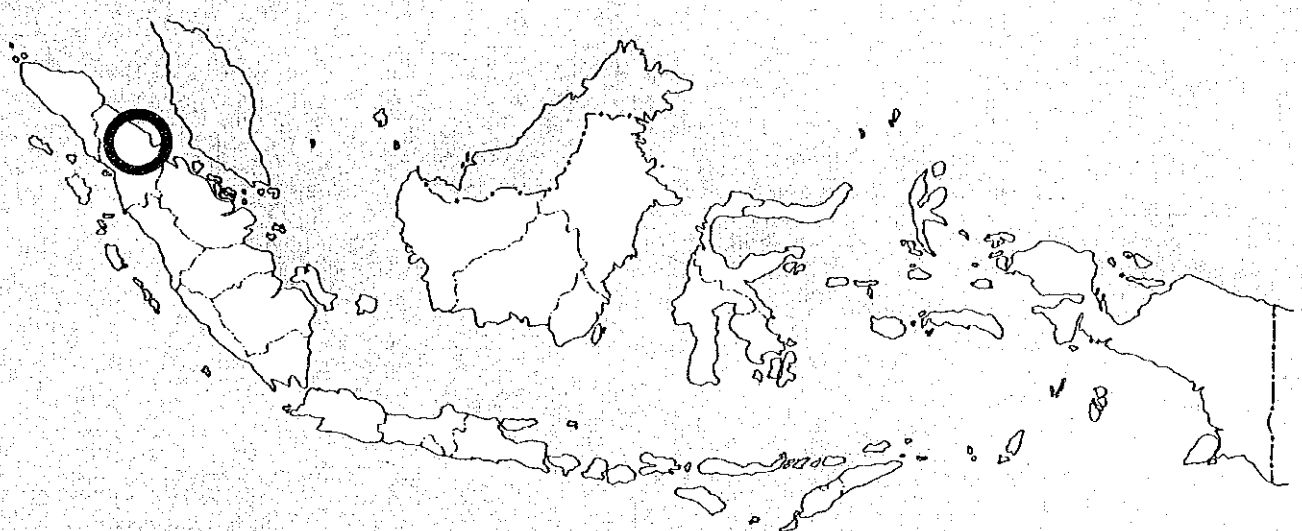
MASTER PLAN STUDY ON LOWER ASAHAN RIVER BASIN DEVELOPMENT

Volume 4

In-depth Study on the Silau-Bunut Rehabilitation Irrigation Project



July 1990

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

MASTER PLAN STUDY ON LOWER ASAHAN RIVER BASIN DEVELOPMENT

Volume 4

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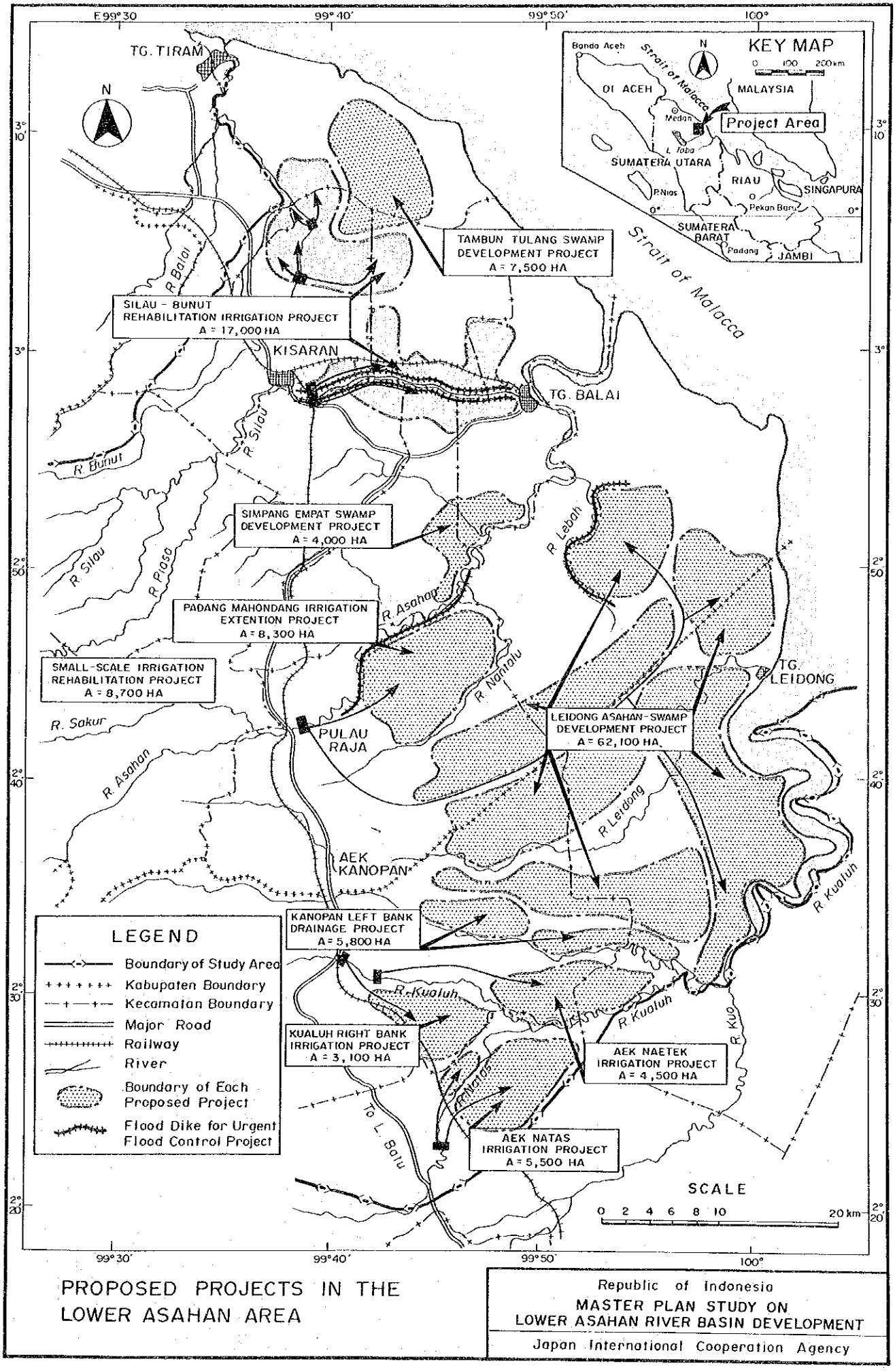
July 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

LIST OF REPORTS

Volume 1	Main Report
Volume 2	Flood Control Plan (Part-I study) (Reprinted from previous Interim Report submitted in October 1985)
Volume 3	Agricultural Development Plan (Stage 1 of Part-II study)
Volume 4	In-depth Study on the Silau-Bunut Rehabilitation Irrigation Project (Stage 2 of Part-II study)



PROPOSED PROJECTS IN THE LOWER ASAHAN AREA

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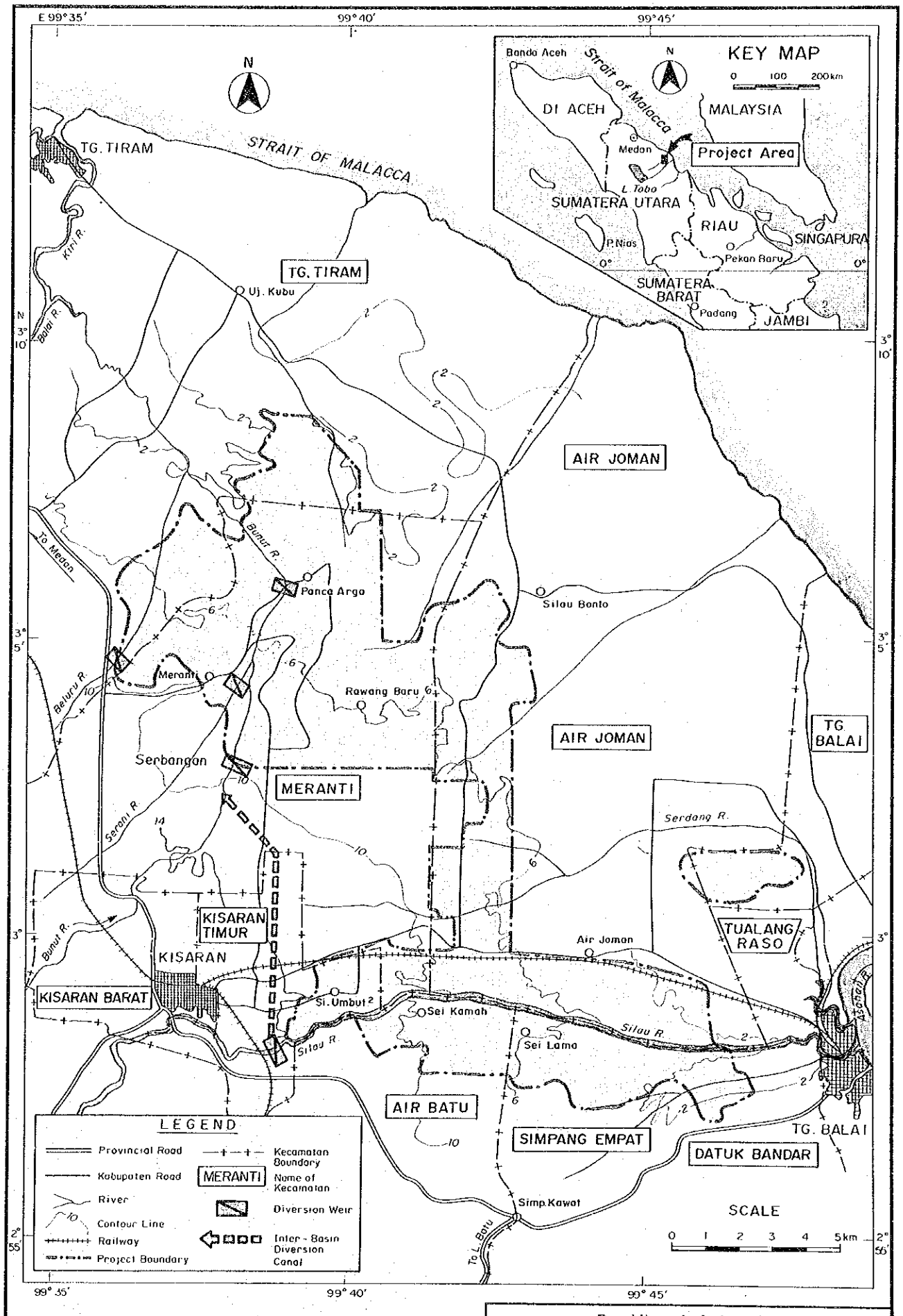
Japan International Cooperation Agency



SILAU - BUNUT REHABILITATION IRRIGATION PROJECT

Republic of Indonesia
MASTER PLAN STUDY ON
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Japan International Cooperation Agency

MASTER PLAN STUDY
ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT

(VOLUME 4)

In-depth Study on the Silau-Bunut Rehabilitation Irrigation Project

CONTENTS

APPENDICES

TABLES

FIGURES

GLOSSARY OF TERMS AND ABBREVIATIONS

BAPPEDA	-	Badan Perencanaan Pembangunan Daerah (Provincial Development Planning Board)
BAPPENAS	-	Badan Perencanaan Pembanguanan Nasional (National Development Planning Board)
BIMAS	-	Bimbingan Massal
BPP	-	Balai Penyuluhan Pertanian (Rural Extension Center)
BRI	-	Bank Rakyat Indonesia (People's Bank of Indonesia)
BRIUD	-	Bank Rakyat Indonesia Unit Desa (Village branch of BRI)
Bupati	-	District Chief, Head of Kabupaten
Cabang Dinas	-	PU Seksi, (Administrative area for irrigation with the PU-Wilayah)
Camat	-	Sub-district Chief, Head of Kecamatan
CRIFC	-	Central Research Institute for Food Crops
CS	-	Construction supervision
Desa	-	Village or group of small villages
DGFCA	-	Director General of Food Crops Agriculture, Ministry of Agriculture
DGWRD	-	Directorate General of Water Resources Development, Ministry of Public Works
DIP	-	Project Implementation Budget
DOI	-	Directorate of Irrigation
DPU	-	Departemen Pekerjaan Umum (Ministry of Public Works)
FC	-	Foreign currency
E/S	-	Engineering services
FY	-	Fiscal year (April 1 to March 31)
GDP	-	Gross Domestic Product

GOI	-	Government of Indonesia
Golongan	-	Division of an irrigation area in order to phase planting and reduce peak water demand
Gotong royong	-	Mutual self help assistance
HYV	-	High yielding variety
IBRD	-	International Bank for Reconstruction and Development (World Bank)
ICB	-	International competitive bidding
IGGI	-	Inter-governmental Group on Indonesia
INMAS	-	Intensifikasi Massal (massive intensification for self sufficiency in food)
INSUS	-	Intensifikasi Khusus (special intensification program)
ISSP	-	Irrigaiton Sub-Sector Project
JICA	-	Japan International Cooperation Agency
Julu	-	Official responsible for the day-to-day operation of an irrigation area, generally no greater than 1,000 ha
Kabupaten	-	District (sub-division of province)
Kecamatan	-	Sub-district within the Kabupaten
KUD	-	Koperasi Unit Desa (village unit co-operative)
KUPEDES	-	Kredit Umum Pedesaan (general rural credit program)
KUT	-	Kredit Usaha Tani
LC	-	Local currency
LCB	-	Local competitive bidding
LP3ES	-	Lembaga Penelitian Pendidikan dan Penuangan, Ekonomi dan Social (Institute of Research, Education & Information for Social & Economy)
LS	-	Lump sum
M & E	-	Monitoring and evaluation

MCM	-	Million cubic meter (10^6 m^3)
M/M	-	Man-months
OECF	-	The Overseas Economic Cooperation Fund, Japan
O&M	-	Operation and maintenance
PBME	-	Project benefit monitoring and evaluation
Pengamat	-	Water distribution supervisor
Polowijo	-	All annual crops other than rice, sugar or vegetables grown on wet paddy land
PMF	-	Probable maximum flood
PMP	-	Probable maximum precipitation
PPA	-	Penjaga Pintu Air (Gate operator)
PPK	-	Penyuluhan Pertanian Kecamatan (Agricultural officer in Kecamatan)
PPL	-	Penyuluh Pertanian Lapangan (Field extension worker)
PPM	-	Penyuluh Pertanian Madya (agricultural extension supervisor)
PPS	-	Penyuluh Pertanian Spesialis (Subject matter specialist)
P2AT	-	Proyek Pengembangan Air Tanah (Groundwater Development Project)
P3A	-	Perkumpulan Petani Pemakai Air (Water User's Association)
P3A Union	-	Water User's Association Union
P3SA	-	Proyek Pengembangan dan Penyelidikan Sumber-sumber Air (Water Resources Development and Planning Project)
Rp.	-	Indonesian Rupiah
PTT	-	Soil Research Center, Bogor
PU	-	Pekerjaan Umum (Ministry of Public Works)
PUD	-	Pekerjaan Umum Daerah/PU Kabupaten (Public Works Service of District)

Sawah	-	Wet rice field
SCF	-	Standard conversion factor
S/W	-	Scope of Work
TA	-	Technical Assistance
TOR	-	Terms of reference
Ulu-ulu	-	An employee of the P3A responsible for O & M of the tertiary unit (Water master)
UNDP	-	United Nations Development Program
Waker	-	Assistant to the Juru stationed at the main river offtake
WKPP	-	Wilayah Kerja Penyuluh Pertanian (working area of field extension worker)
WUA	-	Water User Association
WUAO	-	Water User Association Organizer

CONVERSION FACTORS

	Metric to Imperial		Imperial to Metric	
Length	1 cm	= 0.349 inch	1 inch	= 2.54 cm
	1 m	= 3.28 feet	1 foot	= 30.48 cm
	1 km	= 0.621 mile	1 mile	= 1.609 km
Area	1 m^2	= 10.76 sq.ft	1 sq.ft	= 0.0929 m^2
	1 ha	= 2.471 acres	1 acre	= 0.4047 ha
	1 km^2	= 0.386 sq.mile	1 sq.mile	= 2.59 km^2
Volume	1 lit	= 0.22 gal (imp)	1 gal (imp)	= 4.55 lit
	1 m^3	= 35.3 cu.ft	1 cu.ft	= 28.32 lit
	1 MCM	= 1 x 10^6 m^3		
		= 811 acre-ft	1 acre-ft	= 1,233.5 m^3
Weight	1 kg	= 2.20 lb	1 lb	= 0.4536 kg
	1 ton	= 0.984 long ton	1 long ton	= 1.016 ton
Derived	1 m^3/sec	= 35.3 cusec	1 cusec	= 0.0283 m^3/sec
Measures		= 19.0 mgd	1 mgd	= 0.0526 m^3/sec
	1 ton/ha	= 891 lb/acre	1 lb/acre	= 1.12 kg/ha

Temperatire

°C = (°F - 32) x 5/9 °F = 1.8 x °C + 32

CURRENCY EQUIVALENT

(as of late 1989)

US$ 1 = Rp.1,770

1. INTRODUCTION

This is the report on the in-depth study on the Silau-Bunut rehabilitation irrigation project prepared in accordance with the Scope of Work agreed on July 27, 1984 between the Japan International Cooperation Agency (JICA) and the Directorate General of Water Resources Development (DGWRD), Ministry of Public Works, the Government of the Republic of Indonesia.

The Silau-Bunut rehabilitation irrigation project is the highest priority project selected in the agricultural master plan study in the lower Asahan river basin with about 6,000 km^2 that was conducted within the framework of "Master Plan Study on Lower Asahan River Basin Development" during the period of June to September, 1989.

The in-depth study (feasibility study level) on the Silau-Bunut rehabilitation irrigation project was carried out during the period from October 1989 to March 1990.

This report is supported by following four Appendices:

Appendix 4-A	Soils
Appendix 4-B	Climate and Hydrology
Appendix 4-C	Irrigation and Drainage
Appendix 4-D	Agriculture and Agro-economy

2. BACKGROUND

Agriculture plays a dominant role in the Indonesia economy sharing about 24% of gross domestic product and contributing about 55% of the employment, and 56% of non-oil exports in 1985. Some two-thirds of rural and 10% of the urban households depend on agriculture for their livelihood. Of the some 57 million ha in the country suitable for agriculture, about 23.5 million ha are under cultivation, of which about 5.3 million ha are irrigated.

The Government's economic development strategy places strong emphasis on rural and regional development and includes intervention in key areas of agricultural sector. The aim of this has been to enhance food production, especially of rice, to meet increasing domestic demand, to provide rural employment, and to achieve balanced regional development.

During Pelita I and II (1969/70-1978/79), the main emphasis was placed on increase of rice production. More than half of the agricultural sector development expenditure was given to rehabilitation and expansion of irrigation facility with the aim of increasing rice production. During Pelita III and IV (1979/80-1988/89), emphasis has been widened to include intensification programs for other crops.

Through the performance of sectoral development from Pelita I to Pelita IV, the rice production has been greatly increased. Paddy production increased from 18 million tons in 1969 to 41 million tons in 1988. Self-sufficiency in rice was realized in 1985. Since then, however, there has been no substantial increase in the annual paddy production in Indonesia, mainly due to conversion of high productive paddy fields into urban and industrial areas in Java where IS the leading producer of rice in Indonesia. Thus domestic paddy demand has gradually gained upon domestic production.

Under such situation Pelita V started from April 1989. The targets of the Pelita V are to: (a) raise the living standards, enlighten

the minds and to improve the well-being of all the people more evenly and equitably, and (b) lay solid foundations for subsequent development.

To achieve the above targets, priority is given to economic development, putting emphasis on the agricultural and industrial sectors. Sustainment of self-sufficiency in rice is one of the most important policies in the agricultural sector.

For this purpose, Pelita V presents irrigation sub-sector development programs which consist of: (a) program for rehabilitation and maintenance of the existing irrigation/drainage systems (775,000 ha), (b) program for construction of new irrigation systems (500,000 ha), and (c) program for swamp area developments (444,200 ha).

Since Pelita III, the Government has gradually shifted irrigation development emphasis to the outer islands. In Pelita V, the Government gives high priority to irrigation development in the outer islands.

North Sumatra province is one of the most promising areas for irrigation development in the outer islands. Agriculture is the main source of employment in the province, accounting for 35% of gross regional domestic product. Despite excellent water resources, however, agricultural production, in particular production of food crops, has been far below its potential. This is mainly due to frequent flood damage, the poor condition of existing irrigation systems, shortage of irrigation water, inadequacy of O&M, etc. Thus, North Sumatra province is a region of rice shortage. In the region a considerable amount of rice has had to be imported from other provinces as well as from foreign countries.

The project area is located in Kabupaten Asahan in North Sumatra province. It is the north-western part of the lower Asahan river basin (study area of the agricultural master plan) having about 6,000 km^2 in which about 10% of the total rice production in North Sumatra province is provided. The project area is much blessed with rich water and land resources. Despite of such excellent resources, increasing

agricultural production in the project area has been hindered by frequent inundation in the low flat area along the Silau river and Bunut river, lack of irrigation and drainage systems, the poor conditions of the existing irrigation systems, etc.

Furthermore, there is no large scale industry in the project area because there are no underground mineral resources and the electric power supply in the area is poor.

The above circumstances show the urgent need to raise the level of regional domestic production by socio-economic development in addition to other measures. The ever-increasing population means that there is an increasingly pressing need to job opportunities and to stabilize living conditions as well.

3. THE PROJECT AREA

3.1 Social Conditions and Rural Infrastructure

The project area lies in the central part of North Sumatra province about 160 km southeast of Medan, capital of the province.

Administratively, the project area is located fully or partly within the jurisdiction of 26 Desas, 8 Kecamatans, and one Kabupaten in North Sumatra province as follows;

Kabupaten	:	Asahan
Kecamatan	:	Air Joman, Meranti, Tj. Tiram, Kisaran Timur, Air Batu, S.Empat, Tj. Balai, D. Bandar
Desa	:	Banjar, Silau Lama, Silo Bonto, Rawang Baru, Rawang Pasar IV, Meranti, Rawang Lama, S.Beluru, Pd.Bungur, S.Mentaram, Desa Gajah, Durian, Air Putih, Uj. Kubu, Mutiara, Subur, Siumbut Umbut, Par. Lembu, B. Serbangan, Air Joman, Punggulan, S.Kamah I, S.Kamah II, S. Lama, Kapias Batu VIII, Sijambi II

The basic socio-economic data of the villages related to the project area are shown in Tables D-1 and D-2 and illustrated in Figs. D-1 to D-4.

All the desas in the project area were settled during the period between 1920's and 1960's. Thirty two (32) % of total desas were settled in from 1920 to 1939, 60% from 1940 to 1960 and 8% after 1960. Most people came from Java and from the land around the Lake Toba.

The population of the all villages related to the project area is estimated at 133,400 consisting of total households of 24,400 in 1987. An average population density in the area is estimated at 263 persons per km^2, ranging from 92 in Uj. Kubu to 1,408 in Mutiara. An average

family size is estimated at 5.5. The population in the area is estimated to comprise 52% males and 48% females.

The available labor force of the, population ranging from 15 to 49 years of age, is estimated at about 47% of the total population. 42% of the total population is shared by the people of which age is less than 15. The population over 50 years of age occupies about 11%.

The population classified by ethnic groups in the area comprises Javanese (53%), Batak (30%), Melayu (12%) and others including Minang, Banjar, etc. (5%). However the composition of the ethnic groups at the level of desas differs considerably dipending on location as shown in Fig. D-2. Such differences in composition seems to accrue from the land settlement programmes. It is considered that the irrigation canal layout should be done taking into consideration of the distribution of ethnic groups in the area in view of proper water management in the project.

The population if classified by religion is Muslim (81%), Christian (18%) and others (1%). Distribution of population classified by religion is illustrated in Fig. D-3. Such distribution seems to have a high correlation with ethnic groups.

There are no reliable data on land tenurial status and actual cultivated farm size in the area except data from the agricultural census conducted in 1983. Thus, the tenurial survey was conducted for major 21 desas.

The tenurial status of desas in the area is shown in Table D-2. The percentage of owner operators ranges from 29% in Sijambi-II to 100% in Air Putih. The percentage of tenants occupies 48% in Sijambi-II at maximum and 0% in Air Putih. The percentage of partly owner operator is from 32% in Desa Gajah at maximum to 0% in Air Putih, Pd. Bungur and Siumbut Umbut. It is estimated that the percentage of owners is more than 70% of the farmers.

The actual cultivated farm size in the area differs considerably from place to place as shown in Table D-2. The actual cultivated farm size is summarized below:

(Unit: ha/farmer)

Description	Owner Operator	Tenant	Partly Owner Operator	Average
Paddy field				
(i) maximum	1.51	1.50	3.00	1.41
(ii) minimum	0.32	0.33	0.43	0.32
Total agr. land				
(i) maximum	2.16	2.00	3.75	2.17
(ii) minimum	0.40	0.33	0.43	0.40

An inventory of major rural infrastructures in the desas concerned in the project area is presented in Table D-3.

Basic social infrastructures such as education, religious and medical facilities are considered to be fairly well established in the project area, although there are some differences in the density of facility among desas. Schools of various levels operated in the desas concerned are 192 in total, of which primary and junior level schools account for 86%. There is an agricultural college in Rawang Pasar IV, Kc. Meranti where training of PPL and progressive farmers is aimed at. Religious facilities comprise mosques, churches and other worship buildings and amount to 313 in total and amongst these mosques occupy about 73%. Medical facilities in the area number 158, while major facilities are available at the primary level as medical posts and health centers. A general hospital is operated in Kisaran, Kabupaten capital.

Electricity supply is principally restricted to desas located close to Kisaran. The electrification ratio in the Silau irrigation area is considerably higher than in the Bunut irrigation area. The ratio in the project area as a whole is only around 25%. While, an electric supply project is ongoing to improve the poor electrification level in the Bunut area.

Piped water supply is only available in Mutiara and B. Serbangan. Almost all desas depend on wells for domestic water supply.

The main transportation network in the area is road transportation. While, transportation by small boat along rivers and drainage canals is also an important means in wet season in lowlying isolated areas. Major road network in the area is gravel-paved roads connected with main asphalt-paved road outside of the project area. Transportation and communication in villages located away from paved roads depend solely on non-paved roads which are not jeepable in wet season and sometimes even in dry season. Road transportation in the wet season in those isolated areas is possible only by foot. Therefore, one of the main constraints in socio-economic activities in those areas is lack of road transportation, especially in wet season.

Location of the main social infrastructures in the project area is illustrated in Fig. D-5.

3.2 Climate and Hydrology

3.2.1 Agricultural climate

The project area lies in the tropical monsoon zone. The annual average temperature is about 26°C with very little seasonal variation throughout a year. The temperature varies from a maximum of 32°C to a minimum of 22°C. The climatic conditions of the area are shown in Table B-1.

The area is affected by the northeast monsoon from the China Sea in September through December and southwest monsoon from the Indian Ocean in March through May. The main wet season begins on the coast facing the Strait of Malacca with heaviest rain in October and it reaches the coast of the Indian Ocean after one or one and a half months. The secondary rainy season, however, begins on the Indian Ocean side. However, due to the existence of a mountain range over 2,000 m high to the west of the area, the influence of the monsoon is

weakened and the area can receive considerable rainfall even in the dry season. There are no severe dry months.

The annual rainfall is about 1,500 to 2,000 mm in the project area and about 2,000 to 3,500 mm to the west towards the mountains as shown in Fig. B-1. In general the water resources in the area are ample. A detailed description of the rainfall conditions and their characteristics are given in Tables B-2 to B-4.

Relative humidity is as high as 88% on average ranging between 90% in the highest month and 87% in the lowest. Wind velocity is as weak as 0.2 m/s on annual average with very little seasonal variation. Sunshine is generally short, due to the many rainy days, more than 15 days in a month during the wet season.

Design rainfalls in the irrigation and drainage plan are estimated based on the available rainfall data at eight (8) rainfall stations in and around the project area. Design rainfall for irrigation was determined by using the data at Hessa station. Design rainfall for drainage was determined by using the data at Sei Baleh station. An average rainfall distribution of each station is illustrated in Fig. B-2. Details are presented in the proceeding Section 4.4.

3.2.2 River system and river runoff

(1) River system

The major rivers in the project area are the Silau and Bunut rivers. The principal features of the rivers are summarized below:

Item		Silau river	Bunut river
1. Catchment area at river mouth	(km^2)	1,180	621
2. River length	(km)	124	59
3. Elevation of upper basin	(El. m)	1,100	82
4 River gradient		1/1,550	1/2,230
5. Elevation of river bed at 50 km upstream from river mouth	(El. m)	22.5	13.6
6. Annual runoff	(MCM)	2,170	783
7. Annual mean discharge	(m^3/s)	69	25
8. 5-year drought discharge	(m^3/s)	30	10
9. Runoff coefficient		0.70	0.50
10. Length of tidal reach	(km)	5	18
11. Length of sea water intrusion	(km)	0	10

The Silau river is the largest tributary of the Asahan river. The river originates on the eastern part of Mt. Parparean and subsequently flows northwestwards along steep and narrow valleys. Afterwards, the river continues to flow northeastwards and joins a right tributary of the Piasa river at Jati Sari. From Jati Sari to Kisaran, it flows northwards with meandering. Downstream from Kisaran, the river changes its direction to eastwards and finally joins the mainstream of the Asahan river at Tanjung Balai.

In the stretch from Kisaran to the confluence with the Asahan river, there are some irrigation free intakes and drainage outlets. The land on the both banks of the river has been developed for paddy fields. In order to protect such areas, continuous small flood protection dikes of 36 km in total have been constructed on the both banks of the river.

The Bunut river is a tributary of the Kiri river. The river originates on the northern slope of the Mt. Parparean and flows northeastwards in parallel with the Silau river up to near Kisaran. After passing through rubber and oil palm plantations and paddy fields, it joins the Balai river about 10 km upstream from the estuary of the Kiri river . In the lower reach of Kisaran, the flood protection dikes of about

14 km long in total, right side of 9.5 km and left side of about 4.0 km, have been constructed by DPU and local peoples to protect the paddy fields extending over the both banks of the river. The paddy fields suffer from severe shortage of irrigation water due to the absolute small drought discharge of the river and from flood damages.

The existing river facilities such as flood control dikes and related river structures are presented in Table C-5.

(2) Low-flow runoff

1) General

For irrigation planning, the low-flow runoff analysis for the Silau and the Bunut rivers was made by using "Tank Model method". The analysis was made on a 10 day basis discharge for 20 years at Kisaran highway bridge and Prapat Janji on the Silau river, and highway bridge on the Bunut river as follows. Also the basic years for water resource study as well as for river maintenance discharges were determined for the following:

(i) Kisaran highway bridge on the Silau river; the low-flow analysis for the proposed integrated diversion weir and inter-basin plan (Alternative-2) on the Silau; (CA = 1,050 km^2)

(ii) Prapat Janji on the Silau river; the low-flow analysis for the inter-basin plan (Alternative-1) from the Silau river to the Bunut river (CA = 605 km^2)

(iii) Highway bridge on the Bunut river; the low-flow analysis to examine the available water of the river (CA = 115 km^2)

The map showing locations of hydrological gauging stations and isohyetal lines of annual rainfall is presented in Fig. B-1.

2) Runoff analysis of the Silau river

The runoff analyses at the Kisaran highway bridge and Prapat Janji sites are made based on (a) the actual measured record at the Kisaran site for 17 years and at Tinggi Raja site for 5 years, and (b) the representative rainfall in the area as shown in Table B-8. The relations between runoffs and rainfalls of the selected stations are presented in Figs. B-3 and B-4. The "Tank Model Method" is applied to estimate the discharges for 21 continuous years. The discharge at Prapat Janji site is estimated based on the estimated discharges at Kisaran and T. Raja.

The applied tank model is envisaged as three storage tanks with the dimensions shown in Fig. B-5. The simulation results of the low-flow runoff by the tank model method are shown in Tables B-8 and B-9 and Figs. B-6 and B-7. The estimated monthly average discharges based on the 10-days basis low-flow analysis are tabulated in Tables B-11 to B-13.

3) Runoff analysis of the Bunut river

The runoff analysis is made at the highway bridge site by applying the tank model method. The analysis are made based on the areal rainfall and water level measurement record for 5 months in 1985 and discharge measurement result by the Team in 1989.

The applied tank model is similar to that for the Silau river and dimensions of the tanks for the Bunut river is shown in Fig. B-5. The estimated monthly average discharge based on the 10-day basis analysis for 20 years from 1968 to 1987 is shown in Table B-14.

(3) Flood flow runoff

The flood discharge in the rivers in the project area is relatively large due to the high rainfall intensity and relatively steep river bed gradients.

Major floods in the past were recorded in 1973, 1977, 1979 and 1984. Of them, large floods were observed as follows :

Date of Occurrence	Name of River	Gauging Station	Basin ave. 2-day Rainfall (mm)	Peak Discharge (m^3/s)	Specific Discharge ($m^3/s/km^2$)
Jan. 1984	Asahan	Pulau Raja	63	521	0.76
Dec. 1973	Silau	Kisaran	122	800	0.76

The inundated area and houses damaged by the above flood in the Asahan is estimated at about 2,110 ha of agricultural land and 562 houses. For the Silau river, the maximum flood above caused damage by inundation to 5,760 ha of agricultural land and 7,300 houses.

3.2.3 Water quality and sedimentation

From water quality analyses, the quality of water in rivers originating from the mountain range is all within tolerable limits and suitable for irrigation as shown in Tables A-34 and A-35 in Appendix 3A of Volume III.

The total annual sediment yield in the Silau and the Asahan river basin ranges between 500 and 550 m^3/km^2, out of which the specific sediment of riverbed materials is about 260 m^3/km^2 for the Asahan river and about 400 m^3/km^2 for the Silau river. The above sediment production is considered to be attributable mainly to sheet erosion of the ground surface of the mountains and hilly area.

3.2.4 Tide and sea water intrusion

(1) General

The range of the tidal fluctuation of the Strait of Malacca is high to moderate. Tidal fluctuation estimated at the estuary of the Asahan river is about 2.2 meter under normal condition and 4.4 m at the maximum. At Kuala Tanjung it is 1.5 m and 3.2 m, respectively. Due to the tide effects, certain parts of the low-lying areas near the sea coast in the project area suffer from poor drainage (Ref. to Section 1.4 of Appendix 3-A in Volume III).

According to the result of sea water intrusion survey conducted at the spring tide during low flow, the possible maximum distance of sea water intrusion is about 6 km in the Asahan and 10 km in the Bunut rivers (Ref. to tables and figures in Section 1.5 of Appendix 3-A). The existing intakes for domestic water supply and irrigation are located far upstream of the end point of possible sea water intrusion and, therefore, there are no problems for river water use at present.

(2) Tidal influence in the project area

A tidal infuence survey was made to clarify the range of tidal reach in the low-lying areas and to investigate the amplitude of the tidal action in the existing drainage canals and natural river at spring tide in November 1989. The objective drainage canals were (a) Tambung Tulang drain, Ujung Kubu drain in the low-lying area in the downstream reach of the Bunut area, and (b) Banitan river and Bandar Jepang canal in the low-lying area of the Silau river

The area influenced by tidal action was investigated by interview surveys of farmers in the area. Based on the investigation, the maximum tidal influence area is delineated as shown in Fig. B-8. In general, the tidal action reaches 6-8 km upstream from the sea. The tidal influence observed in the existing canals and drain in November 1989 is shown in Figs. B-8 to B-10. These results tell that:

(i) Tidal reach retreats downstream in the wet season due to much more discharge than that in dry season.

(ii) A canal with a higher canal bed elevation is less affected by tidal action than a canal with a lower canal bed elevation.

(iii) The canal bed elevations of the existing drains and rivers are too high to drain excess water flowing down from upstream area since all of the elevations of canals and drains are higher than El. 0 m. The existing drainage canals are not affected by the tidal action in the sea.

(iv) Amplitude of tidal influence in the canal is reduced in upstream reaches.

3.3 Soils

The soils in the project area are classified into six (6) soil units and the same are further subclassified into ten (10) soil subunits on the basis of surface soil texture, effective soil depth and drainage condition. The subunits are employed as soil mapping unit and land unit for land classification. The distribution and land suitability classes of the soils are indicated in Table 3-1 and Fig. 3-1.

The soil units include (1) partly ripened, poorly drained low land soils, (2) partly ripened, very poorly drained low land soils, (3) medium textured alluvial soils, (4) flat volcanic tuff soils, (5) coarse textured volcanic tuff soils, and (6) moderately deep organic soils.

Both the (1) and (2) are distributed in the flat to swampy lowlying area in the project area. These soils are fine-textured, poorly to very poorly drained soils with deep effective soil depth, soil reaction is acid to slightly acid. The classification of the two is based on drainage conditions. In the (1), seasonal drying of surface soil is identified through profile observation. While the (2) is considered to be saturated with moisture or inundated almost throughout a year. The soil unit (1) is predominantly used for rice cultivation (mostly local variety) and

partly for coconut fields. The (2) is almost exclusively used for cultivation of local variety of paddy. Considerably high productivity of rice farming is expected under proper irrigation in the (1). However, drainage improvement is considered to be prerequisite in the very poorly drained soil unit (2) for the successful irrigation farming. The unit (1) occupies 1,650 ha or 11.5% of the project area. The unit (2) accounts for 2,630 ha or 18.4% of the same. The unit (2) is subclassified into two subunits based on the content of organic material in the surface layer.

Alluvial soils (3) are found along the Silau river and are medium-textured in general. Soil reaction is slightly acid. The area distributed with the soils is predominantly used for paddy field with the exception of limited area for coconut field. The potential for irrigated rice farming is considered to be high when the area is freed from seasonal flood occurring frequently at present. The unit covers 1,710 ha or 12.0% of the project area. The unit is subclassified into two subunits in accordance with texture, effective soil depth and drainage condition.

The soil units (4) and (5) are soils derived from volcanic tuff deposits and extensively distributed in the upland area of the project area. The former is fine to medium-textured and the later has coarse-textured surface soil. Soil reaction is slightly acid to acid. Both the units are primarily used for paddy cultivation, while majority of coconut fields in the project area are developed in these areas. High productivity of irrigated paddy under intensive farming is anticipated because of preferable internal drainability in case of the unit (4). While, fertilizer application in the area distributed with the unit (5) is carefully practiced in order to minimize percolation losses. The unit (4) accounts for 6,550 ha or 45.8% of the project area and the unit (5) represents 1,240 ha or 8.7% of the project area. The unit (4) is further subclassified into three subunits.

The unit (6) occupies only 360 ha (2.5%) and presently used for rice cultivation. The depth of well decomposed peat layer is not so deep. Bearing capacity of the soils is low and drainage improvement is required for successful irrigation farming.

Descriptions of soil profile and physico-chemical properties of soils are presented in Appendix 4-A.

Potential land suitability classification of the soils in the project area for both irrigated paddy and upland crops are examined principally in accordance with the FAO procedure (A Framework for Land Evaluation, Soil Bulletin 32). The classification criteria are prepared based on the criteria defined by the Soil Research Center (PTT, 1981) with some modification made taking into consideration of the proposed irrigation and drainage development and the envisaged intensive farming in the present project. In addition, the flood control plan of the Silau river under the stage of detailed design is also taken into account and the criterion on the frequency of flood is excluded from the criteria employed. The criteria are presented in Table A-3.

Results of the potential land suitability classification are shown in Table 3-1 and Fig. 3-1 and summarized below:

Land Suitability Classification

Land Suitability Class		Paddy		Upland Crop	
		ha	%	ha	%
S1	Suitable	750	5.2	-	-
S2	Moderately suitable	11,470	80.2	8,260	57.8
S3	Marginally suitable	1,920	13.4	5,880	41.1
N	Not suitable	-	-	-	-
NR	Non-agricultural land	160	1.1	160	1.1
	Total	14,300	100.0	14,300	100.0

It is concluded that all the soils in the project area can be used for irrigation farming. In particular for irrigated paddy cultivation, 85% of land resources in the area are classified into class S1 and S2.

3.4 Existing Irrigation and Drainage Conditions

3.4.1 General

The history of irrigation in the project area is relatively short. In former times the main focus for agricultural development was placed on tree crop plantations such as oil palm, rubber and coconuts. Paddy schemes in the area have been developed only in the last 20 years by DPU North Sumatra province and the district public service office of Kabupaten Asahan.

Irrigation schemes in the area are gravity irrigation type diverting irrigation water from the Bunut and the Silau rivers. The principal features and location of the existing irrigation schemes managed by DPU are shown in Tables 3-2 and 3-3 and Fig. C-1.

Irrigation schemes in the Bunut river basin are relatively well maintained. However, the irrigable area for dry season paddy is quite limited due to water shortage during dry months. On the other hand, the existing irrigation schemes in the lower Silau area suffer from water shortage due to the low intake water level in the Silau river, though the river discharge during dry months is abundant.

3.4.2 Inventory of existing irrigation and drainage facilities

(1) General

The existing irrigation schemes in the project area are broadly divided into two areas according to water sources; The Silau area and the Bunut area. The irrigation schemes managed by the government agencies is 13, of which 9 schemes are in the Silau area and 4 in the Bunut area.

The inventory of the major existing irrigation and drainage facilities in the area was surveyed by referring to the data and information obtained from irrigation service offices in Kisaran.

The investigations were made by means of additional data collection at the district irrigation service offices of DPU North Sumatra Province and Kabupaten Asahan, field surveys of the existing canals and related structures, and interviews to the village chiefs and farmers about irrigation and drainage conditions and degree.

In addition, structural condition of all the existing irrigation and drainage facilities were assessed according to the criteria which categorize condition of the existing structures into four (4) classes on the basis of degree of deterioration of them.

The command areas and major facilities of the existing irrigation schemes is mapped in Fig. C-1.

(2) Existing irrigation and drainage facilities

According to the survey results, there are 52 canals of 194 km in total, consisting of 30 irrigation canals of 84 km long and 22 drainage canals of 110 km. The related structures on the canals are 228 nos. in total, consisting of 197 on irrigation canals and 31 on drainage canals. A summary of the results is shown below and in Table 3-3, and the details are tabulated in Tables C-1 to C-2.

Area	Irrigation Canal		Drain Canal		Structures (nos.)**	
	No.	L(km)	No.	L(km)	Irri.	Drain.
Silau	12	53.3	12	44.3	107	12
Bunut	18	30.9	10	65.8*	90	19
Total	30	84.2	22	110.1	197	31

* : Including drains in Tambung Tulang area
**: No. of diversion weir and intake is included

There are four (4) diversion weirs on the Bunut river but no weir across the river on the Silau river. The present conditions of diversion weirs on the Bunut river are presented in Figs. C-3 to C-5. All of the irrigation water for the Silau area is diverted by the free intake method.

The canals are all unlined earth canals with trapezoidal sections. The structures on irrigation canals consist of 74 turnouts, 15 check structures, 49 bridges, etc. Most of the structures except the slabs of bridges are made of stone and/or brick masonry. It is noted that no discharge measuring device and spillway/wasteway was found.

The key dimensions of canal sections and related structures were measured and recorded in the field to examine the capacity of the facilities. The salient features of existing irrigation canals are tabulated in Table C-3.

It is noteworthy that there are no jeepable inspection road along the canals.

(3) Structural condition of the facilities

The structural condition of facilities was also investigated and assessed based on the following classification:

Class-A	:	Well maintained and functioning completely
Class-B	:	Functioning properly and rather good condition
Class-C	:	Deteriorated or partially collapsed
Class-D	:	Completely collapsed

The structural conditions of the canals are summarized below and their details are shown in Tables C-1 to C-2.

(Unit: km)

Area	Irrigation Canal					Drainage Canal				
	A	B	C	D	Total	A	B	C	D	Total
Silau	0.9	41.7	10.6	0.1	53.3	0.0	22.5	16.4	5.4	44.3
Bunut	0.0	25.7	4.1	1.1	30.9	0.0	46.9	18.9	0.0	65.8
Total	0.9	67.4	14.7	1.2	84.2	0.0	69.4	35.3	5.4	110.1
(%)	(1)	(80)	(18)	(1)	(100)	(0)	(63)	(32)	(5)	(100)

Regarding to the condition of related structures, most of them are categorized into Class B.

(4) Defects and damages observed

The defects and/or damages observed on the above existing irrigation and drainage facilities through the inventory surveys were as below:

(i) Canal deterioration has been caused by erosion of side slopes and siltation and the canal capacity has been reduced in the most of drainage canals.

(ii) Proper discharge control can not be made at each check structure because these check structures only provided wooden stop-log and considerable water leaks through are observed stop-log; some check structures raise up the water level permanently throughout the irrigation season by wooden logs or planks, but in many cases no check activity has been made.

(iii) Upstream transitions and downstream protection works have been damaged due to improper length of them.

(iv) Due to non protective structure of canal such as spillway and wasteway, the canal banks have been breached at many portions.

(v) Because of no inspection roads along the canals, no periodical inspections have been made and the damages located far from the public roads have remained unrepaired.

(vi) No proper water management and monitoring of irrigation activities has been made because of no provision of discharge measuring device; even at the diversion site on the river, no device exists.

3.4.3 Irrigation and drainage conditions

(1) Irrigation conditions

The irrigation condition of the existing irrigation area is classified on the basis of the following three degrees;

Grade I : Paddy field irrigated throughout year except severe drought in dry season,

Grade II : Paddy field irrigated in high water (rainy) season (generally during September to January)

Grade III : Paddy field irrigated only in flood season (generally during October to December)

The investigation results are summarized below and details and locations are presented in Table 3-2 and Fig. 3-2.

(Unit: ha)

Area	Irrigation Condition			Total
	I	II	III	
Silau	1,040	440	980	2,460
Bunut	600	1,020	750	2,370
Total	1,640	1,460	1,730	4,830
(%)	(34)	(30)	(36)	(100)

In the project area, the irrigation area is about 4,800 ha in total. As seen in the above table, however, the Grade I irrigation areas only amount to about 1,600 ha (34% of total irrigation area). Grade I areas are located mainly on the right bank of the Silau river (Sei Silau, Bandar Saleh and Sijambi schemes), and on the upper-stream part of Serbangan scheme on the right bank of the Bunut river.

The remaining 3,200 ha (66%) are under irrigation only during the wet season or flood season. Grade II areas are located in the downstream part of Sei Silau scheme on the right bank of the Silau river and the middle reach part of the Serbangan scheme in the Bunut

area. Grade III areas, with the most serious water shortages are no better than rainfed and are located mainly on the left bank of the Silau river (S. Umbut-Umbut, Binjai Serbangan, Tasik Malaya, and Kapias Batu VIII schemes) and the most downstream part of the Serbangan scheme.

(2) Causes of poor irrigation condition

The main causes of poor irrigation conditions in the area are itemized below.

(a) Malfunctioning of free intakes on the Silau river
(b) Improper alignment of irrigation canals
(c) Absolute shortage of river discharge in the Bunut river
(d) Low provision level and deterioration of irrigation facilities
(e) Lack of water management activities

The detailed description of the irrigation conditions in the areas suffered from severe water shortage is given as follows:

Schemes in the left bank of the Silau river

All of the irrigation area of about 1,000 ha managed by PUD have been suffered from very severe irrigation water shortage conditions. It is considered that the main cause of improper irrigation water supply to these areas is malfunction of free intakes.

As mentioned in proceeding section, all of the irrigation waters are diverted by the free intake method in the Silau area. Fig. C-2 shows the relationship between bottom elevation of gate and fluctuation of annual water levels at four free intake points in various condition of river flow, namely, the driest year of the last 20 years (1972), drought year having once in five years return period (1977), higher water level year (1984), and average year (1985).

The figure tells that the formation level of intake gate of Si Umbut-Umbut and Tasik Malaya free intake is too high to divert the river water. Even during the period when the river water level is

higher than the bottom level elevation, the intake water depth is less than 1.0 m.

In addition to the above reason, the alignment of irrigation canals in Si Umbut-Umbut area is considered improper. The main irrigation canal is not aligned in the highest position, and some section are aligned in the large depression area.

Schemes in the Bunut river

The fundamental constraints of the water shortage are caused by the limited available water resources of the Bunut river in dry season. On the advice of the Agricultural Department the cropping schedule is set in the driest season from June to September. The available discharge in the season is estimated at 2-3 m^3/s. Assuming a peak irrigation water requirement of 1.5-2 l/sec/ha, the irrigable area is estimated at 1,000-2,000 ha at the maximum. In comparison with paddy area of DPU schemes of about 3,700 ha, the available river water of the Bunut is too small to irrigate all areas.

The cause of poor irrigation condition in the Serbangan scheme is malfunctioning of the diversion weir. Round shaped banana stems are used as stop-logs, and a considerable amount of water leaks from the weir. Absence of any water management activity in the area is also a cause of water shortage. Every year the most upstream part of main irrigation canal only enjoy the benefit of irrigation and the remaining downstream areas have been left under drought condition.

Regarding the Panca Arga scheme, the lack of water in dry season is very severe. Since most of the river water is diverted by the Serbangan weir, water available to the scheme is basically limited to the leakage from Serbangan weir. The low provision level of irrigation canals is also a cause of the poor irrigation condition.

(3) Drainage condition

Drainage conditions of the project area are classified into the following three grades.

Grade I : Areas which are free from seasonal flooding and inundation, including the area poorly drained due to micro-relief condition.

Grade II : Areas which suffer from seasonal flooding in the wet season, generally from October to December. The average inundation depth is assumed to be more than 30 cm.

Grade III : Areas which are submerged throughout a year. The maximum water standing is assumed to be more than 100 cm and the minimum, 30 cm on average.

The present flooding status and main drainage canals including natural drains is presented in Fig. 3-3. The lands higher than about El. 4 m are free from the seasonal flooding (Grade I area), and lands lower than El. 2 m are submerged throughout a year (Grade III area).

The main drainage channels in the area are: (a) Silau and Serdang rivers and Bandar Jepang canal in the Silau area; all of them flow into the Asahan river, and (b) Bunut river and three artificial drainage canals to the Strait of Malacca in the Bunut are.

Drainage condition in the Silau area

The areas suffered from seasonal floodings and submerged throughout a year are mainly located in both banks of the most downstream reaches of the Silau river due to less capacity of the drainage canals, low elevation of lower than El. 2-3 m, and tidal influences. The downstream reaches of the Si Umbut Umbut scheme is suffered from seasonal floodings even at the area extending higher than El. 10 m due to (a) less capacity and malfunction of the drainage gate on the Silau river and (b) topographic depression of the area.

Due to the flood flow, some portions of the existing dikes are breached every year. It is noteworthy that the detailed design of the flood prevention works, being composed of construction of new dikes and dredging of river bed lower, was finished by Directorate of River of DGWRD in June 1989. The design works was made in accordance with the recommendation made in the previous Part I study of the Study.

Drainage condition in the Bunut area

All of the area of Panca Arga scheme and the downstream part of the Silo Bonto scheme are suffered from seasonal floodings. Main causes of the such poor drainage condition and flooding are : (a) low provision level of drainage networks, and (b) inadequate flow capacity in the river channel of the Bunut river. An excess water evacuated from upstream paddy fields and coconut plantations is also one of the causes.

3.4.4 Road condition

There is no inspection road along canals for daily operation and maintenance purposes. The existing village/Kabupaten roads are used as access roads to the irrigation area.

The existing public road network is in quite good condition in and around the project area. The area is bounded by provincial roads 6 m wide, which are paved with hot-mixed asphalt, on the western and southern side. The Kabupaten roads run across the area from south to north. Most of the Kabupaten roads are paved with macadam for a width of 3-4 m. In addition to the above main public networks, many village roads exist in the area. The village roads are unpaved earth surfaces 3-4 m wide. Most of these unpaved roads are located in low-lying areas and are impassable in the wet season.

The inventory list and present main road network and their pavement condition are presented in Table C-4 and Fig. C-6.

3.4.5 Operation and maintenance

The existing 13 irrigation schemes in the project area were constructed by and have been managed by two irrigation service agencies, namely (a) the irrigation service branch office of DPU North Sumatra Province at Kisaran (PUP) and (b) irrigation service section of public service department of the Kabupaten Asahan (PUD). Four (4) PUD's schemes are located in the left bank of the Silau river and its commanding area is about 2,800 ha in total. The commanding areas of PUP of about 6,900 ha in total are located on the right bank of the Silau river and both banks of the Bunut river.

There is an irrigation committee headed by Bupati, chief of the Kabupaten Asahan, to formulate the basic irrigation policies, to solve the problems concerned the irrigation, and to adjust activities among the agencies concerned to the irrigation and agricultural activities in Kabupaten Asahan. The structure and members of the committee are presented in Fig. C-7. The activities of the committee, however, are not so significant due mainly to (a) less information of irrigation and agricultural activities to the committee members, and (b) relatively low provision level of the irrigation facilities.

The water management for irrigation schemes has not been executed properly by both the irrigation agencies due to lack of trained irrigation service staff, no provision of O&M equipment, and insufficient budget for the work. As a result, there is neither an established water management procedure nor operation records of water management. Organization of irrigation service branch office of DPU North Sumatra Province is shown in Table C-7.

Though water users' associations of beneficiaries have been organized in each village level by the local government, no significant activities have been executed because of insufficient water supply to each field and low provision level of on-farm facilities. Detailed description of the association is described in Section 3.9.

3.5 Land Use and Farming

3.5.1 General

A land use survey was carried out for the project area. Five land use categories and four subcategories were adopted in the land use study. The preliminary land use maps were prepared on the basis of the topographic maps on a scale of 1/5,000 with one meter contour interval that JICA Jakarta office provided with. The preliminary land use maps were finalized after checking upon them in the field.

The present state of farming was investigated by the field surveys and a questionnaire survey for the farmers in and around the project area. Due to time limitation of the survey, a random sampling method could not be applied. A purposeful sampling method had therefore to be applied to the questionnaire survey. Selection of respondent farmers was carefully carried out in consultation with extension workers and chiefs of desas. The total number of samples amounted to about 230 covering 22 desas in and around the project area.

In addition, a rice yield survey was carried out to identify the defects hampering the increase of paddy yields under present condition. The sampling was made at 17 sites of paddy fields in total. The survey was performed basically in accordance with the method proposed by Dr. S. Matsushima.

3.5.2 Present land use

In the project area, almost all the land resources are used for agricultural production and the extent of unused and/or less used land is quite limited as shown in Table 3-4. The predominant land use category is paddy field which accounts for 75% of the total project area, followed by coconut field accounting for 15%, housing yard (6%), others (3%) and upland field (2%). The general map of the present land use is presented in Fig. 3-4. Land use characteristics of the two major categories are as explained below.

(1) Paddy field

The 10,700 ha of paddy fields occupying the project area can be classified into four sub-categories according to the land use intensity and characteristics, namely, (a) irrigated paddy field where irrigation water supply throughout a year is available and double cropping of paddy is practiced (hereinafter called "irrigated paddy field I"), (b) irrigated paddy field where irrigation water supply is only available in the wet season and cultivation of dry season paddy is partly practiced under nearly rainfed conditions (hereinafter called "irrigated paddy field II"), (c) rainfed paddy fields where cultivation of HYV with short to medium growth duration is practiced (hereinafter called "rainfed paddy field/HYV), and (d) rainfed paddy field where cultivation of local variety of paddy with long growth duration is exclusively practiced due primarily to restricted drainage condition of land (hereinafter called "rainfed paddy field/local").

Irrigated paddy field I: The irrigated paddy field I accounting for 1,640 ha and 15.3% of the whole paddy field is generally located at areas close to irrigation intake facilities where irrigation water supply is ensured throughout a year. This subcategory corresponds to Grade I irrigation area classified in accordance with irrigation condition as indicated in Section 3.4.3. In the area, double cropping of HYV paddy is practiced in two cropping seasons in the area, namely, wet season paddy and dry season paddy. While, shortage of irrigation water in the dry season and/or seasonal inundation often bring about annual fluctuation of cropping season.

Irrigated paddy field II: The irrigated paddy field II where irrigated in high water (wet) season is generally situated in the down reach of irrigation systems and even in the vicinity to irrigation intake facilities which are not functioning as planned. This subcategory corresponds to Grade II irrigation area and the areal extent is 1,460 ha and 13.6% of the total paddy field. The predominant land use in the area is a single cropping of wet season paddy. However, cropping of paddy in dry season under nearly rainfed conditions is also practiced in the limited part of the subcategory. The areal extent of under double

cropping of paddy is considered to be affected by rainfall distribution in dry season and not constant from year to year. Upland crop cultivation in dry season in the paddy field is extremely limited to negligible.

Rainfed paddy field/HYV: The rainfed paddy field/HYV is generally located in the upper part of the project area and sometimes even in the vicinity of irrigation intake facilities, and is fairly clearly demarcated from the rainfed paddy field/local in the lowlying area. In the area, single cropping of HYV paddy in wet season is exclusively practiced and cropping in dry season is not practiced generally. This subcategory includes Grade III irrigation area (1,730 ha and 16.2% of the total paddy field) where irrigation water supply is only available in flood season when the excess water is problem for paddy cultivation. The areal extent of the subcategory is 3,880 ha and 36.3% of the total paddy field.

Rainfed paddy field/local: The rainfed paddy field/local is located in lowlying area of the project area and accounts for 3,720 ha and 34.8% of the total paddy field. The area is liable to seasonal flooding and inundation every year and local variety of paddy with long growth duration (5-6 months) is planted. The practice of "kernap" is adopted for transplanting in order to mitigate unpredictable damages caused by flooding and seasonal inundation. The distribution of the subcategory is illustrated in Fig. D-7.

(2) Coconut fields

Coconut fields in the project area occupies 2,150 ha and 15% of the total area and greater part of the same are located in upland areas and northern part of the project area. Coconut fields in the project area could be subclassified into fields with pure coconut stands and fields with intercrops, although the delineation of the two is impossible. Coconut fields close to a housing yard are generally intercropped with various crops including banana, cassava, maize and cocoa. Fields with pure coconut stands are usually located outside of intercropped fields and away from housing yards, and the plot size of field is generally larger than the intercropped coconut fields. Recently, intercropping of

cocoa between coconut trees has been gradually introduced to the project area. In the project area, intercropping of paddy under coconut stands (or intercropping of coconut on wide ridges in paddy fields) is seldom practiced as extensively observed in the coastal area north of the project area.

3.5.3 Cropping season and crop variety

The main cropping season of paddy in the project area is the wet season. Transplanting of high yielding variety is generally practiced from the beginning to middle of wet season. Harvesting time is after the onset of dry season. In the case of local varieties of paddy, transplanting to the entire field is carried out generally in November to December. Cultivation of dry season paddy commences after the harvest of wet season paddy and harvesting is completed before the onset of wet season.

However, the actual cropping season in the area is considerably influenced by climatic conditions of each year, especially, by the time of the beginning of the wet season and the depth and duration of seasonal inundation. In order to grasp the actual status of cropping season in the project area, monthly planted area of paddy in the concerned desas from 1984 to 1988 collected from BPP are analyzed as shown in Table D-4. According to the table, the prevailing cropping calendar in the project area is understood as shown in the following table.

Crop Season	Rice Variety	Transplanting Time	Harvesting Time
Wet season	HYV	Oct. - Dec.	Jan. - Mar.
	Local	Nov. - Jan.	Feb. - Apr.
Dry season	HYV	May - July	Aug. - Oct.

In the project area, the recommended cropping schedule of paddy is prescribed by Bupati office every year (Pengaturan Tehnis Pelaksanaan Pola Tanam & Tertib Tanam). According to the same, the recommended transplanting times for wet and dry season HYV are Oct.-

Nov. and May-June, respectively. As for local variety, Nov.-Dec. is the prescribed transplanting time, in general. However, as indicated in the table, the actual transplanting time in the past is considerably deferred from the prescribed schedule. Especially the said situation is clear in dry season cropping and large proportion of the same are planted in July. This fact means that a large proportion of dry season paddy matures during wet season when the area is liable to inundation and flooding. Delay in transplanting in the dry season may force farmers to postpone transplanting of wet season paddy, may be to December as indicated in the previous table.

The main reasons for the deviation of actual cropping season from the recommended schedule are considered to be: (a) water shortage, (b) flood, (c) seasonal inundation and poor drainage and, (d) farmers' intentions. Digression from the prescribed cropping season results in yield reduction of paddy, attributable to; (a) harvesting in the rainy season, (b) transplanting of aged seedlings, and (c) less sunshine hours in the maturing stage of paddy. In addition, the said lingering cropping season is considered to be one of the major causes of pest and disease prevailing in the project area which are also main limiting factors of paddy yield. These facts are considered to be major constraints preventing an increase in productivity of paddy in the area.

The main rice varieties prevailing in the project area is IR-46 and IR-64 for HYV and as for local variety Pagi-sore (Ramos) is exclusively cultivated. Other rice varieties include Bahbolon, IR-54 for HYV. Growth duration of HYVs grown in the project area is around 120 days and that of Pagisore is 150 - 180 days. IR-46 is a resistant variety to brown planthopper and recommended by BPP for cultivation in the wet season.

Cultivation of upland crops such as cassava and maize is practiced throughout a year, in particular in dry season, although area under cultivation is limited. Cultivation of upland crops in paddy fields is seldom practiced, however, in desa Silo Lama part of paddy fields are used for upland crop cultivation including cassava and maize in dry season.

Coconut planting is commonly practiced in upland areas and the northern part of the project area. While, most of coconuts fields are aged and productivity is generally low.

3.5.4 Cropping pattern and intensity

Paddy cropping systems in the project area are classified into the four patterns, namely: (a) double cropping of paddy (Pattern I), (b) wet season paddy + limited cropping of dry season paddy (Pattern II), (c) single cropping of high yielding variety in wet season (Pattern III), and (d) single cropping of local variety in wet season (Pattern IV); according to the land use subcategories of paddy fields. The prevailing cropping patterns in the area are illustrated in Fig. D-6.

Pattern I is practiced in the irrigated area where an annual supply of irrigation water is available (irrigated paddy field I) and cropping intensity is about 200% per year. The pattern II is practiced in an irrigation command area where the irrigation water supply in dry season is extremely limited or where an irrigation water supply is only available in the wet season (irrigated paddy field II). Pattern III is practiced in the rainfed paddy field/HYV where cultivation of dry season crop is seldom carried out. Pattern IV is predominantly practiced in lowlying areas where seasonal inundation and poor drainage hamper the introduction of intensive paddy cultivation and cultivation of dry season paddy is not practiced.

In areas where Pattern II is adopted, cultivation of dry season paddy is partly practiced especially when the rainfall in dry season is enough to start paddy cultivation in that season. Accordingly, the planting area of paddy in the dry season is inconstant and productivity is unstable and low. Accordingly, the annual variation of cropping intensity in Pattern II is considered fairly large.

The estimation of cropping intensity in the project area was made on the basis of data on planted area and harvested area of paddy from 1984 to 1988 in major desas concerned. The detail result of the same

is presented in Table D-5 and the summary is indicated as shown in the following table.

Annual Cropping Intensity of Paddy in Concerned Desas

(Unit: %)

Irrigation Area	1984	1985	1986	1987	1988	Average
Silau	136	121	121	112	125	123
Bunut	106	112	122	117	127	117
Project Area	117	115	122	115	127	119

As shown in the table, the overall cropping intensity in the area concerned is around 120% on average. Assuming the cropping intensity in Pattern I, Pattern III and Pattern IV are 200%, 100% and 100%, respectively, which are estimated through the field survey, farm economic survey and various interview surveys conducted in the second stage, the cropping intensity of the Pattern II in the project area is calculated at 134% on average as shown in the following table.

	Cultivable Area (ha)	Cropping Intensity (%)	Cropped Area (ha)
Pattern I	1,560	200	3,120
Pattern II	1,390	134	1,860
Pattern III	3,680	100	3,680
Pattern IV	3,530	100	3,530
Project area	10,160	120	12,190

On the basis of the above study, the present cropping intensity of the project area is estimated for the present study as indicated below.

Estimated Cropping Intensity in the Project Area

(Unit: %)

	Wet Season	Dry Season	Annual
Pattern I	100	100	200
Pattern II	100	35	135
Pattern III	100	-	100
Pattern IV	100	-	100

3.5.5 Crop yields

Paddy yield in the project area was estimated on the basis of the farm economic survey performed as mentioned in Section 3.5.1 General. Yields of paddy in the project area were estimated as follows;

(Unit: ton/ha; dry paddy)

Subcategory	Wet Season	Dry Season
Irrigated paddy field	3.7	3.5
Rainfed paddy field (HYV)	2.4	2.3 1/
Rainfed paddy field (local)	1.1	-

1/: Yield of dry season paddy under rainfed conditions in the irrigated paddy field II.

At the same time, a rice yield survey was carried out to identify the defects hampering the increase of paddy yields under present condition. The yields for rainfed paddy local is not covered in this survey, it being out of the harvesting season. The results of the survey are summarized in Table D-6.

The yield component of rice comprises 4 factors: (a) the number of panicles per ha, (b) the number of spikelet (grains) per panicle, (c) percentage of ripened grains and (d) 1,000 grain weight. In order to find the defects of the present paddy yield, the relationship between unit yield and each yield components was examined. The correlation is shown as follows;

unit yield	:	number of panicle/ha	r = 0.72
unit yield	:	number of spikelet/panicle	r = 0.21
unit yield	:	% of ripened grains	r = 0.59
unit yield	:	1,000 grain weight	r = 0.29

The statistical analysis indicates that correlation of unit yield of rice to number of panicles/ha and percent of ripened grains is significant, under 95% of reliability. Therefore the most important factors for increase of paddy yield are twofold: (a) the number of panicle/ha and (b) percent of ripened grains.

The general method for increasing the number of panicle per ha is considered as follows;

a) raising healthy seedlings
b) applying an adequate amount of basal fertilizer
c) preventing seedlings from rooting damage after transplanting
d) shallow transplanting
e) careful water management
f) suppressing non-bearing and weak tillers

The general method for increasing the percentage of ripened grains is considered as follows;

a) creating favorable conditions during the period from the initiation of young panicles to heading

b) preventing the production of an excessive number of spikelets

c) making the rice plant strong and healthy by the heading time

d) top-dressing with nitrogenous fertilizers at the full heading time

e) making the rice plant head at the optimum time when good weather lasts for 15 days before heading and 20 days after heading, for 35 days in total

f) reducing damage caused by disease and pest after heading

g) preventing the plant lodging

h) increasing the root activity

In the planning not only of farming practices but also of irrigation and drainage, attention will be given to these general countermeasures.

3.5.6 Farming practices and farm inputs

(1) Farming practices

Fairly intensive rice farming has already been introduced in the greater part of project area, however, conspicuous differences in farming practices of paddy cultivation among farmers growing high yielding variety and those growing local variety are identified through the farm economic survey as in indicated in Table D-7.

Land preparation is commonly practiced by the combination of draft animal and manual labour in the paddy field HYV grown, while manual land preparation is exclusively prevailing in the paddy field local variety grown. Partly mechanical land preparation is practiced in the paddy field HYV grown. As for planting method of paddy, transplanting is practiced in the whole area, however, the "kernap" system is commonly adopted in the area where local variety grown.

The method of harvesting is commonly use of the sickle except the area local variety grown where ani-ani method is prevailing into. With the exception of harvesting by farmers themselves, systems of sharing harvested product, so called as "BORONG", is common. The sharing rate is different depending on location. The prevailing rate is 20% and 13%. The harvested paddy (gabah kering panen) is generally sold to buying agents without drying after harvest and quality of paddy is usually in low grade.

The prevailing farming practices in the project area are indicated in Table D-8.

(2) Farm inputs

As in the farming practices, there are evident differences in the amount of farm inputs between farmers growing HYV and those growing local varieties as identified through the farm economic survey as shown in Table D-7.

The main rice variety prevailing in the project area is IR-46 and IR-64 for HYV and Pagi Sore for local variety. As shown in the table, amount of HYV seeds sown in irrigated field and rainfed field are considerably different, 55 kg and 68 kg per ha on average, respectively. In case of local variety, the same is 44 kg. More than 80% of farmers stock seed from their harvest for the next cropping. Most of the farmers growing HYV use urea and TSP. Regarding KCl, about 60% and 10% of the farmers apply it to irrigated and rainfed paddy field, respectively. The level of fertilizers applied is similar to the level of INSUS package A/B. On the contrary, the farmers growing local variety provide fertilizers on the low level at the rate of less than 30% of the farmers. Agro-chemical (insecticide) supply is commonly practiced in the project area and almost all the farmers growing HYV and 70% of the farmers growing local variety reported use of chemicals. The average amount of chemicals used per ha is in the same level among the farmers growing HYV and the same of the farmers growing local variety is comparatively low.

The total amounts of fertilizers and agro-chemicals(insecticide) applied in the project area are estimated as shown in Table D-9. Annual fertilizer application amounts to 2,800 tons, of which urea accounts for 50%. The amount of insecticides used annually is estimated to be 26 m^3 in the project area.

3.5.7 Labor requirements

(1) Manual labor requirements

The present labor requirements per ha and annual labor requirements in the project area are estimated as indicated in Table D-

10. The labor requirement per ha of paddy cultivation is estimated to be in the range of about 130 to 140 man-days at present and the annual labor requirement at present in the whole project area is estimated to total 1,682 thousand man-days.

Assuming that land preparation work is performed in three weeks and harvesting/processing work in two weeks in a farm at present, the peak demand period for labor forces is harvesting time. On the said assumption, per farm base labor balance study for paddy farming of typical farms at the peak demand period of harvesting time is shown below.

Labor Balance at Peak Demand Period/Harvesting Time

	Irrigated Paddy Field I	Irrigated Paddy Field II 2/	Rainfed Paddy Field/HYV	Rainfed Paddy Field/Local
Farm size (ha)	1.1	0.8	0.8	1.9
Labor requirement for harvesting/ processing (man-days)	44	32	28	57
Available labor force for the period/farm (man-days) 1/	30	30	30	30
Balance	-14	-2	+2	-27

1/: Assumed available labor force per farm is 2.5.
2 weeks x 6 working days/week x 2.5 labor force/farm=30
2/: Wet season

As shown in the table, labor shortage in harvesting time is indicated in rainfed paddy field/local and irrigated paddy fields. The shortage is overcome primarily by prevailing labor procurement system of "Borong". Even in the rest paddy fields, the system is common in the project area.

(2) Animal labor requirements

The buffalo and cattle population in the desas concerned and the estimated population of the same in the project area are indicated in

Table D-11. As shown in the table, the number of buffaloes and cattle in the project area is estimated to be 1,082 and 605, respectively.

Assuming that the draft animal requirement for the presently prevailing land preparation, the combined use of draft animal and manual labor, in about 70% of the paddy field HYV cultivated is fulfilled within the project area and that the land preparation work is performed in about 2 months in a planting season, the labor balance of draft animal requirement is calculated as indicated in Table D-12. As shown in the table, under the said assumptions, it is indicated that the land preparation in the paddy field HYV cultivated is carried out by forcing draft animal 8 hrs work/day and the total requirement amounts to about 23,000 pair of animal days. Although mechanical and solely manual land preparation is practiced at present, it is concluded that land preparation works in the area are conducted by placing heavy duty on draft animals. Land preparation in the lowlying paddy field where local variety cultivated is generally practiced manually.

3.5.8 Farming facilities and on-farm equipment

Farming facilities existing in the concerned desas are indicated in Table D-11 and summarized as shown below.

Irrigation Area	Rice Mill	Rice Storage	Warehouse
Silau irrigation area	56	5	11
Bunut irrigation area	30	1	4
Project area	86	6	15

The number of rice mills in the concerned desas is 86 in total, including 2 large scale mills and 2 RMUs of KUD. The milling capacity of RMU is about 8.0 tons/day on an average. The remaining 82 mills are of small scale with milling capacity of 1.0 to 2.0 tons/day. The small scale mills in village and even RMU are usually operated for milling small quantity of paddy at a time, mainly milling for family consumption. Restricted drying spaces in the project area may be partly attributable

to the same situation. Accordingly, the milling capacity in the project area is considered enough to meet the milling requirement at present.

Shortage of storage facilities of farm products is evident in the project area. 14 and 22 desas among 23 desas reported no public warehouse and rice storage,respectively, as shown in Table D-11. The fact that farmers are marketing their products at comparatively lower price during harvesting season and the fact that some farmers sell out most or all of paddy immediately after harvest without stocking even family requirement may partly be attributable to the shortage of storage capacity in villages.

Number of on-farm equipment in the concerned desas is summarized in the following table.

Irrigation Area	Engine Thresher	Pedal Thresher	Tractor	Hand Tractor
Silau irrigation area	48	280	1	1
Bunut irrigation area	109	24	10	5
Project area	157	304	11	6

The number of tractor is limited to 11 units, although the hiring services of tractor is becoming popular in the project area. Engine thresher and pedal thresher in the concerned desas totals respectively 157 and 304 units. Most of them are considered to be used in common under the prevailing harvesting system of "Borong". The capacity of engine thresher and pedal thresher is about 2.0 tons/day and 0.7 tons/day, respectively. The number of thresher is not considered enough to the present output and manual threshing is still practiced in the project area.

3.5.9 Constraints for farming

Major constraints which have hampered productivity of paddy in the project area identified through the questionnaire and field survey are as follow;

- Water shortage in dry season/lack of irrigation facilities or malfunction of the same,
- Floods and poor drainage,
- Infection and damage by pests, diseases and rats,
- Insufficient agricultural supporting services, especially in rainfed paddy field in lowlying area (rainfed paddy field/local), and
- Insufficient farming facilities, on-farm equipment and draft animal.

Among the said constraints, damages caused by pests, diseases and rats extensively infesting paddy fields in the project area which were identified through farmers' interviews and field survey should be controlled agronomically including the regulation of cropping season in order to secure stable high productivity of paddy. Major pests, diseases and rats affecting paddy in the project area are as follow;

Pest	Brown planthopper (*Nilaparvata lugens*)
	White stem borer (*Tryporyza incertulas*)
	White-backed planthopper (*Sogatella furcifera*)
Disease	Blast (*Pyricularia oryzae*)
	Brown spot (*Cochliobolus miyabeanus*)
Rat	Rattus argentiventer

As for the control activities of pests and diseases of paddy, the pests and diseases forecasting is done in the project area by the Plant Protection Center and agro-chemical spraying is commonly practiced by farmers. While, control is not performed successfully at present, due partly to difficulty in concerted and extensive control operation as the cropping season of paddy is staggered. Agro-chemicals including rodenticide commonly used in the project area are as follows;

Agro-chemicals

Insecticide	Baycarb (BPMC, fenobcarb) Currater 3-G (carbofuran) Mipcin (MIPC) Applaud (buprofezin)
Fungicide	Rabcide (fthalide), Delsene Mx-200 (carbendazin)
Rodenticide	Klerat (brodifacoum)
Herbicide	U-46 (MCPA), Saturn-D (thiobencarb)

In addition to the chemical control of pests and diseases, ecological control through the regulation of cropping seasons is attempted by Bupati office by prescribing the recommended cropping schedule for paddy as explained in the Section 3.5.3.

Occasionally rats cause serious damage to paddy cultivation in the project area, in particular in lowlying rainfed paddy field where local variety is grown. In the project area, an integrated rat control program comprising of: (a) hunting before and after cultivation in paddy fields, (b) use of rodenticide, (c) weeding of dikes and surroundings to reduce shelter for rats, and (d) smudging of burrow by sulfur; are recommended by BPP and cooperative operation by farmer's group is practiced under the guidance of PPL, though the areal extent covered by such operation is restricted. However, the successful control of rats is not achieved in the project area. Major reasons for the same are; (a) integrated control operation is sometimes impossible due to different growing stage of paddy in an area, (b) existence of tree crop estate and swamp land surrounding paddy field which provide shelter to rat, and (c) difficulty in organizing farmers for cooperative control.

3.6 Farmer's Economy

The farmer's economic survey was carried out for the three kinds of the farmers: (a) farmers growing HYV in the irrigated paddy field, (b) farmers growing HYV in the rainfed paddy field and (c) farmers growing local variety in the rainfed paddy field.

The results are summarized in Table D-13. All the figures in this table are an average value.

Net income of the farmer is summarized as follows;

(Unit: Rp. 1000)

Item	Farmers Growing HYV in Irrigated	Farmers Growing HYV in Rainfed	Farmers Growing Local Variety in Rainfed
Farm size (ha)	1.1	0.79	1.85
Farm income	1,399	332	508
i) paddy	1,249	277	390
ii) other crop	109	22	68
iii) livestock	41	33	50
Non-farm income	298	232	547
Total income	1,697	564	1,055

The annual farm income of the farmers ranges from Rp. 0.33 million to Rp. 1.4 million. Income derived from paddy occupies over 80% of the total farm income in any types of the farmers. Income from other crops is mainly derived from coconuts and vegetables in the coconut and home yard. Livestock production is mainly chicken. Non-farm income comprises incomes from working in another paddy field and estate, from money borrowed, from remittance, from fisheries, from pension, from some trading jobs, etc. Particularly income from pension occupies considerable portion of the non-farm income.

Except for farmers growing HYV in the irrigated paddy area, farm income is nearly equivalent to the non-farm income.

The total annual income of the farmers is from Rp. 0.56 million for the farmers growing HYV in the rainfed paddy area in minimum and Rp. 1.7 million for the farmers growing HYV in the irrigated paddy field at maximum. At any cases the annual income of the farmers is low. For increasing farm income it is essential to increase present unit yield of rice and cropping intensity under introduction of year round irrigation.

In order to examine the land use change of coconut field to irrigated paddy field and the results of farmers' intention survey to the change from the farm economic view point, farm economic survey was conducted in the Silau irrigation area where the intention survey of coconut farmers were done as shown in the Section 3.7. The results of the survey are indicated in comparison with the average farm budget of irrigated paddy farming at present in the project area in the following table.

Comparison of Annual Farm Income per Ha

	Irrigated Paddy 1/	Coconut	Balance
Gross income (Rp.000)	1,736	437	1,299
Production cost (Rp.000)	601	40	561
Net income (Rp.000)	1,135	397	738
Labor requirement (man-days/per ha)	280	50	230
Gross income per labor (Rp.000)	6.2	8.7	-2.5

1/: Double cropping of paddy per year

As shown in the table, considerably higher net income per ha is achieved from irrigated paddy cultivation even under the present condition, though the labor productivity is higher in coconut farming in which any farming practices except for harvesting and fertilization are seldom done. Under the with project condition in which improvement of irrigation water supply is projected, further increase of farm income in paddy farming is anticipated. Accordingly, the results of intention survey conducted in the Silau area as indicated in the Section 3.7, positive response of majority of coconut farmers toward land use change, is considered reasonable from farm economic view point.

3.7 Intention of Coconut Farmers in the Project Area

The reconnaissance survey indicated that considerable numbers of the coconut farmers have expectation to change their present coconut farms into the paddy fields. So a detailed survey was carried out of the coconut farmers who live in the both sides of the Silau river

and the northern part of the project area, where there are a lot of coconut yards in the project area.

The results are shown in Table D-14. Over 70% of the coconut farmers, most being concurrent paddy farmers, in both sides of the Silau river responded to willingness to change present land use. On the other hand, over 30% of the coconut farmers in the northern part except Desa Silau Lama responded to negative answer for changing the present land use.

The coconut trees in the both sides of the Silau river were planted between 1944 and 1960 on an average. An age of the most coconut trees exceeds 25 years. From an economic aspect, it is considered that these trees are over economic age for production. Moreover the present market for coconut oil is depressed and the price is low. Also most of the coconut farmers on both sides are concurrent paddy farmers. Farm size of coconut farms is small. Under such situation, it seems that considerable numbers of the farmers responded positively to changing their present coconut farms into the paddy. All the chiefs of desas expressed consent to change the present land use.

However, coconut farmers in the northern part of the project area have relatively large scale coconut farms. The rate of farmers who are engaged in only coconut tree cultivation is high. The coconut trees in the area were planted between 1960 and 1972 on average and are young in comparison with the Silau area. Further the local government has made every endeavor to plant cash trees such as cacao and coffee in this area. Considerable areas were planted by such cash trees in this area. These backgrounds caused negative replies from farmers to the question of changing present land use.

This situation has to be reflected in future land use planning in the areas extending on both sides of the Silau river in regard to changing the present coconut farms scattered in the existing irrigation scheme into the paddy field. Of course the extent of the area to be converted in to paddy fields should be carefully delineated.

From the technical viewpoint, an economic irrigation canal layout becomes possible by converting coconut farm to paddy field in the Silau area.

3.8 Marketing and Processing

The Government interventions in the market of agricultural products have concentrated on rice by the National Logistics Agency (BULOG) at the national level and Regional Logistics Depot (DOLOG) at the provincial level. BULOG has been able to defend the floor price procuring up to about 10% of total production through the village cooperatives (KUDs).

North Sumatra province is the region of the rice shortage. DOLOG in North Sumatra province has procured rice from other provinces, mainly from Java and foreign countries. The actual procured amount of rice in North Sumatra province ranges from 33,000 tons in 1984/85 at minimum and 245,000 tons in 1986/87 at maximum since 1970's.

The marketing of rice from the farmers to consumers in the project area comprises four channels such as through (a) local market, (b) KUD, (c) local rice millers and (d) agent/broker at village level. Paddy is generally marketed to the buyers in the form of wet paddy (gabah kering panen) after harvest.

The results of the farmer's economic survey indicate that 60 to 80% of respondent farmers sell all or some part of paddy products immediately after harvesting. Because most of the farmers need to obtain cash for paying debt, buying commodities for living, etc. Shortage of drying yard for paddy is also the cause of the same Then the farmers must buy rice in the local market in the project area. The economic survey indicates that the respondent farmers to buy rice in the local market account for about 30% in the irrigated paddy field, about 50% in the rainfed paddy field growing high yielding variety and about 80% in the rainfed paddy growing local variety, respectively.

The main marketing channel of paddy in the project area is the channel through agent/broker who shares 60 to 90 % of rice market followed by rice miller, local market and KUD as shown in Table D-13.

Marketed paddy through the channels mentioned earlier is generally dried in drying yard of rice mills before processing. There are 2 large scale rice mills in the project area and 5 large scale rice mills located close to the same operated by private sector. Supposing that an average milling capacity of the mill is 6,000 to 7,000 tons/year, the total milling capacity of the said mills is estimated to be 42,000 to 49,000 tons/year. In addition, there exist 84 small scale rice mills and RMU, in the desas concerned as discussed in the Section 3.5.8. Accordingly, the milling capacity in and around the project area is considered sufficient for the present output. However, in village level, milling capacity is considered insufficient if all the outputs are milled in village level prior to marketing as the milling capacity of small scale mill is limited as discussed in the Section 3.5.8.

With respect to warehousing, it is estimated that the total capacity of the warehouses in and around the project area including Kisaran and Kotamadya Tj. Balai amounts to over 6,000 tons, which provides sufficient space for the present output.

3.9 Agricultural Support Systems

The present overall organization structure on agricultural development is illustrated on Fig. 3-5, containing the government organizations and farmer's organizations.

3.9.1 Mass guidance of agricultural intensification program (BIMAS Program)

BIMAS Program is one of the strongest administrative supporting services for agricultural development in Indonesia. The present BIMAS Program implemented in North Sumatra Province is INMUM, INSUS and SUPRA INSUS. INMUM is applied for individual farmers and

INSUS is applied for farmer groups. SUPRA INSUS is applied for several farmer groups under the same large irrigation system with average irrigated paddy field of 25,000 ha.

For successful implementation, BIMAS Committee chaired by Governor and BIMAS Daily Executive Committee chaired by chief of Regional Agriculture Office are organized at Provincial level. At kabupaten, kecamatan and village level each BIMAS coordination committee chaired by Bupati, Camat and Lurah, respectively is also organized for strong support of implementation of BIMAS Program.

3.9.2 Agricultural extension service

One of the strongest supporting arms for implementation of BIMAS Program is agricultural extension service.

At the kabupaten level, kabupaten BIMAS office is in charge of budget arrangement and personnel management of extension service in the kabupaten including Rural Extension Center (BPP).

Recommendations and guidance in technical practices are prepared by respective service offices of kabupaten. In general, the chief of Kabupaten Food Crops Agriculture Service Office is appointed as the chairman of BIMAS Daily Execution Coordination Committee of kabupaten and the chairman of Forum on Agricultural Extension Coordination in kabupaten simultaneously.

Agricultural extension staff consists of three kinds, i.e. Subject-matter Specialist (PPS), Subject-sector Supervisor (PPUP) and Field Extension Worker (PPL). In kabupaten level, 3 PPS are appointed on an average.There are 9 BPP in Asahan kabupaten, of which 5 BPP cover the whole Project area, namely BPP Sungai Balai, BPP Rawang Baru, BPP Sentang, BPP Sipaku and BPP Sijambi. Number of BPP leader, PPUP and PPL in those 5 BPP are 5, 18 and 47 in total respectively as shown in Table D-15. Total working areas of those 5 BPP consist of 10 kecamatan, 109 villages 43,200 farm household, 30,600 ha of paddy

fields and 42,400 ha of farmers estate crops areas as shown in Table D-16 in detail.

In the project area,one extension worker (PPL) covers 1.5 villages, 920 farm households and 650 ha of paddy fields on an average.

Each Rural Extension Center (BPP) is equipped with similar office building with a leader's room, a large office room and a meeting room with furnitures such as desks, chairs, cabinets and black board.

All extension workers are equipped with a motor-cycle provided by the Government, however other extension facilities such as slide projector, tape recorder, soil tester etc. and modern stationeries such as copy machine, calculator/computer are not provided yet.

Daily activities of extension worker are carried out under the training and visit (TV) system.

Technical information is mostly decided by recommended technology packages A, B, C and D under BIMAS Program. The packages mostly consist of production technique. Post harvest technology, farm mechanization technique and farm management methods including marketing business are not sufficiently provided.

3.9.3 Seed multiplication and distribution

Total certified paddy seed production in North Sumatra was 1,223 tons in 1988 and 1,476 tons in 1989, of which more than 95% of certified paddy seeds were produced by North Sumatra Branch of Sang Hyang Seri seed company (SHS).

North Sumatra Branch of SHS seed company has three seed processing units (UPB), of which one UPB is located in Asahan Kabupaten. This seed processing unit was established in 1986 with capacity of 1,000 tons of paddy seed production per cropping season and equipped with mechanical dryer, concrete drying yard, cleaner and packing machine. Instead of no own farm field, UPB is operating seed

production by adopting "joint working system with progressive farmers groups". Present number of joint working farmer groups is 26 in the project area.

After processing into 5 kg vinyl pack, the extension seeds are distributed to farmers through KUD, PT Pertani and appointed distributors in each kabupaten.

3.9.4 Agricultural research service

Agricultural research service in North Sumatra Province is covered by SARIF station in Sukaramai under Central Research Institute for Food Crops (CRIFC). The main activities of the station are to execute experimental work under the instruction and supervision of the CRIFC and to collect information from extension services and to produce the foundation seeds of newly recommended varieties of food crops such as rice, maize, soybeans, peanuts and mungbeans.

In order to carry out adaptability test for new recommended agricultural technique, Agricultural Development Center was intended to establish in each Province, but it is not realized yet in North Sumatra Province. At present, such adaptability test is conducted in trial fields of each Rural Extension Center (BPP).

3.9.5 Agricultural credit

The Indonesian People's Bank (Bank Rakyat Indonesia/BRI) is the state bank specializing in agricultural credit. The Bank is authorized to finance BIMAS credit for qualified individual farmers.

Since 1985, the BIMAS package system has been replaced by other credit systems as follows:

(i) A continuation of the BIMAS credit through a reliable KUD as an intensification credit channel, whereby the farmer can get a loan which is selected from packages A, B, C and D according to his requirement.

(ii) "Kupedes" credit (General credit for rural area). It can be utilized by farmers if a reliable KUD is not available. Kupedes credit has been extended through BRI.UD (Village Unit Sub Branch of Indonesian People's Bank) since May 1984 for farmers who have more than 1.0 ha of paddy fields and more than 2.0 ha of upland. The loan amount of the credit can be decided between Rp. 25,000 and Rp. 1,000,000 for investment and operational purpose with 1% to 2% of monthly interest rate depending on certain conditions.

(iii) "KIK" credit (Small investment credit) is a government credit program especially for small investments which has been applied to such agricultural activities as land development program where new paddy fields are constructed.

3.9.6 Farmer's organization

(1) KUD (Cooperative)

In the whole project area, there are 14 KUDs, of which 9 KUDs are in the Bunut irrigation area and 5 KUDs in the Silau irrigation area as shown in Table D-17. Most of KUDs in the project area were established more than ten years ago, however number of membership is still limited to only 3,930 farmers, or is about 21% of total farm households in the covering area.

Average number of members per KUD is 256 in the Bunut irrigation area and 406 in the Silau irrigation area. The largest number of member of KUD is 818 and the smallest is only 45 members.

Admission fee and annual membership fee are mostly same, Rp. 3,000 and Rp. 2,400 respectively.

Main function of KUD is such economic activities as supply of farm inputs, farm credit (especially BIMAS credit since 1982/83),

processing and marketing of farm products. However, four KUDs have no key facilities such as storage, small shop (Kiosk) and rice mill.

There are two RMUs in two KUDs. The milling capacity is 1 ton/hr or more than 2,000 tons per year. However, it seems to be too over capacity for management capability of these KUDs. At present, operation hour is only limited to 1.5 hr/day in one KUD and 3 hr/day in the other. Usually, these rice mills are used for milling operation service to the member farmers who bring about 10-50 kg of paddy for milling at one time. Therefore, actual operation efficiency of RMU has to be decreased to about or less than a half of designed capacity.

Activities of KUD in the project area are not yet so active. According to the BIMAS Program in 1988 applied in the related villages, potential handling amount of farm input in each KUD is estimated at Rp. 1,648 million in total as shown in Table D-18. Actual handling amount and sales amount of KUDs in the project area in 1988 were Rp. 635 million and Rp. 384 million respectively which were only 38.5% and 23.3% of potential handling amount estimated.

Low tone of KUD's activities makes feeling of farmers non attractive to KUD. No farmer pay attention to the development of KUD. This causes little increase of number of new members and much increase of members without payment of membership fees.

Present main problems facing by most of KUD in the project area are summarized as follows:

(i) management skill of KUD is still primitive.
(ii) service of KUD is not sufficient.
(iii) location of KUD is far from most of farmers.
(iv) shortage of fund of KUD hardly gets economic scale merit.

(2) Water User's Associations (P3A)

In the North Sumatra Province, Water User's Associations (P3A) were once organized in every village in early 1970, although irrigation

facilities did not cover all the villages. After the irrigation systems were developed by PU Province or PU Kabupaten, some consolidation in organizational structure of P3A was made since late 1970. At present, total number of P3A in the project area is counted 14 of which 10 P3As are organized as P3A Union.

In general, executive staffs other than chairman, secretary and treasures comprise a few water masters (Ulu-ulu) and several ditch tenders (Ili-ili) depending on the scale of irrigation system. Most of the P3A Unions appoint advisors from generally village chief and field extension worker (PPL) concerned.

Ulu-ulu covers one irrigation block with around 60 to 150 ha. Under the ulu-ulu, the area is sub-divided into several irrigation units of around 10 to 30 ha commanded by each ili-ili as shown in Fig. D-8.

Special characteristics of P3A organization in the project area is closely integrated with farmer groups. In general, one ili-ili consists of one farmer group although there are some variation.

The areas of some farmer groups are completely under irrigated paddy field and just same as of irrigation unit. Some farmer groups have partly rainfed paddy fields which are out of irrigation unit, as shown in Fig. D-8.

The most serious problem of P3A is the existence of large number of non-member farmers in the planned irrigation area.

In the Bunut irrigation area, average participation rate of member farmers is only 52% and in the Silau irrigation area, 66 % as shown in Tables D-19 and D-20. This is mainly because actual irrigated area is decreased to some extent about 70-50 % of original planned irrigation area at present. Most non-member farmers are actually not benefiting from the irrigation system. Amount of membership fee fluctuates by season and by year. This makes effective management of P3A very difficult.

(3) Farmer groups

In order to facilitate the agricultural intensification program, all extension workers have been promoting farmer groups based on the following standard prepared by the central government. Namely, each farmer group is organized with the farmers:

(i) in one continuous farm fields of around 25-100 ha,
(ii) in one whole hamlet,
(iii) in one irrigation unit and,
(iv) total number of farmer groups is sixteen in each working area of extension workers.

The present applied working pattern of extension workers is so called training and visit (TV) system aiming to visit every farmer groups or key farmers (leader of farmer group) once two weeks or twice a month. Therefore, the number of 16 farmer groups in each working area of extension workers makes smooth operation of TV system of extension activities.

In the project area, more than 90% of the farmer groups were established during the six years from 1975 to 1980. The number of farmers' groups is 173 in the Bunut irrigation area and 108 in the Silau irrigation area. The average number of member farmers is 62 per farmer group, and average paddy field of a farmer group is about 44 ha ranging from 23 ha to 55 ha in the project area.

In the project area, about 26% are classified as Primary Groups, about 49% are Advanced Groups and about 24% groups are Progressive Groups. Excellent Groups have not been realized yet, not only in the project area but also in the whole Province at present.

Organization of farmer groups classified as Primary Group is simple enough. Only one key farmer (leader of farmer group) and secretary are appointed, however those of Progressive Groups have a treasurer, sub farmer groups such as Food Crops, Livestock, Plantation Crops and Fishery and some sections such as P3A, Plant Protection,

Information, Radio Listening, Woman Farmer and Rural Youth as required and necessary for the members, as shown in Fig. D-9.

Generally, most farmers' groups have no admission fee and no membership fee, therefore no accounting record and no common property, except a few farmer groups which own a meeting cottage with desks and chairs.

Most of the farmers' groups have regular weekly meeting with extension workers. The topic of meeting is usually technical notice on the following weekly farm practices which are directed under the recommended technology package.

Activities of farmer groups should be more emphasized on self-determination joint activities such as group cultivation carried out by joint working farmer groups of seed production at present, joint utilization, management and ownership of farm machinery and joint marketing in order to be a core self-depending farmer group by solving their own technical and economic problems of the group.

3.9.7 Plant protection services

Plant protection services in Indonesia are provided by the Department of Plant Protection, Director General of Food Crops Agriculture Service. Under the department, five Plant Protection Centers are established and actual activities are performed by the Center. The plant protection services by the Center are primarily focused on forecasting of pest and disease occurrence. In North Sumatra province, the center is established in Medan which covers both North Sumatra and Ache provinces. The functions of the Center comprises forecasting and control of pest and disease, dissemination of plant protection technique and research activities. While, the major activity is forecasting and other activities are limited. Field activities of the Center are performed by two Laboratories and three Plant Protection Brigades in the province. Plant protection services in the project area is carried out by the Laboratory and Brigade stationed in Kisaran. With respect to forecasting of pest and disease occurrence,

field survey is carried out by field observers (PHP) stationed in BPP and the results of the observance are reported to the Food Crops Agriculture Service Office of Kabupaten Asahan through BPP for further action. In principle, control activities are responsibility of farmers under the guidance of the Office and BPP. The control activities of the Center is limited to supply of chemicals and control equipment to farmers. Chemicals supplied by the Center in the Kabupaten Asahan in the past three years are indicated below;

(Unit: kg)

	1986	1987	1988	Average	Area Covered 1/
Insecticide	2,501	3,430	3,942	3,291	3,291 ha
Fungicide	40	618	70	243	243 ha
Rodenticide	560	250	500	437	437 ha

1/: Average area covered by services. Rate of supply is 1 kg/ha.

As indicated in the table, chemical supplies by the Center are limited and actual control of pests and diseases in the area is depending on farmer's intention. As described in Section 3.5.9, pests and diseases including rat attack are one of the serious constraints which limits paddy productivity in the project area. Therefore, the organization of further integrated control activities of farmers and agencies concerned are an important action for the productivity increase of paddy in the project area.

4. THE PROJECT

4.1 Basic Concept

4.1.1 Development needs

North Sumatra province has suffered from a shortage of rice for many years. Rice has had to be imported from other provinces. In recent years about 200,000 tons of rice has been imported.

The total population in North Sumatra province was estimated to be about 9.9 million in 1987. The population in 2005, target year of the master plan, is estimated at about 13.6 million. Demand of rice in the target year is forecast to be about 3.6 million tons of paddy. On the other hand, production of rice in year of 2005 (the target year) will be only 2.4 million tons of paddy if new irrigation and/or drainage projects are not implemented during the period up to the target year. It is predicted that a 1.2 million tons shortage of paddy will occur by the year 2005 in the province. It is, therefore, important to place a development priority on increasing in provincial rice production .

The lower Asahan river basin having about 6,000 km^2 has the big potential to contribute significantly to achieve self-sufficiency in rice in North Sumatra province by increasing paddy production.

The Silau-Bunut rehabilitation irrigation project is the first priority project among ten projects that were formulated in the agricultural master plan in the lower Asahan river basin and follows the basic concept proposed in the master plan.

As explained in Chapter 3, the project area, unit yields of paddy are low, and rice production is severely affected by natural disasters such as droughts, pests and diseases, floods, etc. In spite that irrigation area occupies 45% of the total paddy field in the project area, the area having year round irrigation systems is only 15% of the total paddy field. With the exception of the small part of the irrigation area,

irrigation water supply is not made properly due to deterioration of facilities, malfunction of the facilities, improper alignment of the existing canals, shortage of water management activity, etc. Moreover, absolute shortage of the river discharge during the dry season occurs in the irrigation area in the Bunut river basin. As a result, cropping intensity in the project area is low.

Furthermore, the farm size per farm household is small, so that farmer's economy remains at the subsistence level. It is necessary to raise farmer's incomes through enhancement of agriculture, especially of rice production.

4.1.2 Objectives and strategy for development

The assessment of development needs for the project area indicates that the Silau-Bunut irrigation project should aim:

(i) to maximize the potential agricultural benefits through efficient use of the available land and water resources,

(ii) to increase rice production for self-sufficiency of rice in North Sumatra province, and

(iii) to upgrade the present depressed living standards of the farmers in the project area.

In order to maximize the potential agricultural benefits, special attention has been paid on water resources development through inter-basin transfer of available water of the Silau river to the Bunut river basin. Also some part of the coconut farm where extends over both sides of the Silau river has been planned to change into the paddy field.

For increasing rice production, it is necessary (a) to increase the unit yields of paddy, (b) to increase the annual cropping intensity of paddy in the existing paddy fields, and (c) to increase the area of paddy fields.

To increase the unit yield of paddy, improved irrigation farming should be introduced. To increase cropping intensity and the area of paddy fields, the following measures are essential; (a) rehabilitation and improvement of the existing irrigation and/or drainage systems, (b) diversion of available water of the Silau river to the Bunut river basin, (c) provision of irrigation and drainage facilities to rainfed paddy, and (d) land use change in some portion of the coconut field.

In addition, institutional reinforcement not only for the government staff but also for farmers in the project area is essential for smooth and effective operation and maintenance of the project.

4.2 Delineation of the Project Area

4.2.1 General

Delineation of the project area is made from broad and comprehensive viewpoints taking into account all the related factors such as water sources available for irrigation, agricultural conditions, land use, soils and land suitability, flood control, present irrigation and drainage conditions, as well as socio-economic conditions, etc. Of these, the most crucial factors for the present project-formulation works are considered to be the following:

(i) Available water resources for irrigation development without provision of artificial reservoirs in rivers or farm ponds

(ii) Drainability by means of a gravity system

(iii) Land suitability especially with respect to soils

The objective area for the in-depth study of about 20,000 ha is located in and around the first priority area selected in the Master Plan Study on Agricultural Development. It is noted that most of the objective area of the study is covered by the detailed topographic maps at 1/5,000.

As a result of the study, an area of 14,300 ha gross, 10,300 ha net paddy area, was delineated as the project area.

The basic data and information employed and/or referred to for the delineation study are summarized below:

(i) Topographic maps (S= 1/50,000, CI= 25 m, 1974)

(ii) Detailed topographic maps
(S=1/5,000, CI= 1.0 m, coverage area = 20,800 ha, Oct. 1989, JICA)

(iii) Low-flow analysis results of the Silau and the Bunut rivers
(10-day basis, 20 years)

(iv) Tidal condition survey results (Nov. 1989)

(v) Semi-detailed soil map
(S = 1/50,000, Directorate of Planning of DGWRD/CV. SECON, 1989)

(vi) Land suitability map (S = 1/50,000, DGWRD/CV. SECON, 1989)

(vii) Inventory survey results of existing irrigation and drainage areas (Oct/Nov. 1989)

(viii)) Irrigation and drainage condition investigation results

(ix) Detailed design of the "Urgent flood control project for the Silau River" (Directorate of River, DGWRD, June, 1989)

4.2.2 Delineation of the project area

Based on the results of surveys and investigations in the field, and studies and analyses on the various fields, the delineation is made by the following criteria. The main points assessed and their salient descriptions are summarized as below.

Drainability

The ground elevation of the project area had to be higher than El. 2 m to ensure the proper drainage taking into account the tidal influence to the low-lying area. Existing paddy fields located below El. 2 m, within the detailed mapping area at S=1/5,000, are estimated to amount to about 1,200 ha. The lowlying area below El. 2 m is to be

developed under the Tambung Tulang Swamp Project in future in accordance with the schedule proposed in the Master Plan.

Water source

The maximum commanded area of the Silau and Bunut rivers to meet the irrigation demand of the proposed cropping pattern, is estimated at 11,000 ha through water balance study. The water balance study is made taking into consideration the downstream river maintenance flow of 26 m^3/sec for the Silau river and 1.8 m^3/sec for the Bunut river. A detailed description of the water balance study is given in Section 4.4.4.

Soil condition

The results of the soil survey indicate that all the soils in the area with ground elevation higher than El.2 m. are classified into class S1, class S2 and class S3 in land suitability . These soils are suitable for irrigation farming.

Land use condition

In principal, the objective area of the project is the existing paddy fields. Some coconuts fields which are scattered in the existing irrigated paddy field areas, however, are considered to be changed into paddy field in the with project condition. These areas will be included in the project area when the farmers' intentions to change the land use condition to paddy field are confirmed by the field investigation.

Irrigability

Assuming that the present intake water level of the four river intakes on the Bunut river is not raised by the project to avoid a significant change of present river channel, about 200 ha of the existing paddy area on the left bank of the river have been excluded since gravity irrigation is the basic concept of the irrigation plan.

The project area is delineated on the detailed topographic map of S=1/5,000 by reference physical boundaries such as roads and rivers. As a result, the deliniated project area is 14,300 ha in gross with net paddy fields of 10,300 ha.

4.3 Agricultural Development Plan

4.3.1 Proposed land use

In accordance with the development strategy for efficient use of the available land and water resources, increase of rice production and improved irrigation farming, expansion and strengthening of irrigated rice farming is envisaged in the present project. The basic approaches for formulation of future land use are as follows;

(i) introduction or improvement of irrigated rice farming through the development and rehabilitation of irrigation and drainage facilities,

(ii) some of coconut fields (750 ha) to be converted into paddy field in order to comply with farmers' intentions to introduce double cropping of irrigated paddy,

(iii) development of upland fields and swampy grassland is not intended and continuation of present land use is assumed, and

(iv) 10% of the gross area of paddy fields to be utilized for canal, road and other facilities under the project.

In accordance with the above, the future land use in the project area is formulated as indicated in Table 4-1. Irrigated paddy field where irrigation water supply throughout a year is possible will increase to 10,300 ha in net from the present 1,480 ha. The implementation of development of irrigation and drainage facilities will provide a firm base for successful irrigation farming and the realization of the plan is anticipated after the completion of the project.

4.3.2 Proposed cropping pattern

For formulation of future cropping pattern, various factors affecting the cropping pattern including: (a) climatic conditions, (b) plant physiological features, (c) farming practices, (d) water balance study, (e) drainage study, (f) water management and (g) land suitability; have been conceived as well as the following basic principles:

The proposed pattern is;

(i) to create possible benefits for the farmers and the nation as a whole as well,
(ii) to make optimum utilization of water to be supplied by the project, and
(iii) to conform with the existing social tradition and be acceptable to farmers.

On the basis of the above study, double cropping of paddy per year is formulated as the proposed cropping pattern as illustrated in Fig. 4-1.

The possibility of introducing upland crops in the dry season has been examined, however, soil acidity and farmer's reluctance to upland crop cultivation during the dry season due to pest attacks present great difficulties. Accordingly, upland crop cultivation is not proposed.

In the pattern, high yielding varieties are planned to be introduced in both wet and dry seasons. Wet season paddy will be transplanted from October to December and harvested from February to March. Dry season paddy will be transplanted from April to May and harvested from July to August. The staggering period is designed to be 1.5 months. The framework of the cropping calendar is made taking into consideration of the followings:

(i) The harvesting time should avoid the wettest period.

(ii) The period between the end of harvesting and the beginning of planting is designed to avoid overlapping in order to prevent damages from pests, diseases and rats.

(iii) The calendar is designed so as to benefit from sunny weather in the critical growth periods in terms of sunlight requirement as much as possible. The critical growth period is from about 15 days before heading to about 25 days after heading.

(iv) In order to prevent damage to seedlings and young plants at the stage of planting from inundation, commencement of wet season cultivation is designed to avoid the wettest periods of September and October as far as possible.

4.3.3 Proposed farming practices and farm labor balance

(1) Proposed farming practices

Proper farming practices are essential for realizing the full exploitation of agricultural potential in the project area. It is necessary to introduce high yielding varieties with appropriate farming practices along with the development and strengthening of institutional supports. The existing farming practices with local varieties should be improved and replaced with the farming practices proposed.

The proposed farming practices are formulated on the basis of the findings of the rice cutting survey conducted and the farming guidelines prepared by the provincial Food Crops Agriculture Service Office. In the proposed practices, high productivity of paddy shall be aimed at especially through: (a) improvement of land preparation practice or introduction of an appropriate practice of the same, (b) cultivation of certified seeds, (c) proper preparation of seedlings, (d) adequate planting density, (e) intensive application of farm inputs, (f) proper crop management including water management in the field, and (g) regulation of cropping seasons aimed at reduction of infestation and

damage caused by pests, diseases and rats. On the basis of the basic principles, the future farming practices are proposed as indicated in Table D-21.

The total amount of fertilizers applied per year in the project area under the proposed farming practices is estimated to be 11.9 thousand tons, an increase of 9 thousand tons from the present level or about 420% of the same. The amount of agro-chemicals used per year will increase to 62 m^3 from the present 26 m^3 or about 240% of the present level as shown in the following table.

Description	With Project		Present/Without	Balance
	per Ha (kg)	Total (ton)	Total (ton)	(ton)
Fertilizer				
Urea	225	4,600	1,400	3,200
TSP	150	3,100	1,100	2,000
KCl	100	2,100	200	1,900
Anmm.Sulphate	100	2,100	100	2,000
Total	575	11,900	2,800	9,100
	(l)	(m^3)	(m^3)	(m^3)
Agro-chemicals	3.0	62	26	36
Cropped area/year (ha)		20,600	12,960	7,640

(2) Farm labor balance

The labor, draft animal and machinery requirements per ha with and without project conditions are estimated as shown in Table D-22. The available labor forces, draft animals and machinery in the project area are estimated as indicated in Table D-11.

The irrigated paddy field envisaged under the project is 10,300 ha, slightly decreased from the cultivable area under without project condition (including coconut fields converted into paddy field under the project). While, the cropping intensity will rise from the present/without 120% to 200% in the project. On the basis of the proposed cropping pattern and the proposed farming practices, the balance of manual labor was calculated as indicated as shown in Table D-

22. The annual total labor requirement is estimated to be about 3.32 million man-days, an increase of 1.64 million man-days from the requirement of 1.68 million man-days under the present and without project condition. Upon completion of the project, the annual participation ratio of available labor forces in the project area will increase to about 60% from the present/without 30% and the employment opportunities of those engaging in farming will be about doubled in the future.

The monthly basis labor balance study is indicated in Table D-23. As shown in the table, the peak demand period for labor occurs in November and April, major seasons for land preparation and transplanting, while the future labor requirement will be fulfilled within the project area with limited supplemental labor supply from desas concerned.

The results of the labor balance study on draft animal requirements are indicated in Table D-24. Assuming that the presently practiced land preparation methods are continued, the combination of draft animal and manual labor in 70% of the paddy fields presently HYV grown (6,950 ha) and manual preparation and in the rest mechanical preparation, the draft animal requirement in the future will be fulfilled within the project area by forcing considerably heavy duty on draft animals as presently practiced. While if the introduction of land preparation by draft animal is envisaged in the whole project area, the shortage of about 29,000 pairs of animal days or about 1,900 heads of draft animals of working age is predicted in the project area. Accordingly, efforts for the expansion of mechanical land preparation, the strengthening of INTEK (Intensifikasi Ternak Kerja, Draft Animal Labor Intensification) program and the import of draft animals to the project area will be required in order to support the introduction of appropriate land preparation practices by farmers. Specifically, the strengthening of INTEK program which has been newly operated in the project area is to be promoted.