REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS

DIRECTORATE GENERAL
OF
WATER RESOURCES DEVELOPMENT

ROKAN RIVER BASIN
OVERALL IRRIGATION DEVELOPMENT PLAN STUDY

VOLUME II

OVERALL IRRIGATION DEVELOPMENT
PLAN STUDY IN ROKAN RIVER BASIN

OCTOBER 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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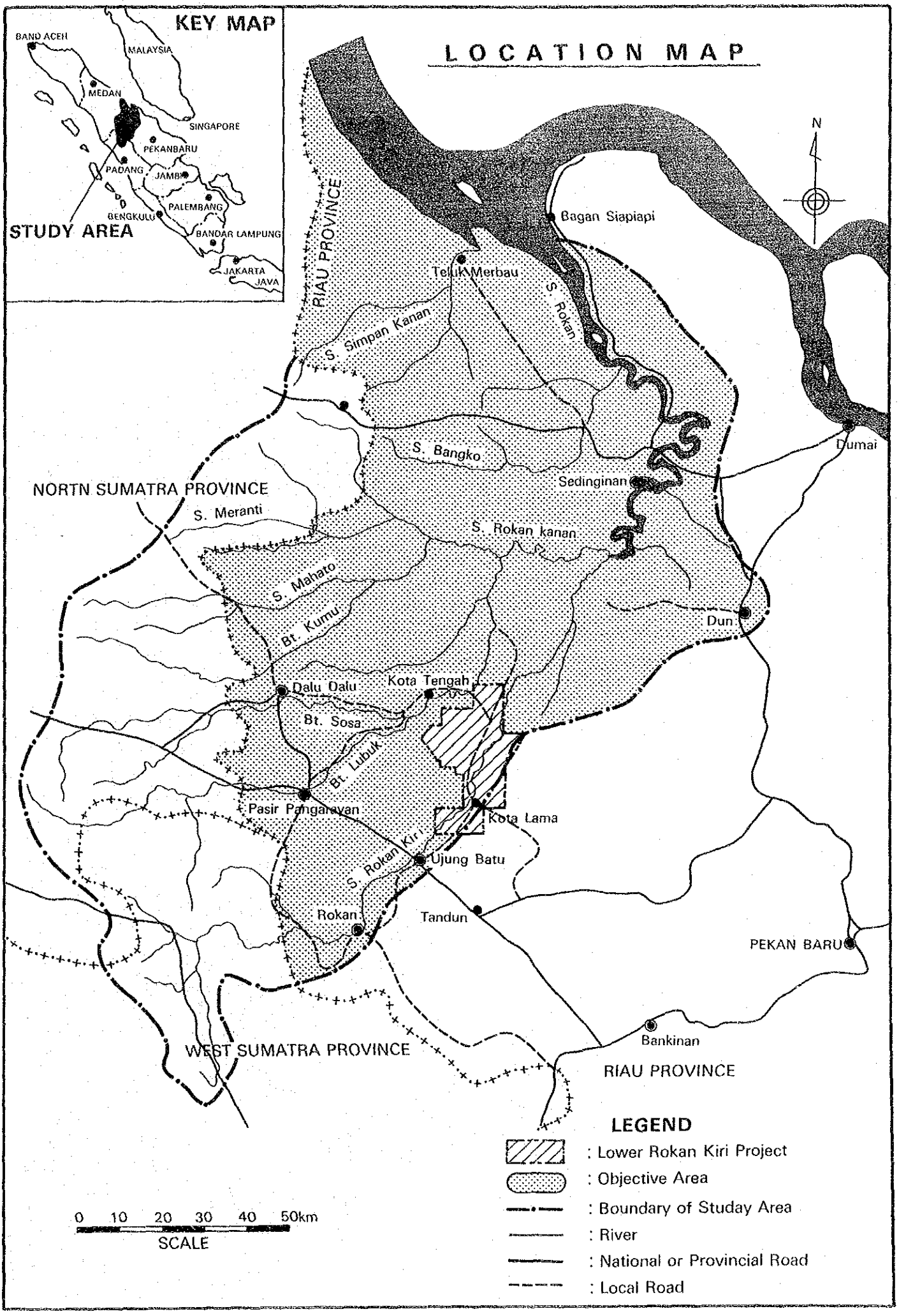
KEY MAP
BAND ACEH
MALAYSIA
MEDAN
SINGAPORE
PEKANBARU
PADANG
JAMBI
PALEMBANG
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BANDAR LAMPUNG
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STUDY AREA
LOCATION MAP
N
RIAU PROVINCE
Bagan Siapiapi
Teluk Merbau
S. Rokan
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Dun
Dalu Dalu
Kota Tengah
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Pasir Pengaraian
Kota Lama
S. Rokan Kiri
Ujung Batu
Rokan
Tandun
PEKAN BARU
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WEST SUMATRA PROVINCE
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LEGEND
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: Objective Area
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: River
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0 10 20 30 40 50km
SCALE

ROKAN RIVER BASIN
OVERALL IRRIGATION DEVELOPMENT PLAN STUDY

FINAL REPORT

VOLUME II

OVERALL IRRIGATION DEVELOPMENT PLAN STUDY IN ROKAN RIVER BASIN

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1. INTRODUCTION

1.1 Authority

The Final Report was made in accordance with the Inception Report which was prepared based on 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.

The Final Report consists of the following four(4) Volumes:

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

This is the Volume II report and presents the results of analysis for collected data and information during Phase I field survey including dry season survey, establishment of basic development plan and selection of the priority project. The report also presents the conclusion and recommendation as the results of the Phase I study.

This Volume II Report involves the following:

Main contents with Tables and Figures
Annex A : Socio-economy
Annex B : Meteo-hydrology
Annex C : Soil and land use
Annex D : Farm practices
Annex E : Agro-economy
Annex F : Irrigation and drainage
Annex G : Rural infrastructure
Annex H : Remote sensing analysis

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 Km^2 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 Km^2. The objective area where is in the Riau province becomes 16,059 Km^2.

(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 Work Activities

Based on the Scope of Work, the Study is divided into two stages, that is, Phase I and Phase II. Each Phase covers the following;

In Phase I Study, natural condition, socio-economic condition, agricultural situation, development plan and problems to be

solved of the Study area were grasped in field work. Following this, in home office work in Japan, all the collected data and information were arranged and analyzed and then the basin development plan was established. The priority project for irrigation development was selected among the areas for irrigation development in the Objective area. The results in the Phase I Study was compiled in this Volume II Report.

Moreover, in order to supplement the Phase I field work which was carried out in rainy season, the dry season field survey was done focusing on the following.

1) To grasp the condition of the Study area in dry season,
2) To conduct field scurvy for approximate intake point of the priority area,
3) To conduct river discharge observation in dry season and
4) To grasp the planting condition and method of food crops in dry season.

In Phase II field survey, the supplemental field work for the selected priority area in relevant to the establishment of the development plan is to be carried out. Then irrigation development plan for the priority area is to be established. After the analyzing all of the data, a feasibility study on both technical and financial aspects for the priority area is to be carried out in Phase II home office work. The results of the study is to be presented in the final report.

The Phase I field survey was carried out for 2.3 months from the beginning of January to the end of March 1991 and the Phase I home office work was carried out for 1.5 months from the beginning of Jun to the middle of August 1991. Prior to the Phase I home office work, the Phase I dry season field survey was conducted from June 1,1991 for 3 weeks.

For the execution of the Phase I field scurvy, JICA despatched the Study team consisting of 10 experts, while 9 counter personnel of the Government of Indonesia participated. The Phase I dry season field scurvy was carried out by 4 experts.

At the time of completion of the Phase I field survey, JICA Study team submitted the progress report(I) presenting survey results, list of collected data and preliminary evaluation of the development potential of the Rokan River Basin to the Government of Indonesia.

1.5 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 Km^2 including the Rokan River Basin of 18,405 Km^2 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.

The detail analysis method and results are shown in Annexes. The results are used for the following study in this report.

1) To grasp present topographic conditions of the study area such as elevation, slope, etc.,

2) to grasp vegetation, road conditions, location of the existing transmigration schemes, etc.,

3) to refer for the preparation of present land use map, soil map,and geological map,

4) to identify swamp area and agricultural potential area,

5) to collect basic information for environmental assessment taking into account the secular change, and

6) to grasp change of river condition.

2. ECONOMIC BACKGROUND

2.1 National Economic Background

2.1.1 General

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. Land area and population distribution in Indonesia is presented in Table 2.1.1.

Indonesia is administratively divided into 27 Provinces, including the special territories of Jakarta, Yogyakarta and Aceh. The Provinces are subdivided into 55 municipalities (Kotamadyas) and 241 districts (Kabupatens). The Provinces as well as Kotamadyas and Kabupatens are autonomous. Kabupatens are further subdivided into approximately 3,600 subdistricts (Kecamatans) and about 67,000 villages (Kelurahan/Desa).

Indonesia is the fifth most populous nation in the world with a population of 179.2 million in 1990 and an annual growth rate of 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.

2.1.2 National Economy

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 (see Table 2.1.2). 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%. Small holders estate crops production grew at an average growth rate of 4.3% per annum. The mining and quarrying sector declined both relatively and absolutely, owing to a fall in the real value of oil and gas output. Other sectors showing below-average growth performance included construction and services. Among sectors registering above-average growth, manufacturing outperformed others. Non-oil/gas manufacturing registered an annual average of 12.4% which was outperformed by the higher growth rates of petroleum refining (22.4%) and liquid natural gas (14%). Growth in the very small utilities sector (electricity, gas and water)

is put at almost 12% annually in real terms, while banking and financial institutions recorded almost 9% growth.

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.

2.1.3 Economic Development Plans

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.

Repelita V envisages an overall growth target of 5 per cent per annum. While mining sector is projected to grow at a lower rate of 0.4%, agriculture sector is expected to grow at a slightly higher rate (3.6%) than in the 1980s. Although the highest growth rate is expected for the industry sector, the projected rate is somewhat lower than REPELITA IV. The rapid growth in this sector is unlikely to be repeated in early 1990s. Higher growth rates are expected in construction, trade and transport sectors.

2.1.4 Role of Agriculture in National Economy

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. Some two-thirds of rural households depend on agriculture for their livelihood. 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.

Within the sector, the food crop subsector remains the largest, accounting for 61% of agriculture's contribution to GDP. Rice, the staple and dominant crop in Indonesia, accounts for 62% of the annually harvested area of all food crops; maize accounts for 17%, cassava for 8%, and soybean for 6%.

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.

The irrigation subsector plays a key role in increasing food production by increasing cropping intensities and expanding the area under cultivation through the supply of irrigation water. During Pelita I and II, emphasis in the irrigation subsector was on rehabilitation of old irrigation systems to achieve benefits quickly and at low cost. During Pelita III, greater emphasis was placed on the development of new irrigation facilities and the construction of tertiary facilities for efficient on-farm water management. Pelita IV included a shift in emphasis away from large scale irrigation and flood control works to the development and rehabilitation of small and medium scale projects. The government's thrust during Repelita V will be on an integrated approach to improving irrigated agricultural production which combines the construction and rehabilitation of the necessary physical infrastructure for irrigation and drainage with the institutional support required to increase agricultural productivity and efficiency on a sustainable basis. In addition to placing priority on improving operation and maintenance (O&M) and utilization of existing irrigation and drainage systems, Repelita V also emphasizes expansion of irrigation area, particularly in transmigration area, and river and flood control.

2.2 Regional Economic Background

2.2.1 Description of Riau Province

(1) Location and Population

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 km^2. 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, as presented in Table 2.2.1. This high growth rate is mainly due to rapid migration flow to the province icluding general as well as spontaneous transmigrants.

The province has five districts (Kabupaten; Indragiri Hulu, Indragiri Hilir, Kepulauan Riau, Bengkalis and Kampar) and two municipalities (Kotamadya; Pekanbaru and Batam). Pekanbaru is the capital of the province. Bengkalis occupies the largest part of the province (32.4%), followed by Kampar (29.5%).

In terms of population density, Pekanbaru, the capital of the province, is the most densely populated (892 persons per km^2), followed by Batam (175 persons per km^2) and Kepulauan Riau (61 persons per km^2). Bangkalis and Kampar are not so densely populated due to larger land areas.

(2) Economic Base

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. Trade and commerce sector accounted for 7.5%, followed by manufacturing (6.7%) and agriculture (5.5%). In terms of GRDP excluding petroleum, the agriculture sector had the largest share at 26.2% in 1988. (See Table 2.2.2).

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.

GRDP including petroleum at 1983 constant price increased at an annual average of 9.6% during 1985 and 1988, while GRDP excluding petroleum grew at 7.2% during the same period.

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. Services sector

ranked the second, accounting for 15.5%, followed by trade and commerce (11.1%) and manufacturing (4.3%). The mining sector employed only 1.6% of the total labor force in 1988.

2.2.2 Agriculture Sector

The agriculture sector in Riau province plays a key role in its economy, accounting for 26.2% of GRDP in 1988 excluding petroleum, and almost 60% of the employment in the province. Within the sector, estate crops subsector showed the average annual growth rate of 15.1% during 1983 and 1988. Oil palm production increased from 135,000 tons in 1984 to 194,000 tons in 1988 with a high growth rate of 88.9% per annum. During the same period, coconut and rubber production increased at an annual average of 9.5% and 3.2%, respectively. 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 from 15.3% in 1985 to 24.9% in 1988.

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 production in 1989 (255,680 tons of milled rice) could not meet the requirement of approximately 443,800 tons of milled rice in the province.

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.

2.2.3 Role of Agriculture in Regional Development

The basic objectives of the provincial Fifth Provincial Five-year Development Plan (REPELITA V) are; (i) to upgrade standard of living, education, and welfare of the population; (ii) to support, expand and complete the implementation of the national development plan (Repelita V); and (iii) to establish a strong base for the coming Sixth Five-Year Development Plan (Repelita IV). Based on the objectives, priority for developement has been placed on agriculture, industry and communication sectors. Development of these priority sectors is aimed at increasing income level of the people, expanding employment opportunities, and achieving balanced economic structure of the province.

In agriculture sector, the first priority is placed on achievement of self-sufficiency in foodstuffs, especially rice, as the province is suffering from rice deficit for many years. Continued efforts to increase the production and to improve the quality of food crops are required. 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.

2.2.4 Transmigration Program

Indonesia has a long history in conducting its transmigration program. Throughout the 20th century, transmigration has been regarded as a means of reducing overcrowding in Java and providing land and employment to the poor. More recently, in 1980s, transmigration has also been seen as a means of increasing national food production and reducing Indonesia's dependence on imports, stimulating development in remote and under populated provinces and exploiting underutilized natural resources.

Transmigration conducted under government support is called general transmigration (transmigrasi umum). Other form of transmigration is called spontaneous transmigration (trasmigrasi swakarsa), conducted at the expenses of transmigrants themselves.

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

3.1.1 Land

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 areas in the North Sumatra Province and West Sumatra Province are 3,690 Km² and 2,350 Km² respectively. Accordingly, the Objective Area in the Riau Province for the Study becomes 16,069 Km².

The distance from Pekanbaru, the capital of the Riau Province, to the eastern end of the Study Area is about 200 Km and to Pasirpangarayan, the center of the Study Area, is about 130 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. The tidal effect on the Rokan river reaches Sedinginan about 60 Km² from the estuary and some areas have been developed for irrigation using tidal difference. However, salt intrusion in dry season causes problems in the area.

3.1.2 Climate

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. According to the monthly rainfall and run-off patterns, duration from November to May is defined as the wet season and from June to October as dry season.

In the Study Area, sixteen(16) rainfall stations including five(5) new stations installed in 1990, four(4) meteorological stations

including one(1) new station installed in 1990 and nine(9) water level gauging stations including one(1) new station installed in 1990 are being operated by the Provincial PU. Fig.3.1.1 shows the location of these stations. The monthly mean rainfall and meteorological features at each station are illustrated in Fig.3.1.2 and Fig.3.1.3 respectively.

(1) Rainfall

The monthly rainfall in the Study Area ranges widely depending on year. The maximum daily rainfall in the Study Area is recorded as 199 mm at Rao MT of the West Sumatra Province on October 15,1989. The isohyetal map in the Study Area is presented in Fig.3.1.4.

(2) Evaporation

The annual mean evaporation ranges from 1,359 mm to 1,710 mm depending on the locations and daily evaporation on the monthly average ranges 3 mm/day to 4 mm/day.

(3) Wind Velocity

The annual mean wind velocity ranges from 16.6 Km/day to 32.5 Km/day depending on the locations and daily mean wind velocity varies from 11.8 Km/day to 35.2 Km/day.

(4) Air Temperature

The annual mean air temperatures are 25.3°C to 28.0°C and the maximum and minimum ones are 29.7°C to 32.7°C and 21.2°C to 23.5°C respectively.

(5) Relative Humidity

The average annual relative humidity shows the high value of 91.4% at Kota Lama and average monthly ones in the area vary from 82.5% to 92.6%.

(6) Sunshine Ratio

The average annual sunshine ratio is 37.6% to 46.1% and the average monthly ones range 31.0% at the minimum to 57.4% at the maximum.

(7) Solar Radiation

The annual solar radiation is 193 to 308 cal/cm^2/day depending on the locations and the average monthly ones vary from 164 at minimum and 321 cal/cm^2/day at maximum.

Under the meteorological condition mentioned above, it is important to consider the relevant agroclimatic factors in planning crop

production.

Precipitation is the most important such factor affecting crop production. The amount of precipitation is important for perennial crops and the amount of monthly precipitation is highly important for annual crops. In general, months in which it rains more than 100 mm are referred to a "humid months". "Dry months" are those where the rainfall is less than 60 mm, and "intermediate months" are those where the rainfall is between 60 to 100 mm. According to the foregoing criteria, all months throughout the year are humid months in the Objective Area.

In the Objective Area, the minimum temperatures is 21.1° and the maximum one is 32.7°. Accordingly, temperature is not a critical factor for agriculture in the area.

Strong wind can cause abnormal evapotranspiration and lodging. However, the Objective Area is located in the doldrums and thus the risk of strong wind is almost none. Also, high humidity can be a cause of pest epidemic. Although the relative humidity in the Objective Area is more than 80% throughout the year, pest epidemic is no serious at present.

The fluctuation range for day length is approximately 1 hour and thus the photosensitivity of crops and varieties should be carefully considered in the planning of agricultural development.

Solar radiation is essential for photosynthesis in crop growth. In a tropical zone such as the Objective Area, there is very little possibility of solar radiation shortage. Nevertheless, it is well known that there is a positive correlation between solar radiation and rice yield. In other words, rice yield under irrigation in the dry season is often higher than that of the rainy season.

3.1.3 Vegetation

According to the remote sensing analysis and field investigation, the vegetation in the Study Area can be classified into three(3) types, that is, forest, plantation and grassland.

Forest is further divided into natural forest and secondary forest. Natural forest includes semi-natural forest. Semi-natural forest means a forest in which big and useful trees have already cut down but is physiognomically the same with a natural forest. On the basis of the difference inhabitant, swamp forest can be extracted from the broad-sense natural forest. Moreover, the swamp forest includes mangrove forest existing near the river mouth. The mangrove forest includes emergent trees of more than 30 m in height and has high diversity in flora and fauna. Secondary forest which is less than 20 m in height is a forest that has been regrown after cutting and burning. The diversity in the secondary forest is lower than that of the natural forest.

In plantation, rubber, oil palm and coconut palm are planted. The diversity in plantation is generally very low excluding rubber plantation under bad management. Grassland can be divided into some types. As the artificial vegetation, farm land can be distinguished and rice, maize, soybean, peanut and cassava are being cultivated. Alang-alang(Imperata cylindrica) grassland is compensatory vegetation and occupies abandoned places after shifting cultivation.

Topography of the study area is generally classified into three(3) areas; mountain, wavy hill and flat plane area. Vegetation of the Study Area also corresponds with the topography.

a. Mountain Area

The mountain area is located at the upper reaches of the Rokan river and composed of steep slope. Natural or semi-natural forest covers almost whole area. Protected forest are fixed in this area.

b. Wavy Hill Area

The wavy hill area is situated at the midstream of the Rokan river. This area has relatively large population and well developed. So, artificial or compensatory vegetation are widely distributed. Natural conservation forest is fixed in the south of Duri and is known as the habitat of elephants, sumatra tigers and tapirs.

c. Flat Plane Area

A flat plane area is composed of swamp area and alluvial plane area. The swamp area occupies the northern part of the Study Area i.e. the downstream of the Rokan river with low altitude, approximately under 20 m. The alluvial plane is distributed along the big rivers. Wide area of alluvial plane is developed for cultivated field, plantation and grassland. On the other hand, the swamp area is covered with natural or semi-natural forests. Potential vegetation of the swamp is forests and developed on woody peat.

3.1.4 Rivers

The total area of the whole Rokan river basin is 18,405 Km^2 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. Fig.3.1.5 presents sub-basins in the Rokan river and Fig.3.1.6 shows Rokan River Basin System.

Basin Division of Rokan River Basin

Sub-basin Block No.	Main River	Area (km²)	Number of Tertiary Basin
Block 1	S. Rokan Kiri	4,312	6
Block 2	Bt. Lubuk	4,610	9
Block 3	Bt. Kumu	3,913	8
Block 4	S. Bangko	1,565	2
Block 5	S. Rokan	4,005	5
Total		18,405	30

The provincial PU has been recorded continuous river water level and carried out river flow discharge measurement at AWLR stations from time to time since 1977. Those data show that river discharges and river water level have good correlation as shown Annex B. Thus, rating curves for all AWLR stations were estimated by applying the least square method based on the flow measurement records. The run-off discharge at estuary of the Rokan River is very difficult to assume due to effect by tidal. Therefore, the discharge at estuary is estimated by accumulating river run off from sub-basins. The river run-off discharges from sub-basins, Block 1 to Block 3, are estimated by employing mathematical simulation model(Tank model) using rainfall records of the base year 1984. The estimated total annual run-off are as follow :

Run-off from the Main Rivers in the Rokan River Basin
(Year 1984-Base Year)

No. of Block	River Name	Area (km²)	Annual Run-off (Million m³)
Block 1	S. Rokan Kiri	4,312	4,506
Block 2	Bt. Lubuk	4,610	4,692
Block 3	Bt. Kumu	3,913	4,513
Total		12,835	13,711

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 o.66 $m^3/s/Km^2$ in case of return period of 50 years and at 1.43 to 0.86 $m^3/s/Km^2$ in case of that of 500 years.

Although the confluent places of the Rokan and Rokan Kiri rivers are inundated area by flood, no damage is reported because of undeveloped area. River training works has not been carried out up to now.

3.1.5 Geology

The Rokan river basin lies on the Sundaland Plate extending to Karimantan Island and Central Sumatra Basin which formed by sediments from the collapsed materials of Barisan Mountains. The geological materials recognized in the Study Area are sedimentary rocks from recent Quaternary to Carboniferous, igneous rocks after Tertiary and granites before Tertiary.

The area on the alluvial plain from the coastal area of the Strait of Malacca to the river basin of the Rokan river and its tributaries was formed during the Holocene to Younger Pleistocene in Quaternary. The area called Minas Hills lies on around Duri, the west part of the Rokan river and southern foot hills of the Barisan Mountains parallel to the line of the Barisan Mountains and forms the anticline of Duri and Kampar. Deeply gullied sand hills are found in this area. The sediments are mainly composed of Younger Pleistocene stratum and main rock is weathered tuffs.

The foothills of the Barisan Mountains are mainly covered by the Tertiary sediments, sometimes capped with terraces composed of Pleistocene deposits. Main rocks in this area are calcareous shells, sandstone and siltstone. Southern parts are widely gullied. Barisan Geanticline lies in the higher areas from this zone and is deeply dissected. Barisan Geanticline geologically is a part of the geanticline which is a major feature of Western Sumatra and composed of old sediments from Carboniferous to Triassic and igneous rocks.

The folding anticlinal structure develops in the Miocene sediment which is the basement of the Central Sumatra Basin. The oil fields locate on this sediment and produce the most important natural resource in Indonesia.

The simplified geological map is shown in Fig.3.1.7.

3.1.6 Soil

The soils of the Rokan River Basin can be basically divided into 3 regions named (i) The Eastern Coastal Swampland which lies on the coast, swamp area and alluvial plain of the Sungai Rokan and its tributaries, (ii) The Eastern Plains and Hills which are the flat area adjacent to Eastern Coastal Swampland and monotonous rolling sedimentary plains and hills adjacent to the Barisan Mountains and (iii) the Barisan Mountains themselves.

These soils can be classified into 6 soil groups and 12 soils from the view point of land system and soil-forming processes as shown in Table 3.1.1.

The soils of the Eastern Coastal Swamp Lands cover the alluvial soil at the downstream of the Rokan River and peat soils which lie on coastal area, and the area sandwiched by rivers where organic materials are deeply accumulated. These areas cover

approximately 40 % (9,214 km^2) of the Study Area, and peat soils cover 6,235 km^2. These areas are very flat with less than 2 % slope. The dominant soils are classified basically as Entisols (Aquents, Fluvents) and Histosols (Hemist, Saprists) by the Soil Taxonomy (USDA) classification.

The soils of Eastern Plain and Hills cover the alluvial plains of tributaries of the Rokan River. These soils include soil with high organic content in the surface layer and weathered tuffaceous sediments in the sub-surface layer called Marine Terrace Soil, and the soils which are well weathered and generally lie on hilly area called reddish yellow Podosol Soil. These soils cover approximately 40 % (8,417 km^2). The dominant slope of Marine Terrace Soil is less than 2 %. The slopes of other soils are, however, between 2 to 25 % . The dominant soils are classified basically as Inceptisols (Aquepts) and Ultisols (Udults) by the Soil Taxonomy (USDA) classification.

Followings are the other characteristics of the soils in the Study Area.

- The soils of the Barisan Mountains lie on the mountainous area and have more than 40 % slope.

- Since Tidal Swamp Soil shows high salt contents and Peat Soil has less developed soil layer, further detailed investigation will be necessary for the development of these area.

The main characteristics and the occupied area of these soils in the Study Area are summarized in Tables 3.1.2 and 3.1.3 respectively. The soil map is also shown in Fig.3.1.8.

3.2 Socioeconomic Situations

3.2.1 Administrative Divisions

The Riau province administratively consists of five districts (Kabupaten) and two municipalities (Kotamadya). Among these, the Objective Area is included within the boundaries of the Kabupatens of Kampar and Bengkalis. The capitals of Kabupaten Kampar and Kabupaten Bengkalis are located in Bangkinang and Bengkalis, respectively. These capitals are located out of the Objective Area.

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 197 villages (Kelurahan/Desa).

The Objective Area (10 sub-districts) has an administrative area of 16,353 km^2, occupying approximately 28 % of the total area of Kabupaten Kampar and Kabupaten Bengkalis. Administrative divisions of the Objective Area are presented both in Table 3.2.1 and Figure 3.2.1.

3.2.2 Population and Employment

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 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. Among the 10 sub-districts in the Objective Area, the highest growth rate is recorded in Tandun (Kabupaten Kampar) at 13.59%, the second in Tambusai (Kabupaten Kampar) at 11.75%, followed by Kubu (Kabupaten Bengkalis) at 10.31%, and Kunto Darusalam (Kabupaten Kampar) at 10.08%. The highest population density is recorded in Rambah at 71 persons per km^2, followed by Bangko at 39 persons per km^2 and Tandun at 36 persons per km^2. The average population density was 26 persons per km^2 in 1990. (See Table 3.2.2).

The main economic activity is considered to be agriculture in the Objective Area. Based on the data of the 1983 Agricultural Census, it is estimated that the share of farm household in the Objective Area (10 sub-districts of Kabupaten Kampar and Kabupaten Bengkalis) is approximately 72% of the total households.

3.2.3 Transmigration Program

Transmigration program in Indonesia has been conducted not only

to reduce the overcrowded population, but also to stimulate development in remote and under populated provinces and to exploit underutilized natural resources. Transmigration program in the Objective Area has also been conducted as a means of manpower development and balanced distribution of the population, aiming at improving standard of living of the population in and around the transmigration areas. Under the transmigration program, the emphasis has been placed on production increase in major food crops. Since around 1986, however, increase in estate crops production has also been considered important. With the increase in number of the state as well as private plantation enterprises in the Objective Area, transmigration program has started to place emphasis also on increase of estate crops production under the nucleus estate smallholders system, although food crops production has still been the national top priority in agriculture sector.

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.

3.2.4 Social Infrastructure

(1) Public Roads and Inland Water Transportation

As indicated in Fig.3.2.2, 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. Total road length in the Objective Area is shown in Table 3.2.2.

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".

The following table indicates the road density and length in Riau as well as Objective Area.

	Unit	Riau	Objective Area
Road Length	km	6,220	784
Road Density	m/km²	65.8	48.8
Per Capita Length	m/person	2.19	1.84

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.

Inland waterways are likewise important to the Objective area. This is particularly true of the swampy middle reaches of the Rokan river basin where lack of roads makes water transport the sole means of movement. Twenty four 3-ton boats are registered at Ujung Tanjung in Bangkalis District, and eighteen 1-ton vessels at Ujung Batu in Kampar District. These vessels are all motored, and ply the waterways according to unfixed schedules.

In addition, population along rivers use small paddled boats for day to day movement. Waterways are also used to transport a portion of the lumber cut in the area forests.

(2) Power Supply

Power in Riau Province is provided from 2 sources: (i) the government owned utility PLN, and privately operated diesel generators. However, individual generators serve only their immediate isolated areas, and remain unconnected by any type of grid. According to available data for 1987/88, PLN supplied an annual 562,119 kWH from facilities totalling 93,112 kW of capacity (105 sites). Civilian generating capacity totals 441,527 kW.

With regards to the Objective area specifically, PLN operates generating facilities at the kecamatan capitals of Pasir Pangarayan (220 kW: 1982) and Ujung Batu (300 kW 1984). Additional facilities are planned this year (FY 1991/92) for Rokan, Kota Tengah and Dalu Dalu. Electrification rates for the districts which encompass the Objective area are 19% for Kampar (41 out of 211 villages or "desa") and 22% for Bengkalis (65 out of 290 villages).

(3) Domestic Water

According to statistical data for 1989, 14 water service pipeline systems exist in urban areas of Riau Province,utilizing rivers and springs for water source. However, this is indicative of a

very low cover ratio for water supply facilities given the fact that there are 2 municipalities (Kotamadya) and 76 districs (kecamatans) in the province.

As in the case of the overall province, 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. According to information from concerned agencies, 1 shallow well is excavated for every 4 transmigrant families. However, these are not outfitted with pumps. Furthermore,some of the wells are dry in the dry season.

Detailed data on water quality in the Objective area is not available. However, contamination from organic content of the peat moss layer in swampy area, and saline intrusion in low coastal area is reported. Although population in these areas catch rainwater for domestic use, there is a general shortage of potable water. These residents accordingly strongly desire a stable water supply.

It is also noted that population within the Objective area have the custom of first boiling water prior to drinking, regardless of the source (river, water supply system, etc.).

3.3 Agricultural Situation

3.3.1 Land Use

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 (see Table 3.3.1 and Fig. 3.3.1).

In the forest area, tidal forest distributes near coastal area and the peat swamp forest widely spreads around the downstream of the Sungai Rokan. On the other hand, logged primary forest which produces timber mainly distributes in the west part of Batang Kumu and natural forest distributes mainly in the Barisan mountainous area.

Bush and grassland are scattered in the Study Area with relative concentration near the village area. Many bush and grassland areas remain as a result of diversion of cultivated land and deforestation.

In cultivated area, upland permanent crops are grown around Pasir Pangarayan. Wetland rice is widely cultivated in the narrow alluvial plain of the rivers around Pasir Pangarayan and Kotatengah and around Batang Sumpur as isolated spots. Tidal cultivation of rice is taken place around the mouth of the Sungai Rokan. Shifting cultivation is mainly carried out in and around thickly populated area by local and transmigrant farmers. As for plantation, oilpalm cultivation is carried out under large scale commercial plantation. In contrast, rubber and coconut cultivations 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 area for the oilpalm plantation is going to be increased.

Most of the land except the area under present use is occupied by Protected Forest, Conservation Forest and Limited Production Forest in West Sumatra and North Sumatra Provinces. On the other hand, Fixed Production Forest and Conversion Forest occupy 60% of the total forest area in Riau Province (see Table 3.3.2).

3.3.2 Irrigation and Drainage

(1) Existing Irrigation and Drainage Schemes

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. As shown in the following

table, 8(eight) schemes concentrate in Kabupaten Kampar where are located in the southern part of the Objective Area; the total irrigation scheme areas in Kabupaten Kampar are 4,061 ha. The number of schemes and DPUP's revised irrigation areas by Kabupaten are as follows:

Kabupaten	No. of Schemes	DPUP'Planned Irrigation Area(ha)
Kampar	8	4,061
Bengkalis	2	1,464
Total	10	5,525

Out of the total areas of 5,525 ha, 4,370 ha is potential area now for which the main system has already been developed, and 1,155 ha is potential area for which the main system has not been developed yet. Now, the existing paddy field is 1,628 ha in which the tertiary system has already been developed for 1,303 ha.

The existing irrigation schemes depend on tributaries of the Lubuk, Rokan Kiri, Kumu, Rokan Kanan, Rokan rivers for sources of water supply. As diversion weirs have been constructed on these tributaries at the foot of hills, their catchment areas are small. Consequently, the quantity of water available in these tributaries is limited. In the dry season, the available natural flows of these small rivers are extremely small and quite often run dry. For this reason, the most of the existing irrigation facilities can only supply water for paddy cultivation during the wet season.

By referring to the result of hydrological analysis, water availability at intake sites was reviewed for the existing 10 irrigation schemes on the basis of non-exceedance probable discharge in five years. As a result, re-estimated irrigable area is 4,587 ha in wet season, and 3,159 ha in dry season.

The present level of all irrigation systems prevailing in the Objective Area belongs to semi-technical irrigation system according to the design standard published by Directorate General of Water Resources Development, Ministry of Public Works. In the design standard, the definition of semi-technical irrigation system is mentioned as follows:

1. Headworks	permanent or semi-permanent structure
2. Capacity of structures to measure and regulate discharge	fair
3. Canal system	irrigation and drainage not completely separated

4. Tertiary system	not developed or with low tertiary structure density
5. Overall efficiency	40-50%
6. Size	up to 2,000 ha

Primary canals of irrigation schemes run along contour lines at the foot of hills. Soil washed out from hillsides directly enter canals, reduce the maximum design flow of canals and break them. In addition, lack of any preventive measures against highly permeable soils results in leakage from earth canals and collapses of slopes. These conditions have extremely impaired function of irrigation canals.

On the other hand, although the quantity of available river water is subject to limitations, irrigation water is directly supplied to fish ponds from the irrigation canal, and is released to the lower part. There are many command's areas to be irrigated by canals with small gradient. If fish ponds are constructed near such canals, it is very difficult for the water to flow back to canals from inlets of fish ponds. Pond owners are apt to consider running water condition as prerequisite to breed fish. Such condition makes intake water impossible to use for the irrigation purpose. Without any thorough understanding of these farmers, effective use of water will not be accomplished even with complete main systems.

In addition, beneficial farmers are not willing to allow such tertiary canals to be laid in their own farmlands because they do not want to reduce their lands in some areas.

(2) Operation and Maintenace

Most of the existing irrigation schemes have own management head(Pengamat), and he is responsible for the operation and maintenance for the schemes. Although most of the irrigation schemes have own organizations, beneficial farmers live far away from their paddy fields and apart from each other. As a result, it is difficult to organize these beneficial farmers when operation and maintenance works are carried out in the group work manner. Further, operation and maintenance organizations do not function as intended in some schemes.

In the case of the Kaiti-Samo scheme, the office head (Pengamat) is responsible for the operation and maintenance of the Kaiti-Samo, Menaming, Sei Perak, and Aek Tangum schemes. The office employs for the Samo scheme 3(three)irrigation field workers for the 3(three)secondary canal areas DK I, DK II, and DK III, one operation and maintenance supervisor, one gate keeper and one coordinator of the field workers. On the other hand, Public Works staff training and guidance was given by local consultant about the following items:

- Formation of water users associations and land development

- Strengthening of O & M personnel
- To set up routine maintenance and to do special maintenance works as cleaning the heavily overgrown supply and main canal
- Setting up a cropping calendar and a water distribution administration
- Putting operation boards at offtake structures and to calibrate the discharge of the river over the diversion weir and the measurement structure in the supply canal
- Making a proposal for office equipment and a first O & M budget

3.3.3 Crop Production

(1) Crop Production

(a) Food Crops

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.

Besides rice, principle food crops in Riau Province are maize, cassava, soybean, peanut, and green gram in descending order of planted area in the year of 1988. Major vegetables produced in Riau Province are chili, vegetable beans, cucumber, egg plant and kangkong which can grow under hot and dry climate. Fruits are produced mainly in home gardens on a small scale rather than in large scale plantation. The main fruits are banana, orange, pineapple, durian, and rambutan. Food Crops production statistics in Riau is presented in Table 3.3.3.

In Kabupaten Kampar rice is planted mainly in upland. On the other hand, rice is planted in wetland in Kab. Bengkalis. In the Objective Area the productivity of wetland paddy, 3.57 ton/ha, is higher than the average of the whole Province at 2.99 ton/ha. This yield is, however, lower than the national average of approximately 4 ton/ha. The reason for this low productivity is a lack of good irrigation, namely irrigation facility which can supply enough water throughout the year.

As for upland paddy the yields of Kab. Bengkalis are almost the same as that of the provincial average. On the other hand the yield of Kab. Kampar is slightly higher than the provincial average.

The rice production share of the Objective Area is approximately 22 % of that for the whole province. The production shares of palawija crops in the Objective Area are 13 % for maize, 58 % for soybean, 32 % for cassava, 17 % for sweet potato, 73 % for peanut

and 18 % for vegetable beans. Summary of food crops production in the Objective Area is shown in Table 3.3.4.

(b) Plantation Crops

The main plantation crops are rubber, coconut and oil palm. The production of plantation crops in 1989 is as follows:

Production and Planted Area of Plantation Crops of Riau Province

Crop	Planted Area (ha) NYP*	P**	OS***	Total	Prod'tn (ton)	No of Farmers
Rubber	116,542	190,388	70,665	377,595	104,297	117,957
Coconut	92,111	176,672	48,962	317,745	194,321	182,064
Oil palm	108,442	86,533	-	194,975	263,938	17,555
Coffee	2,733	5,472	1,633	9,838	1,675	-
Clove	3,645	5,573	3,501	12,719	755	6,918
Cacao	512	45	51	608	11	-

* : Not yet producing
** : Producing at present
***: Old stage
Source : Laporan Tahunan, Dinas Perkebunan Propinsi Daerah Tingkat I Riau, 1989.

The production increase of these crops is one important policy in both the National and Regional REPELITA V in order to meet the demand of raw materials for domestic manufacturers and of the international market.

In the Objective Area plantation crop area is expanding for all the three types, namely the government owned plantations, private large estates and small scale farmers' plantation. Especially private large estate is increasing rapidly.

(2) Livestock and Fowls

The number of livestock and fowls in Riau Province is increasing as a whole. Especially cattle numbers have expanded by 150% from 31,748 to 80,337 in the recent five years. Kab. Kampar is the main area of livestock production and one third of cattle and more than half of water buffalo of the province are raised in 1988. On the other hand, the livestock and fowl sector is not active in Kab. Bengkalis except for boar which is mainly consumed by population of Chinese origin .

The government programme for cattle production increase is now going on extensively in transmigration areas under the assistance of the World Bank and IFAD. The objective of this programme is to provide transmigrants with draft animal power.

(3) Farming Practices

(a) Wet Land Paddy

Wet land paddy is divided into rainfed and irrigated. In the Objective Area only 10 % of wet land paddy is in Kab. Kampar and 90 % in Kab. Bengkalis. Some wet land paddy in Kab. Kampar is irrigated and enjoyed high yield of 3.75 ton/ha in 1989. On the other hand, wet land paddy in Kab. Bengkalis is rainfed except for tidal swamp development area and the yield is slightly lower, namely 3.55 ton/ha.

The tidal swamp development area in Kab. Bengkalis is 3,650 ha near the river mouth of the Rokan River. Out of this 3,650 ha, 3,473 ha is used for rice and 779 ha for other crops with a cropping intensity of 116 % in the cropping season of 1989.

The cropping pattern is sowing in September, transplanting in October at the seedling age of approx. 30 days and harvesting in January for rainy season planting and from March to July for dry season planting. The majority of farmers, however, do not use fertilizers. The yield is low at 2.33 ton/ha due to poor drainage and unfavourable soil conditions. The productivity of other crops is also low.

There are ten ordinary irrigation schemes, but they are not fully operational because of the various technical reasons explained in the chapter on irrigation.

Besides the reasons above there are some agronomic reasons, namely not very fertile soil, non-optimal fertilizer application in quantity, timing and type, selection of rice varieties and improper farming practices. Consequently the productivity here is not very high.

The general cropping season is, however, from September/October to January/February in the rainy season and from April/May to July/August in the dry season as shown in Fig.3.3.2.

The three most popular HYVs are PB 42, Sentani and Tondano and the most popular local variety is Kalpatal.

Mechanization level is primitive for land preparation. Manual plowing and oxen plowing are usually practiced, but not plowing by tractor. Harvesting is carried out by sickle and Ani-Ani. The harvested rice is immediately threshed mainly manually or pedal thresher, and then rice is dried at the farmer's yard or paddy field.

Fertilizer use is quite different by area and farmer. In irrigated paddy field fertilizers are generally used more than in rainfed.

(b) Dry Land Paddy

Dry land paddy is cultivated mainly in the intermediate area of the Rokan River Basin. This rice is sown by direct seeding from August/September/October to January/February. The varieties used are both local varieties and HYVs. The yield is relatively high at 2.46 ton/ha as one of dry land paddy according to the Government statistics. Under shifting cultivation land preparation is minimal, namely slash and burn grass and not plowing, and seeds are sown in holes made by stick. Mixed cropping with palawija crops is often practices.

Fertilizer is intensively used in newly transmigrated areas without irrigation, because farm inputs are supplied in a subsidized package.

(c) Palawija (Secondary) Crops

The cropping seasons of palawija crops are both wet and dry season as shown in Fig.3.3.2. Cultivation method of palawija crops is different in the case of shifting cultivation and cultivation in the transmigration area. The former is least intensive and often mixed cropping. The yield is, however, relatively high, especially that of beans. The reasons for this high yield are presumably preferable soil condition and relatively reliable rainfall. In transmigration areas, fertilizer is used in relatively large amount but the yield is not distinctively high. The reasons for this low yield are:

(i) soil fertility is low due to continuous cultivation and soil erosion,
(ii) run-off of applied fertilizer by rain, and
(iii) other unstable factors such as rain might minimize the effect of fertilizer.

3.3.4 Inland Fishery

Marine fishery plays a dominant role in the province, accounting for 92.6 % of the total fishery production. Inland fishery, including aquaculture, accounted only for 7.4% of the total production. In terms of the value, however, the share of inland fishery accounted for 15.4% due to its higher unit prices.

Fishery production in Riau increased from 156,099 tons in 1984 to 172,198 tons in 1988 at an annual average of 2.48 %. Marine fishery grew at an annual average of 2.35 %, while inland fishery's production grew at an annual growth of 4.25 % during the same period. It is noteworthy that freshwater and brackish water aquaculture production had the higher annual growth rates of 22.8% and 12.5 %, respectively. (See Table 3.3.5)

In Kabupaten Kampar, most of fishery production comes from inland

fishery including inland open water (rivers and swamp areas) and fresh water aquaculture. Out of total production of 4,942 tons in 1989, 4,342 tons (87.9%) comes from inland open water, 363 tons (7.3%) from fresh water aquaculture, 222 tons (4.5%) from marine water and 13 tons (0.3%) from paddy field. Taking into account the population of Kabupaten Kampar in 1989 (534,642 persons), per capita supply of fish is estimated as 9.24 kg per person per year which is below the recommendable intake level of 11.5 kg.

As for inland fishery in 6 sub-districts of the Objective Area within Kabupaten Kampar, the total production in 1989 was 1,289.5 tons, of which 1,162.6 tons (90%) comes from inland open water, 120.9 tons (9%) from freshwater aquaculture and 5 tons from paddy field. No production from marine fishery and brackish water aquaculture are recorded in the area due to its location.

Of the total fresh water aquaculture production of 120.9 tons in the 6 sub-districts, 87.1 tons or 72% are produced in Rambah. The number of households who are engagaed in fresh water aquaculture totaled 1,182 in the 6 sub-districts, of which households in Rambah and Rokan IV Koto accounted for 396 (33.5%) and 295 (25.0%), respectively.

Fish catches in inland open waters include Jambal (catfishes), Gabus (snake heads), Sepat Siam, Tambakan (kissing gouramy), etc. The fish species that are cultured at present are common carp (ikan mas; Cyprinus Carpio), tilapia (ikan nila; Tilapia Nilotica), giant gouramy (ikan gurami; Osphronemus gouramy), puntius (ikan tawes; Puntius Javanicus), kissing gouramy (tambakan; Helostoma teminchi), nilem carp (nilem; Osteochilus hasselti), etc.

Traditional small scale fishing gears are utilized in the Objective Area. These fishiing gears include gill net (jaring tetap), portable net (bubu), long line (rawai), hook and line (pancing), portable lift net (anco), scoop net (serok), etc.

Inland fishery catch in the Objective Area is either consumed by fishermen and fish farmers or marketed to several market places in the Study Area. Approximately 50% of the total catch are consumed fresh, and the remaining are preserved as dried, salted and smoked fishes. In the Objective Area in Kabupaten Kampar, out of the total fish catch (1,405.8 tons), 50.5 % are consumed fresh, 38.5% are preserved as dried/salted fishes, and 11% are preserved as smoked fishes.

As for inland fishery in Kabupaten Bengkalis, most production are recorded in Mandau and Tanah Putih. Of the total production of inland open water fishery in 1989 of 3,327 tons, 3,277 tons or 98.5% came from Mandau and Tanah Putih. Most of aquaculture production are carried out also in the two sub-districts, producing 46 tons in 1989. Fish species and consumption pattern of fishes in Kabupaten Bengkalis are almost the same as Kabupaten Kampar.

3.4 Agroeconomic Situations

3.4.1 Agroeconomic Features

(1) Farm Population

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.

Based on the results of the 1983 Agricultural Census, 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. (See Table 3.4.1).

(2) Land Tenure and Holding

The 1983 Agricultural 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. Out of 683,800ha, 19,100ha of land are rented to others for agricultural activities, and the remaining 664,700ha are controlled by land owners. The balance between 709,200ha and 664,700, i.e. 44,500ha are classified as the tenant land. The average land holding size of the province was 2.55ha per farm household in 1973 and 2.65ha per farm household in 1983.

In the Objective Area, 92,981 ha of land were owned by 42,787 farm households, averaging 2.17 ha per farm household. Of the 92,981 ha of land, 1,194 ha of land are rented to others, and the remaining 91,201 ha were controlled by land owners. The land under tenancy accounted for 1,780 ha or 1.9 % of the total land controlled by both owner and tenant farm households.

(3) Food Balance

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.

3.4.2 Agricultural Supporting Services

(1) General

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.

(2) Agricultural Intensification Program

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.

(3) Research

The national agricultural research system is coordinated and

administered by AARD. AARD has its research centers in the fields of agricultural statistics, soils, agroeconomy, 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.

(4) Extension Services

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 Kecamantan 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). Against 68 WKBPPs, 57 heads of BPP have been appointed, of which only 38 BPP buildings have been prepared for their activities.

In the Objective Area, there are 10 BPPs to provide agricultural

extension services in foodcrops, livestock, estate crops and fisheries.

(5) Agricultural Credit

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 Prosperou 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.

(6) Farm Input Supply

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.

(7) Marketing and Processing

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.

3.4.3 Farmer Organizations

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 sub-divided 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

3.5.1 Protected Vegetation, Fauna and Flora

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 Km^2 and 617 Km^2 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 Km^2(34.7%) and 3,326 Km^2(15.0%), respectively. The rest area of forests is conversion forest of 3,380 Km^2(15.3%). In this conversion forest, any development project is regulated for land use. The detail classification is discussed in Annex.

3.5.2 Environmental Impact

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. Referring the above criteria and the other similar project reports, the environmental components for this study are decided as follow;

1) Hydrological component

The decrement of water quantity and pollution of water quality on the lower reaches of rivers shall be studied. They may affect many other components as aquatic flora

and fauna, fishery, inland navigation etc.

2) Climatic component

Change of land cover may bring micro climatic changes.

3) Geological component

Soil erosion is one of geological components. It may cause pollution of water quality, increment of sediment and finally, it becomes biological and socio-economic impacts.

4) Biological component

Forest exploitation is a direct negative impact. Forest exploitation makes flora very simple and, as a results, may affect habitat of wild animals. If forest exploitation is carried out in natural or semi-natural forest, possibility of vanishing valuable flora and fauna becomes very high.

5) Socio-economic component

Agricultural development is considered to be negative impacts from a socio-economic view point. Effects on fishery caused by hydrological impact shall be taken into account.

Taking into consideration the environmental impacts mentioned above, the following shall be carefully studied for the selection of a priority area.

- to avoid area with steep slope
- to avoid natural forest
- to consider water utilization of the downstream

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 Kecamatans 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 Kecamatans 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 Kecamatans 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.

In the circumstances as mentioned above, special emphasis has been placed on agricultural development including development of irrigation systems in the formulation of the Basin Development Plan. In addition to it, potentials for development of inland fishery, social infrastructures (water supply, transport infrastructures and hydropwer), and watershed management from the environmental viewpoint, are also discussed in this Chapter.

4.2 Agricultural Development

4.2.1 Development Strategy

As explained in Chapter 2, 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. Increse 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 Kecamantan 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 thining) and to improve farm land soil. Improved farming technology should be developed in experimetal farms and transferred to the farmers through agricultural extension services network.

4.2.3 Agricultural Production Intensification

(1) Crops Selection

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.

(2) Proposed Cropping Pattern

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.

(3) Paddy Production Plan

Irrigated paddy field will be expanded to 47,000 ha with cropping intensity of 180 %. Planted area for paddy will total 84,600 ha with the proposed yield of 5.25 tons per ha. Rainfed paddy field will be 20,000 ha with cropping intensity of 110% and 4 tons of yield per ha. Upland rice will be planted on 30,000 ha of dryland with 3 tons of yield per ha. Paddy production in the future (in 2020) will be estimated at about 620,000 tons (unhusked rice) or 6.9 times the present production.

Rice demand in the target year (2020) is estimated at about 460,000 tons (unhusked rice) in the Objective Area, on the assumption of the projected population of 2.12 million with per capita consumption of 141 kg of milled rice and conversion ratio of 65 % from paddy to milled rice.

It is apparent from the above calculation that the projected paddy production in the Objective Area will be able to achieve the target of self-sufficiency in rice production and also to supply surplus rice for other part of the province under the proposed agricultural development plan.

(4) Palawija Crops Production Plan

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.

(5) Estate Crops Production

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 increse 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.

4.2.4 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) Research

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 demonstration farms in the Objective Area to carry out such experiments.

(2) Extension Services

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 reagrd 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) Agricultural Credit

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 strtengthened 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) Input Supply

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) Marketing and Processing

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.

4.2.5 Inland Fishery Development

(1) Development Strategy

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-suffcient. 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.

(2) Development Measures

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

1) Education and Organzation of Fish Farmers

Education and training program undertaken by Dinas Perikanan is required to be strengthened through provision of increased number of extension services personnel and improved facilities for education and training of fish farmers. At the same time, promotion of suitable fish farmers' organizations is needed to streamline the sale and purchase of production input and output related to fisheries activities.

2) Fish Cage Culture (Keramba) in Open Waters

It is reported that a farmers' group at Menaming village is using a fish cage in the Menaming river producing about 100 kg of fish in 1988. However, cage culture is still at its initial stage in the Objective Area. In order to increase the

production of fish culture, Dinas Perikanan is recommending the utilization of the rectangular floating cage made of bammboo or wood with size of two by three meteres and one meter in depth. Carp culture is recommended for cage culture.

One unit of cage with a capacity of 6 m3 can rear about 600 carp fries. The net cage culture would increase the rearing density to 150kg/m2 that is higher than in the case of fish pond. The location of the net cage culture should be carefully selected taking into consideration the water depth, water current condition, and fewer possibility of damage by floating materials.

3) Hatchery Improvement and Extension

It is reported that out of the total requirement of 7.15 million tons fish fries in Kabupaten Kampar, only 1.75 million tons or 24% are provided by the hatchery of Dinas Perikanan at Bangkinang and by some fish fries ponds in Kampar and some other areas. In order to meet the increasing requirement of fish fries, the facilities the existing hatchery at Bangkinang should be upgraded. The upgrading will involve the provision of vehicles for transporting fish fries as well as equipment such as generators, pumps and laboratory equipment. The existing pond area will be upgraded and an additional pond will be constructed.

4) Fish Pond Culture (Kolam)

The establishment of new fish ponds must depend on the marketability of the fish as well as availability of fish fries and water source. In consideration of increasing supply of irrigation water and fish fries in the future, there is great possibility of establishing new fish ponds in the Objective Area. Surplus water extracting from any of irrigation projects could be utilized for fish pond culture in consultation with Dinas PU. 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.

4.3 Irrigation Development

(1) Existing Irrigation Schemes

As mentioned in 3.3.2, 10 irrigation schemes are being carried out covering a total irrigable area of 5,525 ha in the Objective Area. Out of the total areas of 5,525 ha, 4,370 ha is potential area now for which the main system has already been developed, and 1,155 ha is potential area for which the main system has not been developed yet. Now, the existing paddy field is 1,628 ha in which the tertiary system has already been developed for 1,303 ha. Now, irrigation is being carried out for the area of 1,303 ha in wet season, and for that of 394 ha in dry season.

The delay of the development that is due to the following reasons obstructs the attainment of the goal.

A) Financial reason
B) Step by step development of paddy field conducted by Ministry of Agriculture, and
C) Limit of river discharge

To review the optimum development scale for the existing irrigation schemes, water balance computation is made. The focal points to be taken into account are available quantity of river discharge at the water source sites and irrigation water requirements for the prevailing cropping patterns are compared with the dependable flows and the potential areas.

By referring to the result of hydrological analysis, water availability at intake sites is reviewed for the existing 10 irrigation schemes on the basis of non-exceedance probable discharge in five years. As a result, re-estimated irrigable area is 4,587 ha in wet season, and 3,159 ha in dry season. Out of the existing 10 irrigation schemes in the Objective Area, only 3(three) schemes have reasonable planning, while the remaining 7(seven) schemes have inadequate planning.

As diversion weirs have been constructed on these tributaries at the foot of hills, their catchment areas are small. Consequently, the quantity of water available in these tributaries is limited.

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.

Except for the above existing schemes, there exist partly tidal swamp development schemes that are located on alluvium along the Rokan river mouth. However, such infrastructures as access roads, domestic waters, etc. are still less developed. In addition to these conditions, irrigation water can not be derived from the Rokan river due to salt intrusion during dry season. Therefore, most people have escaped from the area, and the benefitted area is being reduced. For the development of lower area, arrangement of infrastructure is a prerequisite subject.

(2) New Irrigation Schemes

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.

In studying new irrigation development areas, gravity irrigation system without a reservoir is regarded as the given condition. Based on this concept, locations of water sources for new projects were surveyed, paying attention to the following items:

1) Sufficient water available to irrigable area
2) Flow condition at weir sites to be proposed
3) Easiness of water conveyance
4) Easiness of weir construction
5) Extent of inundation after completion of weirs
6) Inland navigation at weir sites to be proposed

From the view point of topography and soil, the area with 60m-25m expanding over from hilly area to peneplain 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 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.