5.3 Pulau Pinang Scheme

5.3.1 Area-wise Conditions in the Scheme

The Pulau Pinang Scheme has 9,832 ha of the net paddy area with five (5) sub-schemes. Out of five (5) sub-schemes, one sub-scheme of Sungai Burung (231 ha) is located in the Pinang Island and excluded from this Feasibility Study. The other four (4) sub-schemes namely, Sungai Muda, Pinang Tunggal, Sungai Kulim and Sungai Jarak, are situated at the north western part of the State of Pulau Pinang in the Peninsular. Those four (4) sub-schemes are comprised of the following Kawasan (block) :

- Sg. Muda Sub -scheme	:	Kawasan M1,M2,M3,M4,M5 and M6
- Pinang Tunggal Sub-scheme	:	Kawasan P1A, P1B and P2 (P1B is non-granary area)
- Sg. Kulim Sub-scheme	:	Kawasan K1A, K1B, K2A, K2B, K3, K4, K5 and K6 (K1A, K2A, K5 and K6 are non-granary area)
- Sg. Jarak Sub-scheme	:	Kawasan Pokok Tampang and Padang Menora

The area-wise present conditions for four (4) sub-schemes are summarized as shown in Table 5.3.1 "Area-Wise Conditions in Pulau Pinang Scheme". From this table, it is noted that the crop yield in Sungai Jarak Sub-scheme is lower comparing yields in other three(3) sub-schemes because of insufficient irrigation facilities.

5.3.2 Proposed Modernization Plan

(1) System Management

(a) Central Control Station

A central control station is proposed located at the DID Seberang Jaya Office. This will coordinate water management system that involves coordinating irrigation for the 4 schemes (Sg. Muda, Pinang Tunggal, Sg. Jarak and Sg. Kulim) and the inter-basin transfer via the Jarak Transfer Canal.

(b) Reorganizing O&M responsibility

The review of field staff positions and proposed reduction is based on assuming 80% reduction for gatekeeper and General Workers. Derived figures for Sg. Muda and Sg. Kulim Scheme are shown below.

(Estimated O&M Field Staff Reduction for Sg. Muda Scheme)

Scheme	Nos. (1997)	Total Cost (1997) (RM)	Proposed Nos.	Revised Cost (RM)	Annual Reduction (RM)	% Cost Reduction	Staff Cost Reduction (RM/ha)
SII	2	-	2	-	-	-	-
II	0	-	0	-	-	-	-
Irrigation Technician	5	-	5	-	-	-	-
Pump Operator	4	-	4	-	-	-	-
Sub-total	11	170,153	11	170,513	-	-	-
Gatekeeper	27	-	5	-	-	-	-
General Worker	18	340,936	4	68,187	-	-	-
Total	56	511,449	20	238,700	272,749	53	38

(Estimated O&M Field Staff Reduction for Sg. Kulim Scheme)

Scheme	Nos. (1997)	Total Cost (1997) (RM)	Proposed Nos.	Revised Cost (RM)	Annual Reduction (RM)	% Cost Reduction	Staff Cost Reduction (RM/ha)
SII	1	-	1	-	-	-	-
II	0	-	0	-	-	-	-
Irrigation Technician	3	-	3	-	-	-	-
Pump Operator	3	-	3	-	-	-	-
Sub-total	7	103,139	7	103,139	-	-	-
Gatekeeper	8	-	2	-	-	-	-
General Worker	20	200,846	4	40,169	-	-	-
Total	35	303,985	13	143,308	160,677	53	53

The impact on the overall O&M staff strength for IADP Pulau Pinang cannot be estimated directly due to incomplete data. Instead, adopting the average reduction rate of the Kerian and Besut Schemes, the impact on the O&M overall staff is summarized below.

IADP	Scheme	Present			After Staff Reduction		
		Total Staff	No/1000ha	Cost/ha '97	Total Staff	No/1000ha	Cost/ha '97
Pulau Pinang	Pulau Pinang	204	21	186	75	8	78

Using the above figure, the estimated staff strength reduction is 63%, staff cost reduction is 58% for IADP Pulau Pinang.

(c) Re-packaging O&M contracts and indents works

The estimated 1997 DID expenditure on irrigation O&M for IADP Pulau Pinang is RM 1.72 million/yr. Out of these about RM 1.2 million are undertaken by farmers through indent works. More than 300 indent jobs are administered by the DID staff every year. Recently, the DID awarded these works under a single contract for 2 years duration with the State Farmers' Organization. Thus administratively, the DID now manages one large contract instead of 300 small ones. This is an administrative relief for the DID.

(d) Water Users' Groups

IADP Pulau Pinang began its WUG program at the end of 1997. The planned targets are shown below:

Scheme	Total Target WUG	Planned 1997	Planned 1998	Balance
Sg. Muda	105	6	61	38
Sg. Kulim	10	3	7	0
P. Tunggal	7	0	2	5
Sg. Jarak	3	0	2	1
sub-total	125	9	72	44
Sg. Burung	3	0	1	2
Total	128	9	73	46

IADP Pulau Pinang also see this program as a strategy for farmers who opt not to join any Farmers' Group to be organize under the WUGs. As a member of a WUG, these farmers will indirectly be involved in the Farmers' Groups issues. The basic characteristics of the proposed WUGs in IADP Pulau Pinang is summarized below:

Scheme	Farmers (Nos.)	WUG (Nos.)	Area/WUG (ha)	Farmer/WUG (Nos.)
Sg. Muda	-	105	68	-
Sg. Kulim	-	10	117	-
P. Tunggal	-	7	117	-
Sg. Jarak	-	3	123	-
Total/Average	7,301	125	76	58

Formation of WUG requires intensive promotion by field officers. A special training program for WUG leaders should be developed. For on-site training, a two separate one-day sessions is proposed. For the WUG leaders, one 3-days training duration is proposed at National Water Management Training Centre. These training sessions should include promoting in-field infrastructure development program and land consolidation. The one-day on-site training program will be once during the off-season and once during the main season during the initial crop growth stage when farm activities are relatively low.

(2) Telemetry and Telecontrol System

Presently, there is no telemetry system for water management in this area. A telemetry system for flood warning is planned by DID Pinang. The test system of this plan comprises one central station and five rainfall/water level remote stations using telephone lines. It is now in operation. In and around the scheme, there are eight rainfall gauge stations and two water level gauge stations for flood warning but these gauges are not telemetered. For the scheme, there exist three headworks and four pumping stations, which are controlled locally. The following telemetry and telecontrol system is proposed for modernization of water management in Pulau Pinang area :

(a) Establishment of a central control station with the master equipment of telemetry system at DID Seberang Jaya Office

(b) Establishment of observation network : 4 rainfall remote stations and 53 water level remote stations, of which locations are shown in the next section (3) System Infrastructure.

(c) Establishment of communication system : 150 MHz radio link

(d) Establishment of computer system

(i) Irrigation Water Management System (IWMS)

- Computer program for estimating daily rainfall, discharge, irrigation water requirement, gate opening level, pump operation time, etc.
- Hardware and software necessary for IWMS
  - Hardware : CPU - MMX 200MHz
    RAM - 64MB
    Storage - 4GB (8GB)
    CD ROM - 16X
    Network Interface - Ethernet / 10BASE-T
  - OS : Window 95
  - Software : Microsoft Office 95 Professional Edition
    Visual Basic 5.0 Professional Edition
  - Printer : Network Color Printer IEEE802.3 10BASE-T
  - Network : Hub IEEE802.3 10BASE-T

(ii) Irrigation Monitoring and Feedback System (IMFS)

- Proposed IMFS network for the Kerian scheme

IADP/Office	Master (Nos.)	Player (Nos.)	Additional TV (Nos.)
PMU	-	-	1
DID Component	-	-	1
DOA Component	-	1	-
DID Central Control Station	1	1	1
DID Field Office	-	2	-
FDC	-	4	-
PPK	-	3	-
Total	1	11	3

- Hardware and software necessary for IWMS

Items	Master Station	Play Station
- Hardware	(Desktop)	(Notebook)
• CPU	MMX 200MHz	MMX 166MHz
• RAM	64MB	32MB
• Network interface	Ethernet / 10BASE-T	—
• Storage	4.0 GB	2.0 GB
• CD ROM(inner)	16X	8X
- OS	Window 95	Window 95
- Software		

• Scala Information	IC Master software	IC Player software
• Multimedia	Scala MM200	---
• Business Soft	Microsoft Office Pro.	Microsoft Office Pro.

(e) Establishment of gate/pump telecontrol system : locations of the existing gates and pumps to be motorized for remote control are shown in the following section (3) System Infrastructure.

(3) System Infrastructure

(a) Irrigation Facilities

Major subjects in the scheme are labour-saving for water management and farming and proper distribution of water sources such as Muda river, Kulim river and Jarak river for agriculture, industry and domestic supply. Provision of concrete lining and water management facilities are proposed as the measures. There are insufficient structures in Sungai Jarak sub-scheme which result in low yield. Additional structures such as regulating structures are provided to this sub-scheme. Rehabilitation and improvement plans for irrigation facilities in Pulau Pinang Scheme are summarized below and given in Table 5.3.2 "Rehabilitation and Improvement Plan of System Infrastructure".

(i) Concrete lining : Main canals 35 km, secondary canals 79 km including removal of sediment in the canals

(ii) Provision of regulating structures : 6 nos. on main canal , 12 nos. on secondary canal

(iii) Rehabilitation of damaged structures : Replacement of diversion gates 2 nos.

(b) Drainage Facilities

Condition of drainage facilities in the scheme is relatively well, however, following desilting works are planned in tertiary drains :

(i) Desilting of tertiary drains : 40 km

(c) Farm Roads

One of the major subjects in the scheme is improvement of farm roads, which makes large scale mechanized farming possible. Since the area in / around the scheme is well developed, the farm roads are utilized not only for farming but also for commerce and living transportation. Accordingly, farm roads along main canals are proposed to be paved by asphalt. Farm roads along tertiary canals, which have narrow width for mechanized farming, widening up to 2.5 m is planned. Improvement plans of farm roads in the scheme are shown below and the details are presented in Table 5.3.2.

(i) Pavement along main canal : Asphalt pavement 11 km
(ii) Widening along tertiary canals : 100 km

(d) Water Management Facilities

For effective use of water sources to agriculture, industry and living supply, it is essential to grasp required irrigation water immediately and to avoid excess water intake. For this purpose, central water management system is introduced providing control and monitoring points at intake and major diversion structures, and rainfall station at representative locations in the scheme. Those points are classified into key point, second point and third point. Since irrigation schedule is established in the sub-schemes individually, those points are planned in the respective sub-scheme.

(i) Key Control Point

- Sungai Muda sub-scheme is divided into six (6) blocks and irrigation schedule in the sub-scheme is set up in the respective blocks. Accordingly, five (5) key control points are proposed to regulate intake water at Bumbong Lima Pump Station and diversion water to the each block.
- In Pinang Tunggal sub-scheme, a key control point is provided to regulate intake water at Pinang Tunggal Pump Station because total irrigation area in the sub-scheme is rather small (less than 1,000 ha).
- Sungai Kulim sub-scheme is also established a key control point at Kulim Headworks in order to manage the whole area.
- Since command area of 388 ha in Sungai Jarak sub-scheme is quite small, water management in the sub-scheme is executed by monitoring point.

Water level gauges, remote control gates and remote control panels for pumps are installed at those points.

(ii) Second Control Points

- In Sungai Muda sub-scheme, three (3) second control points other than above key control points are provided at the diversion structures, of which mis-operation gives much affects to the proper water distribution in the sub-scheme.
- In Sungai Kulim sub-scheme, a second control point is established in order to regulate Block K3 and K4.

At those points, water level gauges and remote control gates are also provided.

(iii) Key Monitoring Points

- In Sungai Muda sub-scheme, two (2) key monitoring points are installed at downstream of diversion structures on main canal, where key control points are not planned. Those confirm whether discharge and water distribution on main canal are proper or not.
- In Pinang Tunggal sub-scheme, a key monitoring point are set up at the point diverted from TA. PB to TA. PS.
- In Sungai Kulim sub-scheme, a key monitoring point is provided at the lower reaches of the point which isn't being controlled in the key control point mentioned above.

- In Sungai Jarak sub-scheme, where key control points are not provided, four (4) key monitoring points are installed at Sungai Jarak and Sungai Kreh headworks and Padang Cempedak and Kreh pump stations.

  Water level gauges are equipped at the points to check canal discharge.

(iv) Second Monitoring Points
- Second monitoring points are proposed to be provided on secondary canals in Sungai Muda sub-scheme in taking consideration of its large scale command. Respective block in the sub-scheme mentioned above (i) is irrigated by three stages, so eight (8) second monitoring points are installed at the points to check water distribution for those blocks as well as at beginning of secondary canals covering about 500 ha command. Water level gauges are equipped at those points.

(v) Third Monitoring Points
- In Sungai Muda sub-scheme, eleven (11) third monitoring points are installed at the points diverting water from secondary canals to tertiary canals, which are not being controlled in the key and second points mentioned above.
- In Pinang Tunggal sub-scheme, a third monitoring point is provided at middle reaches of main canal TA. PS.
- In Sungai Kulim sub-scheme, a third monitoring point is installed at boundary point of block K2A and K2B on secondary canal, which covers block K2.

Table 5.3.3 "Required Works for Control and Monitoring Points" shows locations and required works for provision of those control and monitoring points.

(e) Rainfall Stations

Following four (4) rainfall stations are provided at the representative locations in the each sub-scheme in order to calculate daily water requirement and to execute proper water distribution through the control and monitoring points mentioned above. Existing station is utilized for Sungai Muda sub-scheme, however, the installment are to be replaced due to their superannuating.

- Station R 5503034 : for Sg. Muda sub-scheme
- P. Tunggal Pump Station : for Pinang Tunggal sub-scheme
- Padang Cempedak Pump Station : for Sungai Jarak sub-scheme
- Offtake point for TA. 2 : for Sungai Kulim sub-scheme

The control points, monitoring points and rainfall stations are to be connected with telemetry and telecontrol system for the central management as presented in Fig. 5.3.1 "Layout of Water Management / Monitoring Facilities".

(4) In-field Infrastructure

Physical improvement refers to on-farm infrastructure development comprising land leveling, in-field channels and control boxes. The table below summarizes the in-field infrastructure works for Pulau Pinang Scheme.

Scheme	Lots for improvement (nos.)	Area for land leveling (ha.)	In-field channel (km)	In-field control boxes (nos.)
Sg. Muda	10,129	6,564	985	2,626
P. Tunggal	1,123	697	105	279
Sg. Jarak	384	283	42	113
Sg. Kulim	1,284	1,053	158	421
Total	12,920	8,597	1,290	3,439

The land leveling will be based on the DOA's specification of zero grading at +/- 5 cm accuracy covering 100% of 10m x 10m grid points. It is estimated that 40% of the land leveling works will be by the DOA. The remaining 60% will be the private sector. The PPK will be encouraged to undertake these works. For in-field channels, the criteria is to achieve a density of 150m/ha. Two(2) control boxes are provided for one consolidated lot.

(5) Land Consolidation

The land consolidation targets for Besut scheme are shown below.

Scheme	Block	No. of Farmers (no.)	No. of Lots (no.)	No. of Consolidated Farms (no.)
Sg. Muda	M1	-	2,186	265
	M2	-	911	144
	M3	-	2,590	290
	M4	-	666	68
	M5	-	3,281	431
	M6	-	1,495	179
Sub-total		-	11,129	1,377
Sg. Kulim	K1b&k2a	-	467	93
	K3	-	553	92
	K4	-	407	92
Sub-total		-	1,427	277
P. Tunggal	P1A	-	337	39
	P2	-	911	149
Sub-total		-	1,248	188
Sg. Jarak	P.Tampang	-	193	34
	P.Merona	-	234	44
Sub-total		-	427	78
Total		7,301	14,231	1,920

Each consolidation aims for 5 ha farm plot. The challenge is obtaining the farmers' and lot owners' consent. Implementing this land consolidation program therefore would require a specially developed approach and by a team of trained specialists. The IADP PMU should lead this program with assistance from the DOA. The PPK should also be a member of this team.

(6) Agriculture

(a) Cropping Schedule

The present cropping schedule in the Pulau Pinang scheme is divided into 4 schedules, however the area where is put in schedule 4, is being distributed among the other 3 schedules. The revised cropping pattern is recommendable judging from the water balance and rainfall condition during the harvesting time. The first season crops is defined as off-season crop which lasts from March until September. The second season crop is called as main-season crop with a cultivation period between September and February. The areas to be adopted the revised schedule are summarized below.

(Unit: ha)

Schedule	Area
Schedule 1	3,312
Schedule 2	3,223
Schedule 3	3,066

(b) Planting method and Mechanization

The wet direct seeding method is common in Pulau Pinang scheme. The dry direct seeding method is done only in the small area in Sungai Muda. The wet direct seeding method is recommended in the Pulau Pinang scheme in both seasons. This wet direct seeding method is favorable for weed control. At present, the land preparation is normally done twice or 3 times before seeding. The first and second ploughing are done by the 4 wheels tractor on the contract basis. The utilization of 2 wheels tractor for land preparation is popular in the Pulau Pinang area. 2 wheels tractor is used for the last land preparation after first or second land preparation. The existing number of 4W tractor in the Pulau Pinang area is 43 which are owned by FMC and IADP Pulau Pinang. Additionally, the number of 4W tractors which are owned by private sector like contractors and farmers is estimated at about 80. It is estimated that 123 units can be used together.

After implementation of the project, full mechanized farming should be established in the Pulau Pinang scheme. It is estimated that 214 units of 4W tractors will be necessary at a peak period during the cropping season. The farm mechanization will be partially supported by the private sector (contractors) in future. Assuming that the existing number of 4W tractors be kept in the future, the farmers' groups will own 91 units of tractors for the difference in number between peak requirement and availability. The farmers' groups will also own some necessary managing implements for fertilizing and chemical application. The managing implements include light weight 4W tractor (10-20 hp class) for management and implements (attachments) such as broad caster, power blower, boom sprayer carpet duster, etc. Harvesting work is being conducted on the contract basis and will also be done by the contract work with combine harvesters owned by contractors and FMC in future. The farmers' groups will own chopper spreader attached on the outlet of the combine harvester considering working efficiency of land preparation. The chopper spreader is used commonly for chopping and spreading the residue.

The proposed mechanization farming system by integrated work is shown below.

(Unit: Nos.)

Machinery/equipment	Necessary	Availability	Purchase
I. 4W tractor			
1. 60hp class	214	123*	91
2. Management tractor (10-20hp class)	91		91
II. Implements			
Lime spreader	4		4
Rotavator	153	62	91
Paddy harrow	57		57
Rearbucket or Land roller			
Granule applicator/Broadcaster	78		78
Boom sprayer	26		26
Carpet duster	26		26
III. Combine harvester (6t class)	43	43	
chopper spreader	43		43

*: 33 by FMC Pulau Pinang, 10 by DOA, 80 by contractors (including farmer), source: Farm machinery services for farmers

The proposed mechanization farming system by integrated work is as shown below.

Mechanization system for Wet seeding

Two times of Land preparation (tractor + rotavator) => Paddling (tractor + paddy harrow) => Seeding (tractor + power blower/granule applicator or broadcaster) => Fertilizing and chemical application (tractor + granule applicator/carpet duster/boom sprayer) => Harvesting (combine harvester)

Under the Wet direct seeding system, land preparation should be done two times and paddling should be done one time after land preparation. These operations are effective in weeds control and land leveling. The 4W tractor for management will ran on the fixed way (trainline) which is set up in the paddy field in 10m or 15m interval.

(c) Paddy varieties and management practices

(i) Paddy varieties

MR84 and MR185 should be introduced as recommendable varieties. According to the result of the field test done by MADA, the most suitable number of paddy plants is estimated at 150-180 number per square meter. The seeding amount of paddy is decided between 60 - 80 kg/ha on the presumption that one thousand grain weight is 26g and the average germination rate is 60-65% based on the data of MADA experiments.

(ii) Fertilizer application

Most of farmers in the Pulau Pinang area depend on the subsidized fertilizer of about 80kg/ha only. The significant of scheduled fertilizing activities should be stressed onto the farmers. The fertilizer application method according to the MARDI recommendation should be adopted in the Pulau Pinang scheme. The

paddy cultivation management package recommended by MARDI and DOA is considered. The proposed fertilizer amount and apply timing are as follows:

- Amount and rate of fertilizer : N:P (P_2O_5):K (K_2O)= 100:40:30 (kg/ha)
  N : 1st; 1/4, 2nd; 1/4 and 3rd; 1/2 on 15 - 21 day after sowing (HST), 45 - 50 HST and panicle initiation stage respectively
  P : 15 - 21 HST together with N
  K : 15 - 21 HST together with N

A detailed soil investigation survey has not been done in the Pulau Pinang scheme. According to the "Reconnaissance Soil Survey of Pinang and Province Wellesley", the majority of soils in Pulau Pinang scheme are classified as class I or II of soil suitability class for agriculture as shown Table 5.3.4 "Soil Classification and Suitability for Paddy". In general, it can be said that the Pulau Pinang scheme has the potential to support good plant growth with good yields. However, some cases of copper deficiency are reported. The apply of minor elements dressing should also be considered. The area-wise optimum rate and amount of fertilizer will be obtained through the practice of DRIS.

(d) Pest Management

As for the weed control, two times of herbicide application for wet direct seeding is recommended. Regarding the decease, the damage of Tungro virus sometimes occurred in the past. This decease is carried by Green Hopper. It is important to pay attention to the occurrence of this harmful insect. Chemical application to control the weed, pest and decease should be carefully done with special attention to the environmental aspect. For the pest and weed control, proper measure should be made in line with DOA recommendations. IPM (Integrated Pest Management) method should be accelerated in the Pulau Pinang scheme.

The proposed farming practice for Pulau Pinang is shown in Table 5.3.5 "Proposed Farming Practices".

(e) Marketing

Since labor shift to non-agriculture sector is significant in the Pulau Pinang area, it is important and urgent to reduce the burden of farming work from the individual farmers by promoting group work. For this purpose, PPK should be utilized as a coordinator between farmers' groups and relating agencies. The role of PPK, in this context, is to arrange contractor, farm input and sale destination according to the request from farmers' groups. In this system, what the farmers' groups have to do is just to request the arrangement to PPK. In addition, it is preferable for the farmers' groups to shift to bulk purchase and sale through PPK or mini estate in an early stage.

(f) Rural Credit

The credit needs to be expected in future would be (i) loan for establishment of farmers' group, (ii) loan for purchase of farm input, and (ii) loan for procurement of agricultural machinery. Short term loan and paddy loan presently provided by PPK and BPM will be intensified by applying to farmers' group in addition to individual farmers. As to the procurement of agricultural machinery, it is estimated that RM18.1 million will be necessary. BPM or PPK should prepare to have enough fund to cover this amount. Besides, it is necessary to prepare a loan scheme which supports the upgrading of farming system into mini estate.

(7) Farmers' Organization

(a) Present Situation

Based on the currently available data. About 5,807 farmers out of the total of 17,906 (32%) are involved in group-based farming as against 12,099 assumed to be still farming on individual basis. Out of the 5,807 farmers, 922 (17%) are involved in paddy farming under the supervision of PPK while the rest (4,885) are under ladang kelompok of DOA. There are only 2 mini-estates managed by PPK in the Pulau Pinang IADP area. One is the Bukit Merah mini-estate and the other is Kg Kuu/Kg Paya mini-estate involving 32 participating farmers and 112 hectares. Great strides have been made by both DOA and PPK in organising the farmers in Pulau Pinang IADP area since 1970s. While acknowledging the different approaches to agricultural and rural development adopted by both DOA and PPK leading to the current state of affairs and due to lack of data, it has been observed that the formation of these ladang kelompok, and mini-estates has not been based wholly on irrigation systems boundaries but rather on kampung and mukim boundaries.

The Study Team however has observed that serious attention has been given by both DOA and PPK in efforts to improve farm productivity. In this context, various attempts have been made on laser-guided land leveling (DOA), experimentation on joint-venture approach to paddy farming (initiated by MARDI and later handed over to PPK) and on-farm water management improvement through water user group approach that is being currently pursued by Pulau Pinang IADP.

(b) Proposed Modernization Plan

Given the rather well-planned irrigation systems layout in the IADP scheme, and the agencies' long years of practical exposure to and experience with development dynamics in the scheme, it is felt that the proposed modernisation of irrigation water management systems can be implemented rather smoothly in this area. however further attention needs to be given to the following :

(i) Adjusting and re-organising the boundaries of those ladang kelompok (under both DOA and PPK) and of mini-estates (under PPK) that do not fall within the irrigation systems boundaries in order to streamline the arrangements as to expedite the formation of efficient organic production units. This is essential in

view of the need to create the basis for the formation of water user groups that are dependent on common water sources (along the line of Kubang Depu model while acknowledging local differences). This calls for intensive social engineering works and in this respect the proposed Inter-granary Task Force is imperative and useful. Members of this Task Force can be deployed from such agencies as MADA,KETARA, KADA, and the National Water Management Training Centre (NWMTC).

(ii) Streamlining the organisational arrangements with regard to the operation of ladang kelompok of both DOA and PPK so as to (1) ensure legality factor, which is one of the key elements that could determine sustainability of economic ventures, (2) enable fair distribution of economic opportunities to the target group i.e. the farmers. These two factors are highlighted based on two respective observations. One is the substantial amount of funds accumulated by members of ladang kelompok in Permatang Tuan Samat which is under the supervision of DOA, which calls for legal coverage in terms of financial rules and procedure , and the other is the desire of members of this ladang kelompok to participate in O&M contract works of DID. These contract works have been awarded by DID to Farmers Organization which then distributed the works to eight PPKs in the IADP Pulau Pinang scheme. Knowing of these kinds of opportunities, the members of DOA-supervised ladang kelompok expressed their desire to participate directly rather than through PPK. It was perceived that a possible reason why DID awarded such works directly to PPK was due to the fact that PPK is equipped with legality framework and this fulfilled financial procedures of the government. This seemingly conflicting situation has to be avoided in view of the need to develop efficient and functional organic production units to achieve higher production output.

(iii) Incorporating the roles of combine harvesters' owners or their representatives in relevant decision making process, notably through the Planting Schedule Committee. This approach is proposed in view of the criticality of the roles of combine harvesters in paddy farming activities. Representation from the private sector is needed as PPK-owned harvesters are very limited in number and that PPK serves only 30% of the machinery service.

(iv) Strengthening the roles and capability of farmers' groups (under the supervision of both the DOA and the PPK) in water management through the proposed water user group (WUG) or Kumpulan Pengurusan Air (KPA). This exercise has to be undertaken based on the Guideline On Formation Of Water User Group currently being prepared by the government.

5.3.3 Cost Estimate

(1) Basic Conditions and Assumptions for the Cost Estimates

Unit Prices of the respective works of Pulau Pinang Scheme are estimated based on the contract prices of similar works taken from Muda Irrigation Project in Pulau Pinang as well as the Government Price Schedule issued in 1993. Consumer Price Index issued by the Central Bank of Malaysia and Statistics Department was used for updating prices to October 1997 level. As for construction of major canal structures, it made efforts to obtain the latest information from the site office. Reference data for the cost estimates are as follows:

(i) Muda Irrigation Project, Block M1A, 1996, Pulau Pinang
(ii) Standard Price for Construction Works, 1992/1993, DID

(2) Construction Cost

Initial investment costs for the scheme, which is divided into the works for system infrastructure, in-field infrastructure and water management / monitoring facilities, comprise direct construction cost, physical contingency (15% of direct construction cost), engineering cost (10% of direct construction cost), administration and management cost (5% of direct construction cost). Those are summarized below and shown in Table 5.3.6 to Table 5.3.9 "Direct Construction Cost". The details are given in Annex VII "Cost Estimate".

(Unit : RM)

Item	Direct cost	Contingency,engineering administration cost	Total
System infrastructure	26,034,700	7,810,400	33,845,100
In-field infrastructure	3,320,800	996,200	4,317,000
Water management	7,929,900	2,379,300	10,309,200
Total	37,285,400	11,185,900	48,471,300

(3) Replacement Cost and O & M Cost

Replacement cost of infrastructures is estimated at 20% of initial construction cost every 20 years. While, for replacement cost of water management / monitoring system, initial equipment cost is applied every 10 years. O&M costs, which are expected to occur every year, are estimated at RM 299 /ha/year in Sungai Muda sub-scheme, RM 425 /ha/year in Pinang Tunggal sub-scheme, RM 380 /ha/year in Sungai Jarak sub-scheme and RM 525 /ha/year in Sungai Kulim sub-scheme. Moreover, RM 250,000 /year is applied to management cost for the water management system. The replacement and O & M costs for the scheme is summarized as follows:

(Unit : 1,000 RM)

Item	Cost
Replacement cost	
- Infrastructure (every 20 years)	7,632
- Water management/monitoring (every 10 years)	7,930
O & M cost (annual)	3,584

(4) Training Cost for Water Users' Group

Training for 125 water users' groups, which are to be formatted in this works, will be planned at both off-site (National Water Management Training Center) and on-sites. The former is executed for three years with participation of 2 leaders from each group. The latter is carried out on all members of groups for five years. The costs are estimated at RM 373,010 consisting of RM 300,000 for off-site training and RM 73,010 for on-site training. The details are given in Table 5.3.10 "Training Cost for Water Users' Group".

5.3.4 Implementation Schedule

(1) General

The works for modernization of water management system in the scheme such as improvement of system infrastructure and in-field infrastructure and establishment of water management / monitoring system will be commenced from 1999 and completed in 2006, in taking into consideration of the accomplishment of the target of the National Agricultural Policy. Training of water users' group, which will be put the management of tertiary system, will be carried out in parallel with the above works.

(2) Implementation Plan for Rehabilitation and Improvement of System Infrastructure

A degree of execution priority of rehabilitation and improvement of system infrastructure in the scheme is put in order of (i) irrigation facilities, (ii) drainage facilities, (iii) farm road and (iv) water management facilities. However, taking into consideration that improvement of in-field infrastructures shall be executed based on the establishment of major system infrastructures, execution of the above improvement works has arrangement in a row and it is started in 1999. Periods of respective work are set in 4 years for irrigation improvement, 1 year for drainage facilities and 2 years for farm road improvement. The executing agency of the works is DID.

(3) Implementation Plan for Improvement of In-field Infrastructure

Improvement works of in-field infrastructures will be executed in parallel with those for system infrastructure and will be completed in 2006. Among 8,597 ha of required land leveling area, 3,439 ha will be executed by DOA and the remaining 5,158 ha will be carried out by private sectors managed by PPK. Construction works of in-field channels and control boxes will be executed by DOA with the target of 161 km/year and 430 nos./year, respectively. Land consolidation will be implemented by close cooperation among DOA, IADP PMU and LPP/PPK. Annual target of consolidated farmhouse is 236 houses/year.

(4) Implementation Plan for Establishment of Water Management / Monitoring Facilities

Implementation for the establishment of water management/monitoring facilities is scheduled in 3 years with the execution order of (i) Establishment of communication links, rainfall station, water level gauges and computer system, (ii) Introducing electric moving gates for telecontrol and establishment of monitoring system for telecontrol gates and pumps, (iii) Establishment of remote control system for telecontrol gates and pumps. Installation of water

level gauges and control gates shall be executed in parallel with the improvement works of system infrastructures mentioned above (2). Monitoring feedback system will be introduced in 4 years, in order of the master station and player stations. The works are carried out by DID with referring to on-going Besut Pilot Project.

(5) Implementation Plan for Formation of Water Users' Group and Training

The work will be carried out in 5 years from 1999. 125 water users' groups will be formatted in Pulau Pinang Scheme and annual target of group formation is estimated at 25 group/year. As for the training of the water users' group, off-site training at National Water Management Center in 3 years and on-site training in 5 years are planned. 250 persons consisting of 2 leaders from each group joint off-site training and all group members participate off-site training. Number of participants in a session is planned to be about 40 persons. Off-site training will be executed at seven groups while on-site training will be carried out at 100 sessions/year. Off-site training is managed by DID and on-site training is executed by IADP PMU.

The implementation schedule of the works for modernization of water management system in Pulau Pinang Scheme is presented in Fig. 5.3.2 "Implementation Schedule" and its disbursement schedule is given in Table 5.3.11 "Disbursement Schedule".

5.3.5 Project Evaluation

(1) General

The project evaluation is made from economic and financial viewpoints in order to assess the feasibility of the project in Kerian scheme. Economic evaluation is made by using Economic Internal Rate of Return (EIRR), Benefit-Cost Ratio (B/C) and Net Present Value (NPV). In addition, sensitivity analysis is made for the cases of (i) increase of construction cost, (ii) decrease of benefit by applying EIRR. For the financial aspect, farm budget of typical farm size is prepared and analyzed. In addition, repayment capacity of farmers is also examined for the procurement of agricultural machinery (Annex VIII "Project Evaluation").

(2) Economic Evaluation

(a) Basic Condition

Economic evaluation is carried out based on the following conditions.

(i) The economic useful life of the project is 50 years from the start of the Project.
(ii) All prices are expressed in 1997 constant price (end of 1997).
(iii) The exchange rate is fixed at US$1.0=RM4.4=Yen129.5 as of January, 1998.
(iv) The economic price of local currency portions is calculated by applying the Standard Conversion Factor (0.987).
(v) Economic price or cost is calculated by omitting transfer payments such as tax, subsidy and interest.

(vi) Economic prices of farm input (Urea, TSP, Potash) and tradable farm produce (paddy) are estimated based on the World Bank projection of world market prices for 2005 in constant 1997 terms.

(vii) The part of unskilled labor is converted to the economic value by applying the conversion factor of 0.987 with considering labor scarcity in Malaysia.

(viii) The construction components are converted to economic value applying Construction Conversion Factors which are calculated on the basis of proportions of local and foreign costs, transfer payments and other local costs at the local portion.

(ix) The build-up period from the completion of land consolidation and construction of facilities is assumed to be five years. The benefit is assumed to increase year by year and reach its full value in the 12th year after the commencement of the project.

(b) Economic Cost

The economic cost of the project is calculated based on the basic conditions mentioned above and by applying Construction Conversion Factors to the financial cost.

(Unit : 1,000RM)

Items	Financial	Economic
I.System Infrastructure	33,846	32,368
II.In-field Structure	4,317	4,075
III. Water Management / Monitoring System		
1. Telemetry & Telecontrol	9,387	9,211
2. Feedback System	920	903
IV. Training for WUG	373	349

Economic cost of O&M cost and replacement cost are summarized in the table below.

(Unit : 1,000RM)

Items	Financial	Economic	Remarks
1. O & M Cost	3,584	3,537	Annual
2. Replacement Cost			
- System Infrastructure	6,412	6,132	Every 20 years
- In-field structure	863	815	Every 20 years
- Water management system	7,221	7,086	Every 10 years
- Feedback system	708	694	Every 10 years

(c) Economic Benefit

Economic price of tradable goods is estimated based on the World Bank projection of world market prices. For non-tradable goods, present market price is applied as economic price. Value of unskilled labor is calculated by applying the Standard Conversion Factor with considering the labor scarcity in Malaysia. The expected benefit from the project are increase of paddy production owing to improved farming practice and water management and reduction of labor input owing to farm mechanization. These benefits are assumed to be reflected in the increase of yield, increase of cropping intensity and reduction of labor cost. The project benefit is defined as the difference of the net production value between "with-project case" and "without-

project case". For the "without-project case", it is assumed that present condition will continue through the project life of 50 years and there will be no change in the yield, cost and return. The benefit at the full developed stage is calculated as below.

(Unit : 1,000RM)

Net Production Value (without case)	19,957
Net Production Value (with case)	49,663
Incremental Benefit	29,705

(d) Economic Evaluation

Based on the project cost and benefit estimated above, the cost and benefit flow is prepared as in Table 5.3.12 "Benefit and Cost Flow" and EIRR, B/C and NPV are calculated as below.

EIRR (%)	19.5
B/C	2.08
NPV (1,000RM)	80,131

The sensitivity analysis is made in terms of EIRR for the case of (i) 10% and 20% increase of construction cost and (ii) 10% and 20% of decrease of benefit. The results are shown in the following table.

(Unit : %)

Benefit	Construction Cost		
	0% Increase	10% Increase	20% Increase
0% decrease	19.5	18.6	17.8
10% decrease	18.0	17.1	16.4
20% decrease	16.4	15.6	14.9

The above results indicate that the project is economically viable showing 19.5% of EIRR, 2.08 of B/C and RM80.1 million of NPV. While the sensitivity analysis indicated that the project viability is insensitive against adverse effects of cost increase and benefit decrease.

(2) Financial Analysis

(a) Farm Budget Analysis

The farm budget analysis is made by assuming that average land holding size of 1.32ha is equivalent for typical farm operation size. After the implementation of the project, both gross farm income and net farm income are expected to increase to a great extent. Net reserve of farmers is also expected to increase from RM2,470 per year to RM6,810 per year. The farm budget for present condition and "with-project case" are shown in the following table :

(Unit : RM)

Items	Present	With-project
1. Gross Farm Income	5,580	11,590
2. Production Cost	2,360	4,030
3. Net Farm Income (1-2)	3,220	7,560
4. Non-farm Income	9,200	9,200
5. Total Income (3+4)	12,420	16,760
6. Living Expense	9,950	9,950
7. Net Reserve (5-6)	2,470	6,810

(b) Procurement Cost of Agricultural Machinery

The loan scheme of BPM or FOA would be utilized for the procurement of agricultural machinery. Farmers will pay the rental fee for procured machinery and this fee will be set as equivalent to the present rental fee. The loan repayment will be allotted from this rental fee. Procurement cost and interest of loan and total repayment amount are estimated as below.

(Unit : 1,000RM)

Procurement Cost of Machinery (Loan Principal)	18,805
Interest (Repayment period 5years, rate 6.5%)*	2,586
Total repayment amount	20,671
Average annual repayment	4,134
Annual Repayment per ha (RM/ha/year)	431
Annual machinery using cost in "with case" (RM)	600

*: Annual repayment for principal is assumed to be RM 3.6 million.

From the above table, average repayment amount per hectare is about RM431, while the present rental fee is RM600. With this rental fee of RM600, farmers still can earn RM2,660 per ha in the "with-project" condition. Therefore, it would be possible for farmers to repay the loan and operation and maintenance cost. Besides, imposing the rental fee which is equivalent to the present condition would be acceptable for the farmers.

5.4 Environmental Management Plan

5.4.1 Introduction

(1) Objectives

In Malaysia, Environmental Management Plan (EMP) is expected to be formulated as part of Environmental Impact Assessment (EIA). This is usually conducted subsequent to IEE, because much information is required to complete this process. EMP is expected to achieve the following items:

(a) Identify key potential impact areas
(b) Establish a program for monitoring the potential impacts
(c) Establish reporting and mitigating (including emergency) response procedures

For specifications of the monitoring program, the following items are required:

(a) The type of monitoring
(b) The locations of monitoring stations
(c) The types of measurements to be undertaken

(2) Key Factors for Developing and Implementing an EMP

Key factors to develop and implement an EMP are listed as follows:

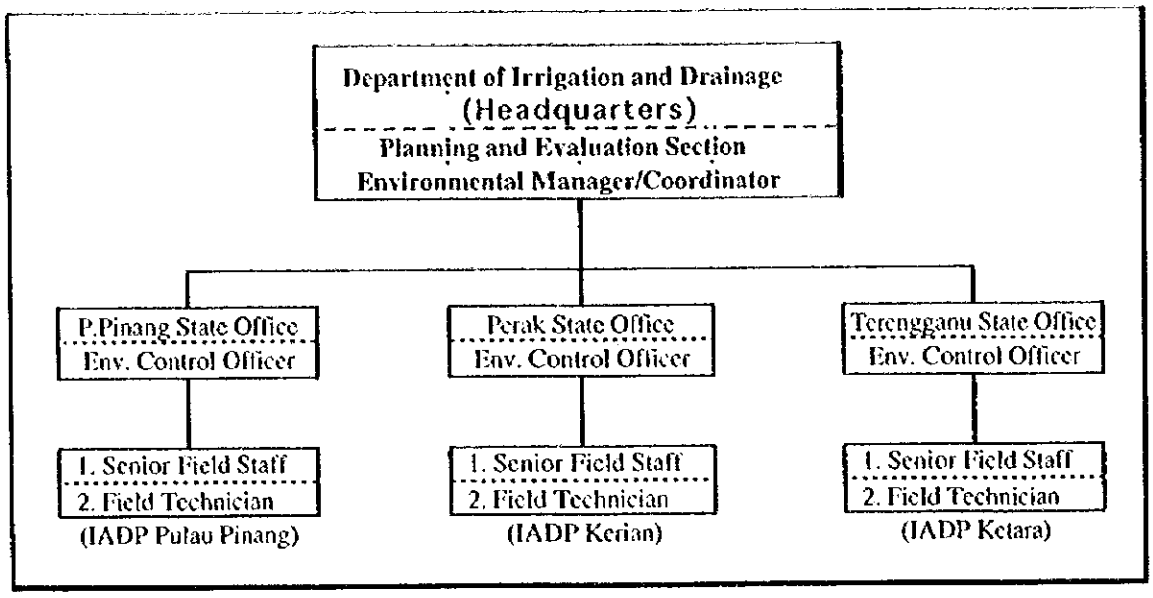
(a) Public acceptance, particularly by local farmers
(b) Environmental Policy
(c) Institutional structure and resource allocations
(d) Environmental evaluation and management program
(e) Training and education (agricultural practice including chemical use)
(f) Data management and communications

5.4.2 Environmental Management Plan

(1) Staffing and Institutional Framework

For the smooth operation of the EMP, the development of an institutional framework, which enables the allocation of qualified staff to appropriate positions is inevitable. It is proposed that the following four positions be established in the DID to take certain responsibilities in the plan :

(a) Environmental Manager/Coordinator: Headquarters of the DID (Planning and Evaluation Section)
(b) Environmental Control Officer: Each State Office of the DID
(c) Senior Field Staff: Each field office (IADP Office/Granary Area)
(d) Field Technician: Each field office (IADP Office/Granary Area)



Institutional Framework of the DID with the Environmental Management Plan (EMP)

These positions can be filled by new employees and/or concurrently held by present staff who are highly qualified to those positions. Qualifications and duties of each position are proposed as follows :

(a) Environmental Manager/Coordinator

(Qualifications and Experience)

- A University degree in natural sciences is required. At least five-year or more work experience in the field of environmental science (e.g.research and consulting) with the knowledge of Malaysia's environmental policy and legislation.

(Duties)

- Management and development of overall environmental monitoring and evaluation programs
- Internal and external communication/networking regarding environmental issues
- Implementing environmental management actions
- Maintenance of database
- Organizing staff training programs
- Supervising environmental control officers

(b) Environmental Control Officer

(Qualifications and Experience)

- A diploma or certificate in agriculture, engineering or natural sciences from College or Institute with a few years of work experience in relation to environmental issues is required. The advanced knowledge of computer is essential.

(Duties)

- Supervising field staff to conduct water sampling and analysis
- Data analysis and management
- Communication with headquarters (DID) regarding environmental data
- Evaluation of environmental impacts (i.e. water quality)
- Collating environmental data submitted by each local office
- Preparation of a half-yearly report to headquarters
- Organizing management actions with the DOA (i.e. changes in the use of agro-chemicals by farmers when required)

(c) Senior Field Staff

(Qualifications and Experience)

- Minimum requirement of a high school diploma with some subjects in science and a few years of field experience is necessary. Automobile drivers license with a good record is essential. Field staff must have completed a proper training on water sampling and analysis, and the knowledge of basic computer use is required.

(Duties)

- Conducting/supervising all field sampling and data collection
- Maintenance of field equipment
- Communication with the environmental control officer
- Data entry and basic analysis (i.e. WQI calculation)
- Laboratory analysis (delivery of water samples to the laboratory)
- Preparation of a monthly environmental report (water quality report)
- Implementing management actions with the DOA (i.e. changes in the use of agro-chemicals by farmers)

(d) Field Technician

(Qualifications and Experience)

- Minimum requirement of a high school diploma with some subjects in science. Automobile drivers license with a good record is essential. Technicians must complete a training program on water sampling and analysis.

(Duties)

- Conducting all the field sampling and data collection
- Maintenance of field equipment
- Laboratory analysis (delivery of water samples to the laboratory)
- Data entry and basic analysis

(2) Inter-departmental Information Flow

Efficient transfer of information is the key factor of the effective EMP. Establishment of inter-departmental linkages between various departments and agencies (e.g. DID, DOE and DOA) is, therefore, crucial to implement the plan. A conceptual framework of the information

network of the EMP is shown in Fig. 5.4.1 "Conceptual Inter-Department Information Network of the Water Monitoring System". This is a cyclic system indicating a flow of necessary actions and information. All management decisions must be based on scientific data with a systematic monitoring system, and all management actions should be evaluated subsequently. There is no "dead end" within this work flow, and this information network should be active at any stage.

(3) Staff Training

Staff training programs are an important part of the EMP. The training programs should be focused on data collection (water sampling/analysis), computer applications, data quality control/assurance and communication skills. It is important to design the training programs for particular purposes, and all instructors must be highly qualified. It is proposed to organize three levels of training, and the programs should be planed in cooperation with various departments. Particularly, the DOE currently offers some training programs in environmental management, so that the staff of the DID should be participating in the programs whenever possible. Regarding the training programs of the water quality sampling, National Hydraulic Research Institute (NAHRIM) can play the key roles in designing the programs. Furthermore, collaboration with Universities, research institutions and the Departments of Chemistry, Agriculture and Public Health is also encouraged. The topics to be included in the training programs are proposed as follows:

Level	Approximate Qualifications	Topics
1.	Environmental Control Officer/ Other qualified staff	• Design and planning env. management programs • Data analysis (use of computer) • Environmental policy and related issues • Environmental impact evaluation and mitigation • Report writing and communication skills • Others
2.	Senior Field Staff/ Other qualified staff	• Principles of environmental management • Computer application (some analysis: WQI) • Environmental science (ecology and chemistry) (ecological sampling methods) • Report writing and communication skills • Others
3.	Field Technician/ Other qualified Staff	• Basic computer application • Basic environmental science (ecology and chemistry) • Ecology of fauna and flora (around paddy fields focusing on field identification) • Field sampling techniques • Basic laboratory analysis • Basic report writing and communication skills • Others

In addition to the staff training programs, it is important for the DID staff to attend occasional seminars and workshops when relevant programs are available. It is encouraged that the knowledge of environmental management and issues be kept updated whenever possible.

(4) Water Quality Monitoring System

(a) Parameters

This is a permanent water quality monitoring system that is designed particularly to check the quality of drainage water from the paddy fields as well as to monitor effectiveness of management actions such as controlling the use of agro-chemicals by farmers. The following table indicates a list of parameters, which is a minimum requirement for the monitoring system. Other parameters can be included when it is necessary. The standard values of each parameter within water quality classes, which are defined by the DOE are also shown in the table, and water quality should be remained above Class III at all the time.

Parameters	Water Quality Classes					
	I	IIA	IIB	III	IV	V
• Ammoniacal Nitrogen (Nh_3N) (mg/l)	0.1	0.3	0.3	0.9	2.7	2.7
• BOD (mg/l)	1	3	3	6	12	12
• COD (mg/l)	10	25	25	50	100	100
• DO (mg/l)	7	5 - 7	5 - 7	3 - 5	3	1
• SS (mg/l)	25	50	50	150	300	300
• pH	6.5- 8.5	6.5-9.0	6.5- 9.0	5.0-9.0	5.0- 9.0	—
• Phosphorus (mg/l)	N.L.	< 0.2	< 0.2	< 0.1	—	0.1 <
• Nitrate (mg/l)	—	—	—	—	—	—

N.L. = Natural levels

Class I : (Water Supply I) No treatment necessary, (Fishery I) Acceptable for very sensitive aquatic species

Class IIA : (Water Supply II) Conventional treatment required, (Fishery II)Acceptable for sensitive aquatic species

Class IIB : Acceptable for recreational use with body contact

Class III : (Water Supply III) Extensive treatment required, (Fishery III) Acceptable for common and tolerant species. Acceptable for livestock drinking

Class IV : Acceptable for irrigation

Class V : None of the above

Changes in general water quality can also be evaluated with the water quality index (WQI) being used by the DOE (Annex VI "Environment"). Using WQI values for the evaluation of drainage water allows comparison with other water quality data. Calculation of the WQI involves NH_3N, BOD, COD, DO, SS and pH, and its formulae are presented in "Annex VI". It is recommended to have a guidance with the DOE for this analysis, and WQI values should be calculated in each month.

Present water quality of the study sites (IADP Pulau Pinang, IADP Kerian and IADP Ketara) was found to be only slightly polluted (WQI 70 - 80) in the first Phase of this study, so it is assumed that each parameter of the drainage water around the paddy fields is not polluted seriously (at least Class III) at the present time.

For irrigation purposes, other parameters are also suggested to be monitored. These parameters include: dissolved solids, specific conductance, sodium (Na), boron (B), calcium (Ca), chlorides (Cl), potassium (K) and trace metals.

(b) Sampling Locations

Establishment of fixed sampling stations in IADP Pulau Pinang, IADP Kerian and IADP Ketara (Besut) to monitor water quality is proposed. Proposed sampling locations are listed in the following table as well as shown in the maps (Fig. 5.4.2 to 5.4.5 "Water Quality Sampling Locations") :

Scheme	Plot No.	Name of River (Station)
IADP Pulau Pinang (Fig.5.4.2 and 5.4.3)	P 1	• Bumbong Lima Pump Station
	P 2	• Pinang Tunggal Pump Station
	P 3	• Kreh Pump Station
	P 4	• Padang Cemedak Pump Station
	S 1	• Sg. Kreh
	S 2	• Sg. Tembus
	S 3	• Sg. Abdul
	S 4	• Sg. To Sani
	S 5	• Sg. Jarak
	S 6	• Sg. Jalutong
	S 7	•
	S 8	• Sg. Derhaka
	S 9	• Sg. Kulim
IADP Kerian (Fig 5.4.4)	P 1	• PT 30
	P 2	• Sg. Bogak Pump Station
	S 1	• Sg. Bakau
	S 2	• Sg. Tg. Piandang
	S 3	• Pt. Tokin
	S 4	• Sg. Kurau
	S 5	• Sg. Kurau
	S 6	• TSN Besar
IADP Ketara (Besut) (Fig 5.4.5)	P 1	• Sg. Kena Pump Station
	P 2	• Alor Air Putih Pump Station
	P 3	• Sg. Gerong Pump Station
	S 1	• Sg. Kena
	S 2	• Sg. Jerteh
	S 3	• Sg. Besut
	S 4	• Sg. Angga
	S 5	• Sg. Kerandang

Major drainage canals are selected for water sampling stations, which can check chemical residues efficiently. Pumping stations to recycle water for irrigation are important points to monitor water quality. These locations are shown as P in the maps. Major water intake points are also included in the monitoring system. Therefore, the system enables to check water quality for irrigation purposes, and also the results can be compared before and after the water use for irrigation.

(c) Sampling Procedure

It is recommended that water sampling be carried out at least twice a month at each sampling station to obtain representative data for a month. However, the frequency of the sampling can be adjusted subsequently according to the propensity of the results. It is important to collect water samples when agro-chemicals are being applied. Fertilizers

are normally used in a seeding period. On the other hand, insecticide and herbicide are applied on an irregular basis. Frequent sampling is recommended when a large amount of agro-chemicals is being used.

Sampling methods should be consistent with those of the DOE, and it is also recommended to have a guidance of the Department of Chemistry. All the necessary equipment for the sampling should be purchased and managed by the DID. Simple analysis can be carried out in the field; however, cooperation with institutions such as the Department of Chemistry and/or National Hydraulic Research Institute of Malaysia (NAHRIM) is required for more complicated laboratory analysis.

(5) Cost Estimate for the Monitoring System

Cost estimate of the water quality monitoring system in each Scheme is summarized in the following table. The O & M cost contains miscellaneous requirements such as glassware, sampling bottles, fuel and others. This miscellaneous cost is relatively large in the early stage of the program. This budget plan was constructed with the 13 sampling stations in Pulau Pinang Scheme and 8 stations in Kerian and Ketara Schemes respectively. Sampling frequency of once a month at each sampling station is applied in this calculation. Breakdown of this estimate is presented in Annex VI "Environment".

(Unit: RM)

Scheme	Equipment	Staff Remuneration/Year	O & M/Year
IADP Pulau Pinang	23,500	128,500	9,510
IADP Kerian	23,500	128,500	6,600
IADP Ketara	23,500	128,500	6,600
Total	70,500	385,500	22,710

Total cost of the water monitoring system in the three granary areas is estimated at RM 478,710. However, all the proposed personnel would not be necessary in the first year. Minimum requirement in the first year of the program is perhaps a field technician in each scheme, and other staff can be added in subsequent stages. When only one field technician in each scheme was deployed in the first year, a total cost of water monitoring system would be RM 136,710 .

(6) Data Management

All the water quality data should be stored on computer files using locally available software packages (e.g. Lotus 1-2-3, dBase and Excel). Primary data collected at each IADP Office/Granary Area must be analyzed (e.g. WQI) and compiled into a monthly report. The monthly report must be forwarded to the State Office of the DID, and the senior field officer is responsible for this process.

Environmental control officer at each State Office collates all the data from local offices, and compiles a half-yearly report of the State. Then, the report should be transferred and properly stored at headquarters of the DID. It is recommended that the data be on a home page of the DID so that any government agencies, interest groups and individuals can have access to

the data. Particularly, the DID should have an active communication with various departments regarding water quality related environmental issues.

5.4.3 Mitigation Measures

(1) Control of Chemical Application

The most beneficial output of the water monitoring system is to allow management of agro-chemicals with scientifically sound water quality data. When any excessive use of agro-chemicals is detected, it is important to search precisely for a possible cause. Then, appropriate management actions must be taken place immediately, and the DID and the DOA should play the key role in such a process. Therefore, there must be a smooth communication network between those departments. In addition, the DOA is currently encouraging the farmers to follow established cropping schedules, so that fertilizers can be used more effectively. It has been suggested that long-lasting coated fertilizers (e.g. nitrogen) can be used to minimize adverse effects, but these are usually expensive.

Furthermore, the DOA recommends that only readily decomposable insecticides and herbicides be used. Although those chemicals normally contain toxic substances, it is inevitable to use them for some circumstances, so that they must be used very carefully. On the other hand, development of alternative methods to control pest populations is encouraged. Integrated Pest Management (IPM) of the DOA seems to be an appropriate approach to minimize adverse effects of using insecticides and herbicides.

(2) Integrated Pest Management (IPM)

Integrated Pest Management (IPM) of the DOA started mainly in the 1980s in Malaysia. Primary function of this program is to use biological agents to control pests and weeds in agricultural practices. It also includes a surveillance system and subsidy scheme encouraging appropriate use of pesticides. Effective use of pesticides with readily decomposable chemical substance is also an important part of the IPM. Therefore, this program can be a mitigation measure for reducing possible adverse effects of using insecticides, herbicides and other forms of agro-chemical in rice production.

It is reported that the IPM has been successful and an effective method to control pest populations in the rice farming practice. However, it seems that only limited data are currently available on its effectiveness. Before any management action is taken, important hypotheses must be tested statistically. This type of study must have treatment and control areas for a direct comparison. A research institution such as MARDI should be involved heavily in this type of project. It is also encouraged to collaborate with Universities, and graduate students in related fields (e.g. agriculture, zoology and ecology) can conduct research on various aspects of the IPM.

For example, releasing the barn owl (Tyto alba) with nest boxes around rice fields for controlling rat populations is one of the major practices of the IPM program. The main hypothesis with this program that must be tested is: the owls released in the field can actually control rat populations on the rice fields. The treatment site should be a rice field with a closed

population of rats and owls, and the ecology of those animals should be studied to examine the hypothesis. Basic ecological aspects that must be analyzed in this experiment are listed as follows:

- Feeding behavior of the owls
- Population dynamics of the owls and rats
- Home range of the owls
- Utilization of the nest boxes by the owls

Furthermore, different biological agents (e.g. catfish and Muskovi ducks) to control a variety of pests have been considered and introduced into some rice fields. Having these animals as predators in the program, different pest species are expected to be reduced. However, crucial hypotheses must be tested with scientifically designed experiments before management actions are implemented. It is also very important to replicate the experiments, particularly when a management program plans to be carried out in a new area.

5.4.4 Other Environmental Issues

In the rice farming practice, considerable amounts of secondary product such as paddy straws, husks and rice bran are normally produced. The estimated weight of those products in Malaysia is shown in the following table. Most of these products, except rice bran, are not fully utilized at the present time. Most of the paddy straws are left in the paddy fields to be burned or plowed-in after the harvest. Much of the rice husks are also burned. It is said that this burning practice may cause some impacts on air quality. Although burning paddy straws makes ash, which can be nutrient for paddy in the following season, it has been suggested that the burning practice be reduced. Therefore, making compost with the secondary products has been suggested as an alternative usage of the products.

Items	Estimate (1,000 tons/year)
Paddy straw	1,629.7
Paddy husk	277.1
Rice bran	55.3
Total	1,962.1

(Hayakawa 1997: International Cooperation in Agriculture and Forestry. Vol.20, No.1•2)

Organic farming is considered as a safe and productive agricultural practice. There is a technique available to make compost with paddy straws, paddy husks, rice bran and chicken dung with the aid of effective microorganisms (EM). EM is a mixture of about 80 species of naturally occurring microorganisms, which can improve soil condition and plant growth. This is commercially available and currently being used at KADA. One cycle of making compost normally takes about 45 days. However, collecting rice straws in the field may present a problem of labor input. Furthermore, it requires considerable space if this program is to be economically viable.

5.5 Conclusion and Recommendation

5.5.1 Conclusion

The Economic Internal Rate of Return (EIRR) of the three(3) priority schemes are estimated to be 24.1% for the Kerian scheme, 19.5% for the Pulau Pinang scheme and 11.2% for the Besut scheme. It can be said that the projects are technically feasible and economically viable with a viewpoint of national economy. Through the study, the projects are justified summarized as below:

(a) Introduction of telemetry/telecontrol system with computer system in addition to the improvement and rehabilitation of irrigation facilities and farm roads, will rationalize management systems and promote effective use of water resources. This will contribute on the accomplishment of the target of the NAP.

(b) For farm economy, it is expected that the current gross farm income will be doubled approximately after the implementation of the project. This will contribute to improve farmers' living standard and to motivate farmers' positive attitude toward paddy production.

(c) It is expected that the introduction of the latest technologies such as telemetry/telecontrol system, computer system and coherent mechanized agricultural operation together with organizing water users group can modernize and activate the rural area.

(d) Particular remarks of three schemes are summarized below :

(i) Kerian scheme
Rehabilitation of drainage systems and improvement of farm roads will enable to employ direct seeding method with machinery, which can save labor and largely increase crop production. It is expected to modernize the water management system by replacing the existing telemetry system with new telemetry/ telecontrol system and computer system.

(ii) Ketara (Besut) scheme
This scheme is selected as the pilot project area, and in prior to other granaries, farmers' group have been established based on the irrigation system. With this background, this scheme is expected to lead other granaries and be act as a model for modernization of granaries.

(iii) Pulau Pinang scheme
Introduction of modern water management system and group farming are expected to increase rice production and to sustain the agricultural activities in the scheme which is adjacent to industrial area.

5.5.2 Recommendation

The three schemes will increase rice production and contribute to secure stable source of food, so it is concluded that this is a realistic and appropriate plan for reaching the target of the NAP. It is, therefore, recommended that this project be implemented as soon as possible. Strategic plans to increase production and maintenance of granary areas are summarized in the following:

(a) Implementation of environmental management plan
The project is not heavily involved in construction of large buildings or land clearing, so the impact that will possibly cause to surrounding environment is predicted to be minimal. However, no study has conducted to monitor effects of using agro-chemicals. It is, therefore, recommended that a water quality monitoring system be introduced for the purpose of checking drainage water discharged from paddy fields and also for monitoring utilization of agro-chemicals by farmers.

(b) Securing additional water resources in Ketara (Besut) scheme
Water shortage represents a major problem and there are large fluctuations in water discharge in Ketara (Besut) scheme, so that cropping intensity is unstable in this area. From 1994 to 1995, a feasibility study was conduced on a multi-purpose water resources project (Paya Peda Dam) by DID, which is located upstream of Angga River to secure irrigation and drinking water and to control flood. This project includes Ketara (Besut) granary area together with other small irrigation schemes. No decisive implementation schedule has been planned yet, but it is recommended that the implementation of this project be seriously considered in the light of future water demand.

(c) Establishment of water users group
Farmers' groups in study areas are not firmly structured yet, and it appears that this grouping process is still in the initial stage. It is important that these farmers' groups be rearranged to water users groups to make farming practice more efficient. Therefore, it is necessary that organizations such as IADP PMU, DID, DOA, PPK, FELCRA and National Water Management Training Center must realize the importance of formulating water users groups and make a hasty action to implement this reform.

(d) Consensus of farmers toward land consolidation
Land consolidation which requires rearrangement of farming plots is essential to introduce mechanized farming practice, and farmers and land owners must reach an agreement on such a plan if it is to be implemented. It is, therefore, recommended that IADP PMU play a primary role in such a plan, and PPK and DOA must cooperate to form a task force to support the implementation.

(e) Durability of the Project
It is inevitable to form an organization that leads and operates centralized management on farmers on behalf of present IADP PMU, which has been organized for development and for implementation of the Project. Farmers'

Organization Authority (FOA) is probably the most appropriate institution for this task. It is urged that DID and DOA provide technical support, and FOA act as a center of management and operation of granary areas.

PART - VI

PILOT PROJECT

6.1 General

A pilot project has been implemented by the Malaysian Government with technical advice and guidance of the JICA Study Team during the field work period for Phase II, Feasibility Study according to the Minutes of Meeting on Scope of Work for the Study on Modernization of Irrigation Water Management System in the Granary Areas of Peninsular Malaysia agreed between Malaysian Government and JICA on 20 November 1996. The Ketara (Besut) Scheme has been selected as the pilot project through discussion at the meeting on the Progress Report (I) with the Steering Committee at the end of May 1997. Prior to implementation, a meeting had been held to discuss work items and time schedule for implementation of the pilot project at the IADP Ketara (Besut) Office on September 22 and 23, 1997, and based on the result of the discussions, the pilot project has been commenced immediately after the meeting.

6.2 Description of the Pilot Project

In implementing the pilot project, two systems were proposed, namely a) Irrigation Water Management System and b) Irrigation Monitoring and Feedback System. The features of these systems are described in the following sections :

6.2.1 Irrigation Water Management System

(1) Purpose

The objectives for introducing the irrigation water management system are as follows :

(a) Effective use of irrigation water, reduction of operation loss (raise of efficiency) and increase of paddy production
(b) Preservation of facilities and prevention of disaster
(c) Saving cost for operation and management
(d) Achievement of a more effective representation and participation of farmers, and attainment of sustainable development in irrigation agriculture

(2) Basic Consideration

For the establishment of irrigation water management system, the following considerations are made :

(a) Timely collection of data and information on water management through measurement and transmission of various data such as rainfall, river runoff, reservoir storage, intake volume, water distribution amount, etc.

(b) Processing of collected data and direction of water control for proper water management by on-site and/or remote control system
(c) Safety control and early action of countermeasures for extraordinary conditions through introduction of warning system for flooding, management system on water shortage in drought year to prevent from drought disaster and protection system of irrigation facilities in emergency cases
(d) Utilization of accumulated data through water management system for the future modification of the project and for the regional development

(3) Proposed System and Facilities

The proposed system consists of :

(a) Observation system
(b) Communication system (telemetry and telecontrol system)
(c) Data management system
(d) Remote control system for gate and pump operations

For the establishment of these systems, the following facilities should be provided :

(a) Observation system
  (i) Installation of rainfall stations in the representing areas
  (ii) Installation of water level gauges at river, diversion points of irrigation canals and drains, and gate opening gauges at intake and diversion gates
(b) Communication system (telemetry and telecontrol system)
  (i) Establishment of telephone line linking among central station, remote stations and other agencies concerned
  (ii) Establishment of electric lines for TM/TC equipment
  (iii) Installation of TM/TC equipment at both central and remote stations
  (iv) Establishment of central and remote stations
(c) Data management system
  (i) Establishment of computer system for estimation of water requirement, H-Q calculation of river, canals and drains, and water balance, etc.
  (ii) Estimation of optimum water distribution as well as gate opening level and pump operation hour
  (iii) Installation of computer equipment for the above system
(d) Remote control system for gate and pump operations
  (i) Motorization of gated structures
  (ii) Establishment of remote control system for gated structures and pumps

Fig. 6.2.1 to 6.2.3 "Schematic Diagram of Telemetry and Telecontrol System" show the schematic diagrams of telemetry and telecontrol system.

(4) Pilot Project Works

In the framework of the above proposed water management system, the following works have been executed as the pilot project in Besut scheme :

(a) Establishment of observation network of 2 rainfall stations and 6 water level stations at Besut river, Besut intake and major diversion points of irrigation canals as shown in Fig. 6.2.4 "General Layout of Telemetry and Telecontrol System"
(b) Establishment of telephone line linking among central and remote stations, installation of TM/TC equipment at both central and remote stations, and establishment of electric lines for remote stations
(c) Establishment of data management and processing system comprising computer hardware and software
(d) Establishment of central and remote stations

6.2.2 Irrigation Monitoring and Feedback System

(1) Purpose

To provide updated irrigation and farm activity information so that farmers can respond in good time to take necessary preparatory steps, adhere to schedules and alert them on any change of status. The same information is also useful for O&M field staff. In addition, the system can be utilized as a communication medium for agriculture extension services and general information.

(2) Background

Keeping to irrigation schedule is a critical aspect of double cropping production. Maintaining the schedule is also the basic assumption in the planning and design of the tertiary system for an optimized resource (water, machinery, manpower, farm input) demand over a season. Past experience show that this assumption is not easily attainable. One management aspect to strengthen is coordination between irrigation managers, agriculture managers, the PMU of the IADP office and of course the farmers. From the operation perspective, a common monitoring system is proposed to alert managers and farmers to prepare for sequential production activities, alert them of any potential delays so that timely corrective measures can be initiated.

(3) Proposed System

The proposed monitoring and feedback system is a computer based system using telephone line communication. This system allows the systems manager to produce, author and schedule and distribute multimedia messages and information for TV output. Since a telephone line is used, the information can be transmitted and displayed at any number of stations from a single central center.

Within a granary, the basic system comprise a master station connected to one or more player stations on site. The master station is the source of all information presentations and controls the presentation schedules of the player stations. Subsequently the system can be upgraded to one with multi-master stations and interlinked with each other. Ultimately, the system can be extended to an inter-granary network with links to the Ministry of Agriculture and relevant Federal Departments.

Fig. 6.2.5 to 6.2.7 show the schematic diagrams of irrigation monitoring and information feedback system.

(4) Pilot Project Works

For the pilot project, one master station to be installed at the central control station and one player station to be installed at one compartment office are proposed.

6.2.3 Integration of the Water Management System and the Monitoring and Feedback System

To ensure that the systems installed functions effectively, they must be managed and operated in an integrated manner. Most important is to appreciate that both systems have their own specific purpose and that the O&M staff work procedure is an integral component.

The Water Management System(WMS) collects data on water resources and irrigation for use of the technical personnel, i.e. the O&M staff of the DID. The data and information presentation are thus technical in nature but easily understood by the systems operators. The basic data are rainfall and water level information, and these data are transformed into decision-making information mainly on water availability status and system allocation levels. On the other hand, the Irrigation Monitoring and Feedback System(IMFS) is targeted to mainly for the farmers and field staffs. This must be less technical in nature and easily understood. Thus data obtained from the WMS must be suitably represented for the IMFS. The water level and rainfall data collected through the WMS can be directly connected to the IMFS via a computer link and programming. Only the display format will differ. The key information necessary for farmers are rainfall, water level and supply conditions.

Apart from the system computer linkage, the planning input and actions of the PMU, the DID, DOA, LPP/PKK and BERNAS components of the IADP are critical. These must be well supported by field staff for activity feedback update and ensuring that information transmission to farmers is executed. A season's planning information must be provided by the PMU and the respective components at the start of every season. Clear targets for each activity are critical and should be input into the IMFS. During a season's operations, monitoring feedback must be provided by the field staff as part of their work program. A feedback format and schedule must be set-up. A weekly reporting and updating must be carried out with allowances for insertion of urgent and important messages at any time necessary.

Overall, farmers' response to the information is the main concern. From the onset, the field staff must encourage leaders of the farmers' groups to constantly refer to the IMFS for updated information and to ensure that the farmers' groups undertake positive action in response to the information. Gradually, the system should allow for feedback information to be provided by each farmers' group via the manager of the player stations. In the case of Besut, this will be the respective DID Compartment Stations. Farmers' response to the information must be relayed back to central control by the Compartment Stations. This is turn should be indicated in the subsequent information transmission by the Central Control.

6.3 Implementation of the Pilot Project

The following works has been implemented by DID with the technical advice and guidance of the JICA Study Team during the field work period for Phase II :

6.3.1 Establishment of Central Control Station

A Central Control Station has been established in the IADP Ketara Office based on the discussion held on 23 September 1997 and the following works have been made :

(a) Installation/supply of wiring, telephone line and electricity
(b) Supply of office equipment
(c) Provide office space for DID O & M staff

6.3.2 Procurement and Installation of Telemetry System

The following equipment and facilities of the telemetry system are procured and installed. Details are shown in Annex IX "Pilot Project".

(a) Master controller at the central control station
(b) Three(3) remote telemetry units at Besut intake site and two(2) major diversion points, "G" and "O"
(c) Two(2) tipping bucket rainfall sensors at Besut intake site and diversion point "O"
(d) Six(6) analog/digital water level sensors at upstream and downstream sites of Besut intake and diversion points of "G" and "O"
(e) Remote control device for a off-take gate at diversion point of "G"
(f) Hardware and software for irrigation water management system
(g) Hardware and software for irrigation monitoring and feedback system

6.3.3 Design of Irrigation Water Management System

The irrigation water management system has various functions such as data calculation, guidance for proper decision making for daily operation and project monitoring. From the viewpoint of computer system, the water management system is developed under the following concept :

(a) Easy operation

The operator of the existing irrigation system in the Besut scheme will be the user for the water management system and user oriented concept should be adopted. The system shall have user friendly interface and minimum routine work so that the user can operate the system easily.

(b) Easy maintenance

The system should be maintained in good condition and project information shall be updated with the latest one. Even if there are some changes in various project

information, the user shall not have to change program itself. The user can easily change the project information in screen, excel file or text file as shown below.

- Irrigation schedule data can be updated in screen.
- Kumpulan Petani data can be updated in excel file.
- Project data except for calculation of ETo can be updated in excel file.
- Project data for calculation of ETo can be updated in text file.

(c) Easy extension

The number of rainfall stations and water level stations shall be installed in future. The system has many blank spaces for these additional stations. Therefore, the user can install new stations without changing program.

The irrigation water management system will be used for decision making for daily irrigation system operation and project monitoring. On the other hand, Supervisory Control and Data Acquisition (SCADA) system which be included in the master controller, will be used for data collecting, primary data calculation and telecontrol. The water management system and the SCADA system will be connected by using Ethernet as shown in Fig.6.3.1 "Layout of Water Management System and SCADA System" and data exchange will be done based on the Comma Separated Variable (CSV) format.

Visual Basic(VB) version 5 is the latest and the most popular programming language for Windows 95. Consequently, VB is selected for developing the water management system.

Irrigation water management system is developed to assist irrigation system operator in proper decision making. Basically, the system has two functions, one is daily operation function and the other is project monitoring function.

(a) Daily Operation Function

The objective of this function is to guide irrigation system operator to proper daily operation. To achieve proper operation, the following information will be useful for the operator.

- Water demand at major diversion points
- Actual water supply at major diversion points
- Proper distribution simulation
- Required gate opening level

To get such kind of information, functions shown below are established in the water management system. In the system, the required information is displayed in graphic so that the user can understand them easily.

(i) Water demand at major diversion points
- Rainfall data reading function
- Water requirement calculation function
- Diversion discharge function
- Kumpulan Petani data input function

(ii) Actual water supply at major diversion points
- Water level data reading function
- H-Q calculation function
- Canal data input function

(iii) Proper water distribution
- Intake operation function
- Water balance simulation function

(iv) Required gate opening level
- Gate opening level data reading function
- Gate operation guidance function
- Target gate opening level data sending function to SCADA system
- Gate data input function

(b) Project Monitoring

The objective of this function is monitoring the irrigation system.

- Rainfall Trend Monitoring Function
- Water Level Monitoring Function

By using the irrigation water management system, operation factor in present condition will be upgraded and modernized as shown below without burden.

Operation Factor	Present Operation		Modernized Operation System	
Data Collection	On Sight	->	In Central Office	SCADA
Data Collection Frequency	Daily	->	Hourly	SCADA
Calculation Frequency	Seasonally	->	Daily	WMS
Water Distribution	Experience	->	Simulation	WMS

Note : WMS = Water Management System
SCADA = Supervisory Control and Data Acquisition

The design sheets, flow chart and operation manual of program for irrigation water management system are attached in Annex IX "Pilot Project".

6.3.4 Development of Program for Irrigation Monitoring and Feedback System

The main criteria on choice of system is that the information must be easily updated, the display simple messages and carries good visual impact. The recommended software for the system is the SCALA Infochannel. For the pilot project, the SCALA MM200 software is recommended for initial development and as a demonstration.

The content of the demonstration package is divided into the following three(3) segments :

(a) Irrigation and farm activities

In this segment, the contents are
i) irrigation schedule,

ii) alert messages on dates of field activities,
iii) farmers preparatory works necessary,
iv) status of field activities, and
v) water management information which includes rainfall and water supply and water level status at the Besut and Angga Barrage, and current information on operations and maintenance.

(b) Agronomic

This segment comprise messages pertaining to
i) recommended farm and crop husbandry practices,
ii) alert messages on DRIP, and
iii) current issues and problems such as pest and disease outbreaks and recommended management.

(c) Administrative

The administrative segment comprise
i) administrative and motivational message from IADP PMU and component heads, DID O&M section and Compartment Task Forces (Pasukan Petugas Komparttmen),
ii) paddy production statistics (yield and production) and targets, and
iii) news on current issues.

TABLES

Table 2.1.1 Paddy Planted Area and Cropping Intensity

(Unit: ha)

	Pulau Pinang			Kerian			Sungai Manik			Seberang Perak			Kemasin Semerak			Ketara (Besut)		
	Annual	Main	Off	Annual	Main	Off	Annual	Main	Off	Annual	Main	Off	Annual	Main	Off	Annual	Main	Off
1985 Planted area	13,866	6,794	7,072	40,803	23,267	17,536	7,966	6,070	1,896	9,423	5,782	3,641	0			6,048	2,716	3,332
Cropping Intens	113%	56%	58%	172%	98%	74%	126%	96%	30%	108%	66%	42%	0%	0%	0%	117%	53%	65%
1986 Planted area	16,021	7,859	8,162	35,976	21,812	14,164	11,269	5,313	5,956	7,627	5,610	2,017	0			5,591	2,119	3,472
Cropping Intens	131%	64%	67%	152%	92%	60%	178%	84%	94%	88%	64%	23%	0%	0%	0%	108%	41%	67%
1987 Planted area	18,959	8,981	9,978	44,013	23,498	20,515	12,260	5,954	6,306	9,105	3,508	5,597	13,654	4,561	9,093	6,671	3,813	2,858
Cropping Intens	155%	73%	82%	186%	99%	87%	194%	94%	100%	105%	40%	64%	128%	43%	85%	129%	74%	55%
1988 Planted area	20,216	10,209	10,007	41,498	23,582	17,916	12,059	6,145	5,914	11,718	4,918	6,800	5,475	5,259	216	5,889	4,184	1,705
Cropping Intens	165%	83%	82%	175%	100%	76%	191%	97%	94%	135%	57%	78%	51%	49%	2%	114%	81%	33%
1989 Planted area	20,275	10,168	10,107	36,395	21,542	14,853	9,575	3,480	6,095	15,078	7,465	7,613	5,794	4,968	826	7,756	3,910	3,846
Cropping Intens	166%	83%	83%	154%	91%	63%	152%	55%	96%	173%	86%	87%	54%	47%	8%	150%	76%	74%
1990 Planted area	21,805	10,275	11,530	38,974	23,293	15,681	12,086	5,978	6,108	17,130	8,505	8,625	3,916	3,899	17	7,975	4,199	3,776
Cropping Intens	178%	84%	94%	165%	98%	66%	191%	95%	97%	197%	98%	99%	37%	37%	0%	154%	81%	73%
1991 Planted area	22,334	11,427	10,907	39,259	22,747	16,512	12,166	6,104	6,062	17,094	8,531	8,563	4,379	4,191	188	8,116	4,233	3,883
Cropping Intens	182%	93%	89%	166%	96%	70%	193%	97%	96%	196%	98%	98%	41%	39%	2%	157%	82%	75%
1992 Planted area	23,918	11,723	12,195	42,492	19,512	22,980	11,929	5,916	6,013	15,476	7,185	8,291	5,302	4,955	347	7,945	4,221	3,724
Cropping Intens	195%	96%	100%	180%	82%	97%	189%	94%	95%	178%	83%	95%	50%	46%	3%	154%	82%	72%
1993 Planted area	20,412	9,491	10,921	40,219	22,732	17,487	12,031	5,975	6,056	16,610	7,972	8,638	7,520	6,413	1,107	9,263	4,819	4,444
Cropping Intens	184%	95%	89%	170%	96%	74%	190%	95%	96%	191%	92%	99%	71%	60%	10%	179%	93%	86%
1994 Planted area	18,864	9,183	9,681	32,974	17,130	15,844	12,085	6,069	6,016	16,944	8,599	8,345	9,168	7,381	1,787	8,868	4,894	3,974
Cropping Intens	190%	92%	97%	139%	72%	67%	191%	96%	95%	195%	99%	96%	86%	69%	17%	172%	95%	77%
1995 Planted area	19,278	9,552	9,726	36,503	21,939	14,564	12,114	6,027	6,087	17,134	8,591	8,543	7,481	6,447	1,034	9,522	4,949	4,573
Cropping Intens	194%	96%	98%	154%	93%	62%	192%	95%	96%	197%	99%	98%	70%	60%	10%	184%	96%	89%

Source: Paddy Statistics of Malaysia, 1994
IADP Kerian/Sungai Manik Office

Table 2.1.2 Paddy Production and Average Yields

(Unit: ton)

	IADP Pulau Pinang			Kerian			Sungai Manik			Seberang Perak			Kemasin Semerak			Ketara (Besut)		
	Annual	Main	Off	Annual	Main	Off	Annual	Main	Off	Annual	Main	Off	Annual	Main	Off	Annual	Main	Off
1985 Production	31,673	14,594	17,079	123,156	66,783	56,374	20,892	15,899	4,992	20,516	10,645	9,871	0			19,542	8,846	10,696
Average Yields	2.28	2.15	2.42	3.02	2.87	3.21	2.62	2.62	2.63	2.18	1.84	2.71				3.23	3.26	3.21
1986 Production	42,489	19,946	22,543	116,121	68,953	47,167	32,840	15,704	17,137	18,101	13,750	4,351	0			13,987	6,376	7,611
Average Yields	2.65	2.54	2.76	3.23	3.16	3.33	2.91	2.96	2.88	2.37	2.45	2.16				2.50	3.01	2.19
1987 Production	50,605	25,740	24,865	139,390	74,268	65,123	34,189	17,534	16,654	24,041	10,121	13,920	35,440	11,489	23,951	21,806	13,281	8,525
Average Yields	2.67	2.87	2.49	3.17	3.16	3.17	2.79	2.94	2.64	2.64	2.89	2.49	2.60	2.52	2.63	3.27	3.48	2.98
1988 Production	41,900	22,286	19,614	102,389	54,677	47,712	21,168	13,428	7,740	29,183	12,693	16,490	11,858	11,544	314	16,158	11,410	4,748
Average Yields	2.07	2.18	1.96	2.47	2.32	2.66	1.76	2.19	1.31	2.49	2.58	2.43	2.17	2.20	1.46	2.74	2.73	2.79
1989 Production	51,131	23,559	27,572	95,126	57,016	38,109	20,714	8,842	11,873	46,087	20,073	26,014	12,839	11,789	1,050	23,803	12,684	11,119
Average Yields	2.52	2.32	2.73	2.61	2.65	2.57	2.16	2.54	1.95	3.06	2.69	3.42	2.22	2.37	1.27	3.07	3.24	2.89
1990 Production	35,869	20,488	15,381	102,759	57,875	44,884	25,929	12,288	13,641	70,511	35,381	35,130	6,532	6,507	25	25,523	14,025	11,498
Average Yields	1.65	1.99	1.33	2.64	2.48	2.86	2.15	2.06	2.23	4.12	4.16	4.07	1.67	1.67	1.48	3.20	3.34	3.05
1991 Production	49,614	22,237	27,377	113,078	67,388	45,690	31,882	15,963	15,919	67,226	36,922	30,304	13,288	12,879	409	24,840	14,896	9,944
Average Yields	2.22	1.95	2.51	2.88	2.96	2.77	2.62	2.62	2.63	3.93	4.33	3.54	3.03	3.07	2.17	3.06	3.52	2.56
1992 Production	62,843	31,465	31,378	121,994	47,636	74,358	31,514	14,312	17,202	48,669	23,481	25,188	15,344	14,161	1,183	18,428	9,848	8,580
Average Yields	2.63	2.68	2.57	2.87	2.44	3.24	2.64	2.42	2.86	3.15	3.27	3.04	2.89	2.86	3.41	2.32	2.33	2.30
1993 Production	59,578	28,682	30,896	130,505	74,627	55,878	39,324	21,771	17,553	58,763	29,472	29,291	22,544	19,393	3,151	31,538	15,695	15,843
Average Yields	2.92	3.02	2.83	3.24	3.28	3.20	3.27	3.64	2.90	3.54	3.70	3.39	3.00	3.02	2.85	3.41	3.26	3.57
1994 Production	58,627	34,115	24,512	75,908	43,955	31,953	40,219	22,069	18,150	62,656	26,038	36,618	24,567	20,659	3,908	28,832	17,423	11,409
Average Yields	3.11	3.72	2.53	2.30	2.57	2.02	3.33	3.64	3.02	3.70	3.03	4.39	2.68	2.80	2.19	3.25	3.56	2.87
1995 Production	62,708	32,295	30,413	121,856	63,488	58,368	41,101	20,913	20,188	56,952	29,837	27,115	19,748	18,509	1,239	35,296	19,281	16,015
Average Yields	3.25	3.38	3.13	3.34	2.89	4.01	3.39	3.47	3.32	3.32	3.47	3.17	2.64	2.87	1.20	3.71	3.90	3.50

Source: Paddy Statistics of Malaysia, 1994
IADP Kerian/Sungai Manik Office

Table 2.1.3 Summary of Farm Inputs in the Study Area

Scheme	IADP Purau Pinang	Kerian	Sungai Manik	Seberang Perak	FELCRA	Kemasin Semarak	Besut	Chui Chak (sample)
1. Average Yield*1								
Annual	2.80t/ha	2.94t/ha	3.05t/ha	3.53t/ha		2.82t/ha	3.18t/ha	6 - 7t/ha
Main season	2.90t/ha	2.86t/ha	3.16t/ha	3.57t/gha		2.91t/ha	3.34t/ha	
Off season	2.71t/ha	3.05t/ha	2.94t/ha	3.50t/ha		2.22t/ha	3.00t/ha	
2. Seed rate								
	75 - 80kg/ha (WDS)	40-100kg/ha (WDS, app. 40%) 100-150kg/ha (DDS, app. 60%) 25kg/ha (TP, app. 70 - 80%)	40-100kg/ha (DDW and WDS)	80-100kg/ha (WDS)	80-100kg/ha (WDS)	40-60kg/ha (WDS)	50kg/ha (WDS)	80-100kg/ha (WDS)
3. Fertilizer Application								
	1) 17.5:15.5:10 200kg/ha 15DAS 2) Urea 40kg/ha 45DAS 3) Urea 60kg/aa 55DAS 4) 16:16:16 150kg/ha 75DAS Total N 105 (Nkg/ha) (Recommendation) Actual*2 Total N 80 (Nkg/ha)	1) Mixture 35:31:20 80kg/ha 20DAS 2) Urea 40kg/ha 45DAS 3) 15:15:15 125kg 80DAS Total N 84 (Nkg/ha) Actual Total N 80 (Nkg/ha)	1) 17.5:15.5:10 200kg/ha 20DAS 2) Urea 100kg/ha 40DAS 3) 15:15:15 50kg 75DAS Total N 89 (Nkg/ha) Actual Total N 80 (Nkg/ha)	1) 17.5:15.5:10 200kg/ha 15DAS 2) Urea 100kg/ha 35DAS 3) Urea after 100kg/ha flowering 4) 12:9:22.3 150kg/ha PAI Total N 145 (Nkg/ha) (Recommendation) Actual Total N 80 (Nkg/ha)	1) 17.5:15.5:10 200kg/ha 15DAS 2) Urea 100kg/ha 25DAS 3) Urea 100kg/ha 65DAS 4) Urea 100kg/ha 80-90DAS Total N 150-170 (Nkg/ha)	1) 17.5:15.5:10 100kg/ha 15DAS 2) 17.5:15.5:10 100kg/ha Urea 40kg/ha 45DAS 3) Urea 80kg/ha 65DAS 4) Baja makmur 125kg/ha 65DAS Total N 109 (Nkg/ha) (Recommendation) Actual Total N 80 (Nkg/ha)	1) 17.5:15.5:10 200kg/ha 20DAS 2) Urea 75kg/ha 45DAS 3) 12:12:17 125kg/ha 55DAS 4) Urea 75kg/ha 65DAS Total N 119 (Nkg/ha) (Recomme 119 Actual Total N 80 (Nkg/ha)	1) 17.5:15.5:10 150kg/ha 24DAS 2) 17.5:15.5:10 50kg/ha 31DAS 3) Urea 100kg/ha 46DAS 4) Urea 84kg/ha 56DAS 5) Urea 84kg/ha 72DAS 6) 15:15:15 125kg/ha 56DAS Total N 177

DAS: Days after seeding
PAI: Panicle Initiation

*1: 5 years average (1991-1995)
*2: Government Subsidy fertilizer

Table 2.1.4 Estimated Farm Inputs and Labour Requirements

(Unit: per ha)

Items	Unit	Direct Seeding						
		Pilot Pinang	Kerian		Sungai Manik	Seberang Perak	Besut	Kemasin Semerak
			DS	TP		exc. FELCRA		
1. Seed Material	(kg)	80	80	25	100	100	80	50
Fertilizer								
1. Subsidy								
NPK	(kg)	200	200	200	200	200	200	200
Urea	(kg)	100	100	100	100	100	100	100
NPK								
2. Additional								
NPK	(kg)							
Urea								
Compost	(kg)							
2. Agrochemicals								
Insecticide	(kg/ha)		0.75	0.5				
	(lit./ha)		1	0.85	0.63		2.47	10
	(lit./ha)				1.25		0.12	
Fungicides	(kg/ha)						19.77	
	(lit./ha)	0.1						
Herbicides	(kg/ha)		0.75	1.65		0.04	2.47	2.5
	(lit./ha)	6	8.7	6.6	7.5	1.65	4.9	
Rat control	(lit./ha)				0.63	0.80	0.6	
	(kg/ha)	1						1
3. Machinery (Contract)								
Tractor	(times)	3	2		3	3	2	3
Combine	(times)	1	1		1	1	1	1
Transport		1	1	1	1	1	1	1
4. Labour								
Land Prepn.	(md)			10.3			0.4 *	
Nursery	(md)			2.7				
Planting	(md)							
Direct Seedin	(md)	2.7	0.6		0.8	3.2	0.5	3.0
Transplanting	(md)			14.5				
Replanting	(md)		3.7	1.3	2.1		2.5	
Fertilizer Application	(md)	2.3	1.6	2.3	2.1	6.5	4.6	5.0
Chemical Application	(md)	5.4	1.8	2.0	2.3	6.9	2.4	5.4
Manual Weeding	(md)		1.0	1.2				
Water Management	(md)	2.6	2.2	2.2	2.9	2.2	2.5	12.0
Crop Watching	(md)							
Harvesting	(md)			21.5				
Processing	(md)							
Total	(md)	13.0	10.9	58.0	10.3	18.8	12.9	25.4
	(mh)	104.0	86.8	464.3	82.3	150.4	103.6	203.2

Remarks: Figures were revised and up-dated by the Consultancy Team, based on the colected data and result of field survey.

1 man-day = 8 man-hrs

*: 2W tractor

Table 2.1.5 General Features of Irrigation and Drainage (Pulau Pinang Scheme)

Description	Features	Remarks
1. Number and Name of Sub-Scheme	*5 sub-schemes* - Sungai Muda - Sungai Kulim - Pinang Tunggal - Sungai Jarak - Sungai Burung	
2. Number and Name of Irrigation Block	*17 blocks*	
- Sungai Muda	6 blocks (Block M1, M2, M3, M4, M5&M6)	Block M1A under rehabilitation partly Block M6 under commisioning process
- Sungai Kulim	6 blocks (Block K1, K2, K3, K4, K5, K6)	K1A, K2A, K5, K6 non-granary
- Pinang Tunggal	2 blocks (Block P1 & P2)	P1B non-granary
- Sungai Jarak	2 blocks (Pokok Tampang & Padang Menora)	
- Sungai Burung	1 block	
3. Net Irrigation Area	9,832 ha	
- Sungai Muda	6,888 ha	
- Sungai Kulim	1,387 ha	
- Pinang Tunggal	938 ha	
- Sungai Jarak	388 ha	
- Sungai Burung	231 ha	
4. Water Source		
- Sungai Muda	Sungai Muda	
- Pinang Tunggal	Sungai Muda	
- Sungai Kulim	Sungai Kulim	
- Sungai Jarak	Sungai Jarak	
- Sungai Burung	Sungai Burung, Sungai Tuti Teras	
5. Intake Method		
- Sungai Muda	Pumping	1 main P/S and 1 Booster P/S
- Pinang Tunggal	Pumping	1 main P/S and 1 Booster P/S
- Sungai Kulim	Gravity	
- Sungai Jarak	Gravity + Pumping	Supplemented from Pinang Tunggal
- Sungai Burung	Gravity	
6. Designed Intake Discharge		
- Sungai Muda		
Bumbung Lima Pump Station	2.8 m³/sec/each x 3 nos. 5.6m³/sec/each x 1 nos.	under construction of 8 new pumps (2.8 m3/sec/each)
- Pinang Tunggal		
Pinang Tinggal Pump Station	3.8 m³/sec/each x 2 nos. 2.8m³/sec/each x 1 nos.	
- Sungai Kulim Headworks	2.50 m3/sec	
- Sungai Jarak Headworks	0.84 m3/sec	
- Sungai Burung Headworks	0.50 m3/sec	
7. Unit Field Water Requirement		
- Sungai Muda	2.6 lit/sec/ha at peak	
- Sungai Kulim	2.6 lit/sec/ha at peak	
- Pinang Tunggal	2.6 lit/sec/ha at peak	
- Sungai Jarak	2.6 lit/sec/ha at peak	
- Sungai Burung	2.5 lit/sec/ha at peak	
8. Irrigation Facilities		
Main canal		
- Sungai Muda	7.8 km	Sedimentation in main canal
- Sungai Kulim	6.7 km	
- Pinang Tunggal	13.9 km	
- Sungai Jarak	5.8 km	
Secondary canal		
- Sungai Muda	67.9 km	
- Sungai Kulim	7.7 km	
- Pinang Tunggal	-	
- Sungai Jarak	3.0 km	
Tertiary canal		lined by concrete
- Sungai Muda	202.4 km	
- Sungai Kulim	24.2 km	
- Pinang Tunggal	29.6 km	
- Sungai Jarak	7.8 km	
Related Structures		
- Sungai Muda	407 nos.	
- Sungai Kulim	60 nos.	
- Pinang Tunggal	100 nos.	
- Sungai Jarak	-	
9. Drainage Facilities		
Main & secondary drains	95 km	
Tertiary drain	207 km	
10. Farm Road	340 km	4-5 width with laterite surfacing

Table 2.1.6 General Features of Irrigation and Drainage (Kerian Scheme)

Description	Features	Remarks
1. Number and Name of Sub-Scheme	*2 sub-schemes* - Kerian Laut Sub-Scheme - Kerian Darat Sub-Scheme	
2 Number and Name of Irrigation Block - Kerian Laut Sub-Scheme - Kerian Darat Sub-Scheme	*8 Blocks* 4 Blocks (Block A, B, C and D) 4 Blocks (Block E, F, G and H)	
3. Net Irrigation Area	*23,560 ha*	
- Kerian Laut Sub-Scheme	13,726 ha	
Compartment A	2,403 ha	
Compartment B	4,001 ha	
Compartment C	3,960 ha	
Compartment D	3,362 ha	
- Kerian Darat Sub-Scheme	9,834 ha	
Compartment E	2,344 ha	
Compartment F	2,697 ha	
Compartment G	2,143 ha	
Compartment H	2,650 ha	
4. Water Source		
- Kerian Laut Sub-Scheme	Bukit Merah Reservoir and Kerian River	
- Kerian Darat Sub-Scheme	Bukit Merah Reservoir	
5. Intake Method		
- Kerian Laut Sub-Scheme	Gravity (Bukit Merah Reservoir) + pump (Bogak P/S)	
	Bukit Merah Reservoir	Huge weed in the reservoir
	Storage capacity : 56 million m3	
	Catchment area : 480 km2	
	Reservoir area : 34 km2	
	Intake gate : 1.83 m x 2.13 m x 6 nos.	
	Bogak Pumping Station	
	Electrical pump 5.1 m3/sec/each ,4 nos.	
- Kerian Darat Sub-Scheme	Gravity (Bukit Merah Reservoir)	
6. Designed Intake Discharge		
- Bukit Merah Reservoir	35.3 m3/sec	
- Bogak Pump Station	5.1 m3/sec/each x 4 nos.	
7. Unit Field Water Requirement	2.3 lit/sec/ha at peak	
8. Irrigation Facilities		
Main canal	62.7 km	
Secondary canals	343.0 km	
Tertiary canals	320.1 km	lined with concrete
Related Structures	2,524 nos.	
9. Drainage Facilities		
Main & Secondary drains	570 km	
Tertiary drain	473 km	
10. Farm Road	700 km	

Table 2.1.7 General Features of Irrigation and Drainage (Sungai Manik Scheme)

Description	Features	Remarks
1. Number and Name of Sub-area	*2 sub-schemes* - Labu Kubong Sub-Scheme - Sg. Manik Sub-Scheme	
2. Number and Name of Irrigation Block - Labu Kubong Sub-Scheme - Sg. Manik Sub-Scheme	*9 blocks* 4 blocks (Block 4A, 4B, 5A, 5B) 5 blocks (Block 1A, 1B, 2, 3A, 3B)	
3. Net Irrigation Area	*6,318 ha*	
- Labu Kubong	2,716 ha	
Block 4A	756 ha	
Block 4B	855 ha	
Block 5A	631 ha	
Block 5B	474 ha	
- Sg. Manik	3,602 ha	
Block 1A	633	
Block 1B	644	
Block 2	1,000	
Block 3A	707	
Block 3B	618	
4. Water Source	Sungai Batang Padan	
5. Intake Method		
- Block 4A, 4B, 5A, 5B, 1A, 1B, 2, 3A	Gravity (Sungai Manik Headworks)	
- Block 3B	Pumping (Chikus Pump Station)	
6. Designed Intake Discharge		
- Sg. Manik Headworks	16.99 m3/sec	
- Chikus Pump Station	0.85 m3/sec	
7. Unit Field Water Requirement	2.80 l/sec/ha at peak	
8. Irrigation Facilities		
Sungai Manik Headworks	Gated weir : Roller gate 6 nos.	Motor driving
	Intake gate : Roller gate 1.5m x 2.5 m x 5 nos.	
Chikus Pump Station	0.43 m3/sec/each x 3 nos.	
Left main canal	1.5 km	
Right main canal	11.9 km	Sediment in canal
Secondary canal	51.2 km	Concrete lining 5.8 km
Tertiary canal	186.5 km	Concrete lining 51.4 km in Labu Kubong
Related structures	422 nos	
9. Drainage Facilities		
Main & secondary drain	61km	
Teriaty drain	181km	
Drainage control gate (tidal gate)	3 nos.	
10. Farm Road	245.3 km	Laterite pavement, 3 m width along main & secondary, 1.8 m width along tertiary canal

Table 2.1.8 General Features of Irrigation and Drainage (Seberang Perak Scheme)

Description	Features	Remarks
1. Number and Name of Sub-Scheme	*2 sub-schemes* - Left Branch Canal Sub-Scheme - Right Branch Canal Sub-Scheme	
2. Number and Name of Irrigation Block - Left Branch Canal Sub-Scheme - Right Branch Canal Sub-Scheme	*7 bloks* 4 blocks (Block A, B, C, D) 3 blocks (Block E, F, G)	
3. Net Irrigation Area	*8,708 ha*	
- Left Branch Canal Sub-Scheme	*4,365 ha*	
Block-A	881 ha	
Block-B	634 ha	
Block-C	1,692 ha	
Block-D	1,158 ha	
- Right Branch Canal Sub-Scheme	*4,343 ha*	
Block-E	1,528 ha	
Block-F	1,384 ha	
Block-G	1,431 ha	
4. Water Source	Sungai Perak	
5. Intake Method	Gravity Free Intake Type (Telok Sena Intake)	
6. Designed Intake Discharge	17.3 m3/sec	
7. Unit Field Water Requirement	2.40 l/sec/ha at peak	
8. Irrigation Facilities		
Telok Sena Intake	Intake gate : 1.50 m x 2.00m x 6 nos.	Manual driving, Steel slide gate
Main canal	8.4 km	Sediment in canal
Left branch canal	22.3 km	
Right branch canal	29.6 km	
Secondary canal	65.9 km	Concrete lining 53.8 km
Tertiary canal	188.6 km	Concrete lining 119.5 km
Related structures	3,075 nos.	
9. Drainage Facilities (including Block H)		
Main & secondary drains	63 km	
Tertiary drain	314 km	
Drainage control gate (tidal gate)	9 nos.	
10. Farm Road	432 km	3.65 width with Laterite surfacing

Table 2.1.9 General Features of Irrigation and Drainage (Kemasin/Semerak Scheme)

Description	Features	Remarks
1. Number and Name of Sub-Scheme	*8 sub-schemes*	
	- Kemasin Hilir	
	- Jelawat Rusa	
	- Semerak Hilir	under design review, no planting presently
	- Semerak Hulu	under design review, no planting presently
	- Semerak Selatan	under design review, no planting presently
	- Semerak Barat	under design review, irrigated by movable pumps
	- Sungai Yong-Gaal	under design review, single cropping
	- Jeram-Rasau	under design review, rainfed area
2. Number and Name of Irrigation Block	*10 blocks*	
- Kemasin Hilir	5 blocks (Block A, B, C, D & E)	
- Jelawat Rusa	5 blocks (Zone A0, B0, C0, B1 & C1)	
3. Irrigation Area including sub-schemes under the design review	6,895 ha	
- Kemasin Hilir	261 ha	
- Jelawat Rusa	1,384 ha	
- Semerak Hilir	1,000 ha	
- Semerak Hulu	174 ha	
- Semerak Selatan	1,100 ha	
- Semerak Barat	115 ha	
- Sungai Yong-Gaal	2,260 ha	
- Jeram-Rasau	601 ha	
4. Water Source		Supplemented from Kada
- Kemasin Hilir	Sungai Kemasin	
- Jelawat Rusa	Sungai Jelawat	
5. Intake Method		
- Kemasin Hilir	Pumping	5 main P/S
- Jelawat Rusa	Pumping	3 main P/S and 2 booster P/S
6. Capacity of Pump Station		
- Kemasin Hilir		
Block-A	137 l/sec/each x 3 nos.	
Block-B	25 l/sec/each x 1 no.	
Block-C	25 l/sec/each x 2 nos.	
Block-D	25 l/sec/each x 3 nos.	
Block-E	125 l/sec/each x 2 nos.	
- Jelawat Rusa		
Block-A	425 l/sec/each x 3 nos.	
Block-B Main P/S	347 l/sec/each x 3 nos.	
Booster P/S	192 l/sec/each x 4 nos.	
Block-C Main P/S	397 l/sec/each x 4 nos.	
Booster P/S	146 l/sec/each x 4 nos.	
7. Unit Field Water Requirement		
- Kemasin Hilir	2.06 l/sec/ha at peak	
- Jelawat Rusa	2.06 l/sec/ha at peak	
8. Irrigation Facilities		
- Kemasin Hilir		
Tertiary canal	8.7 km	Concrete block lining
Related structures	94 nos.	
- Jelawat Rusa		
Main canal	17.9 km	
Tertiary canal	27.4 km	Concrete block lining
Related structures	240 nos.	
9. Drainage Facilities		
- Kemasin Hilir		
Tertiary drain	3 km	
Related structures	13 nos.	
- Jelawat Rusa		
Main drain	27 km	
Secondary drain	20 km	
Tertiary drain	8 km	
Related structures	21 nos.	
- Tidal Gate at Sg. Kemasin		
Type of gate	Electrical roller gate	
Size and number of gate	5.1 m x 4.5 m x 6 nos.	
Power source	Public electricity & Generator (100 kvA 1 no.)	
10. Farm Road	89 km	3 m width with gravel pavement

Table 2.1.10 General Features of Irrigation and Drainage (Besut Scheme)

Description	Features	Remarks
1. Number and Name of Sub-Scheme	*2 sub-schemes* - Angga Sub-Scheme - Besut Sub-Scheme	
2. Number and Name of Irrigation Block	*4 blocks*	
- Angga Sub-Scheme	1 block (Compatment 2)	
- Besut Sub-Scheme	3 blocks (Compatment 1, 3 & 4)	
3. Net Irrigation Area	5,164 ha	
- Angga Sub-Scheme	1,148 ha	
Compatment 2	1,148 ha	
- Besut Sub-Scheme	4,016 ha	
Compatment 1	1,235 ha	
Compatment 3	1,306 ha	
Compatment 4	1,475 ha	
4. Water Source		
- Angga Sub-Scheme	Sungai Angga	
- Besut Sub-Scheme	Sungai Besut	
5. Intake Method		
- Angga Sub-Scheme	Gravity (Angga Barrage)	
- Besut Sub-Scheme	Gravity (Besut Barrage)	
6. Designed Intake Discharge		
- Angga Barrage	3.12 m3/sec	
- Besut Barrage	9.02 m3/sec	
7. Unit Field Water Requirement		
- Angga Sub-Scheme	2.33 l/sec/ha at peak	
- Besut Sub-Scheme	2.33 l/sec/ha at peak	
8. Irrigation Facilities		
- Angga Sub-Scheme		
Angga Barrage	Barrage : Radial gate (7.6 m x 1.2 m x 2nos. Intake gate : Sluice gate (1.3 m x 1.0 m x 2 nos.)	no operation of intake gates due to their damages
Main canal	14.9 km	Sediment in Angga main canal
Secondary canal	20.3 km	Concrete lining 13 km
Tertiary canal	16.0 km	
Related structures	60 nos.	
- Besut Sub-Scheme		
Besut Barrage	Barrage : Roller gate (12.32m x 2.95 m x 4 nos.) Intake gate : Slide gate (1.93m x 2.49m x 3 nos.)	Water leakage
Main canal	32.1 km	Concrete lining 28 km
Secondary canal	65.7 km	Concrete lining 56 km
Tertiary canal	100.5 km	Concrete lining
Related structures	242 nos	
9. Drainage Facilities		
Main & secondary drains	177 km	
Tertiary drain	64 km	
10. Farm Road	241 km	

Table 2.1.11 Crop Budget for Each Granary Area

	Unit	Pulau Pinang			Kenan			Sungai Manik			Seberang Perak			Keamsin Semerak			Besut			Changkat Jong		
		Qty	Price	Cost	Qty	Price	Cost	Qty	Price	Cost	Qty	Price	Cost	Qty	Price	Cost	Qty	Price	Cost	Qty	Price	Cost
Gross Income																						
1. Paddy production	kg	3,090	0.7442	2299.6	2,990	0.7442	2,225	2,990	0.7442	2,225	3,520	0.7442	2619.6	2,770	0.7442	2,061	3460	0.7442	2574.9	7,952	0.7442	5,918
Production Cost				1,284			1,339			1,403			1,562			1,448			1,721			2,683
1. Material Cost				427			343.32			463.9			556			503.8			649			696.12
1) Seed	kg	80	1.0	80	100	1.0	100	100	1.0	100	100	1.0	100	60	1.0	60	50	1.0	50	100	1.0	100
2-1) Fertilizer (Subsidised)				150			120			150			150			160.8			196.5			150
17.5:15.5:10	kg	200	0.48	96		0.48	0	200	0.48	96	200	0.48	96	200	0.48	96	200	0.48	96	200	0.48	96
35:31:20	kg		0.48	0	80	0.48	38.4		0.48	0		0.48	0		0.48	0		0.48	0		0.48	0
12:12:17	kg		0.48	0		0.48	0		0.48	0		0.48	0		0.48	0	125	0.48	60		0.48	0
15:15:15	kg		0.48	0	125	0.48	60		0.48	0		0.48	0		0.48	0		0.48	0		0.48	0
Urea	kg	100	0.54	54	40	0.54	21.6	100	0.54	54	100	0.54	54	120	0.54	64.8	75	0.54	40.5	100	0.54	54
2-2) Fertilizer (Non-Subsidised)				72			0			24			126			60			40.5			150.72
16:16:16	kg	150	0.48	72		0.48	0		0.48	0		0.48	0		0.48	0		0.48	0		0.48	0
15:15:15	kg		0.48	0		0.48	0	50	0.48	24		0.48	0		0.48	0		0.48	0	125	0.48	60
12:9:22.3	kg		0.48	0		0.48	0		0.48	0	150	0.48	72		0.48	0		0.48	0		0.48	0
Urea	kg		0.54	0		0.54	0		0.54	0	100	0.54	54		0.54	0	75	0.54	40.5	168	0.54	90.72
Baja Makmur	kg		0.48	0		0.48	0		0.48	0		0.48	0	125	0.48	60		0.48	0		0.48	0
3) Agro-chemical				125			123.3			189.9			180			223			362			295.4
Pesticide	lit			41			92.1			103.1			90			183			175			110
Weedicide	lit			84			31.3			86.8			90			40			187			185.4
II. Labor Cost				268			217			144			144			264			322			168
Land preparation	md	2.5	20	50		20.0	0		20.0			20.0	0		12.0		6	12.0	72		20.0	
Sowing	md	0.1	20	2	0.6	20.0	12	0.6	20.0	12.5	0.6	20.0	12	3	12.0	36	3.3	12.0	39.6	0.6	20.0	12
Replacing	md	2.5	20	50	3.7	20.0	74		20.0	0		20.0	0		12.0	0	2	12.0	24		20.0	0
Fetrilizaer Application	md	3.7	20	74	1.6	20.0	32	1.9	20.0	37.5	1.9	20.0	38	5	12.0	60	8	12.0	96	3.55	20.0	71
Chemical Application	md	2.4	20	48	2.8	20.0	55	2.5	20.0	50	2.5	20.0	50	14	12.0	168	7.5	12.0	90	4.25	20.0	85
Irrigation	md	2.2	20	44	2.2	20.0	44	2.2	20.0	44	2.2	20.0	44		12.0	0		12.0	0		20.0	0
III. Machinery				504			679.2			700.43			761.21			589.2			648.04			1628.8
Tractor	times	2		199			185			181.25			150			250			300			167
Sprayer	hrs																					
Combine	times	1		249	1		445	2.99	53.0	445	3.52	53.0	524	53	6.0	318	40.7	6.0	244.24	7.95	45.0	1,184
Transport		1		56	41	1.2	49.2	2.99	24.8	74.152	3.52	24.8	87.296	53	0.4	21.2	3.46	30.0	103.8	7.95	35.0	278.31
IV. Miscellaneous				85.2			99.62			94.443			100.52			91.32			101.96			189.68
Net Return																						
With Subsidized Fertilizer				1,165			1,006			972			1,208			774			1,051			3,385
Without Subsidized Fertilizer				1,015			886			822			1,058			613			854			3,235

Table 4.1.1 Rehabilitation and Improvement Plan of System Infrastructure (Master Plan)

(1/2)

Name of Scheme	Rehabilitation/Improvement Plan
IADP Pulau Pinang	*I. Improvement of Irrigation and Drainage Facilities* - Concrete lining including removal of sediment (main canal 35 km, secondary canal 79 km) - Construction of regulating structure (main canal 6 nos., secondary canal 12 nos.) - Repair of damaged structures (2 nos.) - Desilting of drains (tertiary drains 40 km) - Pavement of farm road (asphalt pavement 11 km) - Widening of farm road along tertiary canals (100 km) *II Provision of Water Management Facilities* - Installation of water level stations at main pump stations, intake and major diversion point on main and secondary canals - Installation of rainfall stations (4 locations) - Provision of remote control facilities for major gates and pumps
IADP Kerian	*I. Improvement of Irrigation and Drainage Facilities* - Construction of new drains (17 km) - Desilting of existing drains (570 km) - Construction of bunds (150 km) - Construction and repair of drainage gates (2 locations) - Construction of drainage control structures - Concrete lining including removal of sediment (main canal 62 km, secondary canal 40 km) - Construction of regulating structure (main canal 7 nos., secondary canal 8 nos.) - Repair of damaged structures (16 nos.) - Pavement of farm road (asphalt pavement 40 km) - Widening of farm road along tertiary canals (100 km) *II Provision of Water Management Facilities* - Installation of water level stations at Bukit Merah reservoir intake, Bogak pump station and major diversion point on main and secondary canals - Installation of rainfall stations (4 locations) - Provision of remote control facilities for major gates and pumps
IADP Sungai Manik	*I. Improvement of Irrigation and Drainage Facilities* - Construction of settling basin at downstream of intake structure - Concrete lining (secondary canal 51 km, tertiary canal 135 km) - Construction of regulating structure (secondary canal 2 nos.) - Construction of road crossing structures (4 nos.) - Repair of damaged structures (54 nos.) - Desilting of drains (main drain 12 km) - Pavement of farm road (asphalt pavement 13 km) - Widening of farm road along tertiary canals (42 km) *II Provision of Water Management Facilities* - Installation of water level stations at intake and major diversion point on main and secondary canals - Installation of rainfall stations (2 locations) - Provision of remote control facilities for major gates
IADP Seberang Perak	*I. Improvement of Irrigation and Drainage Facilities* - Removal of sediment in canal (46 km) - Concrete lining (secondary canal 12 km, tertiary canal 69 km) - Construction of regulating structure (5 nos.) - Construction of spillway on main canal - Repair of damaged structures (53 nos.) - Desilting of drains (main drain 13 km) - Construction of farm road (6 km) - Widening of farm road along tertiary canals (35 km) *II Provision of Water Management Facilities* - Installation of water level stations at intake and major diversion point on main and secondary canals - Installation of rainfall stations (2 locations) - Provision of remote control facilities for major gates including motorization of intake and bifurcation gates

Table 4.1.1 Rehabilitation and Improvement Plan of System Infrastructure (Master Plan)

Name of Scheme	Rehabilitation/Improvement Plan
IADP Kemasin/Semerak	*I. Improvement of Irrigation and Drainage Facilities* - Repair of damaged structures (9 nos.) - Desilting of drains (main drain 20 km) - Widening of farm road along tertiary canals (36 km) *II Provision of Water Management Facilities* - Installation of water level stations at major pump stations - Installation of rainfall stations (2 locations)
IADP Besut	*I. Improvement of Irrigation and Drainage Facilities* - Replacement of Angga Barrage - Repair of Besut Barrage gates (4 nos.) - Concrete lining (main & secondary canals 26 km, tertiary canal 3 km) - Heightening of existing lining canal (12 km) - Construction of regulating structure (6 nos.) - Repair of damaged structures (74 nos.) - Desilting of drains (main drain 16 km) - Construction of farm road (6 km) - Construction of drainage control structures (15 nos.) - Pavement of farm road (asphalt pavement 8 km) - Widening of farm road along tertiary canals (27 km) *II Provision of Water Management Facilities* - Installation of water level stations at Angga & Besut Barrage and major diversion point on main and secondary canals - Installation of rainfall stations (3 locations) - Provision of remote control facilities for major gates

Table 4.1.2 Proposed Cropping Intensity based on the Proposed Cropping Pattern

IADP	Irr. area (ha)	Pl/Seed Method	Main Area	Main %	Pl/Seed Method	Off Area	Off %	Pl/Seed Method	Total Area	Total %
Pulau Pinang	9,601	WD	9,601	100.0%	WD	9,601	100.0%	WD	19,202	200.0%
		DD			DD			DD	0	
		Sub-Total	9,601	100.0%	Sub-Total	9,601	100.0%	Sub-Total	19,202	200.0%
Kerian	23,560	WD	19,555	83.0%	WD	0	0.0%	WD	19,555	83.0%
		DD	4,005	17.0%	DD	23,560	100.0%	DD	27,565	117.0%
		Sub-Total	23,560	100.0%	Sub-Total	23,560	100.0%	Sub-Total	47,120	200.0%
Sungai Manik	6,318	WD	6,318	100.0%	WD	6,318	100.0%	WD	12,636	200.0%
		DD			DD			DD		
		Sub-Total	6,318	100.0%	Sub-Total	6,318	100.0%	Sub-Total	12,636	200.0%
Seberang Perak	8,708	WD	8,708	100.0%	WD	8,708	100.0%	WD	17,416	200.0%
		DD			DD			DD		
		Sub-Total	8,708	100.0%	Sub-Total	8,708	100.0%	Sub-Total	17,416	200.0%
Kemasin/ Semerak	6,895	WD	6,895	100.0%	WD	6,895	100.0%	WD	13,790	200.0%
		DD			DD			DD		
		Sub-Total	6,895	100.0%	Sub-Total	6,895	100.0%	Sub-Total	13,790	200.0%
Ketara (Besut)	5,164	WD	5,164	100.0%	WD	3,098	60.0%	WD	8,262	160.0%
		DD			DD	775	15.0%	DD	775	15.0%
		Sub-Total	5,164	100.0%	Sub-Total	3,098	60.0%	Sub-Total	8,262	175.0%
5 Granaries (Study Area)	60,246	WD	56,241	93.4%	WD	34,620	57.5%	WD	90,861	150.8%
		DD	4,005	6.6%	DD	24,335	40.4%	DD	28,340	47.0%
		Sub-Total	60,246	100.0%	Sub-Total	58,955	97.9%	Sub-Total	119,201	197.9%

WD: Wet Direct Seeding

DD: Dry Direct Seeding (germination depend on irrigation waer)

Table 4.1.3 Proposed Farming Practices

(Unit: ha)

Activities	Kind and Amount of Inputs		Man-hr Wet	Man-hr Dry
I. Land preparation				
Wet direct seeding				
1 1st Rotavation	Tractor + Rotavator	1 round	2.0	
2 2nd Rotavation	Tractor + Rotavator	1 round	1.8	
3 Puddling	Tractor + Paddy Harrow	1 round	1.4	
Dry direct seeding				
1 1st Rotavation	Tractor + Rotavator	1 round		1.9
2 2nd Rotavation	Tractor + Rotavator	1 round		1.7
II. Seeding	Seed rate	60 - 80kg/ha		
Wet Seeding	Tractor + Power Blower/Granule applicator or Broadcaster		1.0	
Dry Seeding	Tractor + Power Blower/Granule applicator or Broadcaster			1.0
Pressing	Tractor + Roter bucket/Land Roller			1.0
III. Fertilizing				
Lime or MgO Application (if necessary)			2.0	2.0
	Tractor + Lime sower			
Lime		2.5ton/ha		
MgO		130kg/ha		
1 1st Top dressing	Tractor + Granule applicator/Power		1.2	1.2
2 2nd Top dressing	Brower or Broadcaster		1.2	1.2
3 3rd Top dressing			1.2	1.2
Fertilizer	N:P2O5:K2O=100 - 120:30-50:30-40			
	Subsidy: Mixture 200kg, Urea 100kg			
	Additional: Mix: 100kg			
	Urea 40kg			
IV. Pest and Weed control				
1 Weed control				
Wet direct seeding	Tractor + Granule Applicator, Carpet Dustor, Boom Sprayer			
2 times			2.4	
Dimepiperate/Bensulfuron-methyl (Yukamate/Push)		30-40kg/ha		
2,4PA (2,4-D amine)		30-45kg/ha		
Dry direct seeding	Tractor + Granule Applicator, Carpet Dustor, Boom Sprayer			
3 times				3.1
Thiobencarb (Saturn)		6000-12000ml/ha		
Thiobencarb (Saturn)		30-40kg/ha		
2,4PA (2,4-D amine)		30-45kg/ha		
2 Pest Control	Tractor + Granule Applicator, Carpet Dustor, Boom Sprayer			
2 times				
BPMC (fenobucarb)		30kg/ha	1.9	1.9
Buprofezin		600cc/ha		
3 Rat control	Tractor			
2 times	Drat	250ml/ha	1.3	1.3
V. Harvesting				
1 Harvesting	Combinharvester with chopper		1.0	1.0
2 Transportation	Lorry			
VI Preparatory Work			2.0	2.0
VII Others			10.0	10.0
Total			30.4	30.3

Table 4.2.1 Environmental check-list of the International Commission on Irrigation and Drainage

Category	Check Items	Positive impact very likely	Positive impact possible	No impact likely	Negative impact possible	Negative impact likely	No judgement possible at present	Comments
	Level of impacts	A	B	C	D	E	F	
Hydrology	1-1 Low flow regime						X	
	1-2 Flood regime			X				
	1-3 Operation of dams			X				
	1-4 Fall of water table						X	
	1-5 Rise of water table			X				
Pollution	2-1 Solute dispersion			X				
	2-2 Toxic substances						X	
	2-3 Organic pollution			X				
	2-4 Anaerobic effects			X				
	2-5 Gas emissions			X				
Soils	3-1 Soil salinity			X				
	3-2 Soil properties			X				
	3-3 Saline groundwater			X				
	3-4 Saline drainage			X				
	3-5 Saline intrusion			X				
Sediments	4-1 Local erosion			X				
	4-2 Hinterland effect			X				
	4-3 River morphology			X				
	4-4 Channel regime			X				
	4-5 Sedimentation			X				
	4-6 Estuary erosion			X				
Ecology	5-1 Project lands			X				
	5-2 Water bodies						X	
	5-3 Surrounding areas						X	
	5-4 Valleys & shores			X				
	5-5 Wetlands & plains			X				
	5-6 Rare species			X				
	5-7 Animal migration			X				
	5-8 Natural industry			X				
Socio-economic	6-1 Population change			X				
	6-2 Income & amenity		X					
	6-3 Human migration						X	
	6-4 Resettlement			X				
	6-5 Women's role						X	
	6-6 Minority groups			X				
	6-7 Sites of value		X					
	6-8 Regional effects		X					
	6-9 User involvement		X					
	6-10 Recreation			X				
Health	7-1 Water & sanitation						X	
	7-2 Habitation			X				
	7-3 Health services			X				
	7-4 Nutrition			X				
	7-5 Relocation effect			X				
	7-6 Disease ecology			X				
	7-7 Disease hosts			X				
	7-8 Disease control			X				
	7-9 Other hazards			X				
Imbalance	8-1 Pests & weeds						X	
	8-2 Animal diseases			X				
	8-3 Aquatic weeds			X				
	8-4 Structural damage			X				
	8-5 Animal imbalances			X				
	Total Number	0	4	40	0	0	9	

Table 4.3.1 Initial Investment Cost (Master Plan)

Unit : RM

Scheme	Civil Works			Water Management / Monitoring System			Grand Total
	System Infrastructure	Infield Facilities	Total	Telemetry / Telecontrol System	Feedback System	Total	
Kerian	78,379,000	21,881,000	100,260,000	14,630,000	869,300	15,499,300	115,759,300
Besut	26,796,000	2,435,000	29,231,000	3,524,000	922,800	4,446,800	33,677,800
Pulau Pinang	32,060,000	4,316,000	36,376,000	9,387,000	920,000	10,307,000	46,683,000
Sungai Manik	28,198,000	2,911,000	31,109,000	5,775,000	609,700	6,384,700	37,493,700
Seberang Perak	20,288,000	1,814,000	22,102,000	8,121,000	863,700	8,984,700	31,086,700
Kemasin/Semerak	1,700,000	861,000	2,561,000	830,000	821,300	1,651,300	4,212,300

Table 4.3.2 Cost of Improvement Works for System Infrastructure (1/2) (Master Plan)

Kerian Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Concrete Lining of Canals	42,972,000
Improvement of Drainage Facilities	13,089,000
Improvement of Farm Roads	3,759,000
Improvement of Related Structures	471,000
Total	60,291,000
2. Physical Contingency	9,044,000
3. Engineering Cost	6,029,000
4. Administration Cost	3,015,000
Grand Total	78,379,000

Besut Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Replacement of Besut Barrage Gates	8,000,000
Construction of New Angga Barrage	1,800,000
Concrete Lining of Canals	7,659,000
Improvement of Drainage Facilities	534,000
Improvement of Farm Roads	1,440,000
Improvement of Related Structures	1,179,000
Total	20,612,000
2. Physical Contingency	3,092,000
3. Engineering Cost	2,061,000
4. Administration Cost	1,031,000
Grand Total	26,796,000

Pulau Pinang Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Concrete Lining of Canals	22,473,000
Improvement of Drainage Facilities	99,000
Improvement of Farm Roads	1,860,000
Improvement of Related Structures	230,000
Total	24,662,000
2. Physical Contingency	3,699,000
3. Engineering Cost	2,466,000
4. Administration Cost	1,233,000
Grand Total	32,060,000

Table 4.3.2 Cost of Improvement Works for System Infrastructure (2/2) (Master Plan)

Sungai Manik Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Construction of Settling Basin	113,000
Concrete Lining of Canals	18,600,000
Improvement of Drainage Facilities	74,000
Improvement of Farm Roads	2,095,000
Improvement of Related Structures	808,000
Total	21,690,000
2. Physical Contingency	3,254,000
3. Engineering Cost	2,169,000
4. Administration Cost	1,085,000
Grand Total	28,198,000

Seberang Perak Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Concrete Lining of Canals	10,253,000
Desilting of Irrigation Canals	202,000
Improvement of Drainage Facilities	32,000
Improvement of Farm Roads	331,000
Replacement of Intake Gates	3,888,000
Improvement of Related Structures	900,000
Total	15,606,000
2. Physical Contingency	2,341,000
3. Engineering Cost	1,561,000
4. Administration Cost	780,000
Grand Total	20,288,000

Kemasin/Semerak Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Concrete Lining of Canals	38,000
Improvement of Drainage Facilities	153,000
Improvement of Farm Roads	964,000
Improvement of Related Structures	153,000
Total	1,308,000
2. Physical Contingency	196,000
3. Engineering Cost	131,000
4. Administration Cost	65,000
Grand Total	1,700,000

Table 4.3.3 Cost of Improvement Works for In-field Infrastructure (1/2) (Master Plan)

Kerian Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	5,700,000
Infield Channel	964,000
Control Box	508,000
Tramline	9,659,000
Total	16,831,000
2. Physical Contingency	2,525,000
3. Engineering Cost	1,683,000
4. Administration Cost	842,000
Grand Total	21,881,000

Besut Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	1,443,000
Infield Channel	244,000
Control Box	186,000
Total	1,873,000
2. Physical Contingency	281,000
3. Engineering Cost	187,000
4. Administration Cost	94,000
Grand Total	2,435,000

Pulau Pinang Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	2,665,000
Infield Channel	451,000
Control Box	204,000
Total	3,320,000
2. Physical Contingency	498,000
3. Engineering Cost	332,000
4. Administration Cost	166,000
Grand Total	4,316,000

Table 4.3.3 Cost of Improvement Works for In-field Infrastructure (2/2) (Master Plan)

Sungai Manik Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	1,793,000
Infield Channel	307,000
Control Box	139,000
Total	2,239,000
2. Physical Contingency	336,000
3. Engineering Cost	224,000
4. Administration Cost	112,000
Grand Total	2,911,000

Seberang Perak Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	1,118,000
Infield Channel	190,000
Control Box	87,000
Total	1,395,000
2. Physical Contingency	209,000
3. Engineering Cost	140,000
4. Administration Cost	70,000
Grand Total	1,814,000

Kemasin/Semerak Scheme

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	510,000
Infield Channel	87,000
Control Box	66,000
Total	663,000
2. Physical Contingency	99,000
3. Engineering Cost	66,000
4. Administration Cost	33,000
Grand Total	861,000

Table 4.3.4 Cost for Establishment of Telemetry and Telecontrol Facilities
(Master Plan)

Name of Scheme	Central Station	Repeater Station	Water Level Gauge inc. RTU	Rainfall Gauge inc. RTU	Remote Gate/ Pump	Total Direct Cost	Physical Contingency	Engineering Cost	Administration Cost	Grand Total
Kerian	266,000	39,000	1,212,000	43,000	9,694,000	11,254,000	1,688,000	1,125,000	563,000	14,630,000
Besut			974,000	24,000	1,712,000	2,710,000	407,000	271,000	136,000	3,524,000
Pulau Pinang	266,000		1,344,000	29,000	5,582,000	7,221,000	1,083,000	722,000	361,000	9,387,000
Sg. Manik	266,000		532,000	49,000	3,596,000	4,443,000	666,000	444,000	222,000	5,775,000
Sb. Perak	266,000		1,150,000	5,000	4,826,000	6,247,000	937,000	625,000	312,000	8,121,000
Kemasin/Semerak	266,000		345,000	27,000		638,000	96,000	64,000	32,000	830,000

Table 4.3.5 Cost for Establishment of Monitoring and Feedback Facilities
(Master Plan)

Name of Scheme	Direct Cost	Physical Contingency	Engineering Cost	Administration Cost	Total
Kerian	668,600	100,300	66,900	33,500	869,300
Besut	709,800	106,500	71,000	35,500	922,800
Pulau Pinang	707,600	106,200	70,800	35,400	920,000
Sg. Manik	468,900	70,400	46,900	23,500	609,700
Sb. Perak	664,200	99,700	66,500	33,300	863,700
Kemasin/Semerak	631,700	94,800	63,200	31,600	821,300

Table 4.5.1 Comparison of Five Granary Schemes for Selection of Priority Schemes

Item	Name of Scheme					
	Pulau Pinang	Kerian / Sungai Manik		Seberang Perak	Kemasin Semerak	Ketara (Besut)
		Kerian	Sg. Manik			
(1) Location	Wesst Coast / Pulau Pinang State	Wesst Coast / Perak State	Wesst Coast / Perak State	Wesst Coast / Perak State	East Coast / Kelantan State	East Coast / Terenganu State
(2) Scale (Irrigation Area : ha)	9,832	23,560	6,318	8,708	6,895	5,164
(3) Water Availability	Relatively severe	Not so severe	No problem	No problem	Severe	Severe
(4) Irrigation & Drainage Facilities	Completed / necessity of improvement	Completed / necessity of improvement	Completed / necessity of improvement	Completed / necessity of improvement	Not yet completed	Completed / necessity of improvement
(5) Water Management Sysytem	No telemetry system	Telemetry system exists but not completed.	No telemetry system	No telemetry system	No telemetry system	No telemetry system
(6) Cropping Intensity (Average in 1990 - 1994 : %)	189	164	191	191	57	163
(7) Unit Yield of Paddy (Average in 1990 - 1994 : ton/ha)	2.80	2.94	3.05	3.53	2.82	3.18
(8) Farm Income (RM/Year)	6,407	1,693	3,479	3,713	1,409	2,784
(9) Farm-based Organization						
- Under DOA	108	50	11	6	6	30
- Under PPK	33	31	8	1	13	-
- Estate/Mini estate	2	-	-	1	-	-
(10) Competetion with Indusrialization	Very severe	Severe	Not so severe	Not so severe	Not so severe	Not so severe

Table 4.5.2 Disbursement Schedule (Master Plan)

Unit : x 1000 RM

Scheme \ Year	1999	2000	2001	2002	2003	2004	2005	2006	Total
I. Kerian Scheme									
1. Improvement of System Infrastructures	22,388	22,388	19,638	13,966					78,379
2. Improvement of In-field Infrastructures	2,735	2,735	2,735	2,735	2,735	2,735	2,735	2,735	21,881
3. Water Management / Monitoring System	5,326	5,087	5,034	53					15,499
4. Training of Water Users Group	77	77	128	27	28				337
Total	**30,526**	**30,287**	**27,535**	**16,781**	**2,763**	**2,735**	**2,735**	**2,735**	**116,096**
II. Besut Scheme									
1. Improvement of System Infrastructures	11,696	11,002	4,099						26,796
2. Improvement of In-field Infrastructures	304	304	304	304	304	304	304	304	2,435
3. Water Management / Monitoring System	2,153	2,085	209						4,447
4. Training of Water Users Group	42	6	42	6	6				102
Total	**14,195**	**13,397**	**4,654**	**310**	**310**	**304**	**304**	**304**	**33,780**
III. Pulau Pinang Scheme									
1. Improvement of System Infrastructures	8,941	8,513	7,304	7,304					32,060
2. Improvement of In-field Infrastructures	540	540	540	540	540	540	540	540	4,316
3. Water Management / Monitoring System	3,630	3,339	3,233	105					10,307
4. Training of Water Users Group	100	100	143	15	15				373
Total	**13,210**	**12,491**	**11,219**	**7,963**	**555**	**540**	**540**	**540**	**47,056**
IV. Sungai Manik Scheme									
1. Improvement of System Infrastructures	8,628	7,481	6,045	6,045					28,198
2. Improvement of In-field Infrastructures	364	364	364	364	364	364	364	364	2,911
3. Water Management / Monitoring System	2,888	3,192	305						6,385
4. Training of Water Users Group	8	52	51	8	8				127
Total	**11,887**	**11,089**	**6,765**	**6,417**	**372**	**364**	**364**	**364**	**37,621**
V. Seberang Perak Scheme									
1. Improvement of System Infrastructures	8,159	7,687	4,443						20,288
2. Improvement of In-field Infrastructures	227	227	227	227	227	227	227	227	1,814
3. Water Management / Monitoring System	4,061	4,348	288	288					8,985
4. Training of Water Users Group	5	52	5	5	5				72
Total	**12,451**	**12,314**	**4,963**	**520**	**232**	**227**	**227**	**227**	**31,159**
VI. Kemasin/Semerak Scheme									
1. Improvement of System Infrastructures	1,074	627							1,700
2. Improvement of In-field Infrastructures	287	287	287						861
3. Water Management / Monitoring System	415	415	0	0	506	158	157		1,651
4. Training of Water Users Group	24	71	71	24	23				213
Total	**1,800**	**1,400**	**358**	**24**	**529**	**158**	**157**	**0**	**4,425**
VII. Whole Schemes									
1. Improvement of System Infrastructures	60,883	57,695	41,528	27,314	0	0	0	0	187,421
2. Improvement of In-field Infrastructures	4,457	4,457	4,457	4,170	4,170	4,170	4,170	4,170	34,218
3. Water Management / Monitoring System	18,472	18,466	9,068	446	506	158	157	0	47,273
4. Training of Water Users Group	256	358	440	85	85	0	0	0	1,224
Grand Total	**84,068**	**80,976**	**55,493**	**32,015**	**4,761**	**4,328**	**4,327**	**4,170**	**270,136**

Note : Costs for improvement of system infrastructures and in-field infrastructures show for Jelawat Rusa and Kemasin Hilir sub-schemes.

Table 5.1.1 Area-Wise Conditions in Kerian Scheme

Items	Kerian Laut Sub-scheme				Kerian Darat Sub-scheme				Total / Average
	Compartment A	Compartment B	Compartment C	Compartment D	Compartment E	Compartment P	Compartment G	Compartment H	
Parcel Area (ha)	2,403.0	4,001.0	3,960.0	3,362.0	2,344.0	2,697.0	2,143.0	2,650.0	23,560.0
Planted Area (ha)*1	4,243.7	7,258.3	7,069.0	4,726.3	4,313.7	4,659.3	4,106.0	5,061.5	41,437.9
Cropping Intensity (%)	176.6	181.4	178.5	140.6	184.0	172.8	191.6	191.0	175.9
Yield (t/ha)*2	3.7	3.5	4.2	2.7	2.8	2.8	3.2	3.7	3.4
Production (ton)	15,701.7	25,404.2	29,689.8	12,761.1	12,078.3	13,046.1	13,139.2	18,727.6	140,547.9
Irrigation Schedule									
- Main season	from late Nov. to early Apr.	from late Nov. to early Apr.	from late Nov. to early Apr.	from early Mar. to late Jul.	from early Mar. to late Jun.	from early Mar. to late Jun.	from early Apr. to mid Aug.	from early Mar. to late Jul.	
- Off season	from late Jul. to early Dec.	from late Jul. to early Dec.	from late Jul. to early Dec.	from early Sep. to late Jan.	from early Sep. to early Jan.	from early Sep. to mid Dec.	from early Oct. to mid Feb.	from early Oct. to late Jan.	
Planting Method*1	DS:33%	DS: 9%	DS: 13%	DS: 46%	DS: 58%	DS: 84%	DS: 67%	DS: 84%	DS: 46%
Land Preparation*1	Mech: 44%	Mech: 40%	Mech: 52%	Mech: 58%	Mech: 78%	Mech: 86%	Mech: 90%	Mech: 88%	Mech: 65%
Varieties Used*1	MR84, Semarak, Lain2, 101, Saari								
Fertilizer Application	The majority of farers applies subsidy fertilizer only.								
Harvesting*1	Comb: 45%	Comb: 48%	Comb: 48%	Comb: 55%	Comb: 76%	Comb: 82%	Comb: 71%	Comb: 82%	Comb: 62%
Machinery									
-4 W tractors	1	4	13	9	14	60	80	8	189
-2 W tractors		5		1	5				11
-Combin harvestor	1	4	3	2	3	47	3	4	67
Irrigation System	Canal density : 31 m/ha, earth canal								
Irrigation Condition							Water shortage in off-season		
Drainage System	Drain density : 44 m /ha in average								
Drainage Condition	Poor drainage due to insufficient facilities								
Farm Road	Laterite and non-paved, Road density : approx. 29 m/ha								
Tertiary System	Canal density : 25 m/ha, lined by concrete								
Lots (nos.)	1,955	2,939	2,285	2,624	1,538	1,773	1,385	2,142	16,641
Land Levelling (ha) "done"	0	179	385	1,259	644	647	1,155	902	5,171
"to be done"	2,402	3,822	3,575	2,103	1,700	2,050	675	2,062	18,389
Crop Budget (RM/ha)	Gross Return: RM2,225/ha, Producuon Cost: RM1,219/ha, Net Return: 1,006/ha								
Farm Income (RM/year)*3	Farm Income RM2,989, Non-Farm Income: RM4,627, Total: RM7,616								
Farmers' Organization*4	4	7	10	6	6	5	6	6	50

*1: Source IADP Kerian, 6 seasons average ('94 off season - '96/97 main season) except A (4 season avrage, '94 Off - '95/96 main)

*2: Source IADP Kerian, 11 seasons average ('91/92 ain - '96/97 main)

*3: Farm Income includes non-paddy income and farm wage. (Paddy Income RM1,693, Non-paddy and wage RM1,296)

*4: under DOA

Table 5.1.2 Existing Telemetry Facilities in Kerian Scheme

1. Central Station : Bagan Serai

2. Repeater Station : Bakit Larut

3. Remote Station

Code	Name	Rainfall Gauge	Water Level Gauge
01	Bukit Bertim	1	
02	Jemerang Setar	1	
03	Pondok Tanjung	1	1
04	Bukit Merah Intake	1	1
05	Padang Lalang	1	1
06	Selama	1	1
07	Samagagah	1	1
08	Ampang Jajar	1	1
09	FDC Alor Pongsu		2
10	Alor Pancor	1	
11	Jalan Banjar	1	2
12	Jalan Baru	1	3
13	FDC Kuala Kurau	1	
14	FDC Tg Piandang	1	
15	Sungai Acheh	1	
16	FDC Kubu Gajah	1	
17	FDC Simpang Empat	1	
18	Terusan Selinsing	1	1
19	FDC Kampung Selinsing	1	
20	Sungai Kata		2
21	Kelian Gunung	1	
22	Ibu Bekalan Ijok		1
23	Sungai Merah	1	1
24	(Not used)		
25	Bukit Merah (2)		2

Table 5.1.3 Rehabilitation and Improvement Plan of System Infrastructure (Kerian Scheme)

Work Plan			Remarks
1. Irrigation Canal			
Concrete lining	Main canal Terusan Besar	10 km	from diversion point of main canal Terusan Alor
			Pongus to downstream
	Main canal other than above	52 km	
	Secondary canals		
	TA 564 KN1	3.7 km	
	Panchor 2	3.6 km	
	Kolam 1167 AB	2.2 km	
	TA 74	8.7 km	
	TA 178	6.7 km	
	TA 136	2.0 km	
	TA 206	3.6 km	
	218 K1	5.9 km	
	Air Hitam	3.5 km	
2. Drainage Facilities			
Provision of additional darinage control gate at mouse of Sg. Bharu			
Repair of drainage control gate at mouse of Sg. Burong			
Desilting of drains	Compartment D - F	110 km	
	Compartment A - C	472 km	
Construction of additional outlet pipe	Compartment A - C	800 m	
Contruction of control structure	Compartment A - C	120 nos.	
Construction of bund : 153 km	Compartment A - C	153 km	
Construction of new drain	Compartment A - C	17 km	
Provision of drainage pump	Compartment A - C	10 nos.	
3. Farm road			
Asphalt pavement	along Tersan Besar, Serinsing, Alor		
	Pongus, Tg. Piandang, T. Serong	40 km	
Widening of tertiary roads		100 km	
4. Related structures			
Provision of check structures	on main canal	7 nos.	Key monitoring point
	on secondary canals	8 nos.	Second monitoring point
Replacement of CHO & offtake gate		14 nos.	
Change gate spindle		2 nos.	

Table 5.1.4 Required Works for Control and Monitoring Points (Kerian Scheme)

Kerian Scheme

Point	Location	Required Works				Remarks
		Remote Control Gate Size / Number of Pump	Water Level Gauge nos.	Lining m		
				Primary canal	Branched canal	
Key Control point						
KC1	Intake at Bukit Merah Reservoir	1.85 m x 2.13 m x 6 nos.	2	15		
KC2	Offtake point to Terusan Alor Pongsu	1.50m x 2.00m x 8 nos.	2		15	CHO, proposed lining portion
KC3	Bogak Pump Station	4 nos.	2	15		
KC4	Offtake point to Terusan Tg.Piandang	3.40 m x 3.20 m x 2 nos.	2	30	15	
KC5	Offtake point to TA. 218	1.65 m x 2.60 m x 6 nos.	2	30	15	CHO
Secondary Control Point						
SC1	Offtake point to TA. Kolam 1167	1.20 m x 2.00 m x 3 nos.	2	30	15	
SC2	Offtake point to TA. 74	1.65 m x 2.60 m x 6 nos.	2	30	15	CHO
SC3	Offtake point to TA. 136	1.65 m x 2.60 m x 6 nos.	2	30	15	CHO
Key Monitoring Point						
KM1	Lower reach of offtake for TA. Haji Ali on Terusan Besar		1			proposed lining portion
KM2	Lower reach of offtake for TA. 804 KI, KN on Terusan Besar		1			proposed lining portion
KM3	Lower reach of offtake for TA. Sg. Dungan 1088 on Terusan Besar		1	30		
KM4	Lower reach of offtake for TA. 305 on Terusan T. Serong		1	30		
KM5	Lower reach of offtake for TA. 195 on Terusan Seriosing		1	30		
KM6	Upper reach of offtake for TA. 1B on Terusan Seriosing		1	30		
KM7	Lower reach of offtake for TA. Alor Pongsu 3 on Terusan Alor Pongsu		1	30		
Secondary Monitoring Point						
SM1	Beginning of TA. 315		1	30		
SM2	Beginning of TA. 1B		1	30		
SM3	Beginning of TA. 559 Ki		1	30		
SM4	Beginning of TA. Alor Pongsu 3		1	30		
SM5	Beginning of TA. Panchor 2/1		1	30		
SM6	Beginning of TA. 310 A		1	30		
SM7	Beginning of TA 303		1	30		
SM8	Beginning of TA Air Hitam		1	30		
Tertiary Monitoring Point						
TM1	Beginning of TA Tebok Panchor-A		1	30		
TM2	Beginning of TA Ali Kalang 2		1	30		
TM3	Beginning of TA Hj. Aman 2/1		1	30		
TM4	Beginning of TA Haji Ali		1	30		
TM5	Lower reach of offtake for TA. Ismail 2/1		1	30		
TM6	Lower reach of offtake for TA. 1088 KN-B		1	30		
TM7	Beginning of TA 16		1	30		
TM8	Beginning of TA 206		1	30		
TM9	Beginning of TA Sg. Tongkan		1	30		
TM10	Beginning of Sg. Udang		1	30		
TM11	Beginning of TA 375		1	30		
TM12	Beginning of TA 539		1	30		
TM13	Beginning of TA 564 Kn		1	30		

Table 5.1.5 Soil Classification and Suitability for Paddy in Kerian

	Soil Type and Series	Suitability for Paddy	Area (ha)	Rate (%)
I.	Marine Alluvial Soils			
	Soil Series			
	1 Serong	suitable	9,754.0	27.72%
	2 Bakau	suitable	6,170.1	17.54%
	3 Sabrang	suitable	1,093.5	3.11%
	4 Piandang	marginal	749.3	2.13%
	5 Sedaka	-	245.8	0.70%
	6 Chenan	-	123.1	0.35%
	7 Keranji	unsuitable	11.7	0.03%
	Sub-total		18,147.5	51.58%
II.	Brackish Water Deposits			
	Soil Series			
	1 Beriah	suitable	9,225.9	26.22%
	2 Brown Clay	suitable	1,705.0	4.85%
	3 Sedu	-	180.2	0.51%
	4 Jawa	-	64.8	0.18%
	5 Udang	-	13.4	0.04%
	Sub-total		11,189.3	31.80%
III.	High Organic Matter Soils			
	Soil Series			
	1 Linau	marginal	4,390.0	12.48%
	2 Organic Clay	marginal	1,452.0	4.13%
	Sub-total		5,842.0	16.60%
IV.	Others			
	1 Residental	-	7.3	0.02%
			35,186.1	100.00%

Source: Semi-detailed Soil Servey of the Padi Growing Areas in the Krian District Perak, DOA

	Area (ha)	Rate (%)
Suitable	27,948.5	79.43
Marginal	6,591.3	18.73
Unsuitable	11.7	0.03
ND	634.6	1.80

Table 5.1.6 Proposed Farming Practices for Kerian

Dry Direct Seeding

Days after Seeding	Activities	Input	Remark
-40	Harvesting for Last Season Paddy	Harvestor/manual	
-23	Lime Application Fused magnesium phosphate	GML Lime (2.5ton/ha)	depend on the soil condition (Organic Soil and low pH soil)
-18	1st Land Preparation	4W Tractor + Rotavator	
-7	Rodent/Rat Control	Check or Dra 125 ml	depend on location, either there are rat attack happen or not.
-5	2nd Land Preparation and Land Levelling	4W Tractor + Rotavator	
-1	Selecting Seeds		
0	Seed Sowing and pressing (seed mix with soil)	4W Tractor + Drillseeder + Roterbucket	
0 - 4	Hervicide application before sprouting (1)		(0 - 4 HLT)
5	Water supply		(5 - 8 cm)
25 - 30	Hervicide applicatuon after sprouting (2) Water Control		(5 - 15 HLT) (5 - 10 cm, 5 - 15 HLT)
15-21	1st Fertilizer Application	N:P2O5:K2O= 40:40:30 kg/ha	(15 - 20 HLT)
	Pest control	as required Tractor + Blower or sprayer	4 times fertilizer application for low fertility area 2nd N:40kg/ha 35 HLT 3rd N:20kg/ha 55 HLT 4th N:20kg/ha 75 HLT
45-50	2nd Fertilizer Application	N:40kg/ha	
75 (PIS)	3rd Fertilizer Application	N: 20kg/ha	
	Pest control	as required Tractor + Blower or sprayer	
110	Drainage		
125	Harvesting	Harvester + Lorry	

Wet Direct Seeding

Days after Seeding	Activities	Input	Remark
-40	Harvesting for Last Season Paddy	Harvestor/manual	
-23	Lime Application Fused magnesium phosphate	GML Lime (2.5ton/ha)	depend on the soil condition (Organic Soil and low pH soil)
-18	1st Land Preparation	4W Tractor + Rotavator	15 - 10cm
-15	Water Supply		5 - 8cm
-7	Rodent/Rat Control	Check or Dra 125 ml	depend on location, either there are rat attack happen or not. (-7 - 21 HLT)
-4	Puddling and levelling	4W Tractor + Rotavator Paddy Harrow	(5 - 0 HBT)
-2	Selecting and Soaking Seeds		(2 - 1 HBT)
0	Sowing Sprouting Seeds	Tractor + MGA or Turn Table Wide Blower)	
0 - 4	Hervicide application before sprouting (1)		(0 - 4 HLT)
25 - 30	Hervicide application after sprouting (2) Water Control		(5 - 15 HLT) (5 - 10 cm, 5 - 15 HLT)
15	1st Fertilizer Application	N:P2O5:K2O= 40:30:20 kg/ha	(15 - 20 HLT)
	Pest control	as required Tractor + Blower or sprayer	
45	2nd Fertilizer Application	N:40kg/ha	4 times fertilizer application for low fertility area
75	3rd Fertilizer Application	N: 20kg/ha	2nd N:40kg/ha 35 HLT 3rd N:20kg/ha 55 HLT
	Pest control	as required Tractor + Blower or sprayer	4th N:20kg/ha 75 HLT
110	Drainage		
125	Harvesting	Harvester + Lorry	

Source: IADP Kerian, MARDI and DOA Recommendation

Table 5.1.7 Cost of Improvement Works for System Infrastructure (Kerian Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Concrete Lining of Canals	45,233,400
Improvement of Drainage Facilities	14,542,400
Improvement of Farm Roads	4,176,000
Improvement of Related Structures	470,200
Total	64,422,000
2. Physical Contingency	9,663,300
3. Engineering Cost	6,442,200
4. Administration Cost	3,221,100
Grand Total	83,748,600

Table 5.1.8 Cost of Improvement Works for In-field Infrastructure (Kerian Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	5,700,600
Infield Channel	965,000
Control Box	509,000
Tramline	12,074,500
Total	19,249,100
2. Physical Contingency	2,887,400
3. Engineering Cost	1,924,900
4. Administration Cost	962,500
Grand Total	25,023,900

Table 5.1.9 Cost for Establishment of Telemetry and Telecontrol Facilities (Kerian Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Central Station	266,300
Repeater Station	38,700
Water Level Gauge inc. RTU	1,213,000
Rainfall Gauge inc. RTU	43,400
Remote Gate/ Pump	9,694,100
Total	11,255,500
2. Physical Contingency	1,688,400
3. Engineering Cost	1,125,600
4. Administration Cost	562,800
Grand Total	14,632,300

Table 5.1.10 Cost for Establishment of Monitoring and Feedback Facilities (Kerian Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Master Station	227,000
Player & TV	355,000
Additional TV	6,000
Wiring	58,800
MOA, DID & DOA HQ	21,800
Total	668,600
2. Physical Contingency	100,300
3. Engineering Cost	66,900
4. Administration Cost	33,500
Grand Total	869,300

Table 5.1.11 Training Cost for Water Users' Group (Kerian Scheme)

Off-Site Training

Compartment	WUGs (Nos)	Total WUG Leaders	Training day per Leader	Unit RM/day/person	Total Cost (RM)
Compartment A&B	20	40	3	400	48,000
Compartment C	4	8	3	400	9,600
Compartment D	17	34	3	400	40,800
Compartment E&F	22	44	3	400	52,800
Compartment G&H	21	42	3	400	50,400
Total	84	168			201,600

On-Site Training

Compartment	Farmers (Nos)	WUGs (Nos)	Training day per farmer	Unit RM/day/person	Total Cost (RM)
Compartment A&B		20	2	5	
Compartment C		4	2	5	
Compartment D		17	2	5	
Compartment E&F		22	2	5	
Compartment G&H		21	2	5	
Total	13,485	84			134,850

Table 5.1.12 Disbursement Schedule (Kerian Scheme)

Unit : x 1000 RM

Scheme \ Year	1999	2000	2001	2002	2003	2004	2005	2006	Total
I. Improvement of System Infrastructures									
1. Concrete lining of canals	14,701	14,701	14,701	14,701					58,803
2. Improvement of drainage facilities	6,302	6,302	6,302						18,905
3. Improvement of farm road	2,714	2,714							5,429
4. Improvement of related strucures	306	306							611
Sub-total	**24,023**	**24,023**	**21,003**	**14,701**					**83,749**
II. Improvement of In-field Infrastructures									
1. Land leveling/tramline	2,888	2,888	2,888	2,888	2,888	2,888	2,888	2,888	23,108
2. In-field structures	240	240	240	240	240	240	240	240	1,916
Sub-total	**3,128**	**3,128**	**3,128**	**3,128**	**3,128**	**3,128**	**3,128**	**3,128**	**25,024**
III. Water Management / Monitoring System									
1. Telemerty and telecontrol system	4,877	4,877	4,877						14,632
2. Feedback system	449	210	157	53					869
Sub-total	**5,326**	**5,087**	**5,034**	**53**					**15,501**
IV. Training of Water Users Group	77	77	128	27	28				337
Total	**32,554**	**32,315**	**29,293**	**17,909**	**3,156**	**3,128**	**3,128**	**3,128**	**124,611**

Table 5.1.13 Benefit and Cost Flow of Kerlan Scheme

(RM'000)

Year	Benefit							Cost							B-C
	Without			With			Increm.	System	Infield	Training	Telemetry	O&M	Replace	Total	
	Main	Off	Total	Main	Off	Total	Benefit	Infra.	Infra.	Cost	Feedback	Cost	-ment	Cost	
1	20,555	17,321	37,876	19,645	16,807	36,452	-1,424	22,974	2,952	72	5,227	2,309		33,535	-34,959
2	20,555	17,321	37,876	20,207	17,761	37,968	92	22,974	2,952	72	4,992	4,599		35,590	-35,498
3	20,555	17,321	37,876	22,221	20,166	42,387	4,511	20,086	2,952	120	4,940	6,649		34,747	-30,236
4	20,555	17,321	37,876	25,686	24,023	49,709	11,832	14,059	2,952	25	52	7,804		24,893	-13,061
5	20,555	17,321	37,876	30,602	29,331	59,933	22,056	0	2,952	26	0	7,804		10,783	11,273
6	20,555	17,321	37,876	35,518	34,639	70,157	32,280	0	2,952	0	0	7,804		10,757	21,524
7	20,555	17,321	37,876	40,434	39,947	80,381	42,504	0	2,952	0	0	7,804		10,757	31,748
8	20,555	17,321	37,876	45,350	45,255	90,604	52,728	0	2,952	0	0	7,804		10,757	41,972
9	20,555	17,321	37,876	51,155	51,060	102,215	64,339					7,804		7,804	56,534
10	20,555	17,321	37,876	55,509	55,414	110,923	73,046					7,804	14,664	22,468	50,578
11	20,555	17,321	37,876	58,412	58,316	116,728	78,852					7,804		7,804	71,047
12	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
13	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
14	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
15	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
16	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
17	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
18	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
19	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
20	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804	32,444	40,248	41,506
21	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
22	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
23	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
24	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
25	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
26	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
27	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
28	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
29	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
30	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804	14,664	22,468	59,286
31	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
32	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
33	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
34	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
35	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
36	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
37	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
38	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
39	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
40	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804	32,444	40,248	41,506
41	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
42	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
43	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
44	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
45	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
46	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
47	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
48	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
49	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804		7,804	73,950
50	20,555	17,321	37,876	59,863	59,768	119,630	81,754					7,804	14,664	22,468	59,286
							3,569,227	80,093	23,620	316	15,211	380,355	108,880	608,476	24.1%

IRR	24.1%
B/C	2.59
NPV	277,028

Sensitivity

	Cost		
Benefit	0%	10%	20%
0%	24.1%	22.9%	21.8%
-10%	22.3%	21.1%	20.1%
-20%	20.3%	19.2%	18.3%

Table 5.2.1 Area-Wise Conditions in Besut Scheme

Items	Besut Sub-scheme			Angga S-S		Total / Average
	Compartment 1	Compartment 3	Compartment 4	Compartment 2		
Parcel Area (ha)	1,234.8	1,306.4	1,474.6	1,147.5		5,163.3
Planted Area (ha)*1	2,265.2	2,122.8	2,610.6	2,091.2		9,089.8
Cropping Intensity (%)	183.4	162.5	177.0	182.2		176.0
Yield (t/ha)*2	4.1	4.3	4.2	4.2		4.2
Production (ton)	9,287.3	9,128.0	10,964.5	8,783.0		38,177.2
Irrigation Schedule				up stream PS	down stream PS	
-Main season	from mid. Nov.	from early Dec.	from mid. Nov.	from mid Nov.	from early Dec.	
	to late Mar.	to mid. Apr.	to late Mar.	to late Mar.	to mid. Apr	
-Off season	from early May	from mid. May	from early May	from early May	from mid. May	
	to late Sep.	to early Oct.	to late Sep.	to late Sep.	to early Oct.	
Planting Method	Wet Direct Seeding					
Land Preparation	Mechanized, 1st: by 4W tractor, 2nd by 2W tractor					
Varieties Used	MR84					
Fertilizer Application	The majority of farers applys subsidy fertilizer only.					
Harvesting	Mechanized (combine harvester)					
Machinery						
-4 W tractors	44					44
-2 W tractors	642					642
-Combin harvestor	6					6
Irrigation System	48 m/ha	42 m/ha	58 m/ha	45 m/ha		48 m/ha
Irrigation Condition	Water shortage in drought season					
Drainage System	51 m/ha	52 m/ha	47 m/ha	35 m/ha		46 m/ha
Drainage Condition	Sedimentation in drains					
Farm Road	Road density : 46 m/ha					
Tertiary System	Canal density : 25 m/ha in avarage, lined with concrete					
Lot (nos.)						
Land Levelling (ha) "done"						
"to be done"*3	0	0	60	20		80
Crop Budget (RM/ha)	Gross Return: RM2,575/ha, Production Cost: RM1,525/ha, Net Return RM1,051/ha					
Farm Income (RM/year)	Farm Income: RM2,784, Non-Farm Income: MR3,336 Total RM6,120					
Farmers' Organization*4	8	8	9	5		30

*1: 4seasons average ('95 off - '96/97 main)

*2: Estimated figure based on 5 seasons average ('94/95 main - '96/97 main), net paddy factor: 0.90 is applied.

*3: off-season '98

*4: KP (Kumpulan Petani)

Table 5.2.2 Rehabilitation and Improvement Plan of System Infrastructure (Besut Scheme)

(1/2)

Work Plan			Remarks
1. Replacement of Angga Barrage and Intake structure including construction of control house			
2. Replacement of Besut Barrage gates		4 nos.	
3. Irrigation Canal			
Concrete lining	Besut main canal Point B - E	2.6 km	
	TA. Telaga Nibong	1.8 km	from BP
	Besut secondary canals		
	TA. Lubok Kawah	3.8 km	from BP
	TA. Pulau Panjang	3.1 km	from BP
	TA. Tok Bugis	2.5 km	from BP
	Besut tertiary canals	2.5 km	
	Angga secondary canals		
	TA. Padang Baloh	4.0 km	from BP
	TA. Awek	3.5 km	from BP
	Angga teriary canals	0.5 km	
Heightening of lining	Besut main canal Point E - H	4.8 km	
	Besut main canal Point G-M-N-O	4.0 km	
	Besut secondary canals		
	TA. Pulau Ribu	2.8 km	from BP
Heightening of existing bank and placing of lining newly	Angga main canal (Point 3.7 km to Point R)	4.6 km	
4. Drainage facilities			
Desilting of drains	main drains	16 km	
Provision of drainage control		15 nos.	

Table 5.2.2 Rehabilitation and Improvement Plan of System Infrastructure (Besut Scheme)

(2/2)

Work Plan			Remarks
5. Farm road			
Asphalt pavement	along Besut main canal	5.5 km	
	along Angga main canal	2.5 km	
Widening and laterite pavement	along Besut tertiary canals	14 km	
	along Angga tertiary canals	13 km	
6. Related structures			
Provision of check structures	on Besut main canal	3 nos.	Monitoring points & downstream of point C
	on Angga main canal	2 nos.	Monitoring points
	on Besut secondary canals	1 no.	Monitoring points
Replacement of CHO & offtake gate	on Besut main canal	34 nos.	
	on Besut secondary canals	18 nos.	
	on Angga main canal	2 nos.	
	on Angga secondary canals	5 nos.	
Replacement of check gate and	on Besut main canal	10 nos.	
controldrop gate	on Besut secondary canals	4 nos.	
	on Angga main canal	1 no.	

Table 5.2.3 Required Works for Control and Monitoring Points (Besut Scheme)

Besut Scheme

Point	Location	Required Works				Remarks
		Remote Control Gate Size / Number of Pump	Water Level Gauge nos.	Lining m		
				Primary canal	Branched canal	
Key Control point						
KC1	Intake at Besut Barrage	1.93 m x 2.49 m x 3 nos.	2			proposed lining portion
KC2	Offtake point G on Besut Main Canal	1.60 m x 2.00 m x 1 no.	2			installed
KC3	Intake at Angga Barrage	1.32 m x 1.52 m x 2 nos.	2			including control room
Secondary Control Point						
SC1	Offtake point E on Besut Main Canal	1.60 m x 2.00 m x 1 no.	2			proposed lining portion
SC2	Offtake point M on Besut Main Canal	1.20 m x 1.70 m x 1 no.	2			"
Key Monitoring Point						
KM1	Lower reach of offtake point E on Besut Main canal		1			proposed lining portion
KM2	Lower reach of offtake point M on Besut Main canal		1			"
KM3	Lower reach of offtake point O on Besut Main canal		1			"
KM4	Upper reach of offtake point R on Angga Main Canal		1			"
Secondary Monitoring Point						
SM1	Beginning of TA. Lubuk Lawah (point B on Besut Main Canal)		1			proposed lining portion
SM2	Upper reach of offtake point E on Besut Mian Canal		1			"
SM3	Lower reach of offtake point N on Besut Mian Canal		1			"
SM4	Lower reach of offtake point H on Besut Mian Canal		1			"
SM5	Lower reach of offtake point R on Angga Mian Canal		1			"
Tertiary Monitoring Point						
TM1	Beginning of TA. Lubuk Agu		1			proposed lining portion
TM2	Beginning of TA. Gong Kulim		1			"
TM3	Beginning of TA. Kubang Depu		1			"
TM4	Beginning of TA. Lulau Ribu		1			"
TM5	Beginning of TA. TG. Gelai		1			"
TM6	Beginning of TA. FC1/FG		1			"
TM7	Beginning of TA. HH1		1			"
TM8	Beginning of TA. IJ		1			"
TM9	Beginning of TA. M1a		1			"
TM10	Beginning of TA. M1b		1			proposed lining portion
TM11	Beginning of TA. NN1		1			"
TM12	Beginning of TA. PP1		1			"
TM13	Beginning of TA. QQ1		1			"
TM14	Beginning of TA. Q2a		1			"
TM15	Beginning of TA. Q2b		1			"
TM16	Beginning of TA. Padang Baloh		1			"
TM17	Beginning of TA. Awek		1			"
TM18	Beginning of TA. RR1		1			"
TM19	Beginning of TA. SS1		1			"

Table 5.2.4 List of Recycling Pump in Besut Scheme

LOCATION	COMMAND AREA (ha)	NUMBER OF PUMP (nos.)	TOTAL CAPACITY (m3/sec)	REMARKS
Kuala Kenak	48	1	0.28	
Gong Jelutong	30	2	0.14	
Pangkal Q2C	12	1	0.06	
Alor Bakong	30	2	0.31	
Gerong	61	2	0.28	
Alor Belusu	30	1	0.14	

Table 5.2.5 Soil Classification and Suitability for Paddy in Ketara(Besut)

	Soil Type and Series	Suitability for Paddy	Area (ha)	Rate (%)
I.	Riverine Alluvium			
	Soil Series			
	1 Tok Yong	2 marginal	3,998.2	33.75%
	2 Kg Chempaka	2 marginal	2,143.2	18.09%
	3 Holyrood	3 unsuitable	294.6	2.49%
	4 Kg. Lating	2 marginal	661.7	5.59%
	5 Sg. Jabil	2 marginal	349.2	2.95%
	6 Batu Hitam	2 marginal	36.4	0.31%
	7 Kg. Tepus	2 marginal	635.3	5.36%
	8 Pasir Puteh	3 unsuitable	1,136.7	9.60%
	9 Local Alluvium	3 unsuitable	28.7	0.24%
	10 Kg. Binjai	3 unsuitable	437.9	3.70%
	Sub-total		9,722.0	82.07%
II.	Organic Soils			
	Soil Series			
	1 Brown Clay	3 unsuitable	76.5	0.65%
	2 Peat	3 unsuitable	217.7	1.84%
	Sub-total		294.2	2.48%
III.	Mixed Riverline and Marine Alluvium			
	1 Lubok Itec	3 unsuitable	63.5	0.22%
IV.	Marine Alluvium			
	Soil Series			
	1 Rusila	3 unsuitable	44.5	0.38%
	2 Rudua	3 unsuitable	230.7	1.95%
	Sub-total		275.2	2.32%
V.	Shale			
	1 Malacca Munchong Ass.	3 unsuitable	407.5	3.44%
	2 Durian-Malacca Ass.	3 unsuitable	157.8	1.33%
	Sub-total		565.3	4.77%
VI.	Granite and Granodiorite			
	1 Jerangau	3 unsuitable	29.1	0.25%
	2 Jerangau-Rangam Ass.	3 unsuitable	768.9	6.49%
	Sub-total		798.0	6.74%
VII.	Miscellaneous			
	1 Steepland	3 unsuitable	128.3	1.08%
			11,846.6	100.00%

Source: Semi-detailed Soil Servey of the Padi Growing Areas in the Krian District Perak, DOA

	Area (ha)	Rate (%)
suitable	0	0.00
marginal	7,824.1	66.04
unsuitable	4,022.5	33.96

Table 5.2.6 Proposed Farming Practices for Ketara(Besut)

Dry Direct Seeding

Days after Seeding	Activities	Input	Remark
-23-21	Lime Application (or Magnesium)	GML Lime (2.5ton/ha) (MgO: 180kg/ha)	depend on the soil condition (Organic Soil and low pH soil)
-19-18	1st Land Preparation	4W Tractor + Rotavator	
-7	Rodent/Rat Control	Check or Drat 125 ml	depend on location, either there are rat attack happen or not.
-5	2nd Land Preparation and Land Levelling	4W Tractor + Rotavator	(10 - 15 HBT)
-1	Selecting and Soaking Seeds		Seed selecting but until it
0	Seed Sowing and pressing (seed mix with soil)	4W Tractor + Drillseeder + Roterbucket	
0 - 4	Hervicide application before sprouting (1)		(0 - 4 HLT)
5	Water supply		(5 - 8 cm)
25 - 30	Hervicide application after sprouting (2) Water Control		(5 - 15 HLT) (5 - 10 cm, 5 - 15 HLT)
15-21	1st Fertilizer Application	N:P2O5:K2O= 40:40:30 kg/ha	(15 - 20 HLT) 4 times fertilizer application for low fertility area
	Pest control	as required Tractor + Blower or sprayer	2nd N:40kg/ha 35 HLT 3rd N:20kg/ha 55 HLT 4th N:20kg/ha 75 HLT
45-50	2nd Fertilizer Application	N:40kg/ha	
75 (PIS)	3rd Fertilizer Application	N: 20kg/ha	
	Pest comtrol	as required Tractor + Blower or sprayer	
110-115	Drainage		
125-130	Harvesting	Harvester + Lorry	

Wet Direct Seeding

Days after Seeding	Activities	Input	Remark
-23-21	Lime Application (or Mangesium)	GML Lime (2.5ton/ha) (or MgO 180kg/ha)	depend on the soil condition (Organic Soil and low pH soil)
-19-18	1st Land Preparation	4W Tractor + Rotavator	15 - 10cm
-15	Water Supply		5 - 8cm
-7	Rodent/Rat Control	Check or Drat 125 ml	depend on location, either there are rat attack happen or not.
-4-2	Puddling and levelling	4W Tractor + Rotavator Paddy Harrow	
-3 -2	Selecting and Soaking Seeds		
0	Sowing Sprouting Seeds	Tractor + MGA or Turn Table Wide Blower)	
0 - 4	Hervicide application before sprouting		(0 - 4 HLT)
25 - 30	Hervicide application after sprouting Water Control		(5 - 15 HLT) (5 - 10 cm, 5 - 15 HLT)
15	1st Fertilizer Application	N:P2O5:K2O= 40:30:20 kg/ha	(15 - 20 HLT)
	Pest and control	as required Tractor + Blower or sprayer	
45	2nd Fertilizer Application	N:40kg/ha	4 times fertilizer application for low fertility area
75	3rd Fertilizer Application	N: 20kg/ha	2nd N:40kg/ha 35 HLT 3rd N:20kg/ha 55 HLT 4th N:20kg/ha 75 HLT
	Pest comtrol	as required Tractor + Blower or sprayer	
110-115	Drainage		
125-130	Harvesting	Harvester + Lorry	

Source: IADP Ketara (Besut), MARDI and DOA Recommendation

Table 5.2.7 Cost of Improvement Works for System Infrastructure (Besut Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Replacement of Besut Barrage Gates	8,000,000
Construction of New Angga Barrage	1,800,000
Concrete Lining of Canals	8,509,200
Improvement of Drainage Facilities	533,300
Improvement of Farm Roads	1,439,500
Improvement of Related Structures	1,178,600
Total	21,460,600
2. Physical Contingency	3,219,100
3. Engineering Cost	2,146,100
4. Administration Cost	1,073,000
Grand Total	27,898,800

Table 5.2.8 Cost of Improvement Works for In-field Infrastructure (Besut Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Land Leveling	1,443,300
Infield Channel	244,700
Control Box	186,300
Total	1,874,300
2. Physical Contingency	281,100
3. Engineering Cost	187,400
4. Administration Cost	93,700
Grand Total	2,436,500

Table 5.2.9 Cost for Establishment of Telemetry and Telecontrol Facilities (Besut Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Central Station	Installed in Pilot Project
Repeater Station	0
Water Level Gauge inc. RTU	974,900
Rainfall Gauge inc. RTU	24,200
Remote Gate/ Pump	1,712,100
Total	2,711,200
2. Physical Contingency	406,700
3. Engineering Cost	271,200
4. Administration Cost	135,600
Grand Total	3,524,700

Table 5.2.10 Cost for Establishment of Monitoring and Feedback Facilities (Besut Scheme)

Work Item	Construction Cost (RM)
1. Direct Cost	
Master Station	227,000
Player & TV	390,500
Additional TV	8,000
Wiring	62,500
MOA, DID & DOA HQ	21,800
Total	709,800
2. Physical Contingency	106,500
3. Engineering Cost	71,000
4. Administration Cost	35,500
Grand Total	922,800

Table 5.2.11 Training Cost for Water Users' Group (Besut Scheme)

Off-Site Training

Compartment	WUGs (Nos)	Total WUG Leaders	Training day per Leader	Unit RM/day/person	Total Cost (RM)
Compartment 1	8	16	3	400	19,200
Compartment 2	5	10	3	400	12,000
Compartment 3	8	16	3	400	19,200
Compartment 4	9	18	3	400	21,600
Total	30	60			72,000

On-Site Training

Compartment	Farmers (Nos)	WUGs (Nos)	Training day per farmer	Unit RM/day/person	Total Cost (RM)
Compartment 1	659	8	2	5	6,590
Compartment 2	509	5	2	5	5,090
Compartment 3	858	8	2	5	8,580
Compartment 4	1,028	9	2	5	10,280
Total	3,054	30			30,540

Table 5.2.12 Disbursement Schedule (Besut Scheme)

Unit : x 1000 RM

Scheme \ Year	1999	2000	2001	2002	2003	2004	2005	2006	Total
I. Improvement of System Infrastructures									
1. Replacement of Besut Barrage Improvement	5,200	5,200							10,400
2. Construction of New Angga Barrage	780	780	780						2,340
3. Concrete lining of canals	3,687	3,687	3,687						
4. Improvement of drainage facilities	693								
5. Improvement of farm road	936	936							1,871
6. Improvement of related strucures	766	766							1,532
Sub-total	**12,062**	**11,369**	**4,467**						**27,899**
II. Improvement of In-field Infrastructures									
1. Land leveling/tramline	235	235	235	235	235	235	235	235	1,876
2. In-field structures	70	70	70	70	70	70	70	70	560
Sub-total	**305**	**305**	**305**	**305**	**305**	**305**	**305**	**305**	**2,437**
III. Water Management / Monitoring System									
1. Telemerty and telecontrol system	1,762	1,762							3,525
2. Feedback system	391	323	209						923
Sub-total	**2,153**	**2,085**	**209**						**4,448**
IV. Training of Water Users Group	42	6	42	6	6				102
Total	**14,562**	**13,765**	**5,023**	**311**	**311**	**305**	**305**	**305**	**34,885**

Table 5.2.13 Benefit and Cost Flow of KETARA (Besut) Scheme

(RM'000)

Year	Benefit							Cost							B-C
	Without			With			Increm.	System	Infield	Training	Telemetry	O&M	Replace	Total	
	Main	Off	Total	Main	Off	Total	Benefit	Infra	Infra	Cost	Feedback	Cost	-ment	Cost	
1	5,852	5,179	11,031	5,501	4,818	10,322	-709	11,536	287	39	2,113	684		14,660	-15,369
2	5,852	5,179	11,031	5,449	4,678	10,127	-905	10,873	287	6	2,046	1,332		14,543	-15,449
3	5,852	5,179	11,031	5,682	4,754	10,435	-596	4,272	287	39	205	1,557		6,361	-6,957
4	5,852	5,179	11,031	6,203	5,015	11,249	217	0	287	6	0	1,557		1,850	-1,632
5	5,852	5,179	11,031	7,013	5,554	12,567	1,535	0	287	6	0	1,557		1,850	-314
6	5,852	5,179	11,031	7,823	6,062	13,884	2,853	0	287	0	0	1,557		1,844	1,009
7	5,852	5,179	11,031	8,632	6,570	15,202	4,171	0	287	0	0	1,557		1,844	2,327
8	5,852	5,179	11,031	9,442	7,078	16,520	5,489	0	287	0	0	1,557		1,844	3,645
9	5,852	5,179	11,031	10,595	7,943	18,538	7,507					1,557		1,557	5,950
10	5,852	5,179	11,031	11,460	8,591	20,051	9,020					1,557	3,357	4,914	4,106
11	5,852	5,179	11,031	12,037	9,024	21,060	10,029					1,557		1,557	8,473
12	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
13	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
14	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
15	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
16	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
17	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
18	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
19	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
20	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557	9,153	10,710	-176
21	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
22	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
23	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
24	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
25	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
26	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
27	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
28	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
29	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
30	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557	3,357	4,914	5,620
31	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
32	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
33	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
34	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
35	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
36	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
37	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
38	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
39	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
40	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557	9,153	10,710	-176
41	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
42	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
43	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
44	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
45	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
46	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
47	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
48	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
49	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557		1,557	8,977
50	5,852	5,179	11,031	12,325	9,240	21,565	10,534					1,557	3,357	4,914	5,620
							449,424	26,681	2,300	96	4,365	76,735	28,379	138,555	11.2%

IRR	11.2%
B/C	1.14
NPV	6,178

Sensitivity

	Cost		
Benefit	0%	10%	20%
0%	11.2%	10.6%	10.1%
-10%	10.2%	9.6%	9.1%
-20%	9.1%	8.6%	8.1%