

No. 2

REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS

DIRECTORATE GENERAL
OF
WATER RESOURCES DEVELOPMENT

ROKAN RIVER BASIN
OVERALL IRRIGATION DEVELOPMENT PLAN STUDY

VOLUME I
MAIN REPORT

OCTOBER 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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ROKAN RIVER BASIN OVERALL IRRIGATION DEVELOPMENT PLAN STUDY
VOLUME I
MAIN REPORT

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PREFACE

In response to a request from the Government of Indonesia, the Government of Japan decided to conduct the Rokan River Basin Overall Irrigation Development Plan Study and entrusted the study to the Japan International Cooperation Agency(JICA).

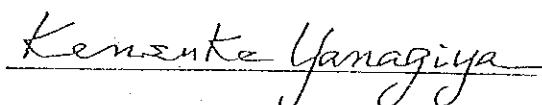
JICA sent to Indonesia a study team headed by Mr. Minoru IKEDA, Japan Irrigation and Reclamation Consultants Co., Ltd., four(4) times between January 1991 and August 1992.

The team held discussion with the officials concerned of the Government of Indonesia, and conducted field survey at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relation between our two countries.

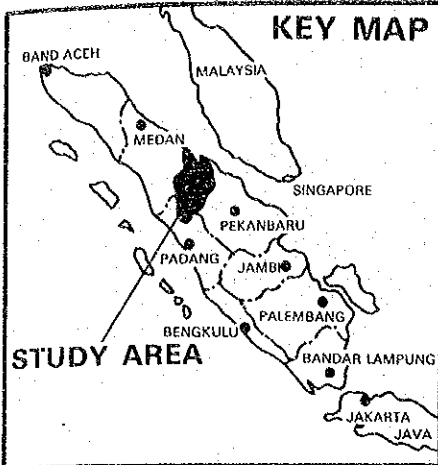
I wish to express my sincere appreciation to the officials concerned of the Government of Indonesia for their close cooperation extended to the team.

Tokyo, October 1992

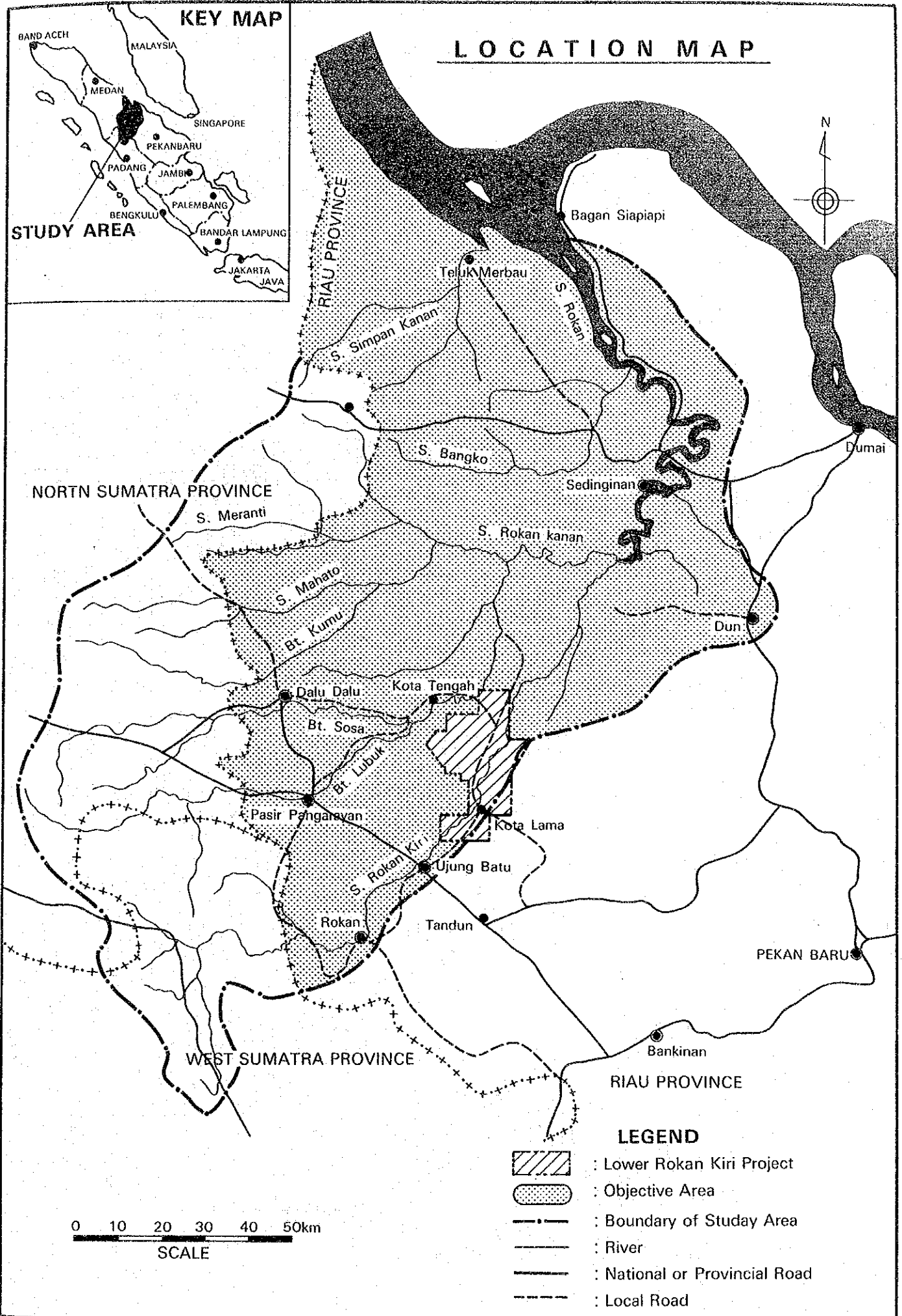


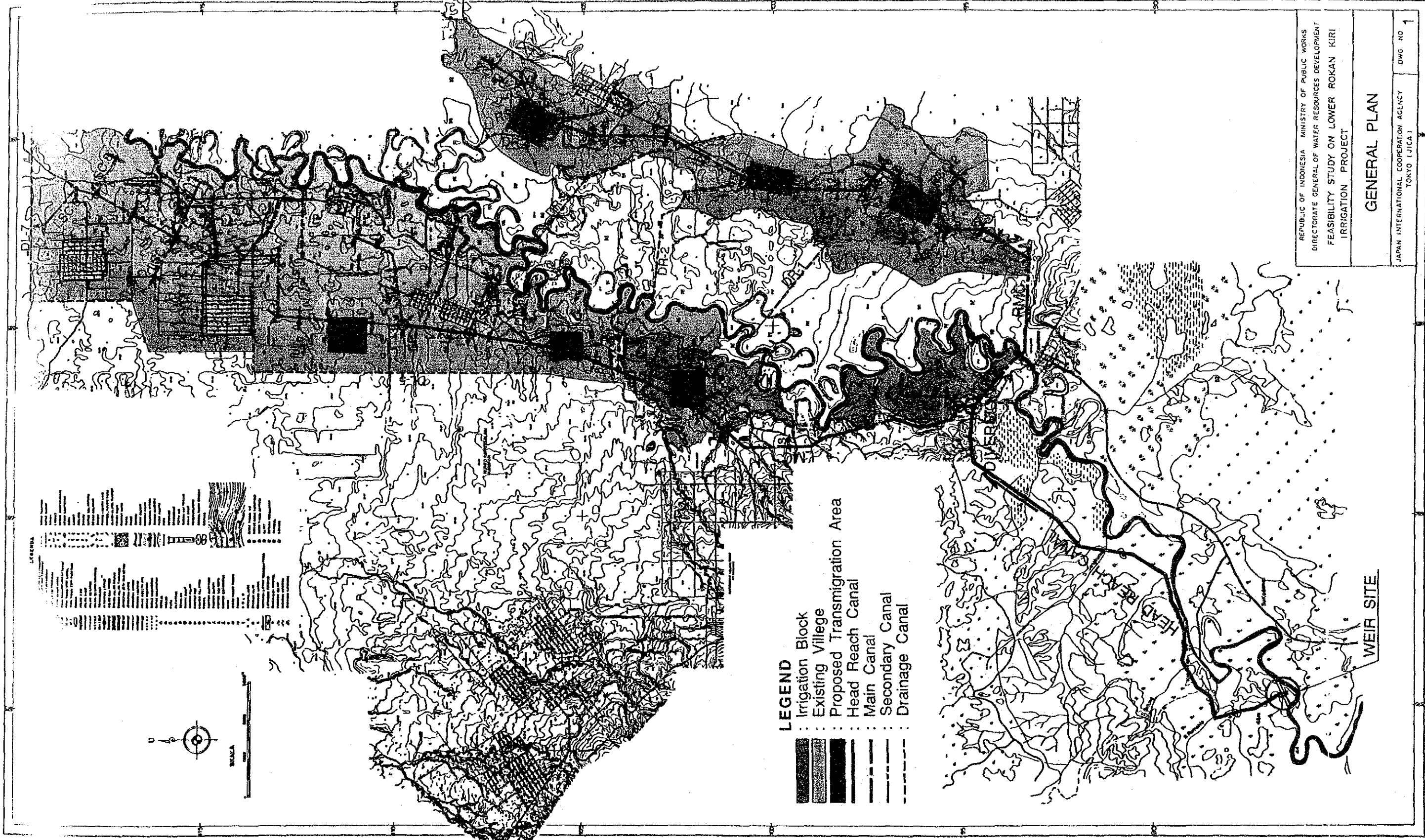
Kensuke Yanagiya
President

Japan International Cooperation Agency



LOCATION MAP





- LEGENDA**
- ▨ : Irrigation Block
 - ▨ : Existing Village
 - ▨ : Proposed Transmigration Area
 - : Head Reach Canal
 - : Main Canal
 - : Secondary Canal
 - - - : Drainage Canal

REPUBLIC OF INDONESIA - MINISTRY OF PUBLIC WORKS
 DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
 FEASIBILITY STUDY ON LOWER ROKAN KIRI
 IRRIGATION PROJECT

GENERAL PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY
 TOKYO (JICA)

DWG NO 1

ROKAN RIVER BASIN
OVERALL IRRIGATION DEVELOPMENT PLAN STUDY

FINAL REPORT

VOLUME I

MAIN REPORT

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ABBREVIATION OF TERMS AND GLOSSARY

AAETE	Agency for Agricultural Education, Training and Extension
AARD	Agency for Agricultural Research and Development
ADB	Asian Development Bank
AGRARIAN	Badan Pertanahan Nasional
ARR	Automatic Rain Recorder
AWLR	Automatic Water Level Recorder
BAKOSURTANAL	National Coordination Agency for Survey and Mapping
BAPPEDA	Badan Perencana Pembangunan Daerah (Provincial Development Planning Board)
BAPPENAS	Badan Perencanaan Pembangunan Nasional (National Development Planning Board)
BI	Bank Indonesia
BIMAS	Bimbingan Massal Swa Sembada Bahan Makanan (Mass Guidance for Self Sufficiency in Foodstuffs)
Bina Marga	Directorate General of Highways
BPP	Balai Penyuluhan Pertanian (Agricultural Extension Center)
BRI	Bank Rakyat Indonesia (People's Bank of Indonesia)
BRIUD	Bank Rakyat Indonesia Unit Desa (Village branch of BPI)
BULOG	Badan Urusan Logistik (National Logistics Agency)
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
DBP	Direktorat Bina Program (Directorate of Planning and programming)
DCF	District Coordination Forum
DCRP	Directorate of City and Regional Planning
Desa	Village or group of small villages
DGCK	Directorate General Cipta Karya
DGFCA	Directorate General of Food Crops

	Agriculture, Ministry of Agriculture
DGWRD	Directorate General of Water Resources Development, Ministry of Public Works
DIP	Project Implementation Budget
DJPP	Direktorat Jenderal Penyiapan Pemukiman
DOI	Directorate of Irrigation
DOLOG	Depot Logistik (Regional Logistics Depot)
DP	Departemen Pertanian
DPE	Departemen Pertambangan dan Energi
DPMA	Direktorat Penyelidikan Masalah Air
DPT	Dinas Pertanian Tanaman Pangan
DPU	Direktorat Pekerjaan Umum (Ministry of Public Works)
DPUP	Departemen Pekerjaan Umum Propinsi
DT	Departemen Transmigrasi
E/S	Engineering services
FC	Foreign currency
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 assistance system
HYV	High yielding variety
IBRD	International Bank for Reconstruction and Development (World Bank)
ICB	International competitive bidding
IFAD	International Fund for Agricultural Development
IGGI	Inter-governmental Group on Indonesia
INMAS	Intensifikasi Massal (massive intensification for self sufficiency in food)
INMUM	Intensifikasi Umum
INSUS	Intensifikasi Khusus (Special intensification program)
IPB	Institute Pertanian Bogor
ISSP	Irrigation 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 or Kab.	Administrative district within the Province
KANWIL	Kantor Wilayah (Regional Office of the Respective Ministries)
Kecamatan or Kec.	Administrative 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
LPT Bogor	Lembaga Penelitian Tanah Bogor (Soil Classification system of Bogor)
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 (1,000,000 m ³)
M/M	Man-months
MOA	Ministry of Agriculture
OECF	The Overseas Economic Cooperation Fund, Japan
O & M	Operation and maintenance
Palawija	Non-rice food crops like maize, cassava, soy-bean and groundnut
P3SA	Proyek Perencanaan Pengembangan Sumber-Sumber Air
P4S	Proyek Pembukaan Persawahan Pasang Surut
PBME	Project benefit monitoring and evaluation
PCF	Provincial Coordination Forum
PDAM	Perusahaan Daerah Air Minum (Ministry of Drinking Water)
PELITA V	The Fifth 5-year Development Plan 1989/1990 - 1993/1994
Pengamat	Water distribution supervisor
PLN	Perusahaan Listrik Negara

PMF	Probable maximum flood
PMP	Probable maximum precipitation
Polowijo	All annual crops other than rice, sugar or vegetables grown on wet paddy land
PPA	Penjaga Pintu Air (Gate operator)
PPK	Penyuluhan Pertanian Kecamatan (Extension workers on Camat Level)
PPL	Penyuluh Pertanian Lapangan Field Extension Worker
PPM	Penyuluh Pertanian Madya (agricultural extension supervisor)
PPS	Penyuluh Pertanian Spesialis (agricultural extension specialist)
PPUP	Penyuluh Pertanian Utama Pratama (subject-sector supervisor)
PPW	Program Pengembangan Wilayah (Regional Development Program)
PRPTE	Program for the rehabilitation and expansion of export crops, Ministry of Agriculture
PT	Dinas Pertanian Tanaman Pangan (agricultural service)
PU	Pekerjaan Umum - Public Works Services
PUSDATA	Pusat Pengolahan Data (Center for Data Processing and Mapping)
PUSKUD	Pusat Koperasi Unit Desa Propinsi Riau (Central of Village Unit Cooperative of Riau Province)
PUS-LITBANG Public	Institute of Hydraulic Engineering Agency For Research and Development, Ministry of Works
PUSRI	Pupuk Sriwijaya
P2AT	Proyek Pengembangan Air Tanah (Groundwater Development Project)
P3A	Perkumpulan Petani Pemakai Air (Water Users Association)
P3SA	Proyek Pengembangan dan Penyelidikan Sumber-sumber Air (Water Resources Development and Planning Project)
RMG	Rheinische Missiongesellschaft
Rp.	Indonesia Rupiah
RSS	Ribed Smoked Sheets of Rubber
Sawah	Wet rice field
SCF	Standard conversion factor

SHS	Sang Hyang Seri Seed Company
SUPRA INSUS	Super Intensifikasi Khusus
S/W	Scope of Work
TA	Technical Assistance
TOR	Terms of reference
TSP	Triple Super Phosphate
Ulu-ulu	an employee of the P3A responsible for O&M of tertiary unit
UNDP	United Nations Development Program
USAID	United States Agency for International Development
USDA	United States Development Agriculture
VOC	Dutch East Indies Company
VRSS	Veterinary Research Sub-Station
Waker	Assistant to the Juru stationed at the main river offtake
WKBPP	Wilayah Kerja Balai Penyuluh Pertanian
WKPP	Wilayah Kerja Penyuluh Pertanian (working area of field extension worker)
WUA	Water User Association
WUAO	Water User Association Organizer

LIST OF COUNTERPART PERSONNEL

<u>Specilaity</u>	<u>Name</u>	<u>Office</u>
Team Leader	Ir. Ishak Hasan	DPUP
Irrigation & Drainage	Ir. Dadi Komardi ME	DPUP
	Ir. Suhenda	DPUP
Hydrology	Ir. Slamet Wahyudi BIE.	DPUP
	Mr. Damsir BIE	DPUP
Geology	Mr. Syahrial Azhar BSc	DPUP
Soil & Land Use	Ir. Januaris	DPUP
Farm Practices and Cultivation	Ir. Ir. Irwan	DPUP
Environment Assessment	Ir. Muhsin Zaini Dipl.HE	DPUP
Agro-economy and institution	Ir. Irwan	DPUP
Facility Plan	Ir. Syamsul Dipl. HE	DPUP
Project Evaluation	Mr. Garwono W. ME	DPUP

LIST OF MEMBER OF SURVEY TEAM

<u>Speciality</u>	<u>Name</u>	<u>Assigned Period</u>
Team Leader	Mr. M. Ikeda	Phase I & II
Irrigation Development plan/ Co-team leader	Mr. H. Arai	Phase I & II
Meteo-hydrology	Mr. Y. Gomyo	Phase I & II
Geology	Mr. H. Asada	Phase II
Basin Development	Mr. T. Miyabayashi	Phase I
Soil and Land Use	Mr. Y. Zaitso	Phase I
Soil and Land Use	Mr. H. Ohnuma	Phase II
Farm Practices	Mr. T. Tamura	Phase I & II
Environmental assessment	Dr. S. Hasegawa	Phase I & II
Agro-economy and institution	Mr. S. Masumura	Phase I & II
Facility Plan	Mr. S. Hoshino	Phase II
Project Evaluation	Mr. T. Tanabe	Phase II

A. SUMMARY

1. INTRODUCTION

1. This is the Final Report(Main Report) prepared in accordance with the Scope of Work(S/W) and Minutes of Meeting agreed upon between Directorate General of Water Resources Development (DGWRD), Ministry of Public Works and Japan International Cooperation Agency(JICA) on October 1990 for the Rokan River Basin Overall Irrigation Development Plan Study.

2. The study was conducted dividing two(2) stages, namely Phase I and Phase II. The Phase I study was carried out from January to August 1991 and in this study, the basin development plan for the Rokan River was set up. As a result, the Lower Rokan Kiri Project, the Lower Sosa Project and Mahato Project have been selected as the irrigation projects to be proposed for further studies. After scrutinizing three projects, the Lower Rokan Kiri Irrigation Project is set up as the priority project finally. In Phase II study, which was made from January to August 1992, the feasibility study on the priority project, the Lower Rokan Kiri Irrigation Project, was carried out to establish irrigation development plan and to study economic feasibility for the implementation of the project.

3. The Final Report consists of four(4) Volumes as follows;

Volume I MAIN REPORT

Volume II OVERALL IRRIGATION DEVELOPMENT PLAN STUDY
IN ROKAN RIVER BASIN

Volume III FEASIBILITY STUDY ON LOWER ROKAN KIRI
IRRIGATION PROJECT

Volume IV DRAWINGS

This main report presents the summary of the Volume II and III above.

2. ECONOMIC BACKGROUND

4. Indonesia is an archipelago consisting of about 13,700 islands of varied size and character. It has a land of about 1.95 million km² and a population of 179.2 million in 1990. An annual growth rate of population in Indonesia is 1.98 per cent between 1980 and 1990.

5. The focus of the current development plan, Repelita V (1989/90-1993/94), is to create a financially sound and consolidated economy, that is, an economy where fluctuations of world oil prices could be cushioned through strengthening of non-

oil/gas industries and the external debt problem could be brought into manageable proportions and where, within a conservative financial policy framework, a dynamic industrial sector is supported by a strong agriculture sector.

6. Riau province is located in the eastern part of central Sumatra island, consisting of about 3,200 small and large islands. It has a land area of 94,561 km² or 2.7% of the total Indonesia, with a total population of 3.28 million in 1990. Population density in 1990 was 35 persons per km². The population of Riau province increased from 2.16 million in 1980 to 3.28 million in 1990 at an annual average of 4.25%, which was more than twice the national population growth. This high growth rate is mainly due to rapid migration flow to the province including general as well as spontaneous transmigrants.

7. The mining sector, especially oil and gas, is playing a dominant role in Riau province, accounting for more than 70% of the total Gross Regional Domestic Product (GRDP) in 1988. Agriculture sector plays a leading role in Riau in terms of working population. Results of 1985 Intercensal Population Survey indicated that 59.7% of the total labor force in Riau were engaged in the agriculture sector whereas, only 1.6% in the mining sector.

8. Estate crops subsector showed the average annual growth rate of 15.1% during 1983 and 1988. Paddy production increased at an annual average of 5.2%. In spite of this high growth rate, which is higher than population growth rate, the province is not self-sufficient in rice production. The deficit of milled rice production is estimated at about 200,000 tons in 1989. One of major problems in food crops subsector rests on its low productivity due to insufficient irrigation system, farming practices, lack of agricultural support services.

9. Rice production in Indonesia was remarkable during Pelita I to IV, and production of husked rice was 18,000,000 ton in 1969. However, it was increase to 41,000,000 ton in 1988, and self-sufficiency of rice was attained in 1984. On the other hand, high productive paddy fields in Java which is a center of rice production have been transferred to housing lands and factories. Thus, since 1985, production of husked rice has been reached limit, and rice production begin not to catch up with demand gradually. In Pelita V began in April, 1989 the continuation of self-sufficiency of rice is one of the most important policies in agriculture sector in Indonesia. Since Pelita III, the priority of irrigation development had been given to the outer island other than Java, and it has been more accelerated in Pelita V. Under these circumstances, formulation of irrigation development is directed to Riau province which is blessed with affluent water resources and land resources.

10 Transmigrants in Riau during 1961-1988 amounted to approximately 65,000 families (280,000 persons). The current Pelita V in Riau has the target of receiving 53,953 families in

total or 10,791 families per annum.

3. STUDY AREA

11 The Study Area is situated in the eastern-central part of Sumatra and mainly in the northern part of the Riau Province. Its geological area is 22,100 Km² as a whole. The western part of the Study area lies in the North Sumatra Province and the southern part in the West Sumatra Province. The objective Area in the Riau Province for the Study counts 16,069 Km².

12 Topographically, the Study Area can be classified into three(3) parts, that is, mountain, hilly and swamp areas. There exists Barisan range in the mountain area of which the highest peak is more than 2,000 m and annual precipitation of about 2,500 mm to 3,500 mm in the area provides abundant water resources to the Study Area. The elevation of the hilly area ranges from 100 m to 25 m. Many plantation estates are being developed in the undulating hilly area of which elevation is more than 50 m. The area of its elevation of less than 50 m is rather flat and considered to be appropriate for irrigation. The vast swamp area spreads from the toe of the hilly area to the coast and it mostly remains as swamp forest.

13 Climate in the Study Area is characterized by tropical monsoon. The average annual rainfall in the Study Area is almost more than 2,000mm and fluctuates year by year.

14 The total area of the whole Rokan river basin is 18,405 Km² and can be divided into five(5) sub-basins according to the big rivers flow into the Rokan river. Each sub-basin is split into thirty(30) tertiary-basins. The annual runoff in the base year of 1984 for each basin estimated at 4,500 million ton for the Rokan Kiri river, 4,700 million ton for the Lubuk river and 4,500 million ton for the Kumu river.

15 About 60 % of the Study Area is occupied by forest and 20 % by bush and grassland. Under these circumstances, approximately 80 % of the study area is not used for cultivation. 20 % of the study area is utilized for crop production. In the Objective Area, 10 irrigation schemes are being carried out covering a total irrigable area of 5,525 ha. However, the existing paddy field is only 1,628 ha and among this 1,303 ha in wet season and 394 ha in dry season are being irrigated now. The present level of all irrigation system prevailing in the Objective Area belongs to semi-technical irrigation system.

16 In Riau Province the production of food crop is in short. Particular attention should be placed on the deficit of rice totaling to as much as 200,000 tons in 1989. Taking into account the projected population growth rate of 3 to 4% p.a. in the future, the province needs to make further efforts to increase rice production.

17 There are various kind of protected fauna and flora in the Study Area. It is estimated that habitats of such protected fauna and flora are limited in natural or semi-natural forest. Such fauna and flora shall be firmly protected in relation with the forest protection. On the other hand, species composition is very simple in the other vegetation, especially in plantation and grassland. The vast swamp area is spreading in the lower part of the Study Area. Almost of the swamp area is covered with natural forest. The natural forest is indispensable to sustain the ecology of fauna and flora inhabiting in and around the natural forest. Therefore, careful adequate investigation and research are required for the establishment of development plan in such vast swamp area.

4. BASIN DEVELOPMENT PLAN

18 The basic objective of economic development in Riau province is to upgrade standards of living, education and welfare of the population in the province. Special emphasis is given to the agriculture sector including food crops and estate crops sub-sectors. Agriculture sector is regarded as one of the most important sectors in Riau province as a means to achieve the basic objective of the provincial development plan. In agriculture sector, the first priority is placed on achievement of self-sufficiency in foodstuffs, especially rice. Increase in the production of palawija crops such as soybean, maize, groundnut, etc. are also required to improve nutrition of the population. In addition, increase in the production of estate crops are also needed to increase exports as well as to meet the demand of domestic industries.

19 The Objective Area has favorable conditions for its agricultural activities. In spite of shortage of irrigation facilities, agricultural activities are extensively conducted in this area which include cultivation of rice, palawija (soybean, groundnut, cassava, maize, etc.) and vegetables in wetland and dryland, and estate crops (rubber, oil palm, coconut, etc.) and fruit tree crops. In addition, livestock farming is extensively conducted in Kabupaten Kampar and pond aquaculture is concentrated in and around Kecamatan Rambah. Taking into account these situations, the Objective Area can be regarded as the center for agricultural activities in the province. Comprehensive agricultural development plan is therefore to be promoted in this area.

20 Present facilities and personnel for agricultural extension services in the Objective Area are not sufficient to ensure the present crop development program and future implementation of irrigated agriculture. Particularly, education and training program for extension workers with regard to irrigated agriculture is indispensable to carry out the future irrigation projects. Education and training on marketing aspect of the agricultural products will also be required in the future.

21. As to inland fishery development, it is required to increase fish catch in open waters and freshwater aquaculture. For this purpose, the following measures are recommended to be implemented in the Objective Area.

- 1) Education and Organization of Fish Farmers
- 2) Fish Cage Culture (Keramba) in Open Waters
- 3) Hatchery Improvement and Extension
- 4) Fish Pond Culture (Kolam)

22. For the improvement of the existing irrigation schemes, the following measures should be adopted:

- 1) Based on the detailed water balance for the whole schemes, the optimum development scale of the irrigation area should be decided, and technical irrigation system should be introduced.
- 2) To maximize the effect of the existing schemes, supplemental water supply to the schemes, or water source conversion of the schemes should be introduced by the utilization of water source for the new schemes. In the formulation of the new irrigation development schemes, incorporation of the existing schemes located close to the new schemes is studied.

23. New irrigation development has good potentiality because of abundant water resources and land resources of the Objective Area. On the other hand, as the Objective Area is blessed with natural resources such as natural forest and tropical rain forest, it is necessary to plan a well-harmonized development. Therefore, the new irrigation development should be made to avoid the protected forest area and swamp area paying careful attention to soil and topographical condition.

24. From the view point of topography and soil, the area with 60m-25m expanding over from hilly area to penneplain is mostly suitable for irrigation area. Other potential area is situated on alluvium distributed at the confluence of the Rokan Kiri river and the Rokan Kanan river. However, for the development of this area, polder development should be applied because the area belongs to perennial flooding area. The basic data such as detailed topographical map and long term water level data are required for this purpose, and study should be made from the long term view of point.

25. The basic approach to the development of domestic water supply in the Objective area is to increase the cover rate for water service facilities. Construction of new facilities and expansion of the existing facilities are required for that purpose. Nevertheless, in order to achieve a long term solution for demand, it is necessary to study water source and development method for swamp and low coastal areas where poor water quality makes the construction of water supply facilities particularly urgent.

26. The major industries in the Objective area are primary products in the agricultural (including plantations) and forestry

sectors. As such, connector roads with processing and consumption centers in Dumai and Pekanbaru are essential. Since there is no road north-south through the area, the following 2 roads are proposed.

- 1) A 97 km road (including 70 km of existing provincial highway) along the Kumu river to connect Dalu Dalu (kecamatan Tambusai) and Sedinginan (kecamatan Tanah Putih).
- 2) A 94 km road (including 58 km of existing provincial highway) along the Rokan Kiri river to connect Kotalama (kecamatan K.Darusalam) and Duri(kecamatan Mandau).

27 The basic orientation for power supply development is to respond to the increment in demand and upgrade customer service. In view of the national strategy to reduce petroleum consumption, it is also necessary over the long term to decrease dependence on diesel consumption. Within this context, diesel generation would be resorted to only where necessary in the short term to meet urgent energy requirements, with hydropower generating capacity to be expanded over the long term. The basic strategy for power supply for the Objective Area is as follows.

- 1) Kota Panjang hydropower station
- 2) Rural electrification
- 3) Strengthening and maintenance of existing diesel facilities
- 4) Survey of potential hydropower sites within the objective area, this would include Rokan Kiri No.1(67 kW) and No.2(65 kW), and Rokan Kanan No.1(46 kW) and No.2(10 kW).

28 It is important to maintain forest cover from the long term standpoints of water and soil conservation within the basin. Accordingly, already deforested areas should be returned to their original state by reforestation, and legal measures strengthened to control cutting of forest. At the same time, the program for permanent settlement of the population engaged in shifting cultivation should be vigorously pursued to contain the practice of slash and burn agriculture.

5. BASIC STRATEGY FOR OVERALL IRRIGATION DEVELOPMENT

29 The Objective Area is still not self-sufficient in some of major food crops such as rice, maize, vegetables, etc. The reasons for the above are, among other things, considered to be as follows.

- 1) Due to large fluctuations of rainfall in the rainy seasons, the agricultural production can not be stabilized.
- 2) Availability of arable land suitable for food crops production is relatively small, occupying only about 20% of the total land area.
- 3) Traditional shifting cultivation is still extensively carried out with lower

- productivity.
- 4) Stable production is not possible due to lack of agricultural infrastructures including irrigation systems.
 - 5) Road system is not adequately provided.
 - 6) Agricultural extension services are not sufficiently provided and are not functioning properly.
 - 7) Agricultural processing facilities are not properly provided.

30 Population of Riau province increased at an annual average of 4.25% between 1980 and 1990. Within the province, Kabupaten Kampar increased at an annual average of 6.2% and Kabupaten Bengkalis at 4.8%. Population of the Objective Area increased at an annual average of 7.0% during 1980 and 1990. The population projection in 1990, 2000, 2010 and 2020 is estimated as follows.

	1990	2000	2010	2020
<u>Riau Province</u>				
Total Population	3,281,046	4,856,750	6,850,926	9,207,072
<u>Objective Area</u>				
Total Population	426,899	801,348	1,368,818	2,125,732
Farm Population	308,990	520,876	821,291	1,169,153

31 Self-sufficiency ratio of paddy, maize, soybeans and groundnut in 2020 will be 85.1%, 72.5%, 31.5% and 73.4% in Riau province. Likewise the percentage will be 49.9%, 96.2%, 77.6% and 175.0%, respectively in the Objective Area.

32 Implementation of the Batang Kumu (with irrigable area of 7,000ha) and another projects in the Rokan River Basin (with irrigable area of 40,000ha in total) will lead to attainment of self-sufficiency in the Objective Area and coverage of major part (61%) of rice deficit in Riau province. It is required therefore to carry out the above mentioned irrigation projects in the Objective Area.

33 The development potential for the Objective Area is estimated as follows.

Classification	Total Area (ha)	Development Potential	
		Developed	New
Forest	798,600 (49.7%)	-	-
Suitable for paddy	65,600 (4.1%)	1,400	64,200
Suitable for upland field/plantation	372,300 (23.2%)	209,500	162,800
Suitable for agriculture from long term view	141,000 (8.8%)	39,800	101,200
Other (unsuitable for agriculture)	228,400 (14.2%)	-	-
Total	1,605,900(100.0%)	250,700	328,200

34 Water resources potential in the Study Area is expressed as long term flow. According to the simulation results, monthly river discharges in the base year of 1984 (non-exceeding of 5 years) for the Rokan river, Lubuk river and Kumu river sub-basins are as follows.

Sub-basin No. Name of river Catchment area	Block 1 S.Rokan Kiri 4,312 Km ²	Block 2 Bt.Lubuk 4,610 Km ²	Block 3 Bt.Kumu 3,913 Km ²
Jan.	141.4 m ³ /s	295.4 m ³ /s	176.1 m ³ /s
Feb.	208.6	196.5	147.4
Mar.	176.6	181.6	234.7
Apr.	180.1	242.2	172.1
May	174.8	145.7	186.4
Jun.	131.2	87.9	174.0
Jul.	86.1	103.1	83.7
Aug.	66.4	74.2	119.7
Sep.	90.6	116.8	60.2
Oct.	93.0	119.6	94.0
Nov.	248.8	113.4	107.1
Dec.	119.3	106.2	155.8
Average	143.1	148.6	142.6
Total runoff (m ³ /year)	4,506 mil.	4,692 mil.	4,513 mil.

35 In line with the objectives of national as well as provincial development plans, the basic development concept has been set as follows.

- 1) The first priority is given to the increase in rice production in order to contribute to attainment of self-sufficiency of rice in the province;
- 2) Priority is also given to the increase in palawija crops to contribute to attainment of self-sufficiency in food crops in the province;
- 3) Development plans are oriented to upgrade the farmers' income level; and
- 4) Participation of local population is to be promoted at every stage of the development activities.

6. IRRIGATION DEVELOPMENT PLAN

36 Based on the land and water resources potentials in the Objective Area, the following six(6) projects are proposed as irrigation development.

- 1) The Bt.Lubuk project
- 2) The Upper Sosa project
- 3) The Lower Sosa project
- 4) The Mahato project
- 5) The Lower Rokan Kiri project

6) The Bt.Lubuk - Upper Sosa project

37 After examining quantities of available discharges at each intake site, potential area is estimated at 44,160 ha in total. Out of the irrigable area of 46,960 ha topographically selected, 44,160 ha is concluded to be the proper scale of new irrigation schemes considering the limitations of water resources.

38 According to the water balance calculation considering all of the water demands such for existing and planning irrigation projects, planned domestic water supply and industrial water, no water deficit is found throughout the base year of 1984 in each sub-basin.

39 The irrigation development plans (18 cases in 6 development areas) formulated in the preceding section has been evaluated and compared in terms of economic internal rate of return (EIRR) for the purpose of identifying development plans to be implemented in the Objective Area for the achievement of the Master Plan target. As a result of economic comparison of the irrigation development plans, the following plans with EIRR of more than 10% have been selected as the ones to be proposed for implementation during the Master Plan period.

- 1) Lower Rokan Kiri Irrigation Development Plan 19,300 ha
- 2) Mahato Irrigation Development Plan 9,000 ha
- 3) Lower Sosa Irrigation Development Plan 11,800 ha

40 The total irrigated area in the Rokan River Basin will be approximately 47,000 ha with the implementation of three(3) Irrigation Development Projects and the Bt.Kumu Project of which the feasibility study has been finished by JICA. The planted area for rice cultivation will total 84,600 ha with the cropping intensity of 180 %. As a result, rice production will be increased to about 420,000 tons (milled rice) in the target year of 2020. Taking into account the irrigated as well as un-irrigated area for rice cultivation in the future, the rice demand and supply forecast will be estimated as follows.

Year	<u>Rice Demand and Supply Forecast</u> <u>in the Objective Area</u>			<u>Rice Deficit</u> <u>in the Province</u>
	<u>Demand</u>	<u>Supply</u>	<u>Balance</u>	
2000	112,990	116,025	+ 3,035 tons	131,652 tons
2010	193,003	267,475	+74,472 tons	184,262 tons
2020	299,728	418,700	+118,972 tons	193,741 tons

41 The second step selection intends to select the priority development plan from the three (3) development plans in Lower Rokan Kiri, Mahato and Lower Sosa areas for the purpose of carrying out its feasibility study. For the priority ranking of the 3 development plans, more elaborate evaluation has been carried out using several criteria for the ranking in due consideration of selection criteria established by the DGWRD (Directorate General of Water Resources Development). Such criteria include water source, soil and topographical conditions,

land use pattern, percentage of transmigrants, accessibility, construction cost per ha, and EIRR. Each criterion has its priority point and weighting point depending on its importance for the development.

42 Three (3) development plans mentioned above did not show much difference in terms of construction cost per ha and EIRR. However, the most influential point rested on such factors as the present land use, accessibility and percentage of transmigrants. As a result of priority ranking of the 3 irrigation development plans, the Lower Rokan Kiri has been ranked the first at the total points of 262, followed by the Lower Sosa at the points of 210, and the Mahato at 200. The result indicates that the detailed study for the Lower Rokan Kiri should be carried out for its early implementation.

7. Feasibility Study on Lower Rokan Kiri Irrigation Project

Project Area

43 The Project Area of Lower Rokan Kiri Irrigation Project is 942 km² surrounded by the administrative boundary of the Kepunuhan and Kunto Darussalam sub-districts. In the Project Area, the area of 426 Km² including the sites for the headworks and the headreach to be constructed and the extent of photo mapping is defined as the Survey Area. The gross area of about 120 km² is situated downstream from Kotalama and is extending over either bank of the Rokan Kiri river. The area is comparatively flat, and ranges from around 40m-20m above sea level.

44 The Rokan Kiri river, which will be water source for the area, has the catchment area of about 3,267 Km² at the headworks location, and the area is well blessed with abundant river discharges all the year round. The mean annual discharge is 146.7 m³/sec, and the minimum mean monthly discharge is 72.6 m³/sec which occurs in July. The total outflow is estimated at about 4,600 million m³ throughout the year. Water quality offers no problem for irrigation. As for soil condition, terraces and alluvial zone excepting hilly area has been concluded to be suitable for irrigation, which occupy about 90% of the irrigable area.

45 The present land use in the Project Area is grouped into orders: primary forest(42.3%), secondary regrowth forest(24.9%), bush/grass land/alang alang(19.3%), plantation(7.5%), cultivable land(3.6%), and others. With respect to the land use condition of cultivable land in the irrigable area, there exist only 2 ha of rainfed paddy fields. In the irrigable area, irrigation facilities have not been installed yet.

46 In the Project Area, the total households are 5,111 of which 3,968 households corresponding to 77.6% of total households are engaging in farming. Population engaging in agriculture is

estimated at about 17,000. Each family was allocated 2.0 ha of land of which 1.75 ha (1.0 ha for 1st cultivable land, and 0.25 ha for 2nd cultivable land) was intended as farmland, and 0.25 ha was as a houseplot/garden. At present, the 2nd cultivable land is still covered with forest, and has not been used for cultivation yet. The number of farmhouses in the irrigable area is 1,216 households of former occupant farmers, and 1,120 households of transmigrants.

47 The principal farm products in the Project Area consist of paddy, upland paddy, maize, cassava, sweet potatoes, peanuts, etc. Generally, yield in the Project Area is low compared to that in the Rokan river basin. According to the farm economy survey in the irrigable area, 58% of farmer's income is derived from agriculture, and the remaining is gained from labors for the large plantations. Within the agricultural income, 52% is obtained from crop, and the remaining 48% is from rubber, small holding of coconut plantation, livestock, and fishery.

48 KUD holds an important position as an economic basis for local farmers. However, lively activities of KUD has been performed unsatisfactory, which is considered to be a cause to obstruct agricultural development in the Project Area. In addition to this condition in the area, agricultural extension services, researches, and finance which are performed insufficiently under the government cause major constraints for agricultural development.

49 From the aspect of environment, forest in the Project Area belongs to convertible forest to which the government has assigned as exploitable forest. This is distinguished from reserved forest and protection forest. However, it is feared that disordered shifting cultivation in the region which has no systematic irrigation system will have a bad influence on the surrounding area. Accordingly, implementation of irrigation scheme can expedite settlement of local people who live in and around Project Area. Thus, prevention against destruction of surrounding nature is being expected.

Development Plan

50 The objectives of Lower Rokan Kiri irrigation project which was formulated on basis of overall irrigation development plan are 1) To stabilize livelihood of the transmigrants who have already settled and former occupant local people in the area by introducing irrigation and drainage system, 2) To contribute increase of rice productivity which is directing attainment to self-sufficiency of rice in Riau province, and 3) To support the government policy on resettlement of people living in the region for protection of natural environment as well as on new transmigration settlement.

51 In deciding the development scale, the following factors are taken into account. Namely, 1) Location and intake water level

of weir, 2) Possible intake discharge and water requirements, 3) Land suitability classification, and 4) Number of household of farmers, allocated area and land use plan.

52 Water resources availability of the Rokan Kiri river is estimated to be about 40,000 ha at the weir site. Thus, it is said that the Project Area has high potential for irrigation development. On the other hand, there are 2,336 households of the existing farmhouses including the transmigration ones at present. In deciding the appropriate scale of development, the following alternatives are studied taking the above factors into account:

- Alternative-1 : Scheme scale on irrigation and drainage plan for the existing farmhouses only.
- Alternative-2 : In addition to the above Alternative-1, new settlement will be made for the area which is located upstream from the Alternative-1 area. Namely, scheme scale is the Alternative-1 area plus upper reach area of the irrigation canal which has been aligned for the Alternative-1.
- Alternative-3 : Scheme scale is expanded to such an extent that water resources as well as land resources can be utilized maximally for irrigation and drainage plan.

53 As a result of comparative study on the above three Alternatives, the Alternative-2, and the Alternative-3 allow to be adopted for development plan. As an urgent measure to stabilize the livelihood of the transmigrants and the former occupant farmers, however, the comparative study leads to the conclusion that the Alternative-2 is the appropriate scale at the present stage. Riau provincial government has already formulated the Project Area as rice production base because affluent water resources and land resources can be expected. Therefore, looking far into the future of the Project Area, the ultimate scale of the development target will be the Alternative-3 properly. Accordingly, in adopting the Alternative-2 for this study, facility plan is drawn up so that the Alternative-2 can be shifted to the Alternative-3 as easy as possible in the future:

54 Implementation of irrigation scheme enables to irrigate paddy fields in the Project Area throughout the year. Thus, the present land use will be changed as follows:

Classification	Present(ha)	Plan(ha)
Primary forest	5,268	304
Secondary forest	3,094	751
Bush/grass/alang ²	2,857	244
Cultivable land (paddy/upland field)	639	8,300
Houseplot/garden	342	2,062
Right-of-way	-	539
Total	12,200	12,00

55 Land allocated to a settlement family unit is as follows:

-	houseplot/garden	0.25 ha
-	1st arable land	1.00 ha
-	2nd arable land	0.75 ha

	Total	2.00 ha
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56 In addition to the above land allotment, 0.25 ha for public land and 0.11 ha for right-of-way per family are taken planned land use into account. Hence, 2,643 ha is used by 1,120 households of the existing transmigration settlement according to the planned land use. In addition, farmland is allotted to 1,216 households of the former occupant farmers and local people in Kotalama and Kota Intan which are located outside of the irrigable area. As a result, new settlement plan is required for the settlement of 2,254 households of farmhouses.

57 Crops to be introduced are decided considering agricultural development strategy in the Project Area. Thus, paddy for wet and dry seasons, and soybeans and peanuts for secondary crops are recommended. The selected crops coincide with the crops selected by SUPRA INSUS which is pushed forward by the government. Cropping patterns are drawn up considering double cropping irrigation per year. However, introduction of secondary crops are taken cropping patterns into consideration according to scatter in labor forces.

58 The target of unit yield after implementation of the scheme are established as follows with reference to the present yield, and prospective yields of other projects:

Crops	Target of Unit Yield(t/ha)	
	With project	Without Project
(1) Wet season paddy		
With irrigation	5.0	3.5
Rainfed	-	0.9
Upland paddy	-	1.0
(2) Dry season paddy		
With irrigation	5.5	-
Rainfed	-	0.9
Upland paddy	-	1.0
(3) Soybeans	1.6	0.7
(4) Peanuts	1.8	0.6

59 As a result, it is estimated that the increased yield of 62,000 ton of rice and 7,300 ton of second crops can be realized in the Project Area after implementation of the scheme. Besides, one of the most important objects of the plan is to increase the farmers' income. In order to attain this object, the basic strategy is to increase the farming size by expanding the cropping area, allocating the labor forces effectively, and introducing the mechanization for agriculture as well as to raise and to stabilize the productivity of crops by introducing the effective farming method and draft animal.

60 Strengthening of the existing farmers' association, and improving the quality of farmers and staff for operation and maintenance through training are essential so that the scheme can be carried out satisfactorily. KUD should be strengthened by the government guideline and support because the channel for agricultural finance is limited in the Project Area.

61 Irrigation and drainage plan is decided considering the following three items on the basis of the appropriate scale of the development plan and agricultural development plan:

- 1) The effective use of the fund, and the maximum utilization of land resources, water resources, and labor forces.
- 2) Accord with environment
- 3) Introduction of gravity irrigation system

Irrigation plan is drawn up by the use of water sources of the Rokan Kiri river. As a result of the study, the maximum potential development area which was assessed by the use of the Rokan Kiri river water sources is larger than the planned area of the Alternative-2. Therefore, special consideration is paid on future plan so that the area can be developed to the utmost limit with the labor forces is being increased after the implementation of the Alternative-2 plan in the Project Area.

Implementation Program

62 The implementation period of this project is about 7 years including 2 years of preparation period. The preparation period includes the detailed design, preparation of tender documents, procurement, and the preparatory period for construction. Construction period is 5 years.

63 Directorate General of Water Resources Development, Ministry of Public Works(hereinafter called DGWRD) is execution body, has responsibility for design, facility construction, and construction supervision, and coordinate and negotiate with authorities concerned concerning implementation of the project.

64 After completion of facilities, the construction supervision office is transferred to Riau provincial government, and turns into the operation and maintenance office. It has responsibility for operation and maintenance of all the facilities including tertiary block. After tertiary block, operation and management is entrusted by water users' association and farmers.

Project Cost and Project Evaluation

65 Project cost consists of preparatory cost, direct construction cost, operation and maintenance cost, procurement cost of material and mechanical equipment, land acquisition, administrative cost, engineering services cost, contingencies, and value added tax. The project cost for this irrigation project is estimated at US\$25.4 million of local portion, US\$36.8 million

of foreign portion, and US\$62.2 million in total.

66 In the case when the project is completed, annual increases of rice of 62,200 tons and upland crops(soybeans and peanuts) of 7,300 tons can be expected. The implementation of the project enables most farmers to obtain high income and other benefit. The annual income of standard farmer possessing 2.0 ha of land is about Rp.516,800 at present. However, the farmer's annual income can be increased to Rp.5,200,000 if the project is implemented.

67 Economic evaluation for the project is made according to the following conditions:

- 1) The exchange rate is set at US\$ 1.0=Rp.2,010.
- 2) Economic life of the project facilities is assumed as 30 years.
- 3) Only direct tangible benefits are quantified. Indirect benefits are qualitatively evaluated.
- 4) The economic farm gate price of paddy (unhusked rice) is estimated as Rp.322/kg based on world market price projection in 2000.
- 5) A shadow wage rate of 0.8 is applied to the financial farm labor costs.
- 6) Agricultural development period is 5 years.
- 7) Discount rate is 10%.
- 8) Price rise ratio affects the project cost and benefit. Therefore, it is not considered in economic evaluation.
- 9) Interest is not taken into account.

68 Economic project cost is calculated using conversion rate on the basis of financial project cost. Economic benefit of the project is assumed to be the benefit of net crop product which is expressed the difference between with project and without project. The project plan is so drawn up that the benefit from irrigation shows a yearly increase and will reach to the target benefit in 5 years after the completion of the project, with the implementation of the project. In the construction planning, development is proceeded by work division, and benefit from irrigation will be brought in 4 years after the commencement of the construction, and will reach to the target benefit in 10 years.

69 Economic internal rate of return(EIRR), Cost-benefit ratio(B/C), and Net present value(NPV) are calculated as follows:

EIRR	:	12.0 %
B/C	:	1.18 (Discount rate 10%)
NPV	:	Rp. 10,275 million (Discount rate 10%)

70 In order to evaluate economic elasticity of the project to which the cost and benefit vary disadvantageously, the sensitivity analysis on the following cases is made, and the conditions and results of 3 cases are as follows:

Case	Condition	EIRR (%)	B/C	NPV (Rp.Mill.)
Case-1	When cost increase 10%	10.8	1.07	4,507
Case-2	When benefit decrease 10%	10.7	1.06	3,480
Case-3	When 2 years delay in construction	10.6	1.06	2,919

71 In view of the results so far studied, it is concluded that the Lower Rokan Kiri project is the project with priority and with adequacy of implementation from economical point of view. As a result of sensitivity analysis, the project is so profitable that EIRR is over discount rate for variation of cost and benefit.

Environmental Impact Assessment

72 The implementation of the project will bring benefit directly to the Project Area. However, it is expected that it influences on environment and socio-economy. The environmental impact caused by the implementation of the project is assessed in accordance with the guideline on environmental impact assessment recommended by the Ministry of Population and Environment.

73 The water quality is expected to be the most effective impact against the physical and chemical elements. Water pollution due to construction, fertilizer and agricultural medicine is feared during and after construction of the Project. The appropriate treatment for polluted water due to construction and soil disposal shall be considered. For the increment of use of fertilizer and agricultural medicine, a proper guidance for the usage is required. The construction of drainage system and its proper operation can improve the present water inundation in the downstream of the irrigable area. Moreover, strengthening of city water supply and medical facilities and implementation of improvement program for the conscious against sanitation are essential for the population.

74 In Indonesia, useful trees in forest with diameter of less than specified one are designated as protected flora. It signifies to reserve natural resources. Trees, however, in the conversion forest are excepted from the protected flora. Since the Project area is located in the conversion forest, this project offers no problem against the protected flora.

75 The protected faunas are designated whole Indonesia to protect precious species. In the Project area, it is certified that the elephant inhabit and other inhabitants to be protected are expected to exist. From a legal point of view, such protected fauna in a development area can be shifted to surrounding areas in order to conserve a species. In formulating a development

plan, it is necessary to consider for wild animals not to disturb their free action by isolating. In construction stage, a flight way for wild animals is required. For the planning, data on wild animals, such as location of habitat, thickness etc. are indispensable. In case of large animals, the action territory is rather wide, so it is feared that overlapping territories of different animals caused by shifting their inhabiting area brings decreasing number of animals and invasion upon other than forest. Therefore, in this context, the particular assessment survey is required for the protected fauna.

76 The primary forest in which effective large-size trees have been cut down occupies about 40% of the study area and assumes virgin forest because of its outward form. Since such primary forest is rich in natural resources and essential for inhabiting fauna and growing flora, it shall be protected as much as possible. On the other hand, deforestation for farm land by this irrigation project is estimated at about 5,000 ha i.e. about only 0.2% against the total forest in the Rokan River Basin. Therefore, it can be said that this project offers few influence with forest.

77 As the primary forest is unsuitable for fuel, the secondary forest is used for fuel sources by the local population. Since this circumstances will continue in the future, the forestation for fuel shall be considered.

78 The implementation of the project will bring positive impact for the socio-economic element such as increment of income and working opportunity etc. On the contrary, negative impact is comparatively small. Since uneasiness and/or questions for the implementation of the project by the local population and conflict between new transmigrants and former habitants are expected, enough pre-information of the project shall be given. Moreover, the Government shall make effort to participate the project formulation with local population.

B. CONCLUSION AND RECOMMENDATION

CONCLUSION

1. In recent years, many large scale plantation projects have been developed in the Objective Area. On the other hand, self-sufficient of food crops is the urgent subject in the Riau Province including the Objective Area. The Objective area is rich in natural resources such as abundant water resources and natural forest with habitats of protected flora and fauna. Under this circumstances, well balanced development plan among production increase of food crops, plantation development and protection of natural resources shall be established.

2. As the Rokan River Overall Irrigation Development Plan, the six(6) projects are proposed. Among them, the following three(3) projects are selected in this study.

- 1) Lower Rokan Kiri Irrigation Project
- 2) Lower Sosa Irrigation Project
- 3) Mahato Irrigation Project

3. The completion of the proposed three(3) projects and Bt. Kumu Irrigation Project of which Feasibility Study has been finished would enable to produce 420,000 tons of rice (polished rice) annually in the target year of 2020, and this amount would satisfy rice demand in the Objective Area and cover a deficit in the Riau Province of about 60 percent.

4. Among three(3) projects, the Lower Rokan Kiri Irrigation Project is selected as the priority project. Then, the Feasibility study was carried out for the project. As a result, the project is judged feasible because the economic internal rate of return is estimated at 12.0%.

RECOMMENDATION

5. The Lower Rokan Kiri Irrigation Project is to supply irrigation water to the existing transmigrants and local farmers as well as new transmigrants. The area has further development potential for irrigation, if the new transmigration program is well proceeded. Therefore, well coordination among BAPPEDA, the transmigration office and the agriculture office in Riau Province is necessary.

6 In order to exploit the benefit generated by the proposed project, it is essential to study and develop appropriate farming practices and to demonstrate and extend these methods and technology. Therefore, the experimental farm having functions of 1)selection of appropriate crops and varieties, 2)development of appropriate farming technology, 3)on-farm and post-harvest mechanization, 4)study on integrated pest management and pest forecasting, etc. should be established.

7. To promote agricultural development including irrigation practice, agricultural supporting service such as, a) training for members of agricultural extension service, b) strengthening of agricultural cooperation service for credit and input supply, and c) improvement of agricultural marketing and processing shall be proceeded.

8. In order to minimize the adverse effects to the protected flora and fauna in the natural forest of the project area due to the implementation of the project, the detailed ecology assessment survey should be carried out.

9. With regard to swamp development, sustainable research and study on soil, selection of suitable crops, tidal effect, protection of flora and fauna, etc. is important. Therefore, establishment of an institute for such research and study is recommended.

1. INTRODUCTION

1.1 Authority

This is the Final Report(Main Report) prepared in accordance with the Scope of Work(S/W) and Minutes of Meeting agreed upon between Directorate General of Water Resources Development(DGWRD), Ministry of Public Works and Japan International Cooperation Agency(JICA) on October 1990 for the Rokan River Basin Overall Irrigation Development Plan Study.

The study was conducted dividing two(2) stages, namely Phase I and Phase II. The Phase I study was carried out from January to August 1991 and in this study, the basin development plan for the Rokan River was set up. As a result, the Lower Rokan Kiri Project, the Lower Sosa Project and Mahato Project have been selected as the irrigation projects to be proposed for further studies. After scrutinizing three projects, the Lower Rokan Kiri Irrigation Project is set up as the priority project finally.

In Phase II study, which was made from January to August 1992, the feasibility study on the priority project, the Lower Rokan Kiri Irrigation Project, was carried out to establish irrigation development plan and to study economic feasibility for the implementation of the project.

The Final Report consists of four(4) Volumes as follows;

- Volume I MAIN REPORT
- Volume II OVERALL IRRIGATION DEVELOPMENT PLAN STUDY
 IN ROKAN RIVER BASIN
- Volume III FEASIBILITY STUDY ON LOWER ROKAN KIRI
 IRRIGATION PROJECT
- VOLUME IV DRAWINGS

1.2 Background of the Study

The Rokan River Basin which is the objective area of the study is rich in land and water resources and consequently has a high potential for agricultural development. Now, many kind of projects such as transmigration, plantation etc. are being in progress in the area. Accordingly, it is urgent program to formulate a well balanced agricultural development plan in the whole basin, in order to improve and stabilize agricultural production and to support transmigration scheme.

With the above-mentioned background, the Government of Indonesia requested the Government of Japan to carry out the "Rokan River

Basin Overall Irrigation Development Plan Study" in June 1990. In reply to this request, JICA sent a preliminary survey team for the Study in September 1990 and agreed with DGWRD on S/W for the Study in October 5, 1990.

1.3 Objectives of the Study

(1) Objectives

The objectives of the Study are:

- To formulate a basic development plan, mainly for irrigation development, in the Rokan River Basin taking the total availability of water resources into account,
- To select a priority project for irrigation development,
- To carry out a feasibility study for the priority project, and
- To provide transfer of technology to Indonesian counterpart personnel in the course of the study.

(2) Study Area

As mentioned in the Inception Report, the study area was about 15,670 Km² in the beginning of the Study. However, in order to cover the whole basin of the river, the estuary was included in the Study area. Thus, the Study area covers 22,100 Km². The objective area where is in the Riau province becomes 16,059 Km².

(3) Target Year of Development

The Fifth Five-Year Development Plan (Repelita V) has covers the period from 1989/90 to 1993/94 corresponding to the final stage of the first 25 Year Long-Term Development. This Repelita V bears very close relation with the definite formulation of the basic concept of the second 25 Year Long-Term Development. In conformity with both frameworks and based on the results of the meeting on the Inception Report for the Study held at DGWRD on January 21, 1991, the target year for long-term development of the Rokan River Basin is set up in 2020 under the present Study.

1.4 Remote Sensing

Remote sensing analysis for the Rokan River Basin Overall Irrigation Development Plan Study was carried out by the Center for Data Processing and Mapping, Ministry of Public Works, Indonesia (hereinafter referred to as PUSDATA) based on the contract between JICA and PUSDATA dated December 19, 1990.

The Objective area for the analysis is located in the central part of Sumatran, mainly in Riau Province and covers 43,513 Km²

including the Rokan River Basin of 18,405 Km² spreading from the east longitude of 99°30' to 101°30' and from 00°00' to 02°30' north latitude.

The objective of the analysis is to prepare the basic data necessary for the study such as land cover, soil moisture, elevation, slope and geology using the satellite data and other supporting data.

2. ECONOMIC BACKGROUND

2.1 National Economic Background

Indonesia is an archipelago consisting of about 13,700 islands of varied size and character. It has a land of about 1.95 million km² and a population of 179.2 million in 1990. The population is unevenly distributed among five major islands (Java, Sumatra, Sulawesi, Kalimantan and Irian Jaya) and some 900 minor ones. An annual growth rate of population in Indonesia is 1.98 per cent between 1980 and 1990. The average density for the country is 92 persons per km². A successfully implemented family planning program has gradually diminished the rate of growth of Indonesia's population, particularly on the densely populated islands.

Real GDP during 1983 and 1988, which corresponds roughly to the period of Pelita IV, grew at an annual average of 5.1% over this period. The rate is slightly higher than the rate of 5.0% per annum which was set out as the targetted rate in Pelita IV. The agriculture sector's share in GDP declined gradually during that period with an overall growth rate of 3.5%. Nevertheless, agriculture is far from stagnant. It is simply overshadowed by industries which are growing very fast. Food crop production exceeded population growth by about one percentage point annually, and estate crops grew at a more respectable 8.9%. The mining and quarrying sector declined both relatively and absolutely, owing to a fall in the real value of oil and gas output. Non-oil/gas manufacturing and liquid natural gas show high growth rate.

The overall growth rate in 1989, the commencing year of Pelita V, is estimated to be 7.4% which is higher than anticipated. Higher estimated GDP growth in 1989 is supported by increased exports of non-oil/gas, increased prices of oil, and increase in government revenue.

The focus of the current development plan, Repelita V (1989/90-1993/94), is to create a financially sound and consolidated economy, that is, an economy where fluctuations of world oil prices could be cushioned through strengthening of non-oil/gas industries and the external debt problem could be brought into manageable proportions and where, within a conservative financial policy framework, a dynamic industrial sector is supported by a strong agriculture sector. In this Repelita V, agriculture sector

is expected to grow at a slightly higher rate (3.6%) than in the 1980s.

In spite of its gradual decline in the share of GDP, the agriculture sector is still the mainstay of the Indonesian economy. Agriculture sector accounts for 21.1% of GDP, more than 55% of the employment, and major part of non-oil export in 1988. Of the some 57 million ha in the country suitable for agriculture, about 23.5 million ha is under cultivation, of which about 5.3 million ha is irrigated. With the exception of estate crops, nearly all agricultural production is undertaken by the country's 18 million smallholders.

During Pelita I and II (1969/70-1978/79), the main emphasis was on increasing rice production. More than half of the agriculture sector development expenditure was directed at the rehabilitation and expansion of irrigation facilities, with the aim of increasing rice production. Infrastructure development was supported by rice intensification programs aimed at increasing use of modern inputs and increasing productivity. During Pelita III and IV (1979/80-1988/89), emphasis has been widened to include intensification programs for other crops, especially maize and soybeans. The overall focus of the current plan (Repelita V, 1989/90-1993/94) is on improving sector efficiency, consolidating rice productivity gains, and promoting diversified cropping systems.

2.2 Reginal Economic Background

Riau province is located in the eastern part of central Sumatra island, consisting of about 3,200 small and large islands. It has a land area of 94,561 sq km or 2.7% of the total Indonesia, with a total population of 3.28 million in 1990. Population density in 1990 was 35 persons per km². The population of Riau province increased from 2.16 million in 1980 to 3.28 million in 1990 at an annual average of 4.25%, which was more than twice the national population growth. This high growth rate is mainly due to rapid migration flow to the province including general as well as spontaneous transmigrants.

The mining sector, especially oil and gas, is playing a dominant role in Riau province, accounting for more than 70% of the total Gross Regional Domestic Product (GRDP) in 1988. In terms of GRDP excluding petroleum, the agriculture sector had the largest share at 26.2% in 1988. GRDP of the Riau province at current prices in

1988 amounted to Rp 9,225.4 billion including petroleum which corresponded to 6.6% of the GDP in Indonesia. In 1988, per capita GRDP in Riau amounted to Rp 620,382 or US\$359 including petroleum. Per capita GRDP is reduced to Rp 427,610 or US\$247 excluding petroleum.

Agriculture sector plays a leading role in Riau in terms of working population. Results of 1985 Intercensal Population Survey indicated that 497,465 persons or 59.7% of the total labor force in Riau were engaged in the agriculture sector.

Within the sector, estate crops subsector showed the average annual growth rate of 15.1% during 1983 and 1988. Although a larger part of estate crops production come from small holders plantations, the share of the state as well as private plantation enterprises has increased year by year. Whereas, food crops subsector showed an annual average growth of 4.0%, which is higher rate than national average. Paddy production increased at an annual average of 5.2% through increase by 2.7% in the harvested area and increase by 2.5% in productivity. In spite of this high growth rate, which is higher than population growth rate, the province is not self-sufficient in rice production. The deficit of milled rice production is estimated at about 200,000 tons in 1989.

One of major problems in food crops subsector rests on its low productivity. Comparison of productivity of major food crops between national and provincial average indicates that production per ha (productivity) in the province is lower than national average in most of major food crops. Especially, in the case of rice production, the national average of 4.02 tons per ha outpaced the provincial average of 2.94 tons per ha. The low productivity in the province is mainly due to lack of agricultural infrastructures including irrigation systems.

Transmigration program in Riau has also been conducted in accordance with the basic policy of the national development plans, as a means of manpower development and balanced distribution of the population, aiming at promoting regional development. Transmigrants in Riau during 1961-1988 amounted to approximately 65,000 families (280,000 persons). The current Pelita V in Riau has the target of receiving 53,953 families in total or 10,791 families per annum.

3. STUDY AREA

3.1 Natural Condition

The Study Area is situated in the eastern-central part of Sumatra and mainly in the northern part of the Riau Province. Its geological area is 22,100 Km² as a whole. It extends from 0°05' to 1°40' north latitude and from 99°40' to 101°15' east longitude. The western part of the Study area lies in the North Sumatra Province and the southern part in the West Sumatra Province. The objective Area in the Riau Province for the Study counts 16,069 Km².

The distance from Pekanbaru, the capital of the Riau Province, to the Study Area is about 100 Km. Administratively, the Objective Area belongs to Kampar and Bengkalis Regencies (Kabupaten).

Topographically, the Study Area can be classified into three(3) parts, that is, mountain, hilly and swamp areas. There exists Barisan range in the mountain area of which the highest peak is more than 2,000 m and annual precipitation of about 2,500 mm to 3,500 mm in the area provides abundant water resources to the Study Area. The elevation of the hilly area ranges from 100 m to 25 m. Many plantation estates are being developed in the undulating hilly area of which elevation is more than 50 m. The area of its elevation of less than 50 m is rather flat and considered to be appropriate for irrigation. The vast swamp area spreads from the toe of the hilly area to the coast and it mostly remains as swamp forest.

Climate in the Study Area is characterized by tropical monsoon. The average annual rainfall in the Study Area varies from 1,800 mm in the coastal area of the northern part to 3,600 mm in the mountain area in the West Sumatra Province. The annual rainfall fluctuates year by year. The average air temperature is 25.3°C to 28.0°C, relative humidity is comparatively high with 84.9 to 91.4 % on an average and the average sunshine ratio shows 37.6 to 46.1 %. Under the meteorological condition mentioned above, it is no problems for the farming practices. The average monthly rainfall and meteorological data of respective stations in the Study area are shown in Fig.3.1 and Fig.3.2 respectively.

The total area of the whole Rokan river basin is 18,405 Km² and can be divided into five(5) sub-basins as shown in Fig.3.3

according to the big rivers flow into the Rokan river. Each sub-basin is split into thirty(30) tertiary-basins. The annual runoff in the base year of 1984 for each basin estimated by the Tank Model Method is as follow;

Sub-basins and Annual Runoff
(Year 1984-Base Year)

No. of Block	River Name	Area (km ²)	No of T-basin	Annual Run-off (Million m ³)
Block 1	S. Rokan Kiri	4,312	6	4,506
Block 2	Bt. Lubuk	4,610	9	4,692
Block 3	Bt. Kumu	3,913	8	4,513
Block 4	S. Bangko	1,565	2	N.A.
Block 5	S. Rokan	4,005	5	N.A.
Total		12,835	30	

Note: Run-off from Block 4 and Block 5 are affected by tidal fluctuation and flow out to the sea or stagnate in the swamp area depending on seasons.

Probable flood flow in the Study Area varies depending on locations. The specific discharges of flood flows are estimated at 1.11 to 0.66 m³/s/Km² in case of return period of 50 years and at 1.43 to 0.86 m³/s/Km² in case of that of 500 years.

The soil map in the Study Area is shown in Fig.3.4 and areas of each soil type is presented in Table 3.1.

3.2 Socioeconomic Situations

The Objective Area is included within the boundaries of the Kabupatens of Kampar and Bengkalis. Kabupaten Kampar consists of 15 sub-districts (Kecamatan), of which 6 sub-districts are wholly or partly included in the Objective Area. Kabupaten Bengkalis consists of 14 sub-districts (Kecamatan), of which 4 sub-districts are wholly or partly included in the Objective Area. The above 10 sub-districts are subdivided into 207 villages (Kelurahan/Desa).

Population of the Objective Area increased from 223,763 in 1980 to 426,899 in 1990 at an annual average of 7.0% which outpaced more than twice the provincial average of 4.25% per annum. This high growth rate is considered to be caused as a result of migration flow due to general as well as spontaneous

transmigration. The number of transmigrants in the Objective Area totaled about 16,650 households (78,000 persons) during 1979 and 1988. Of the 35 settlements, 23 settlements have been provided with the necessary infrastructures and transferred from the Ministry of Transmigration to the jurisdiction of the provincial government to become the new villages. The remaining 12 settlements are on the process of the transfer.

The major roads in the Objective Area are (i) the national highway from Dumai to Kota Pinang in North Sumatra, and (ii) the provincial road from Rantau Berangin (15 km west of Bangkiang) via Tandun, Pasir Pangarayan and Dalu Dalu to Sibubuhan in North Sumatra. These routes traverse the Study Area east-west, and provide access via district roads to the various kecamatan capitals scattered in the area. The above national highway and provincial road are asphalt surface within the Objective area, and in generally good condition. However, many of the district roads are dirt, and impassable during the rainy season when the surface changes to mud. According to 1988 statistical data, 35% (2,160 km) of the total road length in Riau Province is described as "bad" or "extremely bad".

Inland waterways connect the small to medium sized urban areas within Riau Province, and are used for the transport of persons, farm, plantation and forest products, food, fuel and other goods necessary in the daily life of the regional population. These waterways continue to fulfill a major transportation function in the province despite a gradual decline in numbers of vessels and carried loads with increased road development.

Power in Riau Province is provided from 2 sources: (i) the government owned utility PLN, and (ii) privately operated diesel generators. However, individual generators serve only their immediate isolated areas, and remain unconnected by any type of grid. Electrification rate for the districts in the Objective Area is about 20 %.

The cover ratio for water supply facilities within the Objective area is low. The only facilities are those at kecamatan capitals of Bagan Siapi Api (Kecamatan Bangko; 20 l/s), Ujung Batu (Kecamatan Tandun; 5 l/s), and Pasir Pangarayan (Kecamatan Rambah; 10 l/s). The rural population rely on communal shallow wells, river water and rainfall for domestic water. However, these are not outfitted with pumps. Furthermore, some of the wells are dry in the dry season.

3.3 Agricultural Situation

About 60 % of the Study Area is occupied by forest and 20 % by bush and grassland. Under these circumstances, approximately 80 % of the study area is not used for cultivation. 20 % of the study area is utilized for crop production. Bush and grassland are widely present in the Study Area, although relatively concentrated near the village area. Many bush and grassland areas remain as a results of divested cultivated land and cleared forest.

Tidal cultivation of rice distributes around the mouth of the Sungai Rokan. Shifting cultivation is mainly carried out by local and transmigrant farmers.

Oilpalm cultivation is carried out under large scale commercial plantation. Rubber and coconut cultivation are carried out under small scale plantation by private farmers and small companies.

Recent trends of land use are the rapid decrease of forest area and the rapid increase of the large scale plantation. Particularly the cultivated area of the oilpalm plantation is increasing.

Table 3.2 and Fig.3.5 show the present land use in the Objective Area.

In the Objective Area that consists of two Kabupatens, Kampar and Bengkalis, 10 irrigation schemes are being carried out covering a total irrigable area of 5,525 ha. However, the existing paddy field is only 1,628 ha and among this 1,303 ha in wet season and 394 ha in dry season are being irrigated now. The present level of all irrigation system prevailing in the Objective Area belongs to semi-technical irrigation system.

In Riau Province the most important food crop is rice, which occupies approximately three quarters of the cultivated area. There is, however, a severe shortage of rice supply in Riau Province amounting to as much as 200,000 ton of milled rice which are bought from West Sumatra, North Sumatra and other regions. Rice self-sufficiency has been, therefore, a very important goal in the former REPELITAS and current REPELITA V in the Province.

In Kabupaten Kampar rice is planted mainly in upland. On the other hand, rice is planted in wetland in Kab. Bengkalis. The

productivity of rice is lower than the national average. The reason for this low productivity is a lack of good irrigation, namely irrigation facility which can supply enough water throughout the year. Table 3.3 presents the food crop production statistics in the Objective area.

Mechanization level is primitive for land preparation and manual plowing and oxen plowing are practiced, and not plowing by tractor.

3.4 Agroeconomic Situations

The 1983 Agricultural Census indicated that farm households accounted for 88.4% and 70.1% in the 6 sub-districts of Kabupaten Kampar and 4 sub-districts in Kabupaten Bengkalis, respectively. The number of farm household and population in the Objective Area in 1990 has been estimated at 83,696 households with 404,247 persons, accounting for 72.4% of the total households. The Census reported that 709,200ha of land are utilized for agricultural purpose in Riau province, of which 683,800ha or 96.4% are owned by individual owners. In the Objective Area, 92,981 ha of land were owned by 42,787 farm households, averaging 2.17 ha per farm household.

Based on the data on food crops production and estimated population in 1989, food balances for both Riau province and the Objective Area have been prepared as shown in Table 3.4.2. It is noteworthy that Riau province is not self-sufficient in most of major food crops including rice, maize, soybeans, and groundnut. Particular attention should be placed on the deficit of rice totaling to as much as 200,000 tons in 1989. Taking into account the projected population growth rate of 3 to 4% p.a. in the future, the province needs to make further efforts to increase rice production. In the Objective Area, the situation is almost the same as the province. Due to its higher growth rate of population in the Objective Area, continued efforts would be required to increase the production of food crops in this area.

The government's development strategy places strong emphasis on rural and regional development and includes support for key areas of the agricultural sector. Support services to the agriculture sector are provided through a number of government agencies, the most important among them being the Ministry of Agriculture, the Directorate General of Water Resources Development (DGWRD), P.T. Pusri (the public sector fertilizer distribution agency), and

BULOG (the national logistics agency). In addition, village cooperatives (KUDs) have been assigned a major role in the distribution of agricultural inputs and socioeconomic uplift of the farmers. Within the Ministry of Agriculture, the Directorate General of Food Crops Agriculture oversees the provision of support services which are provided by the specialized agencies such as Agency for Agricultural Research and Development (AARD), the Agency for Agricultural Education, Training and Extension (AAETE), and the Agency for the Intensification Programs (BIMAS). These agencies and institutions are providing support services through their provincial as well as Kabupaten offices.

In order to achieve the self-sufficiency in food crops production, especially in rice production, a certain method of agricultural extension, known as BIMAS (Mass Guidance) was introduced in 1968. BIMAS program including its subsequent INSUS (Special Intensification) and SUPRA-INSUS (Super-special Intensification) program has resulted in achieving the level of self-sufficiency in rice production in 1985. Since 1986, the agricultural intensification program started to extend its activities to secondary food crops although rice production has been still the top priority in agricultural production policy. Recent intensification program is trying to expand its activities to integrated development approach including plantations, livestock and fisheries.

In Riau province, the agricultural intensification program, called Prosperous Riau Operation, is extensively promoted since the commencement of PELITA V. Characteristics of this operation is in its integrated development approach which involves combinations of such components as food crops cultivation, poultry farming, fish culture and plantations. This program aims not only to increase the production of food crops such as rice, soybeans and maize, but also to increase production of local chickens, freshwater fishes and cattle for farming.

The national agricultural research system is coordinated and administered by AARD. AARD has its research centers in the fields of agricultural statistics, soils, agroecology, estate crops, horticulture, livestock, and fisheries. The research program for food crops is carried out at six institutes supported by 15 research stations and 45 experimental farms. CRIFC (Central Research Institute for Foodcrops) in Bogor is extending research services through its 7 branch stations in the nation.

There is no agricultural research station in Riau Province.

Agricultural research in this Province is covered by the West Sumatra Branch Station in Sukaramai. Main activities of this station are to execute experimental work under the instruction and supervision of the Central Station at Bogor and to collect information from extension services on the technical problems associated with the farming practices of local farmers.

Extension services are organized by the various departments of the Ministry of Agriculture, coordinated by AAETE. There are 28 agricultural information centers where extension materials are prepared and sent to the 1,650 agricultural extension centers (BPPs) in the country, which are the basic extension units.

There are several institutions involved in agricultural extension services in Riau Province which include, among others, Dinas Pertanian Tanaman Pangan (Provincial Food Crops Services), Dinas Perkebunan (Provincial Plantation Services), Dinas Kehutanan (Provincial Forestry Services), Dinas Peternakan (Provincial Livestock Services), Dinas Perikanan (Provincial Fishery Services), Provincial BIMAS Secretariat, Agricultural Information Center and Agricultural Training Center. At Kabupaten level, there are also several agencies and institutions involved in agricultural extension services such as extension services sections of various Cabang Dinas Offices in agriculture sector, Kabupaten office of Bimas Secretariat, some UPPs (Unit Penyuluhan Pertanian or Agricultural Extension Unit), seed farms, etc.

At Kecamatan level, each BPP (Balai Penyuluhan Pertanian or Agricultural Extension Center) acts as a base camp for the extension services. BPP is responsible for agricultural extension services at field level and each BPP covers one to three Kecamatan.

Riau Province consists of 68 WKBPPs (BPP Extension Working Areas), which are divided into 804 WKPPs (Working Area of Extension Workers). WKPPs are further sub-divided into 6,476 WILKELs (Area of Farmers' Group). In the Objective Area, there are 10 BPPs to provide agricultural extension services in foodcrops, livestock, estate crops and fisheries.

The credit schemes in Indonesia have been only partly successful in reaching the vast majority of food crop farmers. The share of agricultural credit provided by banks to total credit is about 9 %, well below the shares of the industry and trade sectors that are in the range of 35 %. This low ratio of formal credit reflects the high level of self-reliance and credit from informal

sources in the agriculture sector.

In Riau province, institutional credit services for farming are mainly provided by BRI (Bank Rakyat Indonesia), the state owned commercial bank with special task of serving agricultural credit needs of agricultural cooperatives. Although ordinary credit services are available to anybody who can pay the interest rate of around 25 % and who can provide sufficient collateral, most of farmers are unable to pay such a high interest rate for their farming. A concessional credit facility, called KUT (Kredit Usaha Tani or Farming Credit) has been introduced in Riau in 1990 to promote the intensification of rice and palawija crops production in relation to the agricultural intensification program of the Prosperous Riau Operation. Under this credit system, a short-term farming loan covering required working capital and provision of farming inputs are provided by BRI through KUDs to farmers. BRI provides short-term loans for a term of up to 12 months to KUDs and KUDs provide loans for a term of up to 7 months to farmers. The interest rate of BRI of 16 % is levied on the loan provided to KUDs. Against the amount of repayment made within the specified term, a commission of 7 % is paid to KUDs. BRI's services are usually provided through its BRI Unit Desa. Within the Objective Area, BRI has 4 Unit Desa offices at Duri, Bagan Batu, Pasir Panggarayan and Ujung Batu.

Supply of fertilizers and agrochemicals in Riau province is mainly handled by the government enterprises of P.T. Pupuk Sriwidjaja (Pusri) and P.T. Pertani. Fertilizers coming from other provinces (Line I) are stored in the godown of P.T. Pertani at Pekanbaru (Line II) and then distributed to retailers at Kabupaten level (Line III). Fertilizers are distributed to KUDs (Line IV) from Kabupaten level at subsidized prices. P.T. Pusri only handles fertilizers at government subsidized prices. Non-subsidized fertilizers are handled by some other traders. P.T. Pertani is a main supplier of agrochemicals and also a supplier of fertilizers at Line III level. Some private traders also handle fertilizers and agrochemicals although their trading share is not so big as P.T. Pertani. The quantities of fertilizers, agrochemicals and seeds handled by P.T. Pertani, Riau in 1990 are shown in Table 3.4. The table indicates that 95 % of fertilizers are utilized for the production of estate crops and the remaining 5% are for the production of food crops, and 80 % of agrochemicals for estate crops and 20 % for food crops.

National Logistics Agency (BULOG) has been playing an important role in the market of major foodstuffs such as rice, wheat, and

sugar. Its main task is to watch the market situation and take some measures to stabilize the market when the market prices are considered to exceed the allowable level. Such market intervention is carried out for the benefits of both producers and consumers in accordance with price policy of the Government. BULOG has its regional Logistics Depot (DOLOG) at provincial level. There is a DOLOG office at Pekanbaru and six Sub-DOLOGs at Tanjung Pinang, Bengkalis, Dumai, Pulau Batam, Tembilahan and Rengat.

In order to stabilize the prices of rice and palawija, purchase and sale of unhusked rice, milled rice and palawija are based on the floor prices fixed by the government. For instance, purchase price of unhusked rice by KUD from farmers was set at Rp 295 per kg, which is sold to DOLOG at RP 310 based on the floor prices fixed in October 1990.

As Riau is rice deficit province, the DOLOG's main operation is to purchase 50 to 60 thousand tons of rice every year from other provinces and distribute them in the Riau Province. There are 18 units of storage in Riau Province with total capacity of 43,500 tons.

Rice milling facilities in the Objective Area include 75 RMUs (Rice Milling Units) with a combined capacity of 39,145 tons and 79 PPEs (Engelberg Milling Units) with a combined capacity of 6,636 tons. There are no PPEs in the 4 sub-districts of Bengkalis, while 79 units of PPEs are still utilized in the 6 sub-districts of Kampar. It is recommended by the provincial and Kabupaten Agriculture Services that old type of PPEs should be replaced with the new type of RMUs to improve the processing quality of rice.

Processing facilities in Pekanbaru, Kabupaten Kampar and Kabupaten Bengkalis include 4 units of rubber mills, 11 units of oil palm mills and 19 units of copra processing mills.

There are several forms of farmer groups in the agricultural sector for the purpose of agricultural extension services, agricultural cooperatives, pest control, water management, etc. Basic unit is called the farmer group (Kelompok Tani) consisting of between 100 and 150 farm households. A group leader (Kontak Tani) is selected among the members.

BPPs are the basic extension units to extend extension services to the level of farmers. Working area of a BPP is divided into

WKPPs (Working Area for Extension Workers) which are further subdivided into WILKELs (Area of Farmers' Group). Under Training and Visit System, a PPL (field extension worker) visits 16 WILKEL in every 2 weeks to transfer the new agricultural information and farming technology and also to solve the problems faced by the farmers. It is expected that information obtained from a PPL will be transferred by a group leader to the farmers who are members of non-KUDs of the area. In some occasions, meetings are held between government staff and farmers on the implementation of the agricultural intensification program in the province.

In the area where irrigation facilities are available, P3A (Perkumpulan Petani Pemakai Air or Water Users Association) is usually organized to ensure sustained operation and maintenance of the completed on-farm irrigation facilities. The already organized farmer groups will be converted into P3As. In addition to operation and maintenance responsibility, P3As are also responsible for drawing up seasonal programs for equitable distribution of water within their respective command areas.

3.5 Environment

There are various kind of protected fauna and flora in the Study Area. It is estimated that habitats of such protected fauna and flora are limited in natural or semi-natural forest. Such fauna and flora shall be firmly protected in relation with the forest protection. On the other hand, species composition is very simple in the other vegetation, especially in plantation and grassland. The vast swamp area is spreading in the lower part of the Study Area. Almost of the swamp area is covered with natural forest. The natural forest is indispensable to sustain the ecology of fauna and flora inhabiting in and around the natural forest. Therefore, careful adequate investigation and research are required for the establishment of development plan in such vast swamp area.

Natural conservation forest and protected forest where tree felling is forbidden are fixed by the government in the Study Area. The areas of natural conservation forest and protected forest are 1,890 Km² and 617 Km² and occupy 8.5% and 2.8% of the total Study Area, respectively. No development is permitted in these area. Furthermore, limited production forest and fixed production forest are fixed and being maintained as forests. The area of limited production forest and fixed production forest are 7,673 Km²(34.7%) and 3,326 Km²(15.0%), respectively. The rest area of forests is conversion forest of 3,380 Km²(15.3%). In this conversion forest, any development project is regulated for land use.

The basic concept of environmental impact assessment is to reduce or to remove negative impacts and to maximize positive ones for a development project in every stage i.e. selection stage, planning stage and implementation stage. The criteria for environmental impact assessment in Indonesia are 1)Government Regulation No.29,1986 for Environmental Impact Analysis, and 2) Degree No.557/KPTS/1989 on Managing Guideline on Environmental Impact Assessment within the Ministry of PU, and they show the basic concept and procedure on environmental impact survey.

4. BASIN DEVELOPMENT PLAN

4.1 General

The basic objective of economic development in Riau province is to upgrade standards of living, education and welfare of the population in the province. In order to achieve the objective, the province has been divided into six (6) Development Regions called Wilayah Pembangunan (WP). Each WP has its development center as a core for development activities.

Among the 6 WPs, the WP II covers the western part of Kabupaten Kampar, where the 6 Kecamatan of the Objective Area is included, with Pasir Pangarayan as its development center. In WP II, priority of development is given to the agriculture, industry and tourism sectors. Special emphasis is given to the agriculture sector including food crops and estate crops sub-sectors. The WP III covers the whole area of Kabupaten Bengkalis, where the 4 Kecamatan of the Objective Area is included, with Dumai as its development center. In WP III, priority of development is given to mining, industry and agriculture sectors. Within the WP III, agricultural activities are particularly important in the 4 Kecamatan of the Objective Area.

As clearly explained above, the Objective Area with Pasir Pangarayan as its development center is expected to function as the center for agricultural activities in order to achieve self-sufficiency in foodstuffs, especially rice and to increase the production of estate crops to increase exports as well as to meet the demand of domestic industries.

4.2 Agricultural Development

4.2.1 Development Strategy

Agriculture sector is regarded as one of the most important sectors in Riau province as a means to achieve the basic objective of the provincial development plan. In agriculture sector, the first priority is placed on achievement of self-sufficiency in foodstuffs, especially rice. Increase in the

production of palawija crops such as soybean, maize, groundnut, etc. are also required to improve nutrition of the population. In addition, increase in the production of estate crops are also needed to increase exports as well as to meet the demand of domestic industries.

The Objective Area has favorable conditions for its agricultural activities. In spite of shortage of irrigation facilities, agricultural activities are extensively conducted in this area which include cultivation of rice, palawija (soybean, groundnut, cassava, maize, etc.) and vegetables in wetland and dryland, and estate crops (rubber, oil palm, coconut, etc.) and fruit tree crops.

In addition, livestock farming is extensively conducted in Kabupaten Kampar and pond aquaculture is concentrated in and around Kecamatan Rambah. Taking into account these situations, the Objective Area can be regarded as the center for agricultural activities in the province. Comprehensive agricultural development plan is therefore to be promoted in this area.

Agricultural development plan consists of agricultural production intensification program and agricultural supporting services strengthening program. Agricultural production intensification program includes promotion of irrigated rice farming, improved rice farming in non-irrigated land, improved farming of palawija crops, promotion of fruit tree and estate crops. Agricultural supporting services strengthening program includes strengthening of agricultural cooperatives (KUDs), farmer organizations and extension services network to improve the system of agricultural credit, farm input supply, promotion of farming technology, post-harvest and marketing.

4.2.2 Farm Technology Development

Although a variety of farming practices are conducted in the Objective Area including rice, palawija, vegetable, fruit tree and estate crops, there seems to be few farmers who have enough experience in irrigated agriculture. As a whole, traditional shifting cultivation is extensively conducted without any significant technological improvement. Under such a situation, it is necessary to develop farming technology suitable for the area.

In general, it is recommendable to apply improved varieties, to

practice deep plowing cultivation, to improve fertilization process and methods, to introduce rational water management, to introduce light-intercepting characteristics, to practice pest control, to improve all management works (proper intermitted plowing, weeding and thinning) and to improve farm land soil. Improved farming technology should be developed in experimental farms and transferred to the farmers through agricultural extension services network.

Crops selection should be conducted taking into account several factors such as national as well as provincial development policy, regional specific natural conditions (climate, soil, water availability, topography, etc.), farming technology level, agricultural manpower, profitability and marketability.

In consideration of the above factors, appropriate crops selected are rice as a main crop and soybean, groundnut and maize as secondary crops in the irrigated area. These crops are recommended in the national food production intensification program (SUPRA INSUS). These crops can also be applied in non-irrigated land.

From point of view of profitability, vegetables like chili, cowpea, cucumber, eggplant, and onions are recommended although it may not be possible to produce these vegetables on a large scale due to manpower and market limitation.

As estate crops, rubber, oil palm and coconut will continue to be main crops in the Objective Area. In particular, increased plantation of oil palm should be promoted.

In the irrigated land, double croppings of rice or rice-palawija cultivation are proposed with cropping intensity of 180 % for rice and 20 % for palawija cultivation. Selection of palawija crops should be determined taking into consideration of the natural conditions, profitability and marketability. Rice and palawija cultivation is also recommendable on rainfed wetland. Upland rice and palawija cultivation is recommendable on dryland. Vegetable cultivation on a small scale is recommendable particularly in and around Pasir Pangarayan where irrigation water is available. In vegetable cultivation, gramineous crops like upland rice and maize, or pulses like mung bean and groundnut should be intercropped with vegetables in order to retain soil fertility.

Palawija crops cultivation will be expanded to 6,000 ha on

irrigated land with cropping intensity of 20 %. Yield per ha of soybean and groundnut will be increased to 2 tons and 3.5 tons, respectively. Some other crops like mung bean and sweet potato can also be introduced. In addition, palawija crops will be cultivated in about 10,000 ha of non-irrigated land. The total production of palawija crops in the target year will be able to meet the requirement of the Objective Area and the rest of the province.

Expansion of planted area, replanting of estate crops (rubber, oil palm, and coconut), and production intensification through application of improved varieties and fertilization are required to increase the production of estate crops. In addition, integrated approach in extension services including transfer of improved technology, provision of credit supply, marketing and processing is needed particularly for small holders who produce a larger part of estate crops production. Improvement of transport infrastructures including road and inland navigation is vital for smooth marketing of produce.

4.2.3 Strengthening of Agricultural Supporting Services

In order to increase agricultural production, it is also required to improve and strengthen the current agricultural supporting services. Such measures for strengthening will include the following.

1. Agricultural research and experimental facilities are not adequately provided in the Objective Area. In order to ensure the present crop development program and to provide for the successful implementation of the irrigated agriculture, a systematic program of adaptation test of agriculture is indispensable. It is recommended therefore to establish at least one or two experimental farms in the Objective Area to carry out such experiments.

2. Present facilities and personnel for agricultural extension services in the Objective Area are not sufficient to ensure the present crop development program and future implementation of irrigated agriculture. Particularly, education and training program for extension workers with regard to irrigated agriculture is indispensable to carry out the future irrigation projects. Education and training on marketing aspect of the agricultural products will also be required in the future.

3. Institutional credit services are presently available at four (4) offices of BRI Unit Desa in the Objective Area. In consideration of present transport conditions, the number of offices for institutional credit services is not sufficient. In addition, the number of reliable and profitable KUDs (Village Unit Cooperatives) as primary channels for agricultural credit is limited in the Objective Area. In order to improve such situations, agricultural cooperatives should be strengthened under the government guidance and assistance. It is recommended therefore that the government agencies concerned will give the guidance, assistance and facilities for more effective function of these cooperatives through the provision of education and training of cooperative management, credit system, marketing and processing of agricultural products.

4. Present input supply for food crops production in the Objective Area is not considered to function adequately. In order to ensure more stable and efficient supply of agricultural input, strengthening of KUDs management will be required under guidance and assistance of the government extension and training program.

5. Present marketing activities in the Objective Area consist of import of major foodstuffs like rice, flour, and vegetables from other provinces and export of semi-processed or processed estate crops either to other provinces or to foreign countries. It is expected that more rice and palawija crops will be produced and marketed within the Objective Area in the future and that surplus of some of palawija crops must be sold to other provinces. In this context, education and training of extension workers in the field of marketing aspect should be more extensively conducted.

4.2.4 Inland Fishery Development

Fishery production in Riau totaled 172,198 tons in 1988, of which marine fishery accounted for 92.6%, and per capita supply of fish amounted to 57kg. A part of production of marine fishery were exported either to foreign countries or other provinces. Therefore, actual supply of fish will be less than 57kg per person.

In the Objective Area, marine fishery is dominant in Kubu and Bangko of Kabupaten Bengkalis, with per capita supply of 550kg and 220kg, respectively. In Mandau and Tanah Putih of Kabupaten

Bengkalis, inland fishery is dominant, with per capita supply of 19.5kg which is a level of self-sufficiency in fish production. In the 6 sub-districts of Kabupaten Kampar, fishery production is limited to inland fishery due to its location. A larger part of fish demand is dependent on fishes from inland fishery.

The level of production is only 7kg per person in 1989 which is not self-sufficient. Marine fishes are imported from neighbor provinces taking advantage of lower transport cost. In such a situation, it is particularly required to increase fish production in the 6 sub-districts of Kabupaten Kampar through increasing fish catch in open waters and increasing production of freshwater aquaculture.

Based on the development strategy as mentioned above, the following measures are recommended to be implemented in the Objective Area.

- 1) Education and Organization of Fish Farmers
- 2) Fish Cage Culture (Keramba) in Open Waters
- 3) Hatchery Improvement and Extension
- 4) Fish Pond Culture (Kolam)

As freshwater aquaculture will require substantial extension effort, increase in the number of extension workers as well as provision of improved extension facilities would be indispensable.