

# Proposals for agricultural development of the Samarahan and Sadong - Krang Padi Project areas, Sarawak: a pre-feasibility study

## Volume 2 Main Report

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Ministry of Overseas Development

PROPOSALS FOR AGRICULTURAL DEVELOPMENT IN SAMARAHAN AND SADONG-KRANG PADI  
PROJECT AREAS, SARAWAK: A PRE-FEASIBILITY STUDY

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This study is presented in three volumes. Volume 1, the Executive Summary, is a condensed version of Volume 2, the Main Report. Volume 2 describes the background to the study, records the findings of the LRD/ODM Mission and makes recommendations for agricultural development in the two study areas. Volume 3, Appendixes, comprises more detailed information on specialist aspects of the study.

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## ABBREVIATIONS AND ACRONYMS

APPS	Assistance to Padi Planters Scheme
CPS	Coconut Planting Scheme
DID	Drainage and Irrigation Department
FAMA	Federal Agricultural Marketing Authority
JKR	Jabatan Kerja Raya (Public Works Department)
LPN	Lembaga Padi dan Beras Negara (National Padi and Rice Authority)
LRD	Land Resources Division (UK)
MACD	Ministry of Agriculture and Community Development
ODM	Ministry of Overseas Development (UK)
PPU	Padi Production Unit (of the State Planning Unit)
RPS	Rubber Planting Scheme
RRI	Rubber Research Institute, Malaysia
SALCRA	Sarawak Land Consolidation and Rehabilitation Authority
SLDB	Sarawak Land Development Board
SPU	State Planning Unit, Chief Minister's Office

## GLOSSARY

Batang	Major river
Beras	Hulled rice
Gantang	Volumetric measure of rice (0.004546 m <sup>3</sup> )
Gotong royong	Cooperative self help
Kampong	Village
Kati	0.6 kg
Landas	"Wet season"
Munggu (Mg)	Low hill
Padi	General term for the rice crop: unhulled rice
Paya	Swamp: ricefield
Penghulu	Minor official responsible for a group of villages
Pikul	60.5 kg
Tuai rumah ) Tua kampong)	Village headman
Rumah	(Long) house
Sungai	River, stream

## CONVERSION FACTORS

1 hectare = 2.471 ac  
1 kilogram = 2.20 lb  
1 000 kilograms = 1 tonne (t)  
100 kg/ha = 89.22 lb/ac

1 acre = 0.4047 ha  
1 lb = 0.45 kg  
100 lb/ac = 112 kg/ha

1 metre = 1.09 yards  
1 centimetre = 0.39 inches  
1 millimetre = 0.04 inches

1 yard = 0.91 m  
1 foot = 0.30 m  
1 inch = 25.4 mm

1 litre = 1 000 cubic centimetres (ml)  
= 0.039 cubic feet (ft<sup>3</sup>)  
= 0.22 gallons (gal)

1 cubic metre/second = 35.31 cubic feet/second (cusec)  
1 cubic foot/second = 0.028 cubic metre/second (cumec)

### Temperature conversion

Fahrenheit to Centigrade (Celsius)  $(^{\circ}\text{F} - 32) \times 0.5556$   
Centigrade to Fahrenheit  $(^{\circ}\text{C} \times 1.8) + 32$

Throughout this report the currency unit used is the Malaysian ringgit (\$) Weights and measures are expressed in the metric system.

## PART 1 SUMMARY

### OBJECTIVE

The purpose of this pre-feasibility study was to assess the agricultural development potential of two areas in the 1st Division with particular reference to rice production.

### THE STUDY AREAS

The Samarahan area covers 11 700 ha and in 1970 had a resident population of 9 900. The Sadong-Krang area extends to 7 025 ha and had a 1970 population of 9 000.

The soils of the two areas are potentially among the most suitable for crop production in the State. The climate permits a range of crops to be grown throughout the year. In most years irrigation would only be required for an off-season (April-September) crop of rice.

The greater part of both areas is held by the residents under some form of Native land tenure and is farmed by smallholders using traditional methods. The principal crops are rice (rainfed), coconuts and rubber. A feature of the methods of rice production is the extensive use of fallow breaks which may account for half to two-thirds of the land. Yields of tree crops are frequently depressed by the poor drainage. Livestock play a negligible role.

### POSSIBILITIES AND CONSTRAINTS

The State Government is particularly concerned to exploit the potential of the two areas for rice production as a contribution to rice self-sufficiency. The potential for (irrigated) double cropping of rice is, however, limited by the lack of irrigation water in the Samarahan area and the liability to severe flooding of much of the Sadong-Krang area. Furthermore, the techniques for such a farming system have not yet been established. A very substantial

increase in production could be achieved, however, by bringing the entire rice area into annual production, together with an off-season crop of soya beans or maize. To achieve this it is suggested that improved methods for requesting land holdings and a mechanised land cultivation service will be needed. Two other basic needs are water control and improved methods of production of both manual and tree crops. Effective and economic water control requires that specific areas be designated for annual and tree crops. In view of the potential of the two areas for annual crop production, tree crops should be confined to existing good stands and levees and other areas where trees are required for flood or erosion protection.

## RECOMMENDATIONS

1. In view of its particular potential for crop production, the Samarahan area and contiguous hill land should be designated an Agricultural Development Area and an Action Committee established.
2. The following schemes should be developed as examples of what can be achieved through better water control, higher standards of husbandry, mechanisation and improved methods for regulating land holdings:

### Samarahan

Lower Samarahan - 900 ha of rainfed annual cropping of rice and soya beans, and 300 ha of tree crops, principally coconuts underplanted with cacao (or robusta coffee)

### Empila

- A total of 400 ha of irrigated double-cropped small-holders rice in 4 stages

### Sadong-Krang

#### Gedong

- 4 small (53-90 ha) irrigated rice schemes for communities in the Gedong-Gumpeh area

#### Kuala

- A settlement scheme for some 100 families from other parts of the Serian district. The scheme would initially be based on rainfed annual crop production but has the potential subsequently to be irrigated.

The schemes can be implemented by the existing State organisations but technical cooperation will be required in the field of agricultural engineering and probably also in drainage and irrigation engineering, agronomy and sociology.

Further studies are required in a number of fields before the full potential of the two study areas can be developed; these include agronomy (cropping systems), flood alleviation, hydrology, engineering, land tenure, marketing and sociology. Recommendations are made on the implementation of these studies.

## PART 2 INTRODUCTION

### PREFACE

This report presents the results of a pre-feasibility study of the possibilities for agricultural development in the Samarahan and Sadong-Krang padi project areas, Sarawak, Malaysia. The study was made at the request of the Malaysian Government by a Land Resources Division Mission which worked in Sarawak from July to October 1976. A preliminary report was made by the Mission in 1976 for discussion with the Padi Production Unit of the State Planning Unit. The present report is the final report of the team.

### ACKNOWLEDGEMENTS

The members of the LRD/ODM Mission are indebted to a very large number of people, official, commercial and private individuals, for assistance received during the course of the study. They benefited particularly from the cooperation of all members of the Padi Production Unit of the State Planning Unit. They are also indebted to the Director of the State Planning Unit (Encik Mohd Noor Haji Harun), the Director of Agriculture (Encik J T C Kong), the Director of Drainage and Irrigation (Encik Foong Ka Nim), the Director of Lands and Surveys (Encik Borhan Sablo Mohammed) and the Senior Statistician of the Statistics Department (Encik Liew Khay Fatt) for the help received from them and members of their staff. The mission deeply appreciated the cooperation and kindness given to them by many Penghulu-Penghulu, Tua-Tua Kampong, Tuai-Tuai Rumah and farmers in the two study areas.

### THE PRESENT SITUATION: RICE PRODUCTION, IMPORTS AND CONSUMPTION

The area planted to rice each year in Sarawak is not known accurately but estimates are made annually by the Department of Agriculture on the basis of information gathered by its District staff. Since 1968, yields per unit area have been estimated by means of crop cutting tests. From these data on area

and yields, the LRD/ODM team has estimated the level of rice production in the State. In so doing, three assumptions have been made, namely that:

1. 95% of the planted area is actually harvested
2. 10% of the crop as estimated by the crop cutting tests is lost in harvesting
3. The milling out-turn is 60%.

Table 1 shows the figures on this basis for the harvested area, yield of unhulled rice (kg/ha) and total production of hulled rice (t) for hill rice and wet rice for the years 1971-5. The table also records the quantity of rice (as hulled rice) imported in these years: the mean annual figure was 63 815 t.

TABLE 1 Production of wet and hill rice and rice imports for 1971-5

Year	Hill rice			Wet rice			Total production hulled rice (P) (t)	Imported hulled rice (t)	Total rice (T) (t)	P/T %
	Harvested area (ha)	Yield unhulled rice (kg/ha)	Total hulled rice (t)	harvested area (ha)	Yield unhulled rice (kg/ha)	Total hulled rice (t)				
1971	69 550	1 110	46 300	58 450	1 830	64 200	110 500	59 947	170 447	64.8
1972	81 300	900	43 900	57 000	1 870	64 000	107 900	63 679	171 579	62.9
1973	59 350	780	27 800	45 750	1 540	42 300	70 100	70 060	140 160	50.0
1974	63 150	950	36 000	48 100	1 980	57 100	93 100	88 610	181 710	51.2
1975	60 950	920	33 650	51 400	1 610	49 700	83 350	36 780*	120 130	69.4*

\*low imports due to carry over of stock from 1974

The PPU has been charged with achieving self-sufficiency in rice, but "self-sufficiency" has not been defined: in practice it appears to mean the elimination of imports. By this definition the goal can be easily quantified but it fails to take account of the needs of that section of the population which can neither grow nor buy its full requirements of food. It is impossible to estimate how many people are affected and to what degree. For a cereal-based

diet, nutritionists state that on average for a population with a normal distribution of age and occupation, 0.5 kg of milled grain is required per head per day; that is, an annual consumption of 182.5 kg of rice per person. Rice is also required for seed, stock feed (poultry, pigs, dogs), and the additional consumption for rituals and wine, and some is lost to pests, fire etc. If such usage and losses are assumed to amount to 20% of the quantity required for consumption, the total annual needs in terms of hulled rice equivalent will be 219 kg/per person. If the estimates shown in Table 2 are correct, annual per caput usage of rice for the years 1971-4 was 160.25 kg: there is thus an apparent annual shortfall of 59 kg per person. In practice, other foods such as sago, tapioca and maize augment rice, but even so, for a population which is predominantly dependent on rice, there is clearly a substantial inadequacy in present supplies even when account is taken of imports. This opinion is supported by recent nutritional and other studies undertaken by the Medical Department which have identified malnutrition in certain communities throughout the State.

It was against this background that the LRD/ODM study was undertaken.

## THE PROJECT

### Objectives

The mid-term review of the Second Malaysia Plan coincided with the period in 1972-3 when crop failures in traditional rice exporting countries had caused supplies of rice on the world market to become scarce and costly. This situation highlighted Sarawak's dependence on rice imports which were then estimated to comprise some 40% of the total rice consumed in the State. The State Government therefore decided that greater emphasis should be laid on increasing rice production and to this end it established a Padi Production Unit (PPU): this came into being in 1974 and was charged with achieving the following objectives:

1. 100% self sufficiency in rice by 1980

2. Improvement of the wellbeing, income and standard of living of the poor
3. Improvement of land, labour and capital productivity
4. Increased employment opportunities in the rural areas

In the 5 years 1971 to 1975 hill rice was estimated to constitute about 35% of total production. The PPU however considered that this form of rice production had little potential for development and therefore decided to concentrate on wet rice. With the aim of increasing wet rice cultivation the Unit identified eight areas which the reconnaissance soil survey of the State indicated as having suitable soils for wet rice. Investigations are planned into the other determinants of the production potential of these areas, but, on the assumption that the environment is favourable to the rice crop, potential production is estimated as shown in Table 2.

TABLE 2 Potential wet rice development areas in Sarawak. (Source: unpublished data PPU)

Project	Gross area (ha)	Net future rice area (ha)		Area for off-season / cropping (ha)	Annual potential rice production (t)
		Surface	Effective*		
Limbang	17 000	15 300	30 600	0	109 700
Samarahan	7 320	5 360	10 720	0	38 400
Sadong/ Krang	4 050	3 640	7 280	0	22 300
Daro/ Bruit	4 610	3 690	3 690	3 690	8 800
Ai/Lupar	5 980	5 300	5 300	5 300	15 900
Sibu	4 040	3 150	6 300	0	18 900
Sarikei/ Binatang	6 580	5 490	5 490	5 490	16 400
Bakong/ Bakar	2 770	2 490	4 980	0	14 900

\*With irrigation two crops of rice can be grown annually: the 'effective' area is then considered to be double the 'surface' area.  
/For crops other than rice

The Samarahan and Sadong-Krang areas were thus expected to contribute 25% of the total rice production of the eight areas.

A preliminary appraisal of the Limbang area was undertaken by a Belgian team in 1975, and in 1976 the Government of Malaysia requested the UK Government to arrange for a pre-feasibility study of the Samarahan and Sadong-Krang areas. The objectives of the Study were defined as follows:

1. To examine the scope for water use development and management with reference to irrigation, flood control, drainage and the exclusion of salt water
2. To assess the present agricultural situation and to examine the technical and economic feasibility of developing the areas particularly for rice production; to delineate potential areas for the development of agriculture and of agro-based industries allowing for the growth of villages, townships etc. In making recommendations, particular account should be taken of the land tenure system and the socioeconomic characteristics of the areas
3. On the basis of the above findings, to prepare terms of reference for detailed feasibility studies for maximising rice production in the proposed areas. These ultimate studies would have to be in sufficient detail and in a form suitable for submission by the Malaysian Government to an international lending authority for financing implementation of the two projects. A decision to proceed with detailed feasibility studies would rest with the Malaysian Government.

Terms of reference for the Samarahan and Sadong-Krang pre-feasibility study

To meet these objectives the team undertaking the pre-feasibility study was required within a period of 4 months to:

1. Review all pertinent previous studies and reports and collect, process and compile relevant topographic, geological, hydraulic, hydrological, agricultural, soils and socioeconomic data in respect of the project areas

2. Collect such supplementary data as are necessary
  3. Prepare and submit preliminary proposals for the delineation of areas according to the land usage proposed
  4. Prepare and submit preliminary proposals with provisional estimates of cost, for the provision of irrigation, drainage and flood control facilities and for optimum agricultural development of the areas (including settlement schemes if appropriate). Socioeconomic constraints and manpower and mechanization needs should be taken into account and appropriate recommendations made as to how they might respectively be overcome and met
  5. Enable the recipient Government to make an informed judgement on whether to proceed with detailed feasibility studies. In order to satisfy this requirement, the team would, on the basis of their investigations of all the relevant socioeconomic, agronomic and physical data, make a preliminary assessment of the costs and benefits of the projects in the two areas and thus of the rate of return likely to accrue from their implementation. Apart from the capital costs, full account would be taken of the agricultural and other inputs necessary for the optimum agricultural production to be attained. In assessing the incremental benefits, account would be taken of achievable growth rates for agricultural production in the "without"\* situation. Appropriate shadow pricing will be applied
  6. Prepare and submit a programme of detailed topographical, geological, hydrological, agricultural, soils, socioeconomic and other surveys and studies which would be included in the feasibility studies mentioned in Objective 3 of the study
  7. Prepare terms of reference for the aforementioned feasibility studies leading to plans for the optimum exploitation of the land and water resources of the two project areas including layout plans and preliminary designs for the irrigation, drainage, flood control and access road systems
- 
- \*That is the growth rates that would be achieved if no new projects were introduced

Following a discussion of the preliminary findings of the LRD/ODM Mission in September 1976 the terms of reference for the study were amended by the PPU to give emphasis to the following points:

1. Within the Sadong-Krang and Samarahan project areas, identify those sites best suited to increasing rice production, either through raising yield per acre or by expansion of the existing rice areas and with reference to blocks both above and below 500 acres in extent
2. Identify areas planted with existing crops like rubber, coconuts etc. within the project areas where improvement leading to increased agricultural production is possible
3. Examine the possibility of agricultural development projects on those sites comprising either rice production alone or a combination of rice production together with production of coconuts, rubber, etc. as appropriate

#### Team composition

The team comprised:

J R Dunsmore	Agronomist (leader)
S Conlin	Sociologist
P G Herklots	Irrigation engineer (private consultant)
T J Kingham	Hydrologist
C A Robertson	Agricultural economist

## PART 3 THE STUDY AREAS

### LOCATION

Both the study areas lie in the First Division. Their locations are shown on Text Map 1. The Samarahan area lies in the administrative district of Kuching; the Sadong-Krang in the administrative districts of Serian and Lower Sadong (Simunjan). In both cases the areas are confined to those soils suitable for wet rice cultivation which lie between the main river and the adjacent areas of deep peat soils (Anderson Family), strongly saline gley soils of the Rejang Family or residual (hill) soils. The boundaries of the areas thus defined are shown on Separate Maps 1 and 4.

The Samarahan area lies between  $1^{\circ}20'$  N and  $1^{\circ}30'$  N. On the Batang Samarahan, it runs from Kampong Reban down-river (north) to the confluence with the Batu Belat. It also includes land lying on either bank of the Sungai Tuang between Kampong Endap and Muara Tuang and on the Entingan as far as Kampong Nangka. The total area is 11 635 ha (28 755 ac).

The Sadong-Krang area lies between  $1^{\circ}9'$  N and  $1^{\circ}18'$  N. On the Sadong it runs down-river from Kampong Serian Ilir and continues beyond the confluence with the Krang at Gedong to Tanjong Maong (Stage 3 of the Mid-Sadong Scheme). On the Krang it lies between Sungai Merakai Kechil and Gedong. The total area is 7 025 ha (17 360 ac).

In investigating the development potential of the study areas as defined, the Mission took account of farming activities on adjacent land by people living in the study areas and also examined the catchment areas of the Samarahan and Sadong-Krang Rivers.

### CLIMATE

Sarawak has a climate characterised by uniform high temperatures and humidity, and by abundant rainfall which greatly exceeds evaporation in every month. Only one season, the *landas* (wet season), can be readily identified; this prevails from November to March. During the rest of the year, considerable

rainfall may also occur though monthly totals are lower than during the *landas* and there is a marked increase in sunshine and hence solar radiation. This confers a distinct advantage within the study areas for production of (a) a wet rice crop during the *landas* and (b) (except during very occasional dry years) an off-season crop of maize or soya beans which can be grown without irrigation. Elsewhere in the State rainfall in the off-season is probably too scant or unreliable to support such cropping. Appendix 2 gives a detailed account of climatic and hydrological studies for the areas and only the most pertinent data are presented here.

### Rainfall

Average annual rainfall within the study areas lies in the range 3 700 - 4 050 mm. This average increases in a northerly direction towards the sea where falls during the *landas* are heavier than further inland.

The average monthly rainfall distributions at Serian and Paya Paloh (Agricultural Experiment Station), (Figure 1), show that the period June-August (the off season) has the lowest rainfall. Thereafter rainfall rises to its maximum during the *landas* when about 55% of annual rainfall is received. The expected range of monthly rainfall in 8 years out of 10 is also shown.

Daily rainfalls may be high; for example, at Paya Paloh falls of more than 150 mm are not uncommon and the maximum on record was 375 mm on 8 January 1971. Wet days tend to be grouped together so that rainfall rapidly exceeds the drainage capacity of the land (both by infiltration and surface runoff) and temporary flooding results. Although this may be beneficial to planted rice it could seriously affect the performance of other crops and cause considerable difficulty during harvesting and land preparation.

During the off-season, although moderate falls occur each month, distribution tends to be poor. One period of at least 10 days without rain can normally be expected between June and August, and once in every 5 years or so only 25 mm will fall during a 3 week period (Figure 5, Appendix 2). These rainfall records suggest that there is a slight chance of water stress developing in off-season crops.

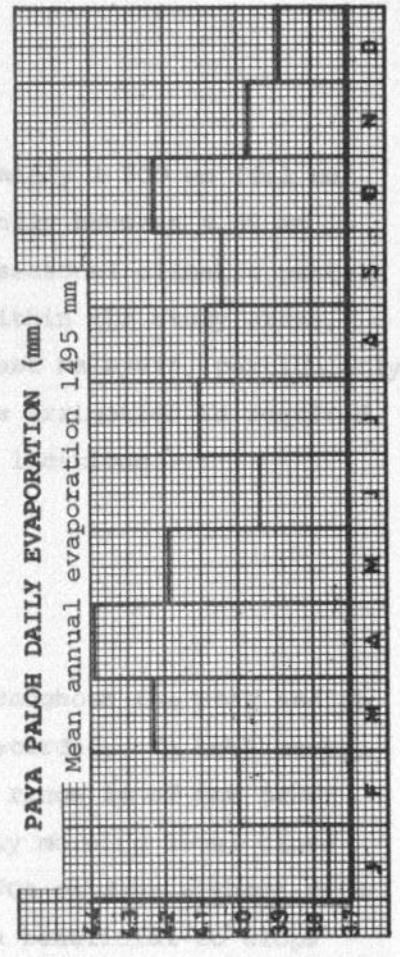
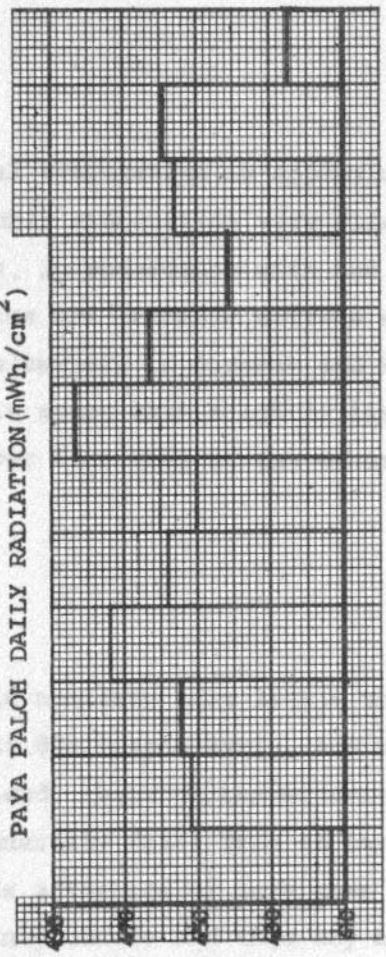
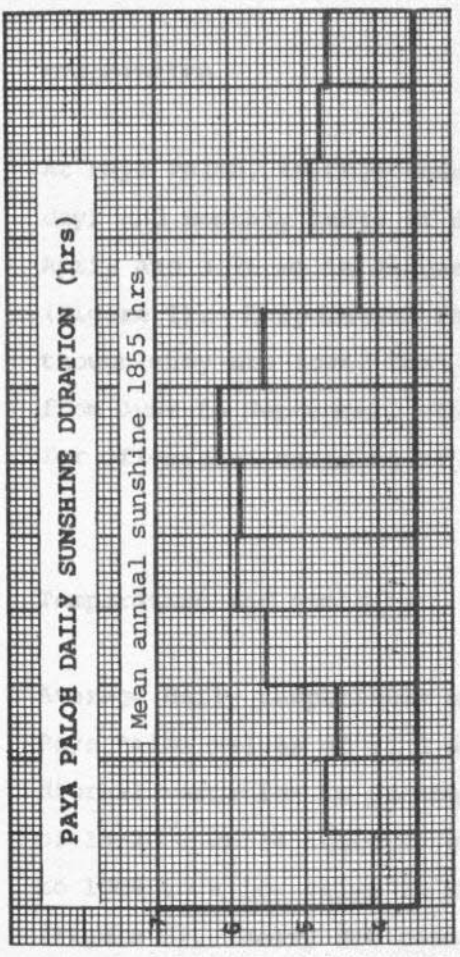
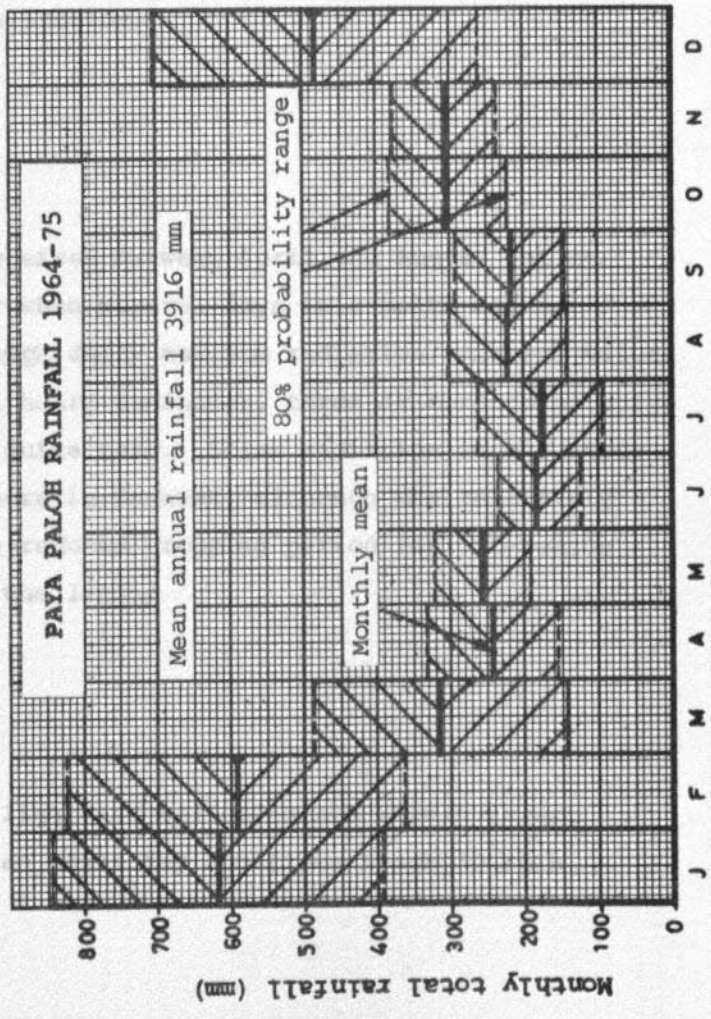
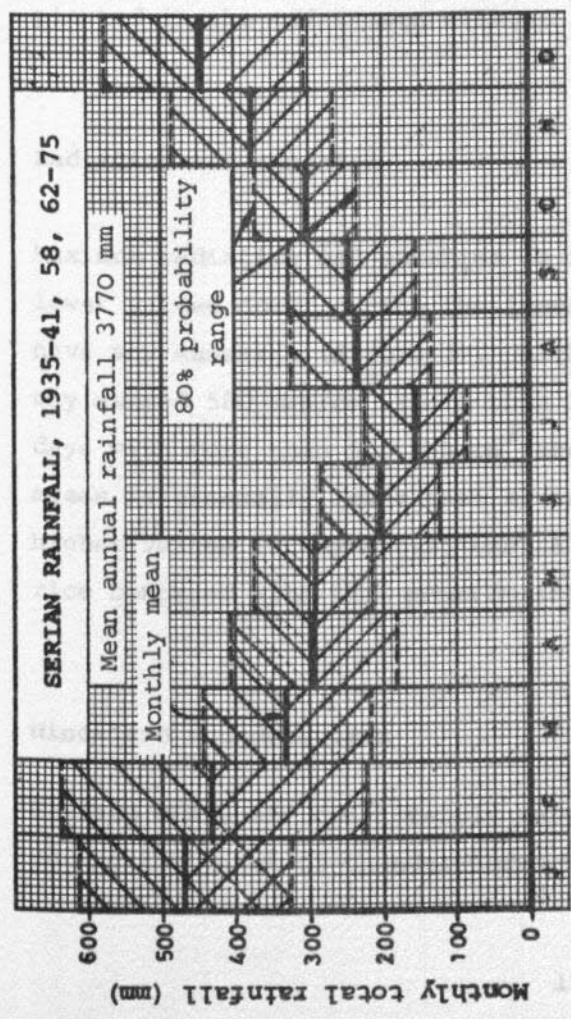


FIGURE 1 Monthly rainfall at Serian and Paya Paloh and sunshine, radiation and evaporation at Paya Paloh

## Evaporation

At Paya Paloh, average annual evaporation is approximately 1 500 mm (4.1 mm/day) and monthly means of daily evaporation vary slightly between 4.39 mm in April and 3.76 mm in January, in accordance with the seasonal climatic pattern (Figure 1). Evaporation rates are probably uniform within the study areas, though they are lower than elsewhere in Sarawak and West Malaysia, particularly from June to September. This means that slightly less irrigation is required for off-season cropping of wet rice than at the other locations.

## Temperature and humidity

Average daily temperature and humidity vary little throughout the year and at Paya Paloh values of 27°C and 83%, respectively, are recorded. In both cases, diurnal variation is pronounced. Diurnal temperature range is of the order of 15-20°C while humidity generally falls from an early morning level close to 100% to a low value in the afternoon of less than 70% on days without rain (Figure 2). Heavy dew commonly occurs and this may be beneficial to crops planted in the off-season without irrigation.

## Radiation and sunshine

Maximum radiation and sunshine is received between April and August whilst lower values occur during the *landas* when several days in a month may not have any sunshine (Figure 1). Although daily maximum radiation/sunshine values may exceed 580 mWh/cm<sup>2</sup> (more than 11 hours sunshine), three or more consecutive days with more than 500 mWh/cm<sup>2</sup> are quite rare. Solar radiation in the study areas is generally lower than elsewhere in Sarawak, although the relatively higher values in May-August ensure a reduced cropping period for off-season rice compared with that grown during the *landas*

## Winds and thunderstorms

Surface winds are consistently very light and seldom exceed 2 km/h except during the onset of thunderstorms when gusts may sometimes reach 30 km/h

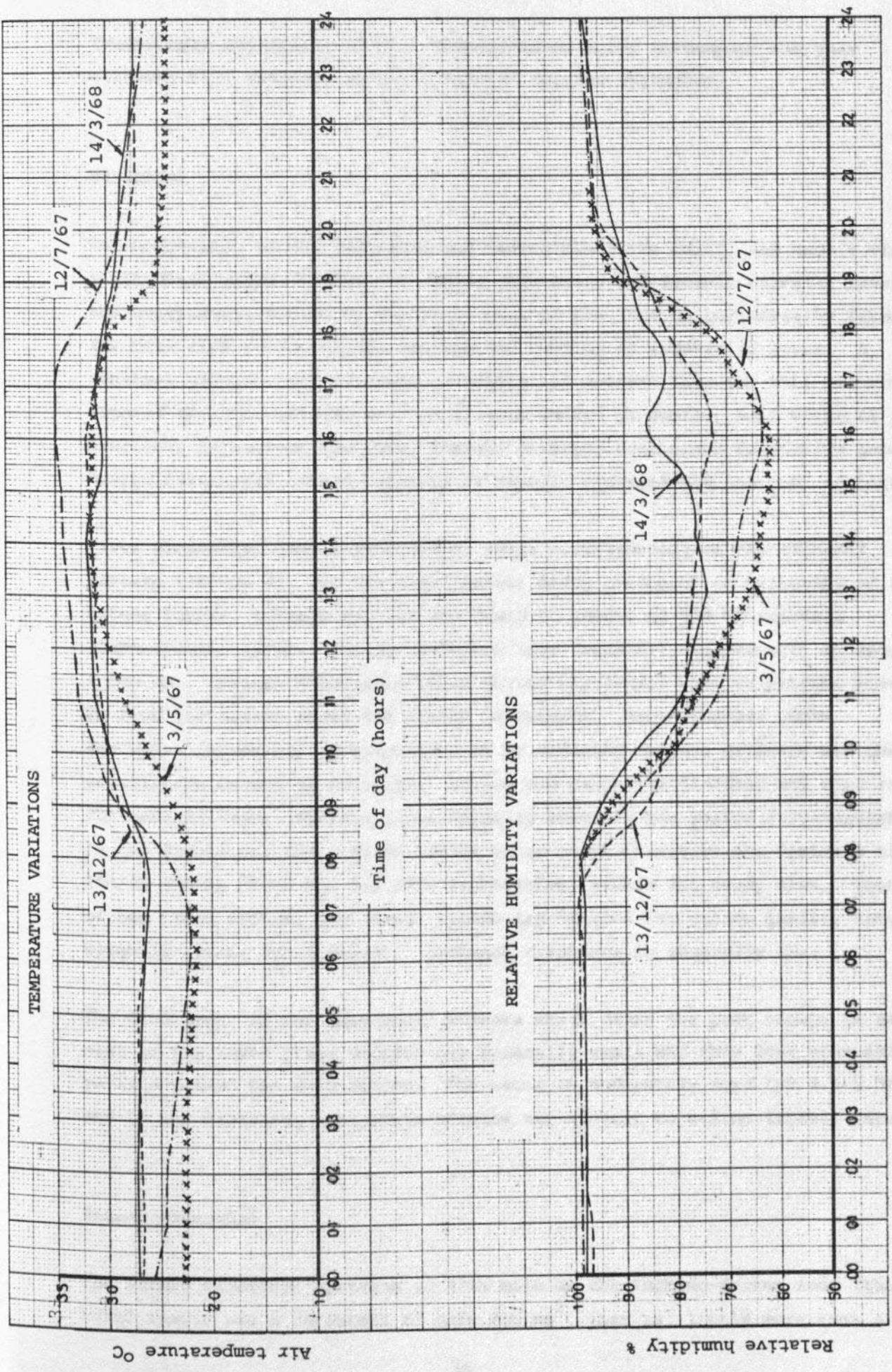


FIGURE 2 Daily variation of temperature and relative humidity at Paya Paloh

(Wageningen University 1971). Thunderstorms occur throughout the year although with greatest severity between May and September.

#### HYDROLOGY

The catchments of the Samarahan and Sadong-Krang are small, and have a wide altitudinal range (Figure 3). Dense vegetation and forests normally cover the catchments, though on the hills much of the land is periodically farmed for hill rice following the cutting and burning of vegetative cover. A constant ground cover of crops or vegetation ensures that the soil is never exposed for long periods and the erosion hazard is small. Soil water is available throughout the year, thereby ensuring continuous vegetative growth. During rainstorms, field capacity is rapidly exceeded and run-off is high.

River discharges show a wide annual range corresponding to the rainfall pattern (Figure 4). In the small Sungai Bedup catchment (a tributary of the Batang Krang), average run-off was found to amount to 67% of rainfall (Takenouchi, 1973). Annual catchment loss (rainfall less runoff) is about 1 500 mm. Maximum discharges occur during the *landas* when rainstorms move in from the sea to cover the entire catchments. Rapid run-off from the upper catchments is hampered both by reducing channel gradient and the penetration inland of the tide. Severe and extensive flooding may then result, for several days. Minimum flows normally occur in the period July-September; in the Samarahan, these allow saline water to penetrate to the upstream tidal limits of the river and its main tributaries, within the study area. Upstream of the tidal effect, the river waters are of good irrigation quality though slightly acidic (pH 5.5-6.0). Sediment discharge is generally low.

The discharge of the many small streams which drain the peat swamps on each side of the lower river courses are generally small and show less seasonal variation than the main rivers. The water is moderately acid (pH 4.5-5.5) and in the Samarahan area these streams are subject to saline (tidal) incursions.

#### Batang Samarahan

The Batang Samarahan upstream of 27th mile on the Kuching-Serian road (the tidal limit) has a catchment of only 260 km<sup>2</sup>, that is, little more than a

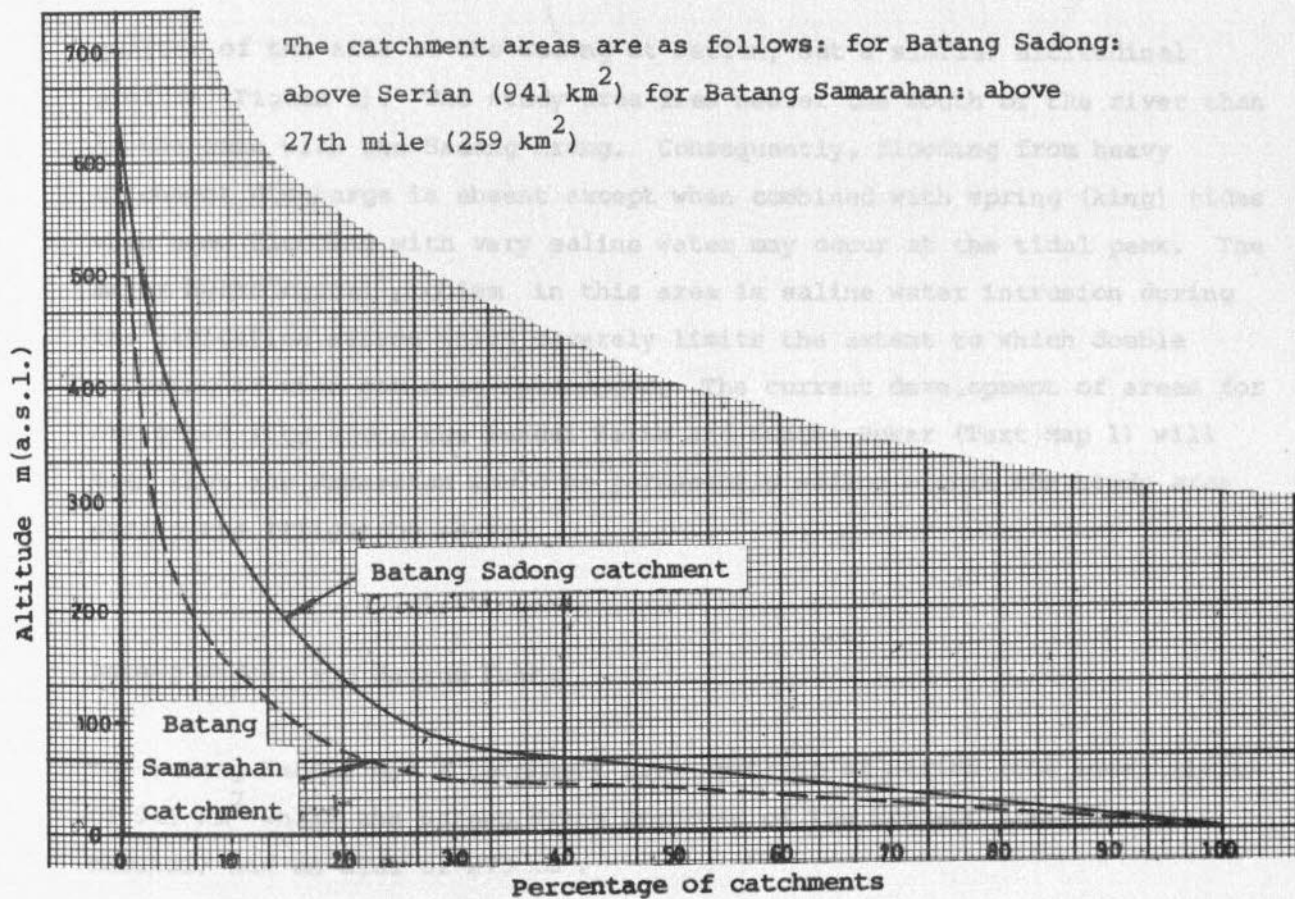


FIGURE 3 Area-altitude relationships: Batang Sadong and Batang Samarahan

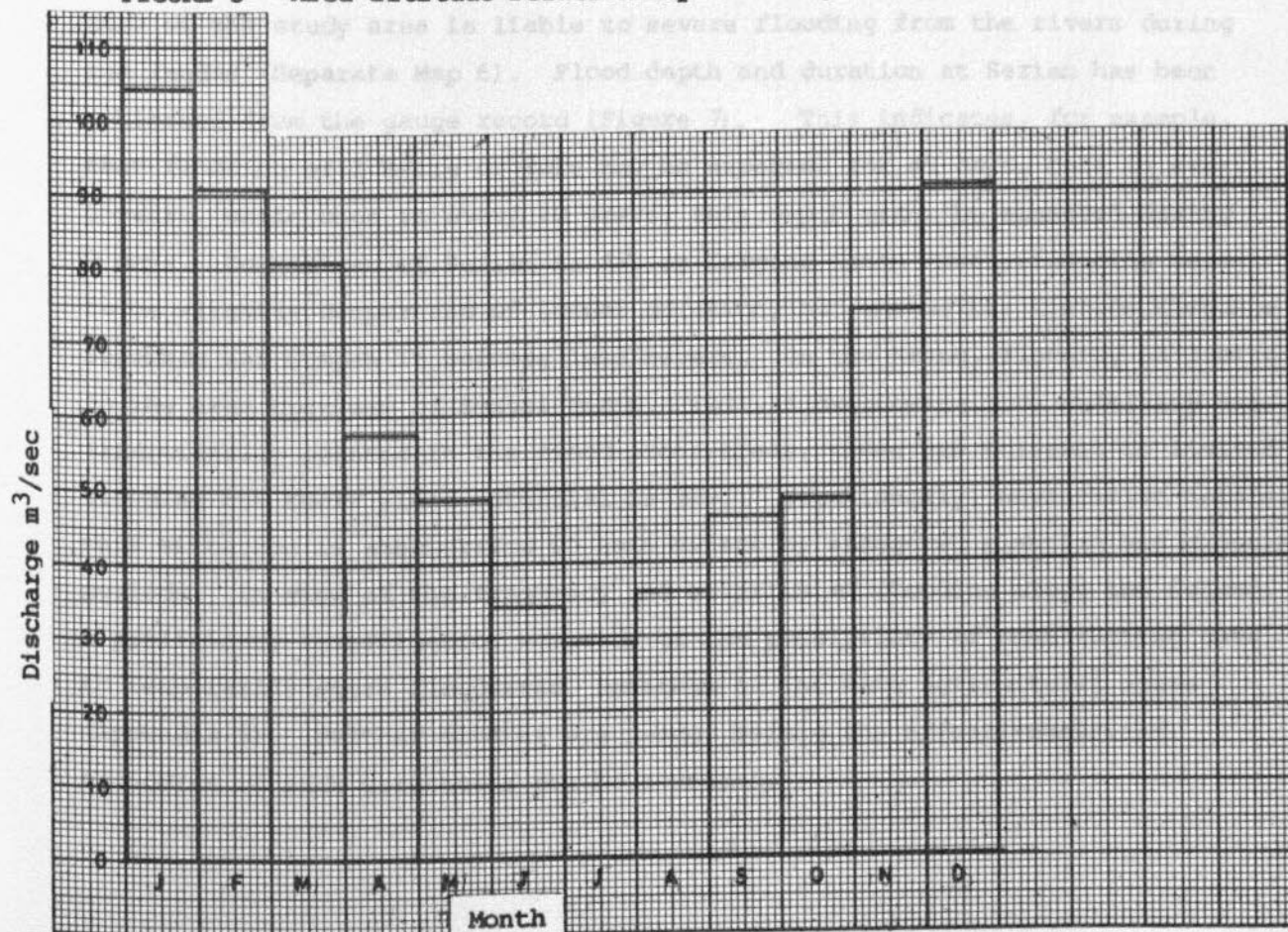


FIGURE 4 Distribution of monthly average discharges in the Batang Sadong at Serian

quarter of the area of the Sadong at Serian, but a similar altitudinal profile (Figure 3). The study area lies nearer the mouth of the river than is the case with the Sadong Krang. Consequently, flooding from heavy catchment discharge is absent except when combined with spring (king) tides when some flooding with very saline water may occur at the tidal peak. The major hydrological problem in this area is saline water intrusion during the irrigation season which severely limits the extent to which double cropping of rice could be introduced. The current development of areas for irrigated rice along the Sungai Serin and Sungai Bukar (Text Map 1) will mean that *the Samarahan would be permanently saline within the study area during the irrigation season.*

#### Batang Sadong and Batang Krang

The Batang Sadong has a catchment area upstream of Serian (the tidal limit) of 941 km<sup>2</sup> while the Batang Krang upstream of the project area (Sungai Marakai) has an area of 273 km<sup>2</sup>.

Much of the study area is liable to severe flooding from the rivers during the *landas* (Separate Map 6). Flood depth and duration at Serian has been estimated from the gauge record (Figure 7). This indicates, for example, that flooding of 1 metre or more may be expected for 4½ days, once in every 5 years, while once in every 10 years, this depth might be exceeded during 9 days. Downstream of Serian as far as Kampong Tanah Puteh, flooding tends to be slightly deeper and of longer duration, but thereafter towards Kampongs Sebemban and Gumpoh it becomes less severe. On the Krang, flooding is limited to the area upstream of Sungai Midin. Tall, slow-growing rice cultivars are traditionally planted in the flood-prone areas; these are tolerant to limited flooding but their yield potential is low. Occasionally, devastation occurs; this situation is ameliorated to some extent by staggered planting and cropping periods. In view of the frequency and severity of flooding along the Sadong, a preliminary investigation was made of the possibility of constructing dams to temporarily store floodwater upstream of the main agricultural areas (Appendix 3). Further studies are needed before the effectiveness and economics of such structures can be assessed.

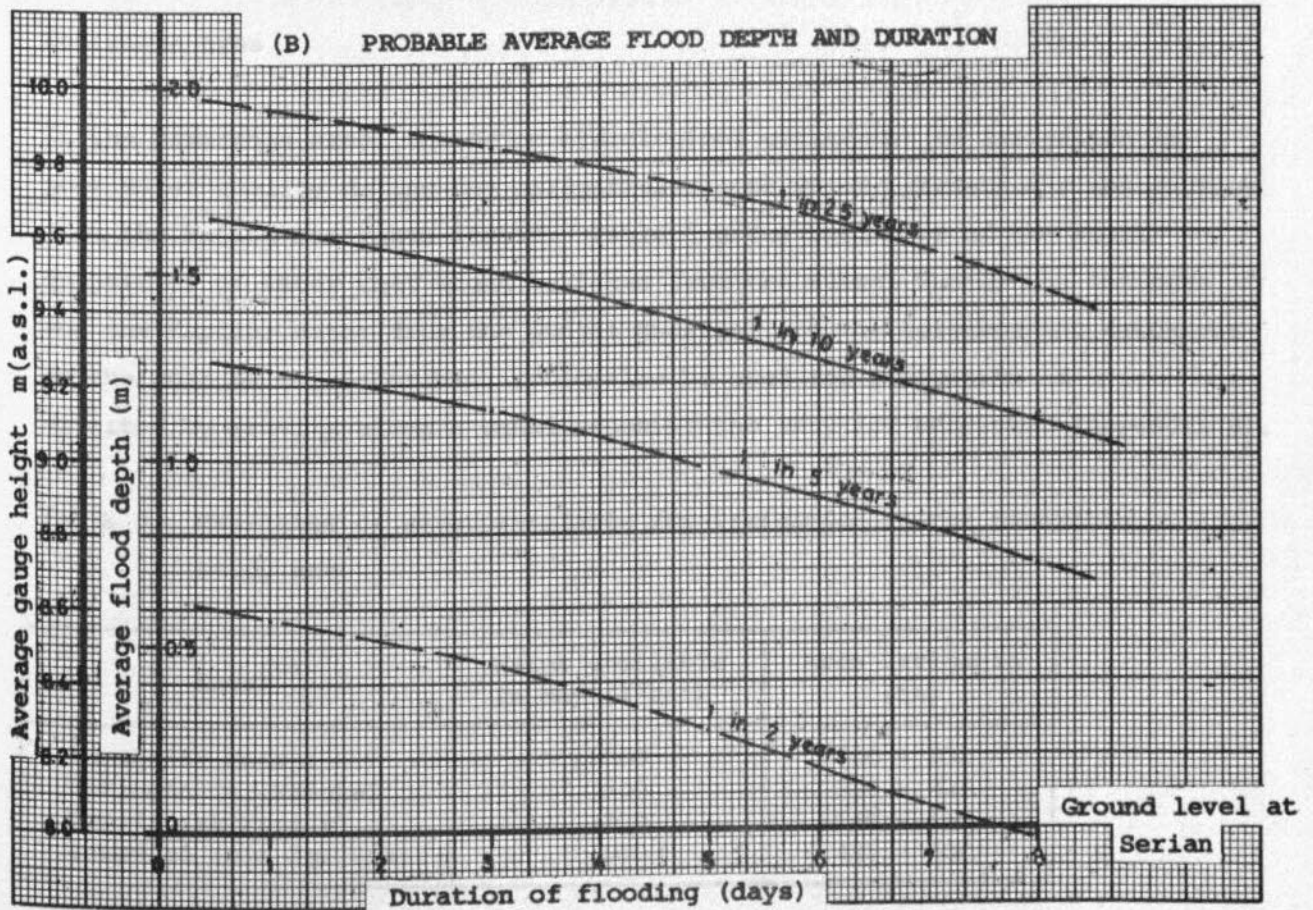
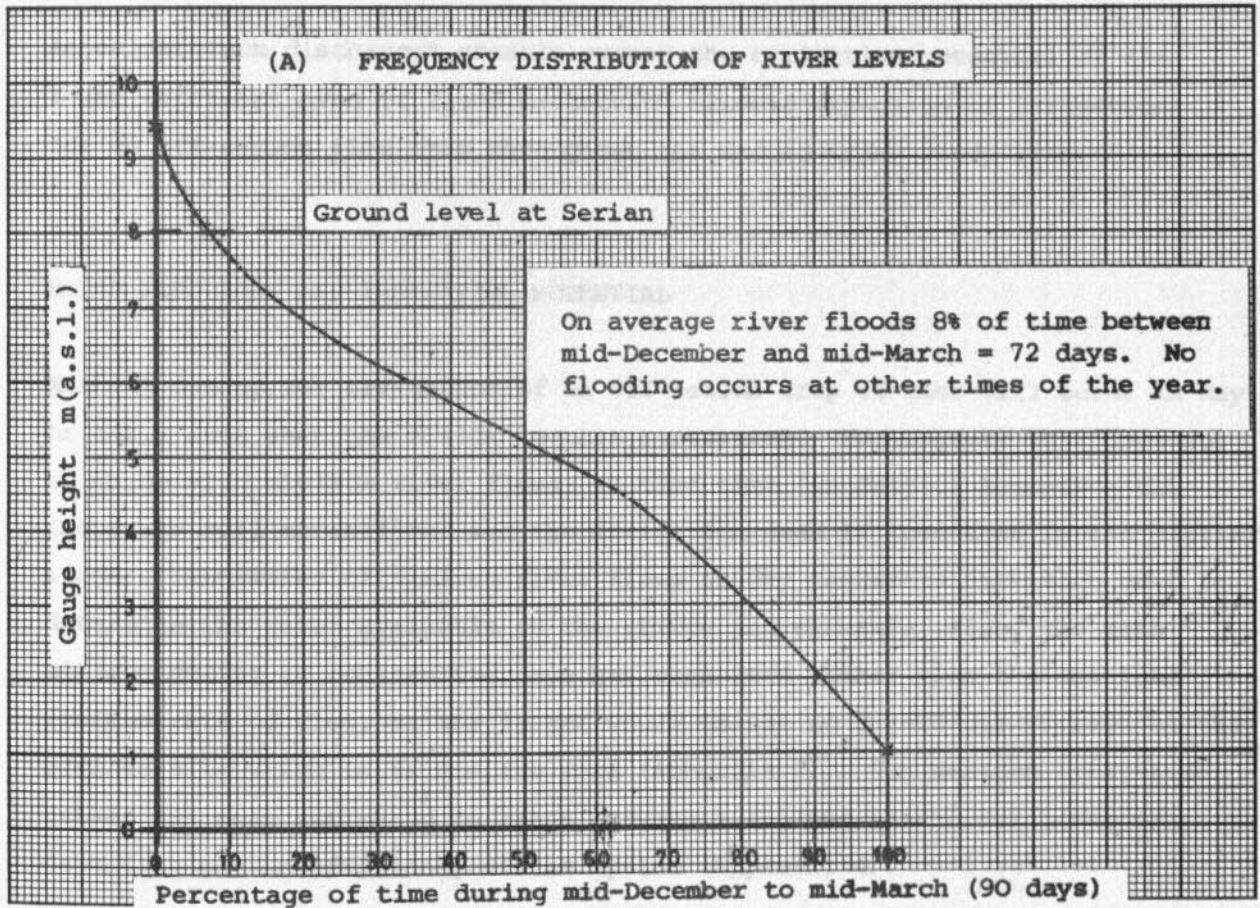


FIGURE 7 Flooding at Serian, mid-December to mid-March

Annual minimum discharges greatly exceed the irrigation potential of the lower catchment even if flood protection allowed expansion of irrigation for an off-season rice crop throughout the Sadong-Krang study area.

#### WATER RESOURCES AND IRRIGATION POTENTIAL

Maximum demand for irrigation of an off-season crop of rice will occur in May or early June when the fields require saturation. Fortunately this does not coincide with minimum river flows; at that time (in July or August) - the crops are well established and the irrigation need is less than in the earlier stages. Estimates of minimum river flows in May therefore have been used to determine the water available in the rivers and streams. Also, the mean minimum during 10 consecutive days has been used rather than the absolute minimum rate of flow, as the latter would assume no day-to-day storage at the offtake site which is seldom the case (Appendix 2). The maximum irrigation demand has been estimated to range between 1.4 l/sec ha and 1.2 l/sec ha depending on the efficiency of the system (Appendix 4).

#### Samarahan area

In the Samarahan area, the major hydrological constraint to irrigation is poor water quality during the irrigation season which prevents any abstraction from the Batang Samarahan itself. Table 3 gives estimates of the small quantities of water that might be taken from the Sungai Tuang, the Entingan and the Empila; water from the Sungai Ensengei, in the neighbouring catchment to the east of the Samarahan, could also be used for irrigation if diverted by gravity along a canal crossing the very low watershed (Appendix 4).

TABLE 3 Estimates of water available for irrigation in the Samarahan study area

River	Water available in May (l/sec)	Area irrigable (ha)
Tuang (at Endap)	1 000	700 - 850
Entingan (at Nangka)	500	350 - 425
Empila (at Empila)	200	140 - 165
Ensengei (via Sg. Sok)	600	425 - 500

Flooding of rice land is not a major problem, as in the Sadong-Krang, but saline water from the river floods over onto adjacent land when spring tides coincide with high river discharges. More prolonged and deeper flooding occurs at the up-river limits of tidal influence at the sites selected for the headworks and pumping stations of the irrigation systems (e.g. at Kg Endap on the Tuang). This leads to relatively expensive and intricate structure designs.

In view of the shortage of fresh water irrigation sources in the Samarahan study area, consideration should be given to tapping the limited supplies from streams which drain the peat swamps, particularly the east bank of the Samarahan. The swamps are slightly domed above the alluvial river plains and store surplus rain water (rather as a sponge would) such that the excess seeps slowly to the rivers in all directions and at a fairly uniform rate compared to the day-to-day variations in rainfall. It is suggested in Appendix 2 that the average flow in the streams can be estimated from the approximate area of swamp drained. Clearly, only very small schemes could be developed on the basis of these streams and the points of abstraction would have to be carefully located if no headworks are to be provided and saline incursion is to be prevented. For example, the pumping station on the Sungai Paloh for the rice experiment station was sited too close to the main river (Samarahan) and consequently, during the irrigation season, only saline water is available in the streams (the Mission measured its conductivity at  $5\ 500\ \mu\text{mhos/cm}$  in July on a rising tide, while water on the rice fields which had recently been pumped from the Paloh, had a conductivity of more than  $8\ 000\ \mu\text{mhos/cm}$  and was thus totally unsuitable for irrigation). This problem could be overcome either by the construction of a tidal gate downstream of the pumping station or, probably more cheaply by moving the pumping station  $\frac{1}{2}$  km upstream and providing an additional delivery pipe or a raised flume. Pump operators should monitor regularly the conductivity of the streams during pumping, using portable conductivity bridges, and endeavour to restrict pumping to the lower portion of the tidal cycle.

#### Sadong-Krang area

In the Sadong-Krang study area, copious supplies of good quality irrigation water are available from both rivers during the off-season (Table 4).

TABLE 4 Estimates of water available for irrigation in the Sadong-Krang study area

River	Water available in May (l/sec)	Area irrigable (ha)
Sadong (at Serian)	12 000	8 500 - 10 000
Krang (at Sg. Meraki)	3 500	2 500 - 2 900

Major irrigation development however cannot proceed on the Sadong floodplain unless periodic flooding is substantially controlled by construction of flood storage dams (see below), but neither the technical nor the economic feasibility of this have yet been adequately investigated. To provide irrigation prior to flood control, except on limited areas downstream of the main flood hazard, cannot be recommended for several reasons:

1. The pumping stations and perhaps the main canals too would have to be sited above maximum flood level and thus would create artificial barriers to water movement, across the flood plain. Flood depth and duration would probably be increased further, as a result
2. Drains and any canals below flood level would require clearing out and perhaps reconstruction after each flood
3. The heavy costs of construction and maintenance would have to be borne by the value of the off-season crop alone.

Bunding and/or construction of polders as a means of safeguarding crops from flooding cannot be recommended in view of the likely effect of increased flooding in areas not protected in this manner. Also, the lowering of the watertable in protected areas would be very difficult during prolonged flooding.

Along the Krang the best rice lands are downstream of the worst flooding and alleviation measures are unnecessary.

## SOILS

The soils of the study areas have been surveyed and mapped at a semi-detailed level (scale 1:25 000) by Lim (1976 a,b) and found to comprise the following soil groups - recent alluvial, saline gleys, gleys and peat. Such soils cover less than 5% of the State and their potential for agricultural development is greater than that of most other soil groups of the country. They are capable of growing the major tree crops (cacao, citrus, coconuts, coffee oil palm and rubber) and a wide range of annual crops including rice, maize and soyabeans. They are also suitable for irrigation.

Most of these soils, however, are naturally poorly drained and some are subject to flooding. From the soil management aspect they can be considered in their groups - recent alluvial, saline gley, gley and peat.

### Recent alluvial soils

The recent alluvial soils are found only in the Sadong-Krang area and are of very limited extent (<400 ha). They occur as narrow levees in the upper parts of the Batang Sadong and Lim (1976a) notes that they are largely planted up to rubber and fruit trees. The management of the soils presents no major problems.

### Saline gley soils

The saline gley soils occur in the Samarahan area. They are clay soils which have formed on recent marine deposits. The groundwater is saline (<500-4 000  $\mu\text{mhos/cm}$  at 25<sup>o</sup>C) particularly in dry periods but this would not preclude development for wet rice production. Such development, though, would require the exclusion of any further saltwater intrusion. The distribution of soils with potentially acid sulphate layers in the Samarahan area is not known, but evidence of the presence of such layers is commonly found in the spoil from the bottom of ditches. From the semi-detailed soil survey (Lim, 1976b) it appears unlikely that these layers would occur within 50 cm of the soil surface and consequently the growth of rice would not be affected. However, tree crops such as coconuts require a rooting zone of 75 - 100 cm and, were acid sulphate soils to develop, growth and yield would be adversely affected.

## Gley soils

The gley soils are non-saline soils which are naturally poorly or very poorly drained. They comprise riverine and marine alluvium and their chemical characteristics may vary according to the parent material from which they have derived. In the Samarahan area some of them may contain horizons of potentially acid sulphate soils (see above) at depths below 50 cm.

In both the saline gley and gley soils the maintenance of appropriate levels of soil moisture in the rooting zone will be one of the major problems in the satisfactory production of off-season annual crops such as maize and beans. The poor growth often seen at the present time is frequently attributable to inadequate drainage, causing waterlogging, or to overdraining resulting in fissuring and cracking, particularly with clays lacking residual plant material. The achievement of suitable soil water conditions requires experience and, in the early stages, farmers will need considerable assistance from the extension services.

## Peat soils

The peat soils have a surface layer of soil 25-100 cm deep with an organic matter content of at least 35%, and sometimes 65% or more. The latter in particular is a poor medium for plant growth and the development of these soils for agriculture requires that the peat layer be consolidated and incorporated into the underlying clay as quickly as possible. If the land is under forest, clearing and draining can reduce the depth of a peat layer from 100 cm to 50 - 70 cm within one year. Subsequent change will depend on the degree of drainage, the quantity of timber in the peat and the type of land use practised. The change will be achieved most quickly if the area is adequately drained, buried timber is removed and land is cropped twice annually. Cropping should be restricted to rainfed crops, e.g. rice alternating with maize or soya beans. Irrigation should not be introduced until the upper layer of the soil has a substantial mineral content. In the first 2-3 years, it will prove very difficult to use machinery for land preparation.

## INFRASTRUCTURE

### Access

Road access into the study areas is recent. The road to Gedong from Serian was completed in 1973, and the road to Muara Tuang from Kuching in 1974. The road to the Samarahan Rubber Estate is at present being upgraded and there are minor roads to Endap and Entingan on the Sungai Tuang. These roads are shown on Text Map 1. Prior to the completion of these roads, transportation was essentially by river, both internally and for trade to the markets of Serian and Kuching. Though now the external trade is tending to move towards the new road heads, internal communications will continue to be by river. The very high cost of bridging means that any further major extension of the road system is unlikely and the present balance between road and river transport is likely to remain.

### Administration and Government agencies

The two study areas lie within the administrative districts of Kuching, Serian and Lower Sadong (Simunjan). Each district is administered by a District Officer who is responsible to the Resident, First Division, and is supported by subordinate staff at district headquarters and, in the study area, at Muara Tuang and Gedong. Each village has its *tua kampong* or *tuai rumah*, (the spokesman recognised by the villagers themselves); a *penghulu*, a Government official appointed from one of the villages, has responsibility for a small group of villages.

Within the districts, various services are provided by a number of Government agencies. The Department of Agriculture is responsible for advising farmers on problems related to agricultural production. It also administers a number of development schemes, e.g. Agricultural Diversification Scheme (ADS), Assistance to Padi Planters Scheme (APPS) and Coconut Planting Scheme (CPS), which give material and cash assistance to individuals to extend their farming enterprises.

The Medical Department runs maternity clinics at Gedong, Kampong Pinang and at Muara Tuang where there is also a dispensary. A travelling dispensary is

based at Kampong Tanah Puteh. These services are supported by a general hospital in Kuching; a second general hospital is being built at Serian.

Most of the villages in the study areas have primary schools for which the Education Department is responsible. Some children of the areas are currently being educated at secondary schools in Kuching and elsewhere. A secondary school is to be opened shortly in Muara Tuang.

The Drainage and Irrigation Department is responsible for the construction and maintenance of large-scale drainage and irrigation schemes and for the collection of hydrological data. There is no drainage and irrigation scheme in the study areas but the Department has been recording river flows in the Sadong since 1962 and more recently in the Samarahan.

The Department of Land and Survey is responsible for the administration of land matters under the provisions of the Land Code. This responsibility includes the alienation of State Land, the registration of all titles, rights, and dispositions affecting land, all cadastral survey whether for new alienations or mutations, the collection of land rents etc, trigonometrical and topographical surveys and mapping, town and country planning and, where Government interests are affected, the valuation of land and property. It has carried out cadastral surveys in parts of both study areas.

The coordination of the work of the Departments is achieved through Action Committees at both Divisional and District levels: these comprise representatives of the Departments under the chairmanship of the administrative officer (Resident or District Officer).

No non-Government agency is working in the field of agricultural development in the study areas.

#### LAND AND POPULATION

The population of the two areas is predominantly Malay and Iban, though there is also a small number of Land Dayaks (Bidayuh) along the southern part of the Sadong area. Basic data are given in Table 5; further information is contained in Appendix 7.

TABLE 5 Population and operated land\* in 1970. (Source: Chander 1976)

Data	Samarahan	Sadong-Krang
Total population	9 883	8 657
Total households	1 793	1 089
Total villages	38	23
Mean household size	5.5	7.9
Total hectares operated	2 875	2 119
Hectares/household	1.6	1.9
Hectares rented <sup>†</sup>	228.3	104.5
% tenancy	7.9	4.9

\*Operated land is land actually being cultivated at the time of the census. This was not ascertained by survey and should be treated with caution.

<sup>†</sup>Often no rental is charged, especially in the case of customary land used by a close relative of the landholder. The land is said to be "borrowed".

The household size in the Sadong-Krang area is distorted by the presence in Gedong of many young men who work in the timber industry; excluding Gedong, the average household size is 6.6.

Iban villages tend to have greater areas of land (cultivated and fallow) available to them than Malay villages. This is demonstrated in Table 6 which compares a Malay with an Iban village in the area of the Krang.

TABLE 6 Population and available land in two villages\*. (Source: Land and Survey Department: Schedule of Alienated Lands and Register of Customary Lands in Proposed Muhibbah Scheme 1973)

Data	Gedong Ulu	Kuala
Main ethnic group	Malay	Iban
Households with land	54	17
Hectares of available land	49.2	144.8
Hectares/household	0.9	8.5

\*Data relate to available land. The Population Census 1970 records operated land for Kpg. Kuala as 8.91 has (22 ac). The difference here is explained by the definition of operated land: "The acreages of land operated by a household normally refer to a fixed reference period during the Census. This period may vary from "Crop season" for certain crops (e.g. rice) to fixed periods like "on the date of interview", "the previous month", or "the previous year" depending on the crops under reference." (Department of Statistics: private communication).

While this represents an extreme situation Malay landholdings throughout the study areas tend to be smaller than those of Ibans, for three reasons. First, Malay rules of inheritance, unlike Iban rules, necessitate greater division of the land. Secondly, Malays tend to hold a greater proportion of alienated land than Ibans, so facilitating land dealings and thus the fragmentation of holdings. Thirdly, the uneven distribution of landholdings within Malay villages leads to a greater degree of tenancy. The figures for the percentage of tenancy in Table 5 do not fully represent the situation developing in some Malay villages of the Samarahan. In Baru and Empila, tenancy was 16.15% and 20.05% respectively in 1970 and, with the opening of the Muara Tuang road, the degree of tenancy has undoubtedly increased.

Associated with the opening of the road there has been a reduction in the amount of rice land available owing to the planting of tree crops. This has resulted in a number of land disputes within and between villages. The nature of these disputes depends on the legal status of rights to land. In areas of individually owned land the increase in land values arising from the development of tree crops has led to the acquisition of land by wealthy non-farmers as an investment and to its loss by smaller farmers. Those without rice land consequently attempt to encroach on lands of other villages. In areas of customary land, where individual land dealings are proscribed by community obligations, larger farmers attempt to establish absolute rights over their holdings of rice land, which leads to disputes within the village.

There are thus shortages of rice land in specific areas which lead to disputes. These shortages are caused by an uneven distribution of rice land rather than by a high population to land ratio. This situation must be understood in relation to present agricultural practices and patterns of land use within the agricultural economy. These are described later in this report.

#### THE LAND CODE

The clearing of virgin forest by individual households for rice production on a system of shifting cultivation and the subsequent inheritance by the kinship group of usufruct rights to the land is the historical basis of the present system of land tenure. Rights to land are established by custom on the basis of a constantly changing interrelationship of kinship, religion,

economic and power relationships within the local community. Customary land tenure is based on an individual's position within the community in which he has certain obligations.

As land use has changed and the population has become more sedentary, so the rules of land tenure have also been changing; individuals can now establish rights to certain lands independently of community obligations. This tendency is legally recognised by the issue of title to land. Such land is termed "alienated land" and can be bought or sold by individuals.

The Land Code was introduced in 1963 to regulate land rights. Five categories of land were defined in order to control land dealings in a multi-ethnic society.

1. Interior Area Land Most of the land in the study areas falls within this broad category. Only persons defined as Natives (i.e. ancestrally deriving from the Indonesian-Malaysian archipelago) can hold land in this category.
2. Native Area Land This category refers to alienated land which can be owned by Natives. This means that legal title to this category of land has been vested in an individual owner by the State, thus facilitating land dealings between Natives.
3. Mixed Zone Land This is again alienated land but land dealings are authorised for non-Natives.
4. Native Customary Land This is again limited to Natives. While legal title has not been officially issued by the State, the law recognises rights established according to customary practices.
5. State Reserve Land Land which is not subject to claims based either on legal title or on customary usage is considered as belonging to the State. In addition the State can reserve land e.g. roads, riverbanks, agricultural experiment stations. Certain areas can also be designated as Native Communal Reserves for specific purposes.

While the Land Code is meant to rationalise land administration, there are a number of logical problems with regard to the relation of Native Area Land and Native Customary Land. First, although both areas are restricted to Natives, the former is alienated land to which title has been granted while the latter is held according to the custom of the particular community. Registration of Native Customary Land establishes a right of individual ownership in law, however, which is equal to that conveyed by the granting of title. The issue of Native Area Land title would therefore seem to be irrelevant (Wong, 1975). On the other hand, legally recognised right of individual ownership of Native Customary Land does not accord with Native custom because such land is not absolutely and individually owned; each plot of land is subject to a "bundle" of rights involving the community as a whole (Richards, 1961). According to custom, individual rights to land can only effectively be established by the planting of perennial cash crops, and consequently the registration of individual ownership of Native Customary Land does not, by custom, apply to land used for wet rice.

Secondly, the Land Code recognises Native Customary Land but it does not codify customary rights. This would be difficult and probably unwise to undertake in view of the changing nature of customary rights. In practice, administration of land matters in the villages is left to the discretion of the *tua kampong*, the spokesman recognised by the villagers themselves, or to the *penghulu*, a Government employee appointed from within the community. In the case of disputes involving outsiders the *penghulu* is meant to advise the District Officer with regard to custom. In this way the law with regard to land tenure neglects local politics within the administrative structure (Hooker, 1972).

Finally, in the Code there are two different meanings implicit in the term "community". On the one hand this refers to the local community; on the other it means the national ethnic community, be it Malay or Dayak. In this situation land dealings and matters of dispute involving outsiders (of the local community) are not regulated by the Code if the other individuals concerned are insiders (of the ethnic community).

The lack of precision in the Land Code on these points leads to certain problems in the administration of land matters for purposes of agricultural development. In the first place there is no control over the disposal of

land by the local community of farmers to outside non-farming interests. This, while it is a recent trend, currently affects the Samarahan area but not Sadong-Krang. Secondly there is no development strategy to guide land administration on the desirability of the adjudication of rights and the issue of title or the creation of Native Communal Reserves in areas of land held under customary rights. Each alternative poses problems. Title is issued according to the procedures of the Torrens system which involves elaborate surveys. The assumption is implicit in this system that land is individually owned. With regard to customary land the process of adjudicating rights in order to issue titles can take several years. If Communal Reserves are created there are often administrative problems in their subsequent administration.

In the study areas much of the land has been subject to cadastral surveys. Separate Maps 2 and 5 record the various land categories. It is clear that development schemes will face numerous administrative problems because different areas have a different legal status. Within a single scheme there might be both types of alienated land, customary land, and Communal Reserves in addition to State Land. It is advisable to rationalise this situation for purposes of the administration of any scheme, otherwise land disputes within the scheme are likely to occur, thereby hindering agricultural development. Rationalisation by means of regulating land holdings is discussed in Chapter 7.

#### THE FARMING SYSTEM

Agriculture in the two study areas is undertaken entirely by small-holders residing in villages. There are no estates, land development schemes or cooperative farms. A number of the communities also farm hill land adjacent to the riverine land of the areas.

There is no intensive production in the areas and it is estimated that at any one time substantially less than half of the land may be under a crop. This is principally due to the method of rice farming where a crop may be followed by 2-4 years fallow. The total land available would be adequate for the needs of the population if it were equitably distributed, (Table 7).

TABLE 7 Land available in the study areas and adjacent hill areas (ha)  
(Interpreted from data provided by Soil Survey Division,  
Department of Agriculture)

Data	Samarahan	Sadong-Krang
Land with soil suitable for rice production	11 635	7 025
Other cultivated land (excluding cultivable but unused land)	3 007	1 517
Total land available	14 642	8 542
Number of households	1 793	1 089
Land available per household	8.2	7.8

Farmers plant both subsistence and cash crops, the predominant ones being wet rice, coconuts and rubber; all others are of minor importance and livestock plays only a limited role. Farmers are well aware of the variations in soil types in their areas and attempt to plant their different crops on the soil most suitable for them. Inherited land rights however exist over most of the study areas and the individual farmer is thus confined to the land over which he has rights. In consequence the distribution of crops presents a patchwork pattern (Plates 1 and 2) and, in many instances, crops have to be planted on unsuitable soil. The greater part of the study areas is naturally poorly drained and the construction of an adequate drainage system is often beyond the unaided capacity of the farmer. Frequently, therefore, coconuts and rubber are found on land more suited to wet rice.

#### Rice

Rice is fundamentally a subsistence crop and is usually sold only in times of necessity or when yields are particularly good; such sales generally take place within the local community.

The 1974/5 Padi Production Survey (PPS) showed that the mean area planted per household varied between the three districts in which the study areas lie from 0.36 ha to 0.46 ha with an overall range from 0.07 to 1.61 ha. However, a survey undertaken in 1976 by the LRD/ODM Mission obtained recall data from respondents in 14 villages in the two study areas and indicated that in

1975/6 the range of areas cultivated went up to 4.86 ha in the Samarahan area and 3.24 ha in the Sadong-Krang, and mean areas per household were 0.85 ha and 1.13 ha respectively.

The principal wet rice experiment station of the Department of Agriculture is situated at Paya Paloh in the Samarahan study area. At this station, which is sited on soils typical of the area, it has been shown that, with irrigation, it is feasible to grow two crops of rice per year. This example is not followed by any members of the farming community in the area. The practice of alternating between a crop of rice and periods of fallow is widespread throughout both study areas; the periods of fallow vary from 1 to 4 or 5 years.

The inclusion of a fallow break in hill rice production is essential for the restoration of soil fertility but the reason for its use in wet rice production has not been established. Farmers usually state that annual cultivation leads to an uncontrollable invasion of weeds. The use of fallow has also been partially attributed to the need to prevent the accelerated development of reducing conditions in these naturally poorly drained soils and to the possibility that older fallow is easier to clear and burn. The fundamental factor however is probably the relative abundance of land compared with the available labour which has encouraged an extensive as opposed to intensive system of farming. Labour scarcity becomes particularly acute at the time of land preparation when the available supply governs the area which can be prepared for planting. Labour is probably also in comparatively short supply for transplanting, weeding and harvesting.

Imbalance between available family labour and available land has traditionally been overcome to a limited extent by the exchange of labour between households or the loan of land to families who can use it, but this has still left the greater proportion of rice land untilled in any given season. More recently, some larger farmers have begun to hire labour. There has also been an increasing tendency to plant traditional rice land with coconuts: thereby farmers will obtain a return from the land they might otherwise be unable to use while at the same time underlining their claim to the land. However, the practice deprives the community as a whole of part of its riceland.

Annual cropping of the same piece of land is undertaken by only a minority of farmers and often includes periodic fallow breaks. The Department of Agriculture has attempted, through its Assistance to Padi Planters Scheme

(APPS) to demonstrate how annual cropping can be achieved. These APPS schemes have shown that padi planters are prepared to work together to build the minor structures required to achieve water control. The reversion in most cases of the APPS areas to traditional methods of usage on the conclusion of the scheme can probably be attributed to the limited success gained in water control and to the fact that the labour requirements for land levelling and cultivation are beyond the capabilities of the participants.

An earlier scheme to introduce buffalos as draught animals to plough the ricefields was not successful and, apart from a small area prepared with chemicals, land cultivation is undertaken by hand. The seed is sown in a dry nursery either within the rice area or on adjacent hill soils. Seedlings may be transplanted once before being planted in the field usually when over one month old - that is, after the optimum stage. The limited effectiveness of land preparation results in weed growth often being abundant. Most of the major weed species can be controlled with the chemicals 2,4-D, MCPA or butachlor, but in practice weeding is carried out by hand and the shortage of labour is a further constraint on increasing the area planted.

The rice cultivars grown in the study areas may be divided into three main groups:

1. Traditional, unimproved
2. Traditional, selected
3. Short term, high yielding

The cultivars of Group 1 are tall and normally take 6 - 7 months from sowing to harvest. They are well suited to present methods of cultivation but are probably not capable of yielding more than 3 000 kg/ha even in optimum conditions. The Department of Agriculture has selected four such cultivars for general adoption - Acheh 62, Baru 3, Lasak and Serendah Kuning. A fifth cultivar, Kara 1 is recommended for areas which may suffer from periodic brackish water flooding. All five have a yield potential of 3 000-4 000 kg/ha. The third group is selected from cultivars bred either in Malaysia or at the International Rice Research Institute (IRRI) for their high yield. However these cultivars require optimum growing conditions if they are to achieve their potential and their use in the study areas is limited at the present time.

The use of fertilisers is largely confined to areas under the APPS and, in as much as it is these areas which are annually cultivated, this is probably appropriate. In other areas, where land has been freshly cleared from fallow and traditional cultivars sown, it can be expected that there would be little or no response to fertilisers.

A range of insect pests has been recorded on wet rice including stemborers, sucking bugs, leaf-eating caterpillars and molecrickets. Quantitative data on crop losses is not available but they are not likely to be serious under the present methods of production. Loss due to attack by rats and birds on the other hand could be severe particularly during the off-season. Diseases are not yet a serious factor on farmers' fields.

The Padi Production Survey (PPS) has obtained estimates of mean yields by districts since 1968 on the basis of crop cutting tests (Table 8). These may be taken as a fair estimate of yields obtained in the two study areas, if allowance is made for the fact that on larger areas harvesting losses could be expected to 5-15%. An estimate of the yields obtained in the two study areas in 1975/6 was obtained by a survey undertaken by the LRD/ODM mission based on yield figures recalled by farmers. These gave a range of yields from 239 to 3 150 kg/ha; the lower figure was obtained from a field which had been severely damaged by floods.

TABLE 8 Mean yields of wet rice by district, 1968-75, in kg/ha of clean, dry padi (Source: Department of Statistics (1976a))

Year	National mean	Kuching	Serian	Lower Sadong
1967/68	2 042	2 719	1 817	2 823
1968/69	2 196	2 372	2 151	2 870
1969/70	2 201	2 985	2 493	2 605
1970/71	2 039	2 429	2 176	2 551
1971/72	2 079	2 330	2 268	2 365
1972/73	1 714	2 209	1 905	856
1973/74	2 199	3 009	2 215	3 167
1974/75	1 788	2 629	1 971	n.a.

n.a. = not available

## Other annual crops

Annual crops other than rice are grown only on a very limited scale. The crop with the most potential is soya bean. Its limited adoption so far may be attributed to the lack of any established seed supply and to marketing difficulties. The unfamiliarity of farming families with the methods of cooking the beans may also be a contributing factor. Good stands of the crop are grown at the Mid-Sadong Scheme where conditions are similar to those in the study areas. Agricultural staff report yields of 1 500 kg/ha of shelled beans. In 1969 four farms in the Nonok Peninsula were recorded as having an average yield of 1 156 kg/ha (Best and Wong, 1973).

The other annual crop with immediate potential for development is maize. It is presently grown to a very limited extent in the study areas in the off-season following the rice crop. When the land has been carefully prepared, the growth and yield are good. Agricultural staff at the Mid-Sadong Scheme report that yields of 1 800 - 2 000 kg/ha are achieved by farmers on the scheme. This would include production from local unimproved cultivars. The recommended cultivar, Metro, is capable of producing yields in excess of 2 500 kg/ha.

## Perennial crops

### Coconuts

In the Samarahan area, coconuts of the tall variety are grown as a cash crop in most villages; the produce is sold mainly as nuts although copra is also prepared. A high proportion of these palms has been planted since 1959 under the Coconut Planting Scheme (CPS). The standard of maintenance is variable. On the heavy soils found in this area adequate drainage is essential if good yields are to be achieved. While main drains have usually been dug, subsidiary drains have not been put in. As a consequence, most mature gardens will be yielding less than the 700 kg/ha per year (= 2 700 nuts/ha) which Ngui (1974) records as the average yield in First and Second Divisions. When palms have been well maintained though, good yields can be obtained: one 11 year old garden near Kampong Baru was said to be yielding 2 650 kg/ha of copra. Improvement to the drainage could increase yields in many gardens

where the palms are still relatively young (10-15 years), although the response in terms of enlarged harvests would not be obtained for 12-18 months (allowing for improvements to the growth of the palm and the subsequent maturing of the fruit bunches).

In the Sadong-Krang area, apart from coconuts grown in the compound for home use, the crop is largely found between Kampong Gumpeh and Gedong. Most were planted in the 1960s under CPS and growth and yields are almost universally poor. Farmers no longer consider the crop to be productive in the area.

Returns both per man-day and per unit area could be substantially increased by converting coconut areas into areas of annual crops but it is considered impracticable to do this in the Samarahan area: it should, however, be policy in the Sadong-Krang. The productivity of coconut land in the Samarahan area should be increased by improvements to the drainage and the underplanting of mature palms with cacao or robusta coffee.

### *Rubber*

Rubber is found in most villages. Holdings established under the Rubber Planting Scheme (RPS) though, are confined to the hill areas; the stands in the study areas themselves consist of material established from unselected seedlings; many are over 20 years old. On naturally better drained areas, where the trees have been given adequate spacing, the vegetative growth has been good and potential yields may be in the region of 350 kg/ha. At the other extreme, trees closely planted on poorly drained soils have a poor girth and may not be capable of yielding over 200 kg/ha. The actual yields obtained vary with the intensity of tapping. Over most of the areas the intensity has increased with the recent rise in the price of rubber.

### MARKETING AND CREDIT

The study areas have well-established marketing systems for farm produce and consumer goods. Farmers with produce for sale usually dispose of it to the local village shopkeepers who pass it on to traders in Muara Tuang or Gedong. From there it is transferred to Kuching, Serian or one of the other major market or milling centres. Produce, particularly copra and pepper,

is sometimes sold direct from the farm to traders in Kuching; rice, however, is customarily traded at the village level in the first instance.

The Lembaga Padi dan Beras Negara (LPN) is currently the sole importer of rice into Sarawak. Imported rice is sold to wholesalers at nine market centres throughout the State; although there is no statutory control over the retail price, the LPN recommends the price level at which its rice should be sold to consumers.

No reliable data are available concerning the quantities of the various products exported from the study areas annually. Both areas, however, appear to be net exporters of rice. One estimate for the Samarahan area puts exports through Muara Tuang at over 400 t of rice in 1976. Among the villages reported to be surplus producers are Melayu and Niup. From Muara Tuang the rice goes to coastal mills for processing, as well as to inland centres.

Credit for purchase of consumer goods is extended by the village shopkeepers who are provisioned by the larger traders in Muara Tuang or Gedong, and they in turn are supplied and financed by merchants in Kuching and the larger towns. Credit charges are closely interrelated with prices through quality discounts on farm produce and adjustment of consumer goods prices, and effective interest rates are very difficult to estimate. There is little use of credit for production purposes.

## PART 4 DEVELOPMENT STRATEGY

### INTRODUCTION

In Part 3 it was shown that, throughout the two study areas, the land is being used extensively for the production of a few crops, principally rice, rubber and coconuts. Methods of production are generally traditional and capable of improvement; yields of all crops could be raised. The use of fallow periods in the rice production system means that only one crop is taken in perhaps 2-5 years from land capable of producing two crops per year. While all the soils present problems for their development, the study areas have a higher potential for annual crop production than over 90% of the land area of the State. They are capable of producing a relatively wide range of crops without irrigation: the only major exception to this is the need for irrigation for off-season rice production.

The two study areas were selected by the Padi Production Unit as being particularly suitable for contributing to the objectives of rice self-sufficiency, raising the standard of living of the rural poor, improving land, labour and capital productivity and increasing employment opportunities. These objectives are not necessarily totally compatible and their relative priority has not been decided by the State Government. After assessment of the study areas and discussion with departmental officials, the Mission concluded that the following specific development objectives were appropriate for the study areas:

1. All cultivable land should be brought into continuous cultivation as soon as possible
2. The land should be used principally for the production of annual crops, especially rice, with tree crops being confined where practicable to areas of existing stands of well-grown trees and to levees where tree crops are required for flood and erosion protection
3. The labour required for the developments proposed in (1) and (2) above should be drawn in the first instance from the locally-based population. If shortage of labour, which cannot be alleviated by

the use of machinery or the natural growth of population in the near future, places a constraint on production, land should be made available to prospective settlers from other rural areas where malnutrition or land shortage has been identified.

These objectives all relate to the need to increase the level of agricultural production in the study areas. The present low level of production, especially of rice, is partly attributable to maldistribution of landholdings amongst the existing population. Thus some people have more land than they are able to cultivate while others have insufficient in relation to their available labour. Some regulation of landholdings, therefore, could in itself contribute to the increase in crop production. The scale on which this increase might be realised can only be estimated after the collection and analysis of the necessary information on land tenure.

Some regulation of land holdings, allied to an increase in the present extension work of the Department of Agriculture, could further increase production and incomes with relatively little capital expenditure. The disadvantage of this approach is that development would be difficult to implement in isolation from other measures such as area water control or land settlement and any increase in output is likely to be achieved only slowly over a long period of time. It is likely that the existing population would be unable to cultivate all the available land without the introduction of mechanisation for land preparation for annual crops. It is considered that such mechanisation could be most efficiently undertaken on the larger scale suggested in the proposals for development (Part 5).

Effective development in the study areas will thus require the introduction of a "package" of measures and this has been incorporated in the proposals of the Mission. The main elements in the package comprise soil water control (including irrigation), mechanisation, land administration and improved methods of production. These will now be discussed in turn.

## PACKAGE COMPONENTS

### Soil water control

The greater part of the two study areas is covered by gley soils which, by definition, have a high watertable for part of the year at least. These conditions are not naturally suited to optimum crop production and a basic requirement for improved yields is sound management of the soil water regime. The crops differ in their requirements; the two extremes are tree crops and irrigated rice. Tree crops require adequate drainage to a depth of 1 m throughout the year, whereas for irrigated rice it will be necessary to inundate the land for much of the growing season, draining it off for harvest and so aerating the root zone annually to prevent the development of severe reducing conditions. Broadly one may divide the basic requirements into those for tree crops and those for annual crops, both irrigated and rainfed. It will therefore be necessary to designate specific areas for these, so that the major drainage works can be designed and constructed accordingly. In the fine-textured soils which are found in the study areas, it is possible to achieve suitable water regimes over relatively small areas (20 ha).

Good water control on the farming areas will not only increase crop yields but also improve access to the land and enable tractors to be used for cultivation.

In the Samarahan study area, water control could be achieved by construction of low perimeter bunds and internal drainage ditches which discharged into the tidal rivers via flap gates. Irrigation facilities can be provided at a few locations on a limited scale. The major areas of irrigation potential are hatched on Separate Map 3, though additional small schemes might be developed from the many small streams which drain from the peat swamps.

In the Sadong-Krang study area, severe flooding frequently occurs and, except on land close to the confluence of the two rivers (Separate Map 6), adequate water control by means of bund and drain construction is not possible. The full agricultural potential of this area, and also of the floodplain upstream of Serian towards Tebakang, can only be realised by control of the

floods; this would require the construction of storage dams higher up the catchment. Preliminary studies (Appendix 3) suggest that such measures, which would be expensive, might not eliminate flooding entirely, and would require an elaborate system of control over their operation. Further studies to determine the possibility of flood control in the Sadong catchment are recommended in Annexe 2, but for the immediate future, major agricultural developments in the study area should be confined to the Gedong and Kuala Schemes (Part 5) where water control and irrigation can be provided.

### Mechanisation

Experience with the Assistance to Padi Planters' Scheme has shown that farmers, using manual methods, are unable to work their land into a suitable condition for regular cropping. This condition can only be achieved with machinery. Following the de-stumping of an area, four to six operations involving ploughing, raking, harrowing and levelling will be required, the number depending upon the initial state of the land (Appendix 9). Such work would have to be carried out in the off-season and need only be done once. Either 4-wheeled or tracked tractors could be used.

In established annual cropping areas, a major constraint on the expansion of the area a family can cultivate both in the *landas* and the off-season is the labour required for land cultivation before planting. Present methods also result in poor standards of cultivation. An economic increase in cropped areas and in yields per unit area and consequently in farm family incomes could be achieved by the introduction of mechanisation. In Peninsular Malaysia such cultivation is achieved with rotovators only but in Sarawak it may also be necessary to use ridgers for off-season cropping.

Such land cultivation could be undertaken with 4-wheeled tractors of about 80 hp; in particularly difficult areas, tracked machines might be needed. Alternatively, pedestrian tractors could be considered. These alternatives are discussed in the economic analysis.



PLATE 3 Land preparation for a ricefield near Kampong Nangka — burning the fallow growth. The rice nursery is in the foreground.



PLATE 4 Ricefield near Serian

## Land administration

In the areas proposed for development schemes, land is mostly held under customary rights but there are also lands held under title (mostly Native Area land). In order to rationalise the administration of the schemes, one of the following two strategies is recommended according to the particular situation obtaining in the area. These are considered in greater depth in Appendix 8.

1. In areas where land is held according to customary rights (the most common situation in the study areas) the whole of the area should be designated a Native Communal Reserve. Specific parts of the area should be designated for rainfed annual or tree crops or for irrigation. Any plots of land held under title within the Reserve should be exchanged for land outside the scheme or purchased by the Government.

It is recommended that smallholders within a scheme are involved directly in its administration. Allocation of land within the Reserve should be undertaken by a Land Committee with elected representatives from each village under the chairmanship of the Agricultural Officer in charge of the scheme. The work of the Land Committee will be closely linked with that of other organisations which might be established within the scheme (e.g. Farmers' Organisation for the distribution of agricultural inputs) so that smallholders participate in decision-making in all aspects of the scheme.

2. In areas where land is mostly held under title all rights to land should be adjudicated and existing titles withdrawn. Before issuing new titles a certain amount of redistribution of landholdings should be undertaken by the Government in order to ensure that all land is cultivated. This can be achieved by Government intervention to purchase land and to redistribute it to smallholders with insufficient land and to tenants who own no land.

The new titles should be issued on condition that suitable crops are grown, that the land cannot be sold for 10 years without permission from the Department of Land and Survey, and that there will be no subdivision of land.

It will be realised that the situation with regard to the relationship between available land and available labour is dynamic and the redistribution of land that meets the present position will not continue to be satisfactory. The question of land distribution therefore must be kept under continual review.

In areas where there is a large surplus of land over the requirements of the existing population, which cannot be reduced substantially by redistribution and by increasing the productivity of labour (e.g. by the introduction of appropriate mechanisation), one of two further actions is recommended:

1. Settlers from areas of land shortage outside the study areas might be introduced. This might be undertaken by the Sarawak Land Development Board (SLDB) with the aim of establishing smallholder ownership of the land either by the issue of title or by the institution of a Native Communal Reserve.
2. The SLDB might manage surplus areas of land as a Government Reserve with a view to supplying the increased demand of the future population of the area.

In order to decide the most relevant strategy for a particular situation, attention should be given to the probable rise in the population of the study areas as a result of natural growth and to holding size in relation to household requirements.

#### Crop production

The range of crops that can be recommended for planting on a major scale in the study areas is limited but adequate for present development purposes; it includes rice, soyabean, maize, coconuts, cacao, coffee and citrus.

From the climatic data it has been calculated that, in most years, irrigation would only be required in annual crop production for growing rice in the off-season. Irrigation would be expensive and limited - in the Samarahan area by the lack of suitable water and in the Sadong-Krang by the problems resulting from severe flooding in the *landas*. Before irrigated rice can be recommended it will be necessary to establish the appropriate techniques, for which purpose

two small areas should be developed immediately, one in each of the study areas. Once the techniques have been established irrigation may be extended elsewhere. Thus initially the basis of annual crop production should be a rainfed system including rice in the *landas* and another crop in the off-season. Such a system is not currently practised by farmers but work at Paya Paloh and elsewhere shows that it is feasible. The off-season crop could be soyabean or maize.

During the *landas*, rainfall may be of such severity that temporary flooding cannot be prevented; this is likely to be a particular problem from December to February. Flooding can be tolerated by rice in the vegetative phase i.e. from 2 weeks after planting until the booting stage approximately 7 weeks before harvesting. The cultivars presently recommended by the Department of Agriculture have a maturation period of 165-180 days. If they were sown in October and planted after 28 days they would be able to tolerate flooding in mid-season and be harvested in March-April. As information becomes available on flooding incidence in specific localities it should be possible to identify more exactly the period of hazard and then, perhaps, to be able to introduce one of the higher-yielding cultivars which have a shorter maturation period. Initially there would be a need for the longer-term cultivars in both rainfed and irrigated areas.

The present state of agronomic knowledge and the availability of markets confine the choice of off-season crops to soyabeans and maize. The soyabean cultivar Nonok (100-110 days) and the maize cultivar Metro (110-120 days) have been shown to yield satisfactorily and are suitable for use initially until improved cultivars are identified. They could be sown in June for harvest in September.

In the irrigated areas in the off-season, serious flooding does not occur and cultivars with a shorter maturation period than the main season cultivars can be used. Those recommended by the Department of Agriculture (Bahagia, Mahsuri line 17 and Sri Sarawak) have a maturation period of 120-140 days; if sown in May they could be harvested in September.

The proposed cropping calendar for rainfed and irrigated areas is presented graphically in Figure 9.





PLATE 5 A coconut holding near Kampong Gumpoh showing the poor growth typical of the area.



PLATE 6 River transport: evacuation of produce from the farm

The major tree crop in the Samarahan area will continue to be coconut. The poor yield now being obtained will be improved when adequate drainage is constructed. Higher returns per unit area and per man-day can be achieved in mature areas (>6 to 8 years) by underplanting the palms with cacao (or robusta coffee), a practice that has been successfully introduced under similar conditions in the Nonok Peninsula.

For reasons that have not been identified, coconuts in the Sadong-Krang area grow poorly and yield very little (Plate 5). The crop can no longer be recommended and the Coconut Planting Scheme (CPS) has been withdrawn. The further step should now be taken of permitting the felling of the palms where no suitable alternative land is available for annual crop production.

Rubber grows in most villages of the study areas. It has the attraction for the smallholder that it is relatively free from pests and diseases, does not deteriorate seriously if neglected for periods of time and can be exploited at need. However, although with good husbandry it can be productive on the soils of the two study areas, it is recommended that national policy should be to confine the crop to areas of hill soils which are much more abundant and where the range of potential crops is more limited. Government assistance should therefore not be given for planting or replanting rubber in the study areas. The same case applies to oilpalm and pepper.

Fruit trees could be grown in addition to coconuts, cacao, and coffee, but these will be of minor importance.

## ECONOMIC ANALYSIS

### Commercial prospects

It is clear from the earlier discussion that a substantial internal market exists for locally produced rice as an import substitute. Maize is also being imported in quantity but locally produced maize should be competitive with the imported product, provided it is of high enough quality and is produced on a scale large enough to attract commercial buyers.

For soyabeans there are import substitution prospects as well as the possibility of an export market in Peninsular Malaysia. Copra and cocoa beans should also find ready markets.

Systematic development of the study areas should lead to a rapid increase in the volume of marketed products. Both areas are favourably placed in relation to the Kuching market which can be reached from both Muara Tuang and Gedong by either road or river. Nevertheless a significant expansion in market flows may, in the early stages at least, overload the existing system, leading to marketing inefficiencies of various kinds. The Federal Agricultural Marketing Authority (FAMA) can assist in alleviating any problems that do arise and this organisation should be involved in the development planning of the study areas from an early stage.

Opportunities for increasing production will generate a higher demand for production inputs and credit, and consideration must be given in advance of development to the nature of demand and the most appropriate channels for distribution of inputs and credit. It is possible that the Farmers' Organisations, currently being promoted in Sarawak could have a major role to play in this connection.

#### Crop production costs and returns

The two major cropping systems agronomically suitable for the study areas are (a) the rainfed production of rice followed by maize or soya beans and (b) coconut holdings underplanted, when mature, by cacao (or robusta coffee). Initially double cropping of rice with irrigation will be of minor importance. Table 9 shows the Mission's estimates for yield, price, net return to the farmer and net social return for the above crops in the Samarahan area, both under traditional conditions and under the improved conditions implied by the proposals. Tree crops can be considered as possible substitutes for rice in so far as environments favouring *landas* season rice could be converted by drainage and flood protection into ones suitable for the growth of tree crops. The available data suggest, however, that a single crop of rice is much more economic than coconuts, and rice followed by soya beans is more remunerative than cacao and coconuts in combination both on a per hectare basis and per

man-day\*. The rice-soya bean system also provides considerably more employment per hectare than coconuts-cacao. Maize is a less attractive crop both economically and in terms of employment.

Given the importance attached to increasing the production of rice and in the light of the data in Table 9, the most economic use of the limited rice land in the Lower Samarahan area is to have a maximum area under a rice-soya beans rotation and a minimum under coconuts with cacao, pure coconuts and maize. Converting coconut land to rice land may, however, be very difficult to attain in practice, since farmers will initially wish to retain at least those portions of their coconut plantations which bear well. Some may also wish to retain stands which establish their claim to the land. In addition, the weakness of the input-output data used in the analysis and the hazards of long-term price projection demand that the estimates of net returns should be treated with caution. For these reasons, the proposals for the Lower Samarahan Scheme (Part 4) incorporate a substantial area of underplanted coconuts on naturally better drained land in association with a significantly greater level of rice production, an extensive area of soya beans, and a higher standard of husbandry practice than exists at present. This solution appears to be the most practicable in view of data weaknesses and the evident desire of the Sarawak Government to promote production of tree crops and encourage diversification of agriculture concurrently with its emphasis on rice production.

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\*The data in Table 9 are biased in favour of tree crops since no account is taken of negative returns during their establishment and the longer gestation period before maximum yields are reached. Returns per man day over the whole cycle of production are less from coconuts-cacao than from rice-soyabeans.

TABLE 9 Estimates of price, yield and net returns from crop production in the Samarahan study area\*

Production system	Rice (landas)	Soya beans	Maize	Coconuts** (copra)	Coconuts** Cacao (beans)
<b>Traditional</b>					
Price (\$/kg)	0.46			0.44	
Yield (kg/ha)	2 200			600	
Net return to producer: \$/ha	972			234	
\$/day	6.4			4.3	
Net social return <sup>†</sup> \$/ha	364			14	
<b>Proposed</b>					
Price (\$/kg)	0.46	0.79	0.33	0.44	<u>0.44</u>
Yield (kg/ha)	2 750	1 250	2 000	1 500	<u>1 500</u>
Net return to producer: \$/ha	1 103	846	415	620	1 735
\$/day	9.0	11.6	6.6	6.1	10.6
Net social return <sup>†</sup> \$/ha	615	554	163	212	1 079

\*For details on which this table is based see Appendix 10.  
 \*\*At maturity  
 †Net return - opportunity cost of labour (charged at \$4/man-day).

### The economics of soil water control and mechanisation in rainfed areas

As discussed above, increased agricultural production in the study areas requires good soil water control and mechanisation for land preparation. Except in the flood-prone areas in the Sadong-Krang, these conditions could be achieved through large-scale schemes requiring considerable capital outlay per unit area initially or, at less cost, on small scale discrete areas (say 20 ha) through existing schemes such as APPS and CPS. The two approaches were therefore analysed (Appendix 10) in connection with the largest compact block in the Samarahan area, the Lower Samarahan (see

Separate Map 3). A development scheme for this block is presented in Part 5. The first approach, termed Option 1, comprises a single scheme for the entire area involving extensive bunding (for flood control and access), draining and the introduction of 4-wheeled tractors for land preparation. The areas covered by existing good stands of coconuts would be designated tree crop areas and planted entirely with palms or with palms and cacao. The remaining land would be cropped twice yearly with rice followed by soya beans. The second approach, Option 2, involves the development of the land by self-help schemes. Farm drains would be constructed on a *gotong royong* basis and pedestrian tractors would be introduced to assist with land cultivation for annual crops. In the Lower Samarahan area the Mission considers that virtually all the land which is currently under rice fallow could be developed in this way, but only 40% of the area would be suitable for soya beans in the off-season because of adverse soil water conditions. The existing coconut areas would either remain in their present state or be tackled on the basis of small scale improvements.

The land use allocation and the summary of the results of the analysis of the two options are shown in Table 10. It should be noted that the analysis is only indicative (being based on rather sketchy data) and requires confirmation at a later date. Under both options it is assumed that the area actually planted to soyabeans will be limited to 75% of the suitable area.

In the economic analysis it is assumed that development progresses at the same pace under both options. Experience with the APPS and CPS suggests that the piecemeal approach of Option 2 would in fact result in much slower development. Further, while this option promises a very satisfactory economic return in relation to capital expenditure, other benefits including employment, farm income levels and production of rice would all be much higher with Option 1. Therefore, unless capital is a major constraint, the Mission recommends the large scale, more capital intensive, approach represented by Option 1.

The findings of the analysis, while specific to the Lower Samarahan area, are likely to be broadly applicable to other comparable parts of the study areas. One such area lies near Kampong Kuala to the south of Gedong. It presents some very difficult technical problems but, if these can be overcome,

TABLE 10 Options for development of the Lower Samarahan Scheme: land use and economic indicators\*

	Current	Proposed	
		Option 1	Option 2
Land use (ha)			
Rubber	5	-	5
Forest (including nipah)	330	-	330
Coconut	139	71	139
Coconut/cocoa	-	214	-
Padi - cultivated	288	910	721
fallow	433	-	-
Soya beans (off season)	-	680	216
Economic indicators			
Net present value (NPV)			
at 10% discount rate (\$'000)	-	1 451	1 281
" 20%     "     "	-	-1 175	139
Internal rate of return (IRR)			
(approximate)	-	15%	23%
Employment (man days)	51 000	203 000	111 000
Rice production (padi) (t)	634	2 500	1 983
Producers' income† (\$'000)	312	1 881	942
Capital requirement** (\$'000)	-	2 923	580

\*Details are presented in Appendix 10. The options are compared over a 30 year period

†At yield maxima, assuming that all direct costs of crop production, including the full costs of tractor operation, fertilisers, etc., are borne by the producer

\*\*Includes earthworks, structures, land clearing, equipment for cultivation, and land acquisition for earthworks

the rate of return should be at least on a par with that expected from the Lower Samarahan area. A development scheme for this site is presented in Part 5.

#### The economics of irrigation

In the section on crop production, it was recommended that two small irrigated areas should be developed to establish appropriate techniques for irrigated rice production. This would also allow a proper appraisal to be made of the economics of providing irrigation in other parts of the study areas. As in the rainfed areas, tractors should be introduced to help with land preparation. The net effect of these two innovations should be an increased area under *landas* rice and two rice crops per year rather than one.

An alternative for the irrigable areas, is to promote soya bean rather than rice production in the off-season, so eliminating the need for investment in irrigation facilities.

As a preliminary test of these alternatives, termed A and B respectively, a comparative economic analysis was undertaken with reference to an irrigable block on the Sungai Empila (see Separate Map 3; a development scheme for this block is presented in Part 5.) The range of cropping possibilities is similar to that outlined in Table 10 above: in addition, the values of the relevant variables for off season rice are estimated to be:

Rice yield	3 000 kg/ha
Net return to producer	₹1 186/ha, ₹8.9/man day
Net social return*	₹654/ha

The current and proposed land use patterns for each alternative (A and B) are set out in Table 11 which allows the alternatives to be compared on the basis of various economic indicators. (Off-season cropping is assumed to be limited to 75% of the available area in both cases.)

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\*Net social return = Net return to the producer - the opportunity cost of labour.

Both alternatives are attractive in terms of returns to producers and to society as a whole, with alternative B promising higher NPV and IRR values than alternative A. However, under irrigation relatively high levels of rice production, producer incomes and employment are achieved and for this reason it is recommended that irrigation be developed on the Sungai Empila and on similar sites elsewhere in the study areas. One such site comprises four *tanjongs* near Gedong; returns to development at this location are expected to be comparable with those shown in Table 11. Development schemes for both sites are presented in Part 5.

TABLE 11 Development alternatives for the Empila Scheme, Stages 1 and 2 land use and economic indicators\*

	Current	Proposed	
		Alternative A Landas Off-season	Alternative B Landas Off-season
Land use (ha)			
Forest	26	-	-
Coconuts	34	-	-
Padi land - fallow	59	-	-
- cultivated	51	170	170
Soya beans (off-season)	-	-	-
			130
Economic indicators			
Net present value (NPV at 10% discount rate (\$'000)	-	358	624
" 20%       "       "	-	-125	111
Internal rate of return (IRR) (approximate)	-	17%	26%
Employment (man-days)	8 000	38 000	30 000
Rice production (padi) (t)	112	858	468
Producers' income <sup>†</sup> (\$'000)	50	318	274
Capital requirement** (\$'000)	-	477	255

\*Details are presented in Appendix 10. The alternatives are compared over a 30 year period.

<sup>†</sup>At yield maxima, assuming all direct costs of crop production, including the full costs of tractor operation, fertilisers, etc., are borne by the producer.

\*\*Includes earthworks, structures, land clearing, equipment for cultivation and irrigation, and land acquisition for earthworks.

## ORGANISATION

### Implementing agencies

The Mission was asked to prepare terms of reference for detailed feasibility studies which it was anticipated would be undertaken by consultants. It is felt, however, that the existing State Government agencies should be able to undertake the responsibility for the development schemes proposed for the two study areas provided the limited technical cooperation discussed in the following section (senior development staff) is made available. Successful implementation will require the close coordination of all concerned. At present, such coordination is the responsibility of the Division and District Action Committees with the field implementation being the responsibility of the individual Departments. In the Sadong-Krang area, the mission's proposals envisage development on a comparatively minor scale where coordination can remain the responsibility of the existing Action Committees. However, in view of the potential of the Samarahan area for early and substantial increases in annual crop (particularly rice) production, it is recommended that this area, together with contiguous areas of hill land farmed by its residents, should be declared an Agricultural Development Area and an Agricultural Development Committee established. The headquarters for the area would be the existing sub-district centre at Muara Tuang. This proposal is discussed in greater detail in Part 6, Implementation.

### Senior development staff

At present, the Sarawak Government does not employ an agricultural engineer and there is no local available expertise in mechanised land preparation for wet rice cultivation. This is a vital requirement, particularly for the Samarahan area, and it is therefore essential that an agricultural engineer with such experience be obtained. If one is not available from Peninsular Malaysia it will be necessary to recruit one from overseas.

Three other key posts will be filled by a drainage and irrigation engineer, an agronomist and a sociologist. Suitably qualified people are available

within the Government service but, in view of the other commitments of their Departments, it may be considered necessary to seek such personnel from elsewhere in Malaysia or from overseas.

The drainage and irrigation engineer will be responsible for the detailed design and supervision of the construction of the engineering works for the Lower Samarahan and Empila schemes (see Part 5).

The agronomist will undertake farm level studies on the problems of implementing cropping systems, principally with annual crops (both rainfed and irrigated), in the schemes. This work will be closely coordinated with the programme being undertaken at Paya Paloh Experiment Station.

The sociologist will be concerned with problems of land tenure, administration and population (Appendix 8).

These four specialists will form the core of the field team running the implementation of the development schemes in the Samarahan area (they will require office accommodation in Muara Tuang). The agricultural engineer will also need workshop facilities sufficient to enable him to maintain the machinery used for the land cultivation service. It is envisaged that the development staff would be housed at Muara Tuang later.

#### Farmer participation

The success of any scheme will depend, as always, on the enthusiasm of the farming families concerned. The importance of involving them or their representatives in all aspects of the scheme from the very earliest stages is stressed (this is discussed further in Part 6).

## PART 5 PROPOSALS FOR DEVELOPMENT

### INTRODUCTION

In Part 4 a general strategy was proposed for the development of the study areas and the economics of the proposals were subjected to a rough economic analysis with reference to two particular blocks of land. Four specific development schemes are now described for development immediately following the preliminary studies defined in Part 6. Two of the schemes are in the Samarahan area and the other two in the Sadong-Krang.

### SAMARAHAN AREA

#### Introduction

The Samarahan area offers a greater prospect for early development than the Sadong-Krang; the major proposals therefore refer to the former. These comprise a scheme for rainfed crop production, the Lower Samarahan scheme, and an irrigated scheme for the double cropping of rice, the Empila scheme. Similar schemes to these, particularly of the former type, can subsequently be designed for all communities in the study area and for similar conditions elsewhere in the State.

Possible future schemes for the Samarahan area have been identified (see Separate Map 3). The largest area for rainfed crop production, after the Lower Samarahan, is the Semawang area (860 ha) but further schemes could be prepared for communities throughout the study area. Irrigated areas would be more limited but are possible at Entingan (150 ha) and on part of the Semawang area. On the Upper Empila an area of 375 ha could eventually be irrigated. It lies at present under primary forest and is covered with Mukah (peat) soils. The problems involved in developing such soils were discussed in Part 3.

In order to achieve success in the schemes as a whole, it is vital that the initial schemes should be carefully planned, implemented with dedication and

given the full and active support of senior members of Government both elected and official.

#### *Lower Samarahan scheme*

##### *Objective*

To bring into full production 900 ha of rainfed annual crops and 300 ha of tree crops.

##### *Location*

On the west bank of the Batang Samarahan between the Loba Batu Belat and the Muara Tuang road (Separate Map 3).

##### *Communities involved*

Kampongs Baru, Rembus, Mapar, Pla-i, Tanjong Bundong and Sungai Batu.

##### *Present land use*

The Lower Samarahan scheme is the largest compact block within the study area. A study of the air photographs shows that the area is relatively intensively cultivated (Plate 1). While coconuts are generally grown along the river bank, where drainage is easiest, these are often interspersed with fallow and active ricefields. Similarly, towards the middle, where drainage is poor, rice fields predominate but some scattered coconut stands can be found. There are two blocks of old seedling rubber, both of which are on poorly drained soil and are overgrown with secondary forest. Few trees are being tapped despite the present high rubber prices; some are being felled for firewood.

### *Soils and water*

The soils of the area are gleys, saline gleys and shallow peat overlying clay; their distribution is shown on Separate Map 1 and their characteristics are discussed in Part 3 and Appendix 1. The area is flat and lies mainly just above high tide level so that flooding with saline water is a minor hazard. The area is naturally drained by a network of tidal creeks of which the Sungai Krui is the most important. The natural drainage has been supplemented in some places by small man-made drains.

### *Land tenure*

Some 2 000 ha of land adjacent to the Muara Tuang-Kuching road was subject to settlement in 1970 after land disputes had occurred involving a number of villages. Part of the land proposed for Stage 1 of the scheme has been designated as a Native Communal Reserve but has not yet been gazetted. In the north of the scheme area very little land has been subject to cadastral survey. (Separate Map 2).

### *Proposals*

It is proposed that:

1. Specific areas should be defined for the production respectively of tree crops and of annual crops (Plate 1) and that a drainage system appropriate to each should be constructed
2. The entire area of annual crop land should be planted under an annual rotation of rice and either soyabean or maize.
3. A mechanised land cultivation service should be introduced to assist farmers to accomplish Objective 2

4. A cadastral survey should be completed throughout the scheme and the area gazetted as Native Communal Reserve
5. Land holdings should be adjusted so that the area available to a family both for rice and tree crops is related to its labour.

In order to make phased implementation of the scheme possible, the areas has been divided into two: the southern section (lying within the points marked A on Plate 1) constitutes Stage 1; Stage 2 is the remainder of the area. The two stages should be implemented independently of each other, Stage 1 (lying nearer the road) being undertaken first. This stage contains 185 ha of rice land and 98 ha of tree crops. Stage 2 contains 725 ha of riceland and 187 ha of tree crops.

Although no formal "pilot" stage is recommended, Stage 1 will in fact correspond to a pilot stage; development will commence within this area and progress should be carefully monitored and evaluated to ensure that lessons learned here are applied throughout the scheme and elsewhere in the study areas also.

#### *Engineering works*

Details of the engineering works and their cost are given in Appendix 9 but are summarised below:

The 1 200 ha scheme is to be surrounded by a perimeter bund to prevent flooding with saltwater from the river, to act as an access route and to define visibly the scheme limits. This bund has been routed to exclude the existing villages (Plate 1). The scheme will also have an internal bund/access which will divide the areas reserved for tree crops from those reserved for annual crops. The proposed alignment of the bunds broadly divide the existing coconut area from the existing rice areas.

In order to obtain better drainage, a network of drains to supplement the existing system is proposed. These will discharge into the river through tidal gate structures which will prevent the entry of salt water and hold internal drainwater levels below mean river water level. Within the rice area, where



PLATE 7 Sungai Entingan, near Kampong Nangka, at low tide during a dry period.



PLATE 8 River fishing with a push-net (*sadak*)

controlled flooding is desirable, the drainage system will be provided with check structures to hold back rainwater during the rice season but allow rapid drainage at the end of the season in order to facilitate harvesting and the subsequent land preparation for the off-season crop.

### *Mechanisation*

The scheme envisages all land within the annual crops areas being cleared of trees, stumps and roots and then brought into good working condition by a thorough cultivation of the land as described in Part 4, Mechanisation. This land preparation would be carried out once only, and it is recommended that it be offered as a free service to induce farmers to participate in the scheme. Subsequently the land would be mechanically tilled prior to each rice and off-season crop. This seasonal service should be planned on a commercial basis preferably from the start or at least within 3 years. At the beginning the service will have to be undertaken by the Department of Agriculture but encouragement should be given to the Farmers' Organisation or private contractors to either take over the enterprise or start their own.

This mechanised land cultivation service should be based at Muara Tuang so that it can service both the Lower Samarahan and the Empila schemes. The implements required for the service and their cost are detailed in Appendix 9.

### *Sungai Empila scheme*

#### *Objectives*

To establish an area of double cropped irrigated rice production with mechanical land preparation, and to identify suitable techniques for such production in similar areas. The scheme will be implemented in two phases each of which has two stages.

### *Location*

On the right bank of the Sungai Empila (Separate Map 3).

### *Communities involved*

Initially, Kampongs Empila and Niup; later stages will also include Kampongs Melayu and Sungai Mata.

### *Present land use*

The four stages of the scheme lie within a total area of 1 000 ha of which about one third is now used for rice and one third for tree crops while the remainder lies under secondary forest.

### *Soils and water*

The soils are predominantly gleys and saline gleys with some shallow peat overlying clay (Separate Map 1). Flooding with saline water from the Batang Samarahan is not considered a serious hazard but the land immediately adjacent to the Sungai Empila is reported to be flooded to a depth of about 1 m with fresh water from the Empila for a number of days each *landas* season.

### *Land tenure*

The area identified as Stage 1 (Plate 2) has not yet been surveyed but is probably claimed under customary rights by the people of Kampong Empila. Stage 2 is currently farmed by the people of Kampongs Empila and Niup. Some of the land held by the people of Niup is Native Area land and parcels of this land are being sold to non-farming interests in Kuching and Muara Tuang. Stage 3 is largely held under customary rights by people of Kampong Melayu, An area within Stage 4 has been under dispute between the villages of Empila,

Niup and Melayu; this land is State land subject to customary claims and no cadastral survey has been undertaken. Other land at Stage 4 is Native Customary land and Native Area land (see Separate Map 2).

### *Proposals*

Irrigated rice production (double cropping) should be implemented over four areas successively (see Plate 2). Stage 1 extends over 80 ha, lies some 1.5 km upstream of Kampong Empila and comprises traditional rice areas of the kampong. On the successful completion of Stage 1, an area of 90 ha immediately down-river (Stage 2) will be developed; this land belongs to Kampongs Empila and Niup. These two stages comprise Phase 1 of the scheme and will exploit all the water available in the Sungai Empila.

Phase 2 will require the augmentation of the water supply by carrying water by canal from the Sungai Tuang to the Sungai Empila. This would enable a total of 800-1 000 ha to be irrigated but the development of Phase 2, which would be the first part of this development, should not be initiated until the economic, agronomic and sociological aspects of Phase 1 have been thoroughly reviewed. Subject to this proving satisfactory, it is proposed that Phase 2, comprising Stages 3 and 4, should be undertaken. The suggested extent of these areas is shown on Plate 2, they total 230 ha. The exact location and extent however can be altered in the light of the response from the people concerned - Kampongs Niup, Melayu and Sungai Mata.

Cadastral survey should be carried out in the part of Stage 1 used by Kampong Empila and in Stage 4 on the State land lying between Kampongs Niup and Melayu. After further studies (see Appendix 8) a decision would be made whether to adjudicate rights in the area or declare it all a Native Communal Reserve.

### *Engineering works*

Details of the engineering works and their cost are given in Appendix 9; they may be summarised as follows:

Irrigation water will be supplied by a canal running along the south-west side of Stage 1. This canal will eventually supply all four stages on the right bank of the Sungai Empila and must therefore be built large enough to carry the supply for all these stages. Offtakes from the canal will supply field channels which will run through the rice fields in the direction of the Sungai Empila. Interspaced with these field channels will be field drains to carry away excess rainwater and facilitate the drying out of the fields prior to harvest. As the land is flat, a simple field irrigation distribution system is envisaged. This may be less economical in the use of water but is more suitable in a location where irrigation is a new technique.

Water from the Sungai Empila cannot be raised by a headworks to supply the canal by gravity without causing severe flooding upstream; pumps will therefore be required. These can be installed progressively as each stage is completed. It is proposed that a headworks is constructed downstream of the pump-site to form a low level pool from which to pump. This headworks will have tidal gates to prevent saltwater being pumped in at high tide. It will also improve upstream drainage during the *landas* season and provide a vehicle access across the Sungai Empila.

In order to provide access within the project area, roads will be constructed along the canal routes. A jetty will be needed at the canal end at the Batang Samarahan. On the completion of the S. Tuang headworks, this access route can be linked up with the Kampong Endap-Kuching road, giving full vehicular access to the scheme. The approximate route for this is shown on Separate Map 3.

### *Mechanisation*

Mechanical cultivation is proposed for the scheme. Before this can be done, some forest clearing, felling of coconut palms and destumping will have to be carried out. An initial thorough cultivation will then be required (see Part 4, Mechanisation). For subsequent seasonal land preparation it is recommended that a tractor service similar to that proposed for the Lower Samarahan scheme be set up; initially two 80-100 hp 4-wheeled tractors equipped with rotovators, rice wheels and ridging and ditching equipment will be required. The administration and service of this small unit can come under the same organisation as the larger unit at the Lower Samarahan scheme.



PLATE 9 Upper Empila area: primary forest and, bottom left, the present condition of the river.

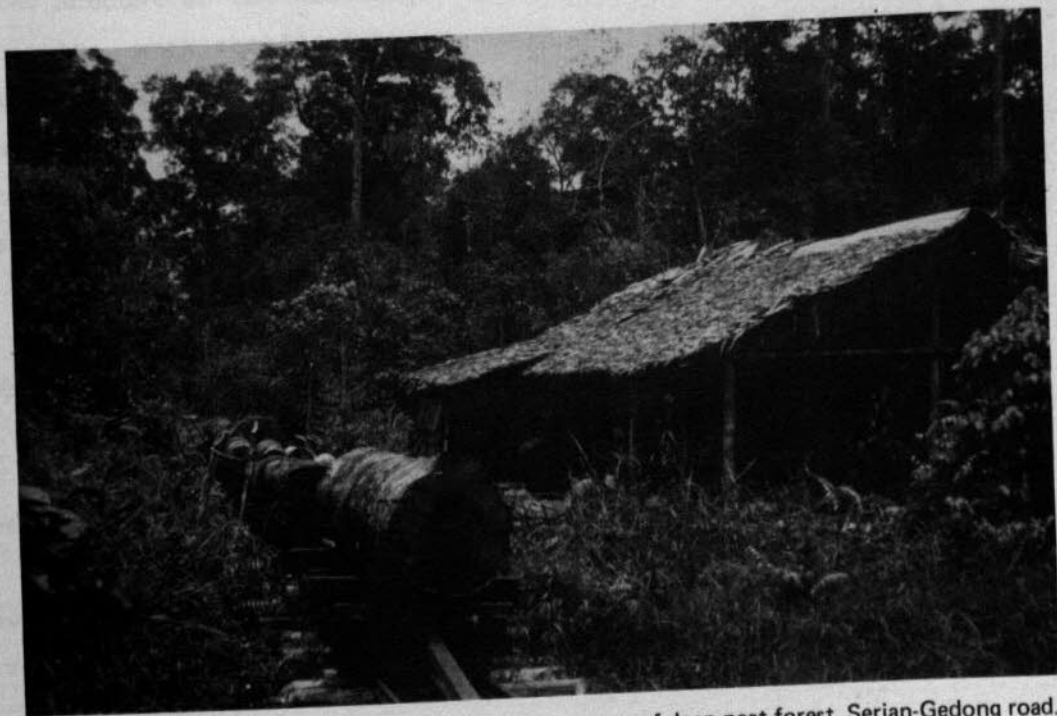


PLATE 10 Extraction of timber by rail from an area of deep peat forest, Serian-Gedong road.

## SADONG-KRANG AREA

### Introduction

It was pointed out in Part 4 that the incidence of severe flooding was a major constraint on the development of farming in the Sadong-Krang area. Two exceptions to this general picture have been identified, however, and these areas are recommended for immediate development. The first comprises the four *tanjongs* (promontories) on the Sadong above Gedong which have a potential for the development of irrigated cropping. The second is the area on the Krang lying between the two Kuala rivers, Ulu and Hilir. This could be developed as a settlement scheme initially based on rain-fed annual crops but later could be served with irrigation. These two schemes, the Gedong scheme and Sungai Kuala scheme, are discussed below.

The flooding over the rest of the Sadong-Krang area can only be prevented by full-scale river control. The studies required to assess the feasibility of such control are discussed in Annexe 2. Until such a system has been designed, no major scheme can be recommended for the flood-prone areas unless it takes account of the flooding. The attainment of a flood control system is problematic: work should therefore begin at once on devising a cropping system suitable for flooding areas. This could best be done through the agency of the Assistance to Padi Planters Scheme (APPS) at the villages of Tanah Puteh and Munggu KUPI. The work on these schemes would be the prelude to the proposed development of *Tanjong Tanah Puteh*.

### Gedong scheme

#### Objective

To develop a total of 268 ha of irrigated double-cropped rice on four *tanjongs* up-river from Gedong.

### *Location*

On Tanjongs Gumpeh, Paoh, Larang and Tajo on the Batang Sadong (Separate Map 6).

### *Communities involved*

Kampongs Gumpeh, Tanjong Paoh, Tajo, Lalang and Gedong

### *Present land use*

Tanjong Gumpeh and Larang have considerable areas under coconuts, largely established under CPS. The growth of the palms is almost universally poor (Plate 5). There are also substantial areas used for rice. Tanjong Paoh, the largest of the four, is mainly used for rice cultivation. Tanjong Tajo is naturally better drained than the others and some good stands of citrus, coconuts and rubber exist: these are mostly along the river banks. About half the land is used for rice cultivation.

### *Soils and water*

The soils of the *tanjongs* are predominantly gley with some shallow peat over clay towards their centres. The areas are not subject to severe flooding and an abundance of irrigation water is available from the Sadong.

### *Land tenure*

Little of the land has been surveyed but it is probable that all the land for the scheme is held by the local communities under customary rights (Separate Map 5).

## Proposals

It is proposed that:

1. The centre of each of the four *tanjongs* be developed for irrigated double cropping of rice. Tree crops would be encouraged along strips of land, averaging 100 m in width, along the river banks (most of the existing trees in bearing are found in such a strip). The trees would offer, in addition to their produce, protection against flooding and erosion. Provision for flood pathways behind the schemes will also be made.
2. Cadastral survey should be carried out on *tanjongs* Gumpeh, Paoh and Larang, and land surplus to the requirements of the population should be determined.

The area of the *tanjongs* to be developed for rice is as follows:

Stage 1	Stage 2	Stage 3	Stage 4	Total
Tanjong Gumpeh	Tanjong Paoh	Tanjong Larang	Tanjong Tajo	
53 ha	90 ha	65 ha	60 ha	268 ha

## Engineering

Each of the four stages will be provided with a low-lift pump driven by a diesel engine. These pumps will be sited at the upstream end of the scheme. They would supply irrigation water through concrete lined canals to the rice fields. The approximate routes of these canals are shown on Separate Map 6. Small secondary canals will distribute water to the fields which would be drained by ditches leading back to the river. The drains will also benefit the tree crop strips as they pass through them.

It is suggested that each stage is built separately in yearly programmes but, if desired, the programme can be completed more quickly. Stages 1 and 2 are the most attractive as there will be little loss of productive crops during implementation.

### *Mechanisation*

As with the Samarahan proposals, it is considered desirable to introduce mechanised land cultivation with the scheme. Each stage will require one tractor and set of implements.

### *The Sungai Kuala scheme*

#### *Objective*

To develop an area of 385 ha of annual cropping by the resident population of the area and settlers from other parts of the Serian district.

#### *Location*

The area 3 km south of Gedong on the Gedong-Serian road between the Sungai Kuala Ulu and the Sungai Kuala Hilir.

#### *Communities involved*

The existing farming communities from Kampong Kuala and Gedong, augmented by settlers from elsewhere in the Serian district.

#### *Present land use*

Mature (seedling) rubber is found in a narrow ribbon along the banks of the Sungai Kuala Hilir. Further from the river, the people of Kampong Kuala cultivate wet rice on a 5-year rice-fallow rotation. Gedong Malays undertake annual cultivation of rice on about 30 ha near the Sungai Kuala Hilir. The rest of the area is under primary forest.

### *Soils and water*

A ribbon of gley soils is found close to the Kuala Ulu and Hilir rivers. The remaining land is covered by peat soils (< 1 m deep) overlying clay. The area is subject to only minor local flooding and there is an abundance of irrigation water available from the Krang.

### *Land tenure*

The people of Kampong Kuala hold customary rights over some 145 ha near the Sungai Kuala Ulu and some Malay farmers from Gedong have rights over 30 ha designated Native Communal Reserve near the Sungai Kuala Hilir. Most of the rest of the land is under primary forest and is State land (Separate Map 5).

### *Proposals*

It is proposed that the area of State land, now lying under primary forest, should be cleared and drained for development of a settlement scheme for indigent rural families in Serian district e.g. Land Dayak in the applied nutrition programme and landless Chinese farmers from Upper Sadong. Ideally the scheme should also include the farmers from Kampong Kuala and Gedong and the land they now farm between the two Kuala rivers, Ulu and Hilir. Native communal reserves should be declared for the existing communities.

The area of State land consists of Mukah soils; the problems involved in developing these were discussed in Part 3, Soils. In spite of these problems the needs of the proposed settlers are sufficiently great to justify the scheme. It must however be realised that considerable assistance will be needed during the first few years of settlement: this will consist of undertaking the initial clearing and drainage of the land, providing materials for house construction, subsistence grants to support the families until their land becomes productive and intensive assistance from extension staff to guide the settlers in developing the techniques of lowland farming.

The houses of the settlers should be sited alongside the Serian-Gedong road to the north of the Sungai Kuala Ulu. Each family will be allocated 0.25 ha of village land as a houselot and vegetable/fruit garden. In addition each will have an area of farm land for the production of rainfed annual crops - rice in the *landas*, soyabeans and maize in the off-season. The size of the farm land cannot be decided without further study.

#### *Engineering works*

The layout of the drainage scheme and the access routes must be decided on the basis of the information available from the semi-detailed soil survey and the topographic survey undertaken for the defunct Muhibbah scheme. These drainage and access routes will be routed to best advantage mid-way between the two Sungai Kuala. The main drain can then connect to Sungai Kuala Hilir. Reserves for possible future irrigation canals should be included. On completion of this preliminary work the whole area can be cleared by contract, marked out and allocated to those to be resettled. Simultaneously the drains can be constructed by excavators.

#### *Mechanisation*

Mechanised land preparation will not be possible in the early years of the scheme but should be introduced later.

## PART 6 IMPLEMENTATION

### INTRODUCTION

In Part 4, Organisation, it was recorded that the LRD/ODM Mission felt that the existing State Government agencies should be able to undertake the responsibility for the development schemes proposed for the two study areas. It was however recommended that a Samarahan Agricultural Development Area be declared and a Development Committee set up (see Part 4, Implementing agencies). It was further recommended (Part 4, Senior development staff) that limited technical cooperation be sought. The subject of implementation will now be discussed in greater detail.

### SAMARAHAN AGRICULTURAL DEVELOPMENT COMMITTEE (SADC)

The responsibility of the Samarahan Agricultural Development Committee (SADC) would be confined to agricultural development: it would not be concerned with other aspects of rural development such as health and education. The Committee's duties would cover policy matters, scheme implementation and subsequently management of schemes. Its place in the development hierarchy is seen as equivalent, for agricultural development matters, of a District Action Committee. A flexible organisation is required to make the best use of technical, financial and personnel resources so that the optimum rate of development is achieved.

Because the development proposals for the area will require expeditious implementation and therefore much closer coordination than is usual, it is essential that overall responsibility should be specifically held by one Department. If this is not done the various components of development will get out of phase. The Department of Agriculture is considered to be the most appropriate Department to take this responsibility; it would be supported by the Administration, Drainage and Irrigation, Land and Survey and the Public Works Departments. Representatives of each of these bodies will form the A D C, under the Chairmanship of the Agricultural Officer. It may be argued that the Agricultural Department would have no authority to enforce their wishes on other Departments: this is correct. The success of the schemes

will depend on the whole-hearted cooperation of the members of the Committee. There should therefore be no conflict but, if there is, the agriculturist would have the right and the duty to take the matter to the Head of the appropriate Department through his own departmental Head.

### Committee structures and responsibilities

The structure of the proposed organisation, shown in Chart 1, is relatively simple. The A D C will be responsible for preparing recommendations for Government approval on such policy matters as target incomes and holding sizes, the forms and extent of Government support for inputs, including credit, and for marketing. In addition to the agriculturist as Chairman, the Committee will comprise representatives from the Departments of Drainage and Irrigation and Land and Survey, the Administration as well as FAMA, the Farmers' Organisation and the Land Committees which will be formed to assist land administration (Appendix 8). During the first few years it is assumed that the technical cooperation specialists will be their Department's representatives on the A D C.

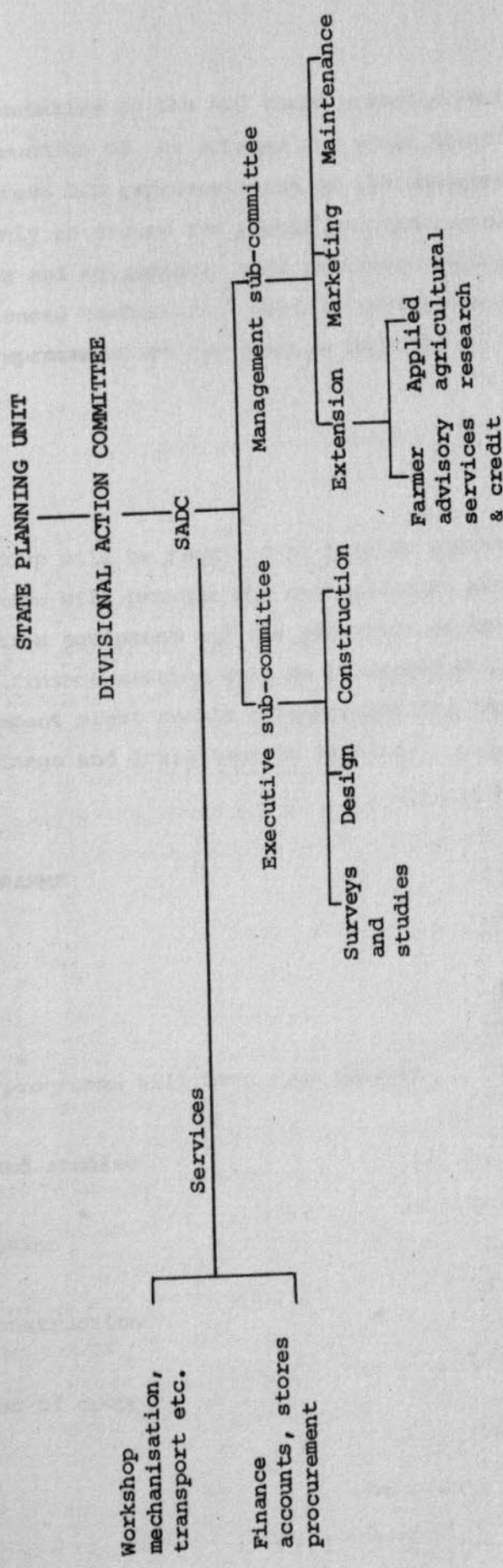
Two smaller sub-committees will be established, one executive and one management.

The executive sub-committee will be responsible for initiation of the schemes including preliminary studies, design and construction (see below). It will comprise technical representatives from the Departments of Agriculture, Drainage and Irrigation and Land and Survey as well as the Administration and spokesmen of the Farmers' Organisation and Land Committees.

The management sub-committee will be responsible for extension, marketing and credit support, applied agricultural research and scheme maintenance. It will comprise representatives from the Departments of Agriculture and Drainage and Irrigation as well as FAMA and the Farmers' Organisation.

It is likely that representatives on the A D C will also sit on one or both of the sub-committees. For example the agriculturist would sit on both. However

CHART 1 Proposed organisation of the Samarahan Agricultural Development Committee (SADC)



while the DID representative on the ADC would probably be responsible for the design and construction of the schemes and would therefore sit on the executive sub-committees DID representation on the management sub-committee would be necessary only to ensure the proper maintenance of drainage and irrigation structures and equipment; this position could therefore be taken by a suitably experienced technician. Similar variations in the status of other departmental representation can also be expected.

#### Service group

A central service group will be required to provide workshop facilities and finance. The workshops will provide the mechanisation service as well as servicing of irrigation equipment and the provision of transport for goods and personnel. The finance section will be concerned with all aspects of the ADC although procurement might remain a responsibility of the Department of Agriculture and Drainage and Irrigation in Kuching.

### IMPLEMENTATION PROGRAMME

#### Introduction

The implementation programme will have four phases:

1. Surveys and studies
2. Scheme design
3. Scheme construction
4. Initiation of cropping

These phases will apply to all schemes in both the study areas, though the extent of preliminary surveys and studies will probably be reduced in later schemes which are essentially an extension of earlier development.

The implementation programmes for Stages 1 and 2 of both the Lower Samarahan and the Sungai Empila schemes are shown on Chart 2. The Gedong and Sungai Kuala schemes in the Sadong-Krang area could proceed simultaneously with these if adequate resources are available. The preliminary surveys and studies can overlap with the design phase but clearly both must be completed before construction begins.

The programmes envisage the construction of the first stages of the two Lower Samarahan schemes during 1978: this implies that the surveys and studies, described briefly below and in the Appendixes, should start immediately. The schemes would then move into the design phase during the latter part of 1977 when the full complement of personnel, including the technical cooperation officers, will have been assembled. As the design and then construction of the first stages proceed, the survey teams would move into the second stage areas during 1978. Cropping in the first stages would start with rice in the 1978/9 *landas*.

#### Phase 1. Surveys and studies

Five subject areas have been identified as requiring investigation prior to scheme initiation:

1. Land and administration
2. Labour
3. Marketing and credit
4. Pre-design engineering studies
5. Agronomy



The objectives of these investigations are listed below: reference is made to the Appendixes which give further details.

1. *Land and administration (Appendixes 7 and 8)*

To assess existing land holdings and tenure within scheme areas and determine the most suitable form of land administration.

To examine ways in which farmers can be involved in management of the schemes.

2. *Labour (Appendixes 5, 7 and 10)*

To assess seasonal and likely long term trends in population both within the schemes and in adjacent areas.

To determine labour availability in relation to crop labour requirements on the schemes and consider how possible bottlenecks could be relieved.

3. *Marketing and credit (Appendix 10)*

To determine whether the present marketing system can cope with the increased flow of goods following initiation of the schemes and consider how any problems might be solved.

To assess the credit needs of producers and consider how these needs may be met.

4. *Pre-design engineering studies (Appendix 9)*

To prepare outline plans of the schemes and carry out topographic and site surveys where appropriate.

## *Agronomy (Appendixes 5 and 9)*

To delineate areas within the schemes suitable for tree crop reserves and to devise agronomic and mechanisation design standards for irrigation and drainage.

### *Phase 2. Scheme design*

The design phase would be carried out as a team effort, following the preliminary surveys and studies and coordination of all disciplines will be achieved through the executive sub-committee.

#### *Layout of schemes and engineering*

For the Lower Samarahan and Sungai Empila schemes, the initial phases will be constructed essentially within the boundaries shown on Plates 1 and 2. Having fixed the boundaries, the layout of the drainage and, for Sungai Empila, the irrigation structures, would be drawn on large-scale maps and the engineering structures then designed in detail. Procurement section within the service group would order material required to be imported as soon as possible.

#### *The cropping system*

Details of the cropping system would be agreed and the phasing in of developments decided. Estimates would be made of the quantity and timing of agricultural inputs to the schemes and similar estimates made for produce off the schemes and its marketing.

### *Phase 3. Construction*

The drainage and, where appropriate, irrigation works could be constructed either by the DID or by contract. In either event the works would be

supervised by the DID representative on the executive sub-committee. The choice between construction under contract or by government is dependent on policy and the available expertise; consideration of both methods has been made in the estimation of costs for earthworks in Appendix 9 but the economic analysis in Appendix 10 uses contract rates.

#### Phase 4. Initiation of cropping

##### *Land cultivation*

The land within all scheme areas except Sungai Kuala after destumping will be thoroughly cultivated by the mechanisation service; subsequently the service will offer a seasonal land cultivation service. This is the responsibility of the workshop section (Chart 1); in order to coordinate this work the agricultural engineer in charge of the service will be a member of the ADC.

##### *Monitoring*

While most of the components of the annual cropping systems proposed for the Lower Samarahan and Empila schemes have been practised at Paya Paloh Experiment Station, the systems have not been undertaken on a large scale nor have they been followed by smallholders. It is therefore imperative that the implementation of the systems should be carefully monitored so that any need for adaptation or alteration is quickly recognised. The agronomic aspects which will require particular attention will include land preparation, weed control, soil water control and fertilisers.

*Land preparation* The most effective methods of mechanised land preparation both for rice and, in rainfed areas, for off-season crops must be confirmed and their effect on the soil and its structure kept under study. In Peninsular Malaysia this cultivation is achieved with rotovators. Under Sarawak conditions other operations may be required e.g. ridging for off-season crops in low-lying areas.

*Weed control* Initially weed control will be done by hand and, with good land preparation, should be less per unit area than at present. If families are to increase the area they cultivate then herbicides may be needed to augment hand labour. Irrespective of the methods used, the degree of weed infestation and any changes in the composition of the species should be recorded. Similarly, while insect pests and diseases are not currently serious the change in cropping pattern could alter this situation.

*Soil water control* Successful crop production will depend on good soil water control at the individual field level. The number of check structures required to maintain the water level for rice and the intensity of tertiary and quaternary drains needed for off-season cropping will vary from place to place and between seasons.

*Fertilisers* In the first 2-3 years of the schemes the response of crops to fertilisers will probably be very limited, but little is currently known on requirements on continuously cropped areas. Factorial fertiliser trials on smallholders' land must therefore be put down immediately in order to enable deficiencies to be identified as soon as they become apparent.

The conditions in the two study areas differ from those in Peninsular Malaysia but the experience gained there could be a valuable guide to the Sarawak worker and the development team should establish contacts with their colleagues in, for example, Kedah and Selangor. Similarly the cropping systems programme taking place in several Asian countries under the aegis of the International Rice Research Institute (IRRI) is highly relevant.

## ANNEXE 1 POLICY INSTRUMENTS

The aim of boosting rice production to the level where Sarawak is self-sufficient is being pursued through a variety of measures including promotion of rice schemes, subsidisation of inputs, and mechanisation. Although there is no statutory control over the price of padi, the National Padi and Rice Authority (LPN), through its influence on retail prices, exerts some control over producers' prices also. Pricing and production policies need to be carefully coordinated in order to avoid the risk of the one being negated by the other.

In addition to the measures being taken to increase rice production, there are also various programmes aimed at promoting production of other annual crops as well as perennials. There is some evidence from the study areas that these programmes are not always seen as being inter-related parts of a whole, with the result that development efforts are not realising their full potential.\*

Alongside the need for rationalisation of land use in the study areas there is also a need to rationalise development programmes so that the various measures being applied in development are complementary rather than competitive. Certainly, initiation of development along the lines recommended in this report should be accompanied by a careful review of the development objectives set for the study areas, the instruments to be used in assisting towards the attainment of these objectives and the inter-relationships amongst them.

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\*For example, coconut planting being encouraged on land which is for all practical purposes unsuited to coconuts but suitable for rice production.

## ANNEXE 2 HYDROLOGICAL RECOMMENDATIONS

### SAMARAHAN CATCHMENT

1. A permanent gauging station should be established on the Sungai Serin at 24th mile. Initially, observations (at least twice a day) could be made of river level on the existing gauge, but the channel must be cleared of fallen trees. Later a stage recorder might be installed nearby. Discharge measurements can be made at the road bridge. Data from this station will provide information on flows in the Samarahan, and also enable pump irrigation to be planned in detail for the proposed scheme in the vicinity of the gauging station.
2. Records of stage and discharge should be continued at Kampong Batu Gong on the Sungai Tuang for at least 2-3 years to determine whether a good relation exists with the data from the Sungai Serin. Records of flow in the Tuang are of paramount importance if the suggestion in Part 5, for diversion of water to the Empila, is to be followed up. The recorder at Kampong Endap is unlikely to yield much further data of value and, provided maximum water levels are carefully noted (as at present by markings on permanent structures), the recorder could be resited e.g. on the Sungai Serin.
3. In view of the proposal that water might be diverted from the Sungai Ensengai in the future, it is recommended that a recording gauge be established as soon as possible in the region of Munggu Tengah. Preferably this will be an instrument which only requires occasional inspection and maintenance in view of the difficulty of access to the site (the Munro LH 144, for example, might be considered). Measurements to define the stage - discharge relationship could be postponed for some time if necessary, in view of the large storage upstream of the proposed gauging site, which results in only moderate flows. There is therefore little chance of a shift occurring in the channel discharge control.
4. Observations should be started on at least one of the small peat streams to determine the possible contribution of the streams to future irrigation

development in the area. This work could be done on the Sungai Paloh at the Rice Research Station, where it has already been suggested (Part 3), that the irrigation pumps be moved further up stream to avoid sucking in saline water from the Samarahan. It should be possible to find a site for the gauging station where a small weir across the stream (possibly of gabions) would both restrict further upstream movement of saline water and allow measurements of the head of water in the stream overflowing the weir, and hence determinations of discharge.

#### SADONG-KRANG CATCHMENTS

In Part 4, it was pointed out that the full agricultural potential of the lower-lying parts of the Sadong catchment would only be realised if measures were taken to alleviate flooding, and that this would require the construction of storage dams in the middle reaches of the two main tributaries. The LRD/ODM Mission was only able to make a brief assessment of the possibility of flood alleviation (Appendix 3) and the further studies detailed below are required before a decision can be reached on the advisability of a scheme. Before these studies are embarked upon, however, it should be borne in mind that the dams themselves are likely to cost at least \$12 million (at 1975 prices) and perhaps could reach double this figure when costs of construction have been determined from outline designs and when allowance is made for investment in the re-siting of villages, roads etc. Also, as discussed in Appendix 3, the potential dangers from incorrect operation of the dams are immense, and therefore a high degree of skill and vigilance will be crucial to their successful operation.

Three possible dam sites have been identified in the catchment on the basis of contours on the 1:50 000 scale maps (Separate Map 7).

The proposed studies are:

1. Installation of a water level recorder and continuous gauging of the Batang Kayan at Kampang Krusin (near Tebakang) for 2 -3 years so that the discharge and flood records can be related to those at Serian. This should also enable data for the Sungai Kedup to be inferred.

2. Detailed mapping at 1:50 000 scale of the three flood storage sites from aerial photographs flown at 2 500 ft. Contours at 3 metre vertical intervals should be drawn within the reservoir areas to enable area/capacity curves to be drawn for each.
3. Detailed survey of the dam and spillway sites to determine quantities of materials, dam dimensions etc. (survey scale 1:500 and contours at 1.5 m vertical interval) and geological investigations to determine dam foundation conditions and possible grouting requirements.
4. Hydrological analysis of all available data to determine design floods and hence assessment of the effectiveness of storage resulting from construction of one or more dams in the main tributaries.
5. Estimates of costs and benefits based on outline designs.

Item 1 should commence immediately. Item 2 should be completed before commencing on 3 and 4. The necessary aerial photographs could be obtained during the 1977 flying season, and machine plotting of contours carried out by Land and Survey, provided control points are first put into the area by D.I.D. The area - capacity curves will confirm the available storage at each site; if adequate, investigations can proceed to 3 and 4, which will involve specialist advice. This would be available from consulting engineers with a proven record of dam design and construction.

No detailed hydrological recommendations are made for the Krang catchment as flooding is not a serious hazard to development of the best agricultural lands.

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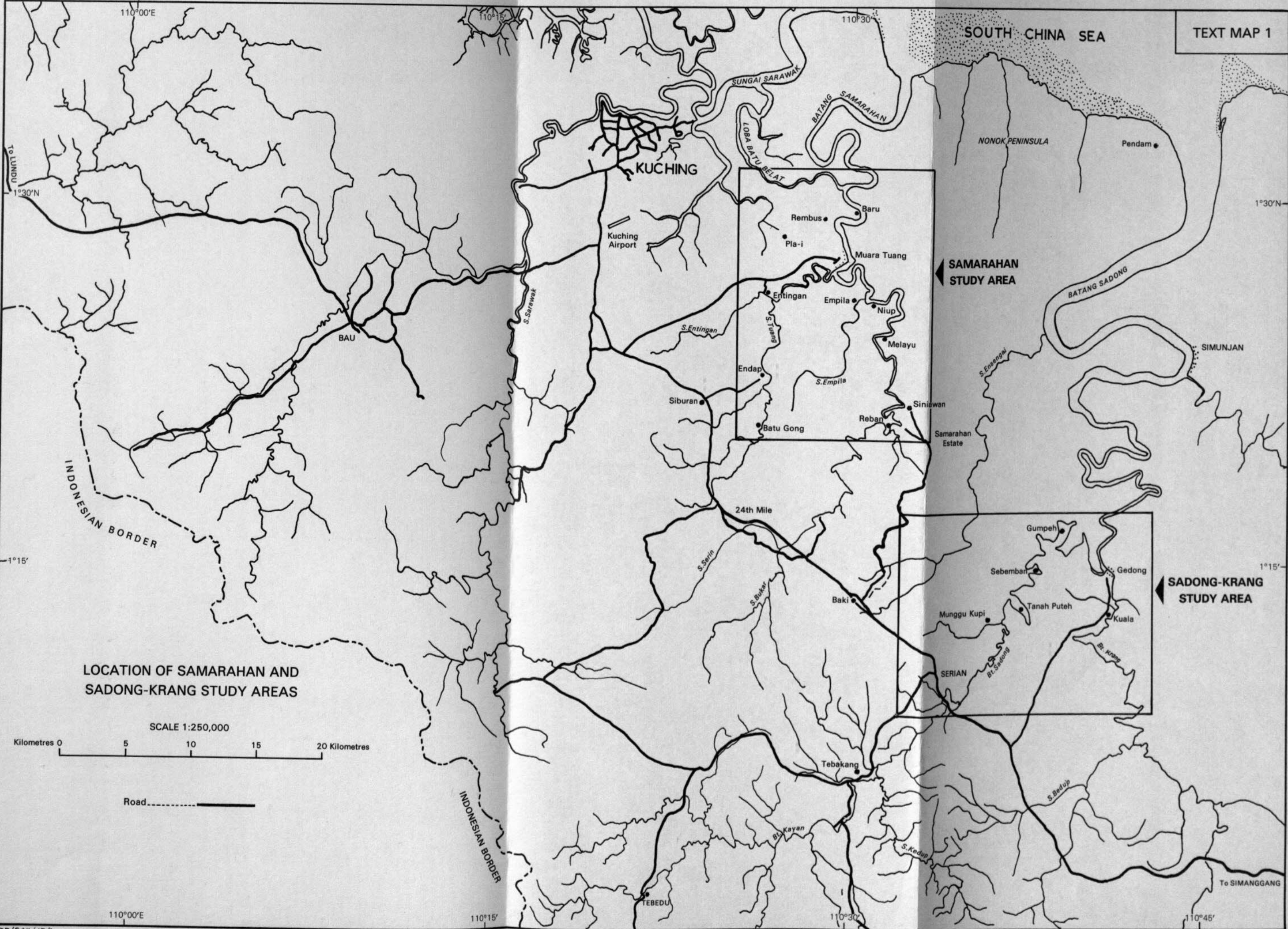
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SOUTH CHINA SEA



LOCATION OF SAMARAHAN AND SADONG-KRANG STUDY AREAS

SCALE 1:250,000

Kilometres 0 5 10 15 20 Kilometres

Road