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FEASIBILITY REPORT
ON
[illegible] IRRIGATION PROJECT

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JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO, JAPAN

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

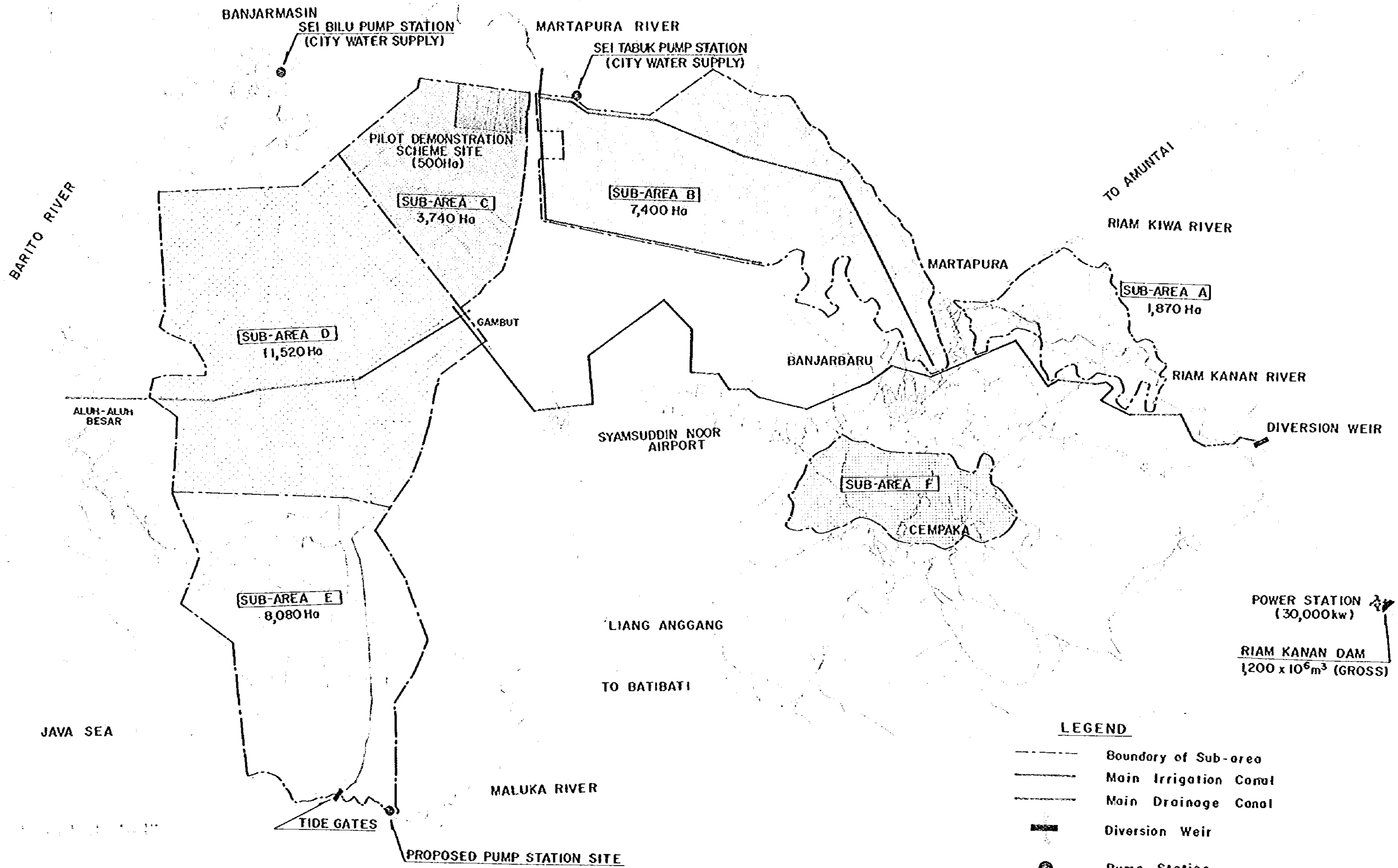
FEASIBILITY REPORT ON THE RIAM KANAN IRRIGATION PROJECT

VOLUME 1 MAIN REPORT

SEPTEMBER 1979

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

Fig.1 General Map



PREFACE

In order to solve shortage of foodstuff and to raise national living standard, the Government of Indonesia has been seriously contemplating the regional development programs in the regions of Kalimantan, Sumatra, etc. as well as Java. The Government of Indonesia particularly has made every endeavours to create the foodstuff production bases outside Java through promoting agricultural developments including transmigration programs.

As the one of the above programs, the Government of Indonesia conducted the master planning of the Barito river basin in Kalimantan under the technical cooperation of the Government of Japan in 1971. As a result, the Riam Kanan Irrigation Project in South Kalimantan was recommended to be realized first in the basin. The Government of Indonesia requested the Government of Japan for the technical cooperation for the feasibility study on the Riam Kanan Irrigation project.

In compliance with this request, Japan International Cooperation Agency (JICA) dispatched a survey team headed by Mr. Kunio Irie, Chief of the Irrigation and Drainage Department of Nippon Koei Co., Ltd. to the project area during the period of 167 days from July 2, 1978 to December 15, 1978. The survey team performed field investigation and study required for the project formulation from the technical and economic points of view, in close cooperation with the Indonesian Authorities concerned.

The feasibility report on the Riam Kanan Irrigation Project is hereby presented based on the findings obtained in the field survey as well as the subsequent study in Japan.

I firmly believe that this report will contribute to the implementation of this project and to the further promotion of friendship between the two countries.

Finally, I take this opportunity to express my hearty gratitude to the Government of Indonesia and other authorities concerned for the kind cooperation and assistance extended to the team, without which the survey work could not be carried out so successfully.

September, 1979.

Shinsaku Hogen
President
Japan International Cooperation Agency
Japan

S U M M A R Y

1. Authority

This is the Feasibility Study Report on the Riam Kanan Irrigation Project (the Project) which is prepared in accordance with the "Scope of Works" agreed upon between the Government of Indonesia and the Government of Japan. This report consists of the Main Report, Annex, Drawings and Data Book and presents the results of the feasibility study on the Project.

2. Project History

The Riam Kanan Irrigation Project has been proposed in the Report on the Barito River Basin Development Plan prepared by Overseas Technical Cooperation Agency (OTCA) in March, 1971 as the priority project for agricultural development in South Kalimantan.

In 1977, the preliminary survey team was dispatched from Japan International Cooperation Agency (JICA) mainly to study the project components and the scope of works for the project feasibility study. In the same year, the topographic maps on a scale of 1 to 5,000 covering the project area were prepared under the technical cooperation by JICA.

With these background, the Government of Indonesia requested the Government of Japan the feasibility study on the Project, and the Government of Japan decided to take up the feasibility study. JICA was appointed as the executing agency of the Government of Japan and dispatched a survey team to Indonesia. The survey team prepared and submitted the draft feasibility report. The comments on this draft report were prepared by the Indonesian Government, and based on the comments this feasibility report is finalized as presented here.

3. Scope of Works

The "Scope of Works" agreed upon between the Government of Indonesia and the Government of Japan in summarized as follows:

(1) Pre-feasibility study on the Riam Kanan Irrigation Project covering about 60,000 ha in gross,

(2) Feasibility study on the priority areas of the Project covering about 40,000 ha in gross, and

(3) Training of the Indonesian counterpart personnel.

4. Background

The Government of Indonesia carried out the First Five-Year Development Plan in the period between 1969 and 1974. During the Plan, annual growth rate of rice production reached 3.5 % and since 1973 rice production increased at an annual growth rate of 2.2 %. The amount of rice produced was 15.4 million tons in 1974.

However, population increased remarkably during the period at the rate of 2.1 % per annum. The demand for foodstuff exceeded the growth of the production of rice, and about one million tons of rice were imported in 1974.

The Second Five-Year Development Plan has been launched in 1974 and aims at the attainment of self-sufficiency in foodstuff. Under the Plan, further increase of food production through introduction of improved irrigation farming is one of the Indonesian Government's strategies.

The area of the Riam Kanan Irrigation Project has favourable natural conditions for further increase of crop production using water available from the Riam Kanan dam now in operation. Therefore, high priority is given to early implementation of this irrigation project.

5. Selection of the Project Area

Selection of the project area proposed for agricultural development is made based on the study result of four main factors affecting the selection. They are soils, land classification, drainability and topography.

The soil and land suitability classification survey reveals the grade of irrigation suitability, say irrigability. The area is classified into four classes. Among them, Classes II and III (suitable to moderately suitable lands), and a part of Class IV (marginally suitable land) are taken up for the selection of areas.

The drainability is studied mainly through the analysis of the present drainage conditions of the area and possible drainage improvement in the future. As a result, the area is classified into four categories: Category 1 (perfect drainable land), Category 2 (favourable drainable land), Category 3 (poorly drainable land) and Category 4 (land not suitable for economical drainage). For selecting the areas for development, the areas in categories 1 and 2, and a part of category 3 are considered.

The topography of the land is evaluated with respect to economical development of irrigation. In this evaluation, priority is given to the gravity irrigation. The selection of the area for the Project is made within the areas which could be irrigated economically and effectively with the proposed diversion weir and the main irrigation canal by gravity.

Superimposing the study results of these four main factors, the final selection of the areas to be proposed for the Project is made. As a result, 32,610 ha of land in net are selected and divided into five sub-areas from A to E. Net irrigable area in each sub-area would be 1,870 ha in the sub-area A, 7,400 ha in the sub-area B, 3,740 ha in the sub-area C, 11,520 ha in the sub-area D and 8,080 ha in the sub-area E, respectively.

6. Proposed Development Plan

Five sub-areas are finally delineated in terms of irrigation and drainage conditions for the study on the proposed development plan. The appraisal suggests that there would be two alternative plans for the development. One is to develop the area with the gravity irrigation scheme, and the other is a plan for developing the area with the combined gravity and pump irrigation scheme.

There are two sources of irrigation water for the development. They are the rivers Riam Kanan and the Maluka. The whole irrigable area, 32,610 ha in net, could be developed as a series of the Project, using the water available from the Riam Kanan by gravity. In this case, 32,100 ha of land would be irrigated for the cultivation of rainy season paddy, but in the dry season the irrigation area would be decreased to 24,530 ha due to the limitation of water available from the Riam Kanan.

The water available from the Maluka by pumping could also be used for increase of irrigation area in the dry season, and 27,990 ha of land would be used for dry season paddy with irrigation.

Both gravity irrigation scheme and combined gravity and pump irrigation scheme have the economic viability for the development with 13.5 % and 13.9 % of the internal rate of return, respectively.

The basic concept of the irrigation development in Indonesia would be first to increase and stabilize yield and production of rainy season paddy with gravity irrigation system, and the intensification of cropping area in dry season within available irrigation water comes second.

In addition, operation and maintenance costs of the irrigation scheme which includes the pump facilities would become higher as compared with those of the gravity irrigation scheme. For these main reasons, it is recommended that priority be given to the development with the gravity irrigation scheme for possible earlier realization of the project effects.

7. The Project Area

The project area is situated in the south-west of Banjarmasin, the capital of South Kalimantan Province. The project area is bounded by the river Barito on the west, the river Marutapura on the north, the river Maluka on the south and Martapura-Batibati road on the east.

The project area extends over very flat alluvial plain with elevations between 0 m and 2 m.

The average rainfall in the project area is about 2,600 mm, but varies widely from year to year ranging between 1,200 mm and 4,300 mm. About 70 % of rainfall occur in the form of intense local storm during the rainy season which lasts from November to April. The monthly mean temperature is about 26°C with little seasonal variation. The annual evaporation is about 1,370 mm. These climatic conditions are suitable for profitable agricultural development, except for uneven distribution of rainfall.

There are two sources of irrigation water in the project area. They are the rivers Riam Kanan and Maluka.

The amount of water available from the river Riam Kanan depends entirely on the discharge released from the existing power station, and the discharge from the power station varies with the power demand. According to information obtained from PLN, the Riam Kanan power station would be operated with 24 MW to 27 MW of power demand at peak time, keeping some reserves for the emergency peak power demand, even after the completion of the Riam Kanan second stage project (additional installation of one more 10-MW power plant) now under construction. For the conservative study, the peak demand of 24 MW in and after 1984 is adopted. Load factor is forecasted to be 65 %. With these figures, 42 m^3/sec of discharge from the power station would be expected as the amount of water available for irrigation in the project area and for the maintenance of the river Martapura. For the maintenance of the Martapura, 8 m^3/sec of mean drought runoff in full 12 years would have to be released from the weir as the minimum maintenance discharge for the purpose. Therefore, the amount of water available for the Project is estimated at 34 m^3/sec.

The river Maluka would be another water source for irrigation in the project area. The preliminary study on available amount of water for the Project is made, and it is estimated at 4.8 m^3/sec.

As for the water quality of the river Riam Kanan, there are no problems for its irrigation use. However, the water of the Maluka is affected by saline water intrusion from the Java Sea. In order to use the water for irrigation purpose, therefore, the construction of gate structure on the Maluka would be required to control the saline water intrusion.

In the project area, no technical irrigation and drainage system exists at present, except for some canal networks, most of which were constructed by local people.

The average land holding per farm household is estimated at 1.0 ha. About 73 % of total farmers are owner farmer, and the remaining is tenant and small owner farmer cum tenant.

Paddy rice is the main crop in this area, and monoculture of paddy rice using flood water in the rainy season is predominant throughout the project area. Paddy seeds are sown during the period from early October to late January. During the period, young seedlings are transplanted two to three times depending on water conditions in the field. The paddy is harvested during the period from early May to late October.

No soil preparation such as ploughing, harrowing, puddling, etc. is usually practiced, and the use of chemical fertilizers and agricultural chemicals is still insignificant in this area.

The food crops other than paddy rice such as maize, cassave, sweet potato, beans, etc. are also grown in small areas and are mostly for home consumption.

The present average yield is estimated at 1.75 tons of dry paddy per ha, and the annual production of dry paddy in the project area is estimated at about 52,400 tons.

The extension services in the project area are still limited because of insufficient staffing and equipment. Improvement of the present staffing and equipment is strongly recommended especially for the successful implementation of the Project.

The paddy field under the BIMAS/INMAS Programs in the project area is very small, because no technical irrigation system exists.

8. Agricultural Development

The agricultural development plan in the project area which would cover 32,610 ha of land in net is formulated to maximize the expected project benefits.

The main concept of the agricultural development would be to:

- Increase and stabilize yield and production of rainy season paddy through proper drainage improvement, supply of clean irrigation water, and introduction of improved irrigation farming,
- increase paddy production by introducing double cropping of paddy rice with year-round irrigation and drainage improvement, high-yielding varieties and improved farming techniques, and
- increase paddy production by opening new agricultural land in the areas which have favourable physical conditions for agricultural development.

In order to achieve the proposed agricultural development in success, the construction of necessary infrastructures and further improvement of supporting services are required as follows:

(1) Construction of the irrigation network consisting of the headworks, the main, secondary, sub-secondary, tertiary and quaternary canals,

(2) Construction and rehabilitation of the drainage network which consists of the main, secondary, sub-secondary, tertiary and quaternary drains,

(3) Construction of road network which includes the main, secondary and tertiary roads,

(4) Reclamation of new farm land, and

(5) Further improvement of the present agricultural supporting services.

The proposed farming for paddy rice cultivation would be practiced basically by manual operations with small farming equipment such as rotary weeder, knap-sack type mist cum duster, treadle thresher, winnower, etc.

The anticipated crop yields under the future with-project condition are estimated at 4.0 tons of dry paddy/ha and 4.5 tons of dry paddy/ha for the rainy season paddy and the dry season paddy, respectively.

The annual production at full development stage would be 238,700 tons of dry paddy, and the increment of the production would be 178,800 tons of dry paddy.

9. Irrigation and Drainage Plans

The maximum water requirement is estimated at 11.8 mm/day which are translated as 1.37 lit/sec/ha and would occur in mid-August. The domestic water is also supplied through the irrigation canals. It is estimated at 0.4 m^3/sec in total.

With the above water requirement and 34 m^3/sec of water available from the Riam Kanan reservoir, the proposed irrigation area would be 32,100 ha in the wet season and 24,530 ha in the dry season.

Most of the project area is low-lying marshy land, and drainage of excess water from the project area is largely affected by fluctuation of the water level in the rivers around the project area. Therefore, proper drainage improvement will play an important role in successful development of the Project in particular. The study is made for proper drainage improvement for the areas under these conditions. The priority is given to the economical drainage improvement by gravity. As a result, the drainage requirements are estimated at 7 lit/sec/ha in the sub-area A, 8 lit/sec/ha in the sub-areas B and E, and 5.9 lit/sec/ha in the sub-areas C and D.

10. Proposed Project Works

A concrete weir with intake structure would be constructed on the river Riam Kanan near village Mandikapau, about 12 km downstream from the Riam Kanan dam. The irrigation canal network to be newly constructed would consist of the main, secondary, sub-secondary, tertiary and field ditch (quaternary canal). The main canal would be about 48 km in length. The total length of other canals would be 131 km for the secondary, 145 km for the sub-secondary, 359 km for the tertiary and 1,262 km for the field ditch.

The main drains 53 km long, the secondary drains 85 km long, the sub-secondary drains 136 km long, the tertiary drains 330 km and the field drains 964 km long would also be newly constructed to control seasonal floodings and surface drainage.

The main roads 122 km long, the secondary roads 361 km long and the tertiary roads 424 km long would be newly constructed. Their width would be 5 m, 4 m and 3.5 m, respectively.

11. Construction Schedule

Time required for the implementation of the Project is estimated at eight years, including project mobilization and the preparatory works, from 1980 to 1987.

It is assumed that all works, except for the quaternary canals and drains which would be constructed by farmers themselves, would be executed on the contract basis.

12. Organization and Management

The Directorate General of Water Resources Development would be the executing agency which would be responsible for the detailed design, supervision and construction of the project works coordinating the activities of all government agencies concerned.

Under the government agencies concerned, it is recommended to organize the project office of the Riam Kanan Irrigation Project for smooth execution of the project works at the job site.

After the completion of the project works, the operation and maintenance office would be organized under the provincial public works service. The office would be responsible for O&M of the diversion weir and the canal network down to the tertiary turnouts.

In connection with the project implementation, it is recommended to make further improvement of the present agricultural supporting services, particularly for the increase in number of the field extension worker (PPL) and for further extension of the BIMAS package program in the project area.

The association to be organized by farmer's themselves should be established to carry out the main activities of (1) O&M of the irrigation and drainage network below the tertiary turnouts, (2) cooperative works for early inspection and protection of pests and diseases, (3) extension of improved farming technics to each farmer and (4) collection of water charge in the future. It would be preferable to establish one association in one Desa.

For the training of the farmers as well as the extention workers and for further research works, it is recommended to organize Pilot Demonstration Scheme (the Scheme) in the Sungai Tabuk area in the sub-area C. The Scheme would cover about 500 ha of land in net. The main activities would be (1) the execution of tertiary and quaternary development, (2) organization of systematic water and farm management as well as the farmer's association, (3) crop demonstration including training and guidance, (4) seed multiplication and (5) agronomic and irrigation engineering field experiments. All programs of the Scheme will have to be carried out under the joint responsibility of the Cooperative Office, Agricultural Extension Offices, Central Research Institute for Agriculture and the Project Office for the successful operations of the Scheme.

13. Project Evaluation

The economic cost for the Project capitalized for 1980 is estimated at US$130.41 million.

The fund requirement for the construction or financial cost is estimated at US$83.79 million in foreign currency and US$106.88 million in local currency, provided that the construction works will be carried out on the contract basis.

The costs for operation, maintenance and replacement of the facilities would be US$0.81 million equivalent per annum.

The direct project benefit at full development stage would be US$28.48 million per annum.

The economic internal rate of return of the Project is estimated at 13.5 %. The sensitivity analysis shows that the internal rate of return for the case of 5 years over-run of the build-up period, 25 % decrease in paddy yield and 15 % increase in the cost is 8.5 %.

14. Conclusion and Recommendation

The necessity of the Riam Kanan Irrigation Project for the regional economic development in South Kalimantan in connection with full use of the existing multipurpose Riam Kanan dam is identified. The Project is proved to be technically and economically feasible.

It is therefore recommended to commence the implementation of the Project as soon as possible.

15. Combined Gravity and Pump Irrigation Scheme

The river Maluka could also be used for further increase of irrigation area during the dry season, particularly in the sub-area E from its location, which could be developed in combination with the gravity irrigation scheme using the water available from the Riam Kanan. The further irrigation development in the sub-area E could be made by lifting the river water in the lower reaches of the Maluka.

Applying the peak water requirement including rural water supply in the dry season and available water from the Maluka (4.8 m^3/sec), the increased irrigation area in the dry season would be 3,460 ha. When this combined gravity and pump irrigation scheme is completed, therefore, total irrigation area during the dry season in the project area would be 24,530 ha + 3,460 ha = 27,990 ha, and further increase of crop production could be expected.

The pump station would be proposed to be located at immediately downstream of the confluence with the river Penggaaungan. The delivery head at this site would be 4 m in total with a discharge of 4.8 m^3/sec. Four sets of pumps with engines would be required, and the pumps would be of mixed flow type. In connection with the construction of the pump station, an additional canal (secondary class) would be required for supplying the pumped water to the irrigation area.

The total fund requirement including the cost for this scheme is estimated at US$201.97 million consisting of US$92.19 million of foreign currency portion and US$109.78 million of local currency portion.

The direct benefit at the full development stage after the completion of the scheme would be US$31.25 million.

The economic internal rate of return of the Project including the pump scheme is estimated at 13.9 % based on the preliminary estimate of the cost and benefit. This preliminary evaluation shows an economic soundness for the introduction of the pump irrigation scheme into the project area.

Principal Features of the Project

1. Project Features

1.1 Proposed Development

(1) Irrigation Area (net area)

Total (ha)	Sub-area A (ha)	Sub-area B (ha)	Sub-area C (ha)	Sub-area D (ha)	Sub-area E (ha)
32,610	1,870	7,400	3,740	11,520	8,080

(2) Diversion Weir

Weir	Concrete weir, 9 m high x 228 m long
Intake structuer	One structure on the left bank only, the intake water level 9.80 m in elevation, 9 sets of sluice gates
After-bay	Gross storage capacity: 4.7 million m^3

(3) Irrigation Canals

Irrigation practice	Year-round irrigation by gravity
Main canal	48.4 km in length
Secondary canals	276 km in total length
Tertiary canals	359 km in total length
Quaternary canals	1,262 km in total length

(4) Drains

Main drains	53 km in total length
Secondary drains	221 km in total length
Tertiary drains	330 km in total length
Quaternary drains	964 km in total length

(5) Related Canal Structures

Turnout	54 nos.
Check gate structure	31 nos.
Bridge	165 nos.
Syphon	2 nos.
Culvert	3 nos.
Drainage sluice	40 nos.

(6) Roads

Main roads	122 km in total length
Secondary roads	361 km in total length
Tertiary roads	424 km in total length

I.2 Combined Gravity and Pump Irrigation Scheme

(1) Increased irrigation area in the dry season	3,460 ha in sub-area E

(2) Pump Station

Pump	Four pump sets of mixed flow type (800 mm in diameter) with four sets of Diesel engines (70 kW each)
Tide control gate	Three sets of roller gates, 8 m in height x 8 m in width

II. Project Cost and Benefit

II.1 Proposed Development

(1) Economic Cost: US$130,410,000

(2) Fund Requirement:

Total (US$1,000)	Local Currency (US$1,000)	Foreign Currency (US$1,000)
190,670	106,880	83,790

(3) Irrigation Benefit: US$28.48 million per annum

II.2 Combined Gravity and Pump Irrigation Scheme

(1) Economic Cost : US$137,660,000

(2) Fund Requirement :

Total (US$1,000)	Local Currency (US$1,000)	Foreign Currency (US$1,000)
201,970	109,780	92,190

(3) Irrigation Benefit: US$31.25 million per annum

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Grossary of Terms and Abbreviation

1. Administrative Organization (Local administration)

Kab.	:	Kabupaten = Regency
Kec.	:	Kecamatan = Township
Desa	:	Village
Bupati	:	Local governor
Camat	:	Chief of Kecamatan
Kepala Desa	:	Chief of Village

2. Organization for Water Resources Development

DPU	:	Ministry of Public Works
DGWRD	:	Directorate General of Water Resources Development
Seksi	:	Public Works Office at Regency Level
PLN	:	Public Corporation of Electricity

3. Organization for Agricultural Development

BRI	:	Indonesia People's Bank
BIMAS/INMAS	:	Mass Guidance for Self-sufficiency in Food
DOLOG	:	Provincial Rice Purchasing Agency
BUUD/KUD	:	Agricultural Cooperative Organization
KIOS	:	Kiosk
ADC	:	Agricultural Development Center
REC	:	Rural Extension Center
CRIA	:	Central Research Institute for Agriculture
PPS	:	Subject Matter Specialist
PPM	:	Extension Supervisor
PPL	:	Field Extension Worker

4. Other Local Terms

Sungai	:	River
Palawijo	:	Upland Crops
Pelita I	:	First Five-Year Development Plan
Pelita II	:	Second Five-Year Development Plan
Pelita III	:	Third Five-Year Development Plan

5. Area and Volume

m^2	:	square meter
ha	:	hectare
km^2	:	square kilometer
lit	:	liter
m^3	:	cubic meter

6. Derived Measures based on the Same Symbols

m^3/sec	:	cubic meter per second
t/ha, ton/ha	:	ton per hectare
m^3/km^2	:	cubic meter per square kilometer
mm/day	:	millimeter per day
lit/sec/ha	:	liter per second per hectare
lit/day	:	liter per day
m^3/km^2/year	:	cubic meter per square kilometer per year
mmho/cm	:	millimhos per centimeter
umho/cm	:	micromhos per centimeter
mg/lit	:	milligram per liter
me/lit	:	mol-equivalent per liter

7. Electric Measures

kV	:	kilovolt
kW	:	kilowatt
kWh	:	kilowatt-hour
MW	:	megawatt

8. Currency

US$	:	United States Dollars
Rp	:	Rupiah

US$1 = Rp 625

CHAPTER I INTRODUCTION

1.1 AUTHORITY

This is the Feasibility Study Report on the Riam Kanan Irrigation Project (the Project) which is prepared in accordance with the "Scope of Works" agreed upon between the Government of Indonesia and the Government of Japan. This report presents the results of the feasibility study on the Project.

1.2 PROJECT HISTORY

The Riam Kanan Irrigation Project has been proposed in the Report on the Barito River Basin Development Plan prepared by Overseas Technical Cooperation Agency (OTCA) in March, 1971 as the priority project for agricultural development in South Kalimantan Province, and very preliminary study on the Project was made under the said Barito River Basin Development Plan.

The Riam Kanan Irrigation Project aims at profitable agricultural development in the area with about 60,000 ha in gross, using water released from the Riam Kanan Multipurpose Dam which was completed in 1972.

In 1972, the topographic maps on a scale of 1 to 50,000 covering the Barito River Basin in which the project area was included were prepared under the technical cooperation provided by OTCA. In addition, soil survey, geological survey and preparation of some topographic maps related to the Project were made by the Government of Indonesia.

In 1977, the preliminary survey team was dispatched from Japan International Cooperation Agency (JICA) mainly to study the project components and the scope of works for the feasibility study on the Project. Following this preliminary survey, more detailed topographic maps on a scale of 1 to 5,000 covering the project area were prepared under the technical cooperation provided by JICA.

With these background, the Government of Indonesia requested the Government of Japan the feasibility study on the Project, and the Government of Japan decided to take up the feasibility study. Japan International Cooperation Agency was appointed as the executing agency of the Government of Japan and it entrusted the feasibility study to Nippon Koei Co., Ltd. in July, 1978.

1.3 WORK PERFORMED

The field survey was carried out in collaboration with the counterpart personnel of the Ministry of Public Works, the Government of Indonesia, from July 2 to December 15 in 1978. During the field survey, the Inception Report (August), the Interim Report (September) and the Draft Feasibility Report (December) on the Project were prepared and submitted to the Government of Indonesia. The comments on the Draft Feasibility Report were prepared by the Indonesian Government. Based on the comments and all results of the studies and analysis, this Feasibility Study Report is prepared.

1.4 PREVIOUS STUDIES

The previous studies on the Project were made and incorporated into the following reports:

(1) Survey Report for Development of Barito River Basin by OTCA in 1971.

(2) Preliminary Survey Report on Riam Kanan Irrigation Project by JICA in 1977.

The data, information and study results presented in these reports are fully used for preparation of this report.

1.5 SCOPE OF WORKS

The summary of the "Scope of Works" agreed upon between the Government of Indonesia and the Government of Japan is as follows:

(1) Pre-feasibility study on the Riam Kanan Irrigation Project covering about 60,000 ha in gross,

(2) Feasibility study on the priority areas of the Project covering about 40,000 ha in gross and,

(3) Training of the Indonesian counterpart personnel in the course of survey and study.

The survey team, headed by Mr. Irie and consisting of 13 experts recruited from Nippon Koei Co., Ltd., made investigations and prepared the draft of the feasibility study report on the Project at the project site. The final technical discussion with the Indonesian Government on the draft report was held in Jakarta during the period from Feb. 5 to Feb. 14 in 1979. Based on this final discussion, this feasibility report is prepared. The name of the experts and their counterpart personnel is listed in Table 1.

The feasibility study report consists of the following four separate volumes:

(1) Main Report
(2) Annex

(3) Drawings
(4) Data Book

This volume is the Main Report giving the summary of the Annex.

CHAPTER II GENERAL BACKGROUND

The natural conditions of Indonesia are favourable for profitable agricultural development. Approximately 7 % or 14 million ha of land are being used as farmland, and about 60 % of population are engaged in agriculture.

The national economy showed a rapid growth during the period of the First Five-Year Development Plan (Pelita I) launched out in 1969. In 1960's, the annual growth rate of GDP was only 2 %, but the growth rate increased to about 7 % per annum during this period. In the final year of the Pelita I (1974), the growth rate was as high as 8.2 %.

The agricultural sector, as a mainstay of the Indonesian economy supporting about 40 % of GDP, increased at the annual rate of 4 % during the period of the Pelita I. With the exception of 1972 which was very drought year, rice production during the Pelita I recorded a high average annual growth rate of 3.5 % due to the improved unit yield and the increased planted area, and since 1973 rice production increased at an annual growth rate of 2.2 %. The total rice production in 1974 reached the level of 15.4 million tons.

Despite of such a remarkable increase in rice production, it could not meet the demand during the Pelita I due to the increase in population and also due to the increase in rice consumption per capita induced by the level-up of the people's living standard. The annual import of rice reached the high level of one million tons in 1974.

Following the Pelita I, the Second Five-Year Development Plan was started in the 1974/75 fiscal year. This plan has been formulated with the aim of increasing the actual GDP at an average annual growth rate of 7.5 % or an increase of 44 % by the final year of the Plan. In the Plan, high priority has been given to the agricultural sector. It has been planned that the share of agricultural production in the GDP would come to be 36 % in the final year of the Plan, assuming the production increase at the annual growth rate of 4.6 %.

What has been strongly advocated in this plan as the specific sectorial object is the attainment of self-sufficiency in food grain, putting particular emphasis on increase in productivity of rice production through introduction of the improved irrigation farming.

However, actual rice production in recent years does not reach the target production set forth in the Plan mainly because of long spell of drought in 1975 and damage due to pests and diseases in a vast area in 1976. In fact, the import of rice in 1976 reached a high level of 1.3 million tons. In addition, it is forecasted by FAO that the import of rice in 1978 will reach 2.8 million tons.

In these circumstances, the Government of Indonesia is making much effort to increase the production of main food crops, especially rice, through further development of the improved irrigation farming as one of the important Indonesian Government's strategies.

The Kalimantan also has a shortage of food grain. South Kalimantan Province has a high potentiality of increasing the production of main food crops particularly in the flat plain in which the Riam Kanan Irrigation Project is located. In this province, furthermore, the Riam Kanan Multipurpose Dam Project already completed plays an important role in promoting further development in Southern part of the Province. Particularly, the water available from the dam is an important source for introduction of irrigation farming into such a potential flat plain. Therefore, high priority is given to early implementation of this irrigation project which will largely contribute to the improvement of the present food supply conditions in Kalimantan.

CHAPTER III SELECTION OF PROJECT AREA

3.1 GENERAL

In the Preliminary Survey Report on the Riam Kanan Irrigation Project prepared in 1977, the project area is tentatively divided into six sub-areas, namely A, B, C, D, E and F (see Fig. 1 General Map). The total gross area is about 60,000 ha.

The field investigations and studies carried out at this time cover total area of about 93,000 ha in gross including the above six sub-areas and their surrounding areas, because the surronding areas are closely related to the areas to be developed under the Project, particularly for the studies on land suitability for irrigation development and proper planning of drainage improvement.

A variety of complex and interrelated land data were collected and analyzed in selecting the area for irrigation development. Systematic appraisal for the soils and topography in terms of irrigation and drainage conditions is briefed in this chapter.

As a result, the land with a total area of 32,610 ha in net are selected for the Project, which consist of 1,870 ha in the sub-area A, 7,400 ha in the sub-area B, 3,740 ha in the sub-area C, 11,520 ha in the sub-area D, and 8,080 ha in the sub-area, repectively.

3.2 SOILS AND LAND CLASSIFICATION

3.2.1 Soils

The soils in the survey area are broadly classified into 4 orders, 10 sub-orders, 12 great groups, 17 sub-groups and 18 families based on their morphological features and specific characteristics as shown in Table 2, in accordance with the Soil Taxonomy compiled by the U.S. Department of Agriculture, 1973.

From the viewpoint of agricultural utilization of soils, the soils are divided into 5 groups.

The soils of the first group including the families (1), (2) and (12) are sandy soils which consist of moderately coarse to fine quartz with small gravels throughout the profile. They are quite deficient in essential plant nutrients. Regarding the physical nature, they are loose in consistence and have very low moisture holding capacity and very high permeability coefficient. In view of soil-crop response, these soils are not suitable for agricultural development.

The second group includes the families (3), (8) and (15). These soils are coarse loamy to sandy textured soil having many gravels and stones throughout the profile. The surface soils are eroded out, which result in exposed gravels on the soil surface. Generally, these soils are strong acid and quite deficient in essential plant nutrients. They have small moisture holding capacity and high permeability coefficient. Arability of these soils is low in the light of the profile features and physical soil properties.

The third group includes the families (4), (5), (7), (9), (10), (13) and (14). These soils are derived from fine clay to silty clay wet and massive alluvium deeply deposited in the low-lying areas. They are extremely hard and firmly consolidated when dry, while soft and friable when wet. They have high moisture holding capacity and low permeability coefficient. They are deficient in chemical elements especially phosphate and available bases, and strong acid in reaction. The deficiency of these chemical properties could be, however, improved through proper operations of irrigation and fertilization. Considering these conditions, the soils are suitable for agricultural development with irrigation.

The fourth group includes the families (6) and (11). The soils are virtually similar to those of the third group. However, these soils are distinguished from the third soils only by special characteristics of soil acidity. When the soils are moistured under the natural conditions, they show strong acid reaction, and the soils particularly sub-soils change to extremely strong acid condition (pH 3.0 to 3.5) when dry. Their potential acidity shown in pH value is 2.5 to 3.0 In view of soil-crop response, the surface soils would be arable, but the sub-soils which lie relatively shallow in the profile would restrict the crop growth. For agricultural use of these soils, attention should be paid for the treatments.

The last group including the families (16), (17) and (18) is the organic soils which are deeply accumulated in the depressions. Generally, they are strong to very strong acid throughout the profile under the present submerged conditions. Once dried by drainage, these soils will show extremely strong acid. Besides, the land surface will irregularly subside by decomposition of organic matters. Because no mineral stratification and fraction are in the profile, essential plant nutrients and available bases are very few. From both technical and economical points of view, the potentiality of these soils for paddy rice culture is extremely low.

3.2.2 Land Classification (see Table 3)

In the light of the morphological and other specific characteristics described above, the land suitability is graded into four classes in accordance with the U.S.B.R. standard modified in 1967.

In this land classification, about 49,100 ha or about 53 % of total survey area are selected as potential arable land (classes II and III). Generally, these lands have sufficient depths, moderate tillability, high irrigability and sustainable surface drainability.

About 22,040 ha of land are graded into marginally arable land (class IV). These lands are also considered as potential arable land. However, further study will be required for agricultural use of some soils in these lands, particularly for reformation of soils when they are dried by drainage improvement. It is rather difficult, at present, to study economical use of these soils for profitable agricultural development. Accordingly, the land in class IV is scarecely recommendable for the Project. The remaining area, 21,640 ha, is classified into class V (economically unsuitable for irrigation farming) and is excluded from the Project.

3.3 CONSIDERATIONS AFFECTING SELECTION OF AREAS

The land classification study reveals the grade of land suitability for profitable irrigation farming. As mentioned before, all surveyed lands are classified into four classes. The lands in classes II and III are taken up for the final study on the areas to be developed under the Project.

The drainability of the land as a whole is considered in relation to the drainage characteristics of topography and fluctuation of river water levels due to tide. For this, data are collected and analyzed regarding: (1) drainage patterns of the areas and subdivision of the areas into sub-areas of different hydrological characteristics, (2) position and fluctuation of inundation water level, (3) ground contours and main direction of water flow, (4) identification of barrier and runoff characteristics and, (5) natural drainage of the areas and eventual inflow from the surrounding areas. Based on the results of the study on possible drainage improvement in the project area taking into account the tidal influence on the river water levels, the drainability of land is classified into the following four categories:

Category 1 : Good. The ground level is higher than the water level outside throughout the year. No measures are needed at the outfalls of the drains.

Category 2 : Favourable. The submergence more than 30 cm in water depth does not occur with the drainage improvement. Miter or flap gates are required at the outfalls.

Category 3 : Poor. In the rainy season, the submergence more than 30 cm in water depth will occure even with the drainage improvement. But in the dry season, the submergency more than 30 cm does not occur with miter or flap gates at the outfalls.

Category 4 : Bad. No gravity drainage can be practiced economically throughout the year.

The lands in categories 1 and 2, and a part of category 3 are taken up for the final selection of the areas proposed for the Project.

The topography of the land is also evaluated with respect to economical development of irrigation. In this evaluation, priority is given to the gravity irrigation. Since the amount of water available from the river Riam Kanan is limited, the survey area is firstly divided into two, the areas where the gravity irrigation can be practiced using water available from the Riam Kanan, and the areas where other water sources have to be applied.

In determining the location of the main irrigation canal, there are two major factors in this project. One is the existence of the Riam Kanan dam, and the other is the soil conditions along the canal. The both restrict the location and elevation of the diversion weir and the main canal. The diversion weir would have to be designed so as not to disturb dam operations due to the backwater caused by damming up the river water level of the Riam Kanan, and the main canal should be aligned avoiding the swamp areas in which the soil conditions for the construction of the canal are obviously bad.

These two restrictions confine the water level at the main canal head between El. 9.00 m and El. 11.00 m. Within this range, the economic comparative study is made in combination of diversion weir and the main canal. The study result indicates that the optimum water level would be El. 9.80 m at the canal head. The location of the canal route is then inevitably settled. The selection of the area for the Project is made within the areas which are effectively irrigable with this main irrigation canal.

Last but not least, the present land use and vegetation of the areas are taken into consideration, since these conditions have large effects on the relative difficulty in making land reclamation for irrigation development.

The delineation of the project area is made, superimposing the study results of soils, drainability, topography, land use and vegetation. As a result, 38,360 ha of land in gross are selected for the final selection of irrigable area to be developed under the Project. The lands thus selected can be divited into five sub-areas A, B, C, D and E mainly from the topography, drainage regime and the existence of roads and rivers.

In these studies, the possibility of developing profitable irrigation farming in the sub-area F which is proposed in the Preliminary Survey Report on the Project is also examined.

The soils in this sub-area F are characterized by loamy to sandy skeletals (gravelly particles) throughout the profile. Due to poor vegetation (alang-alang grass) and undulating topography in the area, almost all the surface soils (humic epipedon) are eroded out, and then, organic matters in the soils are very few.

Inherent plant nutrients are very poor in these soils. Because of very coarse texture quality throughout the profile, the soils have low water holding capacity and very high percolation rate. The tillability or arability of these soils is low in the light of the soil profile features and physical soil properties. With these soil conditions, the land suitability of all lands in this sub-area is classified into class V (unsuitable for irrigation farming).

Since the lands in this area are located in the hilly area with an elevation ranging from 15 m to 35 m, pumping irrigation is required. The preliminary study on suitable pumping sites on the proposed main irrigation canal made it clear that the irrigation water would have to be lifted in a few steps instead of one due to complicated topography for lifting water. This would require high construction cost and difficult operations.

In view of undulating topography in the most area, in addition, it is rather difficult to arrange a suitable farm plot for proper operations of irrigation. Besides, the soils having coarse taxture with exposed gravels throughout the profile make proper water management and farm operations difficult.

As these discussions manifestly indicate that this sub-area is unsuitable for profitable irrigation farming, it is recommended to exclude this area from the Project.

3.4 PROPOSED PROJECT AREA

The above studies made clear the areas which could be developed under the Project. The progress and the results of the studies are summarized in Table 4.

As seen in Table 3, total irrigable area in the project area consisting five sub-areas A, B, C, D and E would be 32,610 ha in net. Net irrigable area in each sub-area would be 1,870 ha in the sub-area A, 7,400 ha in the sub-area B, 3,740 ha in the sub-area C, 11,520 ha in the sub-area D and 8,080 ha in the sub-area E, respectively.

CHAPTER IV PROPOSED DEVELOPMENT PLAN

The appraisal is made for the five sub-areas finally delineated in the previous chapter in terms of irrigation and drainage conditions for the study on the proposed development plan. The appraisal suggests that there would be two alternative plans for the development. One is to develop the area with the gravity irrigation scheme, and the other is a plan for developing the area with the combined gravity and pump irrigation scheme.

As will be mentioned in Chapter V, there are two sources of irrigation water for the development. They are the rivers Riam Kanan and the Maluka. The whole irrigable area, 32,610 ha in net, could be developed as a series of the Project, using the water available from the Riam Kanan by gravity. In this case, 32,100 ha of land would be irrigated for the cultivation of rainy season paddy, but in the dry season the irrigation area would be limited to 24,530 ha, since the water from the Riam Kanan is not sufficient to cover the whole area. In addition to the Riam Kanan, the water available from the Maluka by pumping could also be used for increase of irrigation area in the dry season, and 27,990 ha of land would be used for dry season paddy with irrigation (see Chapter IX).

The comparative study on these two alternatives is made, as will be discussed in the following chapters. A summary of the study is as follows:

	Irrigation area		Total economic cost	Unit cost per ha	IRR
	Wet Season (ha)	Dry Season (ha)	(US$1,000)	(US$1,000)	(%)
Gravity Irrigation Scheme	32,100	24,530	130,410	4,000	13.5
Combined Gravity and Pump Irrigation Scheme	32,100	27,990	137,660	4,220	13.9

The above comparative study shows that the economic internal rate of return of the combined gravity and pump irrigation scheme is a little bit higher than that of the gravity irrigation scheme. However, the basic concept of the irrigation development in Indonesia would be firstly to increase and stabilize yield and production of rainy season paddy by constructing the gravity irrigation system, and the intensification of cropping area in the dry season within available irrigation water comes second.

In addition, operation and maintenance costs of the irrigation scheme which includes the pump facilities would become higher as compared with those of the gravity scheme. For these main reasons, it is recommended that priority be given to the development with gravity irrigation scheme for possible earlier realization of the project effects. The feasibility study on this development is made as presented in the following chapters.

The combined gravity and pump irrigation scheme also shows economic viability for the development, though present study on this scheme is still in the preliminary stage. In connection with the detailed design of pumping scheme for the sub-area E, therefore, further investigation and study will have to be made taking into account the overall development plan of the Project.

CHAPTER V THE PROJECT AREA

5.1 LOCATION

The project area is situated in the south-east of Banjarmasin, the capital of South Kalimantan Province. The area is bounded by the river Barito on the west, the river Martapura on the north, the river Maluka on the south and Martapura-Batibati road on the east. Administratively, a major part of the project area belongs to Kabupaten Banjar.

5.2 POPULATION

The population of the project area is estimated at about 650,000 including the population of Banjarmasin city, 318,000. Annual population growth rate in Kabupaten Banjar in recent six years was about 2.1 %. According to the statistics in 1971, about 67 % of the working population in Kabupaten Banjar is involved in agricultural sector.

5.3 NATURAL RESOURCES

5.3.1 Topography

Most of the project area extends over very flat alluvial plain along the rivers Barito and Martapura with elevations between 0 m and 2 m. The slope of such an alluvial plain is approximately 1/8,000 or 0.013 %.

In the project area, there are three major rivers affecting the project study, the Barito, the Martapura and the Maluka. The Barito runs through the western part of the area. The excess water from the sub-area D and a part of the sub-area E is drained into this river through many streams and channels. The Martapura, a tributary of the Barito, flows along the northern boundary of the project area, collecting excess water from the sub-areas A, B and C. The Maluka which is also a tributary of the Barito flows along the southern boundary of the project area, draining excess water from a part of the sub-area E. The water level of these three rivers fluctuates by tidal influence from the Java Sea, which affects drainage improvement in the project area.

5.3.2 Climate

The climate in the project area is characterized by the tropical monsoons. The average rainfall is about 2,600 mm in the area, but varies widely from year to year ranging between 1,200 mm and 4,300 mm. About 70 % of rainfall occur in the form of intense local storm during the rainy season which lasts from November to April. In the dry season, particularly during the period of three months from July to September, there are often long spells of drought.

The monthly mean temperature is about 26°C with little seasonal variation. However, daily fluctuation shows a wide range of about 8°C to 12°C. The annual mean relative humidity is approximately 80 % with a seasonal variation of about 10 %. The wind velocity is generally low, and no storm damage is expected. The annual evaporation is about 1,370 mm. The daily evaporation averages 3.4 mm in the rainy season and 4.1 mm in the dry season.

5.3.3 Water Resources

There are two sources of irrigation water in the project area. They are the Riam Kanan and the Maluka.

Amount of Water Available from the Riam Kanan

The amount of water available from the Riam Kanan depends entirely on the discharge released through the power plants, and the discharge varies with power demand. While, the release of 40 m^3/sec of water is secured for irrigation and domestic water supply even in droughty year in accordance with the operation manual for the Riam Kanan Reservoir.

According to information obtained from PLN, the Riam Kanan power station would be operated with 24 to 27 MW of power demand at peak time in and after 1984, keeping some reserves for emergency peak power demand, even after the completion of the Riam Kanan second stage project (additional installation of one set of 10-MW power plant) now under construction. For conservative study, the peak power demand of 24 MW is adopted to estimate the amount of water available for the Project. Load factor at that time is forecasted to be 65 %. With these forecasted power demand and load factor, the average output is estimated at 24 MW x 0.65 = 15.6 MW. Based on this estimated output and the study on static head, the amount of water which could be expected from the power station is estimated at 42 m^3/sec. This would be the amount of water available for the Project and the maintenance of the river Martapura.

However, it would not be allowed that all amount of water-available from the power station could be used for the project use only. This means that suitable amount of water would have to be released to the downstream reaches of the Martapura (river maintenance discharge), particularly for protecting the Martapura from the saline water intrusion and water pollution. The study on the suitable maintenance discharge is made in detail in Annex IV. As a result, the mean value of full 12 years' drought runoff at the Riam Kanan dam site is estimated, which is 8 m^3/sec, and this is tentatively recommended as the minimum river maintenance discharge to be released to the downstream reaches, though more detailed study on this matter should be made at the detailed design stage of the Project using more reliable data and information.

Therefore, the amount of water available for the Project is estimated at 42 m^3/sec - 8 m^3/sec = 34 m^3/sec.

Amount of Water Available from the Maluka

The study result shows that the amount of water for the project use from the river Maluka with 80 % dependability is estimated at 4.8 m^3/sec.

Water Quality for Irrigation Use

As for the water quality of the river Riam Kanan, there are no problems for its irrigation use. However, the water of the Maluka is affected by saline water intrusion from the Java Sea. In order to use the water for irrigation purpose, therefore, the construction of gate structure on the Maluka would be required to control the saline water intrusion.

5.3.4 Geology and Construction Materials (refer to Chapter VI)

The engineering geology of two alternative sites for the construction of diversion weir on the Riam Kanan is studied based on the results of detailed field survey and test drilling. One weir site is located near Sungai Asam village, about 12 km downstream from the Riam Kanan dam (site-A), and the other is situated at about 1 km upstream from the site-A, near Mandikapau village (Site -B).

The geology of the foundation for the main irrigation canal is also investigated by digging test pits along the canal, and mechanical tests of soil samples obtained from the test pits were also made for the preliminary design of the canal.

Site-A

Fresh pyroxenite is found at about 10 m deep from the ground surface. This pyroxenite is compact and hard enough for constructing concrete weir with a height of 6 m. The field permeability tests showed that the leakage was negligible in fresh rocks. As a result, this site has favourable geological conditions for the foundation of the proposed concrete weir.

Site-B

Pyroxenite intrudes on both sides of the river Riam Kanan at this site. The fresh bed rock consists of hard taffaceous sandstone. The depth to the fresh hard rock averages 9 m on the left bank, 3 m in the river and 16 m in the right bank area. Deep excavation would be required for removing thick overburden in the right bank area to construct the weir on the fresh hard rock. In order to minimize the construction cost of the weir, the combined fixed and floating types of weir may be considered. In this case, the floating type of weir would be constructed on the weathered rocks which have rather high permeability of 10^{-3} - 10^{-4} cm/sec. Cement grouting may be required for these weathered rocks to minimize the water leakage. The bed rocks other than these weathered rocks are compact and massive enough for the foundation of the proposed concrete weir with a height of about 9 m.

After-bay Area

Most of the area to be submerged by the creation of after-bay is covered with Alluvium and terrace deposits. It is assured from the field permeability tests at the weir sites that K value of this deposits is around the order of 10^{-3} - 10^{-4} cm/sec. Since the area has a gentle topography in general and remarkable faults are not observed, landslide in the after-bay area would not be anticipated.

Main Irrigation Canal

The elongated area along the main irrigation canal is composed of Quaternary sediments, except for some part of the area consisting of Tertiary (Miocene) sediments. Hard rocks are not observed in shallow layers throughout the canal route. Hard rocks (sandstone) are found at about 15 m deep in the hilly areas around Banjarbaru.

The standard penetration test shows that N-value is generally small ranging between N = 2 and N = 7. Careful study on the foundation for large-scale canal structures will be required for proper design of these structures.

High ground water tables, within 0.5 m below the ground surface, are observed in the downstream reaches of the canal. The soils in these reaches are sandy soil in general. Under these conditions, the study on suitable canal lining for these parts may be required.

Construction Materials

There is a quarry site at about 5 km south from the weir site-B. The rocks available at this quarry site are peridotite of igneous intrusive rocks. This can be used as rock rip-rap materials for the construction of diversion weir.

Alluvium and terrace deposits distributed around the weir sites consist of gravel, sand, clay and silt. The grain size analysis of these deposits indicates that sufficient amount of gravel and sand for concrete works could be obtained from these deposits.

Soil mechanical tests of soil samples taken from the area around the weir sites and the area along the canal show that the earth materials available in these areas could be used for embankment in the construction of the weir and canals.

5.4 INFRASTRUCTURES

5.4.1 The Riam Kanan Dam Project

The construction of the Riam Kanan Dam Project was completed in 1972 with the financial assistance of the Japanese Government. The hydropower plants with an installed capacity of 20 MW are now in commercial operation, and the peak power demand is about 12 MW at present. The built-up drawings of the major facilities such as dam, spillway and power station are shown in Dwg. No. 2 attached to this report.

As for the power demand in the future, PLN forecasts that it would increase to 24 to 27 MW in and after 1984. With this forecasted power demand, the installation of additional one set of 10-MW power plant together with the increase of the capacity of transmission line and extension of distribution lines in the rural areas as well as in the cities is under construction by PLN and is completed by the year of 1982.

5.4.2 Present Irrigation and Drainage System

In the project area, no technical irrigation and drainage system exists at present, except for the existing canal networks, most of which were constructed by the local people without any technical advice from the government offices.

5.4.3 Transportation and Communication

The existing road network centers in Banjarmasin. The national highway linking Banjarmasin with Banjarbaru, Martapura and other major towns runs west to east approximately in southern part of the project area. This highway is well maintained, and widening of the road width from the present 9 m to 12 m is now under construction. In the rural areas, transportation by vehicles is still limited because of poor road network in both number and condition. In such rural areas, however, most of the existing streams and channels are used for transporting farm products and other consumable goods using small boats.

Civil airport in Ulin is providing services for transportation of passengers and goods to the major cities not only in Kalimantan but alto in other islands.

The dredging operations on the estuary of the river Barito have made possible the navigation of freights of the 7,000 to 8,000 deadweight ton class to go up the river to the newly completed port of Trisakti in Banjarmasin.

The international and national communication services by telephone and telegram are available in Banjarmasin. However, communications between Banjarmasin and other major cities in the project area are still limited.

5.4.4 Municipal Water Supply

The municipal water supply facility is available only in Banjarmasin. The present supply capacity is 275 lit/sec. The city water is supplied from the Martapura by two pumping stations. One is located at Sei Bilu near the estuary of the Martapura, and the other is at Sei Tabuk, about 25 km upstream from the Sei Bilu pumping station. The Sei Bilu station is mainly used for the water supply services. When the salinity of river water measured at the Sei Bilu station exceeds 200 ppm in Cl^- value, the Sei Tabuk station is operated instead of the Sei Bilu station.

The river Martapura is affected by tide. According to the available data on the salinity of the river water, the saline water intrusion is observed at the Sei Bilu station, according to the season. The maximum Chlorine concentration of about 7,000 ppm was observed in October, 1977, whereas 5,400 ppm and 4,300 ppm in August and September, respectively in 1976. However, the saline water intrusion was not observed at the Sei Tabuk station even before the completion of the Riam Kanan dam, with the exception of the year of 1972 which was very drought year and in which the Riam Kanan dam started to store the water.

As mentioned in this report, 8 m^3/sec of water would be released to the downstream reaches of the Martapura from the proposed diversion weir on the Riam Kanan. As discussed before, the river water of the Martapura at the Sei Tabuk pumping station is not affected by the saline water intrusion, except for the year of 1972. It is considered that the Sei Tabuk station could be used for the city water supply services without saline water problem, when a constant release of 8 m^3/sec of water is secured at the diversion weir site.

5.5 LAND USE AND AGRICULTURAL PRODUCTION

5.5.1 Land Holding and Land Tenure System

Land holding in the project area is generally small in size. About 35 % of total farmers in the area are classified into small-scale farmers who own 0.51 to 1.0 ha of land, and further small farmers whose land holding ranges between 0.1 and 0.5 ha of land occupy about 30 % of total farmers. The average land holding per farm family is estimated at 1 ha.

About 73 % of total farmers are occupied by land owner farmer, about 21 % by tenant and 6 % by land owner cum tenant. The crop sharing system is predominant in the project area. The harvested paddy is shared with the land owner and the tenant at the sharing rates ranging between 50 % to 50 % and 30 % to 70 %.

5.5.2 Present Land Use

Out of 38,360 in gross, 31,020 ha are agricultural land, of which 29,960 ha are used as paddy field, and 1,060 ha as rubber plantation. The remaining 7,340 ha include 4,090 ha of shrub land extending over low-lying flood plain and 3,250 ha of non-agricultural land such as village, compound, streams, roads, etc. (see Table 5).

The paddy field is used for one cropping of paddy rice in the wet season mainly because of no technical irrigation and poor drainage conditions.

Most of rubber plantations has a small productivity because of aged rubber tree. The shrub land is not used for agricultural purpose at present. Because of light inundation with a shallow water depth and suitable soil conditions, however, most of the shrub land would be possible to reclaim for agricultural use with proper irrigation and drainage improvement.

5.5.3 Present Cropping Pattern and Farming Practices

Paddy rice is the main crop in the project area, and monoculture of paddy rice using flood water in the rainy season is predominant throughout the area.

Paddy seeds are sown during the period from early October to late January. During the period, young seedlings are transplanted two to three times depending on the water conditions in the paddy field. After growing for 7 to 10 months, paddy is harvested during the period from May to October. Early transplanting of paddy is generally common in most part of the sub-areas C, D and E. It seems that seasonal flooding is controlled by the existing canal network. While, late transplanting of paddy is practiced mostly in the sub-area B and a part of the D. It may becaused by deep inundation for rather long time. In the depressions in the sub-areas A and B, paddy rice is cultivated only in the dry season from April to October because of deep flooding during the rainy season. The present cropping pattern of paddy cultivation in the project area is illustrated in Fig. 2.

Local varieties such as Lemo, Bayar and some other varieties of the Siam series are planted in most of the area. Recently, improved high-yielding varieties such as Perita I/1, I/2 and C4-63, etc. are introduced, but they are still at the trial stage.

All of the works for farming are operated manually, not using any animal and mechanical power. Seasonal labours are employed to supplement a shortage of family labour at peak time such as transplanting and harvest.

No soil preparation such as ploughing, harrowing, puddling, etc. is usually practiced in the project area. During the growing period of paddy rice, a little attention is paid by the farmers only to weed control and cleaning of field ridges. The use of chemical fertilizers and agricultural chemicals is still insignificant in this area. Threshing and processing of farm products are usually made by hand using small farming instruments such as winnower, etc.

The food crops other than paddy rice such as maize, cassava, sweet potato, beans, etc. are also grown in small areas, most of which are for home consumption.

5.5.4 Crop Yield and Production

Administratively, most of paddy field in the project area belongs to Kabupaten Banjar. The average yield and production of paddy rice in the project area are estimated based on the statistical data obtained from Kabupaten Banjar. Table 6 shows the cultivated area and production of paddy rice in Kabupaten Banjar for recent five years. From this table, the average yield of paddy is estimated at 1.75 tons of dry paddy which are still lower than the average yield of 3 tons/ha in the whole Indonesia. In addition, yield check survey was carried out in 6 Kecamatan in the project area. The survey result also shows that the average yield of dry paddy is 1.75 tons/ha.

The annual production of dry paddy in the project area is estimated at about 52,400 tons.

5.5.5 Marketing and Processing Facilities

Farm Inputs

Most of farm inputs necessary for paddy cultivation such as seeds, fertilizers and chemicals are provided by BUUD/KUD (cooperative) at the subsidized prices through the BIMAS Program. Market flow of the farm inputs in South Kalimantan is shown in Annex VI.

Marketing of Rice

Marketing of rice is handled by middleman, rice miller and BUUD/KUD. The present market flow of rice is given in Annex VI.

The share of marketing of rice by BUUD/KUD is very limited mainly due to the shortage of BUUD/KUD in number in the project area. DOLOG (Depot Logistik) purchases paddy from BUUD/KUD for stabilizing the price of rice at a floor price and sell it when the market prices go up above the ceiling price. However, the operations of DOLOG are still limited to the supply to the military and government employees due to inadequate organization, and insufficient staffing and storage capacity. Most of paddy and rice are handled by middlemen and private companies. This means that the farmers often sell their farm products at unreasonable prices. It is estimated from the present production and rice consumption in Kabupaten Banjar that about 18,000 tons of rice are marketed through DOLOG, private companies and middlemen in Banjarmasin and other major cities in the project area.

Processing Facilities

The main processing facility for farm products in the project area is rice mill. The number and the capacity of the existing rice mills are given in Annex VI.

Small-scale rice mills with a milling capacity of 1 to 2 tons per hour occupy about 65 % of total rice mills in number. It is estimated that each Desa (village) has two rice mills with a total milling capacity of 4 tons/hr on an average. It is assumed from these figures that the present rice mills in the project area would be sufficient in both the capacity and number even after the completion of the Project.

5.5.6 Present Farm Economy

Table 7 shows the present annual budget of a typical owner farmer with 1 ha-land holding. This table indicates that farmers in the project area get their income mainly from farming activities particularly paddy rice cultivation. The income from palawijo cultivation and livestock is very small.

Total annual farm income is estimated at Rp.163,750 for average farm holding 1.0 ha, which correspond to about 73 % of the gross income. The remaining 27 % of the gross income are from the non-farm activities.

Total annual outgo is estimated at Rp.226,420, of which Rp.220,320 are spent for living expenditure, which correspond to about 98 % of the total outgo. The balance of the budget or capacity to pay is therefore estimated at only Rp.1,500 (or US$2.5).

5.6 AGRICULTURAL SUPPORT SERVICES

5.6.1 Agricultural Extension Services

Agricultural extension services in South Kalimantan are operated through systematic organization from the Ministry of Agriculture to the Agricultural Development Center, and down to the Rural Extension Center. The present organization is presented in Annex VI.

There are four rural extension centers in the project area. The centers have PPM (Extension Supervisor) and PPL (Field Extention Worker). The service area by one PPL ranges widely, among Kecamatan, between 1,000 ha and 14,000 ha. A PPL is giving necessary guidance to 16 contact farmers (key farmer) in his service area, and a contact farmer transfers new and improved farming technics which he has learned to a group consisting of 16 to 20 farmers. In addition, some contact farmers operate demonstration farms, each covering 0.1 to 0.2 ha, in their villages for effective transfer of technical knowledge to their member farmers.

In addition to the guidance to 16 contact farmers as the main work, PPL is serving for proper management of demonstration farms, guidance to the farmers under the BIMAS/INMAS Programs, meeting and discussions with the agencies and personnel concerned, and so on. Under these conditions, it would be difficult to expect higher efficiency in his services unless further improvement of the present staffing and equipment is made. Particularly, such an improvement in the project area is essential for successful implementation of the Project.

5.6.2 Research Works

The agricultural research works in South Kalimantan area conducted by the Branch of the Central Research Institute for Agriculture, Kalimantan and seven sub-stations of the Institute located in seven Kabupaten as illustrated in Annex VI. Banjar substation is located in the project area.

In the project area, there is an experimental farm at Handil Manarap in the sub-area C. In this farm, fertilizer tests and test for plant protection are made using local varieties of paddy rice and some high-yielding varieties such as IR-26, IR-28 and IR-36 in about 20 ha of paddy field.

The experimental farm has an office, a storage and paddy drying yard (concrete pavement) and also a simple meteorological station. This farm has a plan to expand its research work in the test field of seed breeding, fertilizer response, weed control, etc. However, the progress of these testing works is still very low, because the staffing, buildings and testing equipment and apparatus are still not sufficient.

5.6.3 Seed Multiplication and Supply

In the project area, there is a seed center, Balai Benih seed center, located in the sub-area C. It covers about 10 ha of paddy field, of which 2 ha are used as seed farm. The seeds of IR-26, IR-28, IR-36 and B4-62C are multiplied. After multiplication at this center, the seeds are distributed to the farmers in response to their request through BUUD/KUD. However, the services in this field are still limited. Further efforts are required for distributing the improved seeds smoothly to as wide area as possible, because the activities of BUUD/KUD in this field are not properly managed.

5.6.4 BIMAS and INMAS Credits

The present BIMAS/INMAS Programs cover only 7 % for the rainy season paddy and 3 % for the dry season paddy of total irrigable area proposed for the Project. The main reason for these small coverages is mainly due to the fact that there is no technical irrigation system in the project area.

According to the farm economy survey, the BIMAS/INMAS Programs being carried out in the project area are BIMAS Biasa and INMAS Biasa. Under these programs, most of paddy cultivation is practiced using local varieties without fertilization and proper plant protection.

5.6.5 Agricultural Cooperatives

The Indonesian Peoples Bank (BRI) provides rural credit all over the country. Since 1964, BIMAS Program has been introduced to attain self-sufficiency in foodstuff. Under the Program, the activities of the Bank have been considerably strengthened to offer special short term loan for paddy production. However, the number of BRI in the project area is still insufficient. Additional establishment will be required particularly for successful implementation of the Project.

The existing agricultural cooperatives in the project area are BUUD (Badan Usaha Unit Desa)/KUD (Koperasi Unit Desa), KIOS and Rice Mill Unit.

Among them, BUUD/KUD plays an important role in providing various services for the farmers to achieve the final purpose of levelling up their living standard mainly through the increase of their farm income. The main activities are the supply of necessary farm inputs such as improved seeds, fertilizers, agricultural chemicals, some farming instruments, etc. and marketing of farm products. The present BUUD/KUD is still not sufficient in number to provide sufficient services for the whole area.

The present activities of these cooperatives are still not sufficient mainly because of the shortage of well-trained managing staff and budget.

CHAPTER VI THE PROJECT

6.1 GENERAL

The agricultural development plan in the project area which would cover 32,610 ha of land in net is formulated to maximize the expected project benefits.

The main concept of the agricultural development would be to:

- increase and stabilize yield and production of rainy season paddy through proper drainage improvement, supply of clean irrigation water, and introduction of improved irrigation farming,

- increase paddy production by introducing double cropping of paddy rice with year-round irrigation and drainage improvement, high-yielding varieties and improved farming techniques, and

- increase paddy production by opening new agricultural land in the areas which have favourable physical conditions for agricultural development.

As mentioned before, the project area is characterized by flat and low topography, and high ground water tables. Because there are no technical irrigation and drainage facilities except for small channels, the existing paddy field often suffers from seasonal floodings in the wet season and a long period of drought in the dry season. Therefore, the paddy field is used for only one cropping of paddy rice in a year. The main constraints to the increased crop production are as follows:

- Poor drainage conditions due to no improved drainage network,

- No technical irrigation system,

- Poor road network, and

- Insufficient agricultural supporting services.

In order to achieve the proposed agricultural development in success, the construction of necessary infrastructures and further improvement of supporting services are required as follows:

(1) Construction of the irrigation network consisting of the headworks, the main, secondary, sub-secondary, tertiary and quaternary canals.

(2) Construction and rehabilitation of the drainage network which consists of the main, secondary, sub-secondary, tertiary and quaternary drains,

(3) Construction of road network which includes the main, secondary and tertiary roads,

(4) Reclamation of new farm lands,

(5) Operation and maintenance of the irrigation and drainage networks, and

(6) Further improvement of the present agricultural support services including establishment of pilot demonstration farm and farmer's association.

6.2 AGRICULTURAL DEVELOPMENT

6.2.1 Proposed Land Use and Cropping Pattern

Land Use

With the completion of the new irrigation and drainage network, all the area proposed for the Project would be turned into technical irrigation area, and the land use is expected to become more intensive with the introduction of irrigation farming. Total irrigated area would be 32,610 ha in net, of which 4,380 ha would be new farm land to be reclaimed from the existing small productive rubber plantations and shrub land.

The proposed land use with the Project is shown in Table 8.

Cropping Pattern

Paddy rice is remained as the main crop in the project area. The proposed cropping pattern of paddy cultivation under the Project is studied, taking into account the climate, irrigation, drainage, agronomic characteristics of paddy varieties and available labour force.

Out of 32,610 ha, 24,020 ha of land with perfect and favourable drainability would be covered with double cropping of paddy rice, and the remaining 8,590 ha of land would be used for single cropping of paddy rice in the dry season (510 ha) and in the wet season (8,080 ha). The proposed cropping patterns are illustrated in Fig. 3.

In order to maximize the crop production with the proposed cropping patterns, high-yielding varieties would be introduced. The high-yielding varieties with a growing period of 110 to 120 days and ones specified for 130 to 140 day-growing would be adopted for the dry season paddy and the wet season paddy, respectively. These varieties would be selected among the improved varieties such as C-series, IR-series, etc.

In order to introduce these new cropping patterns into the project area successfully, it is inevitable to provide strong agricultural services, including training of both field extension workers and farmers, by all government agencies concerned.

6.2.2 Proposed Farming Practices and Farm Inputs

The proposed farming for paddy rice cultivation would be practiced basically by manual operations with small farming equipment such as rotary weeder, knap-sack type mist cum duster, treadle thresher, winnower, etc.

Proper application of fertilizers is essential for full expolitation of agricultural potential of the land under the irrigation farming. The soils are deficient in plant nutrients especially nitrogen, phosphate, effective bases and somewhat potassium. Therefore, these chemical elements are necessary to be supplemented by fertilization. Considering the present soil conditions, suitable fertilizers would be urea, triple-super phosphate (T.S.P.) and potassium chloride (KCl). The chemical fertilizer requirements would be 250 kg/ha of urea, 100 kg/ha of T.S.P. and 60 kg/ha of KCl respectively.

As for the plant protection, intensive application of insecticides would be required to control plant hoppers, stem borers, etc. Considering the life-cycle of these insects, 3 to 4 lit/ha of insecticides would be required for 3 to 4 times application during one cropping. In addition, it would be necessary to apply about 2 lit/ha of fungicides to control the diseases for each crop season.

In order to operate the proposed plant protection works, it is recommended to organize the systematic plant protection program through the farmer's cooperative under the technical guidance of the government agencies concerned.

The improved harvesting method by cutting all straws using sickles which will be suitable for improved high-yielding varieties is proposed in the project area.

Proper water management during paddy cultivation is also very important in order to attain target yields of crop.

6.2.3 Anticipated Yields and Crop Production

The present crop yield is still low mainly because of a shortage of irrigation water and poor drainage conditions. The increase of crop yield could be expected through proper irrigation, drainage improvement and further improvement of the present agricultural supporting services.

The anticipated crop yield under with-project condition is estimated at 4.0 ton-dry paddy/ha and 4.5 ton-dry paddy/ha for the rainy season paddy and the dry season paddy, respectively, based on the results of experiments made in the Burantas river basin in East Java, in the Intangan and Kahakan irrigation area in South Kalimantan and in the project area, using the improved high-yielding varieties. the yields are expected to reach the maximum in the seventh year after introduction of improved irrigation farming.

The annual production at the full stage of the development would be about 238,700 tons of dry paddy, and the increment of the crop production would be about 178,800 tons of dry paddy, as shown in Table 9.

6.2.4 Marketing and Price Prospects

Marketing Prospect of Paddy

The production and consumption of rice in South Kalimantan are at present balanced with some surplus. Most of surplus rice is exported to other provinces in Kalimantan which have a shortage of rice.

The study on future prospect of demand-supply condition of paddy in Kalimantan is made in Annex VI. Assuming that the annual growth rate of population is 2.65% and that the annual growth rate of paddy production is 5%, the estimated paddy production would not catch up with the forecasted demand.

With the completion of the Project, about 120,000 tons of rice would be marketed, most of which would be exported to other provinces.

Price Prospect

Economic farm gate prices of paddy and farm inputs are estimated based on the projected international market prices forecasted by IBRD in 1978 constant US dollars.

Financial gate prices of farm products are estimated based on available data on market prices of farm products in Banjarmasin and Banjarbaru, and from the results of field survey. Financial prices of farm inputs are estimated based on the results of field survey.

The estimated prices are shown in Table 10, and details of the estimation are described in Annex VI.

6.3 IRRIGATION AND DRAINAGE PLANS

6.3.1 Water Source

The source of irrigation water required for the Project will be the Rian Kanan reservoir. As mentioned before, available water for irrigation use would be 34 m^3/sec from the Riam Kanan reservoir.

6.3.2 Water Requirements

The study on irrigation water requirements is made based on the field measurement of consumptive use of water by paddy rice carried out at the experimental farm in the sub-area C, making cross checking of the measured crop consumptive use of water with a potential evapotranspiration calculated using the empirical formula. In the study, the puddling water requirement is estimated at 120 mm, taking into account the soil textures such as clay to clay loam, low percolation and high ground water tables. Percolation loss is also measured in the field, and it is estimated at 1 mm/day in the dry season and 0.5 mm/day in the rainy season, respectively.

Effective rainfall is estimated by applying the daily water depth balance method, using the following assumptions; (1) rainfall less than 5 mm/day is ineffective; (2) the excess beyond 50 mm/day is ineffective; and (3) 90% of the total of each 19-day rainfall through the above procedure is effective. For this estimation, 10-day rainfall with recurrence interval of once in five drought years is used.

Conveyance and operation losses are estimated at 20% and 15%, respectively, which result in 68% of total irrigation efficiency.

The supply of 2 mm/day of water to paddy field is added to the irrigation water requirement in order to provide the land conditions favourable for paddy cultivation through increase horizontal seepage and percolation actions, as well as dilution of acid water coming out from peat soils which exist outside the project area.

The maximum 10-day water requirement is thus estimated at 11.8 mm/day which are translated as 1.37 lit/sec/ha and would occur in mid-August, the dry season. The maximum 10-day water requirement for the wet season paddy is estimated at 2.9 mm/day which correspond to 0.34 lit/sec/ha and would occur during transplanting time.

6.3.3 Rural Water Supply

The water necessary for the domestic use in the rural areas along the irrigation canals is added to the irrigation water requirement. It is estimated at 0.4 m^3/sec in total, assuming that total population in the project area is 330,000 excluding Banjarmasin where the municipal water supply facility is available and that per-capita consumption of water is 100 lit/day.

With the above water requirements and 34 m^3/sec of water available from the Riam Kanan reservoir, the proposed irrigation area would be 32,100 ha in the rainy season and 24,530 ha in the dry season.

6.3.4 Drainage Requirements

As stated before, the drainability of the lands in the project area is classified into four categories, and the lands in categories 1 and 2, and a part of category 3 are selected for the project study.

For the design of suitable drainage improvement plan within a feasible range, the study is made to estimate the drainage requirements for the areas where the drainage improvement could be practiced economically by gravity. The study is made, taking into account the various factors such as topographic conditions, present drainage conditions, soils, water levels, etc. which vary from area to area.

Most of the project area is low-lying marshy land, and the drainage of excess water from the project area is largely affected by fluctuation of the water table in the rivers around the project area. In addition, proper drainage improvement will play an important role in successful implementation of the Project in particular.

Taking into consideration these poor natural conditions, the proposed drainage requirement is estimated based on 3-day consecutive rainfall once in 10 years.

The different values of drainage requirements by the sub-areas are applied to the design of drainage improvement in the project area. The total drainage area covers about 40,000 ha, and the rainfall distribution pattern is not the same throughout the total area. Under these conditions, three different design rainfalls are adopted according to the location of each sub-area in order to estimate the drainage requirements suitable for each sub-area. As a result, the drainage requirements are estimated at 7.0 lit/sec/ha in the sub-area A, 8.0 lit/sec/ha in the sub-areas B and E, and 5.9 lit/sec/ha in the sub-areas C and D. Details of the study are given in Annex VII.

6.4 PROPOSED PROJECT WORKS

6.4.1 Diversion Weir

A diversion weir was proposed to be constructed near Sungai Asam village (site-A), about 12 km downstream from the Riam Kanan dam, in the Preliminary Survey Report on the Project. Topographic survey and geological investigation by core boring were made at this site.

In connection with this feasibility study, detailed field reconnaissance of the proposed weir site was carried out based on the detailed topographic maps on a scale of 1 to 5,000. As a result, another site favourable from the topographic point of view was found near the village Mandikapau (site-B), about 1 km upstream from the site-A. Topographic survey and geological investigation by core boring were also made at this site.

The both sites have generally favourable geological conditions for the foundation of the proposed weir.

In order to select the most suitable weir site and type of the weir, comparative studies are made, estimating the construction costs of the weir and the main irrigation canal, also taking into account the topographical, geological and hydrological conditions of the sites. In this selection, special attention is also paid for the crest elevation of the weir so as not to disturbe the operations of the Riam Kanan power station due to the backwater caused by the construction of the weir. As a result, the site-B is proposed as the most optimum site from both technical and economical points of view. Details of the comparative studies are given in Annex. IX.

By constructing the weir, a small reservoir will be created and would be used as after-bay to regulate the daily fluctuation of discharges from the power station. Total storage of this after-bay would be about 4,700,000 m^3. On the other hand the required regulating capacity is estimated at about 425,000 m^3.

The preliminary design of the weir is made, taking into account the topography, geology and the flood water levels at the proposed weir site which do not disturb the operations of the power station by the effect of the backwater. The principal features of the weir would be as follows (see Drawing No. 5):

Type of weir	Combined fixed and floating types of weir
Crest elevation	El. 10.00 m
Intake water level	El. 9.80 m
Max. intake discharge	34 m^3/sec
Design flood discharge (100-year return period)	530 m^3/sec
Total crest length	228 m
Crest length of fixed weir	48 m
Crest length of floating weir	180 m
Width of intake	26 m
Gate for releasing river maintenance discharge	2.0m x 4.0m x 2 nos. (sluice gate)
Height of weir (from apron to crest)	9.0 m

From the topographical, geological and hydrological conditions of the site, the weir is designed as an overflow type of concrete weir. In order to release the river maintenance discharge to the Martapura, sluice gates would be installed, and these gates could also be used as sand flushing facility.

The design of intake structure is made based on the diversion water requirement of 34 m^3/sec, the intake water level which would be 9.80 m in elevation and the fluctuation range of the water level in the after-bay that would be 0.2 m. Since the sedimentation is not expected to exceed the capacity of the after-bay, no sand settling basin is considered to be installed in the intake structure. In order to control the intake discharge, nine sets of the sluice gates, each with the dimension of 2.0 m (width) x 3.0 m (height), would be installed.

6.4.2 Irrigation Canal Network

The irrigation canal network would be newly constructed and would consist of the main, secondary, sub-secondary, tertiary and quaternary (field ditch) canals.

Main Irrigation Canal

The main canal would run approximately westwards from the diversion weir to the head of the sub-areas C and D, and the total length would be about 48.4 km. The alignment of the canal route is made based on the required intake water level, 9.80 m in elevation, and so as to avoid swamp areas as far as possible. The preliminary design of the main canal is made based on 85%-discharge of the design diversion requirement for easier control of the water level in the canal. The design diversion requirement would be supplied using freeboard of the canal section. Mainly because of high ground water tables and coarse textured soil conditions, the concrete and earth linings would be required for lower reaches of the canal. The length of concrete lining canal would be 24,860 m, earth lining canal, 7,100 m and unlined canal, 16,400 m. Drawing No. 6 shows the longitudinal and cross sections of the canal. The major structures on the canal would be two highway bridges, a few local road bridges, several checks with gates, turnouts, cross drains and one inverted syphon.

Secondary Canals

The alignment of the secondary and sub-secondary canals is shown in Figs. IX-11 and IX-13 in Annex IX. The secondary canal is defined as the canal which is diverted from the main canal to distribute water to each sub-area, and the sub-secondary canal will branch off from the secondary canal to distribute water to each sub-divided sub-area. These canals are designed as unlined with trapezoidal cross section. The water level in the canals is designed to be 30 cm to 50 cm above the paddy field. The design velocity would be between 0.2 m/sec and 0.6 m/sec, and the longitudinal slopes of the canals are designed to be within the range of 1/10,000 to 1/2,000.

The total length of the secondary and sub-secondary irrigation canals in each sub-area is shown in the next page.

Canal	Sub-area A (km)	B (km)	C (km)	D (km)	E (km)	Total (km)
Secondary canal	9	43	20	35	24	131
Sub-secondary canal	15	34	11	54	31	145

The related structures on these canals would be as shown below.

Structure	Sub-area A (Nos.)	B (Nos.)	C (Nos.)	D (Nos.)	E (Nos.)	Total (Nos.)
Turnout	6	14	10	15	9	54
Check gate	4	7	5	9	6	31
Bridge	8	22	13	28	14	85
Syphon	1	-	-	1	-	2

6.4.3 Drainage Network

The drainage network would be newly constructed and would consist of the main, secondary, sub-secondary, tertiray and quaternary drains (field drain).

All drains are designed as unlined with trapezoidal section. The longitudinal slopes of the main, secondary and sub-secondary drains are designed to be the range of 1/10,000 to 1/3,000.

In the design of the capacity of drains, where there is a tidal effect, at the first step, the tentative decision for the capacity of the drains is made, then after calculation of water stage inside the area, the final capacity of the drains is chosen to meet the requirements (submergence is less than 30 cm). The storage-volume curve and water stage outside the area are used in this content. The stage-volume curve for storage calculation is obtained from topographic map. The water stage curve in the rivers is determined in Annex VII. The water level inside the area is calculated by routing a design hydrograph. Through the above procedure, the duration of gate closure, and hence, the capacity of the drains are determined.

The total length of the main, secondary and sub-secondary drains in each sub-area would be as follows:

Drain	Sub-area A (km)	B (km)	C (km)	D (km)	E (km)	Total (km)
Main drain	-	36	-	17	-	53
Secondary drain	6	7	13	33	26	85
Sub-secondary drain	14	33	16	38	35	136

The related structures on these drains would be as follows:

Structure	Sub-area A (Nos.)	B (Nos.)	C (Nos.)	D (Nos.)	E (Nos.)	Total (Nos.)
Drainage sluice	-	16	3	18	3	40
Bridge	7	25	9	25	14	80
Culvert	-	1	-	2	-	3

6.4.4 Tertiary Development

The alignment of the tertiary canals and drains and downwards (quaternary) is shown in Fig. IX-19 in Annex IX. The size of the field block in the tertiary development would be, in principle, 200 m x 600 m including 12 ha of paddy field. Within this field block, rotational irrigation would be carried out at the time of transplanting.

The length of the tertiary irrigation canals would range from 800 m to 1,600 m according to the topography, and the interval between the two tertiary canals would be 600 m. The quaternary canals would be provided with a length of 600 m with an interval of 400 m. These canals would be of earth type.

The length of the tertiary drains would vary from 800 m to 1,600 m, and the quaternary drains would have a length of 600 m. They would be constructed with intervals of 600 m and 400 m, respectively.

The farm roads would also be constructed with a total width of 3.5 m and a height of 0.5 m.

The total length of the tertiary and quaternary canals and drains, and tertiary farm road would be as follows:

Item	Sub-area A (km)	B (km)	C (km)	D (km)	E (km)	Total (km)
Tertiary canal	14.08	82.65	39.16	130.08	93.20	359.17
Tertiary drain	10.12	82.65	29.48	123.31	84.64	330.20
Quaternary canal	68.86	289.71	160.60	390.24	352.82	1,262.23
Quaternary drain	71.06	289.71	113.52	283.20	206.37	963.86
Tertiary farm road	9.90	96.75	40.04	136.86	140.75	424.30

6.4.5 Road Network

Three kinds of new roads would be proposed. They would be the main, secondary and tertiary roads. The alignment of the proposed roads are shown in Fig. IX-21 in Annex IX. The main road would have a width of 5 m with gravel metalling and would be located along the main irrigation canal and the main drain. The secondary roads would be constructed along the secondary and sub-secondary canals with a width of 4 m and gravel metalling. The tertiary roads are farm road which would be constructed along the tertiary canals. No gravel metalling is proposed.

The total length of the main and secondary roads in each sub-area would be as follows:

Road	Sub-area A (km)	B (km)	C (km)	D (km)	E (km)	Total (km)
Main	9	64	5	27	17	122
Secondary	39	99	42	114	67	361

6.4.6 Land Reclamation

Total area which could be reclaimed for paddy field from the existing rubber plantations and shrub lands would be 5,150 ha in gross. The distribution of such lands would be 850 ha in the sub-area A, 4,200 ha in the sub-area B and 100 ha in the sub-area C.

The main works for the reclamation of the rubber plantations would consist of woods cutting, stumping, land clearing and firing. The reclamation of the shrub lands would be easier than that of the rubber plantations, which would also include woods cutting, stumping and firing.

The proposed tertiary development mentioned before would also be applied to these newly reclaimed lands, including the first plowing.

6.4.7 By-pass Structure on Riam Kanan Dam

As mentioned before, irrigation water from the Riam Kanan reservoir depends entirely on the discharge released through the power plants. No outlet facilities for specific irrigation purpose are provided in the dam. This means that would the output of power be stopped due to the occurrence of troubles with the power plants, transmission line, and other related structures, especially in the dry season, no irrigation water is supplied to the project area, and a considerable damage to crops would occur.

In this view, it would be better to construct the specific intake or by-pass structure in due consideration of unforeseeable troubles with the power generation. Technical possibility of constructing such a facility on the existing dam is studied.

Two alternative plans of constructing by-pass structure are considered.

One is to draw water directly from the penstock, and the other is to release water directly from the reservoir to the Aranio river through the channel of the existing emergency spillway. A comparative study of these two plans is made. In due consideration of technical easiness and economical construction, it is recommended to adopt the first alternative plan as a suitable plan for the construction of by-pass. Details are given in IX. 8 of Annex.

6.5 CONSTRUCTION SCHEDULE

Time required for the implementation of the whole project works is estimated at eight years, including project mobilization and the preparatory works, from 1980 to 1987.

Large-scale civil works such as diversion weir, main canal, main drains, main roads, etc. would be carried out mainly by using heavy construction machines. The civil works for the secondary networks and tertiary development would be carried out mainly by manpower with small construction equipment in order to maximize the employment opportunity in and around the project area. It is assumed that all works would be executed on the contract basis.

The quaternary network within a tertiary block would be constructed by farmers themselves under the guidance of the project office.

The proposed implementation schedule is shown in Fig. 4.

6.6 COST ESTIMATES

The cost for the project implementation is estimated on the following assumptions:

(1) The cost estimate is made based on the estimated quantity and volume of the works required for the Project in such a manner that the cost shall reasonably reflect social opportunity costs. The current price level in early 1979 is applied for the estimates.

(2) Major construction equipment and materials such as large-scale gates, cement, steel, etc. would be procured from abroad.

(3) Cost of the imported equipment and materials is estimated based on the international price level. The local costs such as materials and labour are estimated, making reference to the prices used for similar on-going projects in South Karimantan, Java and Sumatra.

(4) For the construction of the quaternary network, only the cost for materials is included in the construction cost.

(5) Associated costs to be financed by the government such as costs for extension services, improvement of social infrastructures, etc. are not included.

(6) Physical contingency in the cost estimate is at about 15 % of the direct cost. Price contingency is estimated based on the estimated price escalation rate at 7 % per annum for foreign currency portion and at 10 % per annum for local currency portion.

(7) All the conversion from Rupiah to US dollars is made at the exchange rate of Rp.625 = US$1.

The cost for the project implementation which is the financial cost of the Project (refer to Chapter VIII) is thus estimated at US$190.67 million consisting of US$83.79 million of foreign currency and US$106.88 million of local currency as shown in Table 11.

The economic cost of the Project is also estimated for economic evaluation on the Project. The economic cost is estimated at the current price level in early 1979 and capitalized for 1980. This does not include taxes and duties, price contingency and transfer payment. As for the construction machinery, only depreciation cost of the machinery is included instead of the purchasing cost. The total economic cost is estimated at US$130.41 million.