, bulking installation charges and handling have been estimated to cost about \$22 per ton of oil and \$17 per ton of kernels.

Replanting Costs

The estimated replanting costs, are given in Table 8.3. Replanting is assumed to be necessary after 25 years and would be rather less costly than initial establishment due to the presence of a road network and the absence of heavy clearing or drainage costs.

TABLE 8.2 SUMMARISED OIL PALM COSTS AND LABOUR REQUIREMENTS FOR ROAD BASED IMPROVEMENT SCHEMES

Year	On-farm costs (\$ per acre)				Ex-farm costs (\$ per acre)				Labour requirements (man days per acre)	
	Land development including labour	Production materials	Production labour at \$5	Total on-farm costs	Transport	Processing	Distribution	Total ex-farm costs	Development	Production
0	60		9	69					11.4	1.7
1	70	114	93	277					11.9	18.5
2	1	68	64	133					0.1	12.7
3	1	75	94	170	2	5	2	9	0.1	18.8
4		93	131	225	11	37	15	63		26.1
5		106	127	234	18	62	26	107		25.4
6		101	105	207	23	79	33	135		20.9
7		101	105	207	26	87	37	150		20.9
8			94	196	26	90	38	154		18.8
9			82	184	27	92	39	158		16.4
10			82	184	27	92	39	158		16.4
11					27	92	39	158		
12					27	91	38	156		
13					26	90	38	154		
14					26	88	37	151		
15					26	87	37	150		
16					25	85	36	146		
17		100	94	195	25	84	35	144		18.7
18		100	94	195	24	82	35	141		18.7
19					23	80	34	137		
20					23	80	34	137		
21						79	33	135		
22						79	33	135		
23						78	33	134		
24						78	33	134		
25						77	32	132		
Total	154	2 467	2 324	4 945	530	1 794	756	3 080	25.7	463.3
NPV at 10%	139	966	951	2 056	170	576	243	989	24.2	189.1

NPV = Net present value

Note: Figures have been rounded up from the values given in the Appendix.

TABLE 8.3 ESTIMATED REPLANTING COSTS OF OIL PALMS (\$ per acre)

Cost item	Clearing previous palms	Years of new plantation		
		1	2	3
Land development	50	59	1	1
Crop production	-	237	134	124
Total	50	296	135	125
Management	59	59	59	59
Overall total cost	109	355	194	184

Labour Requirements

Labour inputs summarised in Tables 8.1 and 8.2 have been estimated on the basis of the activity analysis given in Appendix I. After planting the main jobs on oil palms would be pollination and harvesting, and input requirements for these activities would remain consistent over the productive life of the crop.

Management Requirements and Costs

The management staff required for SLDB estate-type oil palm production have been taken as a standard for all SLDB schemes and large-scale private investors. Operations have been assessed on the basis of a 5 000 acre unit requiring the following:-

	<u>Staff Category</u>	<u>Number staff required</u>
Management	Manager	1
	Assistant Manager	2
	Field Supervisor	4
	Field Assistant	8
		<u>15</u>
Administrative	Clerk/Storeman	2
	Driver	1
	Development Assistant	2
	Labourer	2
		<u>7</u>

Details of the costs of salaries and housing requirements for these staff are given in Appendix I from which the average costs shown in Table 8.4 have been summarised.

The annual cost equivalent of the capital and recurrent items amounts to \$58.60 per acre per annum.

Returns

The expected yields and estimated returns derived from palm oil and kernels sales are summarised in Table 8.5 for public sector, private investors and road-based schemes. Yields and returns from road-based schemes have been taken to be 15 per cent lower than those achieved on public sector schemes.

TABLE 8.4 ESTATE-TYPE OIL PALM MANAGEMENT COSTS
(\$ per acre)

Item	Years of development				
	0	1	2	3	4 and onwards
<u>Capital Costs</u>					
Temporary buildings	6	3	-	-	-
Housing and scheme building	-	1	17	54	-
Vehicles	8	8	8	1	-
Total	14	12	25	55	-
<u>Recurrent Costs</u>					
Salaries and general running costs	11	23	30	36	36
Regional office	-	10	10	10	10
Building maintenance	-	-	-	1	1
Vehicle replacement	-	3	5	5	5
Total	11	36	45	52	52
Overall Total	25	48	70	107	52

TABLE 8.5 OIL PALM YIELDS AND RETURNS (PER ACRE)

Year from planting	Public sector and private investors							Road based improvement			
	Yield ffb tons	Palm oil				Kernels		Yield ffb tons	Palm oil		Kernels
		Oil tons	fob value(1) \$	Export duty \$	Gross sales value \$	Kernels tons	fob gross sales value \$		fob value(1) \$	Gross sales value \$	fob gross sales value \$
3	0.5	0.10	47	4	43	0.015	5	0.4	40	37	4
4	3.6	0.72	317	24	293	0.126	40	3.1	270	249	34
5	6.1	1.22	526	40	486	0.229	71	5.2	447	413	60
6	7.7	1.54	652	50	602	0.308	74	6.6	554	512	63
7	8.5	1.70	709	54	655	0.340	102	7.2	603	556	86
8	8.8	1.76	719	55	664	0.352	104	7.5	611	564	88
9	9.0	1.80	723	55	668	0.360	104	7.7	615	568	88
10	9.0	1.80	715	55	660	0.360	102	7.7	608	562	87
11	9.0	1.80	715	55	660	0.360	102	7.7	608	562	87
12	8.9	1.78	707	54	653	0.356	101	7.6	601	555	86
13	8.8	1.76	699	54	645	0.352	100	7.5	595	549	85
14	8.6	1.72	684	52	632	0.344	98	7.3	581	537	83
15	8.5	1.70	676	52	624	0.340	97	7.2	574	530	82
16	8.3	1.66	660	51	609	0.332	94	7.1	561	518	80
17	8.2	1.64	652	50	602	0.328	93	7.0	554	512	79
18	8.0	1.60	636	49	587	0.320	91	6.8	540	499	77
19	7.8	1.56	620	47	573	0.312	89	6.7	527	487	75
20	7.8	1.56	620	47	573	0.312	89	6.7	527	487	75
21	7.7	1.54	612	47	565	0.308	88	6.6	520	480	74
22	7.7	1.54	612	47	565	0.308	88	6.6	520	480	74
23	7.6	1.52	604	46	558	0.304	86	6.5	513	474	73
24	7.6	1.52	604	46	558	0.304	86	6.5	513	474	73
25	7.5	1.50	596	46	550	0.300	85	6.4	507	468	72

Note (1) Net of 2 per cent sales commission, assumes planting year is 1976.

84 RUBBER

A wealth of information on the costs of rubber production has been obtained from previous feasibility studies, from the Rubber Research Institute and from the ISP. This has been supplemented by local information from the Sarawak Department of Agriculture and from SLDB.

The use of stimulants has not been allowed for in these estimates.

8.4.1 Costs

The costs of rubber production assuming fresh latex is collected from the field and processed in a central factory are summarised in Tables 8.6 and 8.7. Further detailed operation costings for several alternative production systems are given in Appendix II.

TABLE 8.6 SUMMARISED RUBBER COSTS AND LABOUR REQUIREMENTS FOR PUBLIC SECTOR AND PRIVATE INVESTORS SCHEMES

Year	On-farm costs (\$ per acre)				Ex-farm costs (\$ per acre)				Labour requirements (man days per acre)	
	Land development including labour	Production materials	Production labour at \$5	Total on-farm costs	Transport	Processing	Distribution	Total ex-farm costs	Development	Production
0	99			99						
1	140	72	174	386					5.7	
2	4	37	116	157					6.3	34.7
3	4	38	84	126						23.1
4	4	45	67	116						16.8
5	4	45	50	99						13.4
6	61	42	42	145						9.9
7	9	82	128	219	11	39	11	61	0.6	8.3
8	9	58	200	267	14	63	18	95		25.6
9		56	211	276	15	79	22	117		39.9
10		56	228	293	16	89	25	130		42.1
11		56	231	297	17	94	27	138		45.5
12		65	244	318	18	100	29	147		46.2
13		65	247	321	18	106	30	154		48.8
14			252	326	19	113	32	164		49.3
15			252	326	19	113	32	164		50.4
16										50.4
17										
18										
19										
20										
21										
22										
23										
24										
25										
Total	487	1 497	5 046	7 030	337	1 926	546	2 809	12.6	1 008.4
NPV at 10%	336	560	1 631	2 527	87	480	136	703	12.3	325.5

NPV = Net present value

Note: Figures have been rounded up from the values given in the Appendix.

TABLE 8.7 SUMMARISED RUBBER COSTS AND LABOUR REQUIREMENTS FOR ROAD BASED IMPROVEMENT SCHEMES

Year	On-farm costs (\$ per acre)				Ex-farm costs (\$ per acre)				Labour requirements (man days per acre)	
	Land development including labour	Production materials	Production labour at \$5	Total on-farm costs	Transport	Processing	Distribution	Total ex-farm costs	Development	Production
0	60			60					11.4	
1	70	65	173	308					11.9	34.6
2	1	33	115	149					0.1	22.9
3	1	34	83	118					0.1	16.6
4		41	66	108						13.2
5		41	49	91						9.7
6		38	41	80						8.1
7		74	127	202	11	33	9	53		25.4
8		52	199	252	14	54	15	83		39.7
9		51	209	261	15	67	19	101		41.7
10		51	226	278	16	75	22	113		45.1
11		51	229	281	17	80	23	120		45.8
12		59	242	302	18	85	24	127		48.4
13		59	245	305	18	90	26	134		48.9
14			250	310	19	96	27	142		50.0
15			250	310	19	96	27	142		50.0
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
Total	154	1 357	5 004	6 515	337	1 636	460	2 435	25.7	1 001.1
NPV at 10%	139	505	1 615	2 261	87	407	115	609	24.2	322.9

NPV = Net present value

Notes: Figures have been rounded up from the values given in the Appendix.

On-Farm Costs

The general steepness of the land likely to be planted to rubber has been allowed for in the costings by assuming manual land clearing and terracing over two-thirds of the area.

Land development costs have been taken, on estate-type schemes, to cover land clearing with an allowance for manual stacking drainage similar to oil palm and road construction costs based on a requirement of 0.4 chains of road length per acre of rubber planted. On road based schemes no road costs have been included.

Crop production costs have allowed for cover crops, planting assuming field budding, terracing, fertilising, weeding, disease and pest control, tapping and latex collection using the conventional cup system.

Ex-Farm Costs

Reception and transport costs of latex to the factory, or processing centre have been based on tankers collecting from reception centres each serving about 300 acres of plantation. The total cost of this operation has been estimated at \$15 per ton of dry rubber content (drc).

Processing costs have been allowed at \$140 per ton (drc) on the basis of crumb rubber production in a factory of 20 tons per day capacity.

Distribution to port, handling charges and commission have been charged at \$40 per ton drc.

Replanting Costs

Estimated rubber replanting costs are given in Table 8.8. Replanting has been assumed after about 25 years production (30 years from planting) and, as in the case of oil palm, would be less costly than initial development due to the established road and drainage networks.

TABLE 8.8 ESTIMATED REPLANTING COSTS OF RUBBER
(\$ per acre)

Cost item	Clearing previous crop	Years of new plantation						
		1	2	3	4	5	6	7
Land development	70	65	1	1	1	1	1	1
Crop production	-	248	134	121	111	94	81	95
Total	70	313	135	122	112	95	82	96
Management	69	69	69	69	69	69	69	69
Overall total cost	139	382	204	191	181	164	151	165

8.4.2 Labour Requirements

Labour inputs for the production based on latex field material are summarised in Tables 8.6 and 8.7. The detailed activity

analysis given in Appendix II has been the basis for these estimates. The major input, after planting, would be for tapping and latex collection which would increase from year seven until full production is reached in the fourteenth year.

8.4.3 Management Requirements and Costs

Rubber is more demanding of management than oil palm and requires a more intensive staff input. Requirements which apply to estate-type operations have been estimated on the basis of a 4 000 acre unit as follows:

	<u>Staff Category</u>	<u>Number staff required</u>
Management	Manager	1
	Assistant Manager	2
	Field Supervisor	4
	Field Assistant	8
		<u>15</u>
Administrative	Clerk/Storeman	2
	Driver	1
	Development Assistant	2
	Labourer	2
		<u>7</u>

Details of the estimated management costs are given in Appendix II from which the data given in Table 8.9 have been summarised.

The annual equivalent of the capital and recurrent items amount to \$60.80 per acre per annum.

8.4.4 Returns

The assumed yields and calculated fob values of the rubber (drc) produced per acre on estate-type and road-based improvement schemes are given in Table 8.10. The returns from road-based schemes have been assumed to be 15 per cent lower than those for public sector schemes. Constant yields have been assumed from the fourteenth year onwards.

The price on which the values have been based is related to the price and estimated proportions of SMR grade rubber produced by the factory which have been assumed as follows:-

	Assumed percentage of production in grade	Assumed premium or discount compared to RSS grade I price cents/pound
SMR 5L	80	+ 3.0
SMR 10	10	-
SMR 20	10	- 0.3

Assuming the price fob Sarawak would be 47 cents per pound then on the above basis the average factory gate price would be 49 cents per pound. (see also Chapter 3)

TABLE 8.9 ESTIMATED RUBBER MANAGEMENT COSTS
(\$ per acre)

Items	Years of development			
	0	1	2	3 and onwards
<u>Capital Costs</u>				
Temporary buildings	15		-	-
Staff housing and scheme buildings	-	74	-	-
Vehicles and equipment	10	10	5	-
Total Capital Costs	25	84	5	-
<u>Recurrent Costs</u>				
Staff salaries and general running costs	21	43	43	43
Regional office	-	10	10	10
Building maintenance	-	-	2	2
Vehicles replacement		4	4	4
Total Recurrent Costs	21	57	59	59
Overall Total Management Costs	46	141	64	59

TABLE 8.10 ESTIMATED RUBBER YIELDS AND RETURNS (PER ACRE)

Year from planting	Public sector and private investors schemes				Road based improvement			
	Yield drc lbs	fob value \$	Export duty \$	Gross sales value \$	Yield drc lbs	fob value \$	Export duty \$	Gross sales value \$
7	620	304	17	287	527	258	14	244
8	1 010	495	27	468	859	421	23	398
9	1 260	617	34	583	1 071	525	29	496
10	1 420	696	38	685	1 207	591	33	558
11	1 500	735	41	694	1 275	625	34	591
12	1 600	784	43	741	1 360	666	37	629
13	1 700	833	46	787	1 445	780	39	741
14 and onwards	1 800	882	49	833	1 530	750	41	708

85 COCOA

The costs of cocoa production derived here have been largely based on experience in Sabah supplemented with limited information from Sarawak and publications by the ISP.

8.5.1 Costs

The costs of production have been based on the assumption that fresh beans would be delivered to group processing units where fermentation and drying would be carried out. Summaries of the estimated production costs are given in Tables 8.11 and 8.12. Detailed information is given in Appendix III.

TABLE 8.11 ESTIMATED COCOA COSTS AND LABOUR REQUIREMENTS FOR PUBLIC SECTOR AND PRIVATE INVESTORS SCHEMES

Year	On-farm costs (\$ per acre)				Ex-farm costs (\$ per acre)				Labour requirements (man days per acre)	
	Land development including labour	Production materials	Production labour at \$5	Total on-farm costs	Transport	Processing	Distribution	Total ex-farm costs	Development	Production
0	93			93					5.7	
1	254	91	64	409					9.6	12.7
2	13	79	187	279						37.3
3	146	91	154	391					2.0	30.7
4	34	80	115	229	2	18	8	28		22.9
5	34	110	122	266	3	35	16	54		24.4
6		131	133	297	5	53	25	82		26.5
7		131	133	297	5	53	25	82		26.5
8		131		297						
9		141		308						
10		131		297						
11		131		297						
12										
13										
14										
15										
16										
17		141		308						
18		131		297						
19		131		297						
20										
21										
22										
23										
24										
25										
Total	1 254	3 091	3 302	7 647	105	1 113	524	1 742	17.3	658.0
NPV at 10%	726	1 142	1 304	3 172	33	346	162	541	17.0	259.8

NPV = Net present value

Note: Figures have been rounded up from the values given in the Appendix.

On-Farm Costs

The on-farm costs have been estimated assuming that cocoa would be grown on the more gently undulating or flat land much of it requiring drainage. In the land development costs provision has been made for a drainage network equivalent to the tertiary network required for padi rice over about half the cropped area. For the estate-type developments roads have been assumed to be constructed to the same intensity as in oil palms, but roads have not been costed into road-based schemes.

TABLE 8.12 ESTIMATED COCOA COSTS AND LABOUR REQUIREMENTS FOR ROAD BASED IMPROVEMENT SCHEMES

Year	On-farm costs (\$ per acre)				Ex-farm costs (\$ per acre)				Labour requirements (man days per acre)	
	Land development including labour	Production materials	Production labour at \$5	Total on-farm costs	Transport	Processing	Distribution	Total ex-farm costs	Development	Production
0	60			60					11.4	
1	125	82	64	271					14.9	12.7
2	10	71	186	267					0.6	36.6
3	10	82	153	245					0.6	30.0
4		72	114	196	2	15	7	24		22.1
5		99	121	230	3	30	14	47		23.6
6		118	132	260	5	45	21	71		25.7
7		118	132	260	5	45	21	71		25.7
8		118		260						
9		127		269						
10		118		260						
11		118		260						
12										
13										
14										
15										
16										
17		127		269						
18		118		260						
19		118		260						
20										
21										
22										
23										
24										
25										
Total	425	2 784	3 278	6 487	105	945	441	1 491	40.7	639.0
NPV at 10%	275	1 029	1 295	2 599	33	293	137	463	31.7	252.9

NPV = Net present value

Note: Figures have been rounded up from the values given in the Appendix.

Crop production costs have allowed for cover crops, hybrid cocoa seed produced in special seed gardens probably from Sabah, shade to ensure satisfactory early growth, fertilising, weeding, pest and disease control, harvesting and spraying tools.

Ex-Farm Costs

Loading and transport of wet beans to a central processing unit has been costed on the basis of vehicle transport at \$3 per ton dry bean equivalent (dbe). Fermentation, drying in a Samoan type dryer and packaging in polythene lined bags have been costed at \$78 per ton dbe (3.5 cents per pound). Distribution to port, handling and agents fees have been estimated to cost \$36 per ton of dried beans.

Replanting Costs

Estimated replanting costs, including labour charges, are given in Table 8.13. This operation has been assumed to be less costly than initial planting due to reduced road and drainage costs. For farm budgeting purposes replanting has been assumed to occur 30 years after initial planting.

TABLE 8.13 ESTIMATED REPLANTING COSTS OF COCOA
(\$ per acre)

Cost items	Clearing previous crop	Years of new plantation			
		1	2	3	4
Land development	50	89	31	31	31
Crop production	-	154	265	243	193
Total	50	243	296	274	224
Management	69	69	69	69	69
Overall total cost	119	312	365	343	293

8.5.2 Labour Requirements

Production labour inputs are summarised in Tables 8.11 and 8.12. After planting the main operations would be weeding and pest control. Even after production starts maintenance of the crop would require the main labour input. Further details of the activity analysis on which labour estimates have been based is given in Appendix III.

8.5.3 Management Requirements and Costs

The management requirements of cocoa have assumed to be equivalent to those for rubber. Thus the remarks and costs given in Section 8.4.3 also apply to cocoa.

8.5.4 Returns

For the calculation of returns dried beans, at six per cent moisture, have been assumed to be exported through the port near Bintulu at the fob price at \$1 120 per ton. Estimated yields and income per acre are given in Table 8.14. Returns from road-based schemes have been assumed to be 15 per cent lower than those for public sector schemes.

8.6 PEPPER

Although pepper is one of the most important cash crops grown in Sarawak and is the largest single agricultural export from the country few comprehensive production economics studies have been carried out since the early 1960's. The present study is based on information obtained from the Department of Agriculture and case studies carried out by the Consultants in the Study Area.

TABLE 8.14 ESTIMATED COCOA YIELDS AND RETURNS (PER ACRE)

Year	Public sector and private investors schemes		Road-based improvement	
	Yield tons (dbe)	Fob/gross sales value \$	Yield tons (dbe)	Fob/gross sales value \$
4	0.22	250	0.19	213
5	0.45	500	0.38	425
6 and onwards	0.67	750	0.57	637

dbe = dry bean equivalent

8.6.1 Costs

The estimated costs of small-scale production in the intensive development areas are summarised in Table 8.15. It has been assumed that the enterprises would be aimed at producing both black and white pepper at a ratio of 5:4.

TABLE 8.15 ESTIMATED PEPPER COSTS AND LABOUR REQUIREMENTS (ALL SCHEMES)

Year	On-farm costs (\$ per acre)				Ex-farm costs (\$ per acre)				Labour requirements (man days per acre)	
	Land development including labour	Production materials	Production labour at \$5	Total on-farm costs	Transport	Processing	Distribution	Total ex-farm costs	Development	Production
0	195			195					7.0	
1	225	1 626	894	2 745					13.0	178.7
2	2	437	339	778					0.3	67.7
3	2	668	816	1 486		95	396	491	0.3	163.1
4		624	1 166	1 792		165	690	855		233.1
5		668	1 289	1 959		189	793	982		257.7
6		637	1 289	1 928		189	793	982		257.7
7		668	1 184	1 854		168	705	873		236.8
8		624	1 049	1 675		141	592	733		209.8
9		794	951	1 747		122	510	632		190.1
10		624	889	1 515		109	458	567		177.8
11		681	840	1 523		100	417	517		168.0
12		624	816	1 442		95	396	491		163.1
13	195	73		268					10.0	
14	30	500	894	1 424					6.0	176.7
15	2	481	339	822					0.3	67.7
16	2	637	816	1 455		95	396	491	0.3	163.1
17		794	1 166	1 962		165	690	855		233.1
18		624	1 289	1 915		189	793	982		257.7
19		668	1 289	1 959		189	793	982		257.7
20		624	1 184	1 810		168	705	873		236.8
21		668	1 049	1 719		141	592	734		209.8
22		637	951	1 590		132	510	632		190.1
23		668	889	1 559		109	458	568		177.8
24		624	840	1 466		100	417	517		168.0
25		794	816	1 612		95	396	491		163.1
Total	689	16 467	23 044	40 200		2 746	11 500	14 246	42.6	4 607.2
NPV at 10%	507	7 096	9 123	16 726		1 022	4 275	5 297	26.8	1 823.7

NPV = Net present value

Notes: Figures have been rounded up from the values given in the Appendix.

On-Farm Costs

Land development costs have included clearing and surface drainage assuming that the latter operation is completed with manual labour.

Crop production costs have included planting material, terracing and conservation measures as described in Chapter 6, and posts, fertilising, weeding, pest and disease control, processing, small tools and equipment.

Ex-Farm Costs

Transport from the farm to buyers godown or shop has been provided for at \$12 and \$13 per ton of black and white pepper respectively. Distribution costs incurred from dealers buying point to port of shipment have been estimated at \$294 and \$394 per ton of black and white pepper respectively and this item includes a dealers margin of 10 per cent of the fob value of the pepper.

8.6.2 Labour Requirements

Labour inputs are summarised in Table 8.15 which shows that pepper requires the highest inputs per acre of any crop recommended for inclusion in the agricultural plan. Further details are given in Appendix III.

8.6.3 Returns

For the calculation of returns all made pepper has been assumed to be exported. Estimated yields and incomes over a 10 years productive life of vines are given in Table 8.16. Two yield situations have been calculated; the estimated average yield and a lower situation. The estimated fob prices used in these calculations have been as given in Chapter 6, namely;

white pepper \$125 per picul (\$2 100 per ton);
black pepper \$100 per picul (\$1 680 per ton).

8.7 RICE

The costs and returns have been estimated on the basis of a single swamp rice crop produced for subsistence needs under the direction and assistance of the ADU. The main source of information on which the costs have been based was the Department of Agriculture, Sarawak.

TABLE 8.16 ESTIMATED PEPPER YIELDS AND RETURNS(1) (PER ACRE)

Year	Average yield situation							Lower yield situation						
	Green berries		Made pepper(2)		fob value \$	Export duty \$	Gross sales value \$	Green berries		Made pepper		fob value \$	Export duty \$	Gross sales value \$
	Per vine lbs	Per acre tons	White tons	Black tons				Per vine lbs	Per acre tons	White tons	Black tons			
3	17	4.58	0.49	0.90	2 563	62	2 501	13	3.63	0.39	0.71	2 030	49	1 981
4	29	7.97	0.86	1.57	4 462	108	4 354	23	6.36	0.68	1.26	3 562	86	2 476
5	33	9.16	0.98	1.81	5 128	124	5 004	27	7.32	0.79	1.44	4 095	99	3 996
6	33	9.16	0.98	1.81	5 128	124	5 004	27	7.32	0.79	1.44	4 095	99	3 996
7	30	8.15	0.88	1.61	4 561	101	4 460	23	6.36	0.68	1.26	3 562	86	3 476
8	25	6.84	0.73	1.35	3 830	92	3 738	20	5.47	0.59	1.08	3 062	75	2 987
9	22	5.89	0.63	1.16	3 296	80	3 216	17	4.64	0.50	0.91	2 597	53	2 544
10	19	5.29	0.57	1.04	2 962	71	2 891	16	4.16	0.45	0.82	2 331	56	2 275
11	18	4.82	0.52	0.95	2 696	65	2 631	14	3.80	0.41	0.75	2 131	51	2 080
12	17	4.58	0.49	0.90	2 563	62	2 501	13	3.63	0.39	0.71	2 030	49	1 981

Notes (1) Assuming 615 vines planted per acre.

(2) Conversion rates from green berries to made pepper:
Black - 33 per cent
White - 27 per cent

8.7.1 Costs

The combination of mechanised land preparation followed by manual labour for all other production operations as described in Chapter 5 has been assumed. The costs of these operations are summarised in Table 8.17 details are given in Appendix III.

Land development costs have included land clearing, drainage, initial levelling and bunding all assumed to be carried out by the SLDB or a contractor.

Production costs have covered annual land preparation by tractor, seed and nursery, fertilising and weeding. No ex-farm costs have been included since the crop is assumed to be consumed on the farm.

8.7.2 Labour Requirements

Labour inputs are summarised in Table 8.17 and details are given in Appendix III. Transplanting and harvesting would require the highest inputs.

8.7.3 Returns

The returns to rice production have been estimated on the basis of the yields given in Table 8.18 at a farm gate value of \$317 per ton of padi.

TABLE 8.17 ESTIMATED RICE COSTS AND LABOUR REQUIREMENTS

Year	On-farm costs (\$ per acre)				Labour requirements (man days per acre)	
	Land development including labour	Production materials	Production labour at \$5 per day	Total on-farm costs	Development	Production
0	93	Nil	Nil	93	5.7	Nil
1	573	Nil	Nil	573	21.5	Nil
2	383	65	200	648	24.4	40
3	33	65	215	313	Nil	43
4	33	65	210	308	Nil	42
5 and onwards	33	65	220	318	Nil	44
Total for 25 years	1 797	1 560	5 245	8 601	52	1 049
NPV at 10%	1 277	584	1 946	3 806	49	389

TABLE 8.18 RICE YIELDS AND RETURNS (PER ACRE)

Year	Yield of Padi		Gross sales value* \$
	Tons	Pounds	
2	0.78	1 750	247.3
3	0.89	2 000	282.1
4	1.07	2 400	339.2
5 and onwards	1.23	2 750	389.9

Note * At farm gate price of \$317 per ton of padi.

APPENDIX I

TABLE 1.1. OIL PALM PRODUCTION COSTS (\$ PER ACRE)

Operation	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<u>On-farm development</u>																										
Land clearing	93.0	90.4																								
Roads		79.0		133.0	21.0	21.0																				
Drains		2.0	7.6	0.6	0.6	0.6																				
Total (including labour)	93.0	171.4	7.6	133.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6
<u>Development labour</u> (including above) man days	5.7	6.1	0.6	2.0																						
<u>On-farm production</u>																										
<u>Production materials:</u>																										
Cover crop	17.3																									
Inspection and harvesting paths	0.7	0.4	0.9	1.3	1.3	1.0	1.0	0.3	0.3																	
Planting	64.6	4.5																								
Fertilising	27.5	46.5	58.5	76.0	93.6	93.6																				
Weeding and equipment	16.0	21.0	17.1	14.9	12.2	6.9	6.9																			
Pest control		2.1	4.2	6.3	6.3																					
Pollination		0.1	0.1	0.1	0.3	0.3																				
Leaf analysis		2.0	2.0																							
Harvesting tools and equipment		0.1	0.9	1.5	1.9	1.9	2.1	2.2	2.3	2.3	2.2	2.2														
Other tools and equipment	0.8	0.6	0.4	0.3	0.3	0.5	0.5																			
Sub-total materials	126.9	75.1	83.3	103.8	117.3	112.5	112.7	112.1	111.9	111.8	111.8	111.8	111.8	111.8	111.8	111.8	111.8	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5
<u>Production labour</u>																										
Labour input man days	1.7	18.6	12.9	19.0	26.3	25.6	21.1	21.1	19.0	16.8	16.8															
Labour cost at \$5	8.5	93.0	64.5	95.0	131.5	128.0	105.5	105.5	95.0	84.0	84.0															
Total production costs (labour at \$5)	8.5	219.9	139.6	178.3	235.3	245.3	218.0	218.2	207.1	195.9	195.8	195.8														
Total on-farm costs (labour at \$5)	101.5	391.3	147.2	311.9	256.9	286.9	239.8	228.7	217.5	217.5	217.4	217.4	217.4	217.4	217.4	217.4	217.4	228.6	228.6	228.6	228.6	228.6	228.6	228.6	228.6	228.6
<u>Ex-farm costs</u>																										
Loading and transport ffb			1.5	10.8	18.3	23.1	25.5	26.4	27.0	27.0	27.0	26.7	26.4	25.8	25.8	24.9	24.6	24.0	23.4	23.4	23.4	23.1	23.1	22.8	22.8	22.5
Processing			6.0	43.2	73.2	92.4	102.0	105.6	108.0	108.0	108.0	106.8	105.6	103.2	102.0	99.6	98.4	96.0	93.6	93.6	93.6	92.4	92.4	91.2	91.2	90.0
Distribution (palm oil and kernels)			2.5	17.9	30.7	39.1	43.1	44.6	45.6	45.6	45.6	45.2	44.6	43.6	43.1	42.1	41.6	40.6	39.5	39.5	39.5	39.1	39.1	38.5	38.5	38.0
Total ex-farm costs			10.0	71.9	122.2	154.6	170.6	176.6	180.6	180.6	180.6	178.7	176.6	172.6	170.9	166.6	164.6	160.6	156.5	156.5	156.5	154.6	154.6	152.5	152.5	150.5

TABLE I.2 COSTS OF LAND CLEARING FOR OIL PALM IN FOREST AREAS

Service provided by estate/contractor	Item	Cost per acre cleared \$	Remarks
Estate	Survey and renticing	1	
Contractor	Underbrushing	20	5 to 8 acres per man per month
Contractor	Felling	60	3 to 5 acres per man per month
Estate	Burning	3	
Estate	Stacking	70	2 machine hours per acre; 140 hp bulldozer
Contractor	Chain sawing	4	1 chain saw; 2 bulldozers stacking
Estate	Re-burning stacks	5	
Total cost per acre cleared		163	

Note: Assuming that 90 per cent of the area cleared is actually planted (net acreage) the cost per net acre is then \$181 per acre spread over two years as follows:-

Land clearing : Year 0 - \$ 93 per acre planted
 Year 1 - \$ 88 per acre planted
 Weed control spray: Year 1 - \$2.40 per acre planted

TABLE I.3 COSTS OF ROAD CONSTRUCTION FOR OIL PALM SCHEMES

Item	Amount	Cost per unit	Cost per acre oil palm
<u>Construction</u>		\$/chain	\$
14 feet wide secondary road	0.12 chain per acre	27 (up grading forestry road)	3.24
10 to 12 feet wide tertiary road	1.08 chains per acre	38 (new construction)	41.04
Culverting, bridges and drainage			35.00
Sub-total costs in Year 1			79.28
<u>Crushed stone</u>		\$/cubic yard	
14 feet road	11 cubic yard/chain	6 (up grading forestry road)) 53.40
10 feet road	7 cubic yard/chain	6	
Transport of stone	8.9 cubic yard	8	71.00
Spreading and rolling crushed stone		1	8.90
Sub-total costs of gravelling, Year 3			133.30
Overall road cost, Years 1 and 3			212.58
<u>Maintenance</u>			
10 per cent of construction costs from Year 4 onwards			21.00

TABLE I.4 COSTS OF DRAINAGE AND STREAM CLEARING FOR OIL PALM
(DOLLARS)

Year	Labour	Materials	Total
0	0.15	0.30	0.45
1	2.00		2.00
2	3.00	4.55	7.55
Total	5.15	4.85	10.00

TABLE I.5 COVER CROP COSTS FOR OIL PALM ESTABLISHMENT

Item	Amount per acre	Cost per acre
<u>Planting</u>		\$
Pueraria seed	2 pounds	6.60
Centrosema seed	3 pounds	2.10
CIRP	5 pounds	0.35
Contractor labour for planting	1.4 man days	8.00
<u>Sub-total</u>		17.05
<u>Maintenance</u>		
CIRP	180 pounds	12.60
Contract labour for top dressing	0.3 man day	1.50
Contract labour for weeding (2 rounds)	1.0 man day	5.00
<u>Sub-total</u>		19.10
Total		36.15

Note: The cost per acre of plantation assuming 80 per cent area covered is thus:-

Labour	11.60
Materials	17.32
Total	<u>\$28.92</u>

TABLE I.6 OIL PALM PLANTING COSTS
(DOLLARS)

Operation/rate	Labour	Material	Total cost
Lining	8.00		8.00
Clearing, timber from planting points 10 per cent points at \$0.60	3.60		3.60
Platforming, 33 per cent points at \$1.10	22.00		22.00
Seedling palms, 60 palms at \$1.50 each	30.00	60.00	90.00
Planting palms, 60 palms at \$0.35 each	21.00		21.00
CIRP, 0.5 pound per palm		2.10	2.10
Rodent protection, 10 per cent area at \$22.50 per acre		2.50	2.50
Supplying, three palms per acre	1.05	4.50	5.55
Total	85.65	69.10	154.75

Note: The incidence of these costs is estimated to be as follows:-

	<u>Labour</u> \$	<u>Material</u> \$	<u>Total</u> \$
Year 1	84.60	64.60	149.20
Year 2	1.05	4.50	5.55

TABLE I.7 HARVESTING COSTS OF OIL PALM FFB
(DOLLARS)

Year	Labour(1) costs per ton ffb	
	Low rate	High rate
3	9.00	12.00
4 and 5	8.00	11 to 12
6 to 16	6.00	8.00
17 and following	7.00	8.50

Note: (1) Harvesting tools such as knives, baskets etc. are estimated to cost 25 cents per ton of fruit.

TABLE I.8 SCHEME MANAGEMENT SALARIES AND SERVICES COSTS ON OIL PALM SCHEMES
(DOLLARS)

Category/posts	Annual salary	Costs in years for 5 000 acres			
		0	1	2	3 and following
<u>Management staff salaries</u>					
Scheme Manager	19 800	14 850	19 800	19 800	19 800
Assistant Scheme Manager	12 100	6 050	12 100	12 100	24 200
Scheme Supervisors	9 400	9 400	18 800	37 600	37 600
Field Assistants	4 400	8 800	26 400	26 400	35 200
<u>Administrative staff salaries</u>					
Clerk/typist	4 400	2 200	4 400	4 400	4 400
Storeman	4 400		4 400	4 400	4 400
Driver	3 500	2 600	7 000	7 000	7 000
Settler Development Assistant	3 500				3 500
Artisan	3 500		3 500	3 500	3 500
Watchman	1 500		1 500	1 500	1 500
<u>Sub-total</u>		43 900	97 900	111 700	141 100
Add 10 per cent EPF and allowances		4 400	10 000	11 700	14 100
<u>Total salaries</u>		48 300	107 900	128 400	155 200
Average cost per acre		10	21	26	31
<u>Scheme office running costs</u>					
Average cost per acre		3 000	7 500	20 000	25 000
		0.60	1.50	4.00	5.00
Overall total scheme management costs per acre		10.60	22.50	30.00	36.00

TABLE I.9 ADMINISTRATIVE BUILDINGS AND HOUSING COSTS FOR OIL PALM SCHEMES

Item	No. of units	Cost per unit \$	Construction costs in years for 5 000 acres (Dollars)			
			0 & 1	2	3	Total cost
<u>Administrative buildings</u>						
Office	1	30 000			30 000	30 000
Store main	1	10 000			10 000	10 000
P.O.L. store	1	2 000			2 000	2 000
Workshop-cum-garage	1	15 000			15 000	15 000
<u>Sub-total</u>					57 000	57 000
<u>Staff quarters</u>						
Manager	1	40 000			40 000	40 000
Assistant Manager	2	30 000			60 000	60 000
Field Supervisors	4	15 000		30 000	30 000	60 000
Field Assistants	8	8 000		32 000	32 000	64 000
Clerk/typist	1	8 000			8 000	8 000
Storeman	1	8 000			8 000	8 000
Settlement Development Assistant	1	5 000			5 000	5 000
Drivers, watchman and artisan	4	5 000		10 000	10 000	20 000
<u>Sub-total</u>				72 000	193 000	265 000
<u>Furniture and equipment</u>						
Administrative buildings			3 000	5 000		8 000
Houses at 10 per cent				7 000	19 000	26 000
<u>Sub-total</u>			3 000	12 000	19 000	34 000

TABLE I.10 BUILDING MAINTENANCE COSTS FOR OIL PALM SCHEMES
(DOLLARS)

Year	Per 5 000 acre scheme	Cost per acre
1	60	0.12
2	1 740	0.35
3 and following	7 120	1.42

TABLE I.11 VEHICLE AND EQUIPMENT COSTS FOR OIL PALM SCHEMES

Type of vehicle	Total number required*	Cost per unit	Useful life	Cost of initial purchases in years for 5 000 acres (Dollars)		
				0 & 1	2	3
<u>Vehicles</u>		\$	Year			
4 wheel drive pick-up	2	15 000	7	15 000	15 000	
5 ton lorry	½ share	20 000	7	10 000		
Farm tractor 65 hp	2	17 000	7	35 000		
Trailers 3 ton tipping	2	3 400	10	6 800		
600 gallon tank with pump	1	5 500	10		5 500	
Diesel generator 5 Kw	1	5 000	10	5 000		
Radio equipment	1	5 500	7	5 500		
Ditch digger	½ share	40 000	10		20 000	
<u>Agricultural equipment</u> (Pollen drying, storage and testing)		5 000	5			5 000
Total				84 100	40 500	5 000
Average cost per acre				16.80	8.10	1.00

Note: * Certain items such as the 5 ton vehicle and the ditch digger would be required for use on a number of schemes. The cost of these items is included in a share basis and would normally be controlled from regional or group manager level.

TABLE I.12 TYPICAL PHASING OF 60 TONS PER HOUR OIL PALM MILL

Detail	Years from planting							
	3	4	5	6	7	8	9	10 and following
Quantity ffb available tons	3 000	24 600	61 200	107 400	158 400	208 200	240 600	258 000
Capacity installed - tons ffb per hour	Construction and commission first line	30	30	30	60	60	60	60
					(installed 2nd line)			
Phase	1A		1B		Full operation			

TABLE I.13 ESTIMATED CAPITAL COST OF AN OIL PALM MILL OF
60 TONS PER HOUR CAPACITY

Detail	Stage I Phases 1A & B	Stage II Full operation	Total
<u>Capacity installed</u> - tons ffb per hour	30	60	60
<u>Year of scheme installed</u>	3	6	
<u>Cost of installations</u> - \$'000			
Buildings and civil works including mill building and foundation, office, workshop-cum-store, roads, fences, drains, sludge trap and ffb reception ramp	932.0	150.0	1 082.0
Mill plant and machinery, oil storage and weighbridge necessary for sterilising, pressing, oil recovery, kernel recovery, power plant electrical installation and oil storage and ffb weighing	3 598.5	3 001.8	6 600.2
Water supply and effluent treatment/control including intake works, pumping plant, pipelines and storage tanks, disposal areas	550.0	100.0	650.0
Vehicles	36.0		36.0
Installation and servicing including all fees and workshop tools	230.0	95.0	325.0
Staff and labour housing for all employees concerned with mill operation	632.0	195.2	827.2
Overall total	5 978.5	3 542.0	9 520.4

TABLE I.14 OIL PALM PROCESSING COSTS FOR 60 TONS PER HOUR MILL CAPACITY

Detail	Costs per ton ffb processed (Dollars)			Remarks
	Stage 1A	Stage 1B	Full operation	
Tons ffb handled	50 000	100 000	250 000	
Materials including fuel, chemicals and packaging	1.00	1.00	0.96	
Maintenance of plant and equipment	2.50	2.50	1.82	Covers spares materials and contract charges
Maintenance of buildings, roads, housing and water supply	0.50	0.50	0.25	Covers all contract operations and materials
Staff salaries	3.60	2.00	1.20	Covers all management and supervisory staff
Labour	2.10	1.40	1.10	Covers all labour, skilled and unskilled, required for plant operation
General expenses	0.90	0.75	0.65	General office running costs, insurance and administration
<u>Sub-total</u>	10.60	8.15	5.98	
Depreciation of plant and equipment*	17.80	8.90	4.70	
Depreciation of buildings, roads, housing and water supply*	4.60	2.30	1.10	
<u>Sub-total</u>	20.40	10.20	5.80	
Overall total	31.00	18.35	11.78	

Note: * Annualised requirement cost over useful life of the item including interest at 10 per cent per annum.

TABLE I.15 MAINTENANCE AND REPAIR COSTS AND ALLOWANCE FOR DEPRECIATION FOR A 60 TON PER HOUR OIL PALM MILL

Detail	Maintenance and repair costs (Dollars)				Maintenance rate per cent	Expected life Year	Depreciation allowed including interests at 10 per cent(2) (Dollars)	
	Phases 1A and 1B 30 tons per hour		Full operation 60 tons per hour				Stage 1A and B	Full operation
	Capital	Maintenance	Capital	Maintenance				
Mill buildings, fences, sludge trap, off-loading ramp	823 000	4 100	973 000	4 900	0.5	25	90 600	107 100
Staff housing	632 000	12 600	827 200	16 500	2	25	69 600	91 100
Drains	46 000	4 600	46 000	4 600	10	40	4 700	4 700
Water supply	550 000	27 500	650 000	32 500	5(1)	25	60 600	71 600
Roads	63 000	3 800	63 000	3 800	6	40	6 400	6 400
Sub-total	2 114 000	52 600	2 559 200	62 300			231 900	280 900
Mill plant and machinery	3 279 600	246 000	5 751 100	431 300	7.5	8	614 600	1 077 800
Oil storage	283 500	7 100	778 500	19 500	2.5	25	31 200	85 700
Weighbridge	35 300	900	70 600	1 800	2.5	25	3 900	7 800
Vehicles	36 000	1 800	36 000	1 800	5	8	6 800	6 800
Sub-total	3 634 400	255 800	6 636 200	454 400			656 500	1 178 100
Overall total	5 748 400	308 400	9 195 400	516 700			888 400	1 459 000
Tons fruit processed		100 000		250 000				
Average cost per ton		0.50		0.25			4.60	2.30
Building and housing		2.50		1.82			17.80	8.90
Plant and machinery								4.70
Total		3.00		2.07			22.40	11.20
								5.80

Notes (1) Plant only.

(2) Calculated as an annuity or annualised equivalent over the useful life of the item including interest at 10 per cent per annum.

TABLE I.16 SUMMARY OF STAFF AND LABOUR REQUIREMENTS AND WAGES FOR 60 TONS PER HOUR OIL PALM MILL

Category	Salary per annum	Number of persons employed				Total salaries/wage cost (Dollars)			
		Phase 1		Full operation		Phase 1		Full operation	
		Single shift	Two shifts	Two shifts	Three shifts	Single shift	Two shifts	Two shifts	Three shifts
Senior Managerial - (SMS)	19 800	1	1	1	1	19 800	19 800	19 800	19 800
Middle Managerial - (MMS)	12 100	4	5	6	6	48 400	60 500	72 600	72 600
Junior Managerial - (JMS)	9 400	4	4	5	6	37 600	37 600	47 000	56 400
Skilled - (S)	3 500	4	4	6	6	14 000	14 000	21 000	21 000
	4 400	11	13	19	23	48 400	57 200	83 600	101 200
Semi-skilled - (SS)	3 500	5	7	7	8	17 500	24 500	24 500	28 000
	4 400	6	8	9	10	26 400	35 200	39 600	44 000
Unskilled - (U)	1 500	19	31	54	74	28 500	46 500	81 000	111 000
	1 900	10	18	26	38	19 000	34 200	49 400	72 200
Sub-total - management and skilled		24	27	37	42	168 200	189 100	244 000	271 000
Sub-total - semi and unskilled		40	64	96	130	91 400	140 400	194 500	255 200
Total per annum		64	91	133	172	259 600	329 500	438 500	526 200
Add allowances 15 per cent						38 940	49 425	65 775	78 930
Overall total salaries and wages including allowances						298 540	378 925	504 275	605 130
Average salaries and wages cost monthly						24 878	31 577	42 023	50 428

TABLE I.17 SUMMARY OF HOUSING REQUIREMENTS AND COSTS FOR STAFF EMPLOYED IN 60 TONS PER HOUR OIL PALM MILL

House grade	Number of staff per unit	Cost per unit \$	Phase 1A		Phase 1B		Full operation	
			Number of units	Cost \$	Number of units	Cost \$	Number of units	Cost \$
1	1	40 000	1	40 000	1	40 000	1	40 000
2	1	30 000	4	120 000	4	150 000	6	180 000
3	1	15 000	4	60 000	3	60 000	5	75 000
4	1.25	8 000	14	112 000	21	136 000	22	176 000
5	1.25	5 000	15	75 000	29	115 000	31	155 000
6	1.5	3 500	13	45 500	31	73 500	36	126 000
Sub-total				452 500		574 500		752 000
Add furniture				45 250		57 500		75 200
Total - construction				497 750		632 000		827 200
Annual maintenance cost				9 775		12 835		17 410

TABLE I.18 PALM OIL AND KERNEL TRANSPORT REQUIREMENTS AND COSTS

Item	Oil tankers	Kernel trucks
Capacity of vehicle employed	13 tons	15 tons
Number of shifts per day	2	1½
Number of trips per day	2½	2
Tonnage hauled per vehicle per annum	9 750	9 000
Number of drivers per vehicle	2	1½
Number of labourers per vehicle	2	1½
Cost per ton to Bintulu port	\$12.35	\$10.80

TABLE I.19 DISTRIBUTION COSTS OF PALM OIL AND KERNELS (DOLLARS)

Item	Per ton oil	Per ton kernels
Storage at port installation	6.50	3.00
Unloading and loading	3.00	3.00
Total	9.50	6.00

TABLE I.20 BASIC OIL PALM YIELDS

Year from planting	Fresh fruit bunches	Extraction rates	
		Palm oil	Kernels
	Tons	%	%
2½ - 3	0.5	20	3.0
4	3.6	20	3.5
5	6.1		3.75
6	7.7		4.0
7	8.5		4.0
8	8.8		
9	9.0		
10	9.0		
11	9.0		
12	8.9		
13	8.8		
14	8.6		
15	8.5		
16	8.3		
17	8.2		
18	8.0		
19	7.8		
20	7.8		
21	7.7		
22	7.7		
23	7.6		
24	7.6		
25	7.5		

TABLE I.21 SUMMARY OF OIL PALM LABOUR REQUIREMENTS - MAN DAYS PER ACRE

Operation/detail	Years										
	0	1	2	3	4	5	6	7	8	9-16	17-25
Establishment											
Village site clearing and drainage	0.3		0.3								
Survey and land clearing	5.7	5.1									
Nursery operations	1.4	1.6									
Cover crop		3.0									
Lining, platforming		3.9									
Planting palms		4.0	0.3								
Roads and drains construction		1.0	0.6	2.0							
Inspection paths	0.3	1.0	1.5	0.3							
Sub-total establishment	7.7	19.6	2.4	2.3							
Maintenance											
Fertilising and disease control		0.2	0.8	1.1	1.1	1.1	1.1	1.1	1.1	1.3	1.3
Weed control		4.8	10.0	7.0	4.4	4.4	1.2	1.2	1.2	1.2	1.2
Pollination				3.0	7.8	7.6	6.5	5.5	4.4		
Pruning				2.0	2.0	1.7	1.7	1.7	1.7	2.4	3.0
Harvesting paths				1.5	2.0	1.2	0.3	0.3	0.3	0.3	0.3
Roads and drains maintenance		0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.5
Harvesting				1.8	8.7	9.3	10.0	10.0	10.0	11.1	12.8
Sub-total maintenance		5.1	11.1	16.7	27.3	25.6	21.1	21.1	19.0	16.8	19.1
Total	7.7	24.7	13.5	19.0	26.3	25.6	21.1	21.1	19.0	16.8	19.1

TABLE I.22.1 DETAILS OF OIL PALM ESTABLISHMENT ACTIVITIES AND ESTIMATED LABOUR REQUIREMENTS

Operation/detail	Labour force contractor/estate	Total basic requirement man days per acre	Incidence					
			Man days per acre plantation in years					
			0	1	2	3	4	5
Survey and land clearing plantation area								
Survey and location	E	0.20	0.20					
Underbrushing	C	2.50	2.50					
Felling	C	5.50	3.00	2.50				
Stacking and burning	C/E	2.30	-	2.30				
Total		10.50	5.70	4.80				
Survey and clearing village area								
125 acres in central village per 5 000 acre plantation acre	C	0.30			0.30			
Nursery operation: 320 000 seedlings - 80 acre site per 5 000 acres								
Clear site - 1 000 man days	C	0.20	0.20	-				
Bag filling - 2 300 man days	E	0.46	0.23	0.23				
Stacking bags - 1 600 man days	E	0.32	0.16	0.16				
Planting seeds - 230 man days	E	0.05	0.02	0.03				
Shade construction - 1 020 man days	E	0.20	0.20	-				
Re-stacking in main nursery - 1 600 man days	E	0.32	0.16	0.16				
Water - 1 500 man days	E	0.30	0.15	0.15				
Weeding - 3 100 man days	E	0.62	0.20	0.42				
Fertilising - 800 man days	E	0.16	0.04	0.12				
Pest control - 300 man days	E	0.06	0.02	0.04				
Culling - 250 man days	E	0.05	-	0.05				
Loading and transporting - 1 070 man days	E	0.21	-	0.21				
Total		2.95	1.38	1.57				
Lining and platforming								
Lining	C	0.40		0.40				
Platforming	C	3.50		3.50				
Total		3.90	-	3.90				
Cover crop								
Blanket spray and weeding following clearing - 1 round at 0.3 man day	E	0.30		0.30				
Sowing seeds, preparing seeds and fertilisers	C	1.40		1.40				
Fertiliser broadcasting - 1 round at 0.3 man days	E	0.30		0.30				
Weeding cover crop - 2 rounds at 0.5 man day	E	1.00		1.00				
Total		3.00		3.00				
Palm planting								
Census planting points	E	0.01			0.01			
Remove palms and load at nursery - 7 man days per 3 600 palms	E	0.70		0.70				
Carry to planting points - 36 man days per 3 600 palms	C							
Prepare fertiliser for planting holes	E	0.04			0.04			
Holing - 20 palms per day	C	1.30		1.30				
Planting - 35 palms per day	C	1.70		1.70				
Clearing planting points of timber etc. - 3 acres per day	E	0.30		0.30				
Supplying 5% lessees = 3 palms per acre	E	0.20			0.20			
Total		4.25	-	4.00	0.25			
Roads and drains								
Roads - cutting and culverting	C/E	0.50		0.50				
Roads - gravelling and surfacing	C/E	2.00				2.00		
Drainage - nursery and village area	E	0.30	0.30					
Streamline clearing and drainage plantation area	E	1.00		0.50		0.50		
Total		3.80	0.30	1.00	-	2.50		

TABLE I.22.2 DETAILS OF OIL PALM MAINTENANCE ACTIVITIES AND LABOUR REQUIREMENTS - MAN DAYS PER ACRE

Operation/detail	Incidence in years										
	0	1	2	3	4	5	6	7	8	9-16	17-25
MAINTENANCE OF PALMS (all estate labour)											
Fertilisation											
1. Number of rounds		1	2	3	3	3	3	3	3	3	3
2. Rate per acre per round man day		0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
3. Total man days per acre		0.2	0.6	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Pest control (40 per cent area treated)											
1. Number of rounds			2	2	2	2	2	2	2	2	2
2. Rate per acre per round man day			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
3. Total man days per acre			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.4
Weeding (circles, interrows and noxious weeds)											
Sprays											
1. Number of rounds		6	8	6	4	4	3	3	3	3	3
2. Rate per acre per round man day		0.3	0.5	0.5	0.5	0.5	0.2	0.2	0.2	0.2	0.2
3. Total man days per acre		1.8	4.0	3.0	2.0	2.6	0.6	0.6	0.6	0.6	0.6
Slashing											
1. Number of rounds		3	6	4	3	3	1	1	1	1	1
2. Rate per acre per round man day		1.0	1.0	1.0	0.8	0.6	0.6	0.6	0.6	0.6	0.6
3. Total man days per acre		3.0	6.0	4.0	2.4	2.4	0.6	0.6	0.6	0.6	0.6
Inspection paths											
1. Number of rounds		3	4	6	3						
2. Rate per acre per round man day		0.1	0.25	0.25	0.1						
3. Total man days per acre		0.3	1.0	1.5	0.3						
Harvesting paths maintenance											
1. Number of rounds				3	4	4	1	1	1	1	1
2. Rate per acre per round man day				0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3
3. Total man days per acre				1.5	2.0	1.2	0.3	0.3	0.3	0.3	0.3
Pollination											
Application											
1. Number of rounds				30	100	110	110	100	80		
2. Rate per acre per round man day				0.08	0.07	0.06	0.05	0.05	0.05		
3. Sub-total man days per acre				2.4	7.0	6.9	6.0	5.0	4.0		
Collection											
4. Sub-total man days per acre				0.6	0.75	0.7	0.5	0.5	0.4		
5. Total application + collection				3.0	7.75	7.6	6.5	5.5	4.4		
Pruning (1 round per annum)											
1. Number of rounds				1	1	1	1	1	1	1	1
2. Rate per acre per round man day				2.0	2.0	1.7	1.7	1.7	1.7	2.4	3.0
3. Total man days per acre				2.0	2.0	1.7	1.7	1.7	1.7	2.4	3.0
Harvesting (50 rounds per annum)											
1. Tons ffb				0.5	3.5	6.0	9.0	9.0	9.0	8.5	8.0
2. Rate per ton man day				3.5	2.5	1.5	1.1	1.1	1.1	1.3	1.6
3. Total man days per acre				1.8	8.7	9.3	10.0	10.0	10.0	11.1	12.8
Roads and drain maintenance											
1. Number of rounds											
2. Rate per acre per round man day											
3. Total man days per acre		0.10	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.50	0.50

APPENDIX II

TABLE 11.1 RUBBER PRODUCTION COSTS (\$ PER ACRE)

Operation	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
On-farm development																										
Land clearing (including weed spray)	99.0	101.4																								
Roads	28.2	3.0	3.0	3.0	3.0	3.0	60.6	8.6	8.6																	
Drains	10.0	0.6	0.6																							
Total (including labour)	99.0	139.6	3.6	3.6	3.6	3.6	61.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
Development labour (including above) man days	5.7	6.3					0.6																			
On-farm production																										
Production materials:	22.7																									
Cover crop	24.3																									
Planting	14.9	23.5	25.2	33.8	37.7	37.7	48.8	48.8					57.6	57.6												
Fertilising	9.1	12.6	11.3	10.2	6.4	3.6	4.7	4.7	3.6	3.6																
Weeding	1.0	1.0																								
Pest and diseases control																										
Tapping and collection equipment																										
Sub-total materials	72.0	37.1	37.5	45.0	45.1	42.3	82.2	57.5	56.4	56.4	56.4	56.4	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2
Production labour:																										
Labour input man days	34.7	23.1	16.8	13.4	9.9	8.3	25.6	39.9	42.1	45.5	46.2	48.8	49.3	50.4												
Labour cost at \$5	173.5	115.5	84.0	67.0	49.5	41.5	128.0	199.5	210.5	227.5	231.0	244.0	246.5	252.0	252.0											
Total production costs (labour at \$5)	245.5	152.6	121.5	112.0	94.6	83.8	210.2	257.0	266.9	283.9	287.4	309.2	311.7	317.2	317.2											
Total on-farm costs (labour at \$5)	99.0	385.1	156.2	125.1	115.6	98.2	145.0	219.4	266.2	276.1	293.1	296.6	318.4	320.9	326.4	326.4	326.4	326.4	326.4	326.4	326.4	326.4	326.4	326.4	326.4	326.4
Ex-farm costs																										
(Including labour)																										
Reception and transport								10.9	13.6	15.3	16.4	16.9	17.6	18.3	19.0	19.0										
Processing								36.7	63.1	78.8	88.7	93.7	100.0	106.2	112.5	112.5										
Distribution								11.0	18.0	22.4	25.3	26.7	28.5	30.3	32.0	34.0										
Total ex-farm costs								60.6	94.7	116.5	130.4	137.3	146.1	154.8	163.5	163.5	163.5	163.5	163.5	163.5	163.5	163.5	163.5	163.5	163.5	163.5

TABLE II.2 COSTS OF LAND CLEARING FOR RUBBER

Provided by estate/contractor	Item	Cost per acre cleared \$
Estate	Survey and renticing	1
Contractor	Underbrushing	25
Contractor	Felling	60
Estate	Burning	3
Estate	Stacking	80
Contractor	Chain sawing	4
Estate	Re-burning stacks	5
Total cost per acre cleared		178
Cost per acre planted		198

The incidence of these costs is estimated to be 50 per cent in year 0 and 1 respectively.

TABLE II.3 ROAD CONSTRUCTION AND MAINTENANCE COSTS FOR RUBBER

Item	Amount	Cost per unit	Cost per acre of rubber \$
<u>Construction</u> (year 1)	Chain	\$/chain	
Cutting tertiary road	0.3	45	13.50
Up-grading secondary road	0.1	27	2.70
Culverting and bridges		30	12.00
<u>Sub-total</u>			28.20
<u>Gravelling</u> (year 6)	Cubic yard/chain	\$/cubic yard	
Tertiary	7	17)	54.40
Secondary	11	17)	
Spreading and rolling	3.2 cubic yard	1	3.20
<u>Sub-total</u>			57.60
Overall total			85.80
<u>Maintenance</u>			
10 per cent of construction costs:			
Years 2 to 6			3.00
Year 7 and following			8.60

TABLE II.4 COSTS OF DRAINAGE AND STREAM CLEARING FOR RUBBER

Year	Labour	Materials and equipment	Total
1	2.00		2.00
2	3.00	5.00	8.00
Total	5.00	5.00	10.00

Note: Maintenance of drains is estimated at 12 per cent of the initial construction cost from year 3 onwards thus:-

	<u>Labour</u>	<u>Materials</u>	<u>Total</u>
Year 3 onwards	\$0.60	\$0.60	\$1.20

TABLE II.5 RUBBER PLANTING COSTS
(DOLLARS)

Operation/rate	Cost per acre		
	Labour	Materials	Total
Lining	15.00		15.00
Holing and filling, 40 holes per day	22.00		22.00
Clearing, planting points 5 per cent at \$0.50	4.50		4.50
Terracing 66 per cent area; 14 chains at \$4.40 per chain	62.00		62.00
Cost of seeds, \$0.02 each		10.80	10.80
Planting seeds, 1 000 seeds per day - 540 seeds per acre	2.50		2.50
Seed bed preparation and germination 1.3 man days per 1 000 seeds	3.25		3.25
Budwood, 3 to 4 inches per stump at \$0.02 each 250 points		5.00	5.00
Plastic binding strip and budding knives at \$0.02 per point - 250 points		5.00	5.00
Budding 100 per day, 180 per acre	9.00		9.00
Cutting back 2 acres per day	2.50		2.50
Fertiliser 50 pounds CIRP		3.50	3.50
Rebudding (30 per cent failure plus 10 per cent discard) 75 per day	5.00		5.00
Cutting back 2 acres per day	2.50		2.50
Weeding seedlings 2 rounds at 2 acres per day	5.00		5.00
Total cost of planting	133.25	24.30	157.55

Note: These costs are assumed to be incurred within year 1 of the project.

TABLE II.6 ESTIMATED COSTS OF ETHREL STIMULATION

Item	Amount	Cost per acre
		\$
Labour	3.6 man days	18.00
Materials: Ethrel	0.66 pint	22.68
Palm oil	5 pints	2.50
Tools		0.25
Sub-total cost of materials		25.43
Total cost per annum from year 17 onwards		43.43

TABLE II.7 COSTS OF EQUIPMENT AND TOOLS EMPLOYED FOR CONVENTIONAL LATEX TAPPING

Detail/item	Cost per unit	Initial cost per acre \$	Annual repairs and maintenance cost \$
<u>Unstimulated rubber (Year 7 onwards)</u>			
Cups (glass) - 16 ounces	17.5¢	21.00	2.10
Hangers	3.2¢	4.00	0.40
Spouts	0.022¢	0.40	0.20
Tapping knives	\$2.60	0.32	0.32
Churns	\$15.50	1.90	0.40
Sub-total unstimulated		27.72	3.02
<u>Additional costs for stimulated rubber (Year 17 onwards)</u>			
Cups		21.00	2.10
Hangers		4.00	0.40
Churns		1.90	0.40
Sub-total additional costs		26.90	2.90
Total costs for stimulated rubber			5.92

TABLE II.9 TYPICAL LABOUR INPUTS AND COST OF MATERIALS FOR UNSMOKED SHEET PRODUCTION

Item/detail	Costs per 1 000 pounds drc					
	Individual small-holder			Estate/processing centre		
	Labour		Materials cost \$	Labour		Materials cost \$
	Man days	Cost \$		Man days	Cost \$	
Coagulation) Mangling) Drying) Handling/storage)	3.8	19.00	5.00	2.1	10.50	5.00

TABLE II.10 TYPICAL LABOUR INPUTS AND COST OF MATERIALS FOR LARGE LUMP PRODUCTION

Item/detail	Per 1 000 pounds drc			
	Labour		Materials cost \$	Total cost \$
	Man days	Cost \$		
Coagulation) Handling/storage)	0.7	3.50	5.00	8.50

TABLE II.11 TYPICAL COSTS OF EQUIPMENT REQUIRED FOR UNSMOKED SHEET PRODUCTION (DOLLARS)

Item/detail	Individual small-holder		Processing centre	
	Initial	Annual	Initial	Annual repairs and maintenance cost
Building/storage	300	9	2 400	48
Coagulation tanks)	1 200	120	{ 6 000	600
Mangles/sheeting battery)			{ 10 000	750
Drying racks)			{ 400	40
Total	1 500	129	18 800	1 438

TABLE II.12 TYPICAL CAPITAL COSTS OF EQUIPMENT REQUIRED FOR
BUCKET LUMP PRODUCTION
(DOLLARS)

Item/detail	Initial cost	Annual repairs and maintenance cost
Buildings - 250 square feet	1 200	25
Coagulation tanks - 6 by 100 gallon capacity	3 000	300
Utensils and tools	300	30
Total	4 500	355
Average cost per acre - unstimulated rubber	15.00	1.50
Average cost per acre - stimulated rubber	20.00	1.60

TABLE II.13 COSTS OF FRESH LATEX RECEPTION AND TRANSPORT

Item	Initial capital cost \$	Useful life years	Annual costs		
			Depreciation \$	Repairs and maintenance	
				Rate per cent	Cost \$
Reception station					
Building - open shed	1 200	10	195	2	120
500 gallon holding tank	600	5	158	5	30
Scale and utensils	150	5	40	10	15
Sub-total	1 950		393		165
Average costs - unstimulated rubber 300 acres	6.50		1.31		0.55
Per acre served - stimulated rubber 225 acres	8.70		1.74		0.73
Transportation equipment					
Tractor 65 hp	15 600	7	3 204	See note(1)	
Tanker 500 gallons	6 000	7	1 232		7 030
Trailer 3 ton	3 400	10	553		
Sub-total	25 000		4 989		7 030
Average costs - unstimulated rubber 920 acres	27		5.42		7.65(2)
Per acre served - stimulated rubber 640 acres	39		7.80		10.10(2)

Notes (1) Details of operating costs of tractor and tanker are as follows:-

Operating	Hours/annum	Cost per hour	Cost per annum
		\$	\$
Operator	1 800	1.50	2 700
Fuel and oil	1 200	1.20	1 440
Repairs and maintenance	1 200	2.20	2 640
Insurance and licence			250
Total			7 030

(2) In addition to the above a weighing attendant would be required to receive and weigh latex. The labour input is assessed at 2.5 man hours per station per day, at a rate of \$1.00 per hour. The cost would be \$2.50 per acre for unstimulated and \$3.30 for stimulated rubber.

The overall average cost on a dry basis would thus be:-

	Cost per pound cents	Cost per ton \$
Reception station - maintenance	0.03	0.67
Transport	0.51	11.42
Weighing	0.14	3.14
Total	0.68	15.23

TABLE II.14 COSTS OF BUCKET OR POLYBAG COAGULUM TRANSPORT
(DOLLARS)

Item	Cost rate	Average cost per trip	Average cost per ton
Vehicle time cost per year	5 300	1.76	
Driver cost per hour	4.20	5.88	
Vehicle running cost per mile	0.42	5.04	
<u>Total</u> vehicle and driver cost per round trip		12.68	
<u>Add</u> 10 per cent overheads		1.30	
<u>Sub-total</u> vehicle costs		13.98	
Average cost per ton (7 tons load)			2.00
Labour for loading - 3 labourers (double shift) at \$1.00 per hour		4.20	
Average cost per ton (7 tons load)			0.60
Weighing attendant assuming weighing at 2 tons per hour at \$1.00 per hour			0.50
Total weighing, loading and transport cost per ton of field coagulum material			3.10
<u>Cost per ton on a drc basis</u>			
Large lumps and scrap			5.63
Unsmoked sheets			3.87

TABLE II.15 TYPICAL CAPITAL COSTS OF CRUMB RUBBER FACTORY CONSTRUCTION
(DOLLARS)

Item	Cost for basic factory of 10 tons per day		Additional costs for expansion to 20 tons per day		
	Item cost	Total cost	Item cost	Additional cost	Total cost
Factory buildings		200 000		60 000	260 000
Roads and fencing		50 000			50 000
Machinery and equipment		346 000		253 000	599 000
Reception	7 000		7 000		
Macerator/crepers	100 000		80 000		
Creper/hammer mill	50 000		50 000		
Drier	60 000		60 000		
Baler	18 000		18 000		
Electricity	76 000		38 000		
Weighbridge	35 000				
Vehicles 1 LWB + 1 forklift		36 000			36 000
Water supply and storage		25 000		25 000	50 000
Staff housing and quarters		174 700		65 000	239 700
Servicing and installation fees		40 000		10 000	50 000
Total		871 700			1 288 700

TABLE II.16 DETAILS OF FACTORY BUILDINGS COSTS
(DOLLARS)

Details	Cost for 10 ton per day capacity	Addition for 20 ton per day capacity
Factory buildings	200 000	60 000
Roads, earthworks and fencing	50 000	
Service and installation fees	40 000	

TABLE II.17 DETAILS OF STAFF HOUSING COSTS

Details	Required for 10 ton per day factory		Addition for 20 ton per day capacity factory	
	No. of units	Cost \$	No. of units	Cost \$
Manager	1	20 000		
Supervisors	1	9 000		
Foremen and fitters	4	20 000	2	10 000
Clerks and laboratory analyst	2	8 000	2	8 000
Labour	32	112 000	13	45 000
<u>Sub-total</u>		169 000		63 000
Furniture for senior staff houses at 10 per cent		5 700		2 000
Total		174 700		65 000

TABLE II.18 TYPICAL RUBBER FACTORY MAINTENANCE AND DEPRECIATION COSTS

Detail	Annual repairs and maintenance as percentage of initial cost	Maintenance and repairs costs (Dollars)				Expected life years	Depreciation allowed including interest at 10 per cent (Dollars)	
		10 tons per day		20 tons per day			10 tons per day	20 tons per day
		Initial capital cost	Maintenance	Initial capital cost	Maintenance			
Factory buildings	0.5	200 000	1 000	260 000	1 300	25	22 000	28 600
Roads and fencing	5	50 000	2 500	50 000	2 500	25	5 500	5 500
Water supply and storage	5	25 000	1 300	50 000	2 600	25	2 800	5 600
Staff housing and quarters	2	174 700	3 500	239 700	4 800	25	19 200	26 400
Machinery and equipment	7.5	346 000	26 000	599 000	44 900	10	56 300	97 500
Vehicles	7.5	36 000	2 800	36 000	2 800	8	6 700	6 700
<u>Total</u>		831 700	37 100	1 288 700	58 900		112 500	170 300
Annual throughput (tons)		(2 400)		(5 500)			2 400	5 500
Cost per ton		346	15.50	234.30	10.70		46.90	31.00
Cost per pound drc (cents)			0.69		0.48		2.09	1.38

TABLE II.19 RUBBER FACTORY STAFF REQUIREMENT AND SALARY COSTS

Category/operation	For 10 ton per day capacity (2 000 to 2 800 tons per annum)		For 20 ton per day capacity (5 000 to 6 000 tons per annum)			
	Annual salary including regional allowance \$	No. of staff (three shift operation)	Total salaries \$	No. of staff	Total salaries \$	
Management and supervision						
Factory manager	12 100	1	12 100	1	12 100	
Production supervisor	9 400	1	9 400	1	9 400	
Conductors	4 400	2	8 800	3	13 200	
Fitters/chargeman	3 500	2	7 000	3	10 500	
Laboratory analyst	4 400	1	4 400	1	4 400	
Laboratory attendant	3 500	1	3 500	2	7 000	
Clerks	4 400	1	4 400	2	8 800	
Driver	3 500	1	3 500	1	3 500	
Watchman	1 900	2	3 800	2	3 800	
Sub-total salaries cost		12	56 900	16	72 700	
	No. of workers per shift	No. of shifts	Total no. of workers	No. of workers per shift	No. of shifts	Total no. of workers
Unskilled labour						
Reception and preparation	4	3	12	6	3	18
Creping	4	3	12	7	3	21
Hammermilling	2	3	6	3	3	9
Drying	2	3	6	3	3	9
Packaging and warehouse	2	3	6	4	3	12
Powerhouse and general	3	1	3	5	1	5
Total number			45			74
Sub-total wages cost at \$1 500 per annum \$			67 500			111 000
Total salaries and wages \$			124 400			183 700
EPF, medical etc. at 15 per cent \$			18 600			27 500
Total cost per annum \$			143 000			211 200
Total factory output (tons)			2 400			5 500
Average cost per pound drc:-			\$			\$
Total salaries and wages			2.66			1.73
Supervision			1.22			0.68
Labour			1.44			1.05

TABLE II.20 SUMMARY CRUMB RUBBER PROCESSING COSTS OF
BUCKET LUMP FIELD MATERIAL

Item	Cost per pound drc for factory sizes of	
	10 ton factory cents	20 ton factory cents
Salaries and wages	2.70	1.75
Fuel and power	1.00	1.00
Chemicals	0.10	0.10
Repairs and maintenance	0.70	0.50
Packaging	1.00	1.00
Miscellaneous	0.20	0.20
<u>Sub-total</u>	5.70	4.55
Depreciation of buildings and plant	2.10	1.40
Total	7.80	5.95

For factories based on field latex the following variations would be applicable:-

Fuel and power	0.80 cents per pound
Chemicals	0.60 cents per pound

TABLE II.21 TYPICAL MANAGEMENT STAFF AND ADMINISTRATION COSTS OF
RUBBER SCHEMES

Category	Annual salary \$	Total number required	Total cost per scheme \$
A. Management			
Manager	19 800	1	19 800
Assistant Manager	12 100	2	24 200
Senior Supervisor	9 400	4	37 600
Field Assistant	4 400	8	35 200
<u>Sub-total</u>			116 800
B. Administration			
Clerk/typist	4 400	2	8 800
Driver	3 500	1	3 500
Settlement Development Assistant	3 500	2	7 000
Artisan	3 500	1	3 500
Watchman	1 500	1	1 500
<u>Sub-total</u>			24 300
<u>Add EPF and benefits 10 per cent</u>			14 100
Total salaries			155 200
Average cost per acre			38.80
Scheme office running costs			16 000
Average cost per acre			4.00

TABLE II.22 TEMPORARY BUILDING COSTS ON RUBBER SCHEMES

Type of building	Cost \$
Office-cum-store	5 000
P.O.L. store	500
Shop and canteen	3 000
Scheme Manager house	3 000
Assistant Scheme Manager house	3 000
Field Supervisor house	3 000
Field Assistant houses	6 000
Labour 'konsis' (200 workers)	35 000
Total	58 500

Average cost per acre \$14.60

TABLE II.23 ADMINISTRATIVE BUILDINGS AND STAFF HOUSING REQUIREMENTS FOR RUBBER SCHEMES

Type	No. of units	Cost per unit	Total cost
<u>Administrative buildings</u>		\$	\$
Office	1	30 000	30 000
Main store	1	10 000	10 000
P.O.L. store	1	2 000	2 000
<u>Sub-total</u>			42 000
<u>Staff quarters</u>			
Manager	1	40 000	40 000
Assistant manager	2	30 000	60 000
Supervisors	4	15 000	60 000
Field assistants	6	8 000	48 000
Clerk, Settlement Development Assistant	2	5 000	10 000
Driver, watchman, artisan	3	3 500	10 500
<u>Sub-total</u>			228 500
Furniture and equipment at 10 per cent			27 000
Overall total			297 500
Average cost per acre			74.40

TABLE II.24 COST OF VEHICLES AND EQUIPMENT FOR RUBBER SCHEMES

Type of vehicle	Number required	Cost per unit \$	Useful life	Year/s purchased
Four wheel drive pick-up	2	15 000	7	0, 1
Tractor 65 hp	2	17 000	7	0
Trailer 3 ton tipping	2	3 400	10	0
Tanker 600 gallon with pump	1	5 500	10	1
Diesel generator 5 Kw	1	5 000	10	0
Radio equipment-	1	5 500	7	0
Ditch digger	$\frac{1}{2}$ share	40 000	10	2

TABLE II.25 RUBBER DISTRIBUTION COSTS

Item	Detail	Cost per ton \$
Transport	65 miles one way distance rate per ton mile of 16.6 cents	10.80
Port charges	\$8 per ton	8.00
Selling commission etc.	2 per cent of fob value at 47 cents per pound RSS1	21.00
Total cost per ton		39.80
Average cost per pound drc		1.78¢

TABLE II.26 RUBBER YIELDS AND QUANTITIES OF FIELD MATERIALS PRODUCED
POUNDS PER ACRE

Year	Basic yield unstimulated				Yield stimulated(1)				Field materials produced(2)								
	Latex				Latex				Unstimulated			Stimulated					
	Total	High grade	Scrap(3)	D.r.c.	Total	High grade	Scrap(3)	D.r.c.	Latex	Scrap	Field coagulum	Unsmoked sheet	Latex	Scrap	Field coagulum	Unsmoked sheet	
7	620	527	93	620	527	93	620	527	93	1 550	169	958	659	1 550	169	958	659
8	1 010	859	151	1 010	859	151	1 010	859	151	2 526	275	1 562	1 074	2 526	275	1 562	1 074
9	1 260	1 071	189	1 260	1 071	189	1 260	1 071	189	3 150	344	1 947	1 339	3 150	344	1 947	1 339
10	1 420	1 207	213	1 420	1 207	213	1 420	1 207	213	3 550	387	2 195	1 509	3 550	387	2 195	1 509
11	1 500	1 275	225	1 500	1 275	225	1 500	1 275	225	3 750	409	2 318	1 594	3 750	409	2 318	1 594
12	1 600	1 360	240	1 600	1 360	240	1 600	1 360	240	4 000	436	2 473	1 700	4 000	436	2 473	1 700
13	1 700	1 445	255	1 700	1 445	255	1 700	1 445	255	4 250	464	2 627	1 806	4 250	464	2 627	1 806
14	1 800	1 530	270	1 800	1 530	270	1 800	1 530	270	4 500	491	2 782	1 913	4 500	491	2 782	1 913
15	1 800	1 530	270	1 800	1 530	270	1 800	1 530	270	4 500	491	2 782	1 913	4 500	491	2 782	1 913
16	1 800	1 530	270	1 800	1 530	270	1 800	1 530	270	4 500	491	2 782	1 913	4 500	491	2 782	1 913
17	1 800	1 530	270	1 800	1 530	270	1 800	1 530	270	4 500	491	2 782	1 913	4 500	491	2 782	1 913
18	1 800	1 530	270	1 800	1 530	270	1 800	1 530	270	4 500	491	2 782	1 913	4 500	491	2 782	1 913
19	1 800	1 530	270	1 800	1 530	270	1 800	1 530	270	4 500	491	2 782	1 913	4 500	491	2 782	1 913
20	2 000(4)	1 700	300	2 800	2 240	560	2 800	2 240	560	5 000	545	3 091	2 125	5 929	916	3 665	2 520
21	2 000	1 700	300	2 800	2 240	560	2 800	2 240	560	5 000	545	3 091	2 125	5 929	916	3 665	2 520
22	1 900	1 615	285	2 660	2 128	532	2 660	2 128	532	4 750	518	2 936	2 019	6 259	967	3 869	2 660
23	1 900	1 615	285	2 660	2 128	532	2 660	2 128	532	4 750	518	2 936	2 019	6 259	967	3 869	2 660
24	1 800	1 530	270	2 520	2 016	504	2 520	2 016	504	4 500	491	2 782	1 913	5 929	916	3 665	2 520
25	1 800	1 530	270	2 520	2 016	504	2 520	2 016	504	4 500	491	2 782	1 913	5 929	916	3 665	2 520

Notes (1) Increase in yield due to stimulation estimated at 40 per cent of basic yield.

(2) D.r.c. equivalents used for conversion to field materials:-

Latex : 34 per cent
Scrap : 55 per cent
Field coagulum : 55 per cent
Unsmoked sheets : 80 per cent

(3) Scrap unstimulated 15 per cent of d.r.c.
Scrap stimulated 20 per cent of d.r.c.

(4) Small-holding yield assumed to remain at 1 800 pounds per acre for years 20 to 25.

TABLE II.27 LABOUR REQUIREMENTS OF RUBBER BASED ON BUCKET LUMP PRODUCTION (WITH STIMULATION)
MAN DAYS PER ACRE

Operation/detail	Years																								
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14-16	17	18-19	20-21	22	23	24-25				
<u>Estate/farm labour</u>	0.2	11.2	3.9	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Establishment	-	9.1	19.8	16.8	-	-	8.3	9.0	8.9	8.7	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0			
Maintenance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.6	3.6	3.6	3.6	3.6	3.6	3.6			
Stimulation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Opening up tapping panels	-	-	-	-	-	-	0.6	-	-	-	-	0.6	0.6	0.6	-	0.6	-	-	0.6	-	-	-			
Tapping and latex collection	-	-	-	-	-	-	-	16.0	31.0	34.4	36.5	37.2	39.2	40.3	41.4	41.2	47.2	49.5	48.4	48.4	48.4	47.2			
Coagulation	-	-	-	-	-	-	-	0.4	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.4	1.4	1.6	1.5	1.5	1.5	1.4			
Total farm labour requirements	0.2	20.3	23.7	16.8	13.4	9.9	8.9	26.0	40.5	43.8	46.3	47.1	49.8	50.3	51.5	61.8	61.2	63.7	63.1	62.5	61.2				
<u>Contractor labour</u>	5.5	17.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Establishment																									

TABLE II.28 LABOUR REQUIREMENTS OF RUBBER BASED ON BUCKET LUMP PRODUCTION (WITHOUT STIMULATION)
MAN DAYS PER ACRE

Operation/detail	Years																								
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14-16	17	18-19	20-21	22	23	24-25				
<u>Estate/farm labour</u>	0.2	11.2	3.9	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Establishment	-	9.1	19.8	16.8	-	-	8.3	9.0	8.9	8.7	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0			
Maintenance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Opening up tapping panels	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	0.6	-	-	0.6	-	-	-			
Tapping and latex collection	-	-	-	-	-	-	-	16.0	31.0	34.4	36.5	37.2	37.2	40.3	41.4	41.4	41.4	45.4	44.4	44.4	44.4	43.2			
Coagulation	-	-	-	-	-	-	-	0.4	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.4	1.3	1.3	1.3	1.1			
Total labour requirements	0.2	20.3	23.7	16.8	13.4	9.9	8.9	26.0	40.5	43.8	46.3	47.1	49.8	50.3	51.5	52.1	51.5	55.8	55.3	54.7	53.3				
<u>Contractor labour</u>	5.5	17.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Establishment																									

TABLE II.29 LABOUR REQUIREMENTS OF RUBBER BASED ON LATEX PRODUCTION (WITH STIMULATION)
MAN DAYS PER ACRE

Operation/detail	Years																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14-16	17	18-19	20-21	22	23	24-25			
<u>Estate/farm labour</u>																								
Establishment	0.2	11.2	3.9	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Maintenance	-	9.1	19.8	16.8	13.4	9.9	8.3	9.0	8.9	8.7	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0		
Stimulation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.6	3.6	3.6	3.6	3.6	3.6	3.6		
Opening up tapping panels	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-		
Tapping and latex collection	-	-	-	-	-	-	-	16.0	31.0	34.4	36.5	37.2	39.2	40.3	41.4	41.2	47.2	49.5	48.4	48.4	47.2	-		
Total farm labour requirements	0.2	20.3	23.7	16.8	13.4	9.9	8.9	25.6	39.9	43.1	45.5	46.2	48.8	49.3	50.4	54.4	59.8	62.1	61.6	61.0	59.8	-		
<u>Contractor labour</u>																								
Establishment	5.5	20.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

TABLE II.30 LABOUR REQUIREMENTS OF RUBBER BASED ON LATEX PRODUCTION (WITHOUT STIMULATION)
MAN DAYS PER ACRE

Operation/detail	Years																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14-16	17	18-19	20-21	22	23	24-25			
<u>Estate/farm labour</u>																								
Establishment	0.2	11.2	3.9	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Maintenance	-	9.1	19.8	16.8	13.4	9.9	8.3	9.0	8.9	8.7	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0		
Tapping and latex collection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Opening up tapping panels	-	-	-	-	-	-	-	16.0	31.0	34.4	36.5	37.2	39.2	40.3	41.4	41.4	41.4	45.4	44.4	44.4	43.2	-		
Total farm labour requirements	0.2	20.3	23.7	16.8	13.4	9.9	8.9	25.6	39.9	42.1	45.5	46.2	48.8	49.3	50.4	51.0	50.4	54.4	55.0	53.4	52.2	-		
<u>Contractor labour</u>																								
Establishment	5.5	20.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

Note * For small-holding situation assume constant yields and labour input requirements from year 14 onwards.

TABLE II.31 DETAILS OF RUBBER ESTABLISHMENT LABOUR REQUIREMENTS
MAN DAYS PER ACRE

Operation/detail	Labour source	Basic requirement	Years								
			0	1	2	3	4	5	6	7	8
<u>Land clearing</u>											
Surveying	E	0.2	0.2	-	-	-	-	-	-	-	-
Underbrushing	C	2.5	2.5	-	-	-	-	-	-	-	-
Felling	C	5.5	3.0	2.5	-	-	-	-	-	-	-
Stacking and burning	C/E	2.3	-	2.3	-	-	-	-	-	-	-
Cover spray	E	0.3	-	0.3	-	-	-	-	-	-	-
Total		10.8	5.7	5.1	-	-	-	-	-	-	-
<u>Planting</u>											
Lining	C	3.0	-	3.0	-	-	-	-	-	-	-
Terracing	C	12.4	-	12.4	-	-	-	-	-	-	-
Cover crop - sow	C	1.4	-	1.4	-	-	-	-	-	-	-
- fertilising	E	0.3	-	0.3	-	-	-	-	-	-	-
- weeding	E	1.0	-	1.0	-	-	-	-	-	-	-
Clear planting points	E	0.9	-	0.9	-	-	-	-	-	-	-
Holing	C	4.5	-	4.5	-	-	-	-	-	-	-
Seed bed - germinating seed	E	0.6	-	0.6	-	-	-	-	-	-	-
Plant seeds & fertilise holes	E	0.5	-	0.5	-	-	-	-	-	-	-
Seedling maintenance	E	1.0	-	1.0	-	-	-	-	-	-	-
Budding	E	2.8	-	-	2.8	-	-	-	-	-	-
Cutting back	E	0.5	-	-	0.5	-	-	-	-	-	-
Sub-total planting		25.8	-	25.6	3.3	-	-	-	-	-	-
<u>Roads</u>											
Cutting and culverting	C/E	0.2	-	0.2	-	-	-	-	-	-	-
Gravelling	C/E	0.6	-	-	-	-	-	-	0.6	-	-
<u>Drainage</u>											
Stream line clearing	E	1.0	-	1.0	-	-	-	-	-	-	-
Sub-total		2.1	-	1.2	0.3	-	-	-	0.6	-	-
Total - contractor		23.0	5.5	20.7	-	-	-	-	-	-	-
- estate		15.9	0.2	11.2	3.9	-	-	-	0.6	-	-
Overall		38.9	5.7	30.9	3.9	-	-	-	0.6	-	-

TABLE II.32 DETAILS OF RUBBER MAINTENANCE ACTIVITIES AND LABOUR REQUIREMENTS
MAN DAYS PER ACRE

Operation	Years										
	1	2	3	4	5	6	7	8	9	10	11 and following
<u>Fertilising</u>	No. of rounds	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	2.0	2.0
	Rate per round	0.3	0.3	0.4	0.4	0.4	0.6	0.6	0.6	0.6	0.6
	Total man days	0.9	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
<u>Pests</u>	No. of rounds	2	2	2	2	2	2	0.5	0.4	0.5	0.4
	Rate per round	0.12	0.12	0.025	0.12	0.025	0.12	0.025	0.2	0.1	0.2
	Total man days	0.25	0.25	0.05	0.25	0.05	0.25	0.05	0.1	0.05	0.1
<u>Diseases</u>	No. of rounds	3	3	3	3	3	3	3	3	3	3
	Rate per round	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
	Total man days	0.6	0.6	0.9	0.9	0.9	0.6	0.6	0.6	0.6	0.6
<u>Weeding</u>	No. of rounds	3	5	4	4	4	1	1	1	1	1
	Rate per round	0.11	0.11	1.5	0.1	1.5	0.2	1.5	0.2	1.5	0.2
	Total man days	0.3	0.6	6.0	0.4	6.0	0.2	1.5	0.2	1.5	0.2
<u>Circles/strips*</u>	No. of rounds	4	8	6	4	3	2	2	2	2	2
	Rate per round	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8
	Total man days	3.6	7.2	5.4	3.6	2.4	1.6	1.6	1.6	1.6	1.6
<u>Noxious weeds (spray)</u>	No. of rounds	4	4	4	4	2	-	-	-	-	-
	Total man days	0.8	0.8	0.8	0.8	0.4	-	-	-	-	-
	Total man days	-	-	-	-	-	0.5	0.5	0.25	0.25	0.25
<u>Tapping paths</u>	No. of rounds	7.4	16.1	12.7	9.3	5.8	4.1	4.1	3.9	3.9	3.9
	Rate per round	1	3	2	2	2	2	2	2	2	2
	Total man days	0.5	0.5	0.75	0.75	0.75	1.0	1.0	1.0	1.0	1.0
<u>Pruning & sanitation</u>	No. of rounds	0.5	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0
	Rate per round	-	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
	Total man days	9.1	19.8	16.8	13.4	9.9	8.3	9.0	8.9	9.0	9.0
<u>Roads & drains maintenance</u>	No. of rounds	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	Rate per round	-	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
	Total man days	9.1	19.8	16.8	13.4	9.9	8.3	9.0	8.9	9.0	9.0

Note T = Termite; C = Caterpillar
S = Spray; Ch = Changkol

TABLE III.1 COCOA PRODUCTION COSTS (\$ PER ACRE)

Operation	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
On-farm development																										
Land clearing	93.0	90.4																								
Drainage		85.0	13.0	13.0																						
Roads		79.0		133.0	21.0	21.0																				
Total (including labour)	93.0	254.4	13.0	146.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
Development labour (including above) man days																										
On-farm production	5.7	9.6		2.0																						
Production materials:																										
Covers		22.7	12.5		6.9	3.5	3.5																			
Shade		12.5																								
Planting materials at 10 cts		43.5																								
Tools		12.0	0.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Fertilisers			45.8	40.6	44.3	80.3	104.3	104.3																		
Herbicides			14.9	26.0	10.8	5.4	5.4																			
Pest and disease control			5.0	15.5	19.5	19.5																				
Sub-total materials	90.7	76.8	90.6	79.7	110.3	130.8	130.8	130.8	141.2	130.8	130.8	130.8	130.8	130.8	130.8	130.8	141.2	130.8	130.8	130.8	130.8	130.8	130.8	130.8	130.8	130.8
Production labour:																										
Labour input man days		12.7	37.3	30.7	22.9	24.4	26.5	26.5																		
Labour cost at \$5		63.5	186.5	153.5	114.5	122.0	132.5	132.5																		
Total production costs (labour at \$5)	154.2	265.3	244.1	194.2	232.3	263.3	263.3	263.3	273.7	263.3	263.3	263.3	263.3	263.3	263.3	263.3	273.7	263.3	263.3	263.3	263.3	263.3	263.3	263.3	263.3	263.3
Total on-farm costs (labour at \$5)	93.0	408.6	278.3	390.1	228.2	266.3	297.3	297.3	297.3	297.3	297.3	297.3	297.3	297.3	297.3	297.3	307.7	297.3	297.3	297.3	297.3	297.3	297.3	297.3	297.3	297.3
Ex-farm costs																										
Transport to factory					1.7	3.3	5.0	5.0																		
Processing					17.5	35.0	52.5	52.5																		
Distribution					8.2	16.4	24.6	24.6																		
Total ex-farm costs					27.4	54.7	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1	82.1

TABLE III.3 RICE PRODUCTION COSTS (\$ PER ACRE)

Operation	0	1	2	3	4	5 and following
<u>On-farm development</u>						
Land clearing and destumping	93.0	262.0				
Drainage		310.9	188.8	32.5	32.5	32.5
Land levelling and bunding			194.3			
Total (including labour)	93.0	572.9	383.1	32.5	32.5	32.5
Development labour (including above) man days	5.7	21.5	24.4			
<u>On-farm production</u>						
<u>Production materials:</u>						
Land preparation			28.0	28.0	28.0	28.0
Nursery and seed			4.0	4.0	4.0	4.0
Fertilisers			20.0	20.0	20.0	20.0
Weed and pest control			11.0	11.0	11.0	11.0
Tools			2.0	2.0	2.0	2.0
Sub-total materials			65.0	65.0	65.0	65.0
<u>Production labour:</u>						
Labour input man days			40.0	43.0	42.0	44.0
Labour cost at \$5			200.0	215.0	210.0	220.0
Total production costs (labour at \$5)			265.0	280.0	275.0	285.0
Total on-farm costs (labour at \$5)	93.0	572.9	648.1	312.5	307.5	317.5
<u>For economic analysis</u>						
Development	64.5	465.4	261.1	32.5	32.5	32.5
Production materials			65.0	65.0	65.0	65.0

TABLE III.4 COCOA LABOUR REQUIREMENTS
(MAN DAYS PER ACRE)

Item	0	1	2	3	4	5	6 and following
<u>Land development</u>							
Clearing	5.7	5.1					
Roads construction		0.5		2.0			
Drains construction		4.0					
Total land development	5.7	9.6		2.0			
<u>Planting and shade</u>		12.7	22.2	8.0			
<u>Maintenance</u>							
Weeding and pulling suckers			8.4	11.0	6.6	4.6	4.2
Pest control			4.0	7.0	7.0	7.0	7.0
Fertilising			2.0	2.0	3.0	3.0	3.0
Pruning				2.0	3.0	4.0	4.0
Harvesting					2.5	5.0	7.5
Road maintenance			0.1	0.1	0.2	0.2	0.2
Drains maintenance			0.6	0.6	0.6	0.6	0.6
Sub-total maintenance			15.1	22.7	22.9	24.4	26.5
Total	5.7	22.3	37.3	32.7	22.9	24.4	26.5

TABLE III.5 DETAILS OF COCOA ESTABLISHMENT OPERATIONS AND LABOUR REQUIREMENTS

Operation/detail	Total basic requirement man days per acre	Incidence			
		Man days per acre plantation in years			
		0	1	2	3
<u>Survey and land clearing</u>					
Location and clearing nursery area	0.50	0.20	0.30		
Underbrushing	2.50	2.50			
Felling	5.50	3.00	2.50		
Stacking and burning	2.30		2.30		
Total	10.50	5.70	5.10		
<u>Planting</u>					
Covers	3.2		2.7	0.5	
Line shade	3.0		3.0		
Plant shade cuttings	4.0		4.0		
Shade weeding	1.0		1.0		
Nursery for cocoa	2.5			2.5	
Line cocoa	1.0			1.0	
Hole	8.0			8.0	
Plant seedling	4.0			4.0	
Supply losses	0.2			0.2	
Nursery shade	16.0		2.0	6.0	8.0
Total	42.9		12.7	22.2	8.0
<u>Roads and drains</u>					
Road construction	2.5		0.5		2.0
Drains construction	4.0		4.0		
Total	6.5		4.5		2.0

TABLE III.6 PEPPER LABOUR REQUIREMENTS
(MAN DAYS PER ACRE)

Scheme years	Land preparation	Terracing and maintenance	Drainage and maintenance	Making mounds and remounding	Nursery	Holing and erecting posts and maintenance	Planting	Fertiliser	Pruning and training	Weeding	Spraying	Harvesting and processing	Total man days
0													
1	4.00	45.00	60.00	15.40	2.00	24.60	3.50	14.35	6.14	50.31	7.38		176.68
2		2.25	0.30			1.23		14.35	3.07	39.13	7.38		67.71
3		2.25	0.30	10.40		1.23		10.25	3.07	33.54		94.65	163.07
4				10.40				10.25		33.54		164.72	233.14
5												189.31	257.73
6												189.31	257.73
7												168.40	236.82
8												141.37	209.79
9												121.70	190.12
10												109.41	177.83
11												99.57	167.99
12												94.65	163.07

TABLE III.7 RICE LABOUR INPUTS REQUIREMENTS
(MAN DAYS PER ACRE)

Operation/input requirement	Scheme years					
	0	1	2	3	4	5
<u>Development</u>						
Underbrush, fell and burns	6	5				
Destumping		4				
Main drain construction		12				
Secondary drain construction			11			
Land levelling, bunding and land preparation			13			
Total development	6	21	24			
<u>Production</u>						
Levelling and bund making				5	3	3
Nursery preparation and maintenance			6	6	6	6
Transplanting			10	8	8	8
Weed and pest control			4	4	4	4
Bird scaring			4	4	4	4
Harvesting and threshing			14	14	15	16
Miscellaneous			2	2	2	3
Total production			40	43	42	44
Overall total	6	21	64	43	42	44

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