GOVERNMENT OF MALAYSIA

FEASIBILITY STUDY ON RATIONALIZATION AND CROP DIVERSIFICATION IN NON-GRANARY IRRIGATED AREAS IN MALAYSIA

Volume 3

Crop Diversification Study on Selected Schemes

October 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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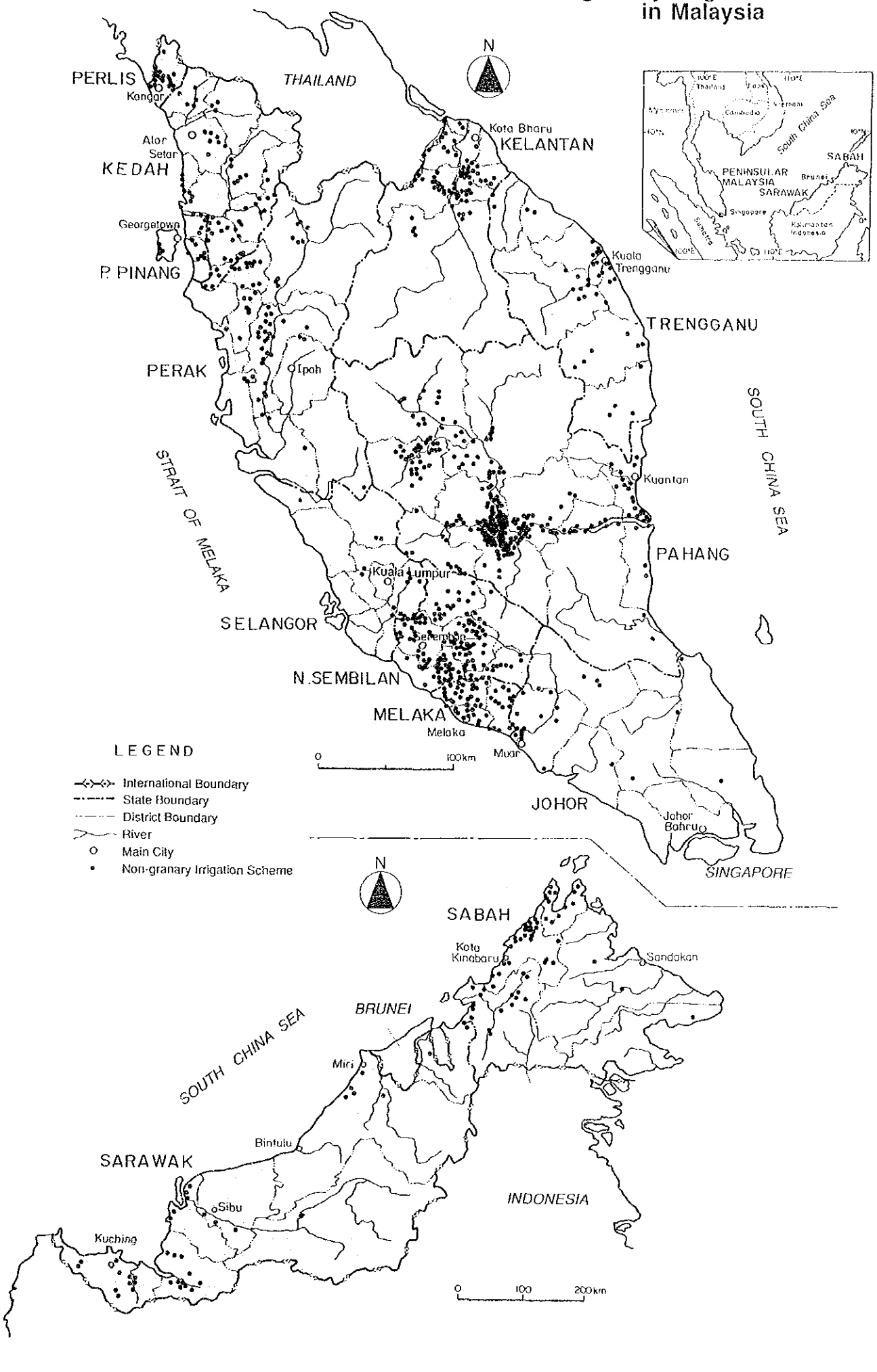
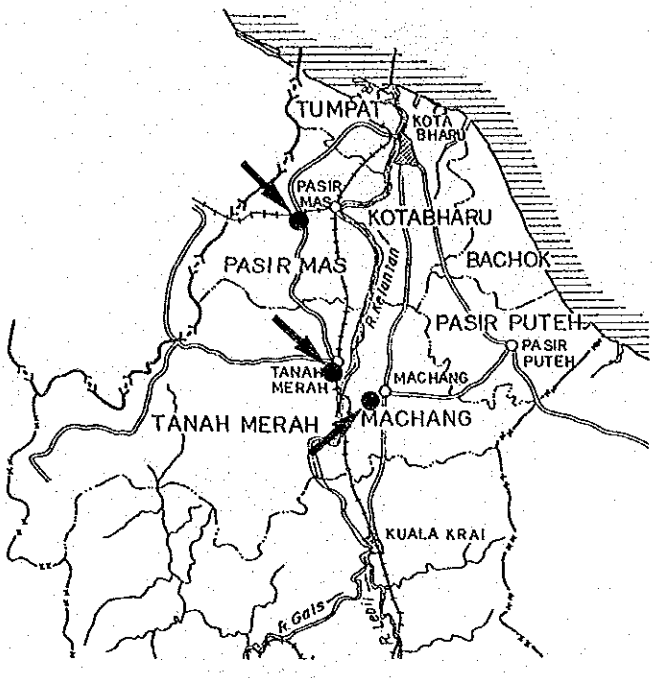
LIST OF REPORTS

Location of Non-granary Irrigation Schemes in Malaysia





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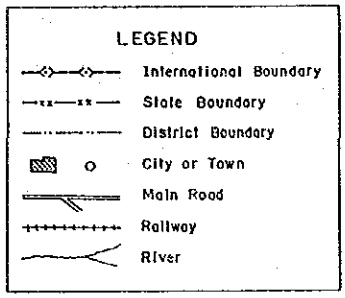
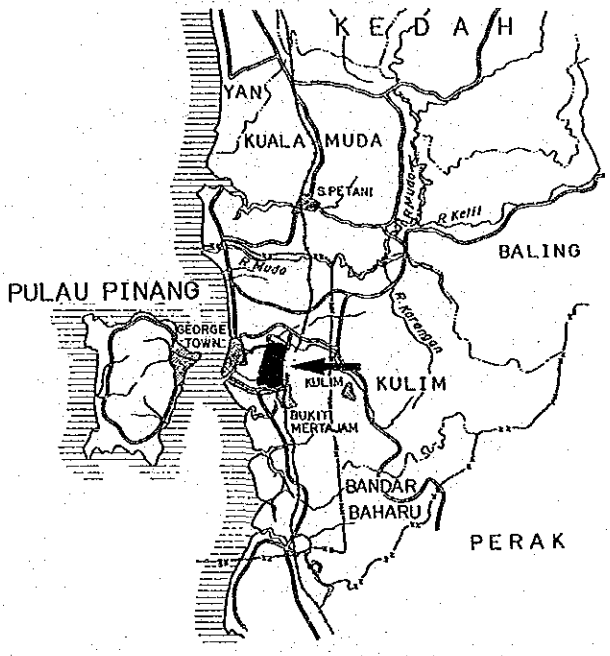
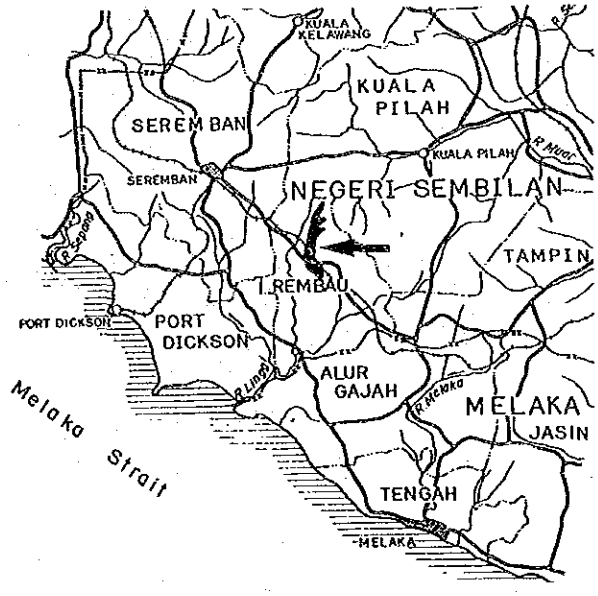




Location of Selected Schemes in P. Pianng



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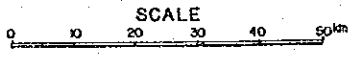

Location of Selected Schemes for Crop Diversification Study

FEASIBILITY STUDY ON RATIONALIZATION AND CROP DIVERSIFICATION IN NON-GRANARY IRRIGATED AREAS IN MALAYSIA

Japan International Cooperation Agency

Feasibility Study on Rationalization and Crop Diversification in Non-granary Irrigated Areas in Malaysia

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Crop Diversification Study on Selected Schemes

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ABBREVIATIONS

Plans

NEP	:	New Economic Policy
NAP	:	National Agricultural Policy
IMP	:	Industrial Master Plan
5MP	:	Fifth Malaysia Plan, 1986-1990

Organizations

BPM	:	Agricultural Bank of Malaysia (Bank Pertanian Malaysia)
DID	:	Department of Irrigation and Drainage
DOA	:	Department of Agriculture
EPU	:	Economic Planning Unit
FAMA	:	Federal Agricultural Marketing Authority
FELCRA	:	Federal Land Consolidation and Rehabilitation Authority
FO	:	Farmer's Organization
FOA	:	Farmer's Organization Authority
JICA	:	Japan International Cooperation Agency
KADA	:	Kembu Agricultural Development Authority
LPN	:	National Paddy and Rice Board
MADA	:	Muda Agricultural Development Authority
MARDI	:	Malaysian Agricultural Research and Development Institute
MOA	:	Ministry of Agriculture

Others

CS	:	Cropping System
EIRR	:	Economic Internal Rate of Return
GDP	:	Gross Domestic Product
HW	:	Headworks
IADP	:	Integrated Agricultural Development Project
O&M	:	Operation and Maintenance
Sg.	:	Sungai (river)

CONVERSION FACTORS

	Metric to Imperial			Imperial to Metric		
Length	1 cm	=	0.394 inch	1 inch	=	2.54 cm
	1 m	=	3.48 feet	1 feet	=	30.48 cm
	1 km	=	0.621 mile	1 mile	=	1,609 km
Area	1 m^2	=	10.76 sq.ft	1 sq.ft	=	0.0929 m^2
	1 ha	=	2,471 acres	1 acre	=	0.4047 ha
	1 km^2	=	0.386 sq.mile	1 sq.mile	=	2.59 km^2
Volume	1 lit	=	0.22 gal (imp)	1 cu.ft	=	28.33 lit
	1 m^3	=	35.3 cu.ft	1 gal (imp)	=	4.55 lit
	1 MCM	=	811 acre-ft	1 acre-ft	=	1,233.5 m^3
Weight	1 kg	=	2.20 lb	1 lb	=	0.4536 kg
	1 ton	=	0.984 long ton	1 long ton	=	1.016 ton
Derived	1 m^3/sec	=	35.3 cusec	1 cusec	=	0.0283 m^3/sec
Measures	1 ton/ha	=	891 lb/acre	1 lb/acre	=	1.12 kg/ha
	1 m^3/sec	=	19.0 mgd	1 mgd	=	0.0529 m^3/sec
Temperature	°C	=	(°F - 32) x 5/9	°F	=	1.8 x °C + 32
Local Measures	1 lit	=	0.22 gantang	1 gantang	=	4.55 lit
	1 kg	=	1.65 kati	1 kati	=	0.606 kg
	1 ton	=	16.5 pikul	1 pikul	=	60.6 kg

CURRENCY EQUIVALENT

(as of mid 1990)

US$ 1.0 = M$ 2.54

INTRODUCTION

Volume 3 of the Final Report presents the results of the crop diversification study for selected schemes in the States of Pulau Pinang, Negeri Sembilan and Kelantan.

A preliminary assessment of crop diversification potential has been made covering all 924 non-granary irrigation schemes based on the methodology explained in Volume 2. The results of the assessment is presented in Volume 5 with priority to potential categories identified scheme by scheme.

Under the present Study, further investigations have been conducted for the purpose of confirming several criteria used for the categorization and identifying guidelines for promotion of crop diversification plans in non-granary irrigated areas. In this regard, typical schemes were selected for feasibility studies. The selected schemes have the following features.

- Schemes with potential for crop diversification under Category 1, where paddy cultivation is presently carried out and promotion of high value crop cultivation can be expected because paddy farmers show a strong tendency to earn more farm income through crop diversification,
- Schemes with potential for crop diversification under Category 2, where labor-saving farming practices are required and promotion of conversion to oil palm and cocoa can be expected, and
- Schemes with potential for crop diversification under Category 3, where irrigated double cropping of paddy is not possible due to water resource limitation and promotion of two cropping systems i.e. main season paddy with off season high-valued upland crops can be encouraged.

Based on the evaluation result and through the discussions with the Steering and Technical Committees, three areas were selected for preparing crop diversification options to revitalize the non-granary irrigation schemes. These are the Sungai Kulim scheme in Pulau

Pinang, the Mampong area in Negeri Sembilan and three schemes in Kelantan, including 12 non-granary irrigation schemes covering 3,209 ha in total as below.

State	Scheme	Irrigable Area (ha)
P. Pinang	Sungai Kulim I	434
	Sungai Kulim II	1,328
	(Sub-total)	(1,762)
N. Sembilan	Ulu Sepri	72
	Mampong	64
	Ampang Limau	131
	Chembong	173
	Ulu Chembong	24
	Anak Air Tontong	33
	Kampung Chuai	20
	(Sub-total)	(517)
Kelantan	Repek	454
	Hilir Sat I	396
	Rawa Bechah Laut	80
	(Sub-total)	(930)
	Total	3,209

The Study has used information obtained through the Inventory Survey as well as supplemental data collected by additional field investigations by the Study Team. The results of the Study are presented in Part-I for Pulau Pinang, in Part-II for Negeri Sembilan and in Part-III for Kelantan of this Volume.

The results of the "Detailed Sample Survey on Farmers' Intentions towards Crop Diversification Plan in Selected Schemes" conducted in the States of P. Pinang and Kelantan are presented in Annex I-1 of Part I and Annex III-1 of Part III, respectively.

Part - I

Crop Diversification Study on Selected Schemes in Pulau Pinang

Feasibility Study on Rationalization and Crop Diversification in Non-granary Irrigated Areas in Malaysia

Volume 3

Part-I

Crop Diversification Study on Selected Schemes in Pulau Pinang

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TABLES

FIGURES

1. INTRODUCTION

1.1 General

This Part-I summarizes the result of the feasibility study on crop diversification for the selected non-granary irrigation schemes in the State of Pulau Pinang (the Study). The objective area of the Study is selected in a part of the Sungai Kulim scheme located in the Perai river basin in the Peninsular side of the State.

The aim of the Study is to present a possible direction to promote crop diversification with high value crop cultivation, to plan upgrading of agricultural infrastructure and the justification of proposed plans.

1.2 Background

In the State of Pulau Pinang, there are 17,815 ha of paddy fields including; (i) a granary area called the Balic Pulau / Seberang Perai area covering 13,000 ha, and (ii) 14 non-granary irrigation schemes commanding 3,541 ha in total.

For the last three years (1985-1987) the average copped area of paddy in these non-granary irrigated schemes is reported to be 2,685 ha for the main season and 2,660 ha for the off season. Non-paddy cropped area in the same period is 1,105 ha. In 5 schemes, the planted area is below 50%, while no scheme is fully idle in P. Pinang. The overall scheme utilization ratio in the non-granary irrigation schemes is estimated at 83% for the main season and 82% for the off season.

In 1986, the *Master Plan for Agricultural Development of the State of Pulau Pinang* was prepared by MOA, which recommended to demarcate the existing paddy fields into two groups as follows:

(a) high productive paddy fields to be continuously maintained in the future; and

(b) suitable areas for promoting crop diversification.

For the purpose of upgrading the existing irrigation and drainage systems to improve productivity of paddy and rubber, the *Balik Pulau/Seberang Perai IADP* has been launched covering the proposed agricultural development area of 77,619 ha.

The whole area of the Sungai Kulim scheme was originally covered by the on-going IADP aiming to achieve intensive double cropping of paddy through upgrading of agricultural infrastructures assuming that the water from the Muda river can be supplemented to this area. However the water transfer plan was cancelled because no more excess water has been available in the Muda river downstream resulting from sharp increase in water consumption by users having vested water rights along the Muda river.

Reflecting such situation, the Sungai Kulim I and II schemes were excluded from the command area of IADP and designated as non-granary irrigation schemes.

In P. Pinang, diversified cropping has been practiced in some non-granary schemes including the Sungai Kulim area. The current non-paddy crop planted area amounts to 1,240 ha for the main season and 177 ha for the off season.

1.3 Selection of the Study Area

The Sungai Kulim scheme is divided into 6 irrigation blocks (Kl to K6) by IADP as shown in Fig. I-l. The Kl block is called the Sungai Kulim I Scheme and the K5 and K6 blocks are the Sungai Kulim II Scheme. In addition to these, a part of K2 and K4 is demarcated as suitable areas for promoting crop diversification and categorized as the non-granary irrigated area.

The Sungai Kulim I and II schemes were selected for the Study in due consideration of their natural conditions suitable for crop diversification, location blessed with large market of diversified crops, and changing socio-economic circumstances by urbanization and industrialization in the State. The selection of these schemes was agreed through discussion with the Steering and Technical Committees as well as the agencies concerned in the State.

2. PRESENT SITUATION OF SELECTED SCHEMES

2.1 Physical Conditions

(1) Location and topography

The Study area is bounded by dense-populated corridor, Butterworth-Perai-Bukit Mertajam, extending over the left bank of the Perai river. The area is on a very flat alluvial plain and interrupted by highlands at its eastern margin where the terrain is undulating to rolling towards Bukit Mertajam of 545 m and Bukit Seraya of 445 m in height.

(2) Climate

The climatic features of the two selected schemes are high rainfall months from September to November and continuous dry months between December and March. There is a morning rainfall maximum during the southwest monsoon season ranging from May to September. Except during the dry months, daily temperature ranges are lower, mainly because of the effects of the sea and land breezes.

Average annual rainfall is about 2,000 to 2,400 mm as shown in Fig. I-2. The 1 in 5 year probable low rainfall is estimated at about 1,070 to 1,270 mm a year. Data on monthly distribution of rainfall, average air temperature, relative humidity and wind speed in the study area are presented below.

Month	Monthly Rainfall (mm)	Relative Temperature (°C)	Wind Humidity (%)	Speed (m)
Jan.	87	27.2	74.6	2.4
Feb.	93	27.5	80.5	2.1
Mar.	167	27.7	82.2	1.8
Apr.	218	27.8	85.3	1.5
May	200	27.7	86.4	1.5
June	140	27.5	85.2	1.4
July	175	27.0	85.8	1.5
Aug.	195	26.9	86.7	1.4
Sept.	318	26.5	87.7	1.5
Oct.	375	26.5	87.9	1.4
Nov.	271	26.6	86.0	1.7
Dec.	172	27.0	78.8	2.4

(3) Rivers

The Kulim river, a tributary of the Perai river, is the main water source for irrigation for the Kulim area. Both IADP granary area (K2 to K4) and the Sungai Kulim I (Kl) and II (K5 & K6) schemes are served by the existing irrigation networks completed in 1938. The catchment area at the existing Kulim headworks is 153 km^2. The river discharge available at the headworks is not sufficient to serve the whole of the Kulim area during the off season. The Kulim river joins the Perai river near the northernmost corner of the Kulim area. There is a stream flow gauging station at Ara Kuda on the upstream of the Kulim headworks. The catchment area at the gauging station is 130 km^2. Monthly mean runoff of the Kulim river is shown in Fig. I-3.

The Jarak river, a tributary of the Perai river, runs in the north of the Kulim river. The catchment area of the Jarak river is almost the same as that of the Kulim river. The Jarak headworks is constructed on the river to serve irrigation water downstream and to transfer water to the Kulim area through a 7.4 km long link canal and a pumping station with a capacity of 2.26 m^3/sec, though these link system has not been used due to an inundation problem upstream as explained in Section 2.5.1.

In the Kulim area there are several small streams which function as a main drain for the area. The Derhaka river runs westward crossing the Kulim area and forms a boundary of K4 and K5 blocks. This river joins the Perai river at 3.5 km upstream of the river mouth of the Perai as shown in Fig. I-6.

(4) Soils

The prevailing soil series in the Study area are Bakau, Kundor and Tualang. The first two soil series are derived from marine sediment, while the third one is originated from riverline sediment. These soil series are of heavy clay with fine-textured and imperfect to poor drainage features.

The Kundor and Tualang soil series have moderate limitation in terms of drainage condition to rubber, sago palm, clove, tobacco and citrus. This drainage condition has no limitation to growth of other crops except papaya and ginger both of which are very sensitive to such drainage condition and therefore not suitable for the Kulim area. With provision of drainage facilities to drain excess surface water from paddy fields after heavy rainfall comes, these two soil series can be expected to be suitable for growing the above five crops.

The Bakau soil series has moderate limitation caused by fine texture and weak structure and further serious limitation derived from poorly drainage condition. Under such soil characteristics, sago palm, paddy and fodder grasses are suitable, while coconut and vegetables are marginal suitable and other crops are not suitable.

2.2 Socio-economic Status

The State of Pulau Pinang of 1,040 km^2 is divided into 5 administrative districts, 2 in the P. Pinang island and 3 in the opposite mainland, Seberang Perai. The Kulim area is located in the Seberang Perai Tengah District of 235 km^2.

According to the "Mid-year Estimated Population" prepared by DOS, the population of the Seberang Perai Tengah District in 1986 was 196,000 and shared 18% of the State population. During the period from 1980 to 1986, population increased by 24,800 with an annual growth rate of 2.8% which was slightly higher than the State average of 2.6%.

The Detailed Sample Survey was carried out in the Study area aiming to clarify socio-economic status in the area and farmers' intentions and requirements towards promotion of crop diversification. Out of around 800 beneficial farm households currently performing farm activities, a total of 209 sample farmers were interviewed. Details of results of the survey are attached in Annex I-1.

According to the Survey, the socio-economic situation in the Study area is as follows:

(a) Of the respondent farmers, 61% are more than 45 years old. Advanced aging of farmers is in progress but not so serious in the Study area compared with the State level of 72%. The mean household size is 5.9 persons with working force of 3.6 persons. Educated farmers share 93% and better than that of 84% in the State.

(b) The annual average gross income of farm household is M$9,750 of which 82% is derived from agriculture. Most of the sample farmers are engaging in subsidiary off-farm jobs, although 88% of them think that the paddy cultivation is important and remunerative.

(c) The participation rate of farmers to farmers' organization is 89% and very high compared with 58% at the State level. With the impeding urbanization pressure, only 18% of the respondent farmers are participating in rural communities which are becoming less active.

(d) Of the respondent farmers, 69% are "pure-tenants" in the Study area. Only 24% are "owner-operators" and 7% are "owner-tenants". This fact results in the preponderance of small uneconomic farm holdings with 63% of the active farmers cultivating no more 1.2 ha and double cropping of paddy practiced by 87% of the respondent farmers. This high percentage also indicates the strong attachment of sample farmers to paddy cultivation.

2.3 Present Land Use

In the Seberang Perai Tengah District, rubber is the most prevailing crop covering 10,500 ha in total followed by coconut of 3,000 ha. Planting areas of other tree crops are cocoa of 500 ha and oil palm of 429 ha. The planted area of paddy has been fluctuating from 450 ha to 2,335 ha between 1980 and 1986. According to the statistics provided by the State DOA, planted areas of major crops in this District are summarized below.

(Unit: ha)

Crop	1980	1981	1982	1983	1984	1985	1986
Paddy							
Main	2,010	1,268	1,457	2,195	2,335	1,255	450
Off	1,480	597	988	1,085	510	635	880
Rubber	10,694	10,785	10,760	10,755	10,525	10,525	10,500
Oil palm	312	329	359	379	399	399	429
Cocoa	339	324	400	425	425	435	500
Coconut	3,220	3,236	3,292	3,292	3,243	3,102	3,012

The planted area of paddy in the Study area in 1985-1987 are as follows:

(Unit: ha)

Scheme	Irrigable Area	Paddy Planted Area	Converted Area	Idle Area
Sungai Kulim I	434	342	92*	–
Sungai Kulim II	1,328	467	–	861
Total	1,762	809	92	861

*Remarks: *; Including two cropping area of 50 ha.*

2.4 Irrigable Area

The Kulim area of 3,223 ha is divided into 6 irrigation blocks consisting of the IADP granary area and the non-granary irrigation schemes as shown below (see Fig. I-1).

(Unit: ha)

Block	IADP Granary	Non-granary Irrigated Area			Total
		Kulim I	Kulim II	Others	
K1	-	434	-	-	434
K2	401	-	-	278	679
K3	397	-	-	-	397
K4	295	-	-	90	385
K5	-	-	997*	-	997
K6	-	-	331*	-	331
Total	1,093	434	1,328	368	3,223

Note: * *A part of K6 block (214 ha) which is covered by the same secondary canal and drainage system as K5 block is regarded as K5 area in the Study.*

2.5 Existing Irrigation and Drainage Conditions

2.5.1 Irrigation facilities

The existing irrigation system of the Kulim Scheme was constructed in 1938. The present conditions of the existing irrigation facilities are briefed below (see Fig. I-4).

(1) Irrigation system of the Kulim area

Kulim headworks

This headworks is functioning well though constructed in 1938. The intake capacity at the headworks is 8.7 m^3/sec. There radial gates (6 m wide, 3 m high) are installed and maintained properly by the DID Seberang Perai District Office.

Kulim main canal

The Kulim main canal is 7 km long from the headworks to the corner of K6 block. This main canal was designed originally to convey irrigation water not only from the Kulim river but also from the Jarak river and the Muda river. The design discharge of the main canal is 8.7 m^3/sec including supply from the Jarak and Muda rivers to meet the peak requirements during the presaturation period of 2.6 lit/sec/ha. The main canal is connected directly with irrigation blocks Kl to K4. For blocks K5 and K6, water is supplied by secondary canals extended from the end of the main canal.

Secondary canal

There are 4 secondary canals (SC) in the Kulim area. All the secondary canals are of earth canal with side slope of 1:1.5. These secondary canals are: SC-1 between K2 and K3 blocks commanding K2 block of 679 ha; SC-2 between K3 and K4 blocks served for K3 block of 397 ha and K4 block of 385 ha; SC-3 stretches westward through the center of K5 block commanding K5 block of 783 ha and part of K6 block covering 214 ha; and SC-4 running southward along the east edge of K6 commanding K6 block of 331 ha.

Secondary canals are silted to the extent of 30% of the cross sectional area. Some of existing structures along secondary canals such as bridges and siphons need to be replaced.

Pumphouse in K6 block

Irrigation water for K6 of 331 ha is lifted by the Kubang Semang I pumphouse (2 nos of 0.35 m^3/sec pumps, 1.2 m head) and by the Kubang Semang II pumphouse (2 nos of 0.21 m^3/sec pumps, 1.5 m head).

On-farm facilities

The total length and density of tertiary irrigation canal by block are listed below.

Block	Area (ha)	Condition of Tertiary Canal		
		Type	Length (km)	Density (m/ha)
K 1	434	earth	11.3	26
K 2	679	concrete	17.0	25
K 3	397	concrete	10.0	25
K 4	385	concrete	9.6	25
K 5	997	earth	18.0	18
K 6	331	earth	5.6	17

According to the IADP criteria. the tertiary irrigation canal is of concrete lined and provided with a density of 25 m/ha.

(3) Irrigation system related to the Kulim area

Jarak headworks

This headworks is for providing irrigation water both to the Jarak non-granary irrigation scheme of 350 ha and to the Kulim area through a link canal. This headworks has 2 radial gates on the main stream and an intake with a capacity of 5.7 m^3/sec. Since its completion, however, the main gates have hardly been operated because oil palm fields extending upstream of the headworks are affected by inundation if the gates were closed.

Jarak - Kulim link canal

This 7.4 km long link canal was constructed aiming at conveying irrigation water from the Jarak river to the Kulim headworks. Furthermore, the Jarak - Kulim link canal was designed so as to function to convey the Muda river water to the Kulim area as illustrated in Fig. I-5. There is a pumphouse with 3 pumps (1.4 m^3/sec each) at the middle point of the

link canal near Padang Chempedak. This canal commands part of the Jarak scheme. The average longitudinal gradient of the canal is about 1/5,000. Along the canal no proper maintenance road is provided.

Siltation in the canal accounts for 30% of the canal cross-section between the Jarak headworks and the Padang Chempedak pumphouse, while 50% from the pumphouse to a Kulim headworks.

2.5.2 Drainage facilities

The Kulim area is divided into three drainage systems, namely Perai, Derhaka and Juru as shown in Fig. 1-6. The commanding area of each system is shown below.

Drainage System	River	Block	Net Irrigable Area (ha)	Catchment Area (ha)
Perai	Perai	K1	434	2,380
		K2	679	
		K3	397	
Derhaka	Derhaka	K4	385	2,100
		K5	343	
		K6	189	
Juru	Juru	K6	158	670
	Permatang Rawa	K5	207	450
	Permatang Rotan	K6	198	280
	Permatang D/H	K5	233	310

Perai drainage system

The Perai Barrage was constructed on the Perai river at 8.3 km upstream of with the river mouth in 1980. The aim of this Barrage is to prevent saline water intrusion upstream, to control flood and to lower water level in the drainage canals in farm lands. However, the main gate of the Perai Barrage has not been operated yet because of inundation problem in the adjacent downstream area. In 1988, JICA carried out a simulation study of gate operation and concluded that that the

water level during 1 in 40 year flood in the Perai river could be lowered by 0.8 m from El. 1.85 m to El. 1.05 m alongside K1 and K2 blocks. Since the ground elevation in K1 and K2 blocks is approximately El. 1.30 m at the lowest area, excessive surface water in K1 block can be drained out by gravity through 3 small natural streams as shown in Fig. I-6. The total drainage capacity of these 3 natural drains is about 41 m^3/sec which is equivalent to the drainage requirements during 1 in 10 year storm rainfall.

Derhaka drainage system

The Derhaka river drains surface water from its catchment area of 2,100 ha to the Perai river through the tidal gate installed 690 m upstream of the confluence with the Perai river. Under IADP, tertiary drains are provided in K4 block extending on the right bank of the Derhaka river. In K5 block, waterlogging sometimes occurs in low-lying parts due to lack of proper field drains. The drainage capacity of the Derhaka river is about 44 m^3/sec which is equivalent to the drainage requirements during 1 in 10 year storm rainfall.

Juru drainage system

Excessive water from K5 and K6 blocks is drained by 3 small rivers, tributaries of the Juru river. Since the longitudinal gradient of these rivers ranges from 1/500 to 1/1,500, water levels of these rivers are not affected by tides. The total drainage capacity is about 35 m^3/sec which is equivalent to the drainage requirements during 1 in 50 year storm rainfall.

2.5.3 Operation and maintenance

(1) Organization

The whole of the Kulim scheme are operated and maintained by DID Seberang Perai District Office. This office covers another one granary and 10 non-granary irrigation schemes. There are 632 staff including 54 senior/junior management staff in the Office. Annual operation and maintenance costs spent for the the Sungai Kulim I and II schemes from 1984 to 1987 are as follows:

Scheme	Irrigable Area (ha)	Annual O & M Cost (M$'000) 1984	1985	1986	1987
Sungai Kulim I	434	90	91	101	98
Sungai Kulim II	1,328	191	194	215	207
Total	1,762	281	285	316	305

The present O&M cost for the Kulim scheme is not sufficient to maintain canal flow capacity as designed.

(2) *Problems in water management*

Water shortage occurs downstream of all blocks due to insufficient water source and/or less flow capacity of main and secondary canals by siltation. In Kl block, the irrigation efficiency seems to be low because the canal is connected with shorter edges of narrow and long plot. Water supply in K6 block is insufficient not only by water shortage at the end of the main canal but also by deterioration of pumps and siltation in connection canal.

2.6 Present Agriculture

2.6.1 Crop production

The results of the Inventory Survey indicate that the paddy planted area has been affected by the available quantity of irrigation water supply to the Sungai Kulim I and II scheme areas although farmers adhere to continue paddy cultivation. In particular, the downstream parts of K5 and K6 blocks in the Sungai Kulim II scheme have been left idle due to less possibility of getting irrigation water.

The average utilization ratio of K5 and K6 blocks for the past three years (1985 to 1987) is 35%. In the Sungai Kulim I scheme area, farmers grow vegetables and sweet corn as the off season crop in an area of 50 ha and sugar cane as the converted crop covering 42 ha.

Average paddy yields for the last five years (1983-1987) have ranged from 1.1 to 4.0 tons/ha for the main season and 1.7 to 4.6 tons/ha for the off season in both the Sungai Kulim I and II scheme areas. The estimated paddy production in these areas is around 9,500 tons on an average for the last five years.

2.6.2 Agricultural supporting services

For smooth implementation of the agricultural development programs under IADP, Federal departments, 13 States and agencies concerned are organized under an implementation committee with a project management unit acting as the secretariat (see Fig. I-7). These are DID, DOA, DOF, DVS, MARDI, FOA, LKIM, FAMA, LPN, BRM, FELCRA, RISDA and PERDA. To ensure the smooth implementation of agricultural development programs at the field level with provision of supporting services such as extension, research, marketing and credit, various implementation teams are established and each is headed by the lead agency concerned.

The main purpose of promoting group farming is to form a contiguous or non-contiguous block of land with economic size and also to manage it by a selected management body by grouping the current small lots of farm land together. A group of farmers is responsible for planning all aspects and making the necessary decisions. In solving technical and logistic problems at the farm level, required assistances are provided by the agencies concerned through an advisor designated among officers of these agencies as illustrated in Fig. I-8. Promotion of farming groups is the responsibility of DOA. Extension services of DOA are systematically provided to farmers through group farming channels as shown in Fig. I-9.

As for farmers' organizations, FOA's main objective is to set up farmers' organization as strong and viable rural institutions capable of uplifting the economic and social status of their members. In exercising its development role, FOA provides farmers' organizations with the following:

(a) Development assistance in the form of basic infrastructures such as office buildings, stores, machineries and vehicles;

(b) Financial assistance for their business or farming operations;

(c) Managerial assistance by assigning management teams to operate and manage farmers' organizations until they are self-sustaining; and

(d) Technical services and guidance programs to enhance the overall development of farmers' organizations.

Farmers are charged M$2 as an entrance fee and M$1 to M$2 for annual membership fee with share investment of M$10 to M$50 only for the first year, when they participate as members in Small Agricultural Units of Area Farmers' Organizations. There are some specific conditions to get membership such as age and farm operation oriented income.

3. CROP DIVERSIFICATION PLAN

3.1 Background

In the Kulim area, the original development target of IADP focussed upon full double cropping of paddy under irrigated condition. As the water diversion plan from the Muda river to the Kulim area was cancelled as mentioned in Section 2.5, the development target of IADP was scaled down as its irrigation source would depend only on the Kulim river. In parallel with this, a total of 1,461 ha was selected as a granary area by cultivating paddy twice a year, and the remaining 1,762 ha for diversification of crops. To avoid incidence of a gap in farm income derived from irrigation water supply to a limited part of the Kulim area, promotion of crop diversification has been identified as an important policy issue in the State of Pulau Pinang.

Currently, 49% of the target area for promoting crop diversification is idle paddy fields mainly because of the above limitation of irrigation water supply. Accordingly, 55% of the farmers interviewed by the Survey think that promotion of crop diversification is a good or welcome idea if a series of structural and non-structural measurements are performed to meet their requirements for growing non-paddy crops in their paddy fields. They also show keen interest in cultivating sweet corn, okra, cucumber and chilli. Neverthless 41% of the respondents (mainly tenant farmers) adhere to paddy cultivation as they consider diversified cropping difficult or impossible taking into account land suitability, crop profitability, labor shortage and intention of land owner.

3.2 Development Concept and Targets

The target of crop diversification in the Kulim area is to realize both high value crop cultivation in irrigated areas and profitable tree crop cultivation in non-irrigated areas based on rationalization of use of water and land resources.

Direct application of crop diversification under Category 1 to the Kulim area will be quite difficult due to the current inclinations of the paddy farmers. Thus, two cropping systems under the Category 3 will be applied initially for periods of up to 3 years. Then full application of the Category 1 will be carried out.

Reflecting farmers adherence to paddy cultivation and misgivings about the success of crop diversification, it is essential to promote the crop diversification program step by step. It is recommended that pilot operation be commenced in a selected farm to encourage the officers concerned and leading farmers in diversified cropping with provision of all measures in an integrated manner.

A stepwise procedure to introduce crop diversification is proposed for the Kulim area with the following targets on condition that the supply of irrigation water is to be assured:

Initial stage;	to introduce non-paddy crops in the off season
Transition stage:	to switch main season paddy to upland crops and achieve 200% cropping intensity of upland crops
Final stage:	to achieve intensive upland crop cultivation by 300% cropping intensity

For areas where the irrigation water supply cannot be assured, promotion of fruit and industrial tree crops cultivation is proposed. It is proposed that tree crop cultivation be concentrated in the downstream part of K5 and K6 blocks where paddy fields have been abandoned due to lack of irrigation water supply. For development of

these areas, a drainage canal network should be provided to realize efficient farm management.

Upgrading of on-farm facilities and assured irrigation supply to the fields would encourage farmers to introduce crop diversification programs. Especially for tenant farmers, adherence to paddy cultivation is strong at present due to misgivings about the success of crop diversification. Accordingly demonstration and extension of farming technology of upland crops will be essential.

3.3 Crop Diversification Plan

(1) Selection of crops

Over 200 varietal trials on various vegetables have been undertaken by MARDI for the purpose of evaluating their adaptability, field performance, yielding capacity, resistance to pests and diseases as well as the quality of the produce. In the course of research work, performance and yield trials are initially conducted for several seasons in MARDI Research stations. Promising varieties are then identified and subsequently tested to determine their suitability for the various soil and environmental conditions.

Lowland vegetables identified for the Kulim area through such screening procedures are as follows:

(a)	Leafy vegetables:	lowland cabbage, lowland cauliflower, etc.
(b)	Fruit vegetables:	chilli, long bean, french bean, egg plant, cucumber, okra, lowland tomato, bittergourd, etc.
(c)	Root vegetables:	- none -
(d)	Other vegetables:	Asparagus, etc.

Regional suitability for growing lowland perennial crops in the Kulim area is studied from the agro-ecological viewpoint. Taking into consideration the advantages and limitations of candidate crops, citrus,

cocoa, rambutan, durian, mango, mangosteen, cempedak, jackfruit, pineapple, and coconut are selected. Paddy fields of Kundor and Tualang soil series should be selected for conversion from the viewpoint of soil suitability for growing these perennial crops.

(2) Requirements for crop diversification

Infrastructures and facilities necessary for vegetable production are road networks, irrigation and drainage systems, transportation facilities, marketing centers and cold rooms. Of these, drainage canals are essential for the removal of heavy rainfall from crop fields within the limited time before upland crops are damaged by waterlogging. Access roads and paths are required to be wide enough for the movement of farm machinery and vehicles to any part of the farm. The minimum width of the main access road should be 4.0 m. Depending on the shape of the farm, the general layout of the plots is required to be rectangular for ease of operation of farm machinery.

Proper nutrition is important for good performances and high yield in vegetable cultivation. Nutrients supplied have to be of the right type not only at the optimal levels but also at the right time and intervals. The determination of nutrient requirements for vegetables is complicated by the fact that it is very dependent on fertilizer residues and previous cropping patterns which are very variable and difficult to quantify. A general guide for nutrient requirements from major vegetables has been drawn up by MARDI based on the results of nutrient uptake and fertilizer response studies as shown below.

	Fertilizer Nutrient Rate (kg/ha)			
Vegetables	Nitrogen	Phosphate	Potassium	Magnesium
Cabbage/cauliflower	170-250	30	200-250	20
Chilli	250-300	100	250-300	50
Longbeans	50-80	30	100-150	20
Cucumber	150-200	30	160-200	20

To ensure good crop performance and yields, cultural practices need to be worked out to suit the soil conditions of paddy fields in the Kulim area, although the general know-how of crop husbandry

techniques are available in other vegetable cultivation areas around the Kulim area. A very important feature in intensive vegetable farming is the predominance of pests and diseases which constitute one of the most serious bottlenecks in vegetable production in Malaysia. Chemical control of pests is now very common in vegetable growing areas in the country. However, farmers' heavy dependence on chemicals for pest control has resulted in the development of insecticide resistance by some pests and the occurrence of considerable high levels of pesticide residue on some harvested crops. It is desirable for the future intensive vegetable cultivation to practice biological and cultural control of diseases with less chemical inputs.

(3) Cropping system (CS)

In line with the basic concept of stepwise promotion of crop diversification, it is proposed to consider the following 6 cropping systems in the Kulim area (see Fig. I-10 to I-12).

Cropping System 1 (CS-1) is set up for the initial stage of the crop diversification promotion program. It will comprise two croppings; main season paddy and off season upland crops under Category 3. For CS-1, upland crops to be grown during the off season are sweet corn, longbean, bittergourd, lowland cabbage and chilli. These are to be introduced to parts of the Kulim I and II scheme areas where paddy is presently grown.

Cropping System 2 (CS-2) is introduced in the existing converted area in the Kulim I scheme during the initial stage. Upland crops to be grown are longbean and bittergourd for the main season and sweet corn and chilli for the off season.

Cropping System 3 (CS-3) is established for the transition stage of the crop diversification promotion program. It consists of double cropping of upland crops under the Category 1. The main season upland crops are sweet corn, longbean, bittergourd, okra, lowland cabbage and lowland cauliflower,

while the off season ones are sweet corn, longbean, bittergourd, lowland cabbage and chilli.

Cropping System 4 (CS-4) is formulated for the final stage of the crop diversification promotion program. In this System under Category 1, upland crops are to be grown three times a year and will comprise sweet corn, longbean, bittergourd, cucumber, okra, lowland cabbage, lowland cauliflower and chilli.

Cropping System 5 (CS-5) is offered to paddy fields with no possibility of receiving irrigation water. Tree crop cultivation without irrigation is formed under Category 2. The proposed tree crops are rambutan and lime as fruit tree crops and cocoa as an industrial tree crop.

Cropping System 6 (CS-6) is also introduced into paddy fields without possibility of irrigation for the time being but with possibility of receiving irrigation water if water source is enhanced. This consists of a short-term perennial crop such as pineapple.

(4) Proposed cropping pattern

For the initial stage, Cropping Pattern A (see Fig. I-10) based on CS-1 and CS-2 is proposed. To secure smooth irrigation water distribution and surface water drainage, on-farm service facilities are to be completed before practicing the proposed cropping pattern. The proposed cropping area in percentage by crop is shown below.

Crop	Two Cropping Area (%)		Converted Area (%)	
	Main Season	Off Season	Main Season	Off Season
Paddy	100	–	–	–
Sweet corn	–	40	–	50
Lowland cabbage	–	40	–	–
Longbean	–	5	50	–
Bittergourd	–	10	50	–
Chilli	–	5	–	50

In the transition stage, the proposed Cropping Pattern B (see Fig. I-11) comprising CS-3, CS-5, and CS-6 is introduced in the whole area of the Sungai Kulim I and II schemes, though the irrigation water source depends fully on the Kulim river. The cropping percentage by crop for irrigated and non-irrigated areas is shown below.

	Upland Crop Area (%)		Tree Crop Area (%)	
Crop	Main Season	Off Season	Short-term	Long-term
Sweet corn	30	30	–	–
Lowland cabbage	20	20	–	–
Lowland cauliflower	10	–	–	–
Longbean	20	30	–	–
Okra	10	–	–	–
Bittergourd	10	10	–	–
Chilli	–	10	–	–
Lime	–	–	–	30
Rambutan	–	–	–	20
Cocoa	–	–	–	50
Pineapple	–	–	100	–

In the final stage of the crop diversification promotion program, the proposed Cropping Pattern C (see Fig. I-12) is to be performed in realizing the target consisting of CS-4 and CS-5 on condition that the irrigation water in the Kulim area is supplemented by the Jarak river. After the water source is increased, the existing non-paddy crop cultivation areas within the granary area (K2 and K4 blocks) is to be also incorporated in this intensive vegetable cultivation area by providing the required water for intensive cropping. The proposed cropping area in percentage by crop is shown below.

Crop	Upland Crop Area (%) 1st Season	2nd Season	3rd Season	Tree Crop Area (%)
Sweet corn	40	–	–	–
Lowland cabbage	–	60	–	–
Lowland cauliflower	–	–	20	–
Longbean	–	–	40	–
Okra	20	–	–	–
Cucumber	–	–	40	–
Bittergourd	40	20	–	–
Chilli	–	20	–	–
Lime	–	–	–	30
Rambutan	–	–	–	20
Cocoa	–	–	–	50

(5) Pilot scheme for demonstration

The pilot scheme for demonstration is recommended to be started under IADP prior to the commencement of the initial stage of the crop diversification program. It is recommended to conduct demonstration works for 8 years covering the whole period of upgrading works of on-farm facilities and the initial period of the Final stage to introduce CS-4.

The proposed pilot scheme sites for demonstration are selected near the border of K1 and K2 blocks in the Sungai Kulim I scheme and K6 block in the Kulim II scheme through discussions with the Implementation Committee of IADP. The pilot scheme sites are to be borrowed from owner farmers. During the demonstration period, owner and tenant farmers are to be trained as core farmers for promoting crop diversification.

The Cropping Systems 1, 3 and 4 will be demonstrated with provision of all supporting services by agencies concerned in an integrated manner.

(6) Crop diversification plan

The proposed crop diversification plans for each block by stage are shown in Table. I-1 in detail and are summarized below.

K1 block

Present Cropping Schedule		Initial	Transition	Final
Main season	Off season	Stage	Stage	Stage
Paddy	Paddy	CS-1	CS-3	CS-4
Paddy	Upland	CS-1	CS-3	CS-4
Upland	Upland	CS-2	CS-3	CS-4

K5 and K6 blocks

Present Cropping Schedule		Initial	Transition	Final
Main season	Off season	Stage	Stage	Stage
Paddy	Paddy	CS-1	CS-3	CS-4
Idle	Idle	Idle	CS-6	CS-4
Idle	Idle	Idle	CS-5	CS-5

K2 and K4 blocks (presently converted to upland fields)

Present Cropping Schedule		Initial	Transition	Final
Main season	Off season	Stage	Stage	Stage
Upland	Upland	(same as the present situation)		CS-4

(7) Anticipated crop yield

Crop yields at the full development stage of the project are conservatively estimated referring DOA's data as shown below:

Conditions	Type of crop	Unit yield (tons/ha)
Without project condition		
Food crops	Paddy	2.25

Conditions	Type of crop	Unit yield (tons/ha)
With project condition		
Food crops	Paddy (direct seeding)	3.5
	Sweet corn (cobs)	42.0
Vegetables	Lowland cabbage	15.0
	Lowland cauliflower	5.9
	Longbean	12.0
	Chilli	12.0
	Bittergourd	10.8
	Okra	21.5
	Cucumber	17.6
Tree crops	Lime	6.0 (8th year)
	Rambutan	9.9 (8th year)
	Cocoa	4.3 (10th year)
	Banana	11.1 (2nd year)
	Pineapple	44.0 (2nd year)

The crop yields are expected to increase year by year and reach the target within 5 years. The increasing rate in yield for vegetables are assumed as follows:

First year	70 % of the full benefit
Second year	80 % of the full benefit
Third year	90% of the full benefit
Fourth year	95 % of the full benefit
Fifth year	100 % of the full benefit

(8) Production of vegetables

At full development of the Project (12th year, or the year 2003), the annual production of vegetables will be about 54,000 tons comprising 15,600 tons of leafy vegetables (cabbage, etc.) and 38,400 tons of fruit vegetables (cucumber, chilli, beans, okra, etc.). This is equivalent to about 50% of the State's total market potential of vegetables of 110,000 tons/year in 2003, assuming that the demand of vegetables in the State will increase in line with the population increase rate of 2.6% per annum.

In addition, it is anticipated that the surplus of vegetables from the Kulim area will contribute to agro-industries to be increased in and around the State in the near future by supplying raw materials.

4. UPGRADING PLAN OF INFRASTRUCTURES

4.1 Approach to the Development

For successful introduction of the crop diversification program, the following approach and measures to develop/improve infrastructures in the Kulim area will fully be considered.

(a) to assure the irrigation supply for upland crops;

- increase tertiary canal density to achieve equitable and effective water management,
- rehabilitate the deteriorated irrigation facilities including pumps in K6 block.
- augment the irrigation water source for the Kulim area by improvement of the existing inter-basin water transfer system from the Jarak river to the Kulim area,

(b) to improve drainage conditions during the main season;

- provide field drains to avoid inundation on upland field during storm rainfall
- provide tidal gates on the natural streams to control the water levels in drains in the project study area

(c) to augment farm road density to improve transportation.

- provide a farm road network
- rehabilitate the deteriorated bridges

4.2 Irrigation Planning

4.2.1 Irrigation development schedule

In line with the basic concept of stepwise development to promote crop diversification in the Kulim area, the irrigation water supply network is also to be extended step by step. In the initial and

transition stages, the irrigation water source for the Study area as well as the Kulim granary area will depend solely on the Kulim river .

After the farmers get used to double cropping of upland crops under irrigated conditions, intensive cropping of upland crops is to be expected with provision of sufficient irrigation water supply. To meet the increased irrigation water demand at the final stage, it is required to enhance irrigation water resources. For this requirement, the available discharge of the Jarak river would have to be conveyed to the Kulim river through the Jarak - Kulim link canal.

The proposed irrigation plan for each promotion stage is summarized below.

Scheme & Block	Area (ha)	Present Condition	Crop Diversification Stage		
			Initial	Transition	Final
Sungai Kulim I					
K1	434	Irrigated	Irrigated	Irrigated	Irrigated
Sungai Kulim II					
K5	315	Irrigated	Irrigated	Irrigated	Irrigated
	204	Idle	Idle	Rainfed	Irrigated
	478	Idle	Idle	Rainfed	Rainfed
K6	153	Irrigated	Irrigated	Irrigated	Irrigated
	61	Idle	Idle	Irrigated	Irrigated
	117	Idle	Idle	Rainfed	Rainfed

4.2.2 Irrigation water requirement

For the granary area, the peak irrigation requirement for double cropping of paddy is estimated at 2.6 lit/sec/ha and the requirement for normal period at 1.3 lit/sec/ha, according to the report *A review of the Available Water Resources and Irrigation Schedule in Seberang Perai, IADP Pulau Pinang.* In this report, the overall irrigation efficiency is assumed to be 60% which is reasonable for the Kulim area.

The effective rainfall was estimated from 1 in 5 year probable rainfall following the procedure introduced in the *National Water Resources Study, Malaysia.* The percolation rate is assumed to be 1

mm/day for paddy fields. The overall irrigation efficiency is assumed to be 60% for paddy and 45% for upland crop cultivation.

Based on the above assumptions and the proposed cropping schedule, the irrigation water demand was calculated for each stage of the crop diversification promotion. The results of the estimate by stage of development is shown in Tables I-2 to I-4 and as summarized below.

Month	Initial	Transition	Final
Irrigation area (ha)	1,270	1,331	1,535
Water demand (m3/sec)			
Jan.	0.72	0.99	1.90
Feb.	0.17	0.57	0.92
Mar.	0.06	0.09	1.10
Apr.	0.19	0.12	1.82
May	0.40	0.38	1.70
June	0.82	0.69	0.93
July	0.80	0.93	1.02
Aug.	0.76	0.58	1.46
Sep.	0.97	0.35	0.95
Oct.	1.22	0.13	0.06
Nov.	0.89	0.28	0.60
Dec.	0.98	0.56	1.49

4.3 Water Balance

The available water resources for the Study area are calculated through a water balance in the basin as follows:

$$An = Qk - Rk - Rn + Qt$$

where, An = available water for the Study area (Kulim I & II)
Qk = available low flow at the Kulim headworks
Qt = available water through the link canal
Rk = water demand in the granary area (IADP)

The available discharge from the Kulim river was estimated by adjusting the discharge records of 27 years (1960 to 1986) observed at the Ara Kuda station based on the catchment area ratio of 1.18 (= 153 km^2/130 km^2). The adjusted figures were processed as the 1 in 5 year low flow available at the Kulim headworks.

Since no river gauging station is available on the Jarak river, river discharge is estimated following the procedure recommended in "Water Resources Publication No.12 - *Average Annual and Surface Water Resources of Peninsular Malaysia.*" prepared by DID. The available dischage at the Jarak headworks can be assessed through water balance between estimated river flow and net demand by users upstream (436 ha in total as shown in Fig. I-5).

The available discharge transferable to the Kulim area through the link canal is limited by the pumping capacity of existing booster station (2.83 m^3/sec) located at the middle point of the link canal. Taking into account the conveyance loss of 20%, the maximum discharge available at the Kulim headworks through the link canal is determined to be 2.26 m^3/sec.

The result of the water balance is shown in Table I-5 and as summarized below.

(Unit: m^3/sec)

	Available Supply		Demand	Available Supply	
Month	Kulim HW	Link Canal	IADP Area	Kulim only	Kulim +Link C
Jan.	2.28	2.24	0.88	1.4	3.64
Feb.	1.62	1.20	0.22	1.4	2.60
Mar.	1.57	0.95	1.42	0.15	1.10
Apr.	2.36	1.66	1.96	0.40	2.06
May	2.98	2.18	1.64	1.34	3.52
June	2.04	1.63	1.20	0.84	2.47
July	2.04	1.56	1.10	0.94	2.50
Aug.	1.69	1.30	0.55	1.14	2.44
Sep.	2.59	2.09	1.20	1.39	3.48
Oct.	4.52	2.26	1.53	2.99	5.25
Nov.	5.49	2.26	1.10	4.39	6.65
Dec.	4.00	2.26	1.20	2.80	5.06

After comparing the available discharge with the water demand in the Study area as shown in the table in Section 4.2.2, the following conclusions have been reached:

(a) the water requirement in the Study area during the Initial and Transition stages can be met by the remaining discharge in the Kulim main canal; and

(b) the cropping schedule in the Final stage can be achieved only after the existing inter-basin water transfer system including the Jarak headworks, a link canal and a pumping station become functionable.

4.4 Upgrading Plan

(1) Planning criteria

The basic criteria for upgrading facilities to secure successful crop diversification are:

(a) to design the irrigation canal with a flow capacity of 2.6 lit/sec/ha to meet the peak requirement;

(b) to design the drainage network so as to drain the 1 in 5 year 1-day storm rainfall within 24 hours; and

(c) to provide a farm road network with a road density of 100 m/ha, which is equivalent to the double the IADP standard.

Other design parameters used for the Study are the same as those of the DID and IADP standards.

The upgrading plan is formulated for all related facilities which need to meet the requirements of the final stage of the crop diversification plan in the Kulim area. The proposed plan is explained hereunder.

(2) On-farm development

To introduce crop diversification, an increase in the density of irrigation and drainage canals and farm roads is required. The design drainage requirement is 1.5 $m^3/sec/km^2$ in K1 block and 1.75 $m^3/sec/km^2$ in K5 & K6 blocks for short-term upland crop cultivation. Field drains and irrigation offtakes need to be augmented to twice the density required by the IADP criteria. In between field offtakes, AC

pipe is proposed to be set along tertiary canals. In the case of perennial tree crop planting, the density of field drains has to be improved up to IADP level. Work quantities for on-farm development are estimated based on a typical layout for 105 ha as shown in Fig. 13, and summarized below.

	for Paddy (IADP)	for Upland Crops
Site clearance	105 ha	105 ha
Land leveling	105 ha	105 ha
Farm road (4 m)		2,050 m
Farm road (3 m)	5,250 m	10,200 m
Tertiary irrigation canal	2,625 m	5,250 m
Tertiary drain canal	2,625 m	5,250 m
Field offtakes	17.5 nos.	70 nos.
Drain outlet	35 nos.	-
Irrigation end	2.5 nos.	5 nos.
Constant head orifice	2.5 nos.	5 nos.
Drain end control	2.5 nos.	5 nos.
AC pipe	-	10,500 m

(3) Secondary canal

To restore the designed flow capacity of existing secondary canals, it is proposed to desilt and reshape flow sections comprising SC-1 for 4 km, SC-2 for 2.5 km, SC-3 for 4 km and SC-4 for 2.5 km.

(4) Rehabilitation of Kubang Semang I pumphouse

In order to secure irrigation water supply to a part of K6 block covering 214 ha, the rehabilitation of the Kubang Semang I pumphouse is proposed. The major work components proposed are to upgrade pump capacity to 0.84 m^3/sec through replacement by new pumps and to construct a new concrete lined canal of 4,000 m in the total length along the east edge of K6 block.

(5) Tidal gate

The design capacity of drainage canals is determined so as to drain the 1-day design storm rainfall within 24 hours. The design

drainage water level is assumed to be 0.15 m below the average ground level during the irrigation supply period. The drainage requirement is estimated to be 1.5 to 1.75 $m^3/sec/km^2$ on paddy fields. Natural streams in the Kulim area have enough drainage capacity so that major improvement works are not necessary. For K1 block, 3 tidal gates are proposed to be newly constructed on the Bongkok Keriang, Kubu and Tok Alang rivers aiming to keep the drainage water level lower.

(6) Bund along the Jarak river

The Jarak headworks has hardly been operated because inundation problems in the upstream adjacent area are caused by closing the main gates. To solve this problem, construction of bunds along the Jarak river is proposed as an effective countermeasure. The length of these bunds will be 1,600 m on the right bank and 1,100 m on the left bank upstream of the headworks. The top width of the bund is designed to be more than 3 m so as to be usable as a maintenance road.

(7) Jarak - Kulim link canal

This inter-basin transfer system consists of a 7.4 km long link canal and a pump station at Padang Chempedak. The design flow capacity is 2.3 m^3/sec. This canal is presently out of use due to severe siltation and insufficient inflow from the Jarak intake. It is estimated that the canal section is reduced by about 30% between the Intake and the Pump station and by 50% between the pump station and the Kulim headworks. In order to enhance water resources by conveying the Jarak water, it is proposed to desilt the whole section of the link canal and to construct a maintenance road along the canal.

4.5 Implementation Plan for Upgrading Works

The proposed implementation schedule is shown in Fig. I-14. Prior to the construction, definitive planning, survey and detailed design works are necessary to be implemented for one year. The

construction period for upgrading works in the Kulim area is proposed to be 6 years based on a stepwise procedure as follows:

(1) Initial stage

The main works in the initial stage will be to upgrade on-farm service facilities so as to establish field conditions suitable for intensive crop diversification. Construction of 3 tidal gates in K1 block and rehabilitation of the pump station in K6 block will also be implemented. The proposed area for upgrading works is 902 ha, namely 434 ha in K1, 315 ha in K5 and 153 ha in K6 blocks. The construction period is assumed to be 2 years.

(2) Transition stage

The main works at this stage will be to improve on-farm service facilities in the area at present idle: namely 685 ha in K5 block and 178 ha in K6 block, and to rehabilitate secondary canals. The construction period is assumed to be 2 years starting immediately after the completion of the initial stage works.

(3) Final stage

The main works at this stage will consist of upgrading on-farm facilities in K5, K2 and K4 blocks, construction of bunds along the Jarak river with a total length of 2.7 km, and rehabilitation of the Jarak - Kulim link canal with a total length of 7.4 km. The construction period is assumed to be 2 years starting immediately after completion of the transition stage works.

4.6 Cost Estimate

(1) Investment costs

The project cost is estimated based on the following assumptions:

(i) Direct construction cost is estimated following the current unit construction cost used for IADP.

(ii) Engineering costs including survey and design are assumed to be 10% of the direct construction cost.

(iii) Physical contingency is assumed to be 15% of the direct construction cost and engineering cost.

(iv) Administration cost is 2% of the direct construction cost and engineering cost.

(v) Annual escalation rate of unit construction cost is 5% per annum.

The unit construction cost for each work item is shown in Table I-6. In line with the proposed implementation schedule, the total project cost including survey and design and physical contingency is estimated at M$22.8 million as shown in Table I-7 in detail and is summarized below.

Stage	Main Work Items	Construction Cost (M$'000) Direct Cost	Total Cost
Initial	On-farm development 902 ha	9,207	11,647
Transition	On-farm development 860 ha	3,247	4,107
Final	Jarak/Kulim link canal and other infrastructures	5,599	7,083
Total		18,053	22,837

(2) Operation and maintenance (O&M) costs

The annual O&M costs increased by implementation of the Project is assumed to be 0.5% of the direct construction cost reflecting the past performance of O&M by DID Seberang Perai District office. The annual O&M cost is estimated at M$112,000 per annum.

(3) Fund disbursement schedule

Fund requirements for implementation of crop diversification program are estimated assuming that the price escalation rate is 4% per annum for direct cost, while the administration cost to support crop diversification program is 1% of total direct construction cost. The fund requirement for the project is estimated at M$ 27.6 million. The fund disbursement schedule is assumed as follows.

(Unit: M$'000)

Year in order	Construc-tion Cost	Admini. Cost	Price Escalation	Fund Requirement	Incremental O&M Cost
1	500	230	0	730	0
2	7,100	230	293	7,623	0
3	4,047	230	349	4,626	36
4	2,060	230	286	2,576	56
5	2,047	230	387	2,664	66
6	3,543	230	817	4,590	76
7	3,540	230	1,000	4,770	90
8 -	0	0	0	0	112
Total	22,837	1,610	3,132	27,579	

5. EVALUATION OF CROP DIVERSIFICATION PLAN

5.1 General

The feasibility of the proposed crop diversification plan is assessed in this Chapter. The financial feasibility is analyzed by calculating the financial internal rate of return (FIRR). Sensitivity analysis is also made in order to evaluate the financial viability of the project against the changes in the cost and benefit and delay in schedule of crop diversification.

5.2 Benefits

It is expected that benefits accrued from the project will be solely irrigation benefits. The net irrigation benefit is defined as the difference of net income by cropping schedule between future with project and without project conditions. The gross benefit, production costs, and net benefit per ha for each crop is estimated referring to the *Guideline on Economic Viability of Selected Crops* prepared by MOA in 1989 (see Appendix E, Volume 2).

The annual net benefit without project condition is estimated at M$1,956/ha as shown in Table I-8. In this calculation, the unit yield of paddy is assumed to be the same as the present level of 2.25 tons/ha. For the area presently cultivating upland crops, combination of sweet corn spinach and sugar cane is assumed for calculating the benefit without project condition.

The incremental benefit will be realised from the third year of the commencement of the project and will reach its maximum at the 18th year of the project implementation, Annual incremental benefit at full development stage for each cropping schedule is shown in Table I-9 for CS-1 to CS-4 and in Table I-10 for CS-5. These are summarized below.

Cropping Schedule	Crop by Season Main	Off	Cropping Intensity (%)	Net income at full Development Stage (M$/ha)
CS-1	Paddy	Upland	200	6,949
CS-2	Upland	Upland	200	7,420
CS-3	Upland	Upland	200	7,695
CS-4	Upland x 3 times		300	14,799
CS-5	Long-term Tree Crops		100	4,667
CS-6	Short-term Tree Crops		100	4,120

Negative benefits are not considered in the evaluation because the proposed works are of a small-scale and can be implemented without disturbance of crop cultivation.

5.3 Financial Evaluation

The financial evaluation is made assuming a project economic life of 30 years. The flow of financial cost and benefit is shown in Table I-11. The financial internal rate of return (FIRR) is estimated by development stage of the project as follows:

Development stage of the Project	FIRR (%)
Initial	22.3
Initial + Transition	21.0
Initial + Transition + Final	27.2

A sensitivity analysis is made to evaluate the soundness of the project against possible adverse changes in the future in the following factors; (1) cost overrun, (2) reduction of net benefit, (3) delay in introducing intensive cropping schedule (CS-3 and CS-4), and (4) combination of the above. The results are presented below.

Alternative case		FIRR (%)
Base		27.2
Case 1-1	cost overrun by 10%	25.9
Case 1-2	cost overrun by 20%	24.8
Case 1-3	cost overrun by 30%	23.8
Case 2-1	reduction of benefit by 10%	24.4
Case 2-2	reduction of benefit by 20%	21.5
Case 2-3	reduction of benefit by 30%	18.5
Case 3-1	delay in introducing CS-3 and CS-4 for 1 year each	25.7
Case 3-2	delay in introducing CS-3 and CS-4 for 2 years each	21.1
Case 4	combination of Case 1-1, 2-1 and 3-1	20.7
Case 4	combination of Case 1-2, 2-2 and 3-2	14.3

The proposed crop diversification program can be justified with FIRR of 27.2%. The sensitivity analysis indicates that viability of the project is rather insensitive to the increase in construction costs or delay in introduction of intensive crop diversification program. However it is rather sensitive to the reduction of benefits by falling of market prices of products and/or reduced crop yields.

6. ROLE OF AGENCIES CONCERNED IN PROMOTING CROP DIVERSIFICATION

To promote crop diversification in non-granary irrigation scheme areas, it is recommended that the existing coordinating committees such as State Planning Coordination Committee and District Agricultural Planning Coordinate Committee need to have the initiative to increase the coordination of their departments and of the agencies concerned and their interlinkages with DID, DOA, FOA, LPN, FAMA and BPM.

The State DID is responsible for planning, design, construction, operation and maintenance, budget arrangement and monitoring of required for upgrading works including irrigation, drainage and farm access roads in each scheme area up to on-farm level. These engineering works are prerequisite to introduction of high value crop diversification in existing irrigated paddy areas.

The role of the State DOA is to set up the cropping schedule, to provide extension and technical services, to supply farm inputs and to promote grouping of farmers participating in crop diversification. The responsibility of FOA is timely provision of farm machinery services for land preparation and harvesting works. As for marketing services, LPN purchases paddy on a subsidy basis, while FAMA makes the necessary arrangement for marketing upland crops. Provision of short-term credit to cover annual farm operation costs is handled by BPM.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

(1) The market potential for diversified crops, especially for vegetables, in the State of P. Pinang is large. The potential for successful crop diversification is high in the Kulim area.

(2) The Kulim I and II schemes selected for the Study have no physical constraints for crop diversification if the water supply can be assured.

(3) To introduce a crop diversification program in the irrigation scheme areas, upgrading of on-farm facilities by increasing the density of irrigation canals, drains and farm roads is prerequisite. The required density is double that of IADP standard for paddy irrigation.

(4) Investment in the proposed upgrading works can financially be justified with FIRR of 27.2%.

(5) Coordination between organizations and agencies related to the crop diversification program is quite important. The existing coordination committees should be fully used for this purpose.

7.2 Recommendations

(1) Operation of a pilot scheme

In the initial stage for promoting crop diversification a description of support services, both technical and non-technical, should be prepared in a package form and be given and explained to the intended paddy farmers. To enable conservative paddy farmers to participate in crop diversification, it is recommended that a pilot demonstration scheme be operated in

which diversified cropping is carried out incorporating all the necessary support services.

For this pilot project, Sungai Kulim non-granary irrigation scheme is recommended, under the direct management of the Project Implementation Team of the Balik Pulau/Seberang Perai IADP.

(2) Establishment of efficient water management

A important aspect in realizing successful crop diversification will be to keep to the cropping schedule as planned. For this, efficient water management in the upgraded irrigation systems including the Jarak link canal is important. To achieve equitable water supply between all the irrigation blocks from K1 to K6, detailed monitoring of present water utilization and supply conditions should be initiated. These data will be correlated and used for detailed planning and design of the upgrading works for the system.

A regulation and practical operation rule for the integrated irrigation and drainage system including the Jarak link canal should be established to avoid serious competition in water use between users.

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Tables

Table I-1 Implementation Schedule of Crop Diversification for the Sungai Kulim I & II Schemes

Cropping System		Present Condition	Without Project	With Project		
				Initial	Transition	Final
K1 Block						
Double cropping of paddy		342	342	-	-	-
Paddy-upland combination		50	50	-	-	-
Converted area		42	42	-	-	-
With Project:	CS-1			392	-	
	CS-2			42	-	-
	CS-3	-	-	-	434	-
	CS-4	-	-	-	-	434
K5 Block						
Double cropping of paddy		315	315	-	-	-
Idle paddy field		682	682	682	-	-
With Project:	CS-1	-	-	315	-	-
	CS-3	-	-	-	315	-
	CS-6	-	-	-	204	
	CS-4	-	-	-	-	519
	CS-5	-	-	-	478	478
K6 Block						
Double cropping of paddy		153	153	-	-	-
Idle paddy field		178	178	178	-	-
With Project:	CS-1	-	-	153	-	-
	CS-3	-	-	-	214	-
	CS-4	-	-	-	-	214
	CS-5	-	-	-	117	117
K2 Block						
Converted area		278	278	278	278	-
With Project:	CS-4	-	-	-	-	278
K4 Block						
Converted are		90	90	90	90	-
With Project:	CS-4	-	-	-	-	90
Whole Scheme						
Double Cropping of Paddy		810	810	-	-	-
Idle paddy field		860	860	860	-	-
Paddy-pland combination		50	50	-	-	-
Converted area in K1		42	42	-	-	-
Converted area in K2 & K4		368	368	368	368	-
With Project:	CS-1	-	-	860	-	-
	CS-2			42	-	-
	CS-3	-	-	-	963	-
	CS-4	-	-	-	-	1,535
	CS-5	-	-	-	595	595
	CS-6	--	-	-	204	-
Total		2,130	2,130	2,130	2,130	2,130

Table I-2 Irrigation Water Demand in Initial Stage

Crop		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1. Unit Irrigation water demand by crop (lit/sec/ha)													
(1) Two cropping area													
Paddy		0.8	0.2	-	-	-	-	-	0.6	1.1	1.4	1.0	1.1
Cabbage		-	-	-	-	0.16	0.68	0.79	0.16	-	-	-	-
Sweet corn		-	-	-	0.22	0.57	1.09	0.95	0.39	-	-	-	-
Longbean		-	-	0.66	0.80	0.96	1.00	0.83	0.29	-	-	-	-
Chilli		-	-	0.72	0.61	0.97	1.00	0.82	0.28	-	-	-	-
Bittergourd		-	-	-	0.42	0.65	0.92	0.80	0.25	-	-	-	-
(2) Converted area													
Sweet corn		-	-	-	-	0.17	0.77	1.28	0.61	-	-	-	-
Longbean		0.73	-	-	-	-	-	-	-	0.83	0.45	0.72	0.98
Chilli		-	-	-	0.22	0.67	0.95	1.17	0.52	-	-	-	-
Bittergourd		0.41	-	-	-	-	-	-	-	0.02	0.21	0.71	0.75
2. Irrigation water demand (m3/sec)													
(1) Two cropping area													
Paddy	860 ha	0.69	0.17	-	-	-	-	-	0.52	0.94	1.20	0.86	0.94
Cabbage	344 ha	-	-	-	-	0.05	0.23	0.27	0.05	-	-	-	-
Sweet corn	344 ha	-	-	-	0.07	0.19	0.37	0.32	0.13	-	-	-	-
Longbean	43 ha	-	-	0.03	0.04	0.04	0.05	0.04	0.01	-	-	-	-
Chilli	43 ha	-	-	0.03	0.03	0.04	0.05	0.04	0.01	-	-	-	-
Bittergourd	86 ha	-	-	-	0.04	0.06	0.08	0.07	0.02	-	-	-	-
Sub-total		0.69	0.17	0.06	0.18	0.38	0.78	0.74	0.74	0.94	1.20	0.86	0.94
(2) Converted area													
Sweet corn	21 ha	-	-	-	-	0.01	0.02	0.03	0.01	-	-	-	-
Longbean	21 ha	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.02	0.02
Chilli	21 ha	-	-	-	0.01	0.01	0.02	0.03	0.01	-	-	-	-
Bittergourd	21 ha	0.01	-	-	-	-	-	-	-	0.01	0.01	0.01	0.02
Sub-total		0.03	-	-	0.01	0.02	0.04	0.06	0.02	0.03	0.02	0.03	0.04
Total		0.72	0.17	0.06	0.19	0.40	0.82	0.80	0.76	0.97	1.22	0.89	0.98

Table I-3 Irrigation Water Demand in Transition Stage

Crop		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1. *Unit irrigation water demand by crop (lit/sec/ha)*													
Bittergourd		-	-	-	-	0.39	0.90	1.08	0.43	-	-	-	-
Bittergourd		0.41	-	-	-	-	-	-	-	0.02	0.21	0.71	0.75
Okra		1.03	0.43	-	-	-	-	-	-	0.24	0.23	0.68	1.01
Cabbage		1.26	0.84	-	-	0.16	0.68	0.79	0.16	-	-	-	0.45
Cauliflower		1.24	0.74	-	-	-	-	-	-	-	-	-	0.45
Sweet corn		1.20	1.02	0.31	-	0.17	0.77	1.28	0.61	-	-	-	0.25
Sweet corn		-	-	-	-	-	0.19	0.90	1.16	0.48	-	-	-
Chilli		-	-	-	0.22	0.67	0.95	1.17	0.52	-	-	-	-
Longbean		-	-	-	0.51	0.92	0.95	0.89	0.42	-	-	-	-
Longbean		-	-	-	-	0.41	0.88	1.09	1.00	0.76	-	-	-
Longbean		0.73	-	-	-	-	-	-	-	0.83	0.45	0.72	0.98
2. *Irrigation water demand (m3/sec)*													
Bittergourd	96 ha	-	-	-	-	0.04	0.09	0.10	0.04	-	-	-	-
Bittergourd	96 ha	0.04	-	-	-	-	-	-	-	0.01	0.02	0.07	0.07
Okra	96 ha	0.10	0.04	-	-	-	-	-	-	0.02	0.02	0.07	0.10
Cabbage	192 ha	-	-	-	-	0.03	0.13	0.15	0.03	-	-	-	-
Cabbage	192 ha	0.24	0.16	-	-	-	-	-	-	-	-	-	0.09
Cauliflower	96 ha	0.12	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Sweet corn	96 ha	0.12	0.10	0.03	-	-	-	-	-	-	-	-	0.02
Sweet corn	96 ha	-	-	-	-	0.02	0.07	0.12	0.06	-	-	-	-
Sweet corn	192 ha	0.23	0.20	0.06	-	-	-	-	-	-	-	-	0.05
Sweet corn	192 ha	-	-	-	-	-	0.04	0.17	0.22	0.09	-	-	-
Chilli	96 ha	-	-	-	0.02	0.07	0.09	0.11	0.05	-	-	-	-
Longbean	192 ha	0.14	-	-	-	-	-	-	-	0.16	0.09	0.14	0.19
Longbean	192 ha	-	-	-	0.10	0.18	0.18	0.17	0.08	-	-	-	-
Longbean	96 ha	-	-	-	-	0.04	0.09	0.11	0.10	0.07	-	-	-
Total		0.99	0.57	0.09	0.12	0.38	0.69	0.93	0.58	0.35	0.13	0.28	0.56

Table I-4 Irrigation Water Demand for CS-4 in Final Stage

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1. Unit irrigation water demand by system (lit/sec/ha)													
1st 1/5		0.4	-	0.9	1.1	1.1	0.2	0.8	1.0	0.2	-	0.4	1.0
2nd 1/5		1.5	1.1	0.3	1.0	1.0	0.7	0.2	1.0	0.6	-	0.6	1.0
3rd 1/5		1.5	1.1	0.3	1.3	1.3	0.7	1.0	1.0	0.6	-	0.6	1.0
4th 1/5		1.4	0.4	1.1	1.4	1.0	0.4	1.0	1.0	0.9	0.1	0.2	0.9
5th 1/5		1.4	0.4	1.0	1.1	1.1	1.0	0.3	0.7	0.8	0.1	0.2	0.9
2. Irrigation water use (m3/sec)													
1st 1/5	307 ha	0.12	-	0.27	0.34	0.34	0.06	0.25	0.31	0.06	-	0.12	0.31
2nd 1/5	307 ha	0.46	0.34	0.09	0.31	0.31	0.22	0.06	0.31	0.18	-	0.18	0.31
3rd 1/5	307 ha	0.46	0.34	0.09	0.40	0.40	0.22	0.31	0.31	0.18	-	0.18	0.31
4th 1/5	307 ha	0.43	0.12	0.34	0.43	0.31	0.12	0.31	0.31	0.28	0.03	0.06	0.28
5th 1/5	307 ha	0.43	0.12	0.31	0.34	0.34	0.31	0.09	0.22	0.25	0.03	0.06	0.28
Total		1.90	0.92	1.10	1.82	1.70	0.93	1.02	1.46	0.95	0.06	0.60	1.49

Remarks:

CS-4 is divided into 5 parts (20% each) for calculation purpose as follows:

1st 1/5:	Cucumber - Sweet corn - Chili - Cucumber
2nd 1/5	Long bean - Sweet corn - Bittergourd - Long bean
3rd 1/5	Long bean - Bittergourd - Lowland cabbage - Long bean
4th 1/5	Lowland cauliflower - Bittergourd - Lowland cabbage - Lowland cauliflower
5th 1/5	Cucumber - Okra - Lowland cabbage - Cucumber

Table I-5 Water Balance in Kulim Area

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1. Water source: Kulim river												
(1) Estimated low flow (m3/sec)	2.28	1.62	1.57	2.36	2.98	2.04	2.04	1.69	2.59	4.52	5.49	4.00
(2) Irrigation water demand for double cropping of paddy in granary area of K2/K3/K4 blocks covering 1,093 ha (lit/sec/ha)	0.8	0.2	1.3	1.8	1.5	1.1	1.0	0.5	1.1	1.4	1.0	1.1
(3) Irrigation water use in granary area (m3/sec)	0.88	0.22	1.42	1.96	1.64	1.20	1.10	0.55	1.20	1.53	1.10	1.20
(4) Available water for non-granary areas (m3/sec)	1.40	1.40	0.15	0.40	1.34	0.84	0.94	1.14	1.39	2.99	4.39	2.80
2. Water source: Kulim and Jarak rivers												
(1) Available water from Sg. Jarak (m3/sec)	2.24	1.20	0.95	1.66	2.18	1.63	1.56	1.30	2.09	2.26	2.26	2.26
(2) Total available irrigation water sources (m3/sec)	3.64	2.60	1.10	2.06	3.52	2.47	2.50	2.44	3.48	5.25	6.65	5.06

Table I-6 Breakdown of Direct Construction Cost for Kulim Area (1/2)

Work Item	Unit	Quantity	Unit Price (M$)	Amount (M$)
A. On-farm Development with High Canal Density (105 ha)				
Clearing/Leveling	m	105	100	10,500
On-farm Field Canal System				
Tertiary irrigation canal	m	5,250	30	157,500
Constant head orifice (CHO)	m	5	1,500	7,500
Field offtake	no.	70	500	35,000
Field pipe (AC)	m	10,500	25	262,500
Irrigation end control	no.	5	500	2,500
On-farm Drainage Canal System				
Field Drain	m	5,250	15	78,750
Drainage end control	no.	5	200	1,000
Farm road				
Road of 4 m wide	m	2,050	20	41,000
Road of 3 m wide	m	10,200	16	163,200
Miscellaneous				152,550
Total				912,000
				(M$8,686/ha)
B. On-farm Development at IADP Level (105 ha)				
Clearing/Leveling	m	105	100	10,500
On-farm Field Canal System				
Tertiary irrigation canal	m	2,625	30	78,750
Constant head orifice (CHO)	m	5	1,500	7,500
Field offtake	no.	18	500	9,000
Irrigation end control	no.	3	500	1,500
On-farm Drainage Canal System				
Field Drain	m	2,625	15	39,375
Drainage end control	no.	3	200	600
Farm road				
Road of 3 m wide	m	5,250	16	84,000
Miscellaneous				46,775
Total				278,000
				(M$2,648/ha)
C. On-farm Development for Short-term Tree Crops (105 ha)				
Clearing/Leveling	m	105	100	10,500
On-farm Drainage Canal System				
Field Drain	m	2,500	15	37,500
Drainage end control	no.	3	200	600
Farm road				
Road of 4 m wide	m	1,000	20	20,000
Miscellaneous				14,400
Total				83,000
				(M$790/ha)
D. On-farm Development for Long-term Tree Crops (105 ha)				
On-farm Drainage Canal System				
Field Drain	m	2,500	15	37,500
Drainage end control	no.	3	200	600
Farm road				
Road of 4 m wide	m	1,000	20	20,000
Miscellaneous				11,900
Total				70,000
				(M$667/ha)

Table I-6 Breakdown of Direct Construction Cost for Kulim Area (2/2)

Work Item	Unit	Quantity	Unit Price (M$)	Amount (M$)
E. Rehabilitation of Secondary Canals in K5 Block (4 km)				
Earth works				
Excavation	cu.m	6,000	3	18,000
Embankment	cu.m	9,600	7	67,200
Surfacing	cu.m	12,000	1	12,000
Structures				
Siphon	nos.	7	21,000	147,000
Bridge	nos.	6	26,000	156,000
Miscellaneous				80,800
Total				481,000
				(M$120/m)
F. Rehabilitation of Secondary Canals in K6 Block (4 km)				
Concrete canal	m	4,000	35	140,000
Earth works				
Embankment	cu.m	9,600	7	67,200
Surfacing	cu.m	12,000	1	12,000
Structures				
Siphon	nos.	14	21,000	294,000
Bridge	nos.	13	26,000	338,000
Miscellaneous				142,800
Total				854,000
				(M$214/m)
G. Construction of Tidal Gate (1 no.)				
Earth works				
Embankment	cu.m	100	3	300
Backfill	cu.m	40	5	200
Concrete	cu.m	4,000	35	140,000
Reinforcement bar	ton	3	1,300	3,380
Form works	sq.m	190	6	1,140
Miscellaneous				29,980
Total				175,000
H. Hightening of Jarak River Bund				
Earth works				
Embankment	cu.m	30,000	7	210,000
Sod facing	sq.m	8,000	1	8,000
Miscellaneous				44,000
Total				262,000
I. Rehabilitation of Jarak/Kulim Link Canal				
Earth works				
Excavation	cu.m	38,000	3	114,000
Embankment	cu.m	40,000	7	280,000
Surfacing	sq.m	45,000	1	45,000
Miscellaneous				91,000
Total				530,000
J. Rehabilitation of Pump Station in K6 Block				
Replacement of pump	nos.	2	380,000	760,000
Civil works	L.S.	1	300,000	300,000
Miscellaneous				260,000
Total				1,320,000

Table I-7 Summary of Construction Cost for the Sungai Kulim Scheme

Work Item		Unit	Quantity	Unit Price (M$)	Amount (M$)
Initial Stage Development					
1 Direct construction Cost					
On-farm Development for Initial Stage					
K1 Block	Paddy to CS-1	ha	342	8,686	2,970,612
	Paddy/Upland to CS-1	ha	50	8,686	434,300
	Upland to CS-2	ha	42	8,686	364,812
K5 Block	Paddy to CS-1	ha	315	8,686	2,736,090
K6 Block	Paddy to CS-1	ha	153	8,686	1,328,958
Rehabilitation of Pump Station in K6 Block		no.	1	1,320,000	1,320,000
Construction of Tidal Gate in K1 Block		no.	3	17,500	52,500
Sub-total					9,207,272
2 Engineering cost (Survey/Design)		L.S.			920,728
3 Physical Contingency					1,519,000
Total cost					11,647,000
Transition Stage Development					
1 Direct construction Cost					
On-farm Development for Transition Stage					
K5 Block	Idle to CS-6	ha	204	790	161,160
	Idle to CS-5	ha	478	667	318,826
K6 Block	Idle to CS-3	ha	61	8,686	529,846
	Idle to CS-5	ha	117	667	78,039
Rehabilitation of secondary canal					
K5 Block		m	6,400	120	768,000
K6 Block		m	6,500	214	1,391,000
Sub-total					3,246,871
2 Engineering cost (Survey/Design)		L.S.			324,687
3 Physical Contingency					535,129
Total cost					4,106,687
Final Stage Development					
1 Direct construction Cost					
On-farm Development for Final Stage					
K5 Block	CS-6 to CS-4	ha	204	7,896	1,610,784
K2 Block	Upland to CS-4	ha	278	8,686	2,414,708
K4 Block	Upland to CS-4	ha	90	8,686	781,740
Jarak Transfer System					
Jarak/Kulim link canal			1	530,000	530,000
Jarak river bund			1	262,000	262,000
Sub-total					5,599,232
2 Engineering cost (Survey/Design)		L.S.			559,923
3 Physical Contingency					923,845
Total cost					7,083,000
Grand Total					22,836,688

Table I-8 Net Benefit per Ha without Project for the Kulim Area

	Planted Area (ha)	Benefit calculation (M$/ha) Gross Benefit	Production Cost	Net Benefit	Estimated Net Benefit (M$)
K1 Block					
Main season paddy	392	2,250	1,420	830	325,360
Off season paddy	342	3,200	1,420	1,780	608,760
Sweet corn	25	2,120	1,700	420	10,500
Spinach	25	5,435	4,014	1,421	35,525
Sugarcane	42	2,479	2,308	171	7,189
K5 Block					
Main season paddy	315	2,250	1,420	830	261,450
Off season paddy	315	2,250	1,420	830	261,450
K6 Block					
Main season paddy	153	2,250	1,420	830	126,990
Off season paddy	153	2,250	1,420	830	126,990
Total	(902)				1,764,214 (M$1,956 / ha)

Table I-9 Net Benefit per Ha for Cropping Systems 1 to 4 with Project for the Kulim Area

Unit: M$/ha

	Planted Area (%)	Gross Benefit	Production cost	Average Annual Net Benefit Year 1	Year 2	Year 3	Year 4	Year 5
1 Cropping System 1								
Paddy-3	100	2,810	1,510					
Longbean	5	7,680	6,250					
Chili	5	18,000	7,470					
Bittergourd	10	7,962	5,253					
Sweet corn	40	2,120	1,700					
Lowland cabbage	40	15,200	5,670					
Total	200	11,818	5,669	2,604	3,786	4,967	5,558	6,259
2 Cropping System 2 (for converted area in K1 Block only)								
Longbean	50	7,680	6,250					
Bittergourd	50	7,962	5,253					
Sweet corn	50	2,120	1,700					
Chili	50	18,000	7,470					
Total	200	17,881	10,337	2,180	3,968	5,756	6,650	7,544
3 Cropping System 3								
Bittergourd-1	10	7,962	5,253					
Okra	10	8,355	5,904					
Lowland cabbage-1	20	15,200	5,670					
Lowland cauliflower	10	16,576	5,820					
Sweet corn-1	30	2,120	1,700					
Longbean-1	20	7,680	6,250					
Chili	10	18,000	7,470					
Sweet corn-2	30	2,120	1,700					
Longbean-2	30	7,680	6,250					
Bittergourd-2	10	7,962	5,253					
Lowland cabbage-2	20	15,200	5,670					
Total	200	17,078	9,383	2,571	4,279	5,987	6,841	7,695
4 Cropping System 4								
Cucumber	40	7,920	7,000					
Longbean	40	7,680	6,250					
Lowland cauliflower	20	16,576	5,820					
Sweet corn	40	2,120	1,700					
Bittergourd-1	40	7,962	5,253					
Okra	20	16,355	5,904					
Chili	20	18,000	7,470					
Bittergourd-2	20	7,962	5,253					
Lowland cabbage	60	15,200	5,670					
Total	300	31,172	16,373	5,447	8,564	11,682	13,240	14,799

Remarks:

(1) Increasing rate of unit yield is assumed as follows.

1st year=70%, 2nd year=80%, 3rd year=90%, 4th year=95%, 5th year=100%

Table I-10 Net Benefit per Ha for Cropping System 5 with Project Condition in the Kulim Area

(Unit: M$/ha)

Year	Lime	Rambutan	Cocoa	Banana*	Overall**
1	-1,833	-1,525	-1,152	-890	-1,876
2	-582	-832	-1,926	1,066	-771
3	-318	-1,195	-1,110	1,045	-367
4	-52	-484	-1,027	-890	-1,071
5	1,829	458	-94	1,066	1,126
6	2,994	458	1,115	1,045	2,070
7	5,100	458	2,075		2,659
8	7,189	6,259	2,433		4,625
9	7,200	6,259	2,433		4,628
10	7,189	6,259	2,515		4,666
11	7,200	6,259	2,515		4,669
12	5,089	6,226	2,330		3,937
13	5,100	6,226	2,330		3,940
14	-1,833	6,226	2,330		1,860
15	-582	6,226	2,330		2,236
16	-318	-1,525	2,330		765
17	-52	-832	2,330		983
18	1,829	-1,195	2,330		1,475
19	2,994	-484	2,330		1,966
20	5,100	458	2,330		2,787
21	7,189	458	2,330		3,413
22	7,200	458	2,330		3,417
23	7,189	6,259	2,330		4,573
24	7,200	6,259	2,330		4,577
25	5,089	6,259	2,330		3,943

Remarks: * = Shade tree for young cocoa for 6 years

** = Weighted average by 30% of lime, 20% of rambutan and 50% of cocoa and banana.

Table I-11 Financial Cost and Benefit Flow for the Sungai Kulim I & II Schemes

(Unit : M$'000)

Year	Cost		(1.00)	Incremental
	Capital	O&M	Total	Benefit
1	500	0	500	0
2	7,100	0	7,100	0
3	4,047	36	4,083	263
4	2,060	56	2,116	1,105
5	2,047	66	2,113	2,196
6	3,543	76	3,619	-524
7	3,540	94	3,634	1,778
8	0	112	112	356
9	0	112	112	4,722
10	0	112	112	10,813
11	0	112	112	16,161
12	0	112	112	21,296
13	0	112	112	22,466
14	0	112	112	22,466
15	0	112	112	22,490
16	0	112	112	22,492
17	0	112	112	22,050
18	0	112	112	22,048
19	0	112	112	20,821
20	0	112	112	21,044
21	0	112	112	20,169
22	0	112	112	20,299
23	0	112	112	20,592
24	0	112	112	20,884
25	0	112	112	21,372
26	0	112	112	21,745
27	0	112	112	21,747
28	0	112	112	22,435
29	0	112	112	22,434
30	0	112	112	22,060
31	0	112	112	22,058
32	0	112	112	20,821
33	0	112	112	21,104
34	0	112	112	21,091
35	0	112	112	21,139

IRR = 27.2%

Part - I

Figures

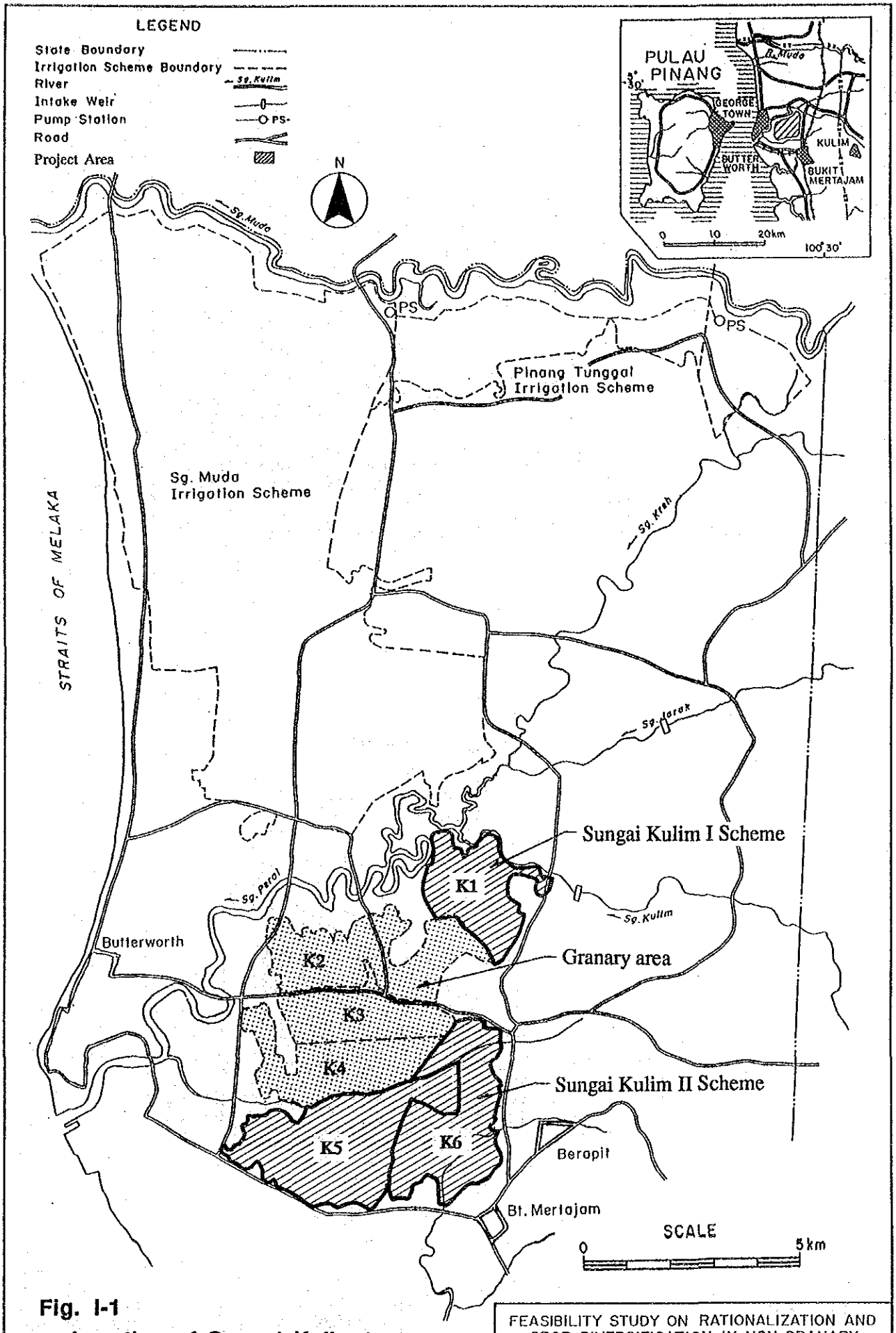

Fig. I-1

Location of Sungai Kulim I & II Schemes

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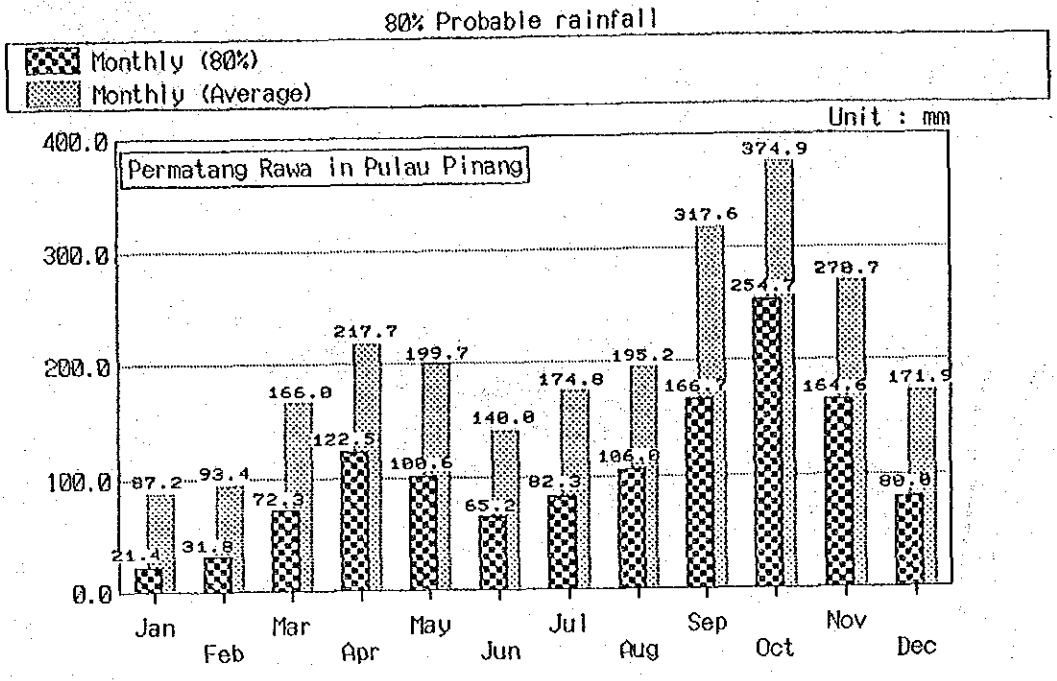

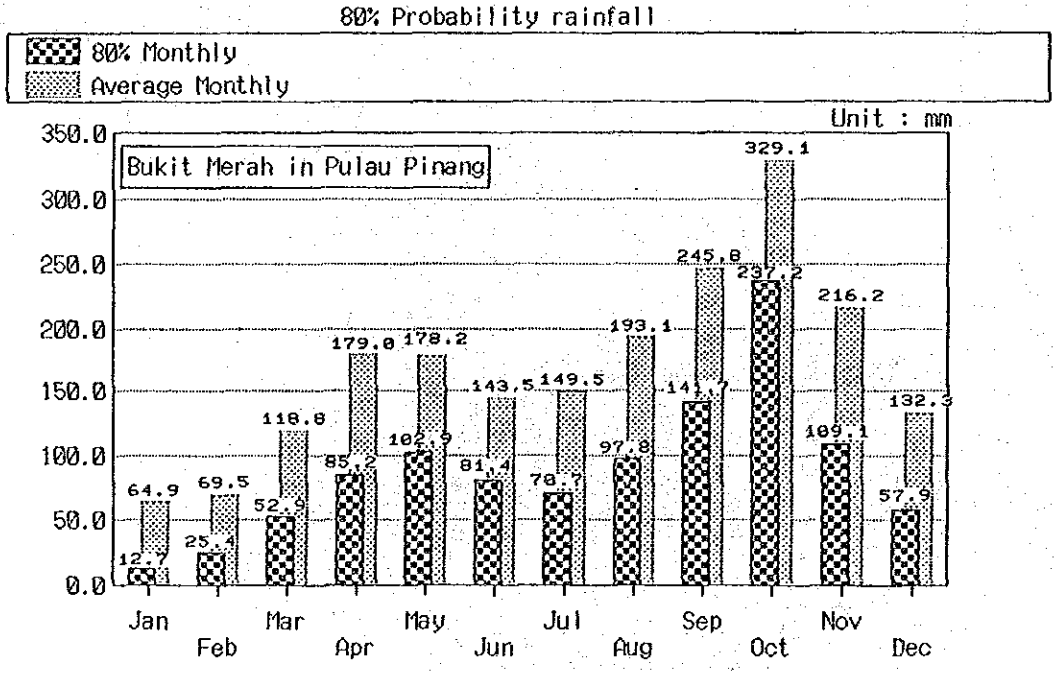

Fig. I-2
Monthly Rainfall in P. Pinang

FEASIBILITY STUDY ON RATIONALIZATION AND CROP DIVERSIFICATION IN NON-GRANARY IRRIGATED AREAS IN MALAYSIA

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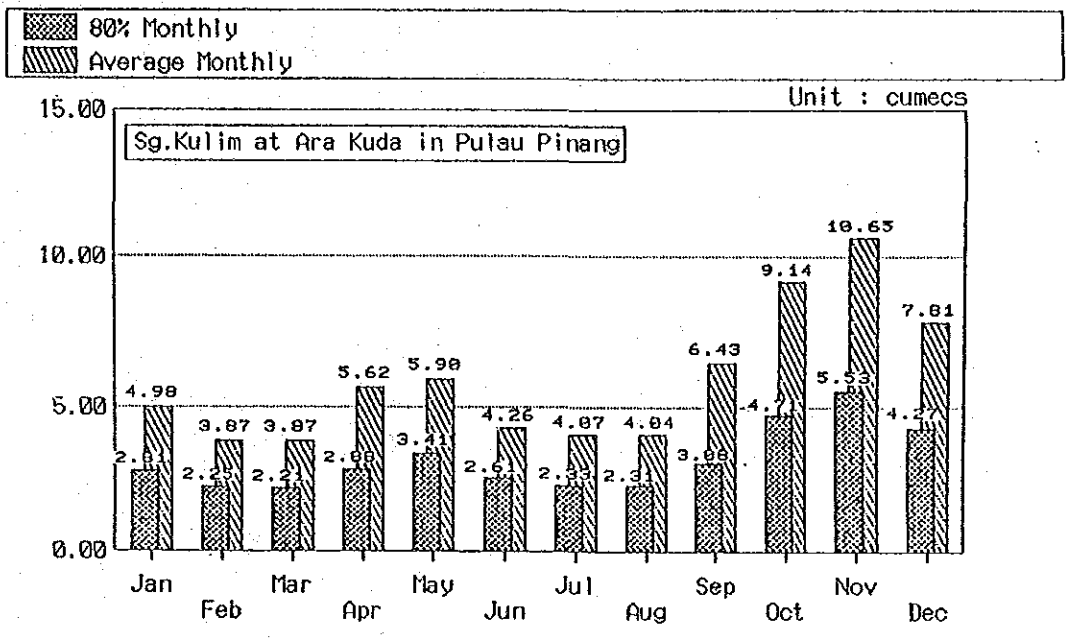

Fig. I-3

Monthly Mean Discharge of the Kulim River

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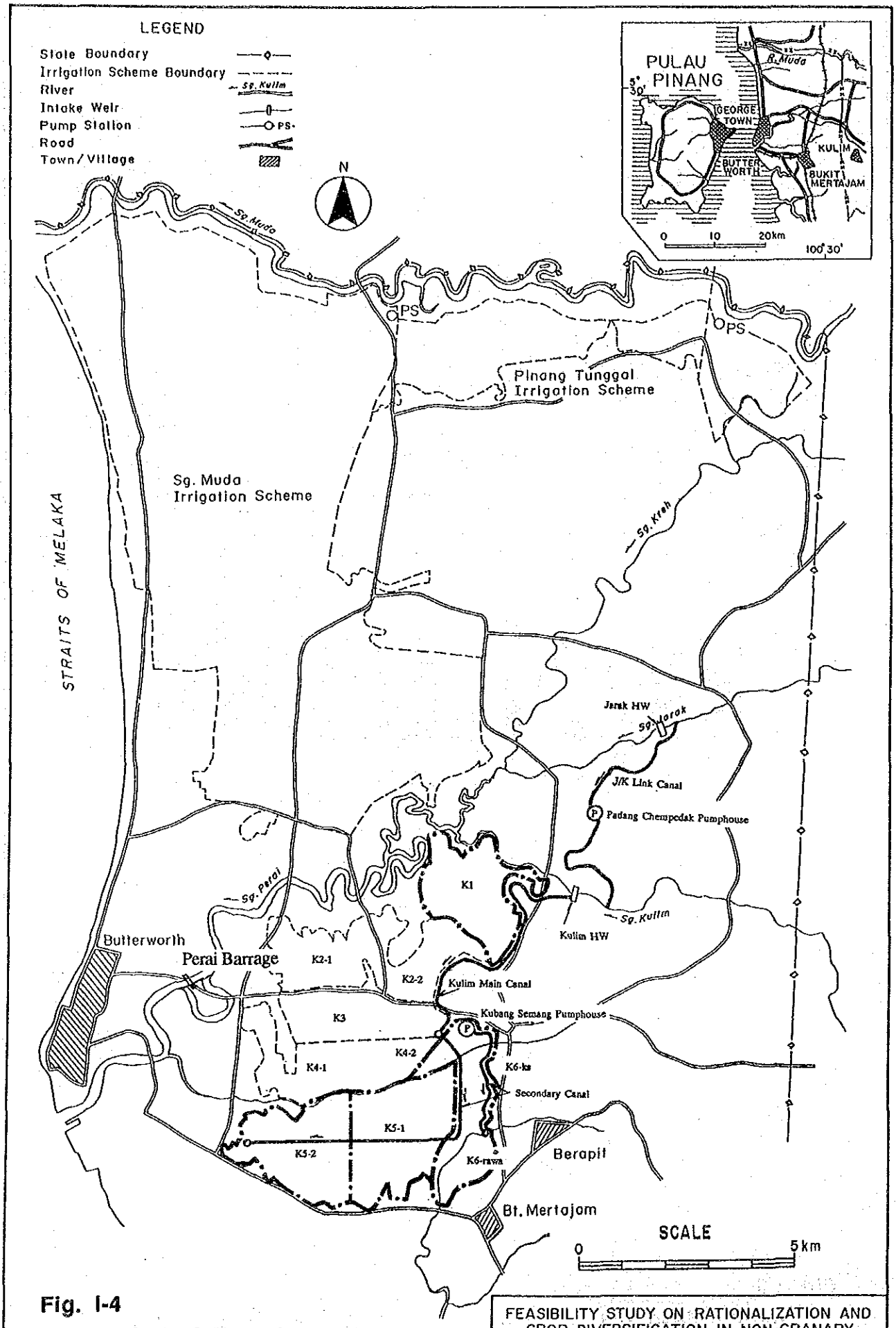

Fig. I-4

Location of Main Irrigation System

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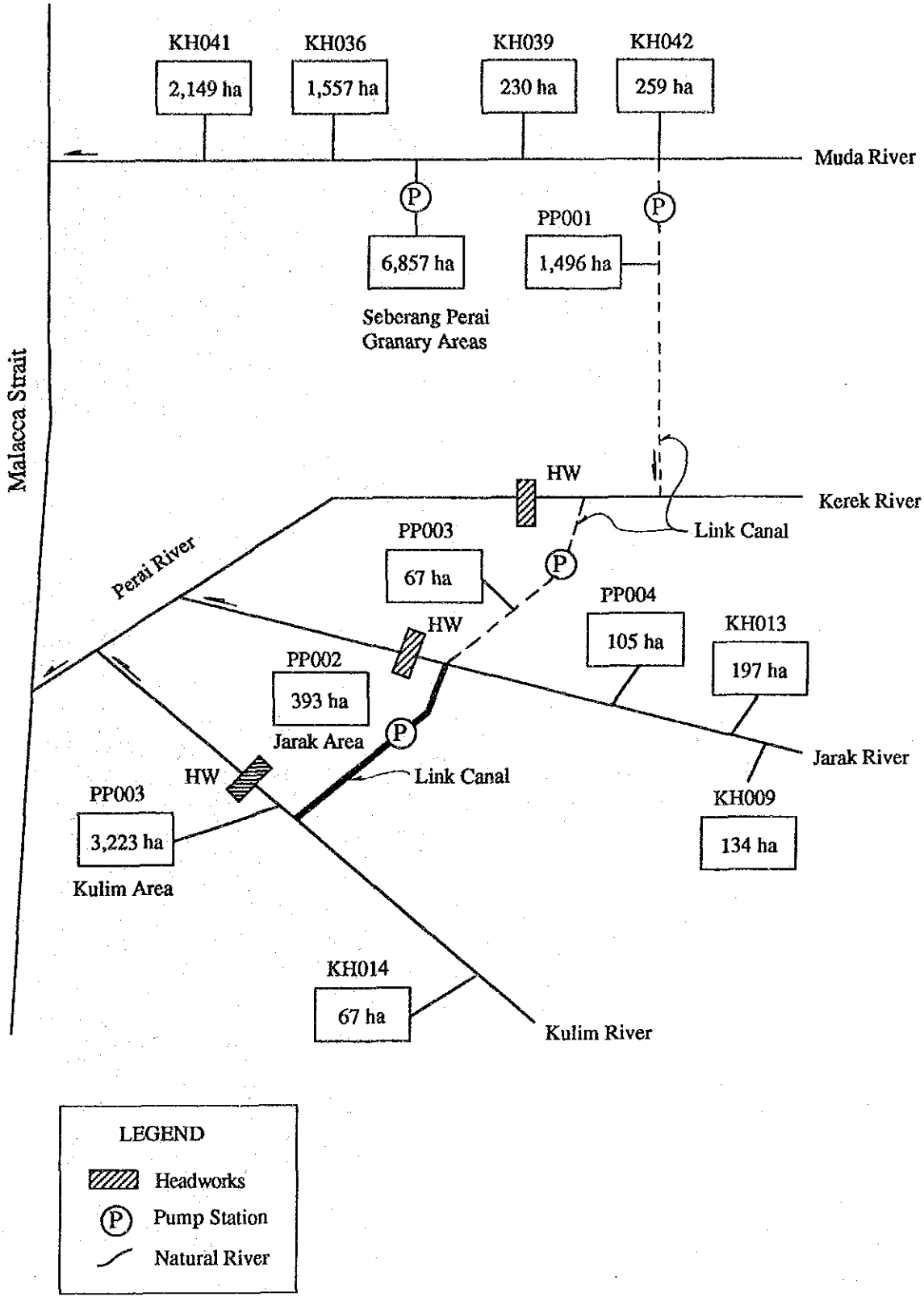

Fig. I-5

Schematic Layout of Irrigation Systems in the Muda and Perai River Basins

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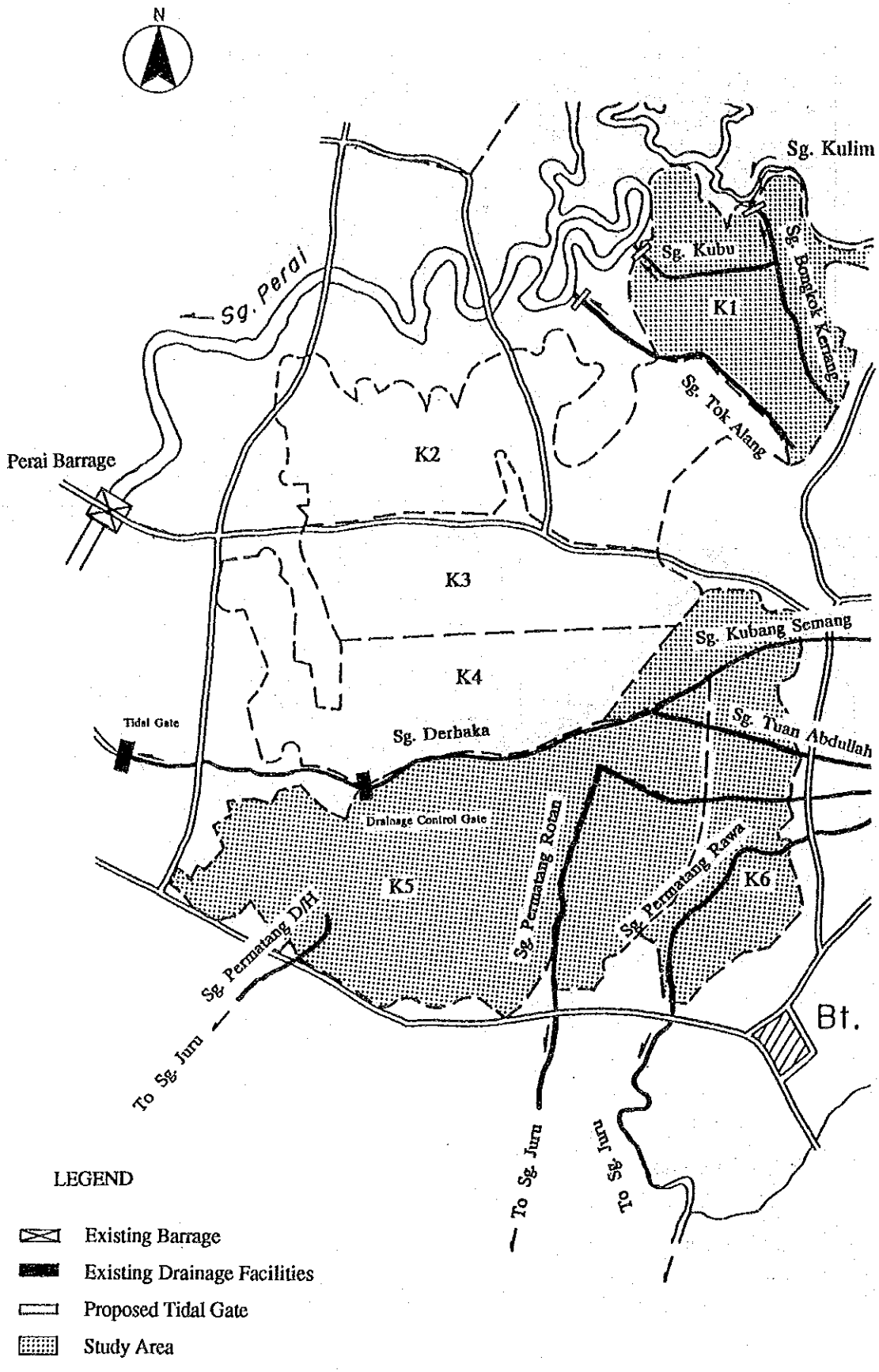

Fig. I-6

Drainage System in and around the Kulim Area

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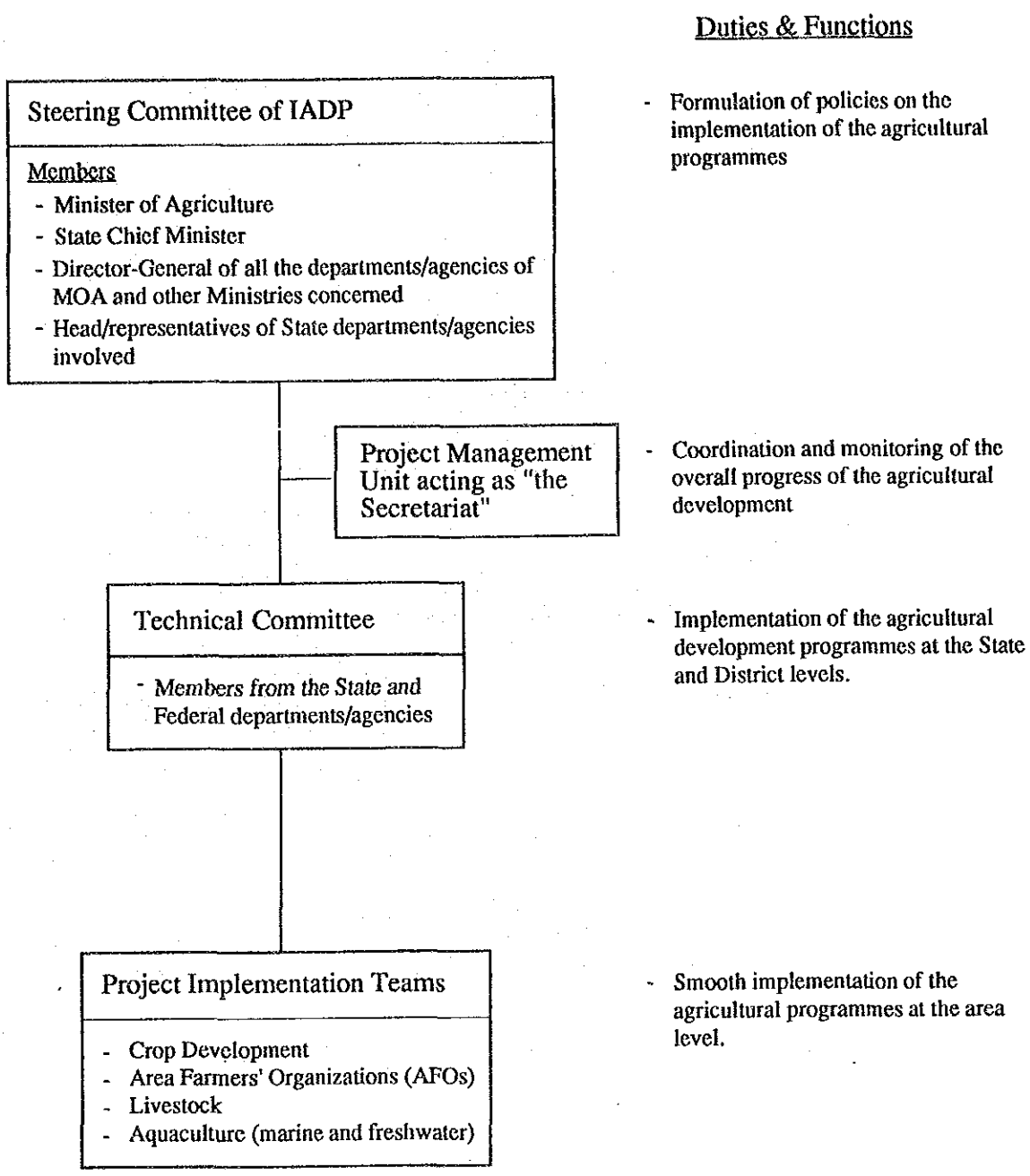

Source : Prepared based on Master Plan for Agricultural Development of the State of Pulau Pinang, Ministry of Agriculture, March, 1986.

Note : This figure was confirmed to be also applicable for the State of Negeri Sembilan.

Fig. I-7

Organization for Implementation of IADP in P. Pinang

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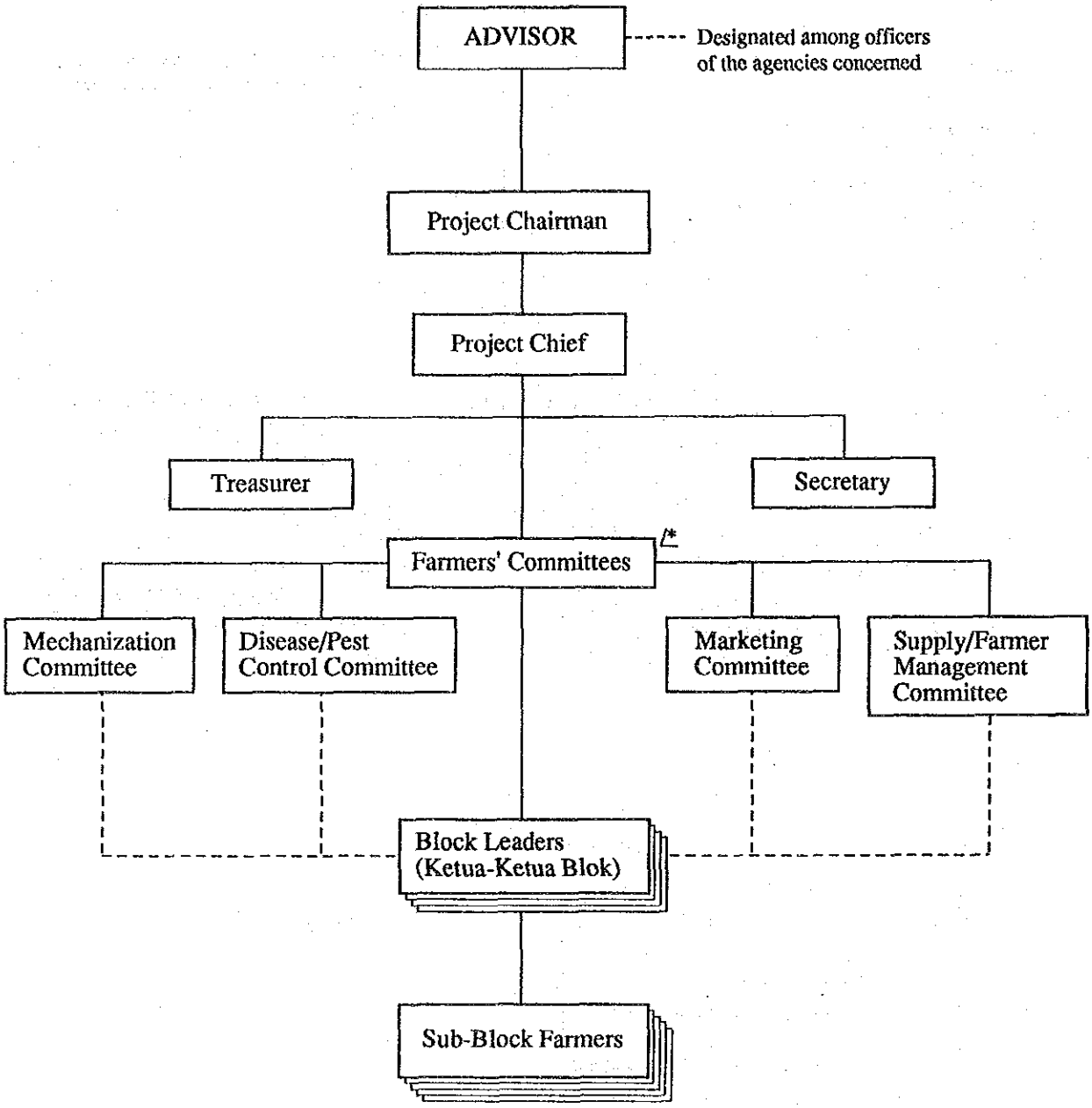
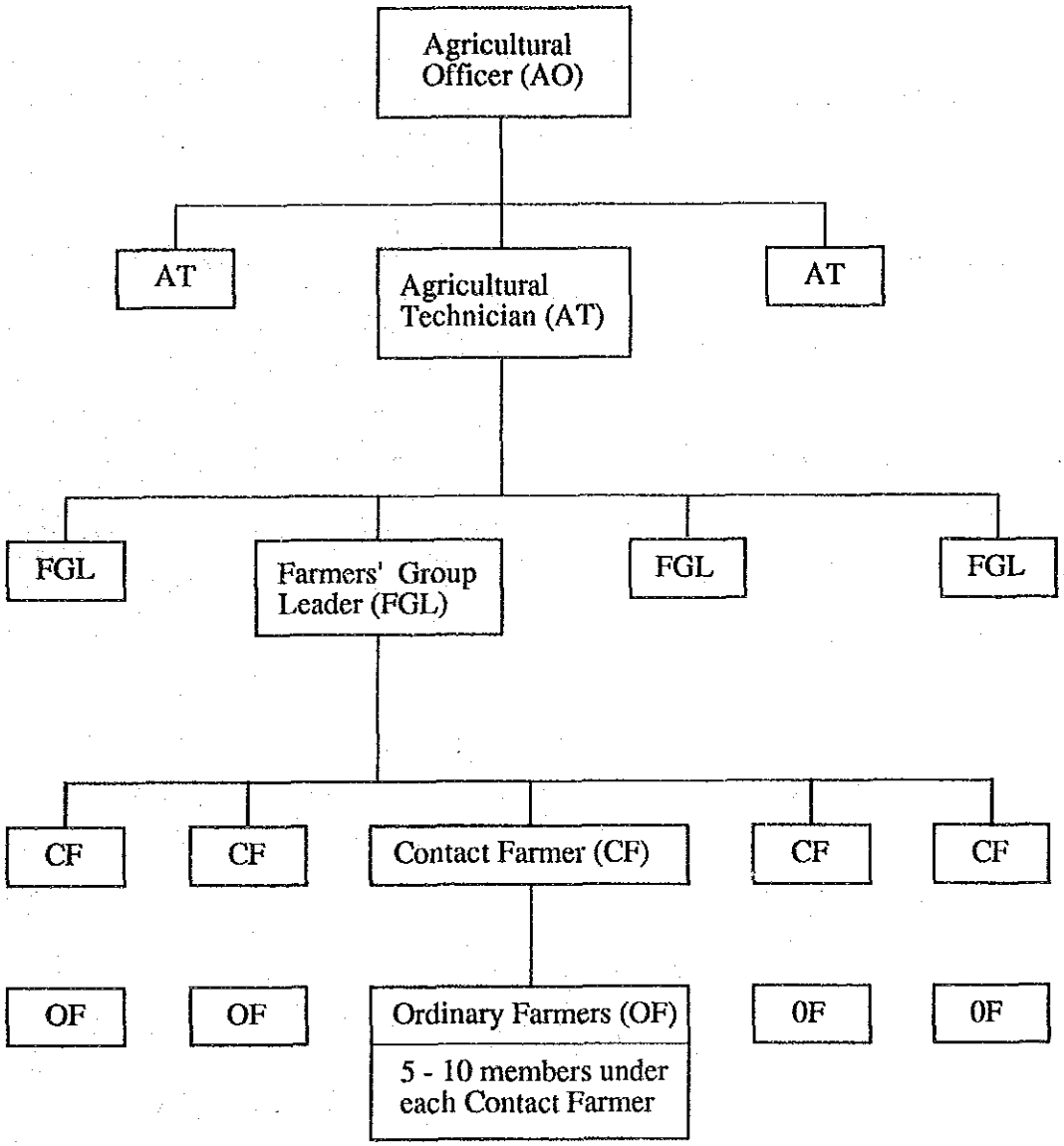


Source : DOA P. Pinang, Kelantan and N. Sembilan

Note : /* Functions and activities of the committees vary according to the conditions of farmers' groups in each area.

Fig. I-8

Organization to Manage Farmers' Group Assisted by DOA in the Projek Kelompok Area



Source: DOA

Fig. I-9

District Level Organization of Extension Services by DOA

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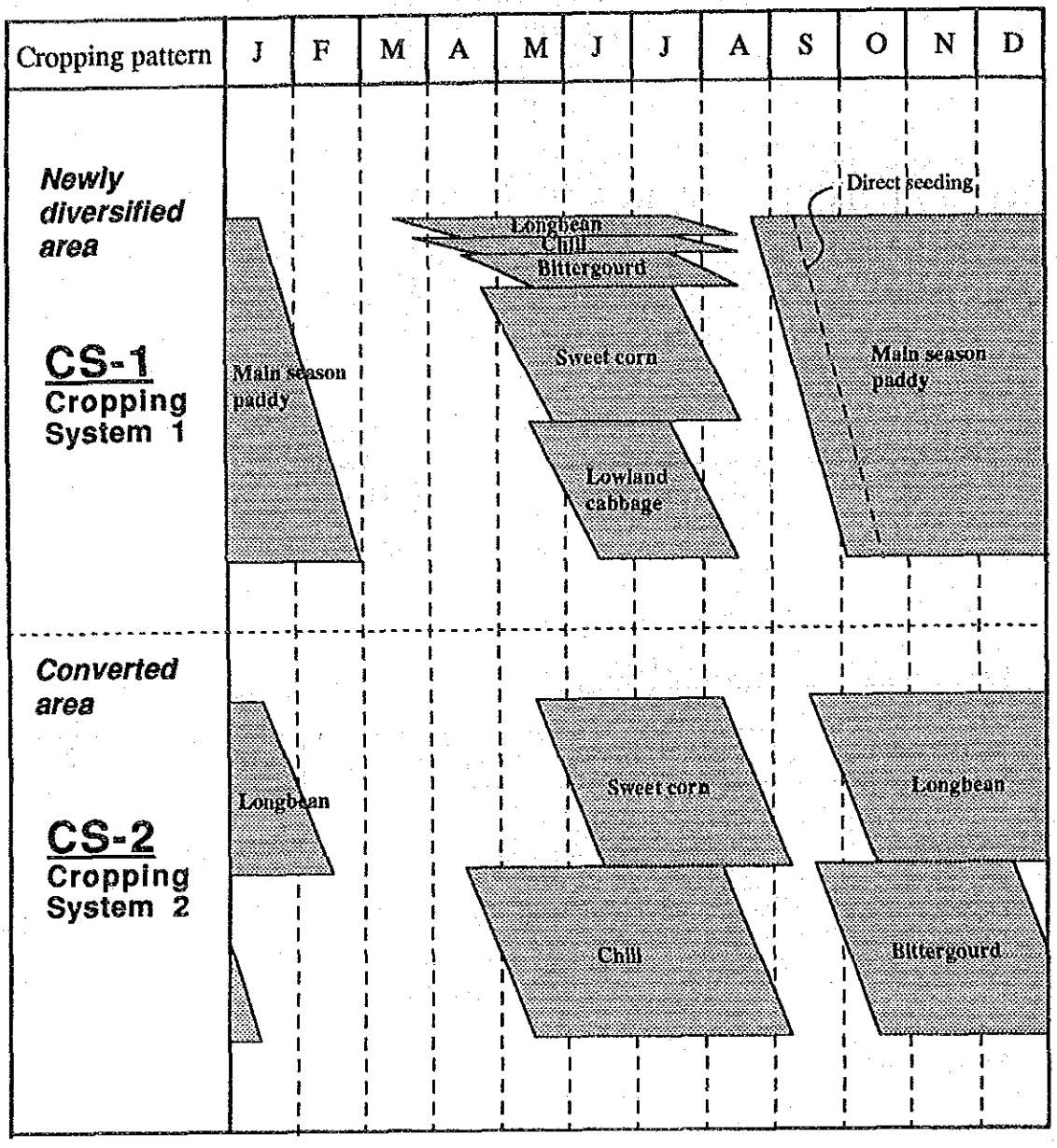

Cropping Pattern A

Fig. I-10

Proposed Cropping Calendar for Initial Stage for the Kulim Area

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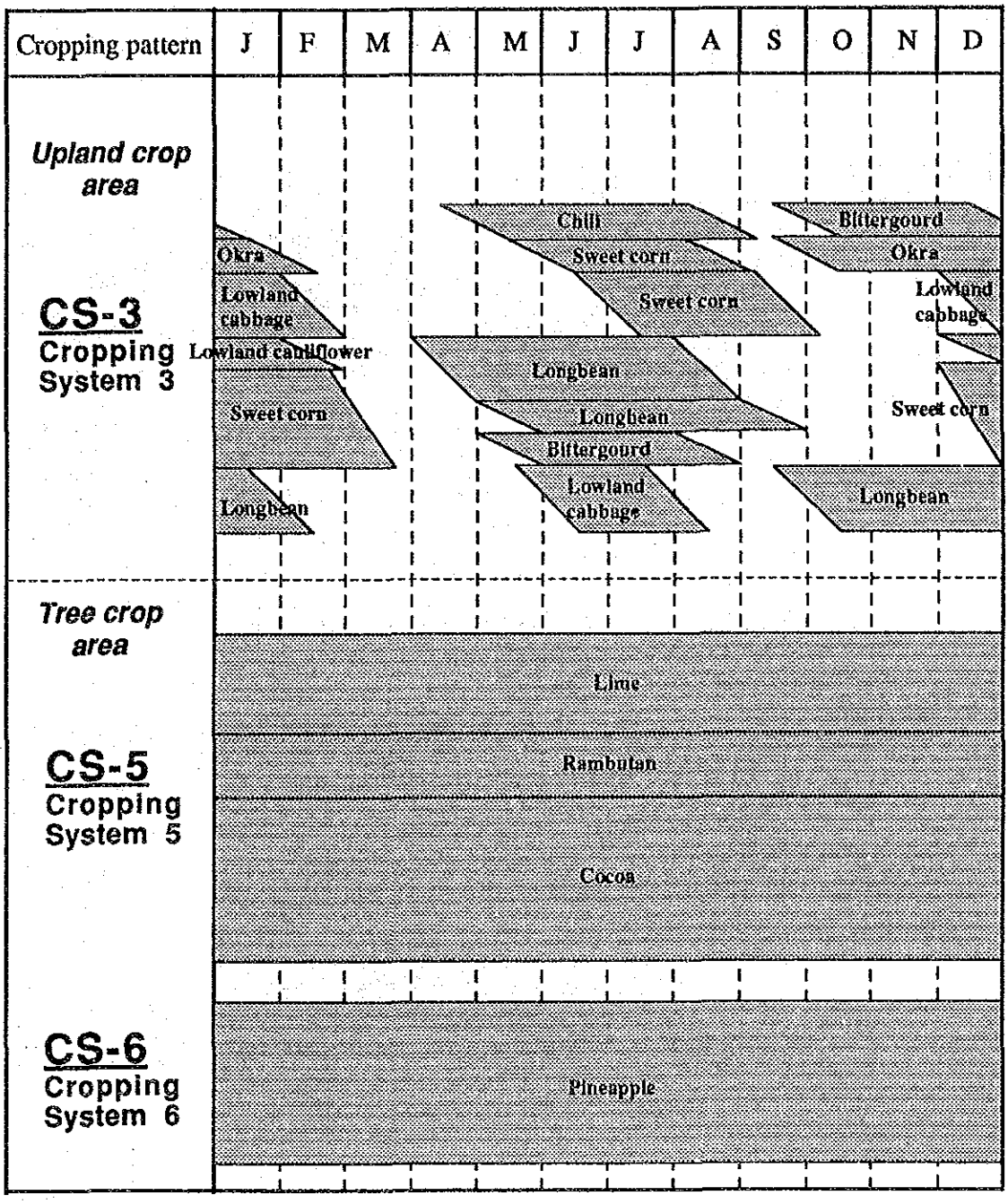

Cropping Pattern B

Fig. I-11

Proposed Cropping Calendar for Transition Stage for the Kulim Area

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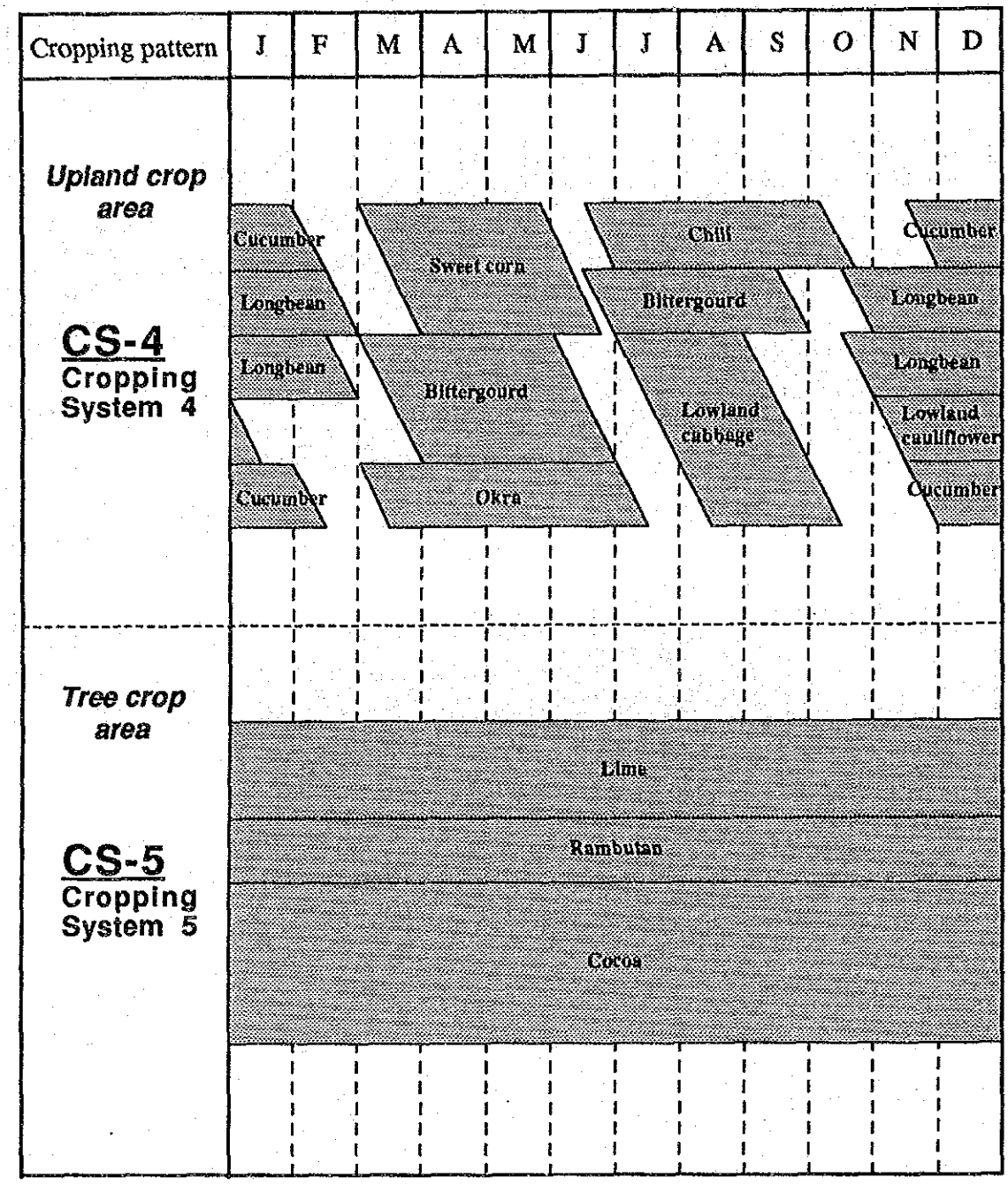

Cropping Pattern C

Fig. I-12

Proposed Cropping Calendar for Final Stage for the Kulim Area

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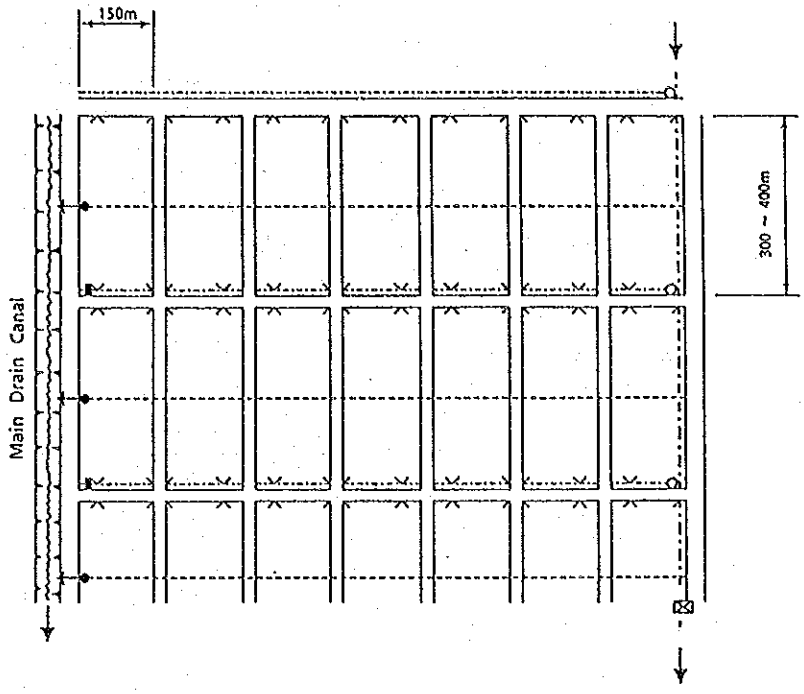
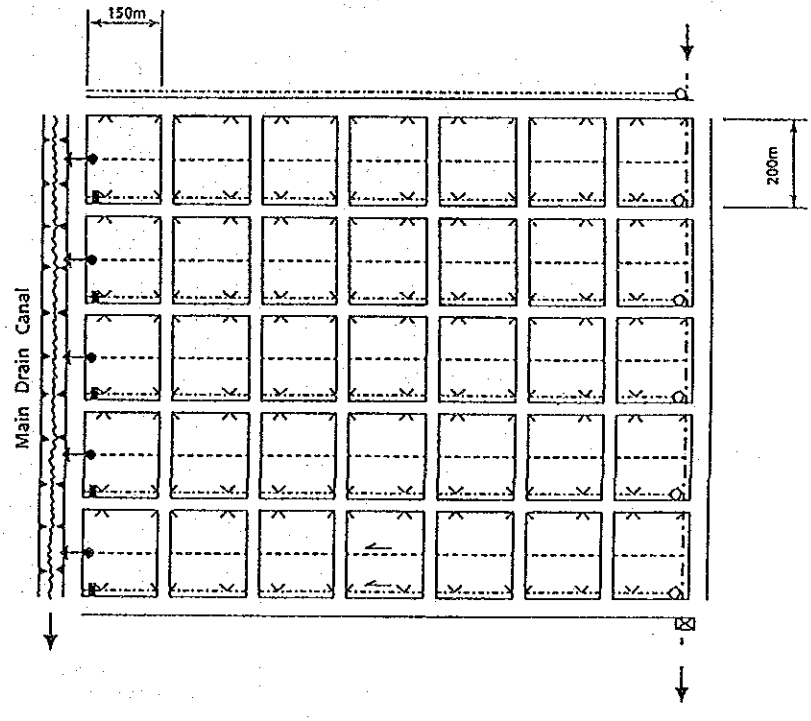
Paddy Cultivation



Upland Crops



LEGEND

	Farm road (4m)	⊠	Irrigation cum crossing control
	Farm road (3m)	o	C.H.O
- - - -	Secondary canal	⌄	Field offtakes
- - - -	Tertiary canal	▮	Irrigation end
------	Field drain	⟵●	Drainage end

Fig. I-13

Typical Layout of On-farm Development

FEASIBILITY STUDY ON RATIONALIZATION AND CROP DIVERSIFICATION IN NON-GRANARY IRRIGATED AREAS IN MALAYSIA

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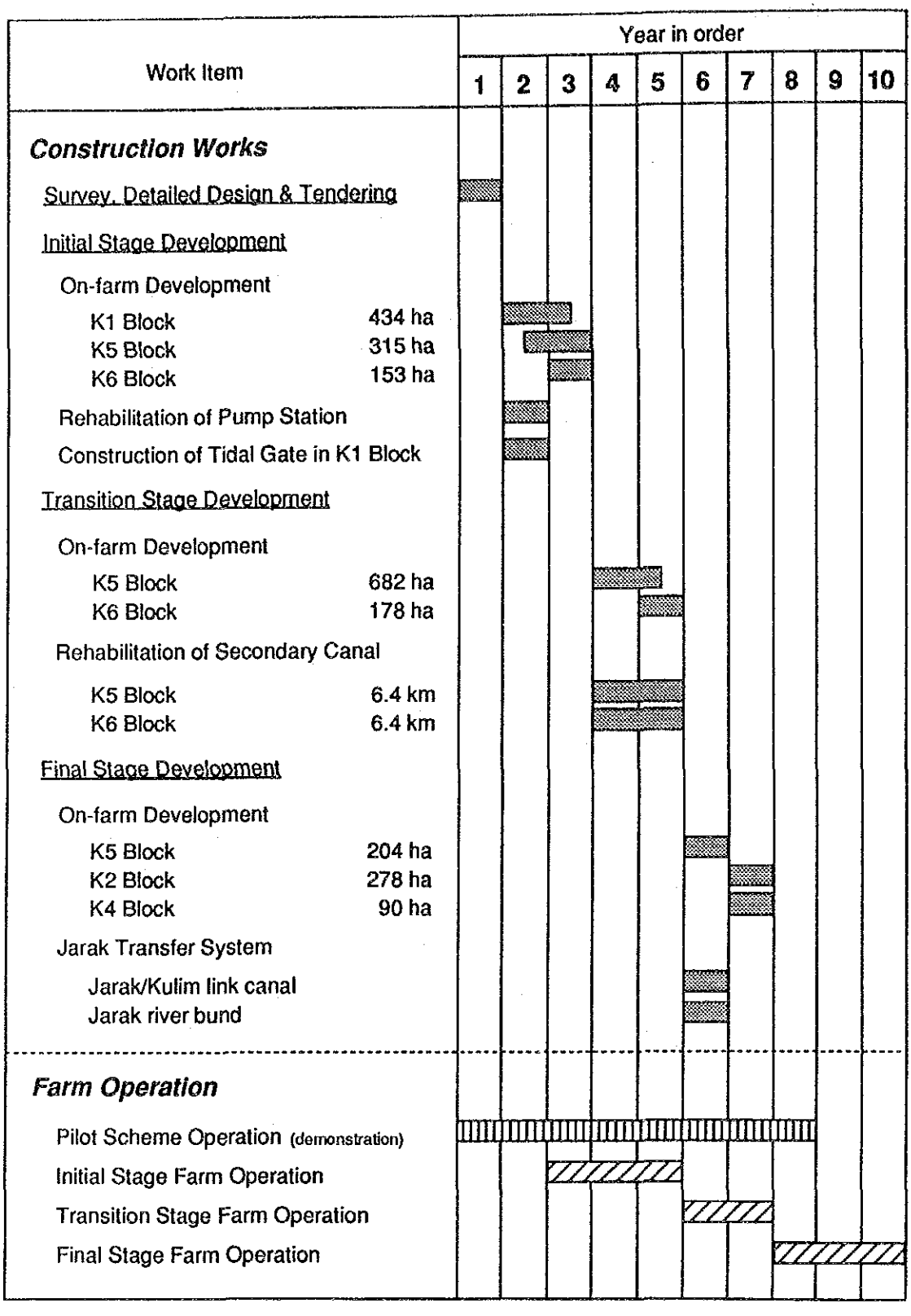

Fig. I-14

Implementation Schedule of Upgrading Works for Sungai Kulim I & II Schemes

FEASIBILITY STUDY ON RATIONALIZATION AND CROP DIVERSIFICATION IN NON-GRANARY IRRIGATED AREAS IN MALAYSIA

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Annex I-1

Detailed Sample Survey on Farmers' Intentions towards Crop Diversification Plan in Selected Schemes in Pulau Pinang

Feasibility Study on Rationalization and Crop Diversification in Non-granary Irrigated Areas in Malaysia

Volume 3

Annex I-1

Detailed Sample Survey on Farmers' Intentions towards Crop Diversification Plan in Selected Schemes in Pulau Pinang

CONTENTS

1. INTRODUCTION

The objective of the Detailed Sample Survey for the selected schemes in the State of Pulau Pinang is to collect benchmark data to be used for evaluating the socio-economic impact of crop diversification on the intended beneficiary households which presently grow paddy under irrigated condition.

The total sampling numbers were allocated according to the planted area and the number of farm households estimated on such assumption that the average farm holding size is 1.25 ha in each scheme as shown below. The target sampling rate is 25% of the estimated farm households. To carry out interviews to respondent farmers, the local Consultant, Frank Small & Associates, was appointed on the sub-contract basis.

Code No. Schemes	Irrigable Area (ha)	Planted Area (ha)	Estimated Nos. of Farm Households	Allocated No. of Sample Farmers
PP006 Sungai Kulim I	757	548	438	63
PP007 Sungai Kulim II	1,185	445	356	146
Total	1,942	993	794	209

2. SOCIO-ECONOMIC AND FARMING CONDITIONS

2.1 Household Characteristics

(1) Age distribution

Of the respondent farmers, 25% were over 55 years old throughout the two scheme areas as shown below. Compared with 42% at the State level, the farmers in the two scheme areas are much younger than those in the whole State. In the general trend that young people are going to leave agriculture for non-farming occupations, it is encouraging to find that 38% of the respondent farmers are no more than 45 years old in the selected scheme areas.

Unit: person (%)

Age Group	Scheme			State of P. Pinang*
	Sg. Kulim I	Sg. Kulim II	Total	
a. 18 - 25	4 (6)	4 (3)	8 (4)	0 (0)
b. 26 - 35	10 (16)	16 (11)	26 (13)	2 (2)
c. 36 - 45	19 (30)	28 (19)	47 (22)	13 (13)
d. 46 - 55	17 (27)	58 (40)	75 (36)	43 (43)
e. over 55	13 (21)	40 (27)	53 (25)	42 (42)
Total Respondents	63 (100)	146 (100)	209 (100)	100 (100)

*Remarks: *; Results of JICA Sample Survey 1989*

(2) Household size and working force

The mean household size is 5.9 persons in the two selected scheme areas and 3.6 persons are considered as working force aged 15 to 55 years old.

Number of Household Member

Unit: Household (%)

Number of Household Member	Scheme			State of P. Pinang*
	Sg. Kulim I	Sg. Kulim II	Total	
a. 1 - 2	2 (4)	7 (5)	9 (4)	6 (6)
b. 3 - 4	11 (18)	32 (22)	43 (21)	36 (36)
c. 5 - 6	28 (44)	53 (36)	81 (39)	26 (26)
d. 7 - 8	15 (24)	42 (29)	57 (27)	22 (22)
e. 9 - 10	6 (9)	10 (7)	16 (8)	7 (7)
f. >10	1 (1)	2 (1)	3 (1)	3 (3)
Total Respondents	63 (100)	146 (100)	209 (100)	100 (100)

*Remarks: *; Results of JICA Sample Survey 1989*

Number of Working Force

Unit: Household (%)

Number of Working Force	Scheme			State of P. Pinang*
	Sg. Kulim I	Sg. Kulim II	Total	
a. 1 - 2	18 (28)	45 (31)	60 (30)	25 (25)
b. 3 - 4	28 (44)	58 (39)	86 (42)	50 (50)
c. 5 - 6	14 (22)	35 (24)	49 (23)	23 (23)
d. 7 - 8	2 (4)	7 (5)	9 (4)	2 (2))
e. 9 - 10	1 (2)	1 (1)	2 (1)	0 (0)
Total Respondents	63 (100)	146 (100)	209 (100)	100 (100)

*Remarks: *; Results of JICA Sample Survey 1989*

In view of the relatively large household size and its important working force, the labour shortage is less acute in the selected scheme areas.

(3) Education level

Of the respondent farmers, 93% are educated, comprising 72% having finished education at primary school level and 21% having taken education at secondary and higher level as shown below. Only 7% of the respondents did not attend any school. The educational level in this area is in general better than that of the State where 16% reported no schooling.