PART - II

PRESENT CONDITIONS OF THE FIVE GRANARIES

2.1 Present Conditions

2.1.1 General

In Malaysia, there exist eight(8) granary areas with the total net irrigation area of about 217,000 ha. Among these, only five(5) areas namely, IADP Pulau Pinang, IADP Kerian / Sungai Manik, IADP Seberang Perak, IADP Kemasin Semerak and IADP Ketara (Besut) are covered by this study and the present conditions of these five(5) areas are described in the following sections. The other three(3) granary areas such as MADA, KADA and IADP N.W. Selangor are not included in the study because of that the production from the areas have almost achieved the government's target and there were some previous studies done by JICA on some of these areas. The net irrigation areas of five(5) granaries to be covered by this study are shown below.

Name of Granary Area	Net Irrigation Area (ha)
IADP Pulau Pinang	9,832
IADP Kerian / Sungai Manik	29,878
IADP Seberang Perak	8,708
IADP Kemasin Semerak	6,895
IADP Ketara (Besut)	5,164
Total	60,477

2.1.2 Location and Administration

Local administrative body of Malaysia is composed of State, District, Mukim and Kampong. Kampong is the smallest administrative body which is equivalent to village. Mukim is the next small local bodies composed of Kampongs, and a set of Mukim forms a District. Local administration bodies concerned for each granary area are summarized as below.

Scheme	State	District	Mukim (no.)
Pulau Pinang	Pulau Pinang	Seberang Perai Utara, Seberang Perai Tengah, Barat Daya	26
Kerian / Sungai Manik			
- Kerian	Perak, P.Pinang	Seberang Perai Selatan, Kerian,	10
- Sungai Manik	Perak	Hilir Perak	2
Seberang Perak	Perak	Perak Tengah	3
Kemasin-Semerak*	Kelantan	Kota Bharu, Bachok, Pasir Putch	19
Besut	Terengganu	Besut	7

* Jajahan and Daerah of Kelantan States are taken as District and Mukim, respectively.

(1) IADP Pulau Pinang Scheme

The IADP Pulau Pinang scheme has 9,832 ha of the total net irrigation area with five(5) sub-schemes. Out of five(5) sub-schemes, one sub-scheme of Sungai Burung is located in the

Pinang Island and the other four(4) sub-schemes are situated at the north western part of the State of Pulau Pinang in the Peninsular.

(2) IADP Kerian / Sungai Manik Scheme

This scheme consists of two separate schemes ; Kerian scheme and Sungai Manik scheme. The Kerian scheme is located at the north west corner of the State of Perak. The town of Bagan Serai is located in the center of the Kerian scheme area and it is about 80 km north west of Ipoh, the capital city of Perak. While, the Sungai Manik scheme is situated at the southern part of the State of Perak being near the town of Teluk Intan about 70 km south of Ipoh. The net irrigation areas of the Kerian and Sungai Manik schemes are 23,560 ha and 6,318 ha, respectively.

(3) IADP Seberang Perak Scheme

The scheme is located on the right bank of Perak River in the State of Perak, about 30 km from Teluk Intan, 80 km south of Ipoh and 200 km north of Kuala Lumpur. The net irrigation area is 8,708 ha which consists of 4,343 ha of Right Branch Canal sub-scheme and 4,365 ha of Left Branch Canal sub-scheme.

(4) IADP Kemasin Semerak Scheme

The IADP Kemasin Semerak scheme is located to the south of Kota Bharu, the capital of Kelantan State, and essentially comprises the districts of Bachok and Pasir Putch. Bounded on the west by the Pengalan Datu river, the main coastal road and the last hills of the mountain chain to the southwest, the southern boundary is the one between the Kelantan and Trengganu States. The South China Sea is its natural boundary to the east. The total irrigable area is 6,895 ha consisting of eight (8) relatively smaller sub-areas.

(5) IADP Ketara (Besut) Scheme

The Besut scheme is located at the north-western corner of the State of Terengganu immediately adjacent to the State of Kelantan. The total net irrigation area is 5,164 ha, of which about 4,017 ha is covered with the Besut barrage and about 1,147 ha with the Angga barrage.

2.1.3 Natural Conditions

(1) IADP Pulau Pinang Scheme

(a) Topography

Muda river, water source for Sungai Muda and Pinang Tunggal sub-schemes, meanders westwards forming a boundary between Pulau Pinang and Kedah State. Jarak river, the water source of Sungai Jarak sub-scheme, merges into the middle reach of Kulim river which is the water source of Sungai Kulim sub-scheme. Kulim river runs southwestwards until the Straits of Malacca. The gradient of ground surface of these schemes is gentle, about 1/3,000 from east to west. Another sub-scheme of

Sungai Burung is located in Balik Pulau, on the south west corner of Pinang Island with water being supplied through Burung river.

(b) Climate

(i) Rainfall

The area falls on the rainfall region of "North West Malaya", which is characterized by, i) two peaks in rainfall during post-equinoctial transition periods between north-east and south-west monsoons, namely from April to May and from September to November, ii) relatively low rainfall during the north east monsoon and iii) moderate precipitation during the south west monsoon. Based on the data collected from relevant meteorological stations, average annual rainfall for this scheme amounts to 2,120 mm in the Peninsular side and 2,415 mm in Sungai Burung sub-scheme.

(ii) Other Climatic Factors

The temperature in and around the scheme area is quite stable throughout a year. Monthly 24 hour mean temperature ranges from 26.6 °C to 27.9 °C and annual average temperatures is estimated to be 27.2 °C. 24 hour mean relative humidity is 82.5 % at Pinang International Airport.

(c) Water sources

Muda river is the water source of Sungai Muda sub-scheme, Pinang Tunggal sub-scheme and a part of Sungai Jarak sub-scheme. The catchment area of Muda river at Ladang Victoria discharge station is 4,010 km^2. Kulim river is the water source of Sungai Kulim sub-scheme and Jarak river is the water source for a part of Sungai Jarak sub-scheme which name is Padang Menora Block. In Sungai Burung sub-scheme, the water for irrigation is mainly diverted from a headworks at Burung river and supplementary irrigation water is diverted at a headworks at Sungai Titi Teras especially in dry season.

(d) Soil

Muda and Kulim sub-schemes are covered with coastal alluvial soils called Kranji and Linau series, and acid sulfate soil called Chengi series. In Burung River sub-scheme on Pinang Island, most of the area is covered with Kranji series. The Kranji series soil has a thin brown to dark yellowish brown A horizon with clayey textures.

(2) IADP Kerian / Sungai Manik Scheme

(a) Topography

Kerian scheme lies on the coastal alluvial plain in the north west of Perak State and the terrain in the scheme is characterized by an alluvial plain in the west coast that slopes gently with a gradient of about 0.01 percent. This is reckoned from the Bukit Merah Reservoir(4 m above msl) to the plain area of Krian Laut(0.8 m above msl) for a distance of 29 km. Sungai Manik scheme is located in the south of the State of Perak.

The scheme area slopes relatively sharply, with an elevation of about 12 m above sea level near the headworks and about 2 m at the flood protection bunds along the Perak river. The topography is more undulating and steeper near the headworks than in the lower portion.

(b) Climate

(i) Rainfall

In terms of rainfall, both Kerian and Sungai Manik schemes belong to "West Malaya Rainfall Region". Average annual rainfall is 2,227 mm in Kerian and 2,333 mm in Sungai Manik. In both schemes, two rainfall peaks which last from March to May and from September to November are recognized. Least precipitation occurs in January in Kerian and in June in Sungai Manik.

(ii) Other Climatic Factors

The temperature is quite constant throughout a year in both schemes. In Kerian, monthly 24 hour mean temperature ranges 26.6 °C to 27.9 °C and average annual temperature is estimated to be 27.2 °C. In Sungai Manik, 24 hour mean temperature ranges 26.2 °C to 27.5 °C and average annual temperature is estimated to be 26.8 °C. 24 hour mean relative humidity is 82.5 % in Kerian and 85.0 % in Sungai Manik Scheme.

(c) Water sources

The water source of Kerian scheme are Bukit Merah Reservoir and Kerian river. In Kerian Darat sub-scheme, all of the irrigation water is provided from Bukit Merah Reservoir. On the other hand, in Kerian Laut sub-scheme, water comes from Bukit Merah Reservoir mainly and water pumped up at Bogak Pump Station at Sungai Kerian is used as supplemental water source. The main inflow of Bukit Merah Reservoir conveyed through Kurau river. The river has 337 km^2 of catchment area at the discharge station located 6.7 km upstream of the reservoir. Supplementary water source for the scheme is Kerian river, which has 629 km^2 of catchment area at Selama. The water source for Sungai Manik scheme is Batang Padang river, a tributary of Perak river. Batang Padang river has a discharge station at Tanjung Keramat, which has 455 km^2 of catchment area at this point.

(d) Soil

The soils in the Kerian paddy area are developed basically on three types of sediments, namely marine alluvium, brackish water deposits and organic rich deposits. The coastal portion of the scheme consists mainly of alluvial soils of marine origin. The inland area consists of mainly alluvial soils of riverine origin. Almost 5,000 ha of land along the Bagan Serai-Parit Buntar road is overlain by slightly acid organic clay muck soils. All soils in Kerian scheme area are suitable for rice growing, however the muck soils are distinctly less productive and requires suitable water management and crop husbandry techniques in order to grow paddy effectively. Sungai Manik scheme is covered with

alluvial soil called Sogomana-Sitiawan-Manik Series which are characterized by light gray to white clays showing strong to moderate prismatic to coarse angular blocky structures an sticky consistence. Clay skins are well developed in these soils.

(3) IADP Seberang Perak Scheme

(a) Topography

Seberang Perak scheme is located at the southeastern edge of an 80,000 ha swampy floodplain on the right bank of the Perak river from which irrigation water is supplied to the scheme, about 10 km inland from the Straits of Malacca. The scheme area slopes gently from 1.9 m above sea level in the north to 1.5 m above sea level in the south.

(b) Climate

(i) Rainfall

This area belongs to "West Malaya Rainfall Region" and average annual rainfall is 2,182 mm. Rainfall pattern in this scheme is similar to that of above Kerian and Sungai Manik schemes. There are two rainfall peaks which last from March to April and from September to November. Least precipitation occurs in June.

(ii) Other Climatic Factors

Like the other schemes, temperature is quite stable throughout a year with 24 hour mean temperature ranging from 26.2 °C to 27.5 °C. Annual average temperature is estimated to be 26.8 °C and the maximum and the minimum monthly temperature occurs in April and December, respectively. 24 hour mean relative humidity is estimated 85.0 %.

(c) Water Sources

The water source of Seberang Perak scheme is Perak river, which is one of the biggest rivers in Peninsular Malaysia. The catchment area of whole Perak river basin reaches approximately 15,000 km^2. The water of the river is so abundant that the irrigation water for the scheme is diverted by free intake at Teluk Sena. Consequently, as far as Seberang Perak scheme is concerned, shortage of irrigation water is not expected to be a serious problem at the moment.

(d) Soil

Most of the scheme area is covered with local alluvium soils of riverine origin.

(4) IADP Kemasin Semerak Scheme

(a) Topography

This scheme comprises of eight sub-schemes. Four rivers, namely, Pengalan Datu, Kemasin, Gali dan and Semerak, which are water sources of the scheme, run meandering eastwards through the scheme area towards the South China Sea. Diversion

from Kelantan river which runs in the west of the scheme will play an important role for the scheme. The overall relief of the scheme area seldom amounts to more than ten meters above sea level. In fact, a large portion of the land does not exceed 2.5 m above sea level.

(b) Climate

(i) Rainfall

The area falls on "East Malaya Rainfall Region" and its average annual rainfall reaches 2,589 mm. The rainfall region has heavy rainfall during the northeast monsoon and light rain during the rest of the year. Usually peak rainfall occurs from November to January.

(ii) Other Climatic Factors

The temperature is stable throughout a year with 24 hour mean temperature ranging from 25.9 °C to 28.1 °C. Annual average temperature is estimated to be 26.9 °C and the maximum and minimum monthly temperature occurs in May and January, respectively. 24 hour mean relative humidity is 82.2 %.

(c) Water Sources

Both Kemasin Hilir sub-scheme and Jelawat Rusa sub-scheme are supplied water from Kemasin river. Annual average discharge and 1/5 probability drought year discharge are 4.5 m^3/s and 1.9 m^3/s, respectively measured at Peringat which is located upstream of Machang Dam. Kemasin river receives excess water from KADA which irrigation water is taken at Kemubu pump station at Kelantan river. The irrigation water for the above two(2) sub-schemes is taken at small 8 pump stations along Kemasin river.

(d) Soil

Alluvial deposits generally characterize the scheme area and are composed of sand, silt and clayey soil. However, past littoral currents have developed raised sand dunes in parallel to the coast line and are now referred to as the Bris Soils Zone. The flat alluvial plains are characterized by deposits which can be classified as marine and fluvial deposits, although it is not always possible to demarcate between the two variations. Marine deposits predominate along the Bris Soils areas and are composed of coarse sand containing shell fragments. Fluvial deposits are generally composed of number of materials including gravel, sand, silt and clay, clayey soils generally predominate.

(5) IADP Ketara (Besut) Scheme

(a) Topography

Besut Scheme is on the coastal plain in the north east of the State of Terengganu. Besut river, one of the two water sources of the scheme, runs northwards towards the South China Sea along the west boundary of the scheme and Angga river, another water source of the scheme, converges to Besut river to the south of the scheme area. The

dominant feature in and around the scheme area is generally level alluvial flood plain and terrace flats of the Besut river. The flood plain slopes down eastwards from about 20 m in the west to 2 m above sea level in the east over a stretch of some 10 km.

(b) Climate

(i) Rainfall

This area is classified as "East Malaya Rainfall Region" and the rainfall has seasonal change similar to that of Kemasin Semerak scheme, however, average annual rainfall is about 2,904 mm, which is more than Kemasin Semerak. Peak in rainfall falls on December.

(ii) Other Climatic Factors

The temperature is stable throughout a year with 24 hour mean temperature ranging from 26.2 °C to 27.8 °C. Annual average temperature is 26.9 °C and the maximum and the minimum temperature occurs in April and January, respectively. 24 hour mean relative humidity is 83.3%.

(c) Water Sources

The water sources of the scheme are Besut river and its tributary, Angga river. The irrigation water diverted at Sungai Besut Headworks is used for Compartment 1,3 and 4 of the scheme. The water for Compartment 2 is diverted at Sungai Angga Headworks. Sungai Besut has 787 km^2 of catchment area at Jerteh Road Bridge. About 80 % of the catchment is steep mountainous country rising to heights of 1,220 m, while the remainder is fairly flat low land.

(d) Soil

Generally, the soils utilized for rice cultivation in this area are of all alluvial origin and these surface formations were deposited in different periods. The Tok Yong series, which is the most widespread soil series on the area, are characterized by a uniform yellowish brown, clay to silty clay loam with friable consistence and strongly to moderately well developed structure. On the eastern and northern edges of the riverine, alluvial formation are marine deposits of a coarse sandy nature forming beach ridges. Organic soils have accumulated in some of the depressions and old river channels adjacent to these beach ridges.

2.1.4 Socio-economic Condition

(1) Population and Labor Force

The estimated population, number of household and average family size of the five(5) granary areas are summarized below. Average family size for five(5) granary areas are about 5.1 persons without significant difference among five(5) granary areas. Based on the Farm Survey conducted by the JICA Study Team, the literacy rate of five(5) granary areas is about

86 %. Considering the national average of 89.3 %, there are still needs for the enhancement of education opportunity in Seberang Perak, Kemasin Semerak and Besut areas.

IADP	Number of House-hold*1	Average Family Size*2	Estimated Population*3 ('000 pers.)	Literacy Rate*4 (%)
Pulau Pinang	7,301	5.0	36,500	91.4
Kerian / Sungai Manik				
- Kerian	13,485	4.9	66,100	91.5
- Sungai Manik	4,030	4.7	18,900	91.5
Seberang Perak	2,333	5.1	11,900	81.2
Kemasin-Semerak	11,889	5.2	61,800	78.8
Besut	3,054	5.2	15,900	81.2

*1: Subsidy Registration, LPP, 1997, Number of registered farmers are used as the estimation of number of households.
*2: Population Census '91, Assumed that family size hasn't changed since '91.
*3: Estimated by number of household multiplied by family size.
*4: Farm Survey, JICA Study Team, 1997. For Kerian/Sg. Manik, data show overall average for both areas.

According to the Population Census 1991, the structure of population by ethnic group shows high degree of mixture in the Pulau Pinang scheme and Kerian / Sungai Manik scheme. On the other hand, more than 96% of people are Malay in Seberang Perak, Kemasin-Semerak and Besut schemes as shown below.

(%)

Ethnic Group	Pulau Pinang	Kerian	Sg. Manik	Seberang Perak	Kemasin-Semerak	Besut
Malay	75.0	62.5	50.1	98.7	97.6	96.5
Chinese	19.4	22.3	23.2	0.1	1.3	1.8
Indian	4.9	9.9	8.2	0.0	0.0	0.1
Others	0.6	5.3	18.5	1.2	1.1	1.6

Note: Figure is calculated based on the Mukim-wise data.
Source: Population Census, 1991, Department of Statistics

Regarding occupational structure of the population between 15 and 64 years old, in the Pulau Pinang, the share for agriculture and related works are only 11% and most popular occupation is production, transport, etc. This implies that labor force is shifting to industrial sector from agricultural sector and, hence, labor scarcity in agricultural sector. On the other hand, Seberang Perak shows highest share for agricultural sector which accounts for about 70%. In other three(3) areas, the share of agriculture ranges from 44 to 48 % and agriculture is still a major source of labor absorption. Occupational structure is summarized as below.

(%)

Scheme	Professional Technical	Administration Service	Agriculture and related works	Production transport,etc.	Others
IADP Pulau Pinang	8.2	22.5	10.8	52.5	6.0
Kerian	6.1	17.8	45.6	29.7	0.7
Sungai Manik	5.2	15.9	56.5	22.2	0.2
Seberang Perak	7.2	12.3	70.4	9.9	0.2
Kemasin Semerak	8.7	21.7	44.5	24.4	0.6
Besut	9.8	21.3	44.9	22.7	1.3

Source: Population Census, 1991, Department of Statistics

(2) Social Infrastructure

The state-wise social indicators of the concerning 4 states and national average are summarized as below.

State	Telephones per 1,000 population	Provided with Piped Water (%)	Electricity Provision (%)	Infant Mortality per 1,000	No.of Doctors per 10,000	Length of Paved Road (km/10km^2)
Pulau Pinang	232.0	99.6	100.0	8.8	7.4	30.2
Perak	164.4	92.9	100.0	11.5	4.7	2.8
Kelantan	180.5	65.7	100.0	9.3	4.0	1.7
Terengganu	181.4	80.2	100.0	12.7	3.0	2.4
Malaysia	164.3	89.1	95.8	9.9	5.3	1.5

Source: 7th Malaysian Plan. The figure is for the year 1995.

(a) Transportation & Communication

All the five schemes are in the good location in terms of connection to the neighboring cities. Pulau Pinang scheme and Kerian scheme are located near the motorway which accesses to Ipoh, the capital city of Perak State and Kuala Lumpur to the south. Besides, both schemes are also close to George Town and are accessible to other major cities by air. Kemasin-Semerak scheme and Besut scheme are connected by the national highway (Route 3) with Kota Bharu to the north and with Kuala Terengganu to the south. Sungai Manik scheme and Seberang Perak scheme are locating near Teluk Intan which is the capital town of Hilir Perak district and accessible to Kuala Lumpur and Ipoh through the motorway which locates about 30 km to the east. Regarding the road density of each state, based on the length of paved road, all 4 states are above the national average (1.5 km/10 km^2). Especially, Pulau Pinang district performs second highest density (30.2 km/10 km^2) in Malaysia, while that of Kelantan state is low as 1.7 km/10 km^2, which is slightly above the national average. As to communication facility, about 54.6 % of households are facilitated with a telephone according to the result of farm survey, while the state-wise statistics shows 189.5 units per 1,000 population in average of 4 states. Holding rate of television and radio are more than 90 % in five(5) granary areas, which indicates good accessibility to the mas-media.

(b) Water Supply and Energy for Domestic Use

The result of the farm survey shows that the source of drinking water are different between west and east coast. In the west coast, 90 to 100 % of households are using tap water as the source, while less than 50 % can access to the tap water in the east coast. In the east coast, the main source for drinking water is tube well, on which 50 to 70 % of households relies. As to the electricity for lightning, almost all respondents (98.6 %) are using electricity and very few are using kerosene. Regarding the energy for cooking, mainly LP gas are used (91.2 %) and charcoal are also used especially in the Kemasin Semerak (17.9 %), Besut (16.9 %) and Kerian Sungai Manik (7.8 %).

(c) Health and Education

Almost all districts in the five(5) granary areas have at least 1 government hospital except Bachok district in Kelantan (Kemasin-Semerak scheme). However, the number

of doctors per 10,000 persons are below the national average in all the states except Pulau Pinang. Accordingly, infant mortality rate per 1,000 persons are showing relatively high value especially in Perak and Kelantan, which implies that there is the room for improvement. It should be noted, however, the results of the farm survey indicates that hospitals are available within 5 km in average in all areas. Schools are well facilitated in all scheme areas. According to the district-wise data, there are more than 30 primary schools and 10 secondary schools in each district. The average number of students per teacher is approximately 20.3 persons in primary school and 17.1 persons in secondary school. It is consistent with the result of the farm survey which indicates primary school is available within 2.3 km and secondary school is available within 5 km in an average.

2.1.5 Agriculture

(1) Paddy Cultivated Area and Cropping Intensity

Land use of the study area is already defined by farmers and settlers living in the area and, dependent on the availability of irrigation water. Irrigated fields are being used for paddy cultivation. The areas planted with paddy and cropping intensity per season are shown in Table 2.1.1 "Paddy Planted Area and Cropping Intensity". The average annual paddy cultivated area in the study area for 5 years from 1991 to 1995 is estimated at 102,950 ha comprising 55,370 ha in the main season and 47 ,580 ha in the off season respectively, which is about 15 % of the total paddy cultivated area in Malaysia. The average cropping intensities of five(5) years from 1991 to 1995 in the five(5) schemes is summarized below.

(Unit : %)

Name of Scheme	Annual	Main Season	Off Season
Pulau Pinang	189	95	94
Kerian	164	89	75
Sungai Manik	191	95	96
Seberang Perak	191	94	98
Kemasin Semerak	57	50	6
Ketara (Besut)	164	87	77

Source : Paddy Statistics of Malaysia, 1995 and IADP Kerian/Sg.Manik

Irrigation system of the Kemasin Semerak scheme is incomplete. Only 6% of command area is used for paddy growing in the off season, while paddy is grown in the about 50 % during the main season. The average cropping intensity during the last five(5) years from 1991 to 1995 in the study area except Kemasin Semerak was in the range of 160 to 190 %. Mechanized land preparation and direct seeding method have contributed to the increase of the cropping intensity. Cropping intensity of Kerian and Besut schemes remains lower level compared with others because of the lower cropping intensity in the off season owing to poor-drainage of Kerian, and floods and shortage of irrigation water of Besut.

(2) Land Ownership and Tenure System

Based on land tenure, the paddy farmers in the study area are classified into three (3) types, namely owner operator, owner/tenant operator and the tenant operator. Landlords who do not cultivate but instead hire out land to cultivators is called lessors. The majority of farmers in the study area are owner operators and owner/tenant operators. The estimated average

holding size of farm land in the study area ranges from 1.04 to 1.82 ha as shown in the following table :

(Unit : ha)

Name of Scheme	Average Holding Size
Pulau Pinang	1.32
Kerian	1.54
Sungai Manik	1.73
Seberang Perak	1.82
Kemasin Semerak	1.04
Besut	1.29

Source : DOA and PPK in the study area, 1995

Direct seeding technology and mechanized farming have helped in the revitalization of paddy land that were left idle because of absentee landlord and labor shortage. There are now groups of enterprising young farmers looking for paddy land to cultivate as direct seeding makes the effort cost effective. The average operated farm size is gradually increasing year by year as shown below.

(Unit : ha)

Year	Average Farm Size
1972	1.61
1981	1.39
1986	1.91
1988	1.81
1991	2.11

Source : DOA

(3) Cropping Schedule and Agricultural Production

(a) Cropping Schedule

The net irrigation area of the study area is 60,477 ha, of which the major part is double cropped area. The cropping calendar in the study area is characterized by two seasons, the first season from around February / March to July / August called off season and the other season from August / September to January / February called main season. The ideal cropping schedules in five(5) granary areas are developed by the respective IADP offices as shown in Fig. 2.1.1 "Present Cropping Schedule in the Study Area".

Majority of the farmers in the study areas can adhere to the cropping schedule, however some farmers do no follow the schedule, as a result the progress of the actual farming in all the study area is generally behind the schedule. Especially, in compartments A, B and C of the Kerian scheme, several crop seasons have been missed during the last decade due to prolonged staggering of cropping schedule.

(b) Yield and Production

Average unit yields and annual production of paddy are given in the Table 2.1.2 "Paddy Production and Average Yields". The average yields and annual production of paddy of five years from 1991 to 1995 in the study area are summarized below.

Study Area		Production (ton)	Average Yield (ton/ha)
Pulau Pinang	Total	58,674	2.80
	Main Season	29,757	2.90
	Off Season	28,915	2.71
Kerian	Total	112,668	2.94
	Main Season	59,419	2.86
	Off Season	53,249	3.05
Sungai Manik	Total	36,808	3.05
	Main Season	19,006	3.16
	Off Season	17,802	2.94
Seberang Perak	Total	58,853	3.53
	Main Season	29,150	3.57
	Off Season	29,703	3.50
Kemasin Semerak	Total	19,098	2.82
	Main Season	17,120	2.91
	Off Season	1,978	2.22
Ketara (Besut)	Total	27,787	3.18
	Main Season	15,429	3.34
	Off Season	12,358	3.00

Source: Paddy Statistics of Malaysia, 1995 and IADP Kerian

The paddy yields from 1986 to 1995 in the study area is graphically illustrated Fig. 2.1.2 "Average Paddy Yields of the Study Area". The average unit yields in five(5) schemes are beyond national average, however they are unstable and various season by season. The range of the average yield of each scheme from 1991 to 1995 was between 2.22 to 3.57 ton/ha. The average unit yields of paddy in the study area have not reached sufficient levels and are lower than the NAP target yield. The paddy production fluctuated according to the planted area and yield. The average production from 1991 to 1995 of the study area was about 314,000 tons or about 15 % of national production.

(4) Farming Practices

Paddy cultivation in the study area has been modernized with the introduction and promotion of mechanization for the labor intensive works of the paddy cultivation practices except a part of Kerian scheme. These include land preparation and harvesting, which in the traditional method have been highly time consuming and costly. Furthermore, the acute shortage of labor force arising from the Malaysian rapid and strong industrialization which leads to urban migration of young farm labor, has put a tremendous pressure on the need for farm mechanization. The typical farming practices of paddy in the study area as follows :

(a) Planting Method

Generally, there are two different kinds of paddy planting methods in the study area. One is the traditional transplanting method which is practiced in some compartments of Kerian scheme, and another is direct seeding method. Direct seeding has shown significant impact of paddy cultivation since its introduction in 1970's. The present dominance of direct seeding has come as a result of the shortage of labor for transplanting. In IADP Pulau Pinang, direct seeding was adopted as one of the strategy to rehabilitate abandoned or idle paddy land in 1980's.

Two types of direct seeding methods are practiced, namely dry direct seeding and wet direct seeding based on soil moisture condition during land preparation and irrigation water availability. In wet direct seeding, the first half of farm operations generally proceeds in the following order :

Tillage → Initial Irrigation → Puddling → Drainage → Sowing → Seedling establishment → Irrigation

Under wet direct seeding, the field water should be drained after puddling. The soaked seeds are sown under wet soil condition.

On the other hand, under dry seeding, the farm operations normally proceed as shown below. The dry direct seeding is divided into two(2) types according to the irrigation water supply pattern for germination. One is the rainfall induced germination method which uses rainfall seedling establishment and the other is the irrigation induced germination which uses irrigation water for seedling establishment. The latter is safe and stable method.

Tillage → Sowing → Germination → Seedling establishment → Irrigation

The wet direct seeding method with pre-germinated seeds is more commonly practiced in the study area. The dry direct seeding is adopted in Kerian and Sungai Manik scheme during the Off Season. In the east coast granary schemes, sowing of seed is done manually, while both manual and mechanical broadcasting of seeds using mortorblowers are done in the west coast schemes.

(b) Land Preparation

Land preparation has already been mechanized in the large part of the study area on a contract basis. In the study area, 4 wheel tractors and rotovators are used for land preparation. However, pedestrian tractors(2 wheel tractors) are also used in Pulau Pinang, Kerian and Besut. Generally, the pedestrian tractors are owned by farmers and used for 2nd and 3rd tillages after first tillage done by 4 wheel tractors. The areas with a cone index of less than 1.5 kg/cm^2 in Kerian scheme cannot be mechanized and only manual land preparation is permitted.

Two to three times of tillage are done in most cases. The duration between times of tillage ranges from 2 weeks to 30 days before sowing (DBS) for the first round, 5-10 DBS for the second round and 1-3 DBS for the third round for areas with three rounds. For areas practicing two rounds of tillage, the first round is done 7-30 DBS and the second 2-3 DBS.

The tractor arrangement for land preparation especially at the peak period is very important in order to avoid delay from planting schedule. An inadequate arrangement is one of main reasons for the un-adherence to cropping schedule.

(c) Varieties Used

The major recommended varieties of paddy are MR10, MR77, MR84, MR159 and MR167. All these varieties are classed as the short maturation and high yielding types. However, only MR84 is widely used and use of other varieties are very limited because of the suitability for direct seeding. The paddy varieties used in the study area are summarized below.

(Unit : %)

Study Area	MR84	Semerak	MR10	Others
Pulau Pinang	98.3	—	—	1.7
Kerian	21.6	29.7	12.6	36.1
Sungai Manik	100.0	—	—	—
Seberang Perak	100.0	—	—	—
Kemasin Semerak	85.0	—	—	15.0
Ketara (Besut)	100.0	—	—	—

Source : Paddy production survey reports and IADP Kerian/Sg.Manik Office, 1995

The seed rates adopted for direct seeding varies from 40 to 150 kg per ha depending on the area and direct seeding method. The summarized seed rates in the study area are shown as below.

(Unit: kg/ha)

Study Area	Direct Seeding (Wet)	Direct Seeding (Dry)	Trans Planting
Pulau Pinang	75 - 100	—	—
Kerian/Sungai Manik	40 - 100	60 - 150	20 - 25
Seberang Perak	80 - 100	—	—
Kemasin Semerak	40 - 60	—	—
Ketara (Besut)	50	—	—

Source : DOA "Direct Seeding-Impact and Implications on Rice Cultivation Practices" 1993 and data from IADP offices 1995

(d) Fertilizer Application

Fertilizer are subsidized by the Government. Urea 100 kg/ha and compound fertilizer (17.5:15.5:10) of 200 kg/ha based on an agronomic recommendation of 80 kg of Nitrogen, 30 kg of P_2O_5 and 20 kg of K_2O are subsidized in each crop season. In general, farmers apply only subsidized fertilizer and some advanced farmers apply additional fertilizers on their own expenses. Compound fertilizers are commonly used as additional fertilizers. Fertilizer application amounts in the study area are as follows :

(Unit : %)

Study Area	Urea	Mixture	Others	Nitrogen Conversion
Pulau Pinang	94.1	156.5	48.9	78.0
Kerian/Sg.Manik	94.2	187.2	79.3	88.0
Seberang Perak	105.1	206.8	50.0	92.0
Kemasin Semerak	93.9	190.6	—	76.6
Ketara (Besut)	98.8	197.6	—	80.0

Source : Paddy production survey reports and IADP Kerian/Sungai Manik Office, 1995

Applications of fertilizers by farmers who practice direct seeding are made between 14 to 75 days after seeding. Manual broadcast of fertilizers is the common practice except

Seberang Perak where farmers use motorblowers. The comparative table of dosage amount of seed and fertilizer inputs is shown in Table 2.1.3 "Summary of Farm Inputs in the Study Area".

(e) Pest Management

The shift to direct seeded rice in the country has aggravated pest problems, especially weeds and insects. Apart from the impact on pest species, direct seeding has also affected the pest surveillance and forecasting techniques as the techniques were previously based on a transplanting. Operation to control and certain outbreaks have become more difficult to implement effectively, especially if the crop is at the maximum tillering stage onwards. Among the insects that had been reported to come into prominence with direct seeding in the study area are the brown planthopper and the leaf rollers.

The weed management is critical to ensure a good yield with direct seeding method. Hence with the introduction and establishment of direct seeding, emphasis was and is being given to weed control. Farmers in the study area are advised to prepare land well, practice good water management together with appropriate herbicide technology. All IADPs stressed that water management is very important to keep weed population down in paddy fields.

Integrated Pest Management (IPM) has been introduced in some area in the study area and is followed by farmers.

(f) Harvesting

The mechanized harvesting through the use of combine harvesters is commonly done in the study area, and to much smaller extent, reapers and threshers. No manual harvesting is observed except Kerian scheme. Manual harvesting is done in some extent of Kerian scheme because of the low soil bearing capacity under ill-drainage soil condition. The combine harvesters used are of the larger type with cutting size ranging from 12 to 16 feet. Generally after the crop is harvested, the harvested crop is loaded directly onto lorries or tractors in bulk. The rice crop is harvested at varying degrees of grain ripeness, ranging from 65 to 100 % ripeness. The exact stage of ripeness harvested depends largely on the availability and logistics of the combine harvesters. The harvesting and loading work are done by contract.

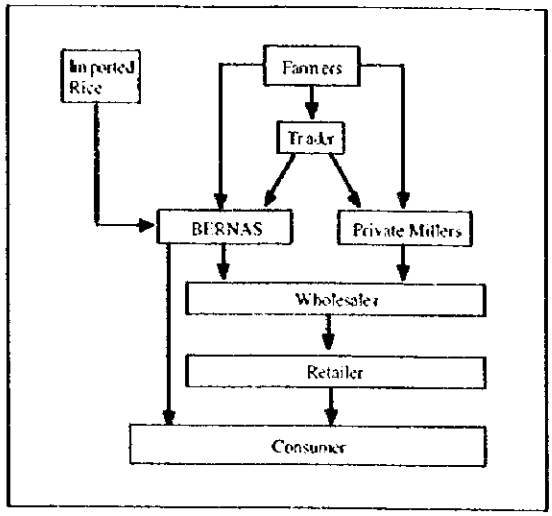
Table 2.1.4 "Estimated Farm Inputs and Labour Requirement" shows the estimated farm inputs and labor requirements in the five(5) granary areas.

(5) Marketing and processing

(a) Marketing Channel

There is no big difference in making channel among five(5) granary areas. As to the harvesting, two(2) methods are used, namely "bulk handling" and "Guni-sack handling". Presently, majority of farmers are using bulk handling although Guni-sack

handling is still dominant in Kerian Scheme. After the harvesting, farmers bring their products to rice mills either directly or through traders. The paddy brought into the mills are graded according to their moisture contents, dirt, unripe grains and germinated grains. The average deduction rate for paddy is about 15 to 20 %. After the milling, rice is sold to the wholesaler or retailers and finally reaches consumers. The marketing flow of paddy is simply summarized as follows :



The selection of marketing destination among farmers is made according to the several conditions such as availability of transportation, accessibility, deduction rate, incentives and so on. According to the result of Farm Survey, about 50.2 % of respondents sell to the BERNAS and 28.5 % sell to the private millers. However, this tendency is different from one area to another because of the reasons stated above.

(b) Rice Mill

Rice mills are categorized into two(2) types, namely BERNAS mills and non-BERNAS mills. Number of rice mills and their capacity in each granary are summarized below.

Name of Scheme	No. of Mills		Annual Capacity*1 (mt/year)	Paddy Prod'n in Scheme*2 (mt)
	Bernas	Non-Bernas		
Pulau Pinang	1	13	294,000	58,674
Kerian	1	9	220,000	112,668
Sungai Manik	1	0	20,000	36,808
Seberang Perak	1	0	40,000	58,853
Kemasin Semerak	1	0	20,000	19,098
Besut	1	2	29,000	27,787
Total	6	24	623,000	313,888

*1 : Annual capacity is calculated by assuming that working hour is 16 hrs/day and working days are 250 days/year.
*2 : Average annual production for 5 years from 1991 to 1995.
Source : MOA, BERNAS, 1997

According to the data shown above, the milling capacity is enough to cover for the present production in Pulau Pinang, Kerian and Kemasin Semerak. Although the

capacities of rice mills within the project area are not enough in Sungai Manik, Seberang Perak and Besut, some portion of products are sold to the private millers from outside of the project area such as Pulau Pinang and Kerian. Accordingly, in total of six areas, balance of milling capacity is large enough to cover present production level.

(c) Price

The Malaysian Government set a floor price for paddy and provides price subsidy in order to stabilize farmers' income. The floor price, usually referred as Government Minimum Price(GMP), has been recently raised by RM 5.39 per 100 kg. As of January 1998, prices of paddy fixed by the government are RM 55.00 per 100kg for Grade 1 and RM 51.69 per 100kg for Grade 2. The price subsidy is RM 24.81 per 100kg irrespective to the Grade. Therefore, the price that the farmers will receive for 100kg of paddy is estimated at about RM 76.51 to RM 79.81.

(d) Farm Input

As to the farm input marketing, the channel is broadly divided into three(3) streams, which are through PPK, DOA and retailers. In case of seeds, DOA sells certified seeds to farmers with about RM1.0/kg, but it is often mentioned that supply is not enough or supply timing is not adequate. Presently, MARDI recommend that seeds should be replaced after three seasons. Based on this recommendation, DOA supplies 30 % of total amount of seeds required for one season. Therefore, the supply does not match with demand of farmers and results in relative excess demand. For the fertilizer, about 100kg of Urea and 200kg of Mixture are subsidized by the government to the registered farmers through PPK. Agro-chemicals are marketed with similar flow as fertilizer.

Based on the result of farm survey, the purchase of farm inputs are mostly done individually and group purchase is not so significant. Farmers insisted that the major problems for the farm-input marketing are high price and untimely supply of farm inputs.

2.1.6 System Infrastructure

(1) IADP Pulau Pinang Scheme

(a) Irrigation System

The IADP Pulau Pinang Scheme consists of five(5) sub-schemes and irrigation water for each sub-scheme are supplied from Muda river, Jarak river, Kulim river, Burung river and Titi Teras river with pumping or gravity intakes as shown below :

Name of Sub-Scheme	Water Source	Intake Method	Irrigation Area
Sungai Muda	Muda river	Pumping	6,888 ha
Pinang Tunggal	Muda river	Pumping	938 ha
Sungai Jarak	Jarak river	Gravity +Pump	388 ha
Sungai Kulim	Kulim river	Gravity	1,387 ha
Sungai Burung	Titi Teras and Burung rivers	Gravity	231 ha

The sub-schemes are divided into several irrigation blocks, which are 6 blocks (Block M1 - M6) in Sungai Muda sub-scheme, 2 blocks (Block P1A and P2) in Pinang Tunggal sub-scheme and 4 blocks (Block K1B, K2B, K3 and K4) in Sungai Kulim sub-scheme and 2 blocks (Pokok Tampang and Padang Menora) in Sungai Jarak sub-scheme. It is noted that Block P1B in Pinang Tunggal sub-scheme and Blocks K1A, K2A, K5 and K6 in Sungai Kulim sub-scheme are excluded from the granary area due to conversion for industrial, residential purposes, etc.

The irrigation water for Sungai Muda sub-scheme and Pinang Tunggal sub-scheme is taken from Muda river through Bumbong Lima pump station and Pinang Tunggal pump station, respectively. A part of water pumped up at Pinang Tunggal pump station flows into Kreh river, a tributary of Jarak river and is reused as irrigation water for Pokok Tampang Block in Sungai Jarak sub-scheme, through the Kreh headworks and pump station. A headworks and Padang Cempedak pump station on Jarak river also supply water to Pokok Tampang Block as well as Padang Menora Block in Sungai Jarak sub-scheme. Sungai Kulim sub-scheme is provided irrigation water from Sungai Kulim Headworks on Kulim river. In Sungai Burung sub-scheme, water for irrigation is mainly supplied from a headworks at Sungai Burung and supplementary irrigation water is diverted at a headworks at Titi Teras river especially in the dry season. These pump stations and headworks are well operated presently. The Bumbong Lima pump station is being improved with 8 new pumps by DID in order to increase intake water volume and is scheduled to be completed in January 1998.

Most of main and secondary canals in the scheme are unlined with trapezoidal sections and some erosion and weed are found in those canals. The tertiary canals except those in K1B block of Kulim sub-scheme consist of concrete lined trapezoidal or U shape block sections. Canal density in the scheme is about 30 m/ha in an average. Canal structures are relatively in well conditions. Irrigation distribution diagrams of the scheme are presented in Annex II "Irrigation and Drainage" of the separate volume of this main report.

(b) Drainage System

Main, secondary and tertiary drains are provided to drain away the standing water in the paddy field and excess water to prevent crop damage and yield reduction due to inundation of the fields, to reclaim swampy waterlogged areas for paddy cultivation and to lower the ground water table to improve the bearing capacity for farm machinery. Some of existing rivers are used for main and secondary drainage system. Density of drain in the scheme is 36 m/ha in an average. There are no serious drainage problems in the scheme presently. Drainage diagrams of the scheme are also given in Annex II.

(c) Farm Road

Farm road with 5 m width and 230 mm laterite surfacing, and with 4 m width and 150 mm laterite surfacing are provided along one side of the main, secondary and tertiary canals, respectively. Density of farm road in the scheme is approximately 25 m/ha. Earth ramps are also provided to enable heavy machinery to go onto the farm land.

Some of farm roads are used not only for farming but also for living transportation and commercial purposes, but in bumpy conditions.

General map and features as well as present conditions of the scheme are shown in Fig. 2.1.3 "General Layout of Irrigation and Drainage System" and Table 2.1.5 "General Features of Irrigation and Drainage", respectively. Irrigation canals, drainage canals and their related structures in the scheme are listed in Annex II "Irrigation and Drainage".

(2) IADP Kerian / Sungai Manik Scheme

Total commanding area of IADP Kerian / Sungai Manik Scheme is 29,878 ha, which consists of 23,560 ha of Kerian Scheme and 6,318 ha of Sungai Manik Scheme.

(a) Kerian Scheme

(i) Irrigation System

The Kerian Scheme is divided into 2 sub-schemes, namely Kerian Laut sub-scheme and Kerian Darat sub-scheme and further those sub-schemes comprise of 8 irrigation compartments designated as A to H. Out of 8 irrigation compartments, 4 compartments, E to H in Kerian Darat sub-scheme are supplied water from the Bukit Merah Reservoir while the remaining 4 compartments, A to D in Kerian Laut get their supply from the reservoir supplemented by Samagagan river, a tributary of Kerian river through the Bogak Pumping Station as summarized below. Twenty-one(21) movable pumps and one fixed booster pump provide water from the drains supplementary in the drought season.

Name of Sub-Scheme	Water Source	Intake Method	Irrigation Area
Kerian Laut	Bukit Merah/Kerian River	Gravity + Pump	13,726 ha
Kerian Darat	Bukit Merah Reservoir	Gravity	9,834 ha

The Terusan Besar main canals, which is diverted from the Bukit Merah Reservoir, conveys water to compartments A to F. Main canals of Terusan Alor Pongsu, Terusan Tg.Piandang and Terusan Serong which are branched from Terusan Besar supply water to compartments E, C, B and A. Compartments G and H are provided water from the Bukit Merah reservoir through the Terusan Serinsing main canal. Secondary canals are branched from the main canals through constant head orifice offtake, and supply water to tertiary canals or directly to the fields. Every farm plots are provided water through farm offtakes installed on secondary and tertiary canals, and water distribution within each farm plot is made by means of overflow or quaternary canal. Both main and secondary canals are unlined trapezoidal sections and tertiary canals are either earth, concrete lined or glass reinforced polyester. Average density of irrigation canal for the scheme is 30 m/ha. At the upper reach of Terusan Besar main canal, seepage is remarkable, and several gated structures such as offtakes and check structures have been damaged. It results in water shortage in the downstream area. Irrigation distribution diagrams of the scheme are shown in Annex II.

(ii) Drainage System

The scheme has a network of secondary and tertiary drains. The ultimate drainage is provided by Kurau and Kerian rivers, and major drainage outlets are flowing directly into the Strait of Malacca through tidal gates. Bund protection dikes were constructed to reduce flooding and provide protection from the influence of sea water in the coastal areas of the scheme. The drainage density in the scheme is approximately 36 m/ha. There are some poor drainage areas especially in compartments A, B and C due to the topography(flat land) and less maintenance of tertiary drains(decrease of capacity). Drainage diagrams of the Kerian Scheme are also given in Annex II.

(iii) Farm Road

Farm roads surfaced with laterite are provided on the bund of main, secondary and tertiary canals, and average density of the roads is 29 m/ha. Effective width of the road along main and secondary canals is 3.0 m to 4.0 m, however that along tertiary canals is insufficient for traveling of farm machinery. Moreover, surface of roads is in muddy conditions during rain.

General layout and features of the scheme are given in Fig. 2.1.4 "General Layout of Irrigation and Drainage System" and Table 2.1.6 "General Features of Irrigation and Drainage", respectively. Lists of irrigation canals, drainage canals and the related structures are attached in Annex II "Irrigation and Drainage".

(b) Sungai Manik Scheme

(i) Irrigation System

The Sungai Manik Scheme consists of 2 sub-schemes, which are Sungai Manik sub-scheme in the southern part and Labu Kubong sub-scheme in the northern part. Those sub-schemes are divided into 5 irrigation blocks in the Sungai Manik sub-scheme, namely Block 1A, 1B, 2, 3A and 3B, and 4 blocks in the Labu Kubong sub-scheme comprising of Block 4A, 4B, 5A and 5B. Irrigation water for the scheme is supplied from Batang Padang river, a tributary of Perak river, mainly through a diversion headworks (Sungai Manik Headworks) and a pumping station (Chikus Pumping Station) supplementary supplies water to Block 3A.

Name of Sub-Scheme	Water Source	Intake Method	Irrigation Area
Sungai Manik	Batang Padang River	Gravity + Pump	3,602 ha
Labu Kubong	Batang Padang River	Gravity	2,716 ha

The Sungai Manik Headworks is gated weir type and diverts water to Right and Left Main Canals through an intake structure. Right Main Canal conveys water to the Labu Kubong sub-scheme and Left Main Canal covers irrigation for the Sungai Manik sub-scheme. A weir located at the downstream of Left Main Canal is provided as a bifurcation structure feeding Secondary Canals 5 and 3A. The Chikus Pumping Station is located at the downstream of the Sungai Manik Headworks below the confluence of Chikus river and Batang Padang river, and the pumping water is supplied to Block 3A

through Secondary Canal 3B. Most of main and secondary canals in the scheme are unlined trapezoidal sections. Tertiary canals in Labu Kubong sub-scheme are almost concrete lined, however those in Sungai Manik sub-scheme are still unlined. Sediment and erosion are found in those earth canal portions. Several diversion offtakes as well as for check structures in the scheme have wooden panel gates and water leakage from the gates is found. Moreover, irregular pipes on some farm offtakes, which have been replaced by farmer themselves, cause in what shortage of the downstream area. irrigation distribution diagrams of the scheme are shown in Annex II.

(ii) Drainage System

Practically all the tertiary drains are located beside tertiary irrigation canals. Water from tertiary drains is collected along secondary drains, which eventually flows into main drain and into the Perak river through 3 tidal gates. Drainage control structures are provided along the drains and rivers to maintain a certain height of water level so as to reduce the seepage loss from paddy fields, and drainage pipe is put at the boundary of every 2 farm lots to drain away water from paddy field. Density of drains in the scheme is 38 m/ha. Drainage diagrams of the scheme are given in Annex II.

(iii) Farm Road

Public roads paved with asphalt is utilized for access to the farm lands. Farm roads are provided on the bund of main, secondary and tertiary canals surfaced with laterite. The width of laterite pavement are 3 m along the main and secondary canals and 1.8 m along the tertiary canals. It is considerably insufficient for mechanized farming.

General layout and features are given in Fig. 2.1.5 "General Layout of Irrigation and Drainage" and Table 2.1.7 "General Features of Irrigation and Drainage", respectively. Lists of irrigation canals, drainage canals and their related structures are presented in Annex II "Irrigation and Drainage".

(3) IADP Seberang Perak Scheme

(a) Irrigation Scheme

The IADP Seberang Perak Scheme consists of Right Branch Canal sub-scheme and Left Branch Canal sub-scheme. The Right Branch Canal sub-scheme is divided into 3 blocks, namely Block E, F and G and the Left Branch Canal sub-scheme comprises of 4 blocks, Block A, B, C and D. A free intake structure at Telok Sena diverts water from Perak river to the scheme area.

Name of Sub-Scheme	Water Source	Intake Method	Irrigation Area
Left Branch Canal	Perak River	Free intake	4,365 ha
Right Branch Canal	Perak River	Free intake	4,343 ha

A main canal conveys water from Telok Sena Intake to a bifurcation located at about 8 km downstream of the intake. The bifurcation structure regulates and controls the amount of discharge into the right branch canal and left branch canal. It seems difficult

to operate both intake and bifurcation gates properly because of their manual moving, so that water surface in main canal and upper reaches of branch canals often rises up to top of canal bank. The main and secondary canals have unlined trapezoidal sections except the secondary canals lined by concrete in the Right Branch Canal sub-scheme. The tertiary canals in the Right Branch Canal sub-scheme consist of concrete-lined trapezoidal or block sections and the remaining are still unlined. The canal density in the scheme is about 35 m/ha. Canal structures on main and branch canals are relatively well maintained, but those on secondary and tertiary canals in Left Branch sub-scheme require to be improved. Irrigation distribution diagrams of the scheme are shown in Annex II.

(b) Drainage System

Water in the paddy fields is collected in tertiary drains and flows into Perak river or its tributaries through main and secondary drains. Drainage water flow to the rivers is controlled by 9 numbers of drainage gate structures (tidal gates) to prevent saline intrusion into the paddy fields. Every tertiary drains have a drainage control structure at their ending in order to regulate the water level in the paddy fields and to serve as drainage crossing for farm machinery. Block II is included in drainage system of the scheme, in which area oil palms are planted as shown in Fig. 2.1.6 "General Layout of Irrigation and Drainage System". Density of drains in the scheme is 43 m/ha. Poor drainage in downstream area is sometimes found due to improper operation of tidal gates. Drainage diagrams of the scheme are given in Annex II.

(c) Farm Road

Public roads along the main and branch canals paved by asphalt with about 7m width, are used for access to the intake and bifurcation structures sites for operation and maintenance of the main and branch canals and for approach to the farm lands. Farm roads with 3.65 m width and laterite surfacing are provided along one side of the secondary canals or secondary drains, however those are in bumpy conditions.

General layout and features as well as present conditions of the scheme are presented in Fig. 2.1.6 "General Layout of Irrigation and Drainage System" and Table 2.1.8 "General Features of Irrigation and Drainage", respectively. Lists of irrigation canals, drainage canals and the related structures are presented in Annex II "Irrigation and Drainage".

(4) IADP Kemasin Semerak Scheme

(a) Irrigation System

The Kemasin Semerak Scheme comprises of eight sub-schemes as shown below. Two(2) phase-wise execution has been adopted for the development of the scheme and the phase-I works, consisting of Kemasin Hilir and Jelawat Rusa sub-schemes in the Kemasin area have been completed. The execution of phase-II works for the remaining sub-schemes in the Semerak area, however, are awaiting for the completion of flood mitigation works which is under executed by DID, because the design review of those sub-schemes shall be referred the results of the said flood mitigation works.

The Kemasin river is a water source for both Kemasin Hilir and Jelawat Rusa sub-schemes. The Kumbu Pumping Station in KADA Scheme shall supply 16.0 m^3/sec of water to the Kemasin Semerak Scheme, which consist 5.0 m^3/sec for Kemasin area through Kemasin river and 11.0 m^3/sec for Semerak area through Semerak river. However, the regulation is not strictly followed due to incomplete sub-schemes mentioned above. Present water supply to the sub-schemes is summarized below.

Name of Sub-Scheme	Water Source	Intake Method	Irrigation Area
Kemasin Hilir	Kemasin River	Pumping	261 ha
Jelawat Rusa	Kemasin River	Pumping	1,384 ha
Semerak Hilir	- no planting presently -		1,000 ha
Semerak Hulu	- no planting presently -		174 ha
Semerak Selatan	- no planting presently -		1,100 ha
Semerak Barat	- irrigated by movable pump -		115 ha
Sungai Yong-Gaal	- single cropping by old facilities -		2,260 ha
Jeram-Rasau	- cropping by rainfed -		601 ha

The Kemasin Hilir sub-scheme consists of 5 blocks, Block A, B, C, D and E and all blocks are supplied water from Kemasin river by pumping up. The Jelawat Rusa sub-scheme, comprising of 5 blocks, Block A0, B0, B1, C0 and C1, is also irrigated by pumping water from Jelawat river, a tributary of Kemasin river. Water supplied to Block B0 and C0 are again pumped up by booster pumps to irrigate Block B1 and C1. Water conveyed by main canal is diverted to secondary, tertiary and quaternary canals through farm offtakes and adjustable weirs and farm offtakes on those canals supply water to every service units. Weir regulator and adjustable weir are used as regulating structures. Canals and related structures in the sub-schemes are relatively well conditions. Irrigation distribution diagrams of the scheme are shown in Annex II.

(b) Drainage System

Excess water within a service unit is drained by quaternary drains flowing into tertiary drains which have their outfalls at the secondary drains. The main drains collect the outflow from the secondary drains and discharge off at the drainage outlets to the rivers. A tidal gate structure on Kemasin river is operated to avoid tidal influence to the main drain. Density of drains in Kemasin Hilir and Jelawat Rusa sub-schemes is 35 m/ha.

(c) Farm Road

Farm roads are provided along the canals and drains to facilitate maintenance and operation of the scheme and farming activities. Those roads are mainly surfaced by gravel with 3.0 m width. Quaternary farm roads are also built across paddy land.

General map and features including present conditions of the scheme are shown in Fig. 2.1.7 "General Layout of Irrigation and Drainage" and Table 2.1.9 "General Features of Irrigation and Drainage", respectively. Lists of irrigation canals, drainage canals and related structures are presented in Annex II "Irrigation and Drainage".

(5) IADP Ketara (Besut) Scheme

(a) Irrigation System

The IADP Ketara (Besut) Scheme consists of 2 sub-schemes, namely Angga Barrage sub-scheme and Besut Barrage sub-scheme. Those sub-schemes are further divided into 4 compartments, which are 1 compartment in the Angga sub-scheme (Compartment 2) and 3 compartments in the Besut sub-scheme (Compartment 1, 3 and 4). There are two(2) water sources to supply water for the scheme consisting of Angga river and Besut river as shown below. In drought season, water in drains are utilized as supplemental sources, which is pumped up to irrigation canals by six(6) recycling pumps.

Name of Sub-Scheme	Water Source	Intake Method	Irrigation Area
Angga	Angga River	Gravity	1,147 ha
Besut	Besut River	Gravity	4,017 ha

The Angga sub-scheme and the Besut sub-scheme are supplied water from Angga river and Besut river through two(2) barrages, namely Angga Barrage and Besut Barrage, respectively. The Angga Barrage consists of two radial gated weirs and two sluice gates for intake. The Besut Barrage comprises of four gated weirs (motor driving roller gates) and three slide gates for intake portion. Much water leakage from the weir gates is found.

The main canals conveys water to downstream and the water is diverted to secondary and tertiary canals through offtake structures. About 20 % of Besut main canal and about 86 % of secondary canals have been lined with concrete. Tertiary canals, of which length about 137 km, are almost lined with consist or glass reinforced polyester. Irrigation facilities in the scheme including structures are rather superannuated, which results in difficulty of proper operation. Irrigation distribution diagrams of the scheme are shown in Annex II.

(b) Drainage System

The drainage system of the scheme are about 177 km of main and secondary drains, and 64 km of tertiary drains. Existing rivers which are flowing in the scheme are fully utilized as main drains. Density of drains in the scheme is about 35 m/ha. Due to sedimentation in the drains, poor drainage fields are found in the downstream area. Drainage diagrams of the scheme are given in Annex II.

(c) Farm Road

Farm roads are mainly provided along the main, secondary and tertiary canals with about 241 km in total length. Those are paved by asphalt(57 km), crashed stone(39 km) and laterite(118 km), and remaining(27 km) is still non-paved. Width of main and secondary farm roads is sufficient for mechanical farming, however that of tertiary farm roads is considerably narrow.

General layout and features as well as present conditions of the scheme are given in Fig. 2.1.8 "General Layout of Irrigation and Drainage System" and Table 2.1.10 "General Features of Irrigation and Drainage", respectively. Lists of irrigation canals, drainage canals and related structures are presented in Annex II "Irrigation and Drainage".

2.1.7 Water Management and O & M

(1) IADP Pulau Pinang Scheme

The Granary Areas System O&M is by the Seberang Java DID District Office. This office comprise the Seberang Perai Utara (SPU) sub-district which covers the Sg.Muda, Pinang Tunggal and Sg.Jarak sub-schemes, and the Seberang Perai Tengah (SPT) sub-district which manages the Sg.Kulim sub-scheme. All the paddy areas in this scheme is said to be gazetted. The irrigation rates ranges between RM 9.88 to RM 34.59 per ha.

The system design module is 2.60 l/s/ha for a 15 day presaturation period at farm level. The module for normal irrigation is 1.30 l/s/ha. Farm offtakes installed serve about 3 ha farm lots. The pipe sizes used are 80 mm, 100 mm and 150 mm with capacities of 15 l/s, 18 l/s and 22 l/s, respectively. For drainage, the module adopted is 8.5 l/s/ha for 1 in five year and 72 hours storm duration, and 300 mm pipe diameter drainage outlets are provided. Up to December 1996, nearly 90 % of the tertiary development of this scheme was completed. The Commissioning Section of the DID Component leads the commissioning process together with the O&M staff of DID Seberang Perai District.

There are no telemetry system for irrigation system management in this scheme. However there is one pilot flood warning telemetry system for the State of Pulau Pinang. Another is planned for water resource. Telecommunication between central office and main gate stations/pump stations is by telephone lines.

Designer's operation manual are available but the documented overall scheme operations and maintenance procedure are not available. No central control section exist for O&M. Designers' operation manual for the system is available but for reference only. Field staff rely totally on experience and judgment for operations and guided by gate opening reference book. Coordination with farmers is through the farmers' groups managed by the DOA. The average O&M cost (1994 and 1995) for four (4) sub-schemes (excluding Sungai Burung) is between RM 100 to 230/ha. In 1997 a major decision was made to award a single contract the State Farmers' Organization Authority for clearing works. Prior to this, the DID office had to administer over 500 indent works annually.

Currently a performance assessment program is being implemented but is still at its early stages. The indicators selected for this granary are Relative Water Supply (RWS), Cropping Intensity (CI), Maintenance Cost (RM/ha), and Water Productivity Index (WPI).

(2) IADP Kerian / Sungai Manik Scheme

(a) The Kerian Scheme

The O&M of this scheme is the responsibility of DID Kerian District. The Scheme is gazetted as an irrigation area. The irrigation rates charged to landowners here range between RM 7.41 to 12.36 per ha in the Perak State and RM 9.88 to 34.59 per ha in the Pulau Pinang State.

The "managed-as-planned" procedure was adopted in 1986. Field staff observes water conditions in the field, record planting activities and reports once a week to the Control Unit formed in 1991 in Bagan Serai. Estimation of water requirement is based on a presaturation module of 2.40 l/s/ha and supplementary module of 1.20 l/s/ha. Water requirement is forwarded to the control unit three days in advance. The operations system is supported by a telemetry system. Telecommunication and the telemetry system use the 150 MHz band radio links.

Farmers non-compliance to schedule appears to be an inherent problem particularly in the Kerian Laut area. This is due to its topographical nature as low lying thus suffer from drainage problem. Transplanting is still practiced in this area and therefore complicate water supply and management. The DID has started a pilot project for polder drainage in this area and will implement this project later for about 4,000 ha.

Maintenance of the irrigation and drainage channels is performed on a fixed cycle of 4 to 5 times a year. Almost 80 % of the clearing works is undertaken by farmers and the remaining 20 % by DID staff. Typically the DID office administer over 1,000 indent works annually. The average O & M cost (1994 and 1995) for this scheme is about RM 200 per ha.

Performance assessment program is already implemented in this scheme. The indicators selected for this scheme are Relative Water Supply (RWS), Cropping Intensity (CI) and Water Productivity Index (WPI).

(b) Sungai Manik Scheme

The operation and maintenance of Sungai Manik Scheme is the responsibility of DID Hilir Perak. This scheme is said to be gazetted. The irrigation rates are between RM 7.41 and RM 12.36 per ha.

Irrigation start dates are fixed for every season. For season 1, supply starts on 15 January for Sungai Manik scheme followed one month later on 15 February for Labu Kubong. For season 2, the supply dates are 15 July and 15 August, respectively. In order to overcome the shortage of water at the downstream sections of the scheme, 13 mobiles pumps deployed. There is no telemetric system in this scheme. Communications between central office and headwork is by telephone only.

The scheme operational procedure is not available and O&M depends mostly on field staff experience and judgment. Channel clearing is performed every two months by farmers through the respective Village Security and Development Committee (JKKK). The O&M cost (1994 and 1995) is estimated at about RM 145 per ha.

A performance assessment program has begun and the indicators adopted are Relative Water Supply (RWS), Cropping Intensity (CI) and Water productivity Index (WPI).

(3) IADP Seberang Perak Scheme

The O&M of this granary is the responsibility of DID Perak Tengah located at Bandar Sri Iskandar. However the O&M staff for the scheme is based at the DID Project Office complex in Sungai Dedap. FELCRA is responsible for the operations of the tertiary system within their area. The scheme is apparently not gazetted. Season 1 begins in February until mid-July and season 2 from August to early February.

The design duty is 5.75 l/s/ha for 7 days presaturation at the farm lot level. Normal supply duty is at 1.2 l/s/ha. For irrigation scheduling, the areas are divided into 3 schedules namely I, II and III at 14 days interval between schedules. In each schedule, the supply is staggered into 2 with 1 week difference between staggers. At the farm level, 150 mm diameter offtake is provided to serve 2 lots totaling 2.4 ha. The maximum capacity is 22.6 l/s for a command of 300 mm. The type used here is the double flap type. Drainage module adopted here is 7.5 l/sec/ha for a 1 in 5 years return interval and 48 hours duration.

There is no updated systems operations manual for this scheme. The O&M staff rely mainly on their experience and judgment in managing the system. The main daily monitoring parameters are the water levels in the Perak River and the main and secondary canals. There is no telemetry system for irrigation in this scheme. The only water level telemetry station in Teluk Sena is for flood level monitoring only. Communications between Teluk Sena and the main office is by telephone. There are no telephone links between the tidal gates and the main office.

Channel clearing works are awarded to either Village Heads, Block Heads or the Area Farmers' Organization. This is carried out on 4 cycles per year. The annual O & M cost (1994 and 1995) is RM 123 per ha.

Performance assessment program is not yet implemented here but this scheme has been selected to be the first scheme to work towards obtaining ISO 9002 certification.

(4) IADP Kemasin Semerak Scheme

Irrigation development for this scheme is divided into 2 phases. Phase 1 is the Kemasin area comprising the Jelawat Rusa Scheme and Lower Kemasin Scheme. Phase 2 are the schemes in the Semerak area in the south. The Lower Kemasin (261ha) and Jelawat Rusa (1,384ha) schemes were completed in 1991/92. These schemes are still under the responsibility of the Project Office and not handed over to the State DID.

The Lower Kemasin Scheme is divided into 5 blocks (about 60 ha each). Each block is further divided into Service Units (SUs) about 12 ha each and with independent intakes. In turn, each SU is divided into 4 plots of nearly equal size. This area size is to achieve presaturation in 10 days. The design capacity is based on peak irrigation duty of 2.06 l/s/ha for 40 days presaturation period. For the Jelawat Rusa Scheme, the area is divided into Zones, each with its own independent irrigation and drainage system. Further area sub-division is as per Lower Kemasin Scheme. The irrigation design duty is also similar.

There is no telemetry system installed. Telecommunications between the central office, one tidal gate station, eight pump stations and one mobile pump station is by 150 MHz band radio links. Performance Assessment Program has just begun and the indicators selected for this scheme are Relative Water Supply (RWS), Presaturation Time Requirement (PTR), Cropping Intensity (CI), and Water Productivity Index (WPI).

Irrigation development for the schemes in the Semerak area has not begun. Presently, these schemes are either with inadequate irrigation facilities or rain-fed areas managed by the DID Pasir Putih District and the DOA.

(5) IADP Ketara (Besut) Scheme

The Besut scheme is managed by DID Northern Terengganu District. The scheme is gazetted as an irrigation area. Water rates imposed here is RM 9.88 per ha. To improve water management, the Besut scheme has reorganized farmers' groups based on the command area of an intake. This scheme is the only granary implementing the formation of Water Users' Group (WUG). Under this exercise the number of Irrigation Service Areas (ISAs) were reorganized into 30 WUGs.

For irrigation administration, this scheme is divided into Phase I and Phase II. Each Phase is sub-divided into compartments. Phase I comprise compartments 1, 2/1 and 4 and Phase II compartments 2/2 and 3. There are two main intakes. One is the Besut Barrage serving compartments 1,3 and 4 and the other intake is the Angga headworks serving compartment 2. Water supply is in two schedules. Phase I is supplied first for presaturation time of 14 days at 2.94 l/s/ha. After 14 days, Phase II area supply begins at the same rate. After presaturation, the irrigation duty is reduced to 1.2 l/s/ha. Total irrigation period is about 150 days.

No telemetry system exist for monitoring the irrigation and drainage network in this scheme. Telecommunication between the central office and main gate station/main pump stations is by telephone.

The annual O&M cost (1994 and 1995) for this scheme is about RM 180 per ha. Clearing works are given to the Farmers' Groups.

Performance assessment program is still at its early stages. The indicators selected for this scheme are Relative Water Supply (RWS), Cropping Intensity (CI) and Water Productivity Index (WPI).

2.1.8 Agricultural Support Services

(1) Agricultural Research

The Malaysian Agricultural Research and Development Institute (MARDI) was established under MARDI ACT in 1969 as a central, integrated organization to undertake agricultural research geared towards the development of locally adapted technology for serving the farming community and agro-based industries. MARDI maintains several station in the study area carrying out agronomic and breeding research. The overall supervision and direction for rice research is the responsibility of the Rice Research Stations.

Research programme is envisaged to concentrate on developing high yielding disease resistant varieties. Farm machinery modification tests and research into ways of reducing post-harvest losses are the other major areas of concern of MARDI. Apart from research carried out by MARDI, field demonstrations by DOA in direct seeding, fertilizer trials, water management and so on are encouraging.

(2) Agricultural Extension and Seed Supply

(a) Agricultural Extension

Agricultural extension service is provided by the State Department of Agriculture staff. The agricultural extension services in the each project area are supervised one Agriculture Officer assisted by Assistant Agricultural Officer and Agricultural Assistants. The agricultural extension services covers almost all technical aspect.

The objectives of agricultural extension services are to guide and train farmers, and to introduce more systematic crop production technique and practices. The training and visit system is adopted. The Agricultural Assistants Officers are also responsible for regulator duties, statistical work and administration of subsidies. Besides formal training courses and field visits to successful farms or progressive farmers, all the IADPs in the study area support their extension services with printed materials such as pamphlets, papers on irrigation schedule and farming technologies. The broad cast on specific direct seeding activities are regularly aired with the assistance of the local radio stations.

(b) Seed Supply

Breeder seeds are obtained from MARDI and planted in Commodity Development Centre in Kedah, Pulau Pinang, Perak, Selangor, Trengganu and Kerantan States for the production and processing of registered seeds. Registered seeds are then distributed and planted in the seed production areas in each Commodity Development Centre as well as through contract farmers in adjacent areas. In the production of certified seeds, these farmers are supplied free registered seeds but the production, harvesting and transport costs have to be borne by the farmers themselves. The seeds produced are brought and processed at the Commodity Development Centres. A standard for the certified seed is prescribed in mixing under 2% of the other paddy varieties, more than 80% of the germination rates and under 14% of the water content. The processed seeds

are then distributed to local farmers, local agriculture agencies and agriculture agencies in other states.

(3) Rural Credit

A multitude of agencies both institutional and non-institutional are serving the credit needs of the farmers. As the institutional source, Agricultural Bank of Malaysia (BPM), Area Framers' Organization (PPK), People's Cooperative Bank of Malaysia and other commercial banks are available. As the non-institutional sources, there are traders, relatives, friends and money lenders. Among the all sources, BPM is the most major credit source for the farmers. BPM has established branches in all five(5) granary areas and works closely with the LPP and PPK to cater the credit needs of farmers. BPM provides various types of loan such as paddy loan, agricultural machinery loan, etc. The paddy loan is utilized mainly for the purchase of farm input and be paid back after the harvesting. Besides BPM, PPK is another major source of credit. It provides production loan, business loan and social-education loan. In most cases, the loan is asked for the production purpose and business purpose. In case of PPK, usually marketing of paddy is tied up with loan repayment. Therefore, its recovery rate is higher than other institutional sources.

According to the Farm Survey, utilization rate of loan in the five(5) granaries is relatively low. The farmers who utilized the loan in the year 1995/96 were only 32% of total respondents. The utilization of loan becomes lower in the east coast (around 10%) comparing with that of the west coast (30~50%). Among the credit sources, the BPM is the most major source which accounts for 79% of total respondents, followed by the 12% of PPK. Farmers answered that major problems for utilizing institutional credit are (i) complicated procedure and (ii) time lag for the loan to realize.

2.1.9 Farmers' Organization

(1) Brief Historical Background

From historical perspective, it can be observed that Malaysia had not had a strong indigenous water-based tradition of its own although historical records show that initial attempts to improve paddy farming were initiated as early as the nineteen century. Even after the establishment of Drainage & Irrigation Department and the Department of Agriculture in 1930s, which marked the beginning of government intervention in irrigation development, paddy farming was undertaken largely on individual basis while mutual-help activities of gotong royong mostly prevailed and were confined more to socio-cultural activities at the kampung level than at the farm level. The absence of indigenous tradition meant that efforts to improve or modernize water management at the farm-level by the water authority would take a long time. And these efforts were started only in late 1960s and early 1970s with the establishment of the Muda irrigation scheme which marked the beginning of large-scale irrigated agriculture development. The ensuing establishment of numerous farmer-oriented organization such as FAMA, FOA, LPN (now known as BERNAS), BPM, MARDI within a short time span resulted in a situation where farmers now found themselves dealing differently with numerous organization in the institutional environment within which they interact.

(2) Rural Institutions and Organizations

Generally paddy farmers in the granary areas are involved in many forms of groupings and organizations. These institutions and organizations can be categorized as a) Village-based, Locally-initiated Organizations, b) Village-oriented Formal Organizations, and c) Project/Farm-based Organizations. Farther details are as follows :

Major Organization at the Community Level
a) Village-based, Locally-initiated Organizations - Village Funeral Association (Khairat Kematian) - Mosque Committee (Jawatankuasa Masjid) - Parent-Teachers' Association (Persatuan Ibu Bapa-Guru)
b) Village-oriented Formal Organizations - Community Development Agency (KEMAS) - Village Development & Security Committee (JKKK)
c) Project/Farm-based Organizations - Group Farming (Ladang Kelompok under DOA, Mini-estate under PPK and estate under FELCRA)

(3) Farm-based Organization

Types and number of farm-based organizations can be examined from three aspects, namely ; a) mode of farming, b) mode of farming arrangements, and c) organizational arrangements as shown below.

Mode of Farming	Mode of Farming Arrangement	Organizational Arrangement
Individual - based	a) Solely individual b) Individual and rice millers - contract farming	Largely private business arrangement
Group - based	a) Ladang Kelompok b) Mini - estate c) Large-scale paddy estate	Department of Agriculture Area Farmers' Organization(PPK) FELCRA

(a) Mode of Farming : from the data available, out of 48,951 farm households in the five granary areas, about 19,579 or 40 % are involved in group-based paddy farming activities, while 29,372 or 60 % are still engaged on an individual basis.

(b) Mode of Farming Arrangements : there are among those within the individual category who establish some kind of contract farming arrangements with private rice millers. Among those who are involved in group-based farming, the predominant arrangement is ladang kelompok which total 297 units all through out the five granary areas. This is followed by mini-estate (5 units) and large scale estate (only one in Seberang Perak).

(c) Organizational Arrangements : two government agencies are key players at the field/operational level in the establishment and supervision of farmer-based organizations, namely the Department of Agriculture and the Area Farmers' Organization (PPK) while the co-ordinating role is played by the Project Management Unit (PMU) of the Integrated Agricultural Development Project (IADP). The sole large-scale paddy estate is under the direct supervision of FELCRA.

The present farmers' organizations in five(5) granary areas are as follows :

Granary	Organization	Ladang Kelompok	Mini - Estate	Estate	No. of Farmers Involved (Total Farm Household)	Area (ha)
Besut*	PPK	---	---	---	---	---
	DOA	30	---	---	3,054 (3,054)	5,164
Kemasin - Semerak	PPK	13	---	---	2,382 (8,616)	3,264
	DOA	6	---	---	372	456
Pulau Pinang	PPK	33	2	---	922 (17,906)	2,244
	DOA	108	---	---	4,885	7,571
Seberang Perak	PPK	1	---	---	121	456
	DOA	6	---	---	595 (3,030)	1,169
	FELCRA	---	---	1	1,239	2,000
Kerian	PPK	31	---	---	1,380 (13,485)	2,867
	DOA	50	---	---	3,735	5,445
Sungai Manik	PPK	8	3 **	---	894 ***(2,860)	2,175
	DOA	11	---	---	---	---

(Note) * : In the Besut Scheme, the establishment and supervision of farmers' group (kumpulan Putani or KPs) are done by Task Forces made up of staff of DOA and DID components of the IADP office

** : These three are currently under the process of upgrading.

*** : This represents common target group of both PPK and DOA of Sungai Manik.

The "Farmers' Organization Act, (Act 109)" jointly promulgated with the "Farmers' Organization Authority Act, (Act 110)" were established in 1973. On this legal basis, farmers' organization structures have been set up at Area (Area Farmers Organization: AFO), State (State Farmers Organization : SFO), and National levels (National Farmers Organization : NAFAS). Generally, AFO is called PPK taking an initial in Malay. PPK is composed of the farmers in the area. The farmer who doesn't register to the PPK, can not receive fertilizer subsidy from the government, and most farmers register to PPK. For registration, the registration fee and annual membership fee are not collected.

PPK is managed by staff sent from FOA. The management unit of PPK consists of a Manager and six to nine Assistant Section Heads, all of whom are FOA officers. In addition to these staff, clerical workers, typists and drivers are locally employed. The members farmers aren't concerned with the management of PPK directly. However, the Board of Directors is composed of the representatives of the registered farmers, and is the highest decision organ and decision-maker in terms of political and financial measures of PPK. The organization chart of the PPK is shown in the Fig.2.1.9 "Organization Structure of Area Farmers Organization and Farmers' Group". There are two major financial sources of PPK, namely annual budgetary allocation of the FOA and PPKs' own generated fund. The investment money from the members farmer is contained in the budget, too. The farmers who want to become investor of PPK have to purchase at least one share of RM 5.00 in value.

The farmers' groups under PPK are operated or managed by a committee called Farmers' Group Committee. The committee comprises a Chairman who is a farmer, a Secretary and a Treasurer, both are staff of PPK. There are four or five other farmer members who are elected to sit in the committee holding various functions such as Crop Protection, Water Management, Farm Machinery, Marketing and Socio-cultural Affairs. With regards the

posts of a Secretary and a Treasurer, in some farmers' groups, they are held by farmers by themselves, while in others, they are held by staff of PPK. This situation depends on the degree or level of progress (maturity) achieved by the farmers' group concerned. The organization chart of the farmers' group under PPK is shown also in the Fig.2.1.9 "Organization Structure of Area Farmers Organization and Farmers' Group". From the viewpoint of the organization structure, there is no significant difference between the farmer groups under PPK and DOA.

2.1.10 Farm Economy

(1) Crop Budget

The typical crop budget per hectare is estimated for each granary area as shown in Table 2.1.11 "Crop Budget for Each Granary Area" and the summary is shown below.

(RM/ha)

Description	Pulau Pinang	Kerian	Sungai Manik	Seberang Perak	Kemasin Semerak	Besut
Yield (kg/ha)	3,090	2,990	2,990	3,520	2,770	3,460
Price (RM/kg)*1	0.74	0.74	0.74	0.74	0.74	0.74
Gross Return	2,300	2,225	2,225	2,620	2,061	2,575
Production Cost*2	1,284	1,339	1,403	1,562	1,448	1,721
Net Return (with subsidy)*3	1,165	1,006	972	1,208	774	1,051
Net Return (w/o subsidy)*4	1,015	886	822	1,058	613	854
Return/Cost Ratio*5	1.79	1.66	1.59	1.68	1.42	1.50

*1: Price is before the increase in Dec. '97. i.e. RM 496.1/t of GMP plus RM 248.1/t of subsidy.
*2: Including the cost of subsidized fertilizer
*3: Net return in case fertilizer is subsidized.
*4: Net return in case farmers pay the cost of subsidized fertilizer.
*5: Return / Cost Ratio = Gross Return / Production Cost
Source: IADP Office, 1995-6

Among five granary areas, two granary areas in the east coast (Kemasin Semerak and Besut) show lower return comparing with those of the west coast. Especially, Kemasin Semerak shows lowest net return and return/cost ratio. The return/cost ratio is less than 2.0 in all granary area, while those of Changkat Jong and MADA are usually above 2.0. This indicates that there is a room for the improvement of cost performance.

As to the component of the cost items, as indicated in Table 2.1.11 "Crop Budget for Each Granary Area", the major cost item is machinery, especially for the rent of combine harvester. For the progressive farmers who apply additional fertilizers and agro-chemicals, cost of fertilizer and agro-chemical also becomes expensive component. However, it differs from one place to another according to their farm management level and their interests in paddy farming.

(2) Farm Income

Family income and poverty rate for each granary area are summarized in the following below :

(RM/Year)

Description	Pulau Pinang	Kerian	Sungai Manik	Seberang Perak*1	Kemasin-Semerak	Besut
Farm Income	6,407	1,693	3,479	3,713	1,409	2,784
Non-farm Income	9,169	5,923	4,337	4,086	4,027	3,336
Total Income	15,576	7,616	7,816	7,799	5,436	6,120
Poverty Rate (%)*2	0.8	3.4	3.9	5.9	15.4	13.0

*1 : Income is estimated from the figure of 1994.
*2 : Poverty rate is calculated based on the data from Ministry of Rural Development.
Source: IADP Annual Report, 1993&1994, Socio-economic Survey 1995 IADP Kerian/Sungai Manik, Ministry of Rural Development, 1995.

In all five(5) granary areas, the main source of income is non-farm income. This tendency becomes significant in the area where the high industrialization is on the process such as Pulau Pinang. In case of Pulau Pinang, there are more job opportunities in non-agricultural sector such as factory, transportation and tourism. On the other hand, the farm income itself is also high RM6,407 per year in this area. This is because of relatively large operating farm size (about 2.87 ha) and high cropping intensity of 189 %. The income level in the east coast are lower than those of west coast, especially in Kemasin Semerak. It can be attributed to the low crop intensity (57 %) and low yield (2.22 t/ha) of paddy in this area. The poverty rate also shows same tendency. It is highest in Kemasin Semerak and lowest in Pulau Pinang.

In Kelantan State, tobacco production is also quite popular among farmers and there are actually some farmers who produce tobacco after harvesting of paddy. According to the study conducted by the Department of Agriculture in 1994, the net return per hectare of tobacco is about RM6,500 which is more than 6 times higher than average return of paddy in Kelantan.

2.1.11 Environment

(1) IADP Pulau Pinang Scheme

(a) Fauna and Flora

No wildlife species that requires conservation plans has been reported within this scheme. There are two forest reserves, Pantai Aceh (100 ha) and Balik Pulau Forest Reserve (166 ha) on Pinang Island. Both of these reserves are located along the western coastline of the island and hold important habitats for migratory birds. However, not much information is available on those reserves.

(b) Water Quality

Sungai Muda sub-scheme is the largest irrigation area in this scheme, and its major source of water supply is Muda river. Most of the water used in this rice field is discharged into the sea through various waterways. The quality of water in Muda river has been gradually deteriorated, and the river is considered as slightly polluted in comparison with the general rating scale of the water quality index. Water quality data are shown in Annex VI "Environment".

(2) IADP Kerian / Sungai Manik Scheme

(a) Kerian Scheme

(i) Fauna and Flora

Kerian area is so large in size and that is considered as a type of wetland. Kerian paddy field has been recognized as a major feeding ground for a large colony of black-crowned night-herons at Kuala Kurau. This area is also known to be an important feeding ground for many bird species. In southern vicinity of this area, Matang Forest Reserve (40,711 ha), a large expanse of mangrove forest, is situated at the north of Kuala Gula extending to the south of Panchor. Another ecosystem needs to be concerned for conservation is Kuala Kurau (250 ha). This area includes only 20 to 30 ha of mangroves at the estuary of Kurau river. However, its location is in the vicinity of the project site; furthermore, this small patch of mangrove forest supports one of the largest colonies (5,000 - 6,000 nests) of black-crowned night-herons in the world. Therefore, this area is considered as highly sensitive and holds a high conservation value.

(ii) Water Quality

The main water supply for Kerian Scheme is the Bukit Merah Reservoir and Bogak river. Most of the water discharged from this scheme is generally drained into the sea, but some of the water is driven into Kurau river. Bukit Merah Reservoir is located upstream of the irrigation system so that there is no impacts from the agricultural activity to its water. Overall water quality of Kurau river has been relatively consistent for the last seven years. It is also noted that the water quality of Kurau river seems to be deteriorated toward downstream (see details in Annex VI "Environment").

(b) Sungai Manik Scheme

(i) Fauna and Flora

There are three major mangrove forests around Sungai Manik Scheme. Melintang Swamp Forest (45,000 ha) is located about 20 km south of this scheme. Rungkup Peninsula holds a 1,000 ha of mangrove forest between estuaries of Perak river and Bernam river. This area, particularly at the north western corner of the peninsular known as Tanjung Beras, is important as a prawn nursery ground and wader habitat. Telok Intan Swamp Forest (4,050 ha) is located at about 10 km north west of this scheme and is a remnant of former large expanse of peat swamp forest. Water regime flowing into this area is affected by the headworks in Batang Padang river within Sungai Manik scheme.

(ii) Water Quality

Most of the water for irrigation is taken from Batang Padang river in this area and water quality of this river does not seem to vary significantly between upstream and downstream, and it is still in an acceptable quality (refer to Annex VI "Environment").

(3) IADP Seberang Perak Scheme

(a) Fauna and Flora

Seberang Perak Scheme is located near Sungai Manik area. Therefore, fauna and flora of important natural ecosystems around this scheme are likely to be consistent with the ones identified in the previous section.

(b) Water Quality

Large amount of water that is used in Sungai Manik Scheme and Seberang Perak Scheme is drained into Perak river. Also, Perak river is the main water source for Seberang Perak Scheme so that water quality of this river is likely to be affected seriously with agricultural practice. Water quality of Perak river tends to be deteriorated toward downstream in the river, but it is still relatively clean (refer to Annex VI "Environment").

(4) IADP Kemasin and Semerak Scheme

(a) Fauna and Flora

Distribution of the mangrove is limited on the eastern side of the Peninsular Malaysia, and only a small patch of mangroves at the mouth of Semerak river has been reported (AGRA Earth & Environmental 1997). "Sensitive ecosystems" around this project site would be Tumpat Lagoon (1,000 ha) and Sungai Golok Melaleuca Swamp (1,020 ha), but these areas are relatively far from Kemasin Semerak Scheme. Tumpat Lagoon is a large estuarine bay located at about 30 km north west of the scheme. A small population of the estuarine crocodile may still exist in this area. Another "sensitive ecosystem," Sungai Golok Melaleuca Swamp, is situated at about 40 km north west of the project area. This area is dominated by Melaleuca cajeputi.

(b) Water Quality

Main sources of irrigation water for Kemasin Scheme are Kelantan river and Kemasin river, and most of the water used in paddy fields of this scheme is drained into Kemasin river. Water quality of Kemasin river is considered to be clean, however water quality of Semerak river tends to be deteriorated toward downstream (refer to Annex VI "Environment").

(5) IADP Ketara (Besut) Scheme

(a) Fauna and Flora

Primary vegetation around this scheme is Melaleuca cajeputi. Telong Melaleuca Swamp (10,000 ha) is located at around northern tip of the State of Terengganu. This is an extensive swamp dominated by Melaleuca cajeputi. Not much information is available for this area and large parts of the swamp have been alienated for agricultural use. There is a nesting ground of leatherback turtle in the south of this scheme. This species is

listed as endangered in the Red List of IUCN, however, this area is about 100 km away and does not seem to be affected significantly.

(b) Water Quality

Overall water quality of Besut river has been slightly improving. Irrigation water for this scheme is taken mainly from Besut river and Angga river. The water used in the paddy fields in this area is discharged mainly into Besut river. Water quality of upstream and downstream in Besut river is regarded as clean (refer to Annex VI "Environment").

2.2 Problems and Constraints to Agricultural Development

Based on the present conditions described above, the problems and constraints to the agricultural development in the view point of the various aspects are summarized as follows :

(1) Agriculture and Agro-economy

The paddy production in the study area still remains at low level against the NAP owing to low yield. From the agricultural and agro-economic viewpoints, the following factors which affect paddy production are observed :

(a) Ageing farmers, shortage of labor force and successor,
(b) Shortage of machine for farming activities and its arrangement by broker
(c) Problems encountered for mechanized harvesting with combine harvesters such as i) insufficient crossings/ramps and poor farm road conditions, ii) high grain losses during harvesting, iii) uneven ripening among adjacent fields and iv) bogging down of machines,
(d) Low return of the paddy income in comparison with other crop,
(e) Farmers' non-compliance to set irrigation schedule, and
(f) Inadequate input of nitrogenous fertilizer

(2) Irrigation and Drainage

In the view point of irrigation and drainage field, present problems and constraints to agricultural development facing in the each granary scheme are summarized as follows :

(a) Pulau Pinang Scheme
  i) Competition of river water use among irrigation, industry and domestic
  ii) Existence of abandon area from paddy cultivation
  iii) Sedimentation and weeds in the main canals
  iv) Bumpy conditions of farm road surface and insufficient road width along tertiary canals

(b) Kerian Scheme
  i) Huge weed in Bukit Merah Reservoir resulting in reduction of storage capacity
  ii) Seepage from main canal Terusan Besar
  iii) Insufficient numbers of regulating structures

iv) Damage of gated structures such as offtakes and check structure
v) Existence of drainage problem areas in Compartment A, B and C
vi) Muddy conditions of farm road surface and insufficient road width along tertiary canals

(c) Sungai Manik Scheme
i) Sedimentation at just downstream of the headwork
ii) Insufficient farm offtake resulted in bank cut for taking water and use of bigger pipes for offtake installed by farmers
iii) Erosion of tertiary canals
iv) Less land consolidation in Sungai Manik sub-scheme
v) Existence of damaged facilities due to less maintenance
vi) Insufficient width of farm roads and crossing structures

(d) Seberang Perak Scheme
i) Huge sedimentation in main canal
ii) Difficulty of proper operation of intake and bifurcation gates because of their manual moving
iii) Existence of damaged facilities due to less maintenance
iv) Less land consolidation in Block A
v) Less control of farm offtake in Block A

(e) Kemasin - Semerak Scheme
i) Delay of irrigation development of Phase II areas due to under execution of Flood Mitigation Project in Semerak area
ii) Less land consolidation

(f) Ketara (Besut) Scheme
i) Water leakage and damage of lifting wires of Besut barrage gates
ii) No operation of Angga intake gates
iii) Huge sedimentation in the canal at downstream of Angga barrage
iv) Decrepitude of facilities

(3) Water Management and O & M System

The following are some of the problems and issues faced in the water management and O&M of the irrigation and drainage facilities :

(a) Lack of record of gazetted areas
(b) Lack of record of irrigation rates and amount collected
(c) Lack of updated version of O&M manuals
(d) Poor database maintenance and retrieval system
(e) No formal documents on commissioned scheme
(f) Inadequate records of monitored O&M parameters
(g) Apparent over reliance on experience and judgment for decision-making
(h) Low level of telemetric application, computer softwares and automation
(i) Inadequate field channels and land leveling not widespread
(j) No Water User Groups and low level of farmers' participation in O&M

(4) Farmers' Organization

Constraints and problems relating to farmers' organization within the granary areas can be categorized generally as a) socio-cultural and b) organizational.

(a) Socio-cultural Constraints and Problems
   i) Absence of indigenous farm-based organizations and recency of irrigated agricultural development
   ii) Incongruent formation unit between village neighbors and farm neighbor (different boundary for village-based organization and irrigation-based organization)
   iii) Ageing of experienced farmers and ageing farmers have no interest in joining the farmers' group
   iv) Declining interest of younger generation of farming members toward paddy farming

(b) Organizational Constraints and Problems
   i) Limited degree of participation by farmers at the system design or project formulation stage
   ii) Low level of confidence by the farmers to operate and maintain the systems
   iii) Existence of two categories of group farming under two government agencies, ladang/bendang kelompok under the supervision of Department of Agriculture(DOA) and projek kelompok and mini-estate under the Area Farmers' Organization(PPK)
   iv) Lack of legal coverage for farmers' group under the supervision of DOA
   v) Absence of standardized quantitative criteria for performance evaluation for upgrading of bendang/ladang kelompok to mini-estate either by DOA or PPK
   vi) Lack of detailed breakdown of different categories of farmers(owner-operators, tenants and owner-tenants) involved in group farming

PART - III

THE MODERNIZATION CONCEPT FOR THE GRANARIES

3.1 Development Potential

3.1.1 Land Resources

The Irrigation Areas Act, 1953 (Revised 1987) is the legal instrument relating to the establishment and regulation of irrigation areas in Malaysia. In order to apply the regulations set forth in this Act, the irrigation areas must be gazetted. The Act however does not define "Granary Areas" per se. The definition of the Granary Areas is instead a policy definition of the Ministry of Agriculture. The gazetting of these irrigation schemes however, provides a legal basis for sustaining their status as Granaries. Five(5) granary areas surveyed in this study have been developed as the irrigation schemes for a long period and these irrigation areas are gazetted. There is very little potential for the granaries to be expanded in size except perhaps for IADP Kemasin-Semerak where the fringe areas may be absorbed into the respective granary. The main potential for land development in all the five granaries is through intensification of landuse. The present effort is to achieve a consistent and sustainable double cropping planting intensity every year. There are also plans by these IADPs to attempt five(5) seasons planting in two(2) years.

3.1.2 Water Resources

An available water in each scheme is determined with due consideration of the relevant river discharges. The following table shows the discharges to be useful in the critical dry season at the average and at the 1/5 probability for five(5) schemes :

Scheme	Sub-Scheme	Water Source	Intake Facility	Discharges in Dry Season (m^3/s)	
				Average	1/5 probability
Pulau Pinang	Sungai Muda	Muda River	Pump Station	70.2	38.8
	Pinang Tunggal	Muda River	Pump Station		
	Sungai Jarak	Muda River	Pump Station		
		Jarak River	Pump Station	-	-
	Sungai Kulim	Kulim River	Headworks	4.4	2.2
Kerian	Kerian Laut	Kurau River	Reservoir	16.2	9.2
	Kerian Darat	Kurau River	Reservoir		
		Kerian River	Pump Station	25.2	13.9
Sungai Manik	Labu Kubong	Batang Padang R.	Headworks	44.7	22.2
	Sungai Manik	Batang Padang R.	Headworks		
		Batang Padang R.	Pump Station		
Seberang Perak	Left Bank Canal	Perak River	Free Intake	385.7	-
	Right Bank C.	Perak River	Free Intake		
Kemasin - Semerak	Jelawat Rusa	Kemasin River	Pump Station	4.5	1.9
	Kemasin Hilir	Kemasin River	Pump Station		
Besut	Besut	Besut River	Headworks	51.0	20.5
	Angga	Angga River	Headworks	13.9	5.2

Whilst IADP Seberang Perak scheme and Sungai Manik sub-scheme of IADP Kerian / Sungai Manik scheme is blessed with adequate water supply, the rest of the schemes are not so fortunate. Water use efficiency improvement is recognized as a strategy to conserve water. The potential of developing new dams must be viewed as a long-term plan and will not be immediately realized. For IADP Pulau Pinang, the construction of Beris Dam upstream of the Muda river should improve water availability. There is also a long-term plan to develop another dam (Reman) and a barrage (Jeniang) along this river. For the Kerian sub-scheme of IADP Kerian / Sungai Manik scheme, the Bukit Merah reservoir storage level (and therefore its storage capacity) will be increased once the issue of the railway track across the reservoir is resolved. There may be a potential for water recycling facilities at the river section downstream of Kerian Barrage. For the Besut scheme, the construction of the proposed Paya Peda Dam should improve supply for irrigation. In the medium term, there is a potential to upgrade the Angga Barrage and Besut Barrage.

3.1.3 Human Resources

The human resource available in five granary areas is estimated based on the population of concerning Mukims of each granary area. The population that economically active and engaged in agriculture and related works are the crude estimation for the human resource to be involved in the process of development. On the basis of this assumption, the available human resource for five granary area is 150,800 persons and those for each area are summarized in the table below. In addition to these people, government officers concerning for the project such as IADP office, DID, FOA, etc. are also the important entity for the project.

(unit: persons)

Name of Scheme	Population as of 1991	Estimated Population for 1997*1	Population between 15-60years*2	Engaged in Agriculture & related works*3
Pulau Pinang	173,193	188,300	114,300	12,300
Kerian	167,439	176,700	101,200	46,100
Sungai Manik	20,294	21,400	11,400	7,000
Seberang Perak	14,222	15,000	7,800	5,500
Kemasin Semerak	246,339	292,400	148,500	66,100
Besut	50,351	60,800	30,800	13,800
Total	671,838	754,600	414,000	150,800

*1 : For the estimation of population in 1997, the annual population growth rate by state is applied. The growth rates are 1.4% for Pulau Pinang State, 0.9% for Perak, 2.9% for Kelantan and 3.2% for Terengganu.

*2 : Population between 15 and 60 years is estimated by assuming that the age structure in 1991 remains same for the year 1997.

*3 : Population engaged in agriculture and related works is estimated by assuming that the occupational structure in 1991 remains same for the year 1997.

The formal institution for farmers is the Area Farmer's Organization (Pertubuhan Peladang Kawasan, PPK) formed pursuant to section 3 of the Farmers' Organization Act, 1973. At the field levels, the Agricultural Department, under its National Extension Project in the mid-80s, organized the farmers by forming Farmers' Group (Kumpulan Tani). Subsequently, farmers' development approach is through these groups rather than the individual. Over the years these groups have shown tremendous capacity to adopt new farming approaches on an organized basis and more commercialized such as group farming (Pertanian

Kelompok) and Mini Estate Farm (Ladang Mini Estet). Most of the labor intensive activities are now mechanized and most recently, many have converted from transplanting to direct seeding. These activities are now mostly contracted to specialized entities. These groups therefore have the experience and capability to adopt to changes associated with modernization of the irrigation systems.

3.2 The Basis of the Proposed Modernization Concept

3.2.1 The National Agricultural Policy on Paddy

The National Agriculture Policy (NAP) provides the framework for formulating the proposed modernization plan for irrigation water management in the five (5) granaries. Discussions with relevant officers within the Ministry of Agriculture and its Departments and Agencies provided some insight of the proposed NAP3 (1998-2010) that is currently studied. Among the areas of concern relevant to this study expressed by the officials are :

(1) Competition for water, low irrigation efficiency (<60%), low water productivity index (<0.2kg/m^3), competition with other sectors,
(2) Small farm units, restricted machinery mobilization & utilization of resources,
(3) Low yield due to low adoption of technology (water management, weed, pest & disease control, low fertilizer application and non-adherence to planting schedules),
(4) Post-harvest losses during harvesting, handling, transportation, drying, milling and storage,
(5) Inadequate infrastructure, small and irregular lots, no suitable machinery, inadequate land leveling and in-field infrastructure, and
(6) Farm road design is out of date with the vehicles and machines.

Proposed new production targets and strategies of the NAP3 are yet to be finalized. However preliminary indications are that the proposed NAP3 will strongly emphasize on accelerated development of the granaries into efficient and productive paddy production centers as expressed below :

(1) The Self Sufficiency Level (SSL) of 65 % will be maintained,
(2) The eight (8) granary areas will be designated as permanent paddy producing areas and possibly supported by the secondary granaries to realize the minimum SSL target,
(3) Land consolidation & rehabilitation to be accelerated to increase production efficiency,
(4) Yield target for the granaries is over 5.5 ton/ha and that this target is to be achieved by 2010,
(5) The production structure should be improved through development of large-scale commercial operation through group farming and estate type production system,
(6) Greater participation of private sector for mechanization services,

(7) Large-scale paddy production will be given special attention whereby the Government may consider infrastructure support for large-scale commercial production,
(8) For production efficiency and productivity gains, institutions involved in R&D, extension services, irrigation and drainage facilities, credit, marketing and farmers institutions will be strengthened, and
(9) Environment-friendly good form practices such as precision farming, integrated pest management (IPM), soil & water conservation measures will be encouraged to ensure sustainability.

3.2.2 Operational Models of Modern Paddy Production System

A review of irrigation and management systems in Malaysia provides some interesting models that indicate their potential successful application in the proposed modernization plan. These include :

(1) The Kerian and MADA telemetric system for rainfall and water level monitoring system and the National and State hydrological monitoring system by DID,
(2) The reorganization of farmers' groups in Besut scheme based on water users' groups,
(3) The land leveling and in-field channel demonstration program of the Department of Agriculture,
(4) The FELCRA management system of the Seberang Perak scheme,
(5) The privately operated commercial farm by LKPP Padi Sdn. Bhd. in Kuala Rompin,
(6) The proposed privatization of maintenance of irrigation and drainage systems in IADP Pulau Pinang,
(7) Harvester-to-lorry harvesting practice in MADA and Barat Laut Selangor,
(8) Adherence to schedules in Barat Laut Selangor IADP,
(9) Performance assessment models for Kerian scheme, and
(10) Estate and group farming approaches.

3.3 Proposed Modernization Program for Irrigation Water Management

From the above, the NAP3 envisages the granaries functioning as efficient and high yielding paddy production centers for the country. Productivity and effective use of resources are major issues and the modernization proposals must positively address them. It should also consider the potential management models, current practices and available technology.

The granaries were planned and designed to produce paddy twice a year every year following predetermined schedules. This production cycle is based primarily on the annual rainfall distribution in a particular area and to avoid peak demands on other resources such as machineries, fertilizers, pesticides and labor. Subsequently the success of the system operations is dependent on strict adherence to schedules by all farmers and the system managers. This planned production cycle is not expected to change during the time frame of NAP3 and irrigation supply / removal schedule will continue to be the pivotal point for all

preceding and succeeding production activities. Therefore, the proposed modernization program for irrigation water management will be geared towards improving timeliness of activities and improved management productivity.

3.3.1 Systems Management

Systems management improvement pertaining to management productivity aims to reduce operations field staff size of the DID. This can be achieved through handover of systems operations and maintenance (O&M) to the farmers' groups for the tertiary systems. The DID's role will be limited to the primary and secondary levels and provide supervisory and advisory services to farmers' groups for the tertiary systems.

For the systems maintenance, the strategy should be to package larger contracts for less number of contractors but over a longer time frame, say over five seasons or three years. This would encourage contractors to invest in modern equipment, retain skilled workers and in the long term develop into highly specialized maintenance contractors.

Decision-making process should be based on a more quantitative rather than qualitative methods. For the systems management, specific performance assessment criteria should be established. The primary indicators are Relative Water Supply (RWS), Water Productivity Index (WPI) and Cropping Intensity (CI). At the same time a database should be maintained. Also an irrigation feedback system for farmer should be established for improved communications with farmers.

The expected benefits from this are :

- Reduce government administrative burden when staff are reduced
- Reduce numbers of contractors for DID to manage
- Encourage the development of skilled O&M contractors
- Enhance farmers cooperation in adherence to schedule and adopting good farming practices.

The DID will be responsible to implement the above program.

3.3.2 Telemetry and Telecontrol System

The Government's emphasis on Information Technology (IT) augers well with the modernization proposal. Under this program, the objective is to provide for a central control station for all the granaries. The control station shall be equipped with a computer system connected to a telemetric system for rainfall and water level monitoring. Data collected will be stored and process for irrigation system management. The control center will also allow for remote monitoring and control of major structures and pumping stations in the irrigation and drainage system. The future plan is for these structures to be upgraded for automation.

The expected benefits from this program are :

- Simplify operations and support fields staff reduction objectives

- Job enrichment for systems operators in the IT field
- Rapid and accurate data and information processing
- Faster and accurate decision-making for effective water use

The DID will be the responsible department to the implementation of this program.

3.3.3 System Infrastructure

Improvement plan of the irrigation and drainage system, which consists of provision of new facilities and rehabilitation/upgrading of the existing facilities, is established in relation to the proposed water management system including the telemetry/telecontrol system and the proposed farming practices.

Provision of control and monitoring points on the canal system and rainfall station in the representative locations of the granary areas are proposed for proper operation of water distribution as well as for effective use of available water. At the control points, which will be mainly the headworks, main pump station and major diversion points of canals, water level gauges and remote control gates will be installed in order to regulate the intake and diversion discharges timely. Monitoring points will be provided at several locations of canals for checking discharge whether the canal operation is proper or not. Adequate operation will be instructed to the site based on the actual discharge of canal which will be observed by water level gauge installed at each monitoring point. These control points, monitoring points and rainfall stations will be linked to telemetry/telecontrol system. Observed data at points/stations will be transferred to the central station of the scheme through the telemetry system, and daily water balance as well as water distribution will be calculated by computer system in the central station.

For the purpose that modern mechanized farming shall be introduced to the granary areas in order to solve labor shortage for farming and realize intensive agriculture, the existing infrastructures such as irrigation and drainage facilities and farm roads will be rehabilitated and/or upgraded. In formulating the rehabilitation and upgrading plan of irrigation and drainage facilities, securing sufficient capacity and reducing water loss of the facilities, preserving required water level in the canals and saving O&M cost shall be also taken into consideration. For the improvement plan of farm roads, it shall be considered that the farm roads be used not only for farming but also other purpose such as living transportation, communication and commerce.

The expected benefits from these programs are :

- Effective use of available water
- Optimum, equal and accurate water distribution
- Easy operation and maintenance
- Forwarding mechanized farming

The DID will have responsibility to implementation of the programs including plan, design and construction.

3.3.4 In-field Infrastructure

Direct seeding is the way forward for paddy production in Malaysia and to support this, land leveling and in-field channel are prerequisites. These in-field improvement facilitate good water level control and even distribution. Currently, the advance farmers are prepared to invest in land leveling. The DOA is also implementing this program on a demonstration basis for zero grading within each plot. Accepting that direct seeding is the preferred planting method, the land leveling program should be formalized and its implementation accelerated for the granaries. The design should not just be for within plot leveling but carefully designed to consider inter-plot levels in relation to the irrigation supply level and drainage levels.

The expected benefits from this program are :

- Even water distribution and depth control reduce water wastage
- More reliable estimate of field water depth
- Better weed control
- Faster water application and removal thus improve timing of operations

This program should be implemented by the DOA but integrated with canal/drain system improvement by the DID.

3.3.5 Land Consolidation

Land consolidation aims at reorganizing farm plots into larger operating plots of about 3 to 5 ha for efficient mechanization and improved productivity. The basic idea is to realign existing bunds without rearrangement of lot boundaries. The expected benefits are :

- Larger operating plots will improve mechanization efficiency and field operations
- Encourage reduction of number of farmers per plot

The IADP PMU, DOA, FOA and PPK should be the implementing agencies for this program.

3.3.6 Agriculture

The granary areas have the potential for supporting paddy plant growth with a high paddy yield of about 5 to 6 ton/ha and the national target is to realize the production potential to its full extent by means of double cropping with the improvement of the physical conditions such as irrigation and drainage facilities, farm roads and farm lands.

In order to attain a stable cropping intensity of more than 180 % per year in the granary areas, paddy planting in each cropping season should follow the irrigation schedule without delay. However, adherence to irrigation schedule is not attained under the present condition mainly due to shortage of water and machinery. It is essential that the present cropping pattern be got back in phase from the irrigation water saving viewpoint considering the improvement and establishment of the mechanization farming system for effective land preparation and harvesting. Farm operation should be practiced in proper manner recommended by MARDI and

DOA such as the amount and timing of fertilizer application, effective and environmentally friendly weed, pest and disease control, etc. The proper water management would enhance the effectiveness of the fertilizer and chemicals. The irrigation feedback system should be utilized for smooth farming operation according to the schedule and for supporting the agricultural extension through the timely advertisement of the information on such as fertilizer application, prevalence of pest and disease, etc.

For attaining the better farm work efficiency with saving cost, mechanization farming should be improved and accelerated from the point of view of labor saving. Since aged farmers are increasing in numbers and man-power availability and young successor are decreasing, it is essential to introduce full mechanized group farming as the countermeasures to overcome the labor shortage with the implementation of farmland improvement measure by the drainage improvement, land leveling and land consolidation.

The expected benefits from this program are :

- Adherence to irrigation schedules
- Reduce manpower requirement
- Achievement of cropping intensity target
- Achievement of yield target

The program should be implemented by the DOA but integrated with mechanization improvement by the PPK.

3.3.7 Farmers' Organization

The prime objective of the modernization of farmers' organization shall be to establish efficient production units at the farm level. This calls re-organizational, consolidation and strengthening of existing modes of farming arrangements (farming by individual farmers, farming on group-farm basis either through ladang kelompok, mini-estate or estate). It also calls for efforts to streamline the existing organizational arrangements, which involves the roles and functions of the various departments and agencies involved in farmers' organization, such as IADP PMU, DID, DOA, FOA, FELCRA and National Water Management Training Center. The roles and contribution of water users' group or kumpulan pengguna air in improving farmers' capacity in water management would be more effective and meaningful only when improvements are made to both farming arrangement and organizational arrangements.

Appropriate strategies proposed include :

a) Re-orientation of the physical layout of the boundaries of ladang kelompok and mini-estate to suit the new irrigation and drainage layout,
b) Strengthening and enhancing the performance of ladang kelompok and mini-estate after the re-orientation exercise, through intensive training, mobilization and extension programs aimed at improving the standard of farm management of the participating farmers,

c) Strengthening the legality base of ladang kelompok under the supervision of DOA by integrating it under the PPK as its yunit pertanian kecil or farmers unit,
d) Upgrading of progressive ladang kelompok to mini-estate for purposes of i) adopting a commercial-oriented management approach to achieve higher productivity, ii) overcoming the constraints of ageing farmers and declining interest of younger generation, labor shortage, and iii) fully utilizing the accumulated wisdom, expertise and practical experience of senior farmers,
e) Enhancing water management practices including handing over of O&M functions to the participating farmers through water users' group which would also be fully mobilized to assist and expedite in-field infrastructure works such as land leveling and land consolidation, and
f) Promoting private sector participation in related farm operations such as harvesting and even in paddy farming through joint-venture or contract farming arrangements with PPK which represents the farmers.

The overall responsibility to improve organizational arrangements should rest with the Ministry of Agriculture, while PMU should be the co-ordinating agency with FOA as the lead agency in organizing and mobilizing the farmers through FO's. Capacity building or human resources development which includes inter-granary training and mobilization of farmers should be the responsibility of the National Water Management Training Center.

3.3.8 Granary Management Structure

The development of the five(5) granaries is managed as an Integrated Agriculture Development Project(IADP). The IADP comprise a Project Management Unit(PMU) reporting direct to the Ministry of Agriculture(refer to Fig. 3.3.1 "General Organization Chart of IADP"). It is supported by two(2) main technical components namely the Department of Irrigation and Drainage(DID) and the Department of Agriculture(DOA). This set-up is staffed and financed by the Federal Government. Besides these components, other relevant agencies are co-opted from their local offices to form part of the PMU team. These include the Farmers' Organization Authority(FOA), the Agriculture Bank, the Malaysian Agriculture Research and Development Institute(MARDI). The DID component is responsible for the design and construction of infrastructure and the DOA component for agriculture extension services.

The present structure and organization of the IADP PMU are for project development and implementation. The plan is that this organization will be dissolved upon project completion through a commissioning process and handover to the State Authority. Presently, the DID and DOA components are gradually downsizing and will eventually close down as projects are handed over upon completion. However, the granaries as the premier paddy production centers for the country, each still needs a formal organization. This is to act as a single focal point for the farmers and to be responsible for the granary performance and sustainability.

In the modernization program for the granaries, special consideration should be given on the content and structure of the PMU. This is particularly important in view of the project

orientation shifting more from development to production. The 7th Malaysia Plan and NAP3 emphasize on farmers' productivity, participation and commercialization. This spirit is carried in the modernization proposed by way of handing over O&M of the tertiary systems, more O&M contract opportunities, on-farm infrastructure development, land consolidation and the formation of WUGs. Achieving all these successfully and in good time require farmers' full cooperation.

The present content of the PMU comprise personnel competent and experienced in project development. Perhaps it is timely that the team should now comprise farmer management personnel. In this context, the FOA appears to be most appropriate at this point in time based on the provisions of Act 110, Farmers' Organization Authority Act, 1973. At the initial stages the role of FOA in the PMU would focus on the strengthening PPK's capacity in the granary development and management. In time when the FOA has gained experience, the PMU can be dissolved if the granary areas are gazetted as Farmers' Development Areas under section 10 of Act 110. The FOA would then be the responsible organization for the granary production and should develop the State Farmers' Organization Authority for eventual granary management. At the national level, a granary management unit should be formed in the MOA to supervise and coordinate production policies.

The most challenging role of this management team is to obtain the full and undivided support of the farmers that is critical for accelerated and smooth implementation of the modernization proposals. The first task is to reorganize the farmers' groups taking into account the WUG boundaries. This should be followed by programs to strengthen their management capabilities, garner cooperation for implementing in-field infrastructure improvement and land consolidation, take-over of tertiary systems O&M and encourage estate-type production system.

This review of the granary organization should be the responsibility of the Ministry of Agriculture.

3.3.9 Commercial Paddy Farming

LKPP Padi Sdn. Bhd., a joint venture between LKPP Negeri and a private company, had taken a bold step to develop and operate a pioneer paddy estate in Malaysia in 1995. The project area is located in the Mukim of Pontian in Rompin District. The total project area is about 1,000 ha with 800 ha suitable for paddy cultivation. To-date, about 250 ha has been developed and planted with rice crop, and operated on a staff size of 22 people. The clearing and development of the balance 550 ha will be completed in 1998. A part of this land was developed under the sub-project called Pontian Right Bank of Integrated Agricultural Development Project Rompin-Endau (IADPRE), 1978 - 1986.

The basic concept of farm layout of the project is to provide infrastructure facilities for full mechanization of farm inputs with low infrastructure development cost as well as low maintenance and operation cost. Farm lot size is ranging from 0.6 ha at steep terrain ground to about 5.0 ha size at flat terrain. Double cropping is practiced in this area and the present unit yield is 3.7 ton/ha . The expected and sustainable average clean yield shall be above 5.0 ton/ha

in order to make large scale paddy farming project viable and look attractive to the private investors. Rice crop is highly subsidized by the Government. Two forms of subsidy is allocated to the farmers, which are the fertilizer subsidy and price subsidy. However, the fertilizer subsidy applies only to small scale farmers who have a rice field of less than 2.43 ha, and therefore LKPP can not receive any subsidies from the Government. The financial analysis of the project is made based on the available data provided by the staff of LKPP. From the analysis, it can be said that the paddy estate is not financially viable without the government's support as far as its maximum yield is 5.0 t/ha, and in order for the estate to be viable, it is necessary to achieve at least 5.5 ha/ha as shown in Annex IV "Agriculture and Agro-economy". However, it should be noted that the cost of main facilities of the project such as a dam and a head race is not included in the cost stream of this analysis because it had been already constructed by the government under IADP Rompin-Endau.

Generally, large scale paddy farming not only needs huge capital investment in infrastructure development but also is beset with low yield performance in the initial first to fifth year of the project periods due to the inherent nature of paddy crop on the new land converted from jungle clearing. The paddy estate by private sector will not be financially viable without any government support. NAP3 indicates that the involvement of private sector in large-scale paddy production be encouraged and supported. Incentives or supportive measures shall be formulated to encourage private investment in large scale food production for securing adequate staple food supply in Malaysia. The paddy production areas the Endau-Rompin region should be provided special support so since it is poised to be the "commercial belt" of Peninsular Malaysia and thus could provide the lead and complement production.

PART - IV

MASTER PLAN FOR FIVE GRANARY SCHEMES

4.1 Modernization Plan of Five Granary Schemes

4.1.1 General

In order to raise paddy production in accordance with nation's policy of attaining self-sufficiency of 65 %, the major issues of the study are (i) ensuring irrigation water supply by rehabilitation and improvement of the existing irrigation and drainage facilities, (ii) modernization of current irrigation water management system from both hardware and software points of view, (iii) establishment of a proper operation and maintenance system, and (iv) farm land consolidation to introduce advanced agricultural practices using large machinery to overcome the shortage of farm labor.

The five(5) granary schemes require some improvement in irrigation water supply particularly for the dry season. Because of a rapid growth of industry and municipal water use, it is difficult to acquire additional water allocation particularly for agricultural purposes. Moreover, activities to create additional water resources are limited from the aspects of natural environment and investment cost, because such projects often involve with land clearing to make ponds and reservoirs. Therefore, an effective use of water resources by upgrading the existing irrigation system and proper water allocation with a suitable water management practice are key factors to increase paddy production.

Farming practices in terms of farmers' organization also need to be refined in the granary areas. A shortage of labor force in paddy production is becoming a serious problem, so that farming practices need to be maintained with a minimal labor. On the other hand, the Department of Irrigation and Drainage (DID) prefers that local farmers participate voluntarily in the operation and maintenance of irrigation facilities, since this will reduce government's burden of high cost and large manpower input. However, it seems that this intention makes the farming even more difficult , and a key factor to succeed the goal of NAP is to develop a operable farming practices with a minimal labor. This rather challenging issue, and mechanization and development of a proper institutional structure and network among farmers are important.

4.1.2 Water Balance Study

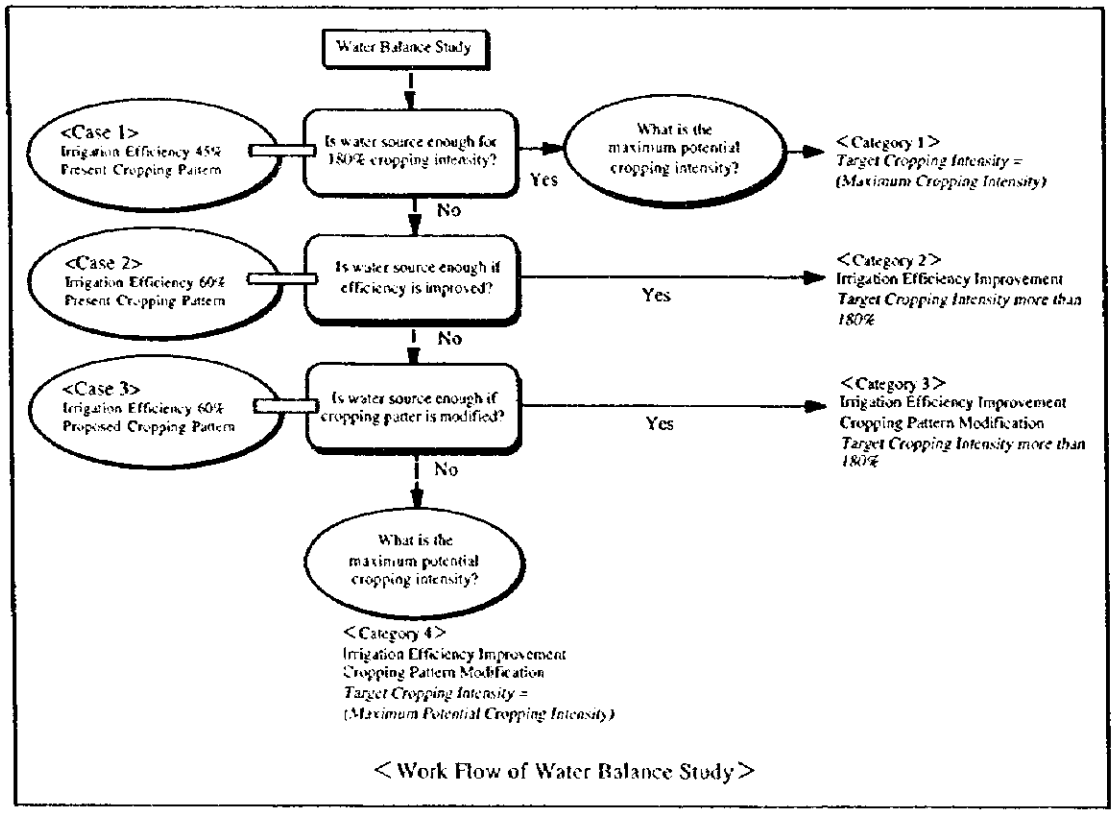
(1) General

Water balance study is made in order to confirm whether five(5) granary areas have enough irrigation water for achieving cropping intensity as high as 180%. By conducting the water balance study, present condition and effect of irrigation water management system modernization can be clearly recognized, which contributes the formulation of water management system planning. As the first step of the study, available water for irrigation in probable drought years are estimated based on river discharges and relevant data. Secondly,

irrigation water requirements in probable drought years are calculated on the basis of various climatic data, etc. Then, the available water for irrigation and irrigation water requirement are compared to judge if the available water meets the requirement. In the study, several conditions shown below are assumed.

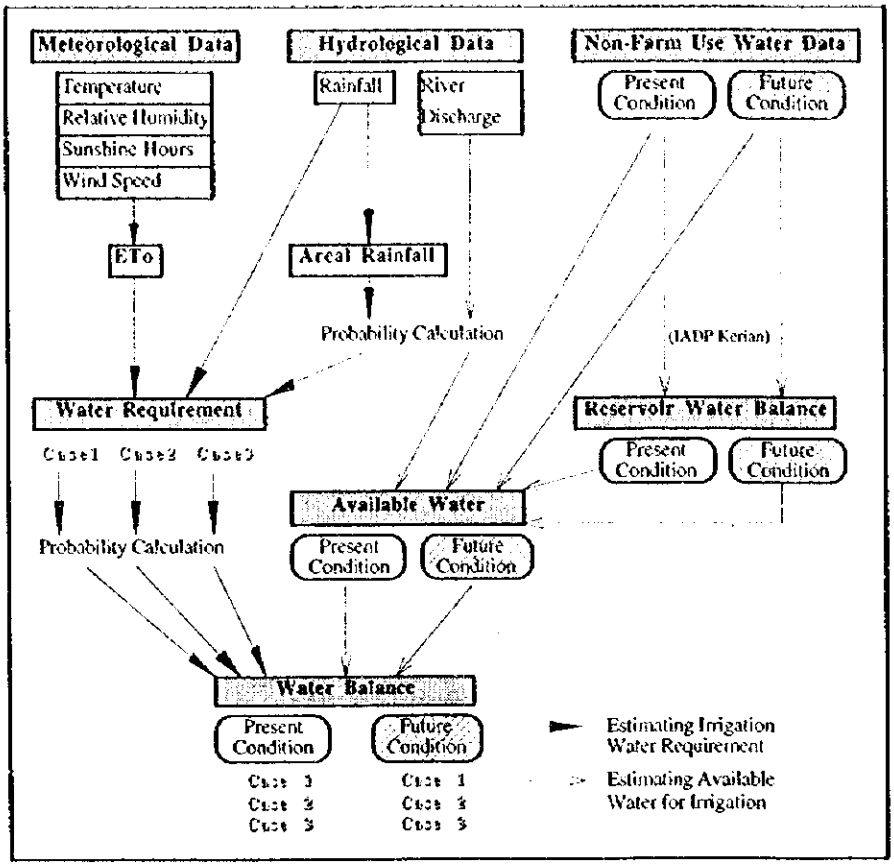
a) Available water for irrigation
   - Present Condition
   - Future Condition (year 2010)
b) Irrigation water requirement
   - Case 1 (overall irrigation efficiency : 45%, present cropping pattern)
   - Case 2 (overall irrigation efficiency : 60%, present cropping pattern)
   - Case 3 (overall irrigation efficiency : 60%, proposed cropping pattern)

The water balance study is conducted along the work flow shown below. Firstly, using the assumed present overall irrigation efficiency of 45% and present cropping pattern, water balance is conducted (Case 1). Secondly, if water sources do not meet the requirement, with the assumption that overall irrigation efficiency is improved as much as 60% thanks to the irrigation system modernization, the calculation is repeated (Case 2). Finally, when water sources still remain insufficient, proposed cropping pattern is applied (Case 3). In the study, target drought probability is set to be less than 1/5, in other words, drought will be occur less than once a five years.



<Work Flow of Water Balance Study>

The flow of water balance calculation is shown below.

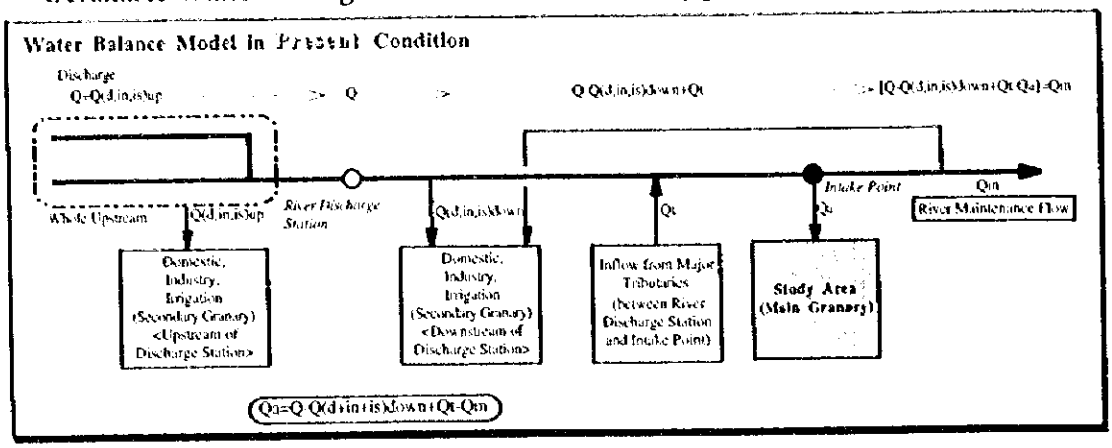


(2) Study Method

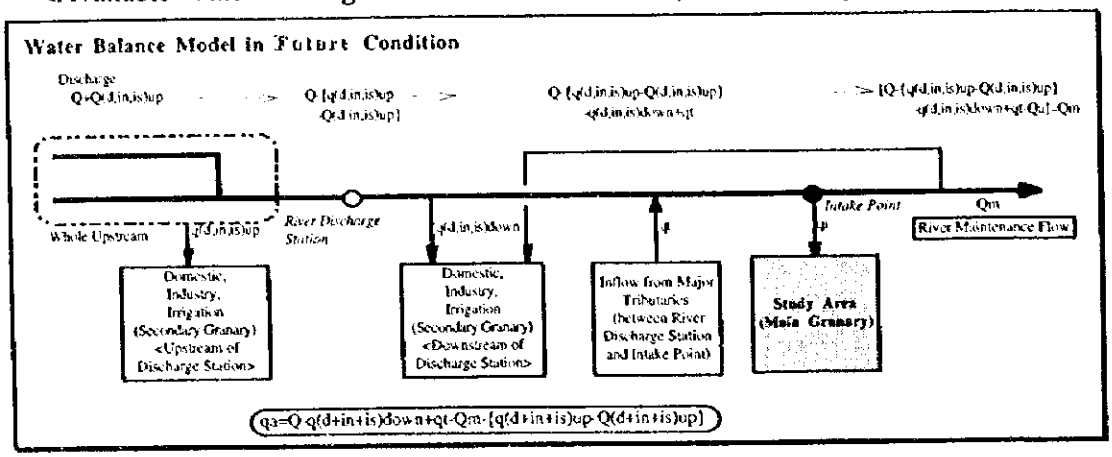
(a) Available water for irrigation

In the study areas, except Jarak river in Pulau Pinang and Angga river in Ketara (Besut), river discharge data is gauged by DID. In the study, available water for irrigation is estimated based on the data in the latest 10 years river discharge data. However, as for Besut river, reliable data period falls on between 1961 and 1964. Hence, 4 x 4 tank model is used for estimation of discharge in the past ten years. Available water of study areas are determined considering present and future water demands of domestic water, industrial water and irrigation water for secondary granary areas. Data on present and future demands of non-farm use water are corrected at relevant agencies. For the river which does not have detail water distribution plan of domestic and industrial water, the estimation based on the capacity of intake facilities are made. The details of estimation are shown in Annex I "Water Balance Study". Concerning river maintenance flow, only data of Muda river is available. Accordingly, the river maintenance flows of the other rivers are estimated based on specific river maintenance flow of Muda river. The general models used for determining available water for irrigation are shown below. The models for respective rivers are shown in "Annex I".

<Available Water for Irrigation in Present Condition (Qa)>



<Available Water for Irrigation in Future Condition (Year 2010) (qa)>



(b) Irrigation Water Requirement

Diversion irrigation water requirement is calculated from every 10 days on the basis of the formula shown below. Concerning cropping method, wet direct seeding, dry direct seeding and transplanting which are being practiced in the study areas are used for the water balance study. For planting period, 120 days for the schemes located on west coast and 130 days for those on east coast are applied.

(i) Presaturation, 2nd standing water supply period

$$DWR = (S + H + ETo + PL - ER) / E$$

DWR	:	Diversion Water Requirement
S	:	Soil Saturation Depth
H	:	Standing Water Depth
ETo	:	Potential Evapotranspiration
PL	:	Percolation
ER	:	Effective Rainfall
E	:	Overall Irrigation Efficiency

For soil saturation depth , DID standard value 150mm is applied. For standing water depth, 100mm derived from DID standard is used for presaturation period and 0mm is used for 2nd standing water supply period. Potential Evapotranspiration (ETo) is estimated by using modified Penman method. Required climatic data are collected from principal meteorological stations closest to the study areas. Percolation (PL) data are obtained from operation and maintenance manuals collected from DID local offices and "Assessment of Selected Performance Indicators for Paddy Irrigation in Kerian Scheme" published by DID in 1995. The maximum and minimum limits of effective rainfall are set as 165mm and 5mm, respectively. Maximum limit 165mm consists of 100mm to make standing water and 65mm to keep standing water depth. 65mm derives from paddy plot water balance shown in "Annex I". The minimum limit 5mm is decided considering the rainfall to be kept in stems of rice plants. In presaturation and 2nd standing water supply period, 10-days areal rainfall in 1/5 probability drought year are used for estimating effective rainfall. Overall irrigation efficiencies are assumed to be 45% for present irrigation system and 60% for modernized irrigation system.

(ii) Normal supply period

$$DWR = (ETo \times Kc + PL - ER) / E$$

DWR	:	Diversion Water Requirement
ETo	:	Potential Evapotranspiration
Kc	:	Crop coefficient
PL	:	Percolation
ER	:	Effective Rainfall
E	:	Overall Irrigation Efficiency

The maximum and minimum effective rainfalls for normal supply period are set as 65mm and 5mm, respectively. The nearest rainfall station data (more than 20years) are used for estimating diversion water requirement. Probability calculation is done in order to estimate water requirement in each probability drought year.

(3) Water Balance in Five Granary Areas

(a) Pulau Pinang Scheme

Pulau Pinang Scheme has three(3) main water sources, namely, Muda river (for Sungai Muda Sub-Scheme, Pinang Tunggal Sub-Scheme and Pokok Tampang Block in Sungai Jarak Sub-Scheme), Kulim river (for Sungai Kulim Sub-Scheme) and Jarak river (for Padang Menora Block in Sungai Jarak Sub-Scheme). Kulim and Jarak Sub-Scheme receive supplementary irrigation water from Muda river system, so that water balance study of Muda river is quite important for Pulau Pinang Scheme. The water balance study of Muda river basin including the biggest granary area of MADA scheme has been done in "Comprehensive Management Plan of Muda River Basin (JICA,1995)". According to the result, granary areas in Muda river basin can achieve 200% of cropping intensity if proposed water resources structures such as Beris Dam, Jeniang Transfer, Naok Dam and Reman Dam be constructed.

(b) Kerian Scheme

For Kerian Scheme, water balance model considering Bukit Merah reservoir storage function is developed. In the model, it is assumed that Kerian Darat Sub-Scheme which completely depends on the reservoir water source is given priority for the water distribution. Kerian Laut Sub-Scheme is given excess water from Bukit Merah reservoir and supplemented by Bogak Pump Station. The water balance model used for the study is described in "Annex I". In Kerian Scheme, present cropping pattern is quite different from the original one. According to the water balance study, the scheme can achieve 180% of cropping intensity in <Case 1> (present cropping pattern). However, from viewpoints of farming activities and water management, it is recommended to use proposed cropping pattern <Case 3> which is similar to the original pattern. <Case 3> has high water demand peak compare with <Case 2>, but <Case 3> can achieve 200% of cropping intensity. In Kerian Scheme, it is quite important to operate Bukit Merah reservoir with proper management method. For proper reservoir operation, it is important to decide command area of Bukit Merah reservoir and Bogak Pump Station. Command areas of Bukit Merah reservoir and Bogak Pump Station in 1/5 probability drought year are shown in Fig. 4.1.1 "Command Area Distribution in Kerian Scheme". 10-days basis reservoir water level transition in 1/5 probability drought year is shown in Fig. 4.1.2 "10-Days Basis Transition of Bukit Merah Reservoir Water Level". For proper reservoir operation, "Draught-Required Reservoir Storage Curve" method shown in "Annex I" is recommended.

(c) Sungai Manik Scheme

Sungai Manik Scheme has sufficient water to achieve 180% cropping intensity even in present condition <Case 1>, and the scheme can conduct 200% cropping intensity from water source point of view.

(d) Seberang Perak Scheme

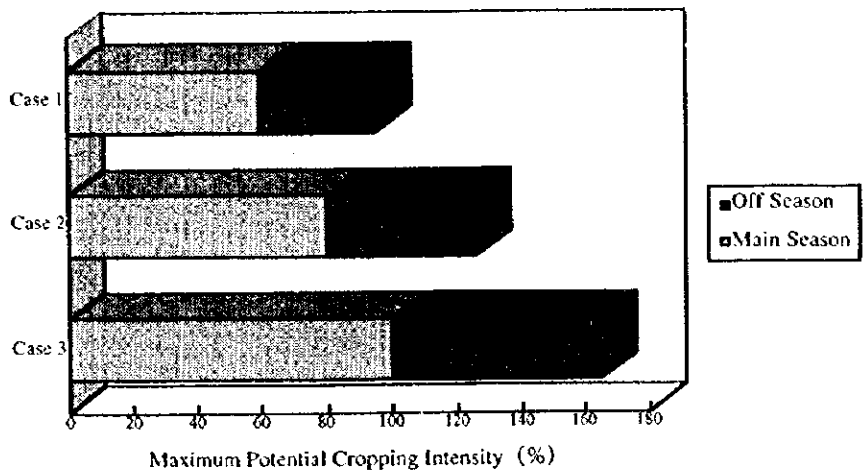
For Seberang Perak scheme, detail water balance study could not be made because of non-availability of proper Perak river discharge data. However, it can be said that the scheme has abundant water resource according to the rough river discharge data given by DID Ipoh. The scheme can accomplish not only 180% but also 200% cropping intensity even in low irrigation efficiency condition <Case 1>.

(e) Kemasin / Semerak Scheme

In Kemasin / Semerak Scheme, only Kemasin Hilir sub-scheme and Jelawat Rusa sub-scheme has operated so that the water balance study is conducted only for the two(2) sub-schemes. In the study, these sub-schemes are regarded as one system since they receive water from the same river (Kemasin river). Kemasin scheme is planed to be provided 5 m^3/sec water from Kemubu Pump Station located at Kelantan river, which has been constructed for KADA. The scheme can attain 200% cropping intensity, if Kemubu Pump Station supply water to Kemasin scheme properly.

(f) Ketara(Besut) Scheme

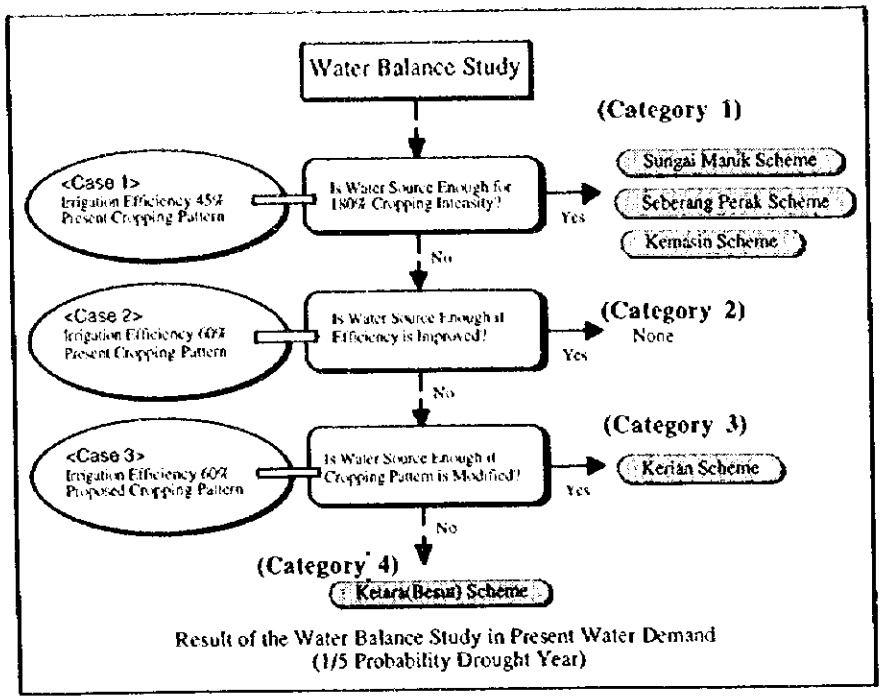
Ketara(Besut) scheme has two(2) water sources, namely Besut river and Angga river. In this area, north east wind peculiar in the east coast area has great influence and as a result, annual and monthly variation of water sources is significant and effective use of river discharge is very difficult. In Besut scheme, the original cropping pattern is considered as recommended cropping pattern <Case 3> and adjustment of present cropping pattern <Case 1> to the original cropping pattern <Case 3> makes great benefit. In addition, partial introduction(about 20% of the total area) of the dry direct seeding in the off season is recommended in order to avoid the high peak water demand during the pre-saturation period. However, even in <Case 3>, the scheme cannot attain 180% cropping intensity in 1/5 probability drought year, hence the scheme is recognized as (Category 4) in work flow of water balance study. The maximum potential cropping intensity of the scheme in 1/5 probability drought year is about 165% in <Case 3> as shown below.



(4) Study Results

Based on the water balance study, the study areas can be classified as shown below. Sungai Manik, Seberang Perak and Kemasin Schemes have enough water to achieve not only 180% cropping intensity but also 200%. Consequently, these schemes are classified as (Category 1) and the target cropping intensity should be set as 200%. Kerian scheme is classified as (Category 3), hence irrigation efficiency improvement and cropping pattern modification are required to get 200% cropping intensity and high yield. Ketara(Besut) scheme is classified as (Category 4), so that irrigation efficiency improvement plan, cropping pattern modification plan and drainage water recycling plan should be taken. In Ketara(Besut) scheme, capacity of recycling pump is about 10% of peak diversion irrigation water requirement. If the scheme can recycle about 10% of irrigation water, the maximum potential cropping intensity in 1/5 probability drought year is about 175%. Pulau Pinang scheme will be able to achieve 200% cropping intensity with the proposed dam projects. In the water balance study, it is assumed that there is no water distribution problem. In case of water distribution problem, there will be water deficit in local areas. The results of 10-days basis water balance in four(4)

schemes except for Pulau Pinang scheme and Seberang Perak scheme are shown in Fig. 4.1.3 " 10-Days Basis Water Balance".



4.1.3 Improvement Plan for System Infrastructure

(1) General

Irrigation and drainage facilities including on-farm facilities in the five(5) granary schemes have been constructed except for Kemasin-Semerak Scheme. Based on the water balance study in the existing irrigation water sources, it is found that the water sources for irrigation are much sufficient only in Sungai Manik and Seberang Perak Schemes. However, it is difficult to extend paddy area in those two schemes, because most of areas possible to be extended are located at lower coastal area and affected by fluctuation of the sea water level. Available irrigation water for the remaining four(4) schemes is quite limited and there is no possibility to develop new water sources for those schemes in a short term. Accordingly, a basic concept of development plan in the irrigation and drainage field will be mainly put on the rehabilitation and improvement of the existing facilities (system infrastructures) such as canals, roads and related structures. Irrigation plan for the respective schemes aims to supply water to the farm land with adequate quantity of water required for crops timely and effectively as well as to distribute the water with the less conveyance and operation losses through improvement of irrigation water supply system. The direct objective of drainage is to improve crop growing condition and working condition for farming by draining excess water on the ground surface and in the soil. Road plan is to be established to keep proper road density and width for mechanized farming and marketing. Since the operation and maintenance works of tertiary system will be transferred from DID to the farmer's groups, the improvement plans for system infrastructures will be considered from the viewpoint of easiness and cost-saving for the said works.

Improvement plans for the system infrastructures in the respective schemes are formulated taking into account the following points, which are picked out from the present problems and constraints to the agricultural development in the each granary scheme as explained in the Part - II "Irrigation and Drainage" :

(a) Pulau Pinang Scheme : Labor-saving in farming and water management
(b) Kerian / Sungai Manik Scheme
  - Kerian Scheme : Saving irrigation water and drainage improvement for introducing mechanized farming and direct seeding in drainage problem area
  - Sungai Manik Scheme : Upgrading of facilities for optimum operation
(c) Seberang Perak Scheme : Upgrading of facilities for optimum operation
(d) Kemasin-Semerak Scheme : Acceleration of flood mitigation project and rehabilitation of damaged facilities
(e) Ketara (Besut) Scheme : Securing water source at headworks, saving irrigation water and rehabilitation of superannuated structures

Improvement plans for system infrastructures consisting of rehabilitation of existing facilities and provision of water management facilities in the respective scheme are described below.

(2) Pulau Pinang Scheme

Since industrialization is being remarkably developed around this scheme, shortage of labor for farming is one of the major constraints for agricultural activity in the scheme. Further, effective use of water sources, such as Muda, Kulim and Jarak rivers, is also essential for agricultural and industrial activities and domestic water supply. Accordingly, the following measures will be recommended for improvement of the scheme :

(a) Labor-saving : Introducing mechanized farming and telemetry and telecontrol system for water management
(b) Establishment of optimum water distribution system : Effective use of water source for agriculture, industry and domestic supply through the optimum irrigation operation by the telemetry and telecontrol system

In taking consideration of the above items and based on the results of the inventory survey of existing structures, and longitudinal and cross section surveys of existing canals, following improvement plans for system infrastructures in the scheme are formulated in order of the priority :

(i) Rehabilitation and improvement of system infrastructures
  - Concrete lining for main and secondary canals including removal of sediment in the canals
  - Provision of regulating structures and rehabilitation of damaged structures
  - Desilting of tertiary drains
  - Pavement and widening of farm roads

(ii) Provision of water management facilities (to be connected with telemetry and telecontrol system)
- Installation of water level gauges at major pump stations, headworks, and major diversion points on main and secondary canals
- Installation of four (4) rainfall stations at representative points of the scheme
- Installation of remote control facilities for major gates and pumps

(3) Kerian / Sungai Manik Scheme

(a) Kerian Scheme

In Kerian scheme, drainage improvement especially in Compartment A, B and C will be executed as first priority works, in order to introduce direct seeding and large scale mechanized farming. Water saving is also essential in the scheme due to the large command area and water distribution following irrigation schedule has to be performed taking advantage of storage capacity of Bekit Merak Reservoir. The reservoir is infested with a local variety of aquatic weed, which must be removed periodically so that storage capacity of the reservoir will be maintained. Following improvement plans for system infrastructures in Kerian Scheme are summarized in order of the priority :

(i) Rehabilitation and improvement of system infrastructures
- Construction of new drains and desilting of existing drains
- Construction of bund
- Provision and rehabilitation of drainage gates
- Concrete lining for main and secondary canals including removal of sediment in the canals
- Provision of regulating structures and rehabilitation of damaged structures
- Pavement and widening of farm roads

(ii) Provision of water management facilities (to be connected with telemetry and telecontrol system)
- Installation of water level gauges at Bukit Merah Reservoir, Bogak Pump Station and major diversion points on main and secondary canals
- Installation of four (4) rainfall stations at representative points of the scheme
- Installation of remote control facilities for major gates and pumps

Operation and maintenance manual containing the method and frequency of weeding of aquatic weed in the reservoir should be prepared for preservation of the storage capacity of the reservoir.

(b) Sungai Manik Scheme

There is sufficient water available for irrigation in the area, however, operation and maintenance of the system is not adequately performed. Silting at the downstream of intake structures, erosion of tertiary canal banks and damaged related structures are observed and subsequently, water distribution is not accurately done. Especially in Sungai Manik sub-scheme, tertiary canals are earthen and land consolidation is not sufficiently executed. Operation and maintenance of tertiary canals and downwards is

planned to be handed over to farmers in future. Therefore, concrete lining over tertiary canals should be introduced for easy operation and maintenance as well as O&M cost reduction. In this scheme, upgrading of the existing facilities will be given high priority. Since drainage problem in the downstream area is found in the rainy season, improvement of drainage facilities is also to be executed. Based on the results of site reconnaissance, inventory survey and canal route survey, rehabilitation and improvement plans of system infrastructures in this scheme are summarized below, in order of the priority :

(i) Rehabilitation and improvement of system infrastructures
- Construction of settling basin at downstream of intake structure
- Concrete lining for main and secondary canals including removal of sediment in the canals
- Provision of regulating structures and road crossing structures, and rehabilitation of damaged structures
- Desilting of main drains
- Pavement and widening of farm roads

(ii) Provision of water management facilities (to be connected with telemetry and telecontrol system)
- Installation of water level gauges at intake, Rambai diversion weir and major diversion points on main and secondary canals
- Installation of two (2) rainfall stations at representative points of the scheme
- Installation of remote control facilities for major gates

(4) Seberang Perak Scheme

For intake of water from Perak river, gate control is manually done, however, the operation does not correspond to the change of water level and irrigation schedule, so occasionally, main canal conveys more than designed volume of water and the water level comes up close to the top of canal embankment. Judging from the results of canal longitudinal and cross sectional survey, silting and erosion are found seriously in main canals. As regards paddy fields, land consolidation is not fully achieved, which is conspicuous particularly in Block A and water diversion is not performed as scheduled, either.

As same as the case in Sungai Manik scheme, there is ample water available in this Scheme. Consequently, taking into above points into consideration, emphasis of rehabilitation and improvement plan will be laid on upgrading of facilities, which are summarized in order of the priority :

(a) Rehabilitation and improvement of system infrastructures
- Removal of sediment and reshaping of main canal
- Concrete lining for secondary and tertiary canals
- Provision of regulating structures and spillway, and rehabilitation of damaged structures
- Desilting of main drains
- Construction of new farm roads and widening of existing farm roads along tertiary canals

(b) Provision of water management facilities (to be connected with telemetry and telecontrol system)
- Motorization of intake and bifurcation gates
- Installation of water level gauges at intake, bifurcation and major diversion points on main and secondary canals
- Installation of two (2) rainfall stations at representative points of the scheme
- Installation of remote control facilities for major gates

(5) Kemasin / Semerak Scheme

As for this Scheme, in Semerak area, flood mitigation project is under progress and six(6) sub-schemes (Semerak Hilir, Semerak Hulu, Semerak Selatan, Semerak Barat, Sungai Yong-Gaal and Jeram Rasau) are scheduled to be implemented after the flood mitigation project is completed. Kemubu Pumping Station, located in adjacent KADA area, is to supply 35 % (16 m^3/sec) of its intake water to Kemasin-Semarak, however, since the sub-schemes are yet to be operated, the distribution from the pump station is not done as planned. Water distribution plan in this area should be decided based on the design review of the six sub-schemes taking into consideration of the two completed sub-schemes (Kemasin Hilir and Jelawat Rusa) and KADA area as well. Facilities in the two completed schemes are relatively well operated and maintained, however, reconsideration shall be necessary based on the results of the review of water distribution plan. Consequently, in the Study, the following rehabilitation and improvement plans for system infrastructures are formulated as regards two(2) on-going projects, namely Kemasin Hilir and Jelawat Rusa.

(a) Rehabilitation and improvement of system infrastructures
- Rehabilitation of structures
- Desilting of main drains
- Provision of farm roads along tertiary canals

(b) Provision of water management facilities (to be connected with telemetry and telecontrol system)
- Installation of water level gauges at major pump stations
- Installation of two (2) rainfall stations at representative points of the scheme

(6) Ketara (Besut) Scheme

According to the results of water balance study, it is judged that water shortage of this scheme is serious and effective water intake and water saving are given the highest priority. Intake structures in this scheme are Angga and Besut Barrages. The former is considerably deteriorated and substantially out of operation and the latter is troubled with seepage through old gates. Therefore, rehabilitation of the both barrages should be given the first priority. For water saving, operational loss and loss from structures themselves have to be controlled as much as possible. In order to achieve this purpose, introduction of telemetry and telecontrol system will be utilized to enable appropriate gate operation to evade unnecessary water distribution. In addition, water loss should be controlled through introduction of concrete lining on canals. As a matter of fact, secondary and tertiary canals in this scheme are concrete lined to significant extent, so, the lining plan will be centered around main canal lining taking into

consideration the ease of operation and maintenance in the future. There are many small size farm plots in the area and so, plot readjustment should be considered for mechanized farming.

Rehabilitation and improvement of system infrastructures in this scheme are summarized as follows:

(a) Rehabilitation and improvement of system infrastructures
- Replacement of Angga Barrage
- Repair of Besut Barrage gates
- Concrete lining for main, secondary and tertiary canals
- Heightening of lining
- Provision of regulating structures and rehabilitation of damaged structures
- Desilting of main drains and provision of drainage controls
- Pavement of farm roads along main canals and widening of existing farm roads along tertiary canals

(b) Provision of water management facilities (to be connected with telemetry and telecontrol system)
- Installation of water level gauges at Besut and Angga barrages and major diversion points on main and secondary canals
- Installation of three (3) rainfall stations at representative points of the scheme
- Installation of remote control facilities for major gates

Rehabilitation and improvement plans for system infrastructures in five(5) granary areas are given in Table 4.1.1 "Rehabilitation and Improvement Plan of System Infrastructure".

4.1.4 Improvement Plan of Water Management and O & M

(1) General

(a) National definition of granaries and database standardization

To improve management coordination, the following are proposed:
(i) Clearly define the physical boundaries and data base year of each granary,
(ii) Standardize all terminologies used in the granary management, and
(iii) Develop a common database structure related to land, water, production, farm input, farmers, farm machinery contractors and administrative structure.

The Paddy Production Statistic Committee should lead this exercise.

(b) Gazette the granary schemes under the Irrigation Act.

All the granaries should be gazetted under the Irrigation Act and the DID should keep copies of record of all gazetted lots and the annual irrigation rates collected. A register of Water User Groups should be kept and maintained. This is with a view to subsequently register them as Irrigation Groups as proposed under the review of the Irrigation Act. The DID should initiate this exercise with the cooperation of State Government.

(c) Gazette the granary as farmers' development area.

This proposal is subject to adoption of the proposal for Farmers' Organization Authority (FOA)" to take the lead in granary management (refer to Part III, item 3.3.8 "Granary Management Structure"). In any case the FOA and the respective PPK should integrate their registrar of farmers in the granary based on the proposed standardized granary database system. The FOA should initiate this program with the cooperation of the Paddy Statistics Committee.

(d) Develop a national standard performance assessment indicators and procedures for the granaries.

It is proposed that standard performance indicators be developed for the granaries particularly for production. The data should be able to positively identify high and low production areas within each granary. The performance indicators could be total granary production vs. 65% self-sufficiency level, total granary production vs. total national production and individual granary contribution to national total. Other performance assessment indicators related to modernization that reflect granary efficiency are timeliness of field activities (planned vs. actual dates), input-output comparison (yield vs. fertilizer; yield vs. other chemicals) and cost related indicators. The DID has initiated a performance assessment program and the indicators adopted are Relative Water Supply (RWS), Water Productivity Index (WPI) and Cropping Intensity (CI). As these relates to national level statistics, the Paddy Production Statistic Committee should take the lead and supported by the IADP PMUs.

(2) Water Management and O & M

(a) Irrigation database and information system

The present irrigation database and structure should be reviewed. It should be integrated with the daily work procedures of the various sections and personnel. The actions necessary are summarized below:

(i) Update irrigation systems inventory,
(ii) Standardize terminologies,
(iii) Develop a database structure for key management information only, and
(iv) Integrate information system with other related department/agencies.

(b) Adopt ISO 9002 standards for irrigation O&M

The O&M of the granaries must take the lead in achieving high standard of management. The Irrigation Division of the DID has initiated efforts for irrigation O&M to comply to ISO 9002. It is proposed that the DID shall implement this program simultaneously for all the granaries. Under this program, the O&M manual should be reviewed accordingly. There should be an edited version for field staffs and a special edition for Water Users' Groups. There should also be a separate manual for maintenance of the canals, drains and structures and with standard specifications.

(c) Maintain planned irrigation schedule

Water supply dates still form the pivot for all farm activities planning within and between seasons in the granaries. However it must be emphasized that in a mechanized system, the water management planning must focus on achieving harvesting and land preparation in the dry months. Since there are no evidence of major changes in rainfall patterns, the seasonal irrigation start dates can be fixed to be the same for every season every year. This is already practiced in IADP Pulau Pinang, Sg. Manik Scheme and Besut Scheme. It is recommended that the original proposed irrigation time and duration be maintained. Any changes of schedules must be limited to within this time frame.

(d) Reorganize O&M responsibility

It is proposed that tertiary systems operations are gradually handed over to the Water Users Groups with the DID acting on a supervisory and advisory role. The DID will continue to be fully responsible for the main and secondary systems management. In the process, the DID field staff size (staff whose scope of works is 100 % irrigation O&M) will be reduced. The Senior Irrigation Inspectors, Irrigation Inspectors, Irrigation Technicians and pump operators operating primary and secondary pumps should be maintained for overall scheme management.

The handover would directly affect the gatekeepers/linesmen and general workers. Generally, they form 80 % of the total field staff strength and account for 80 % of the total field staff salary and emolument. Based on discussions with DID officer, 80 % are involved in tertiary systems O&M. Using this assumption, it was derived that for Kerian Scheme, the impact is a 57 % reduction on overall staff strength and 61 % reduction on staff cost/ha. For Besut, it is 68 % reduction on overall staff strength and 55 % reduction on staff cost/ha The average of these figures are 63 % for overall staff reduction and 58 % staff cost/ha reduction. Applying these figures for the other granaries, the estimated impact on overall O&M staff and cost is summarized below:

IADP	Office/ Scheme	Present			After staff reduction		
		Total staff	No.per 1000ha	Cost per ha	Total staff	No.per 1000ha	Cost per ha
P.Pinang	SPU	204	21	186	75	8	78
Kerian/ S.Manik	Kerian	239	11	100	103	5	39
	Sg. Manik	131	19	157	48	7	66
Sbg. Perak	Sbg. Perak	120	14	87	44	5	37
Kemasin/ Semerak	scheme not ready						
Besut	Besut	56	11	72	18	3	32

Note : SPU figures used as representative for IADP Pulau Pinang

The average O&M staff cost reduction is RM 70/ha/yr. This reduction would relieve the financial and administrative burden of the DID especially if the WUGs operate their

respective system without monetary compensation (as in the case of Kubang Depu WUG, Besut Scheme). Implementing this field staff reduction program must consider the affected staff service contract. The immediate approach is not to replace staff retiring or resigning. Another is reassigning staff to other duties, projects or offices.

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

The estimated 1997 DID expenditure on irrigation O&M of the 5 granaries is more than RM 10 million annually. It is proposed that these works be repackaged into larger contracts in terms of cost, scope of works and over a longer time frame of say, 3 years or 5 seasons.

(f) Irrigation performance assessment

Since the granaries are already in the operational stage, it is recommended that all the granaries irrigation water management system focus on developing the three performance indicators namely the Relative Water Supply (RWS), Water Productivity Index (WPI) and Cropping Index (CI). The proposed targets are RWS=1.65 (approximately equivalent to 60% irrigation efficiency), WPI target between 0.3 to 0.5 kg/cu/m and for the CI at 190%.

(3) Water Management Facilities

(a) Central control station

A central control station for irrigation management should be established in all granaries. This center will coordinate all water management decisions on ground.

(b) Telemetry, telecontrol and computerization

A compact team of O&M personnel must be supported as much as possible by a system that simplifies data collection and processing for quick and accurate decision-making. The appropriate technology is already available for this and in a modern water management system, the facilities generally comprise :

(i) Telecommunication network,
(ii) Rainfall and water level telemetry system,
(iii) Gated structures/pumps monitoring system,
(iv) A computer system with display panels, and
(v) Gated structure/pump telecontrol system.

Water level data at main structures sites in the primary and secondary canals and drains as well as rainfall data will be collected by telemetry. The water management system planning and operations must be supported by a computer. The telemetry system could, at the initial phase, also be used to monitor operations of gates and pumps with the potential for automation. Telemetry system for monitoring is also useful to access the structure/pump performance in the long run so that timely and appropriate preventive

measures can be taken to prevent major system failure. The computer system should also be for system inventory management and a farmers' feedback information service.

The recommended step towards installing the above facilities are as follows :

(Step 1)

(i) Establishment of a telecommunication network

(ii) Installation of rainfall and water level telemetry gauging stations at the necessary sites

(iii) Installation of an appropriate computer system

(Step 2)

(iv) Motorization of main gated structures and electrification of diesel pump

(v) Installation of gated structure/pump monitoring system

(Step 3)

(vi) Installation of telecontrol system for gated structures and pumps

The outline of water management facilities in the granaries are shown in Fig. 4.1.4 to 4.1.9 "General Layout of Telemetry and Telecontrol System", and summarized as below.

Granary	Master Equio.	Radio Repeater	RTU	Rainfall Gauge	Water Level Gauge
P. Pinang	1	-	41	4	53
Kerian	1	1	38	4	44
Sg. Manik	1	-	17	2	21
S. Perak	1	-	34	2	42
Kemasin/Semarak	1	-	11	2	13
Besut	1	-	37	3	38

(c) Irrigation Water Management System (IWMS)

This is a computer model for determining daily irrigation requirement distribution. The basic input are collected via telemetry namely rainfall and water levels. Other input that can be collected via telemetry are those necessary to estimate crop evapotranspiration. It is recommended that all the granary central control stations acquire and develop this system. The following hardware and software are should be provided for estimation of water requirement, H-Q calculation, water balance and optimum water distribution as well as gate opening level and pump operation hour :

(i) Hardware
- CPU MMX 200MHz, RAM 64 MB,
- RAM 54 MB
- Network interface Ethernet / 10 BASE-T
- Hard disk interface SCSI-II
- Storage 4 GB (8 GB)
- CD ROM 16 X
- Monitor 17 inch

(ii) OS
- Window 95

(iii) Software
- Microsoft Office 95 Professional Edition
- Visual Basic 5.0 Professional Edition

(iv) Printer
- Network Color Printer IEEE802.3 10 BASE-T

(v) Network - Hub IEEE802.3 10 BASE-T

(d) Irrigation Monitoring and Feedback System (IMFS)

IMFS is proposed for all the granaries and integrated into the central control stations. Its function is to provide updated irrigation and farm activity information to farmers and O&M field staff and related departments/agencies. The system comprise a network of computers connected by telephone lines. The software is a multi-media software, programmable and its editing and transmission can be automatically scheduled without interrupting display programs. The proposed IMFS network for the Granaries are summarized below.

IADP/Office	Master (Nos.)	Player (Nos.)	Additional TV (Nos.)
Pulau Pinang	1	11	3
Kerian	1	10	4
Sg Manik	1	5	1
Sbg Perak	1	10	1
Kemasin-Semerak	1	9	4
Ketara (Besut)	1	11	4
Min. of Agric		1	2
DID HQ		1	2
DOA HQ		1	2
Total	6	59	22

(e) Integration of the Irrigation Water Management System and the Irrigation Monitoring and Feedback System

The Irrigation Water Management System (IWMS) collects data on water resources and irrigation for use of the DID technical personnel. The Irrigation Monitoring and Feedback System (IMFS) is targeted for farmers and field staffs. Thus data from the IWMS must be suitably represented for the IMFS. The water level and rainfall data collected through the IWMS can be directly connected to the IMFS via a computer link and programming.

Apart from the systems computer linkage, the planning input and actions of PMU, DID, DOA, FOA/PPK and BERNAS which are components of the IADP is critical. These must be well supported by field staff for activity feedback update. A season's planning information must be provided by the PMU at start of every season. Clear targets for each activity input into the IMFS. During a season's operations, monitoring feedback must be provided by the field staff as part of their work program. Updating should be once a week.

(4) Water Users' Group

Formation of Water Users' Group (WUG) requires intensive promotion by field officers. There is also a need to develop and implement group formation and training program for all WUG members on-site. A special off-site training session is proposed for 2 leaders per

WUG at the National Water Management Training Centre. For on-site training, a two separate one-day sessions is proposed. For the WUG leaders, one 3-day training duration is proposed. The estimated number of WUGs to be formed for the five granaries is 334 and summarized below.

IADP/Scheme	Farmers (Nos)	WUGs (Nos)	Area/WUG (ha/WUG)	Farmers/WUG (No/WUG)
Pulau Pinang	7,301	125	77	58
Kerian	13,485	84	282	161
Sg. Manik	4,030	36	176	112
Sbg Perak	2,333	20	183	117
Kemasin-Semerak	11,889	39	177	305
Besut	3,054	30	172	102
Total	42,092	334		

The WUG size ranges from 77 ha/WUG (Pulau Pinang) to 282 ha/WUG (Kerian) and averages at 177 ha/WUG. The average membership size is estimated to be 126/WUG.

(5) In-field Infrastructure Improvement

Physical improvement refers to in-field infrastructure development comprising land leveling, in-field channels and control boxes installation. The table below summarizes the in-field infrastructure works for the granaries.

Granary	Lots for improvement (nos.)	Area for land leveling (ha.)	In-field channel (km)	In-field control boxes (nos.)
Pulau Pinang	12,920	8,597	1,290	3,439
Kerian	12,651	18,389	2,757	7,356
Sg. Manik	3,149	5,783	876	2,313
Sbg. Perak	2,348	3,605	541	1,442
Kemasin-Semerak	15,998	6,025	930	4,137
Ketara (Besut)	5,212	4,656	699	3,105
Total	52,278	47,055	7,093	21,792

Note : For Seberang Perak, blocks E,F&G managed by FELCRA as paddy estate are not included.

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. The assumption is that the DOA will implement 40 % of the land leveling and the remainder 60 % by the private sector. The PPK will be encouraged to undertake these works. In-field channels density target is 150 m/ha and two(2) control boxes is provided for one consolidated lot .

(6) Land Consolidation

The land consolidation approach aims at integrating adjacent lots to form one large operating plot 3 to 5 ha each through removal of field bunds(batas) wherever the need arise or if it is suitable to do so. The proposed consolidated sizes are 5 ha for the schemes located on the west coast and 3 ha for the schemes on east coast of the Peninsular Malaysia considering the present farm sizes. The typical consolidated lots are shown in Fig.4.1.10 "Typical Layout

of Farm Lot". However, for implementation of this plan, a step-by-step process should be applied to confirm proper water distribution and water management within the consolidated plot. It is recommended that firstly water distribution and water management conditions be examined with the precision of land leveling in the comparatively larger operating plot of 1.5 to 2.5 ha which is obtained by dividing the proposed larger operating plot into 2 or more plots by the temporary bunds to be provided within the proposed plot. After confirmation of the proper water distribution and water management and agreement obtained from the participating farmers in the comparatively larger operating lot, the proposed larger operating plot of 3 or 5 ha shall be formed by removing the temporary bunds. The land consolidation requires intensive promotion to get the consensus of lot owners and the group farming system should be considered. In addition, the land consolidation should be performed concurrent with the in-field infrastructure works. The number of paddy lots and target consolidated lots are shown below:

IADP	No. of Farmers (no.)	No. of lots (no.)	Area (ha.)	Estimated no. of consolidated farms (no.)
P. Pinang	7,301	14,231	9,601	1,920
Kerian	13,485	16,641	23,560	4,712
Sg. Manik	4,030	3,499	6,318	1,264
Sbg Perak	2,333	2,609	4,005	801
Kemasin-Semerak	11,889	17,775	6,895	2,298
Besut	3,054	5,790	5,164	1,721

Note : For Seberang Perak, blocks E,F & G managed as a paddy estate by FELCRA are excluded.

(7) National Water management Center

The National Water Management Training Centre (NWMTC) should take the lead in developing and implementing appropriate training programs for (i) staffs operating the modern water management systems and (ii) WUG formation training and promoting in-field infrastructure programs as well as land consolidation. The present training program already include courses on irrigation water management. The course content will need to emphasize the granary irrigation system modernization aspects. It should also include topics on promoting the proposed in-field infrastructure improvement and land consolidation programs. The estimated number of training sessions on-site and off-site is shown below. The off-site training for WUG leaders is proposed to be held at the NWMTC.

IADP	No. of On-site Training Sessions (no.)	No. of Off-site Training Sessions (no.)
Pulau Pinang	500	7
Kerian	676	4
Sungai Manik	184	2
Seberang Perak	102	1
Kemasin/Semarak	199	2
Besut	153	2
Total	1,814	18