(c) Soil on Secondary Canal Route

The secondary canal diverted from the main canal passes through low-lying swampy area. The base layer consists of soil formed in Quaternary Pleistocene and the upper layer is the deposit in back swamp which was formed during the period from the alluvion to the present. Therefore, the poor layer is comparatively thick. The gravity drainage has been deteriorated because the swampy area is located along the coast, and the formation of soil is delayed for fallen trees.

The river deposit covers to the extent of 200-300m on either bank from the present river channel, which has bearing capacity, qc, of $5\text{-}7t/m^2$, and is suitable for the foundation of the secondary canal. In the middle of the swampy area, however, there exists thick poor layer. Especially, in the low lying and flat area located between the Air Hitam and the Air Manjuto, the poor layer is thick.

The sand deposited on coastal levee is distributed to the extent of 1.5km from the coast, and the area extending to the mountainous area from 1.5km shows a tendency to become deeper poor layer gradually. The deepest layer is about 5m, and the bearing capacity qa of $2.5t/m^2$ ($qc=1\text{-}2kg/cm^2$).

The embankment materials can not be found in the area passing through the secondary canal. Consequently, the materials will be conveyed from the terrace area. In the case of embankment constructed on the poor layer, woods should be placed under the embankment to distribute the load. Therefore, the canal route should be selected along the Air Selagan.

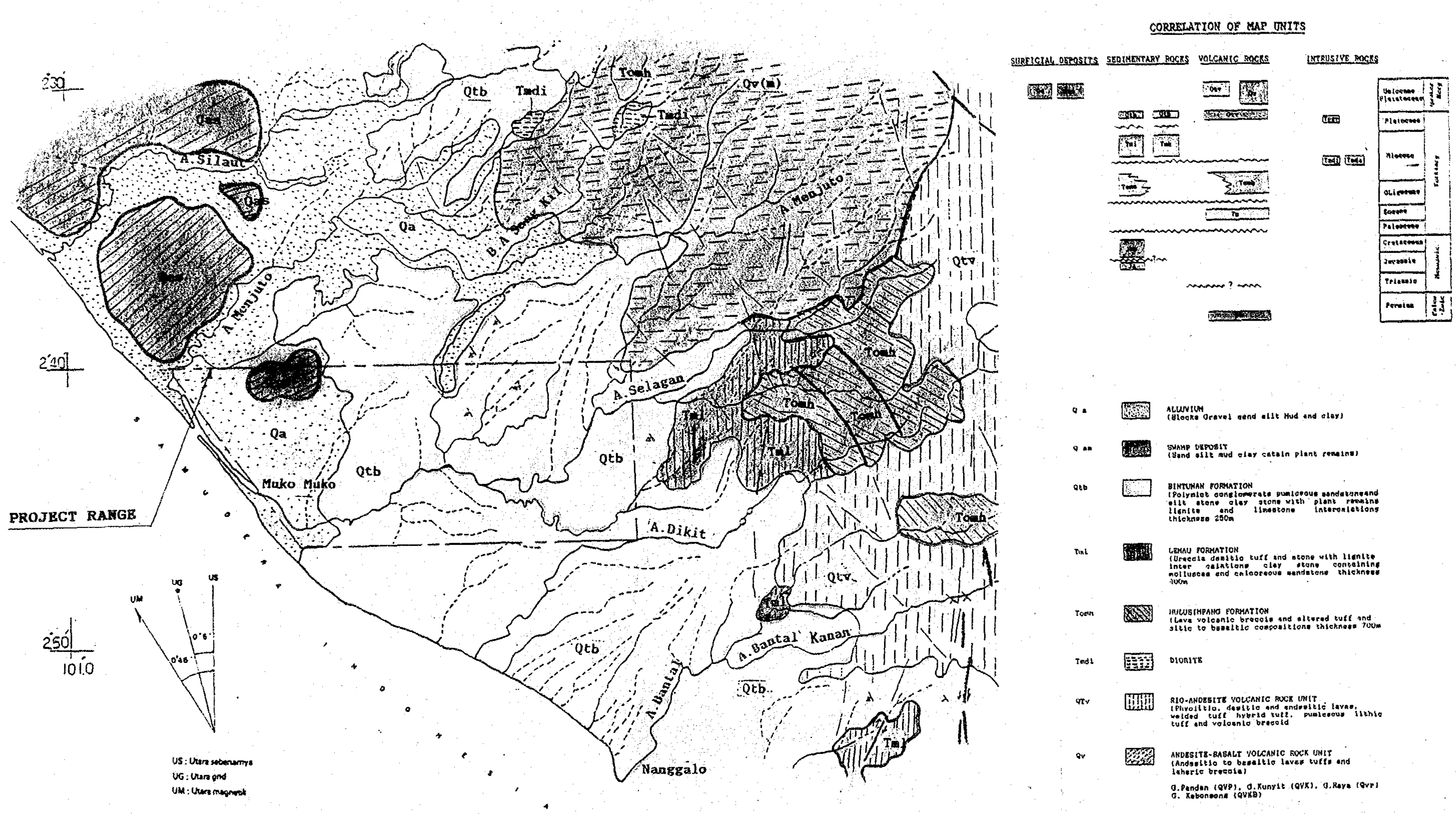


Fig.3.3.4 GEOLOGICAL MAP

REPUBLIC OF INDONESIA MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

AIR SELAGAN IRRIGATION PROJECT
FEASIBILITY STUDY

GEOLOGICAL MAP

JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO (JICA) | DWG. NO. 8

3.3.7 Satellite Remote Sensing

(1) Outline

The Center for Data Processing and Mapping (PUSDATA) of DPU is equipped with exceptional facilities to produce computer analysis enhanced satellite (LANDSAT) images.

DGWRD (DOI-II) issued the request letter dated September 14, 1989 to PUSDATA for providing the Study Team with the remote sensing products of false color map, land cover classification, biomass, soilmoisture and soil color on a scale of 1 to 125,000. The purpose of application is to get general information on the conditions of land use, soil, rivers, etc. in the Study area.

As for the above data, one of them produced on June 29, 1985, that is furnished by PUSDATA, presented so clear satellite images that it was available for the study of the target area.

The other new data, which was produced in Thailand on July 31, 1988, was available to check the secular change of the target area.

From January 24 to 28, 1990, the staff of Center for Data Processing and Mapping, went to the Study area for field survey with the staff of Directorate of Irrigation-II, and the JICA Study Team.

Land cover classification could be produced by the result of using two kinds of data in 1985 and 1988, then a secular change in the study area could be cleared in some extent.

The following Table shows outlines of the process.

Outlines of the process

Data	LANDSAT MSS		LANDSAT MSS
Acquisition date	1985-6 - 29		1988-7 -31
Path/row	236/62		236/62
Scene ID	4107902483		5161302594
Outputs of thematic maps			
False Color Composite	X		X
Land Cover Classification	X		X
Land Cover Classification Changing		X	X
Biomass Estimation			X
Soil Moisture Estimation			X
Soil Color Estimation			X

(2) Results of Data Analysis

The data analysis for 6 (six) kinds of study was carried out with producing the following specialized photograph maps:

1.	False Color Composite Map	(Scale = 1 : 125,000)	: 1985 & 1988
2.	Land Use Map	(")	: 1985 & 1988
3.	Secular Changing Map for Land Use	(")	: 1985 - 1988
4.	Biomass Estimation Map	(")	: 1988
5.	Soil Moisture Map	(")	: 1988
6.	Soil Color Map	(")	: 1988

(For reference:

Report on The Feasibility Study on Air Selagan Irrigation Project in Bengkulu Province by Remote Sensing, March 1990, Center for Data Processing and Mapping, PUSDATA)

In order to study the Secular Change of Land Use and the Biomass Estimation more clearly, furthermore, the analysis for the area of 14,800 ha covering the Air Selagan Development Area was also carried out.

From the above analysis on Secular Change of Land Use, it was realized that the forest occupied 10,000 ha, about 70% as of 1985, was reduced to the half of it in 1988. It is judged that such reduction was mainly caused in relation with the settlement of transmigrants under the transmigration scheme by the Government of the Republic of Indonesia.

As for the analysis on Biomass Estimation, on the other hand, the value lower than 20 kg/m^2 was resulted in to the surrounding area of the Project where the development is proceeded in advance.

Therefore, it is considered that the same tendency will be resulted in for the middle and downstream area of Air Selagan, too.

The results of the above analysis are down in the following tables:

Situation of Land Use

Date	June 29, 1985		July 31, 1988	
Classification	Area(ha)	Ratio(%)	Area(ha)	Ratio(%)
Water Surface	118	0.8	222	1.5
Paddy, Upland rice	2,398	16.2	2,842	19.2
Upland, home yard	1,924	15.0	2,250	15.2
Plantation	0	0	3,892	26.3
Shrubbery	5,447	36.8	2,412	16.3
Forest	4,780	32.3	3,152	21.3
Area covered by cloud	133	0.9	30	0.2
Total:	14,800	100.0	14,800	100.0

Secular Change for Land Use (1985 - 1988)

No.	1985	1986	Area(ha)	Ratio	Remarks
1.	Paddy, Upland rice field Upland, Home yard Plantation	Paddy, Upland rice field Upland, Home yard Plantation	1,125	7.6%	No change
2.	Paddy, Upland rice field	Upland, Home yard, Plantation Forest, Shrubbery, others	1,628	11.0	
3.	Upland, Home yard	Paddy, Upland rice Plantation Forest, Shrubbery, others	1,628	11.0	
4.	Plantation	Paddy, Upland rice field, Upland, Home yard Forest, Shrubbery, others	0	0	
5.	Forest, Shrubbery, others	Paddy, Upland rice field	1,598	10.8	
6.	"	Upland, Home yard	1,554	10.5	
7.	"	Plantation	3,049	20.6	
8.	"	Forest, Shrubbery, others	4,129	27.9	No change
9.	Water Surface		89	0.6	
	Total:		14,800	100.0	

Biomass Estimation, 1988

Classification	Area	Ratio
Water Surface	131 ha	0.9%
0 - 10 kg/m^2	8,286	22.2
10 - 20 "	4,307	29.1
20 - 30 "	6,009	40.6
730	1,006	7.2
Total:	14,800	100.0

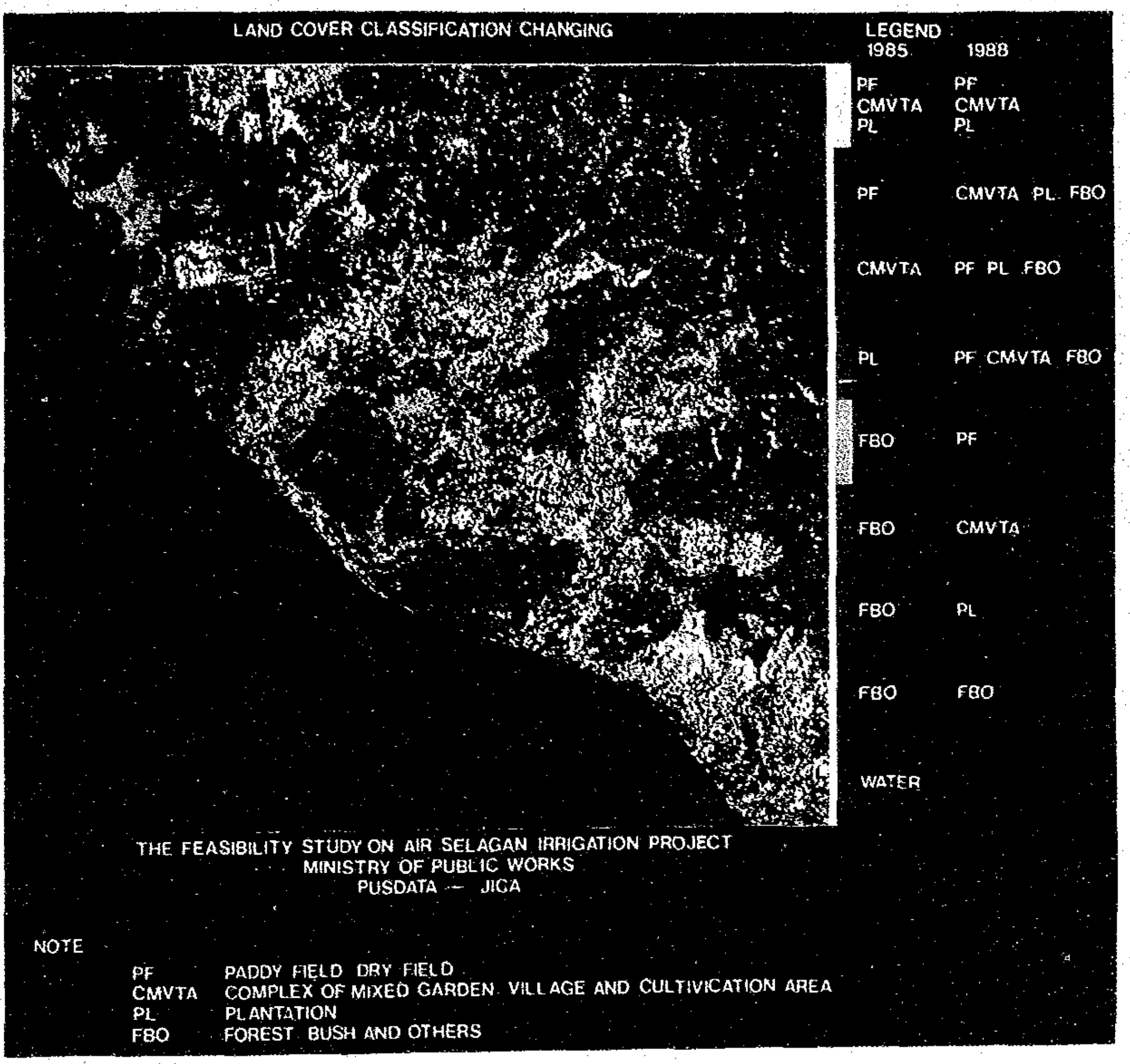


Photo 1 Land Cover Classification changing in 1985 and 1988

3.4 INFRASTRUCTURE

3.4.1 Electric Supply

There is a facility for diesel generator equipped by PLN at the Pondok Baru village about 1 km in the upstream from the Pasar Muko-Muko in the Study area. The generator consists of two (2) nos. of 100 kw and supplies electricity of 90 kw at peak to 450 subscribers in Pasar Muko-Muko, Ujung Padang and Padang Ratu only in the night at present. The other information is as follows:

Supply hour	: 8:00 PM - 6:30 AM
Supply amount	: 450 W/KK
Monthly average electric fare	: Rp.3,500/month/house
Electric fare	: Rp.63.5/KW/hr.
Basic fare	: Rp.1,140/month

In addition to the PLN supply, there are several small private generators supplying electricity to a limited number of customers. In Lubuk Pinang, for example, three (3) small generators supply electricity to 15 consumers.

The electric supply to two (2) villages in Lubuk Pinang about 8.0 km far from the facility is scheduled in 1990 and at present, concrete electric poles are under installation along the provincial road.

In addition, there is a plan to supply electricity to 2,000 households in total adding one generator of 250 kw for approximately 1,000 households in the transmigration areas, SP-I to SP-VI in 1991 to 1992.

3.4.2 Road

The main village in the study area is Pasar Muko-Muko located about 270 km far from Bengkulu and on the way to Padang, the capital of the West Sumatra Province. The road is the provincial one and paved with asphalt from Bengkulu.

The road to the proposed weir site from Penarik village through the Lubuk Sahung village is a prefectural road mostly paved with gravel and partly without pavement.

The road in the study area consists of the prefectural road, transmigration road, woodland path, narrow path, etc. The condition of pavement with sand and gravel is good because the abundant materials from the Selagan river are used.

Road Condition in Bengkulu Province

Division	Pavement			
	Asphalt	Gravel	Without	Total
	km	km	km	km
National road	457	23	-	480
Provincial road	522	80	-	602
District/other road	503	1,092	1,323	2,918
Total	1,482	1,195	1,323	4,000

3.4.3 Airport

There is a local airport constructed in 1982 for transmigration at the place about 5 km to the direction to Padang from Muko-Muko and chartered service is used at present approximately once a month to Padang.

The runway of 23 m in width and 1,000 m in distance is paved with asphalt. There is a plan to develop the line from Bengkulu to Padang through Muko-Muko by the Murpati Airline in 1990 and the required time to Bengkulu and Padang will be greatly reduced.

3.4.4 Water Supply

There is a pumping station for domestic water supply constructed in 1983 near the facility for diesel generation. The water source is the Selagan river. At present, the water is periodically distributed to the beneficiaries with the into discharge of 10 lit/s.

The only area with a piped water supply is Pasar Muko-Muko and the surrounding communities of Ujung Padang, Padang Ratu, Pasar Baru, Pasar Benteng, Jalan kartini, Kampung Dalam and Pasar Belakang. There were originally 600 houses with connections but currently only 236 customers are making use of the piped water supply. The treatment plant is operated by the Department of Public Works and water is pumped from the Air Selagan twice a day from 6.00 AM to 9.00 AM and from 6.00 PM to 8.00 PM. The water is filtered and purified before distribution. There are currently no plans for extending the system.

In addition, a pump for the domestic water is installed by the Cipta Karya of the Ministry of Public Works at the part of the transmigration area, SP-V. All other residents of the Kecamatan obtain their water supplies either from rivers, wells or irrigation canals.

3.4.5 Education

There are currently 52 primary schools (Sekolah Dasar) within the Kecamatan providing educational facilities in 32 villages and 10 transmigration SPs. Of the 52 schools, 51 are government schools and one private. Of the primary schools, 46 operate only one morning session, the other six (including the private school) operate both morning and afternoon sessions. Current enrollment is approximately 8,250 pupils taught in 6 grades by 315 teachers, giving a pupil/teacher ratio of 26:1.

There are 11 junior high schools (SMP) in the Kecamatan with an enrollment of about 925 students. Ten schools are government schools and one private. Together they employ 141 teachers.

Finally there are 2 senior high schools (SMA), a government school with 217 students located in Pasar Muko-Muko, and a private school located at Ujung Padang with 40 pupils.

3.4.6 Medical Facilities

The medical facilities of the kecamatan include 3 health centers (Puskesmas) and 14 clinics (Puskesmas Pembantu). The health centers are each staffed by one doctor and several paramedics and the center at Pasar Muko-Muko also has a dentist and a midwife.

Each of the clinics is staffed by a paramedic.

3.4.7 Mail Facilities

There are two post offices in the Kecamatan located at Pasar Muko-Muko and Lubuk Pinang. From these offices mail is distributed to villages throughout the Kecamatan.

3.4.8 Irrigation Facilities

In a part of the study area, secondary and tertiary canals were constructed in 1988/89 by the Muko-Muko Irrigation Project adjoining the study area for SP-II, SP-III and SP-VI, the urgent transmigration areas. The border between the Selagan Irrigation Project and the Muko-Muko Irrigation Project was decided at the middle between the diversion works BB.3 and BB.4. The canals already constructed are as follows:

Canal	Diversion Work	Length	Planning Discharge	Command Area
SS. BARU Secondary Canal	BB.2-BB.3	1.8 Km	1.33 m^3/s	1,840ha (887ha)
	BB.3-BB.4	1.3	1.08	1,717
	BB.4-BB.5	1.8	0.85	1,292 (547)
	BB.5-BB.6	0.8	1.33	830
	BB.6-BB.7	1.8	1.16	724
	BB.7-BB.8	1.5	0.73	430
	Sub Total	9.0		
Sal. Muka Tertiary Canal	BB.4-BB.4M	1.2 km	0.39 m^3/s	225ha
	BB.5-BB.5M	0.8	0.38	206
	BB.8-BB.8M	0.7	0.57	326
Total		11.7		

Remarks: Figure in ( ) of the command area shows the canal capacity.

In the above table, the canal between BB.2 and BB.5 can not assure the capacity for the command area of 1,840 ha.

If the above canal was used, the actual irrigable area would be estimated at about 600 ha from the viewpoints of the area with peat soil, land elevation, water level of the diversion work, etc.

Further, there are rain-fed paddy fields of about 140 ha in the study area, which are mostly located in the river course and have no irrigation and drainage facilities.

In addition, the free intakes and other intake facilities by gabion are found on the Selagan river in the upstream of the proposed weir site.

3.4.9 Transportation and Telecommunication

The way of transportation to the study area is by vehicle or by airplane. It is usual to use the provincial road from Bengkulu, the capital of the Bengkulu Province, or Padang of the West Sumatra Province and the regular bus between Bengkulu and Padang is served. There is a local airport in Muko-Muko and Padang by chartered aircraft at present.

The road network in the Bengkulu Province consists of 480 km of national road, 602 km of provincial road and 2,918 km of prefectural/village road.

The road of about 270 km between the Bengkulu Municipality and Muko-Muko is paved with asphalt with 4m width. This road is at present the provincial one, but in the near future scheduled to be national one, and connected with Padang in the West Sumatra Province. Therefore, it is easy to ship the agricultural products in the Project area to the capitals in the Bengkulu and West Sumatra Provinces.

There is an enlargement plan between Bengkulu and Ipuh. The roads in the study area are prefectural roads or village roads, and paved with gravel or unpaved, but in the parts of the transmigration area, some roads are paved with asphalt. In addition, the inland navigation to ship wood materials is found in the downstream of the Selagan river.

There is no means of telecommunication by such as telephone, telegram, etc. between Bengkulu, the capital of the Province and the Project are, and the mail is generally used. However, the public offices and private firms use wireless telegraph to communicate with Bengkulu.

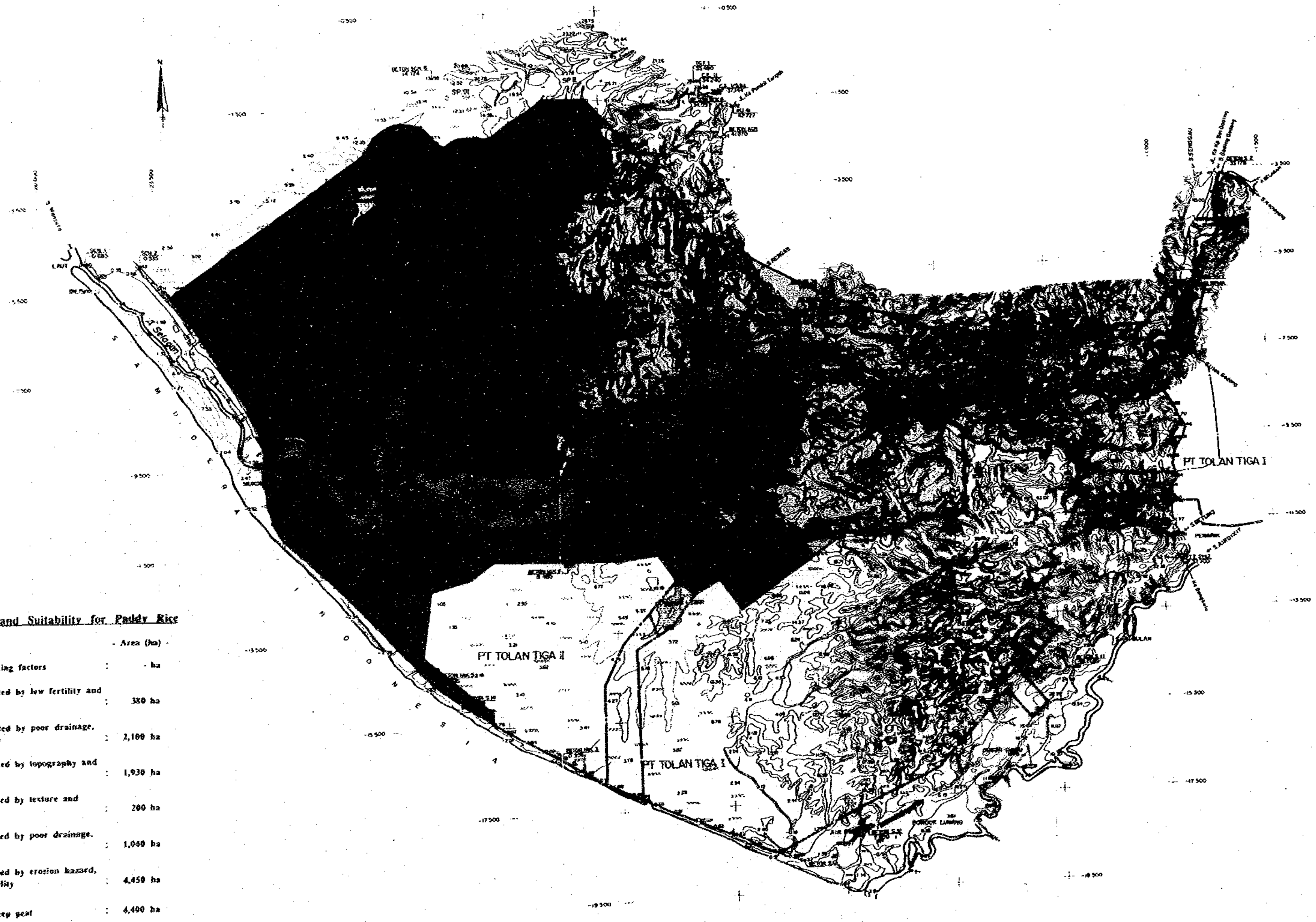
3.5 Land Use and Agricultural Production

3.5.1 Present Land Use

The present land use is shown in Fig. 3.5.1 and summarized as follows:

Present Land Use (ha)

Crops	Total	Left bank	Right bank
Wetland Paddy	140	0	140
Dryland Paddy	950	650	300
Rubber	2,300	810	1,490
Garden	1,200	700	500
Natural Forest	8,620	2,480	6,140
Scrub land	1,040	570	470
Cleared Forest	250	0	250
Others	300		
Total	14,800		



Legend for Land Suitability for Paddy Rice

- Class -		- Area (ha) -
S1	: Highly suitable, no limiting factors	: - ha
S2y	: Moderately suitable, limited by low fertility and occasional flooding	: 380 ha
S2fy	: Moderately suitable, limited by poor drainage, flooding and low fertility	: 2,100 ha
S2ty	: Moderately suitable, limited by topography and low fertility	: 1,930 ha
S2ly	: Moderately suitable, limited by texture and low fertility	: 200 ha
S3vyd	: Marginally suitable, limited by poor drainage, texture and low fertility	: 1,040 ha
S3tye	: Marginally suitable, limited by erosion hazard, topography and low fertility	: 4,450 ha
N1p	: Currently not suitable, deep peat	: 4,400 ha
N2	: Permanently unsuitable	: - ha

- Subscripts -
- d : drainage
- e : erosion hazard
- f : flooding/drainage
- l : texture, sandy loams
- p : peat
- t : topography
  - : S2 slopes : < 20%, vertical interval < 15m
  - : S3 slopes : > 20%, vertical interval > 15m
- v : texture, coarse sand
- y : low fertility

- Others -
- : Survey boundary
- : Project boundary

Fig.3.5.1 PRESENT LAND USE MAP

SCALE 0 1 2 3 4 5 km

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DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

AIR SELAGAN IRRIGATION PROJECT
FEASIBILITY STUDY

LAND SUITABILITY MAP FOR PADDY RICE

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO (JICA)

DWG. NO. 4

3.5.2 Land Holding and Land Tenure

Most of the land farmed by the indigenous population in the project area is held under "adat" or customary rights. Rarely do the local people have "hak milik" or certified ownership to their land, and farm land in particular is held under customary law. A few landholders have full legal title to their house plots, mainly located in Pasar Muko-Muko.

Adat rights to land are established by clearing and cultivating the land. Even if the land is later abandoned when the farmer clears another piece of land to plant upland rice, he still retains rights to the land, particularly if fruit trees have been planted. Many farmers in the project area plant the seedling of rubber on these areas before abandoning them, thus establishing a long term claim to the land. The Government has the right to take adat land for development proposed if it requires it for a transmigration scheme, but this can lead to conflict between the indigenous population and the transmigrants, and cause delay development of the settlement.

3.5.3 Cropping Pattern

Normally, cropping season of lowland rice is in the wet season (July/August to November/December), while, for upland rice, in dry season (August/September to December/January). Cropping of palawija is carried out throughout the year. Mixed cultivation among maize, peanuts, soybeans, cassava, etc. is normally conducted in the study area as shown in Fig. 3.5.2. Present condition of the farm land is shown as follows:

Present Farm Land

Farm land	Area(ha)
Lowland Rice	140
Upland Rice	950
Palawija	1,080
Cassava	120
Rubber	2,300
Total	4,590

The annual harvested area of crops grown in the study area is estimated as follows :

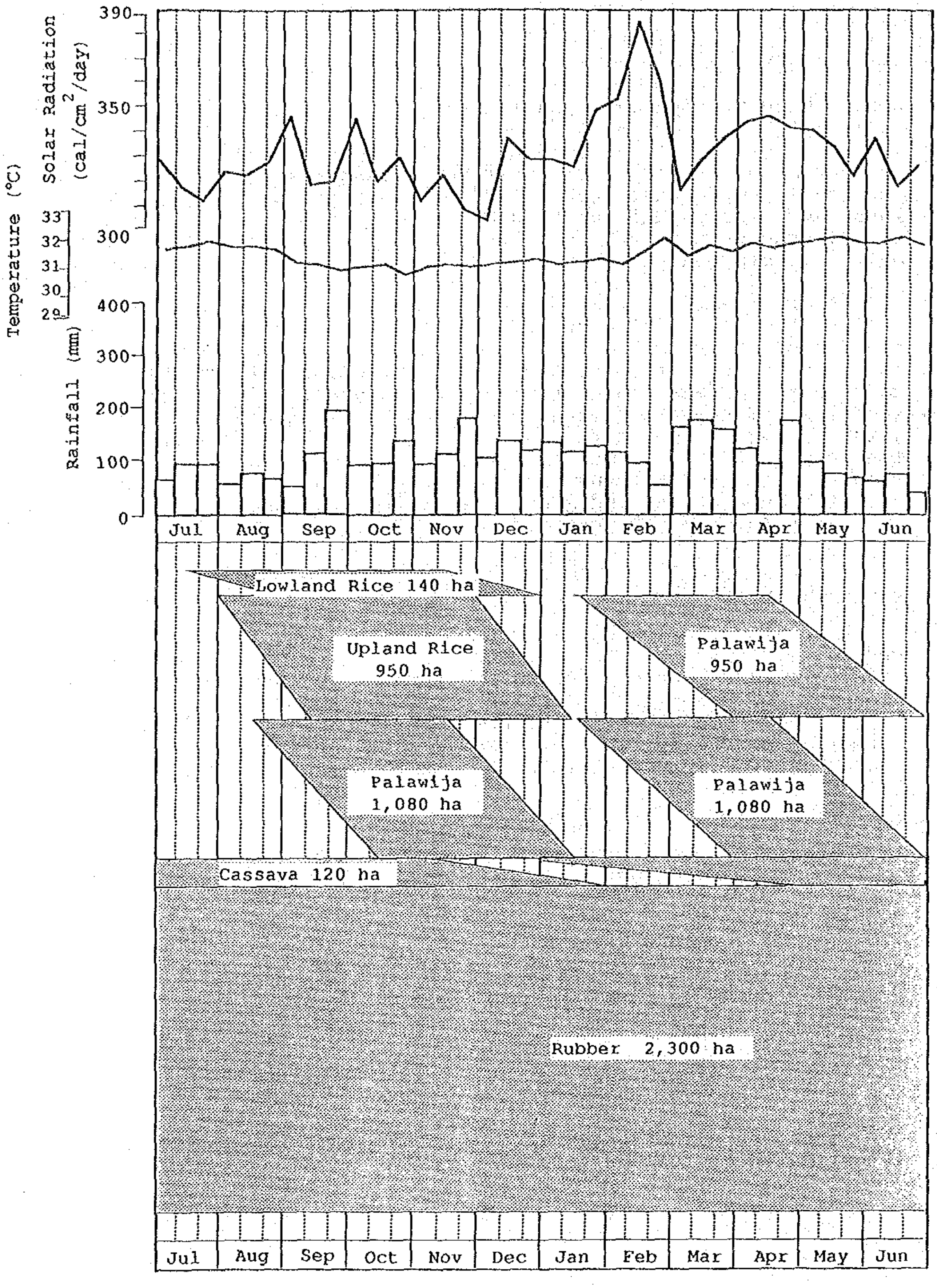


Fig. 3.5.2 Present Cropping Pattern

Annual Harvested Area

(Unit : ha)

	Dry season	Wet season	total
Rice			
lowland rice	140	-	140
upland rice	950	-	950
Palawija			
Maize	220	410	630
peanuts	730	1,370	2,100
Soybeans	130	250	380
Cassava			120
Rubber			2,300
Total			6,620

Note) The period of wet season and dry season is assumed provisionally as follows (refer Fig. 3.5.2).
Wet season : January to June
Dry season : July to December

3.5.4 Farming Practices

(1) Lowland rice

Seeds are generally sown at rate of 30 to 40 kg/ha in the nursery bed which is prepared in the size of about one (1) to five (5) % of the rice field, following seed selection by the fresh water. Seedling are transplanted to the field after around 25 days of sowing.

Land preparation for the rice is kept down to the absolute minimum. Stubble is cut and ploughed in the field. Any conspicuous growth of the weeds is removed. All the land preparation is done by hand.

Application of fertilizer is not done in the project area. Weed control is carried out manually once or twice during one cropping season. Application of agro-chemicals is little used in the project area.

Harvesting practices take place in November and December, using ani-ani instead of the sickle, regularly. Following harvesting, the farmers carry the harvested grains to their home yard and dry them on mats.

(2) Upland rice

Rice seeds are dibbled into holes with around 3-5 cm deep by stick. Seeding rate is around 30 kg/ha. Spacing is approximately 30 x 30 cm. No fertilizer and insecticide are applied.

Land preparation for the rice is kept down to the absolute minimum as same as that for lowland rice. Stubble is cut and ploughed in the field.

Application of fertilizer is not done in the project area. Weed control is carried out. Application of agro-chemicals is little used in the project area.

Harvesting practices take place in December and January, using ani-ani instead of the sickle, regularly. Following harvesting, the farmers carry the harvested grains to their home yard and dry them on mats.

(3) Palawija

The traditional cultivation methods are primitive and mixed cultivation is usual practices. Following weeding and ploughing by hand, seeding is done manually. Most of the varieties used in the project area are local ones. Furthermore, seed multiplication is carried out by farmers themselves. Seeding rate ranges between 25 and 30 kg per ha.

No fertilizer and agro-chemicals are used in the study area. Weeding is done by hand two or three times. Harvesting is done by hand and processing and drying of harvested palawija are carried out in home yards of each farmer.

3.5.5 Crop Yields and Production

(1) Crop varieties and unit yield

Major varieties and unit yield of each crop are summarized as follows :

Crop	Varieties	Unit Yield (ton/ha)
Lowland rice	Sertani Pelita I IR 64 IR 42 IR 36	1.5
Upland rice	Kadubong Uchi Gama Pelita I	1.0
Maize	Arjuna Other varieties/1	1.5
Peanuts	Macan Other varieties/1	0.8
Soybeans	local varieties/1	0.5
Cassava	local varieties/1	7.0

Note : /1: It is difficult to identify the name of varieties

(2) Crop Production

The annual amount of rice and palawija production in the study area is roughly estimated as follows:

Crop	Unit yield (ton/ha)	Harvested area (ha)	Production amount (ton)
Rice			
Upland rice	1.0	950	950
Lowland rice	1.5	140	210
Palawija			
Maize	1.5	630	945
Peanuts	0.8	2,100	1,680
Soybeans	0.5	380	190
Cassava	7.0	120	840

3.5.6 Livestock Production

Present livestock population in the project area is shown as follows. :

(Unit : head)

Cattle	3,060
Karabao	1,280
Sheep	1,330
Pig	30
Chicken	38,800
Duck	400

Population of cattle and water buffalo, which are important for the agricultural activities as a draught animal, has been increased gradually.

3.5.7 Tree Crop Production

Major tree crop in the project area is rubber, which is mainly belong to the villages of Pondok Batu, Tanah Rekah, Pondok Kopi, Trasterunjam, etc. The total planted area is around 2,300 ha, according to the information of BPP Udjung Padang. The planted area of rubber tree is located far from each village. Farm management concerning weeding, protection, etc. for the rubber tree area has not been done sufficiently by farmers themselves.

3.5.8 Marketing

At present only small quantities of food crops are sold by farmers in Muko-Muko. Most indigenous farmers produce food crops for family consumption only, their cash crops being mainly rubber and coffee. Some of the longer established transmigrants sell rice immediately after the harvest. This is essentially the main source of cash available to them, although many have planted coffee, most of the area is not yet in production. Farmers sell milled rice rather than paddy, as the price of rice is less subject to large fluctuation due to the market stabilization operations of DOLOG. However, prices paid to farmers for their rice following the harvest are significantly lower than at other times.

Rice is sold to both local traders and merchants from West Sumatra. It is moved out of the Kecamatan for sale either in West Sumatra or the city of Bengkulu. Rice shortages occur in Muko-Muko in the period prior to the harvest season, and at this time rice is imported into the Kecamatan, mainly from West Sumatra.

3.5.9 Present Situation of Demand for Principal Food Crops

Based on the population of 12,377 persons, related with the study area and per capita consumption figures similar to those for Bengkulu Province as a whole, the estimated relation with current demand and crop production for the principal food crops is given in below table.

Current Demand for Principal Food Crops, Kecamatan Muko-Muko 1990

Crop	Estimated Per Capita Consumption (kg/year)	Total Demand (ton)	Crop Production (ton)
Rice	160	1,980	760/1
Maize	24	29	945
Groundnuts	8	99	1,680
Soybeans	17	210	190
Cassava	68	842	840

Remarks :

/1 : This figures means the total amount of milled rice of wetland and upland paddy, applying the conversion factor of 0.65 to paddy.

Source : Pembanguna Pertanian Tanaman Pangan PropinsiDaerah Tingkat I, Bengkulu, Repelita V, Bengkulu 1988

As shown above table, the shorfall of the milled rice is obviously occurred in the study area.

3.5.10 Prices of Farm Inputs and Outputs

The current farm gate prices of farm inputs and outputs in the study area is estimated on the basis of the collected data from agricultural office and interview survey to the farmers. The list of the prices is elaborated in Table 3.5.1.

3.5.11 Processing and Storage Facilities

Processing facilities within Kecamatan Muko-Muko are primarily limited to rice milling. There are reported to be 36 small private rice mills in the Kecamatan with an average throughput of 350 kg per hour, and 3 larger mills operated by the KUDs with a throughput of between 500-600 kg per hour. Most villages have at least one mill, but these tend to operate far below their capacity for most of the year, with throughput only approaching capacity immediately after the main harvest.

Facilities within the project area for storing large quantities of agricultural products are limited. The KUD's in Muko-Muko and Lubuk Pinang have warehouses for storing fertilizer and agricultural chemicals, and there are storage facilities in each of the four transmigration SPs, but these are used mainly for storing commodities for distribution to the settlers.

Table 3.5.1 Current Farm Gate Prices of Farm Inputs and Outputs

Item		Unit	Curerent Price (Rp.)
1) Farm Outputs			
Paddy		(kg)	250
Maize		(kg)	150
Peanuts		(kg)	500
Soybeans		(kg)	600
Cassava		(kg)	100
Oil palm		(kg)	75
Rubber		(kg)	450
2) Farm Inputs			
a. Seed			
Paddy	Local	(kg)	250
	Improved	〃	450
Maize	Local	(kg)	350
	Improved	〃	1,500
Groundnuts	Local	(kg)	900
	Improved	〃	1,500
Soybeans	Local	(kg)	800
	Improved	〃	1,300
Green beans		(kg)	1,300
Cassava	Local	(per/ha)	7,000
	Improved	〃	10,000
Oil palm		(pieces)	2,000
Rubber		(pieces)	350
b. Fertilizers			
Urea		(kg)	185
T.S.P.		(kg)	210
KCl		(kg)	210
Magnesium		(kg)	90
c. Agro-chemicals			
- Insecticide			
Diasinon 60 EC		(liter)	7,500
Dursban		(liter)	7,700
Lannate L		(liter)	9,500
Mipcin		(liter)	6,200
Sevin		(kg)	6,000
- Fungicide			
Dithane M. 45		(kg)	4,300
- Rodenticide			
Klerat RM/RMB		(kg)	2,100
- Pesticide			
Temic 10 G		(kg)	6,100
d. Hired Labor		(man-day)	2,500
e. Hired Animal		(animal-day)	6,000

3.5.12 Profitability of Crops

Representative crop budgets have been prepared for the major food crops produced in the project area and are summarized as follows.:

Crop Budgets - Present Situation

(Rp/ha)

Crop	Gross Income	Production Cost/1	Net Income
Wetland Paddy	375,000	11,000	364,000
Dryland Paddy	250,000	14,000	236,000
Maize	225,000	14,000	211,000
Groundnuts	400,000	50,000	350,000
Soybeans	300,000	20,000	280,000

Remark) /1 : Excluding labour costs

These budgets indicate that wetland paddy gives the highest net return per hectare, followed by groundnuts and maize, upland rice being the least profitable crops. This result is, however, rather misleading because cassava is grown over relatively limited areas and is mostly grown for domestic consumption with very little wet root actually being sold.

3.5.13 Farm Budgets

The farm budget of typical existing farmers, i.e. transmigrants and local farmer are summarized as follows:

Farm Budget under Present Condition

(Unit: Rp 10^6)

Item	Transmigrants	Local farmer
Farm Sizes (ha/family)	1.25	2.5
I. Gross Income		
- Farm Income	780	1,139
- Off-farm Income	96	96
II. Gross Outgoings		
- Production Cost	72	55
- Living Expenses	739	739
III. Net Reserve	65	442

Major farm income for local farmer is obtained from the products from rubber. The farm income of the local farmer is about five times of transmigrant's one.

According to the transmigration income survey by the world bank, the subsistance level as of 1985 is Rp.50,000/month. The farm income of transmigrants in the project area is estimated at Rp.70,000/month. This level is barely over Rp.50,000/month, about equal to the poverty level.

3.6 Agricultural Support Services

3.6.1 Agricultural Research

In Bengkulu Province, there is no agricultural research station. Agricultural research in this province is covered by the West Sumatra Branch Research Station, Sukarami (SARIF). The main activities of this station are to execute experimental work under the instruction and supervision of the Central Station at Bogor and to collect information from extension services on the technical problems associated with the farming practices of local farmers.

3.6.2 Extension Services

Agricultural extension services in the study area is carried out by two agricultural extension centers (BPP : Balai Penyuluhan Pertanian), e.g. BPP Ujung Padang and BPP Sido Mulyo. Each BPP has several Working Area of a field Extension Worker (WKPP : Wilaya Kerja Balai Penyuluhan Pertanian) which covers several villages. There are some senior extension workers (PPUPs : Penyuluhan Pertanian Urusan Programa) in charge of each section for agriculture, forest, estate crops and fishery, who supervises the activities of some junior extension workers (PPLs : Penyuluhan Pertanian Lapangan) who are stationed at BPP and control the WKPP.

In Kabupaten Bengkulu Utara, there are 5 PPSs, 51 PPUPs and 161 PPLs. Out of these staffs, 51 PPUPs and 181 PPLs belong to 14 BPPs. In the survey area, two BPP, i.e. Ujung Padang and Sido Mulyo, have managed the whole area. Number of PPL is 11 staffs there, who have inspected 12 WKPP.

3.6.3 Agricultural Credit Availability

The major source of credit traditionally available to farmers within the study area was the extended family group, or possibly their neighbors in the village. In the main this situation still persists. The other source of available credit is from merchants, but this again is limited and although detailed information is not available, it is understood that interest rates are very high.

Furthermore, there is the credit system through Bank Rakyat Indonesia (BRI) in Bengkulu Province. In the credit system, Kredit Usaha Tani (KUT), i.e. Bimas credit, is most available one in the Bengkulu Province.

At present there is no BRI sub-branch office in Kecamatan Muko-Muko. In the past an office was opened to provide farmers with credit for the Bimas program, but it subsequently closed due. Then, the farmers in the project area has not applied the credit so far.

3.6.4 Agricultural Cooperative

The existing cooperative system (Koerasi Unit Desa : KUD) was established in accordance with Presidential Decree No. 4, 1984. The members of the cooperative consist of individual persons or small group.

In the study area, there are four KUDs, i.e. KUD Harapan, KUD Maja Makmur as shown in Table 3.6.1. However, there is no active function in those KUDs.

3.6.5 Land Reclamation

The national program has a target of 375,000 ha to be developed during Repelita V. The annual targets are given below.

Land Development Targets for REPELITA V

Year	National Target (ha)	Bengkulu Target (ha)	
		Original	Revised
1989 / 90	100,000	5,312	3,000
1990 / 91	75,000	3,976	5,000
1991 / 92	75,000	3,976	3,976
1992 / 93	75,000	3,976	3,976
1993 / 94	50,000	1,558	1,558
Total	375,000	18,798	17,570

Source:
(1) Directorate General of Food Crop Agriculture, Jakarta 1989.
(2) Land Development Directorate, Dinas Pertanian Tanaman Pangan Bengkulu, March 1990.

The budgets allocated for land clearing and land leveling vary with the vegetation cover. For heavy forest the budget is Rp 850,000/ha; for light forest, Rp 550,000/ha; for brush Rp 400,000/ha; and for upland already cleared for cultivation Rp 300,000/ha. These figures apply nationally, except for the figure for heavy forest where other provinces' cost estimates for land clearing and land leveling in Bengkulu indicate that these sums will be inadequate and that it will be difficult to find contractors willing to undertake land clearing and land leveling for these sums.

Table 3.6.1 Extension Services in Kabupaten Bengkulu Utara

(Nos.)

Kecamatan/BPP	PPS	PPUP	PPL	PHP	RPH	KP2A	BRI	KUD	Kios
Muko-muko Utara									
Ujung Padang	-	4	10	-	5	-	-	(4)	-
Sido Mulyo	-	3	12	1	3	3	-	(3)	-
Talang Empat									
Jayokarta	-	5	12	1	52	5	1	-	5
Anak Dalam	-	3	10	1	5	5	-	6	-
Taba Penanjung									
Pagar Jahti	-	4	9	-	8	-	-	-	-
Pondok Kelapa									
Talang Pauh	-	5	14	2	33	4	1	5	5
Kerkap									
Batu Roto	-	5	19	2	60	29	2	9	23
Lais									
Kuro Tidur	-	5	19	2	145	3	1	14	18
Rotu Samban	-	3	13	1	13	2	-	3	18
Ketahun									
Ketahun	-	5	16	2	82	1	-	14	18
Sebelat	-	4	10	-	5	-	-	-	-
Mukomuko Selatan									
Medan Jaya	5	5	17	2	94	1	-	4	5

Note) 1 PPUP : Penyuluh Pertanian Urusan Programa (Sector Chief)
2 PPL : Penyuluh Pertanian Lapangan (Field Extension Worker)
3 PHP : Pengamat Hama Penyakit (Disease and Pest Controller)
4 RPH : Regu Pemberantas Hama (Farmers' Land Warden Group)
5 KP2A : Kelompok Petani Pemakai Air (Farmers' Water User Group)
6 BRI : Bank Rakyat Indonesia
7 KUD : Koperasi Unit Desa (Village Unit Cooperative)
- Kecamatan Enggano does not have any BPP.

Source) - Dinas Pertanian Kabupaten Bengkulu Utar
- BPP Ujung Padanq

3.7 RELATED PROJECTS

3.7.1 Muko-Muko Irrigation Project

In the neighborhood of the northern part of the Air Selagan Irrigation Project, the Muko-Muko irrigation project which has a commanded area of about 16,000 ha has been constructed from 1983/84 using IBRD loan. As to the development of the left side, main irrigation system was almost constructed up to 1988/89, but that of right side of Air Manjuto river is not yet started except for right side intake facilities at the weir structure.

Then until now, the diversion weir at Air Manjuto river, main and secondary irrigation canal and a part of drainage canal were already constructed for the left side development. Now a part of secondary canal and tertiary canal are under construction using a sector loan of OECF and other fund.

Out of the original plan of Muko-Muko irrigation project, the project has the left bank extension area of about 1,000 ha net irrigation area. According to the schematic diagram of Sub Proyek Irigasi Muko-Muko, the total net area of Muko-Muko Kiri is 6,768 ha. In addition, the right bank also has an extension plan for about 5,000 ha net irrigation area in the Silaut river area.

On the other hand, the intake and canal have a limited capacity in accordance with original plan for Muko-Muko left side development, then after full development of the area, a shortage of delivery capacity will be occurred. Therefore, a part of extension area in the left bank was proposed to enter the Air Selagan Irrigation Project area. As to the irrigation system of this area, some improvement plan will be studied from the view of existing canal capacity, water level and soil condition, etc.

The major feature of plan for Muko-Muko is as follows:

1) Development area

Muko-Muko Kiri	net paddy field	6,768 ha
Muko-Muko Kanan	net paddy field	4,919 ha
Muko-Muko Kanan, Silaut	net paddy field	5,000 ha
Total		16,687 ha

2) Cropping pattern and irrigation area

Wet paddy (Sep.-Dec.)	16,687 ha
Dry paddy (Jan.-Apr.)	12,937 ha
Palawija (May -Aug.)	16,687 ha

3) Weir

Width	100 m
Catchment area	407 km^2
Flood discharge (Q100)	1,780 m^3/s
Mean river discharge	54 m^3/s
Drought discharge	20 m^3/s
Design intake discharge (left)	10.13 m^3/s
Design intake discharge (right)	10.13 m^3/s
Intake water level	EL.29.34 m
Maximum unit water requirement	1.60 l/s/ha

4) Budgetary arrangement

Source	Construction	Year	Amount
IBRD/APBN	Weir Main,Sec,Ter.canal	1983-87	Rp.25,210,981.000
ISSP	Sec. & Ter. canal	1987/88	Rp. 19,063,372
OECF/APBN	Sex. & Ter. canal	1988/89	Rp. 5,789,000,000
OECF/APBN	Ter. canal	1989/90	Rp. 439.535,000

With relation to the use of the existing secondary canal, SS. Baru of the Muko-Muko Project for the Air Selagan Irrigation Project, the following matters are taken into account.

(1) Border between Muko-Muko and Air Selagan Projects

The border between the Muko-Muko Irrigation Project and the Air Selagan Irrigation Project was decided at the middle between the diversion works, BB.3 and BB.4. Therefore, if the secondary canal on the right side of the Selagan river was made to connect with BB.4, the existing canal from the Muko-Muko Project could be used.

(2) Irrigable Area

As described in 3.4.8, the irrigable area by the existing canal would be about 600 ha. Actually, however, it would be necessary to make new canal in the downstream part of the diversion work, BB.7 because the existing canal has a drop structure at BB.7.

3.7.2 Existing Transmigration Scheme

Existing transmigration settlements in the Kecamatan fall into two groups. Firstly there are the settlements at Lubuk Mukti, Suka Maju, Penarik and Tunggal Jaya established on upland areas prior to 1985. These settlements have approximately 2,260 families, or 52 percent of the total transmigration population in the Kecamatan. They are based on the cultivation of upland rice and other food crops and considerable areas of coffee have also been planted. The agricultural system adopted by the transmigrants is thus similar to the indigenous farmers living in the area.

The second group of transmigrants consists of these settled in the Air Manjuto irrigation area. These settlements have been developed since 1985 and were designed to have, in addition to the house plot, an area of irrigated sawah and area devoted to upland crops. In most of the transmigration villages, much of the planned irrigated area has not yet been developed, although there is suitable land the transmigrants are cultivating rainfed sawah. On the upland areas a variety of food crops are being cultivated, the most significant in terms of area being upland rice. In the more established transmigration villages, significant areas of coffee have been planted although most of it is not yet in production.

The number of transmigrants in the study area is 5,213 persons, comprising 1,206 families. SP's II and IV have been settled for 3 to 4 years, but in SP's III and IV the transmigrants have been resident for less than a year.

Each family is allocated 2 ha of land comprising 0.25 ha for the house plot and garden, and 1.75 ha for crop production. Until 1989/99 the transmigrant received 1 hectare of cleared land, known as Lahan Usaha I, to be used for the cultivation of arable crops. If possible this land is provided with irrigation facilities, but the construction of the quaternary canals, and the leveling and bounding of the rice fields, are the responsibility of the transmigrants. Since 1989/90 the transmigrants in the project area have only received 0.75 ha of cleared Lahan Usaha I. The remaining land, 0.75 ha or 1.00, is known as Lahan Usaha II. This land is allocated to the transmigrant but it is not cleared by the Department of Transmigration. This second plot, once cleared by the farmer, may be used either for food crop production or tree crops.

In the project area 2,412 ha have been allocated to transmigrants of which 1,368 ha were cleared by the Department of Transmigration. Farmers in SP's II and IV have subsequently cleared substantial areas of their Lahan Usaha II, for tree crop production, but in SP's III and VI the transmigrants have not had time to clear any significant areas of their LU II land.

3.7.3 P.T. TOLAN TIGA Plantation Scheme and Its Profitability of Crops

(1) P.T. TOLAN TIGA Plantation Scheme

PT Tolan Tiga, a joint venture estate company, has two concession areas of approximately 10,100 ha and 7,520 ha in Kecamatan Muko-Muko, the larger of which borders the project area. The breakdown is as follows:

Block No.	Location	Gross Area	Remarks
1	Tanah Rekah	2,100 ha	MMP-2
2	Dusun Baru	5,600	MMP-1
"	Penarik	2,400	MMP-1
3	Talang Petai	2,300	
4	Lubuk Pinang	5,220	
	Total	17,620	

(MMP : Muko-Muko Project)

The two areas are in the process of being developed and are currently being planted with oil palm, rubber and cocoa. In the larger concession area, 6,000 ha are being planted with oil palm, 2,000 with rubber and up to 1,000 with cocoa. In the second area it is planned to plant 3,500 - 4,000 ha of oil palm, 1,000 ha of rubber and over 500 ha of cocoa.

The blocks relating to the Air Selagan area are ones of Tanah Rekah, Dusun Baru and Penarik. The following table shows the developing situation obtained during the stage of field survey of the Phase II.

Location	Project Name	Name of Crop	Land Clearing Area	Planted Area
Dusun Baru & Penarik	MMP-1	Oil Palm & Rubber	4,900 ha	2,600 ha
Tanah Rekah	MMP-2	Oil Palm	850 ha	250 ha

In prior to the land clearing works shown in the above table, the works for drainage canal excavation and road construction are being constructed using about 500 m interval.

Once the estates are in production, it is planned to construct a rubber factory to produce ribbed smoked sheet (RSS) and two oil palm factories to produce refined palm oil for bulk shipment to Europe. The estates and processing factories will become major employers in the Kecamatan once they reach full production. It is estimated that one harvester is required for every 10 ha of oil palm and one tapper for every 3 ha of rubber. Thus the area planted to oil palm would generate employment for about 1,000 harvesters and the rubber areas work for 1,000 tappers. Together with the factories, maintenance workers and other estate workers, approximately 4,000 full-time jobs are likely to be created.

Those workers and their families are estimated to total about 20,000 people, and this large increase in employment and population will have a major impact on the development of Kecamatan Muko-Muko. In terms of rice consumption alone, a population of this size would require around 3,000 tons of rice per year assuming a per capita consumption figure of 150 kg per year.

It is anticipated that if the proposed Air Selagan project is implemented PT Tolan Tiga will become involved in the development of the proposed 1,200 ha of smallholder oil palm. The settlers will require technical assistance with the planting and maintenance of the oil palm until it comes into production. The high yielding clonal planting material would also be supplied by the estate company. The supply of planting material and technical assistance would be supplied under contract by the estate company. Once the oil palms come into production the estate would purchase the smallholder FFB for processing in their factory. The factory would be responsible for organizing harvesting rounds, FFB collection, etc. The smallholders would be paid on the basis of the quantity and quality of the oil obtained from their fruit. Organizational details will need to be worked out prior to the development of the smallholder oil palm holdings. At full production the smallholders would be producing about 25,000 tons of FFB per annum. The harvesting and collection of this quantity of FFB will require considerable organization and management.

(2) Profitability of Crops

Representative crop budgets have been prepared for the major food crops produced in the project area. These are based on published agricultural data for Kecamatan Muko-Muko, on interviews with staff of the Department of Agriculture, and on farmer interviews.

These budgets indicate that wetland rice gives the highest net return per hectare, followed by groundnuts and cassava, with maize and upland rice being the least profitable crops. When returns per man day of family labour are calculated, cassava gives highest return followed by groundnuts and wetland rice.

This result is, however, rather misleading because cassava is grown over relatively limited areas and is mostly grown for domestic consumption with very little wet root actually being sold. The market for fresh cassava is very limited as there are no facilities in the project area for processing the root into chips or pellets for livestock feed. If in fact farmers planted substantial areas to cassava they would have considerable difficulty in disposing of their surplus production. In practice only limited quantities of food crops are grown for sale. Some transmigrants sell rice and other food crops as this is the only source of cash income open to them, but the majority of local farmers grow rubber and/or coffee as cash crops, and only cultivate sufficient food crops to meet their own requirements.

This situation is exacerbated by the low yields and poor returns per man day that farmers obtain from the cultivation of food crops.

3.7.4 Forest Conservation

The total acreage of the forest in the Bengkulu Province is about 680,000 ha and that in the Kecamatan Muko-Muko Utara is 130,800 ha. The cutting of the major trees used for timber is finished in the study area. At present, the cutting of the trees has been done in the upstream part of Pondok Kopi village except the region of forest conservation near the Barisan range. The main company for cutting trees is PT. DIRGAHAYU which moved to the area in April 1986 from the Ketahun area.

PT. DIRGAHAYU equips a base camp near SP-III on the middle reach of the Selagan river and carries on cutting trees about 40 km in the upstream from there. The cut logs are let to flow using the Selagan river to the estuary and exported to Padang by the ship waiting off the coast. The cut logs are limited more than 50 cm in diameter. The variety consists of Meranti with most shipping amount, Marapari with high quality, Tarin, Juroton, etc.

The companies for cutting trees around the study area are as follows;

- PT. DIRGAHAYU RIMBA
- PT. SARI BALOK
- PT. BINA SAMAKTHA

The status of the land by the Forestry Office in and around the study area is classified into the following:

1) Region of natural conservation forest
2) Region of protection forest: Hutang Lindung
3) H.P.T.; Region of limited production forest
4) Convertible forest for other purpose
5) H.P.H.; Concession land for forest

The above regions of natural conservation forest and protection forest are situated in the upstream area of the proposed weir site and most of the study area belongs to the concession land for forest except the land of protection forest of 300 m in width along the coast. Almost all the major trees in the study area were cut already and trees with small diameter are cut by the transmigrants and local people.

In the plantation area, all trees are burnt without attention to the forest conservation. In the development of the study area, the forests in the swamp and in the high land should be remained as the forest for fire wood.

IV. THE PROJECT

4.1 APPROACH TO THE PROJECT

4.1.1 Objective of the Project

The objective of the Project is to implement an irrigation project mainly for paddy cultivation aiming at contributing to increase the yield for food products to realize an economic stability of the farmers in the region, and encourage the transmigration scheme and the regional development.

The transmigration program has played an important role in sparsely populated area in outer islands for agricultural development and contributed in the regional development.

The local people of about 1,550 households composed of 7 villages, Government transmigration of 4 units and a few social transmigration have settled in the study area. Total 2,310 households are counted up from 1985 to present in the study area and neighboring Muko-Muko Kiri area. In the figure, the transmigrants of 1,290 households have settled since Nov. 1988 as an urgent transmigration program due to the commencement of reservoir operation from Kedung Ombo area in the central Java province.

The Bengkulu Province has limited land for paddy cultivation because of few flat lands and a lot of the land with poor soil condition. Therefore, to promote agricultural development in the study area situated in the agricultural region (northern part of the Province) contemplated by the Provincial Government is not only to contribute the economic stabilization of the transmigrants and local people in the study area, but also to imply the realization of a strong impact of the agricultural development to the region in the neighborhood.

For this purpose, it is necessary to realize prompt implementation of the following matters for the study area to be transmigration area and the land for local people and with no irrigation and drainages facilities using water resources effectively.

a. Construction of systematic irrigation facilities
b. Improvement of drainage conditions by the construction of drainage facilities
c. Development of paddy field and farmland in the trnas-migration area and uncultivated land
d. Coordination to the new transmigration/re-settlement plan in newly developed farm land
e. Construction of operation and maintenance facilities
f. Arrangement of agricultural support services and organization
g. Construction of related social infrastructures

4.1.2 Main Concept for the Project

In the delineation of the development area, the following factors are taken into consideration.

1) Location and intake water level of weir
2) Possible intake discharge and water requirement
3) Land suitability classification
4) Number of household of farmers, allocated area and land use plan

For the study area, the following matters are found about the above items.

1) Even if the intake water level is heightened, the benefited area is not increased so much from a topographical point of view and the backwater at the time of flood due to the proposed weir height does not influence the villages in the upstream of the weir.

2) The discharge of the Selagan river is comparatively abundant and the year-round paddy cultivation by double cropping can be proposed for all the estimated irrigable area.

3) The irrigable are is limited specially from the viewpoints of the soil condition with peaty soil and the land slope.

4) Taking into consideration of the Local Government's policy for the agricultural development in this region, 1.5 ha of farm land is allocated for paddy cultivation per one transmigration family and 25% of the benefited area is assured for the local people. Therefore, it is possible to decide the total number of agricultural household, the number of household of transmigrant and the land use plan.

   With regard to the swampy area which the paddy cultivation could not be introduced because the poor soil condition, the introduction of oil palm cultivation after the excavation of drainage canal is proposed on the base of the allocated land of 2.0 ha per one transmigration family.

5) Ratio of oil palm farmer is 50% of Government transmigration and 50% of forestry worker or shifting farmer in the province.

6) Supply of irrigation water to the existing extension canal (S.S. Baru) in the Muko-Muko Kiri project is designed in the Selagan project considering the future development plan of Muko-Muko project. A part of existing canal facilities is improved and then irrigation to higher land is enabled.

4.2 APPROACH TO A BASIC DEVELOPMENT PLAN

4.2.1 Study Area and Objective Area

The study area is estimated at 22,400 ha as shown in the following table using the border between the Muko-Muko Irrigation Project and the Air Selagan Irrigation Project which is decided by the Provincial Public Works Office. Actually, however, the concession area for plantation by P.T. Tolan Tiga, the private enterprise was permitted by the Provincial Government in the study area and the objective area for the Air Selagan Irrigation Project is decided to be 14,800 ha except the plantation area.

Division	Left Side	Right Side	Total
Objective Area	5,350 ha	9,450 ha	14,800 ha
Plantation Area	7,600	-	7,600
Tolan Tiga - I	(5,600)	-	(5,600)
Tolan Tiga - II	(2,000)	-	(2,000)
Total	12,950	9,450	22,400

The objective area in the study area is divided into the following and the gross irrigable area is estimated at 4,700 ha from the viewpoints of the intake water level, soil and land slope.

Division	Left Side	Right Side	Total
	ha	ha	ha
Gross irrigable area	2,700	2,000	4,700
High land for home yard	900	700	1,600
Steep and other high land	1,210	2,220	3,430
Swamp (Peat area)	260	3,600	3,860
Existing home yard	130	220	350
River and lake	150	180	330
Other (Flood area)	-	530	530
Total	5,350	9,450	14,800

4.2.2 Basic Concept of Agricultural Development

As to the agricultural development in the objective area under the circumstances of the present condition of the transmigration scheme and the land with poor soil condition proposed for oil palm cultivation, the following three (3) alternative development plans are considered as a basic concept.

Plan-1 : Most suitable land for paddy is selected in accordance with present transmigration program including the settlement of local people.

Plan-2 : Suitable land except for heavy peat area is selected in accordance with the condition of land suitability and water resources capacity for paddy.

Plan-3 : Perennial crop like oil palm in the swampy area after construction of drainage canal is introduced in addition to the above alternation Plan-2.

The development area of the study for each plan is formulated as follows:

Plan	Location	Gross Irrigable Area	Net Irrigable Area	Gross Oil Palm Area
		ha	ha	ha
Plan-1	Right Side	1,333	1,200	2,500
	Left Side	1,084	975	--
	Total	2,417	2,175	--
Plan-2	Right Side	2,000	1,800	--
	Lift Side	2,700	2,400	--
	Total	4,700	4,200	--
Plan-3	Right Side	2,000	1,800	2,500
	Left Side	2,700	2,400	--
	Total	4,700	4,200	2,500

From the above results, the following characteristics can be pointed out:

a) In the study area, there exist many hilly areas topographically undulated with steeper slopes which are inadequate for irrigation area.

If the maximum ground surface slope to be employed as an irrigable area shall be 15%, the Gross Irrigation Area is estimated as 4,700 ha (maximum ground elevation : EL. 23.6 m).

b) The maximum back water surface elevation caused by the construction of Headworks gets EL.33.05 m at Kp. Surian Bung Kal under the application of 1/100 probability flood water.

The village is situated at GH.35.0m of ground elevation and there is no influence by the flood. In the case of Plan-2 and -3, it is EL.33.05 which is still same with that of Plan-1.

c) 1/5 probability of river discharge on Air Selagan gets 9.21 m^3/s in minimum, so that the irrigation water required for the planting ratio of 200 %/year can be sufficiently supplied.

d) The Swamp Area reaching 4,400 ha is widely spread in the downstream area.

Such area is expected to be developed for agriculture by the application of drainage improvement.

e) The location where the canal route is planned to be constructed on the hilly site is so topographically undulated that the rather high construction cost than that in flat area is required.

f) Basic Specification for Plan-1, Plan-2 and Plan-3

Each Plan is basically specified as follows:

Plan-1 : Most suitable land for paddy is selected according to the present transmigration program including the settlement of local people.

Plan-2 : Full use of irrigable area for paddy in the Project Area with the settlement of new transmigrants is employed.

Plan-3 : In addition to the above Plan-2, the development of swampy area by the application of drainage canal construction is employed for perennial crop production (oil palm).

- The number of farmers under the Plan-3, which is the largest among 3 plans, is 3,900 KK in total consisting of 2,800 KK for paddy and 1,100 KK for oil palm.

  (Remark : Plan-1 : 1,450 KK in total)

- In case of Plan-1, the slope for canal profile become steeper than that for Plan-2 because of the reduction of required canal water discharge.

Accordingly, the required intake water surface elevation at the Weir Site is forced to be higher than the case of Plan-2 by about 60 cm.

Judging from the increase of construction cost and the decrease of benefited area, the Economic Effect derived from Plan-1 is lower than that of Plan-2.

- In case of Plan-3, the farming area used for paddy field, upland field and plantation (oil palm) gets about 8,000 ha in total. Also, about 2,700 ha for Plan-1 and about 5,200 ha for Plan-2 are respectively expected.

  Therefore, Plan-3 has the best efficiency for Land Use among 3 plans.

- From the Economical Aspect, the priority is given as follows:

  Plan-3 > Plan-2 > Plan-1

From the above study, Plan-3 resulting high priority is finally employed for this Project Planning.

Therefore, the Project Size under the Study is given as follows:

Irrigation Area (paddy field)	:	Net 4,200 ha
Plantation Area (oil palm)	:	Net 2,200 ha
Household for paddy (existing trans.)	:	1,090 KK (incl. planned KK)
Household for paddy (new trans.)	:	1,010 KK
Household for paddy (local)	:	700 KK
Household for oil palm (new trans.)	:	1,100 KK
Headworks (downstream plan)	:	2.3 km upstream from Kp. Lubuk Sahung
Weir height	:	3.8 m
Flood water level (1/100)	:	WS 30.05 m

COMPARISON OF STRUCTURAL PLAN

Item	Plan-1	Plan-2	Plan-3
Gross irrigation area	2,417 ha	4,700 ha	4,700 ha
Net irrigation area	2,175	4,200	4,200
Upland	273	530	806
Oil palm land (Gross)	-	-	2,500
Oil palm land (Net)	-	-	2,200
Existing transmigrants	1,090 KK	1,090 KK	1,090 KK
New settlers	-	1,010	2,110
Local people	360	700	700
Distributed land			
Homeyard	0.25 ha	0.25 ha	0.25/0.25 ha
Paddy field	1.50	1.50	1.50/-
Oil palm land	-	-	-/2.00
Upland	0.25	0.25	0.25/0.25
Water source	Selagan river	Selagan river	Selagan river
Intake facility	Weir	Weir	Weir
Catchment area	375 km^2	375 km^2	375 km^2
Location of weir	Approx. 2.3 km upstream from Kp. Lubuk Sahung		
Elevation of river bed	EL.22.20m	EL.22.20m	EL.22.20m
Height of weir	4.40m	3.80m	3.80m
Elevation of crest	EL.26.60m	EL.26.00m	EL.26.00m
Width of crest	74.00m	74.00m	74.00m
Max. water requirement			
For wet season paddy	1.36 l/s/ha	1.36 /s/ha	1.36 l/s/ha
For dry season paddy	1.53	1.53	1.53
Planning intake discharge	3.33 m^3/s	6.43 m^3/s	6.45 m^3/s
Intake water level	WS26.50 m	WS25.90 m	WS25.90 m
Flood discharge (1/100)	1,000 m^3/s	1,000 m^3/s	1,000 m^3/s
Flood discharge (1/1,000)	1,300	1,300	1,300
Main canal, right side	15.1 km	15.1 km	15.1 km
" left side	14.0	14.0	14.0
Secondary canal, right	13.8	18.1	18.1
" left	5.7	21.6	21.6
Tertiary system, right	1,200 ha	1,800 ha	1,800 ha
" left	975	2,400	2,400
Drainage canal, right	33.4 km	40.1 km	66.9 km
" left	17.9	32.7	32.7

COMPARISON OF APPROXIMATE COST ESTIMATE

Unit : Million Rp.

Item	Plan-1	Plan-2	Plan-3
1. Preparatory Works	1,216	1,659	1,689
2. Main Civil Works	24,314	33,172	33,789
2.1 Weir	4,154	3,973	3,973
2.2 Main Irrig. Canal	11,833	13,436	13,436
2.3 Sec. Irrig. Canal	5,490	10,888	10,888
2.4 Drainage Canal	1,206	1,725	2,342
2.5 Tertiary System	1,631	3,150	3,150
3. O&M Facilities	882	931	980
4. Land Acquisition Cost	125	181	237
5. Administrative Cost	361	697	880
6. Engineering Services	4,342	4,583	4,824
6.1 Detailed Design	1,737	1,834	1,930
6.2 Construction Supervision	2,605	2,749	2,894
Sub-Total	31,240	41,223	42,399
7. Contingencies	1,562	2,061	2,120
Total	32,802	43,284	44,519

Farm Size (paddy + plantation)	2,175 ha	4,200 ha	6,400 ha
Index of Construction Cost	0.74	0.97	1.00
Construction Cost per ha by Farm Size (Mill. Rp./ha)	15.1	10.3	7.0
Economic IRR	6.8%	9.2%	12.7%

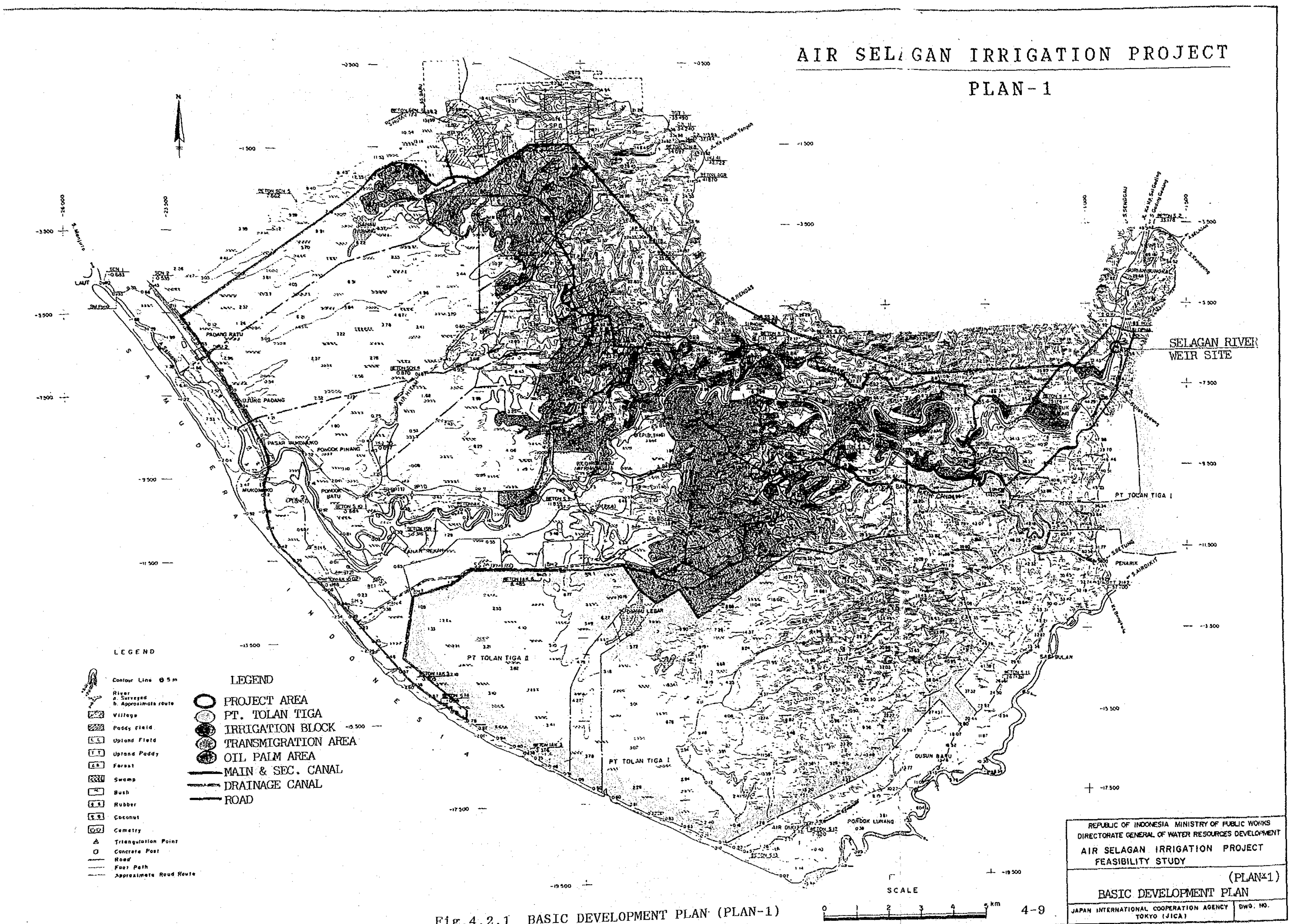


Fig.4.2.1 BASIC DEVELOPMENT PLAN (PLAN-1)

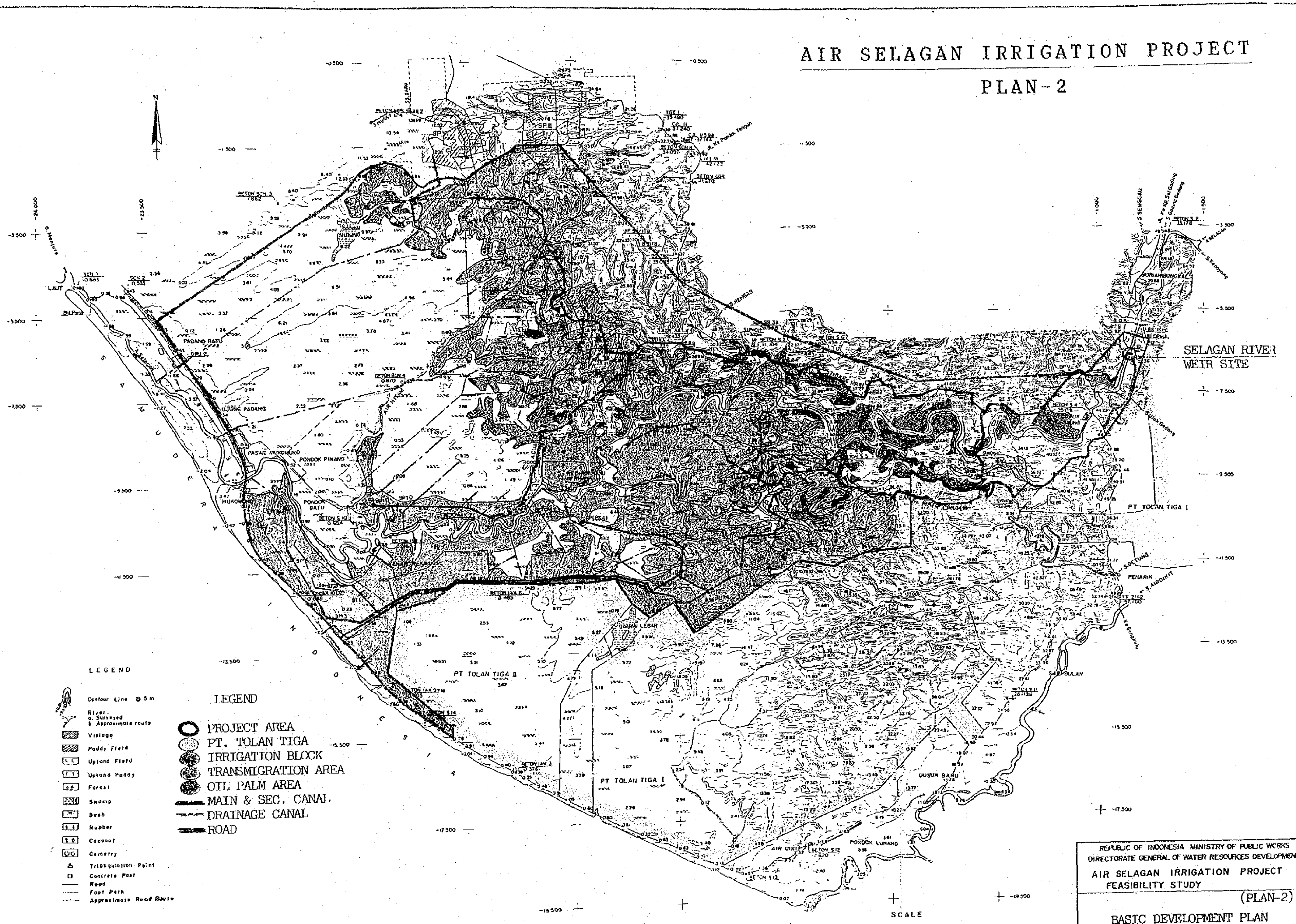


Fig.4.2.2 BASIC DEVELOPMENT PLAN (PLAN-2)

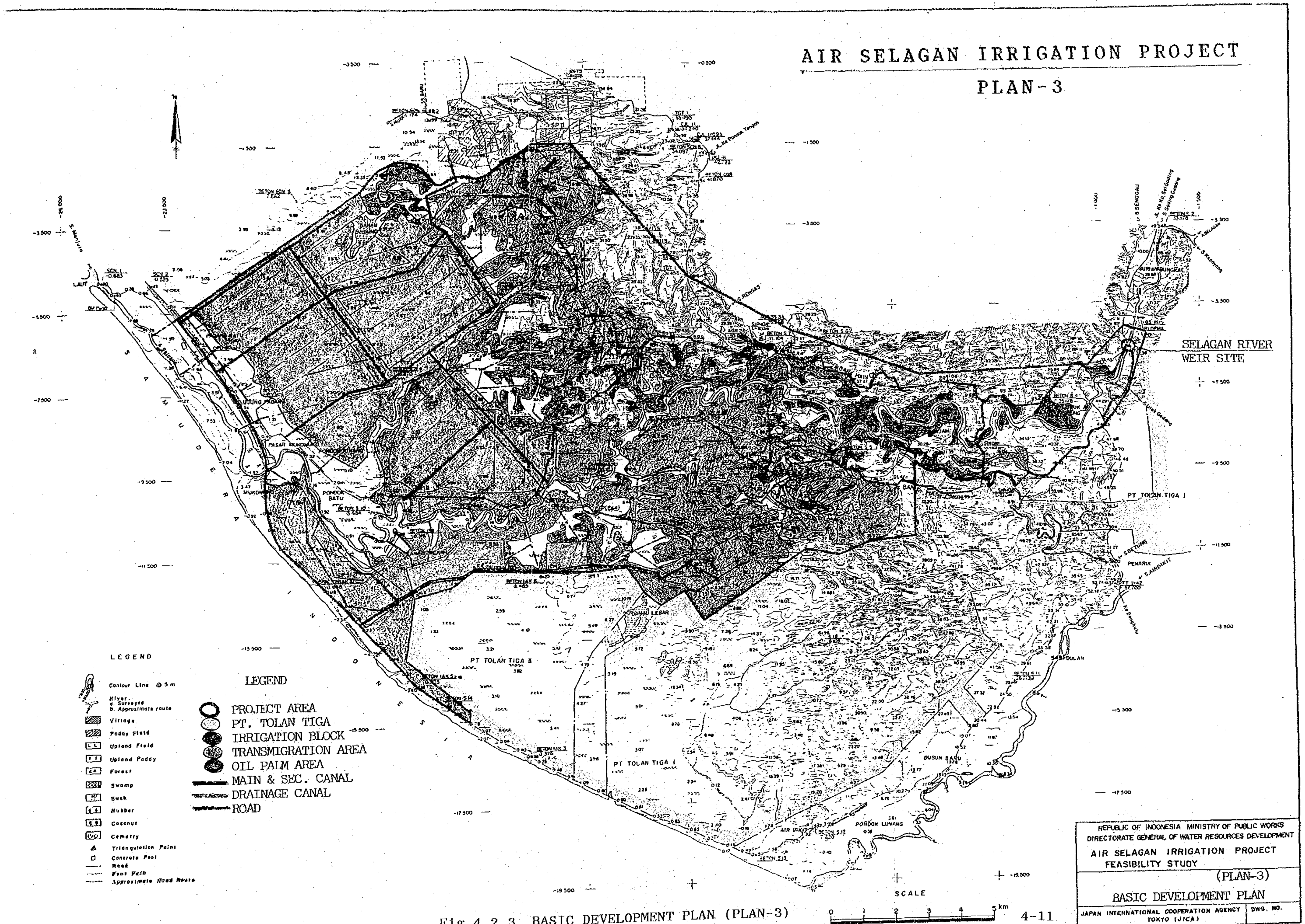


Fig.4.2.3 BASIC DEVELOPMENT PLAN (PLAN-3)

4.2.3 Study of Alternative Plannings

The main point of the development planning of this project is to irrigate the area through out year, introducing double cropping pattern, by the construction of weir in Air Selagan River.

Compared with the development area, the quantity of water is quite abundant, but as the construction cost would be comparatively expensive in view of the topographical conditions and the existing features of the benefited area. Thus, the following alternative studies have been carried out.

Case - 1 : In the case of an intake without diversion dam in Selagan River.

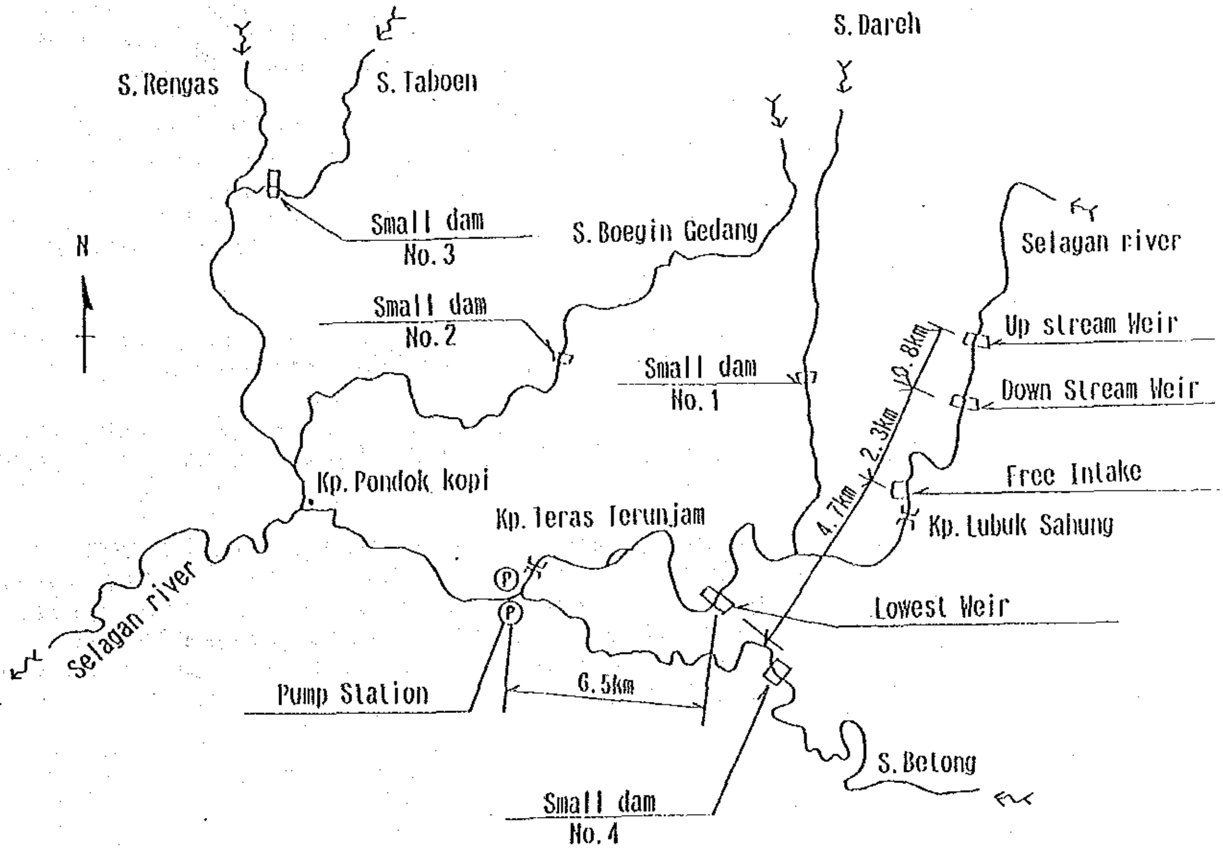
Case - 2 : In the case of construction of weir in the most down-stream of Selagan River.

Case - 3 : In the case of construction of pump station in Selagan River.

Case - 4 : In the case of getting water resources from small dams in the branches of Selagan River.

Each location of the plannings is shown in the following location map.

Location Map of the Intakes for the alternative plannings



(1) The planning of an intake without diversion dam in Selagan River (Case-1)

In the case of the intake without diversion dam, it is practically not possible to take the whole discharge of the river. As the intake capacity of the River is quite small during dry season, the irrigable scale would be much smaller compared with the case of constructing the weir.

With the above consideration, this planning is carried with the condition of constructing a small fixed concrete weir (about 1.0m in height) which is popular in the projects near-by. The location of the intake is selected with the conditions that the flow-line is smooth, the water route is stable, geological condition is good, river-bed is steady, it is easier to connect with the canal, the design discharge is stable for the intake and so on.

There is no such location to fulfill all the conditions. However, the proposed location is selected just the up-stream of Kp. Lubuk Sahung in view of stability of intake. The specific condition of the location is as follows.

a. It is the ending point of the meandering and the water is taken in the right bank where the water route goes straight.

b. There is the shallow bed-rock just in the downstream of the location.

c. The river width is wide (100 m in the width) and the shoal is developed in the center of the River.

d. The elevation of river-bed is EL.16.20m and the elevation of the benefited area is limited in low area.

e. There are houses just in the down-stream of Lubuk Sahung village, the sand blow-off canal is required to pass through the village.

f. The maintenance is not easy, because the back sand is easier to go into the intake from the water route.

g. It is necessary to have a fixed weir of about 1.0m in height through the study of Q-H curve of the cross-section of the existing river.

h. Possible quantity of water intake is about 20% of the river discharge. It is decided by the ratio between the width of intake and the same of the river as natural intake, even if the intake is effective, and irrigable area becomes smaller, and the cultivation ratio also lower in dry season.

As mentioned above, as it is difficult to ensure the design intake water, and to control the inflow of sand in this case, it is decided to be omitted from this planning. But, the approximate dimension in this case is shown as follows:

Approximate Dimension in Case of the Intake without Diversion Dam

Item	Dimension
Location	Kp. Lubuk Sahung
Distance from the river mouth	46.4 Km
Width of existing river	100.0 m
Elevation of existing river-bed	EL.26.20 m
Slope of existing river-bed	1/540
Catchment area	396 Km^2
Design-flood discharge (one hundred year flood discharge probability)	1,056 m^3/sec
Raising height of water surface	1.00 m
Elevation of design intake bed	EL.17.20 m
Designed intake water level	WS 17.40 m
River discharge	
Rainy season (Jan. - May)	22.8 m^3/sec
Dry season (Jul. - Nov.)	9.7 m^3/sec
Probable quantity of water intake	20%
Designed water intake	
Rainy season	4.6 m^3/sec
Dry season	1.9 m^3/sec
Unit duty of water	
Rainy season	1.36 l/sec/ha
Dry season	1.53 l/sec ha
Probable irrigation area	
Rainy season	3,300 ha
Dry season	1,200 ha
Cultivation ratio	136%

(2) The planning of construction of weir in the most down-stream of Selagan River (Case-2)

In this case, the location of weir is selected in the nearest point from the benefited area (6.5 Km up-stream from Kp. Teras Terinjam).

The specific character of the location can be estimated as follows:

a. The river-bed can be 8.5m lower in elevation.

b. The elevation of water intake can be WS 16.40m as the maximum back water of weir can be 8.0m by the double closing system.

c. As the elevation of water intake is low, the benefited area can be as small as Case-1 compared with the other alternatives.

d. Cultivation ratio can be 200%.

e. The structural scale is bigger with 8.0 m of raising water height and 100m in the width. Thus, though construction cost of the weir is expensive, total construction cost is rather cheaper as the irrigated area is smaller. But the unit cost per benefited area is higher and the investment ratio is low.

f. The main benefited area is not possible to be irrigated. (Over the elevation of 19.0m in SP-IV).

As the unit cost ratio is higher than the other alternatives, this planning is cancelled.
(Unit construction : 1.07)

The approximate dimension in this case is shown as follows:

Approximate Dimension in case of construction of weir in the most down-stream of Selagan River

Item	Dimension
Location	6.5 Km up-stream from Kp. Teras Terungjam
Width of existing river-bed	100.0 m
Elevation of existing river-bed	GH 8.50 m
Slope of existing river	1/500
Catchment area	418 Km^2
Design-flood discharge	1,115 m^3/sec
Raising height of water surface	8.00 m
Designed intake water level	WS 16.40 m
Elevation of the benefited area (SP-IV)	GH 11.20 m
Actual irrigable area	About 3,300 ha
Main canal	24.5 Km
Secondary canal	31.2 Km
Cultivation ratio	200%

(3) The planning of construction of pump station (Case-3)

It is examined to apply to construction of pump station in the down-stream without depending on the gravity irrigation.

1) Selection of the location for the pump station

The location is selected with the consideration of the following matters :

- The location where the main canal is the shortest in economic view.

- The location where the pump station can be set in higher place to avoid the influence of the flood.

- The location to avoid the tidal influence.

- The location where is nearer from the existing road.

- The location where it is smoother for the connection with the main canal by pipe line.

Due consideration of the above matters, it is planned to set two (2) pump stations on the both banks in 800m down-stream from Kp. Teras Terunjam.

ii) Outline of the pump stations

		Left bank	Right bank
a)	Designed duty of water	$3.46m^3/sec$ ($208m^3/min$)	$2.57m^3/sec$ ($154m^3/min$)
b)	Kind of the pump	High head mixed flow pump with vertical shaft	The same
c)	Total pump head	20.4m	18.5m
d)	Diameter & number of pumps	ø800mm x 3nos.	ø700mm x 3nos.
e)	Horse power of engine	503 Ps x 3Nos.	354 Ps x 3Nos.
f)	Form of station house	Double stories	The same
g)	Method of construction	Coupure method	The same

iii) Economic comparison

Compared with the construction of weir (Case-2), the converted annual expenditure is about double and this plan is cancelled to be applied.

(4) Examination of the planning of small dams (Case-4)

It is examined for the planning to ensure the water recourses from a group of small dams near the benefited area for economizing the construction cost of the water resource facilities and the canals. In this case, there is no intake water from the main river of Selagan River.

It is possible to select the locations in Rengas River for the right-side benefited area, and in Betong River for the left-side benefited area.

i) Plan of a group of small dams

Elevational control points for the location are WL 14.0m in water level at BB.4, SP-VI in the transmigrated area for the right-bank benefited area, and GH 19.0m in the ground height at SP-IV for the left bank benefited area.

Each independent river system is required for the construction of small dams since the benefited areas are distributed in the both banks of the Selagan River.

Actual paddy cultivation areas are 1,800 ha in the right bank and 2,400 ha in the left bank of the Selagan River. Hence, it is necessary to construct three (3) small dams in the right bank and one (1) small dam in the left bank as those water resources.

The dimension of each dam is as follows:

Approximate Dimension of the Small Dams

No.	Location	Name of River	Catchment area	El. of crest of dam	Length of crest	Height of dam	Embankment volume
			km^2	EL m	m	m	m^3
1	Right-side	S. Dereh	11	28.0	100	6	20,000
2	Right-side	S. Boegingedang	19	25.0	100	6	20,000
3	Right-side	S. Taboen	35	23.0	200	8	50,000
4	Left-side	S. Betoeng	66	25.0	300	15	120,000

ii) Conclusion

Specific character of this plan is as follows:

- It is unavoidable to reduce the benefited area due to the scarcity of the quantity of river discharge in the both banks and cultivation ratio is estimated as 143%.

- There occurs 37 percent of the scarcity of water in the left bank, and it has to be constructed a dam or reservoir inside of Concession area.

- Diversion works for the dams and canals will be in many numbers and it is complicated for the operation and maintenance.

- It is not clear to say that the construction cost of this plan is cheaper than the plan of construction of weir (Case-2).

4.2.4 Relation with Muko-Muko Left-bank Irrigation Development Project.

The border between the area of Air Selagan Irrigation Project and the area of Muko-Muko Left-bank Irrigation Development Project is the same between BB.3 and BB.4. So, the secondary canal of the right bank of Selagan River is connected with BB.4 for the supplementary irrigation from the Air Selagan Irrigation Project and its irrigated area will be about 600 ha.

4.3 Agricultural Development Plan

4.3.1 Proposed Land Use

Of the original 22,400 hectares designated as the survey area, 7,600 hectares have been allocated for development of estate crops by P.T. Tolantiga which is the private estate company. Out of the remaining 14,800 ha, only 4,700 ha are considered to have potential for irrigated rice production. Peat land covers a further 4,440 ha with the depth of peat ranging from one meter to well over three meters.

Based on the suitability of the land for development on various crops, three development plans have been considered. These are :

Plan 1 : The areas most suitable for wetland rice cultivation, including areas already allocated to transmigrants, will be developed for the irrigated rice.

Plan 2 : All potentially irrigable land will be developed excluding the areas of deep peat.

Plan 3 : As for b) above, but with drainage of areas of peat land not suitable for rice cultivation which instead will be planted to oil palm.

Considering the three development plan mentioned above,the developed area are given below.

Development Areas (ha)

Land Use	Plan 1	Plan 2	Plan 3
Gross Paddy Field	2,420	4,700	4,700
(Net Paddy Field)	(2,180)	(4,200)	(4,200)
Upland Crop Field	270	530	800
Oil Palm	-	-	2,500
House lot	270	530	810
Public Land	270	540	830
Total	3,230	6,300	9,640

Taking maximum development of agricultural potential area into consideration, the agricultural development plan of 9,640 ha for plan 3 is primarily conceived in this project, including the irrigated rice field of 4,700 ha. The proposed future land use is elaborated in Table 4.3.1 and summarized as follows :

Proposed Land Use (Unit : ha)

Land use	Rice	Upland crop	Oil palm	House lot	Public land	Total
Right bank	2,000	500	2,500	510	530	6,040
Left bank	2,700	300	0	300	300	3,600
Total	4,700	800	2,500	810	830	9,640

Furthermore, on the basis of the result from the development alternative study (APPENDIX V), distribution of the farm land to the farmers in the project area is shown as follows :

(Unit : ha)

	Rice farmers	Oil palm farmers
LU I	1.00	2.00
LU II	0.75	-
Home yard	0.25	0.50
Total	2.00	2.50

4.3.2 Proposed Crops

In order to attain the objectives of the project, paddy as a staple crop is proposed to cultivate in the suitable land of the project area. Because, production of the staple food should be self-sufficient in the area, in order to improve the levels of the living standard and farmers' income. Following that, the cultivation of the cash crop should be introduced to grade them up. While, in the area which is impossible to execute the irrigation farming, the cultivation of oil palm is proposed under the drainage system.

4.3.3 Proposed Cropping Pattern

Following the completion of the Air Selagan Irrigation Development Project, most of the existing rainfed rice fields will be up-graded to the technical irrigation rice fields and more intensive use of the farmland will become possible. The adequate supply of irrigation water will lead to certain changes of crops and cropping patterns within the project area. It is difficult, however, to forecast how the farmers will change their cultivation pattern of crops. The crops and cropping patterns under the project, have been selected, considering the following basic principles:

a) Maximum cropping intensity should be adopted in the project area, based on the present situation of the project area and other project which is closed to the project.

b) Considering maximum benefits for the farmers, proposed crop under irrigation is rice, while palawija will be adopted for rainfed, provisionally.

c) The cropping pattern must make optimum utilization of water to be supplied by the project.

d) The crops and cropping pattern should be practical with the limited number of family labour, and

e) The crops and cropping pattern must conform with the existing social custom which is acceptable to the farmers.

Taking the information from the field, the cropping season of the palawija was decided as shown in Fig. 4.3.1.

4.3.4 Proposed Farming Practices

The seed requirement will be 30 kg per ha. The paddy seeds to be used in the area should have to be the certificated extension seeds and be selected by using a solution of 1.13 specific gravity before pre-germination. The selected seeds will also have to be disinfected by using an adequate seed disinfectant like Benrate. Pre-germination practice is recommendable for increasing the germination percentage.

Plowing is carried out by animal power, before 7 days of transplanting. After plowing, harrowing and puddling are required for land leveling. These works are recommended to be carried out by using animal power.

The total fertilizer requirement for sustaining the target yields would be 250 kg/ha of urea, 100 kg/ha of TSP and 75 kg/ha of KCl.

As regards plant protection, ecological control will be proposed in the area. But application of some insecticides, e.g. Indobast or Mipcin, is required for the control of brown plant hoppers, black bug, narrow rice bug, rat, etc.

Rats are already of significant importance in the project area and cause damage to present paddy production in the field and after harvest. The use of the standard allocation of 2 kg of zinc phosphide per ha is proposed.

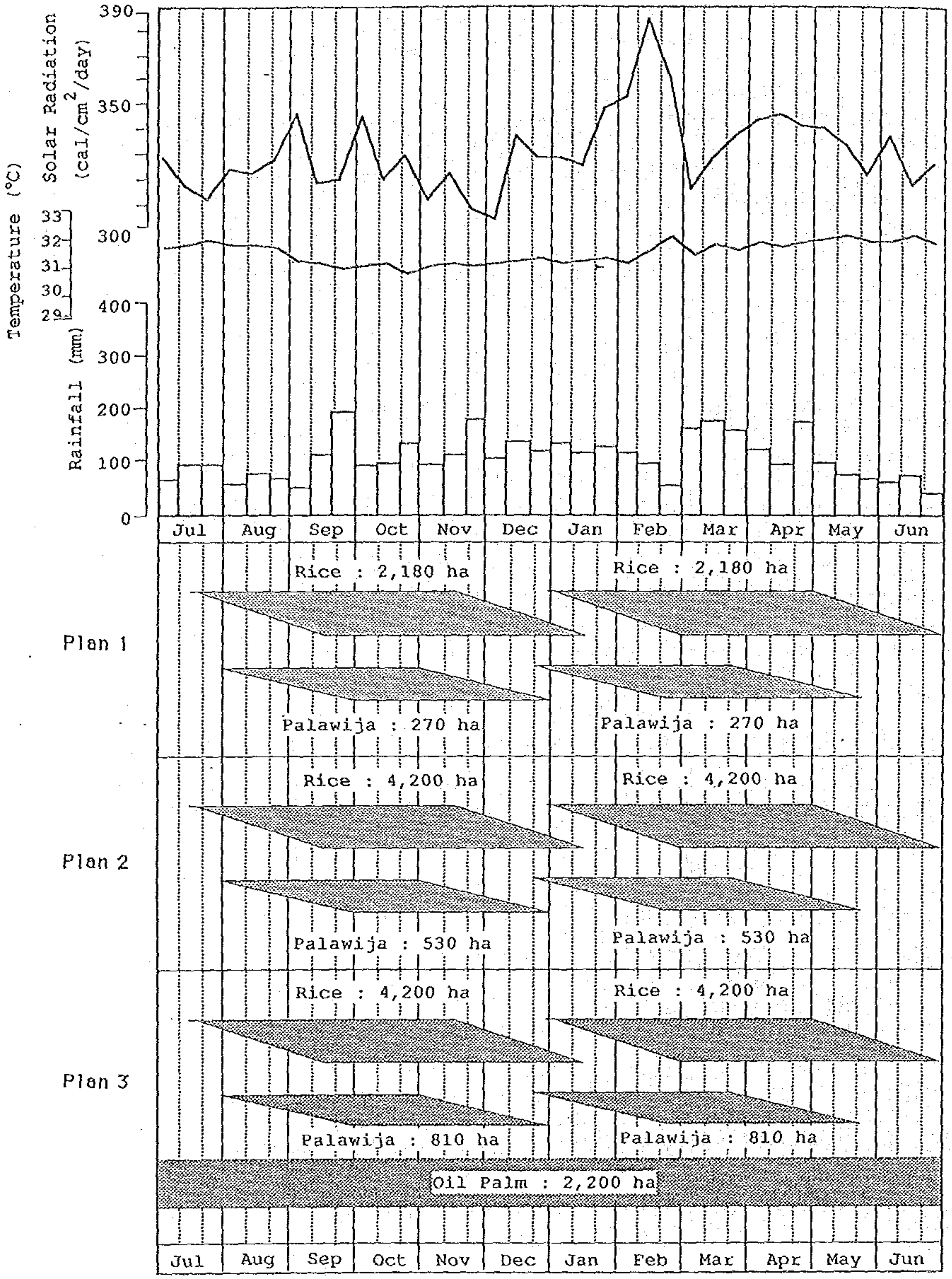
Harvesting and threshing are carried out by manual labor. The harvested paddy will be dried on the paddy field or home yard.

Table 4.3.1 Proposed Land Use

(Unit : ha)

Land Use	Without Project Condition	With Project Condition: Rice	Upland Crop	Oil Palm	House Lot	Public Land	Total
Right Bank : Irrigated rice							
1 Upland Rice	40		40				40
2 Lowland Rice	140	140					140
3 Garden	150		150				150
4 Natural Forest	1,650	1,650					1,650
5 Cleared Forest	100		40		60		100
6 Scrub	340	210			130		340
7 Rubber	280				40	240	280
Sub-total	2,700	2,000	230	0	230	240	2,700
		(1,800)					
Right Bank : Oil Palm Plantation							
1 Natural Forest	3,340		270	2,500	280	290	3,340
Left Bank : Irrigated rice							
1 Upland Rice	380				290	90	380
2 Lowland Rice	0						0
3 Garden	310		300		10		310
4 Natural Forest	2,270	2,270					2,270
5 Cleared Forest	0						0
6 Scrub	460	430				30	460
7 Rubber	180					180	180
Sub-total	3,600	2,700	300	0	300	300	3,600
		(2,400)					
Whole Area							
1 Upland Rice	420	0	40	0	290	90	420
2 Lowland Rice	140	140	0	0	0	0	140
3 Garden	460	0	450	0	10	0	460
4 Natural Forest	7,260	3,920	270	2,500	280	290	7,260
5 Cleared Forest	100	0	40	0	60	0	100
6 Scrub	800	640	0	0	130	30	800
7 Rubber	460	0	0	0	40	420	460
Total	9,640	4,700	800	2,500	810	830	9,640
		(4,200)					

Remark) The figure in the parenthesis means net area cultivated.



Remark) All the figure means net cultivated area.

Fig. 4.3.1 Proposed Cropping Pattern

4.3.5 Anticipated Crop Yields and Production

Certificated seed for promising varieties has been replaced for every four years in order to protect pest and disease. The anticipated yields of paddy and palawija are summarized as follows. Under the without-project condition, no drastic change of land use, crop production, etc. can be expected. The yield under the future without-project condition are estimated to be equal to them under the present condition.

Unit Yield of Major Crops

(Unit : ton/ha)

Crop	without project	with project
Paddy under irrigation system		
1st cropping	-	5.0
2nd cropping	-	5.0
paddy in the rainfed		
Lowland paddy	1.5	-
Upland paddy	1.0	-
Maize	1.5	3.0
Groundnuts	0.8	1.2
Soybeans	0.5	1.0
Cassava	7.0	-

The annual crop production in the project area of 9,640 ha under the with-project condition is estimated as follows :

Annual Crop Production

Crop	Harvested area (ha)	Unit yield (ton/ha)	Production (ton)
Dry paddy			
Wet season	4,200	5.0	21,000
Dry season	4,200	5.0	21,000
Maize	1,080	3.0	3,240
Groundnuts	1,080	1.2	1,296
Soybeans	1,060	1.0	1,060

4.3.6 Processing and Storage

The need for increased milling capacity will depend very much upon which development option is adopted, and the cropping intensities achieved on irrigated paddy field. Assuming that the maximum area of 4,200 ha is developed for irrigated rice, and that double cropping is adopted over the entire area the maximum estimated production would be 42,000 tons. The build up in yields and intensities will occur over five years, so it is assumed that installed milling facilities would gradually increase to keep pace with increased production. There will also be a considerable increase in rice produced on the Air Manjuto irrigation scheme, but again this will build up over a number of years, and it is not envisaged that a shortfall in installed milling capacity will be a constraint on increased rice production.

4.3.7 Marketing of Agricultural Products

If the maximum rice production is expected in 4,200 ha of irrigated rice double cropped, the production of dry paddy in 2000 and 2005 would increase respectively to about 38,860 and 42,000 tons per annum. Considering the amount for seeds/waste and milling rate, this would produce the equivalent of about 22,700 and 24,600 tons of milled rice, respectively. With an annual consumption figure of 160 kg per capita in the project area, local consumption in 2000 would be 4,500 tons leaving about 18,200 tons to be marketed outside the project area (see Table IV-39). Furthermore, in 2005, 6,700 tons for total demand in the project area and 17,900 tons for surplus to be marketed outside the project area.

4.3.8 Transmigration Program

(1) Number of Transmigrants

The number of new transmigrants and settlers who have the irrigated paddy field of 1.5 ha of paddy field, each 0.25 ha of homeyard and upland field and 0.25 ha of public facilities are estimated at 1,350 families, while the settled farmer for oil palm is 1,100 families who have 2.0 ha of oil palm, 0.25 ha of upland field and 0.25 ha of home yard. Furthermore, 700 families out of existing farmers will be settled in the project area as local transmigrants, for which the paddy field only will be prepared.

The settlement of new transmigrants could be implemented during seven years along with the progress of land clearing for proposed irrigated paddy field. The annual number of families to be settled in the area is estimated as follows:

Year	for paddy (families)	for oil palm (families)	Total (families)
1991/92	340		340
1992/93	300		300
1993/94	300		300
1994/95	200		200
1995/96	210		210
1996/97		550	550
1997/98		550	550
Total	1,350	1,100	2,450

(2) Community Development

In the new transmigration area, the houses and shallow wells adequate to the transmigrants are constructed before the settlement. The number of these facilities are 2,450 houses and 613 wells in total. In addition, the public facilities such as school, clinic and market will also be constructed by the Government authorities concerned.

(3) Government Support

The Government has given considerable subsidies to transmigrants, which consist of foods, clothes, farm tools and equipment, during the initial period of 12 months after settlement and farm inputs during the initial three years after settlement. After implementation of the Project, the new transmigrants and resettlers to be settled in the project area could receive fully these subsidies from the Government.

4.3.9 Crop and Farm Budgets

(1) Crop Budgets

Crop budgets for the 'with project' situation have been prepared and are summarized as follows :

(Unit : 1,000 Rp./ha)

Crop	Gross production value	Production cost	Net production value
Paddy	1,250	209	1,041
Maize	450	143	307
Groundnuts	600	173	427
Soybeans	600	157	443

It can be seen that irrigated paddy on the suitable soils gives by far the greatest net return per hectare and per man day, when full production is achieved. Consequently it is anticipated that farmers will concentrate on the production of irrigated rice.

(2) Farm Budgets

Farm incomes for both rice and oil palm farmers in the 'with project' situation will be far higher than the without-project incomes. The result is summarized as follows :

Farm Budget

Item		Rice farmer	Oil palm farmer
Farm size (ha)			
	Paddy field	1.50	
	Oil palm field		2.00
	Upland crop field	0.25	0.25
	Home yard	0.25	0.25
	Total	2.00	2.50
I.	Gross Income (1,000 Rp.)		
	1) Farm income	3,750	3,700
	2) Off-farm income	0	0
	Total	3,750	3,700
II .	Gross Outgo (1,000 Rp.)		
	1) Production cost	786	558
	2) Living expenses	739	739
	Total	1,525	1,297
III.	Net reserve (1,000 Rp.)	2,775	2,403
IV.	Disposal income (1,000 Rp.)	3,514	3,212

4.3.10 Agricultural Support Services

The following items are primarily recommended in order to improve and promote the current agricultural support services for the project.

(1) Agricultural extension services

a) Introducing improved cultivation and management techniques to farmers such as use of High Yielding varieties (HYV), practice of new cropping patterns and calendars with project, and operation of field water management for the proper supply of irrigation water management and draining off excessive water.
b) Improvement of the prevailing training and visit system of extension work held by PPL to be more effective in activity.

(2) Agricultural Credit

a) BRI sub-branch office should be established in the project area in order to cooperate more with the agricultural services and cooperative offices and work out a loaning plan based on the total acreage of paddy field to be cultivated by the irrigation project.

b) The procedure for credit application should be simplified as much as possible both for individuals and groups of farmers, so that realization of BIMAS/INMAS credit will meet the needs of farmers in time. Provision of simplified application from with an easy procedure and readiness of farmers' background data are necessary in making rapid procedure for credit application.

(3) Agricultural Cooperative

a) With realization of the irrigation project, it is certain that crop production will be greatly increased and the requirements of input supply also. In order to meet the new situation, improvement of and additions to KUD facilities will be indispensable. This means that each KUD should have an adequate rice mill, storage facilities and sun-drying floor.

4.3.11 Pilot Farm

In order to complete the project smoothly and improve the self-support and self-sufficience of settled farmers, it would be necessary to establish the pilot farm for the landmark of the agricultural development in the project area.

The functions of the pilot farm are summarized as follows :

a) Demonstration of proper rice cultivation with double cropping.

b) Experimental research on quality improvement and reduction of production costs for paddy and palawija crops.

c) Seed multiplication of certified seeds for the farmers in and around the project area.

d) Execution of the short courses for the farmers in the guidance of advanced farming practices.

It is recommended that the pilot farm be organized under the Government authority concerned. The area required for the experimental farm is estimated at around 5 ha.

4.4 IRRIGATION AND DRAINAGE PLAN

4.4.1 Water Source

Irrigation water is required for the study area all the year round and is supplied from the weir on the Air Selagan whose location was decided during the study.

According to low water discharge analysis, mean annual discharge is 39.6 m^3/sec, and minimum monthly discharge with 5 year probability of non-exceedance. Annual discharge of the Air Selagan is $875x10^6$ with 5 year probability of non-exceedance. Irrigation water to be supplied is $41.9x10^6m^3$ during rainy season, being $49.1x10^6m^3$ during dry season respectively. Namely 10.5% of annual discharge is utilized for irrigation.

4.4.2 Run-off Analysis

(1) Low water discharge analysis

The run-off analysis was carried out by the tank model method using the data on discharge observed at Teras Terunjam (1981 - 1987) and the rainfall data at Pondok Kopi (at Lalan Luas in the case of no data). The ten days mean discharges and the monthly mean discharge at the proposed weir site are as follows:

Unit : m^3/s

Month	First	Second	Third	Mean
Jan.	66.24	43.99	44.35	51.53
Feb.	50.70	32.22	36.78	39.90
Mar.	50.70	56.49	52.11	53.10
Apr.	40.76	34.10	53.95	42.94
May	33.72	28.47	24.89	29.03
Jun.	23.21	25.83	17.15	22.06
Jul.	21.86	21.67	25.64	23.06
Aug.	31.34	17.33	24.15	24.27
Sep.	38.14	36.48	50.71	41.78
Oct.	41.50	46.04	46.59	44.71
Nov.	54.42	40.76	60.65	51.94
Dec.	43.15	52.87	55.78	50.60

Mean : 39.60

Further, the ten days mean discharges and monthly mean discharges in the 1/5 years probability were estimated as follows:

Unit : m^3/s

Month	First	Second	Third	Mean
Jan.	51.67	34.31	34.59	40.19
Feb.	35.31	22.44	25.62	27.79
Mar.	39.68	44.21	40.79	41.56
Apr.	28.06	23.48	37.14	29.56
May	25.53	21.56	18.85	21.98
Jun.	15.50	17.24	11.45	14.73
Jul.	16.61	16.47	19.48	17.52
Aug.	16.66	9.21	12.83	12.90
Sep.	27.69	26.48	36.82	30.33
Oct.	27.23	30.21	30.57	29.34
Nov.	32.37	24.25	36.08	30.90
Dec.	30.81	37.75	39.83	36.13

(2) Flood run-off analysis

Three methods, that is, Melchior's method, rational formula and Haspers method were used for the comparative study on the flood run-off discharge at the proposed weir site. The result is as follows:

Return Period	Melchior'	Rational	Haspers'
year	m^3/sec	m^3/sec	m^3/sec
1,000	1,300	1,319	763
100	856	1,000	603
50	848	913	559
25	749	806	506
10	656	731	466
5	589	656	425
2	496	556	370

From the above table, the result by the rational formula was adopted for the design of the weir.

4.4.3 Irrigation Water Requirement

To estimate irrigation water requirement, the consumptive water use of crop is calculated by the modified Penman method and the crop coefficients due to the guideline of DGWRD using the climatological data at Pondok Kopi for the past 9 years. The effective rainfall is assumed to be 70% of the monthly rainfall in the 1/5 years probability and percolation 3.0 mm/day. The irrigation requirement at field level for land preparation and puddling is estimated by the method of Van de Goor and Zijlstra and the irrigation efficiency is taken as 55%. As a result, the maximum ten days irrigation water requirements are estimated at 1.36 l/sec/ha for wet season paddy and 1.53 l/sec/ha for dry season paddy.

4.4.4 Irrigation Plan

(1) Water resources

The irrigation water for the Project is taken from the weir on the Selagan river for both wet and dry seasons. The maximum and minimum intake discharges are as follows:

Crops	Maximum intake discharge	Minimum intake discharge
Wet season paddy	5.71 m^3/sec	1.09 m^3/sec
Dry season paddy	6.43	0.34

(2) Distribution method of irrigation water

Year round irrigation system and plot to plot irrigation will be adopted for the project area.

Plot to plot irrigation method will be taken at steep slope fields at every several plots. In case of flat area, separated canals for irrigation and drainage will be equipped in order to make a plain farming practice.

(3) Cropping period and irrigation area

The dry season paddy cultivation is proposed to start two and half months after the harvest of the wet season paddy and the period to release water from canal for operation and maintenance is also proposed one month after completion of irrigation period of the dry season paddy cultivation.

The following table shows the most applicable case on the basis of the study.

Season	Group	Commencement date of paddling	Irrigation area	Max. Diversion requirement
Wet	C1,C2	Jan. 1	2,800 ha	1.26 l/s/ha
"	C3	Feb. 11	1,400	1.56
Dry	C1,C2	Jul. 16	2,800	1.83
"	C3	A4g. 26	1,400	1.75

Taking into consideration resorting a weir without storage effect, fluctuation of average ten days discharge., the planning for total household of transmigrants, distribution area for paddy cultivation per household, etc., the most appropriate cropping areas in the both seasons are obtained as the above table.

(4) Ten days intake discharge

Ten days intake discharges for paddy cultivation of 4,200 ha in the both wet and dry seasons are shown in the following table. The intake discharges include the domestic water supply of 0.02 m^3/s (3,000 KK x 5 persons x 100 l/day).

(5) Diversion requirement during development stage

During the development stage, the irrigation efficiency will be planned as 0.50 because new reclaimed paddy fields will need more irrigation water.

Therefore the diversion discharge will increase during development stage for paddy fields. These increase of diversion discharge will be conveyed using canal free board as much as possible.