REPUBLIC OF INDONESIA
Ministry of Public Works
Directorate General of Water Resources Development

PRE-FEASIBILITY STUDY ON THE UPPER KOMERING RIVER BASIN DEVELOPMENT PROJECT

VOLUME I

MAIN REPORT

MARCH 1982

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

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PREFACE

In response to the request of the Government of the Republic of Indonesia, the Japanese Government decided to conduct a pre-feasibility study on the Upper Komering River Basin Agriculture Development Project and entrusted the study to the Japan International Cooperation Agency. The J.I.C.A. sent to Indonesia a survey team headed by Mr. S. Yano from June 29 to September 30, 1981.

The team exchanged views with the officials concerned of the Government of the Republic of Indonesia and conducted a field survey in the Upper Komering area, covering 68,300 ha. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Indonesia for their close co-operation extended to the team.

March 15, 1982

Keisuke Arita
President
Japan International Cooperation Agency

Mr. Keisuke ARITA
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

We are pleased to submit herewith sixty (60) copies of the Pre-Feasibility Report on the Upper Komering River Basin Development Project in the Republic of Indonesia in accordance with the terms of reference issued by your Agency.

As shown in this report, it would be possible, if the Komering river is harnessed adequately, to put about 105,000 hectares of lands under irrigation. Moreover, the Komering river possesses an immense hydropower potential of about 251,200 kilowatts. Thus, from a long-range view, the Upper Komering River Basin is generally accepted to be capable of becoming a new center of agricultural and industrial activities.

In the report, we recommended that the process of land and water development be realized in successive steps with a well-balanced basin planning. This is necessary for fully utilizing the potential water resources of the basin.

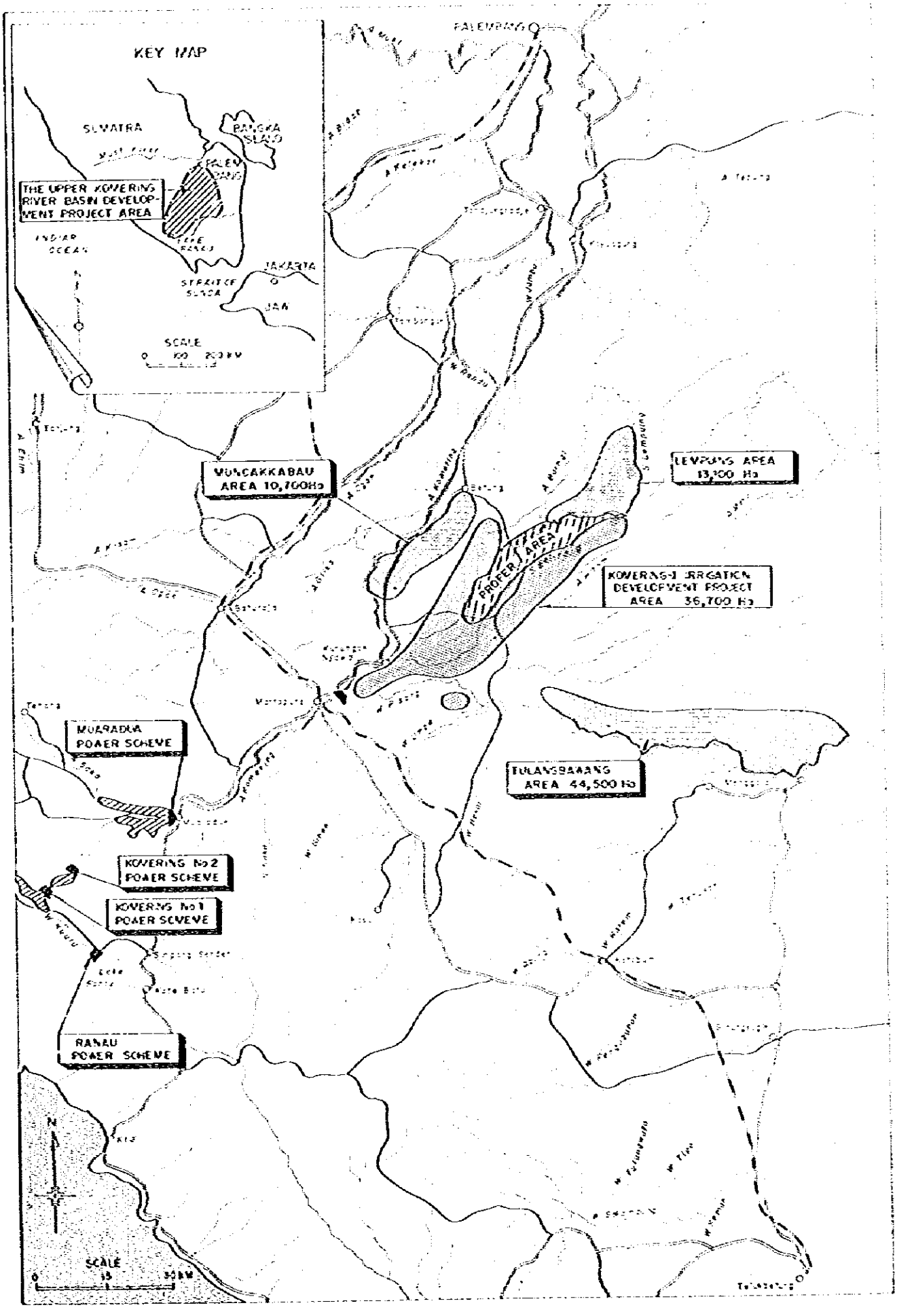
Grateful acknowledgement is made of the help and cooperation received from the officials of your Agency. Sincere thanks are particularly due to the Authorities concerned of the Government of Indonesia and the Embassy of Japan in Indonesia.

Sincerely yours,

S. Yano

Shinichi YANO
Leader of the Study Team for
the Upper Komering River
Basin Development Project

LOCATION OF DEVELOPMENT PLAN



PRE-FEASIBILITY STUDY
ON
THE UPPER KOMERING RIVER BASIN
DEVELOPMENT PROJECT

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ABBREVIATIONS AND LOCAL TERMS

Abbreviations and local terms used in this report are listed below:

A. ABBREVIATIONS

1. Length

mm	millimeter
cm	centimeter
m	meter
km	kilometer

2. Area

cm^2	square centimeter
m^2	square meter
km^2	square kilometer
ha	hectare

3. Volume

lit (l)	liter (= 1,000 cm^3)
m^3	cubic meter

4. Weight

mg	milligram
g	gram
kg	kilogram
t	ton (= 1,000 kg)

5. Time

sec	second
min	minute
hr	hour

6. Other measures

%	percent
PS	horse power
kW	kilowatt
kVA	kilovoltampere
kWh	kilowatthour
MW	megawatt
MWh	megawatthour
GW	gigawatt
GWh	gigawatthour
pH	scale for acidity
°C	centigrade
cm/sec	centimeter per second
m/sec	meter per second
m^3/sec	cubic meter per second
lit/sec/ha	liter per second per hectare
m.e/l	milligram equivalent per liter
mgcl/cm^2	milligram calorie per square centimeter
t/ha	ton per hectare
ppm	part per million
EC	electric conductivity
CEC	cation exchange capacity
No. (Nos.)	number(s)

7. Technical term

EL	elevation above mean sea level
H	height
WL	water level
HWL	height water level
LWL	low water level
FWL	flood water level
Q	discharge

8. Currency

US$	US Dollar
Rp.	Indonesian Rupiah

9. Other abbreviations

FAO	Food and Agriculture Organization of United Nations
UNDP	United Nations Development Program
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
WHO	World Health Organization
GDP	Gross Domestic Products
GRP	Gross Regional Products
DPU	Department of Public Works
P3SA	Sub-directorate of Planning and Programming for Water Resources

B. LOCAL TERMS

Kab.	District (Kabupaten)
Prov.	Province (Provinsi)
OKU	District for Ogan Komering Upper River Basin
OKI	District for Ogan Komering Lower River Basin
BIMAS	Mass Guidance for Self-sufficiency in Food
INMAS	Mass Intensification for Self-sufficiency in Food
BRI	Indonesian People's Bank
CRIA	Central Research Institute for Agriculture, Bogor
PPS	Extension Specialist
PPM	Field Extension Worker
BPP	Rural Extension Center
KUD	Village Unit Cooperative Body
DOLOG	Depot of Logistic
BULOG	Board of Logistic
KIOS	Small Shop
ADC	Agricultural Development Center
UPP	Land Development Unit
KIK	Small Investment Credit
Desa	Village
Kecamatan	Sub-district
Kontak-Tani	Key farmer or leading farmer

Ani-Ani	Small Rice Harvesting Knife
Ulu-Ulu	Water master
WILUD	Wilayah Unit Desa
Pelita (Repelita)	Five-year Development Plan
Dalam Angka	Statistical data
BUUD/KUD	Village farmers' co-operative
BAPPEDA	Regional Planning and Development Agency
BALAI BENIH	Seed Center
PTPT	One of the new organization established under the Ministry of Public Works
Sawah	Paddy field
Polowijo	Second crop, planted after harvest of rainy season paddy
Tegal	Upland field
Ladang	Intermittent cultivation land
Alang-alang	Grass land

CONCLUSION AND RECOMMENDATION

A. SUMMARY OF CONCLUSION

INTRODUCTION

1. This report presents the results of field survey and pre-feasibility study on water resources development of the Upper Komering river basin with particular emphases on the irrigation development of about 68,300 ha and the hydropower development in the Upper Komering river.

2. The government of Indonesia has laid a great emphasis on substantial increase in food production over a wide range of crops and promoting transmigration to outer islands in order to relieve population pressure in the densely-populated islands, through which the Government intends to raise the production of food stuff and to accelerate a more balanced economic development in the region.

3. The Government has formulated the project in 1970 and identified the agricultural and irrigation development of about 48,000 ha in the Belitang Extension Area and hydropower development of some 128 MW in installed capacity in the upper reach of the Komering river. About 33,000 ha of flat land extending along the Tulangbawang river was further conceived to be developed with the diversion of water from the Komering river.

4. In response to the request of the Government of Indonesia on the technical aid to carry out the feasibility study of the project, the Government of Japan decided to provide the technical services for the feasibility study on the project as a part of the technical cooperation program of the Government of Japan.

5. In accordance with the scope of works for feasibility study on the Upper Komering River Basin Development Project agreed upon between the Government of Indonesia and the Government of Japan, the comprehensive study on the project was carried out by JICA (Japan International Co-operation Agency) in cooperation with the Government of Indonesia from September 1979 to April 1980. Following the above study, the feasibility study of the Komering-I area with about 36,700 ha identified as the first priority for irrigation development within the promising irrigation development potentials of around 105,000 ha, was carried out by JICA from July 1980 to June 1981.

GENERAL ECONOMIC BACKGROUND

6. Agriculture in Indonesia has played an important role in its economy, and more than 60% of the national active population are engaged in agriculture. Production of rice, the main staple food in Indonesia, has substantially increased recently, and it is expected to attain the self-sufficiency in rice production in near future, whereas the rice production in the South Sumatra and Lampung provinces still can not meet its increasing demand resulting from the rapid population growth.

7. Indonesia is blessed with substantial energy sources for generation of electricity, i.e. significant deposits of oil, natural gas and coal and hydropower potentials. Indonesia however has by far the lowest per capita production of electricity amongst the ASEAN countries. The supply of electricity is mostly concentrated in the large cities and urban areas. Negligible power supply system is provided in the rural areas despite the eager demand of supply from the waiting consumers.

8. Following the successful implementation of the First and Second Five Year Development Plans (Repelita I and II), the Government has set up the Third Five Year Development Plan (Repelita III) for 1978/80 to 1983/84. Repelita III is a continuation and enhancement of the previous plan and places the major objectives on raising living standard of the people and more equitable distribution of welfare of the whole population.

THE PROJECT AREA

9. The project area is situated in both south-eastern part of the South Sumatra province and the northern part of the Lampung province. The project area; 116,000 ha in gross (68,300 ha in net), consists of three development areas, i.e. Muncak Kabau area (10,700 ha in net), Lempuing area (13,100 ha in net) and Tulangbawang area (44,500 ha in net).

10. The water source of the project is the Komering river. This river originates from the Lake Ranau with a surface area of about 127 km^2 and the elevation of 542 m above mean sea level. Annual average runoff of the Komering river is about 203 m^3/sec at Martapura with about 4,260 km^2 of its catchment area. The maximum monthly runoff of about 292 m^3/sec in April and the minimum monthly runoff of about 136 m^3/sec in September. From the Lake Ranau, about 18.4 m^3/sec of average runoff flow constantly to the Komering river throughout the year. The Komering river transports the considerable quantities of eroded materials to its lower reach. The annual sediment transport is roughly estimated at about 1,000 m^3/km^2 on an average.

11. Climate in the project area is tropical. Average annual rainfall in the project area is approximately 2,630 mm at BK-IX, of which about 80% fall during the rainy season from October to May. The mean temperature in the flat lands is rather little ranging from 26°C to 28°C. The annual relative humidity is as high as about 81% at Belitang. The annual pan evaporation at Belitang is about 1,680 mm on an average.

12. The soils in the proposed agricultural development areas are broadly classified into five Great Groups, i.e. Podzolic Soils, Alluvial Soils, Hydromorphic Soils, Gley Soils and Organic Soils. Except some soils, the soils are suitable for both paddy and upland crops cultivation.

13. Geological investigation reveals that the geological conditions at the Komering No.1 and the Muaradua dam sites will not allow the construction of gravity dam, while the geological condition at the Komering No.2 dam site may allow the construction of both fill-type and gravity-type dams. More definite conclusion will be led after completion of the on-going geological exploration. Construction materials such as embankment materials, core materials, rock materials, sand and gravel are sufficiently available along the Selabung and the Komering rivers.

14. The Muncak Kabau area and the Lempuing area have been settled by transmigrants mainly from Java and Bali islands, and opened up for around 50% and 56% of the total area respectively. These areas are mainly cultivated with rainfed paddy in the lowlands and upland crops such as maize, soybeans, peanuts and cassava in the elevated lands. Average farm size in these areas is about 2 ha. The Tulangbawang area is broadly divided into two categories from the viewpoints of land holding size of farmer; 5-ha area and 2-ha area. The 5-ha area is located in the eastern half of the Tulangbawang area (Tulangbawang east sub-area) and settled with the transmigrants mainly from Java Island. The 2-ha area extends over the western half of the area (Tulangbawang west sub-area). At present, more than 70% of the 2-ha area is still covered with forest and planned to be reclaimed under the resettlement program. Virtually negligible lands are cultivated with paddy, and most of the opened lands are cultivated with upland crops such as maize, cassava, peanuts and perennial crops.

15. Present crop yields in the project area are rather low except for paddy cultivation under BIMAS program. The average yields of crops in the area in 1980/81 were about 2.8 tons/ha of rainy season paddy in the BIMAS program area and 2.0 tons/ha of non BIMAS program area, 1.2 tons/ha of upland paddy, 1.0 ton/ha of maize, 0.7 ton/ha of peanuts, 0.6 ton/ha of soybeans and 6.8 ton/ha of cassava.

16. Four types of cropping pattern are prevailing in the project area. Type-I pattern is predominant in the Muncak Kabau area. Rainfed paddy covering about 60% of the total cultivated area is transplanted during the mid-October to late December. The harvesting is done from the mid-February to early May. Upland crops are planted in the uplands normally during the rainy season introducing crop rotation system by farmers themselves. The cropping intensity of this pattern is 0.91. Type-II pattern prevails in the Lempuing area. Around 65% of the total cultivated area is used for paddy cultivation and the remainings are cultivated with upland crops and perennial crops. The planting and harvesting time of the crops is almost same as that of the Type-I pattern. The Type-III pattern is predominant in the Tulangbawang west sub-area. The farmer mainly cultivates upland crops and some perennial crops. Paddy is cultivated in less than 0.2 ha per farmer. The Type-IV pattern prevails in the Tulangbawang east sub-area. A farmer in this area cultivates about 0.65 ha of upland paddy, about 0.6 ha of upland crops and some parennial crops.

17. The present farming practices in the area are still conventional. Very limited amounts of fertilizer and chemicals are used for paddy cultivation. High yielding varieties of paddy are introduced in the very limited area owing to the lack of irrigation facilities. Upland paddy, maize, cassava, peanuts etc. are traditionally cultivated during the period of rainy season. Negligible amounts of fertilizer and chemicals are applied to both paddy and upland crops cultivation at present.

18. Surplus of paddy produced by the farmer in the project area is mostly marketed through two channels, DOLOG/KUDs and itinerant grain buyers. The DOLOG/KUDs market the rice for stabilization of price of rice under the Government control. The following table shows the present farm gate prices of major farm products prevailing in the project area.

	Price (Rp./kg)
Rice	200
Maize	60
Cassava	25
Soybeans	320
Peanuts	380

19. Extension services to the farmers are carried out by field extension workers (PPL) under the supervision of the Agricultural Extension Office in Kabupaten through PPS and PPM. Service area of PPL averages about 1,600 ha of farmlands. The Belitang Seed Center is located near the project area. The stock seeds of paddy produced at the Center are distributed to some seed growers authorized by the Center. Then, the seeds produced by the seed growers are distributed to farmers through BUUD/KUDs. The amount of paddy seeds is still insufficient.

20. The total number of transmigrants during past 31 years from 1950 to 1980 were about 57,000 families in the South Sumatra province and 74,000 families in the Lampung province. In the South Sumatra province, around 46% of the transmigrants were settled in the Kabupaten OKU, and 16% were in the Kabupaten OKI. As for the Lampung province, around 36% of the transmigrants were settled in the Kabupaten North Lampung. Particularly in the Lampung province, the population increase is high mainly due to the increase of population of transmigrants. These transmigrants, particularly the spontaneous ones, settled in forest areas and deteriorated the forest lands to great extent. Taking these facts seriously, the Lampung Provincial Government has decided not to receive any transmigrants, and instead, to promote the resettlement program for the spontaneous transmigrants who have settled in the forest areas. According to the resettlement program, about 35,000 families are scheduled to be resettled in the Kabupaten North Lampung from 1981 to 1984.

21. Major power demand centers are Palembang and Tanjung Karang in the South Sumatra and Lampung provinces, in which power supply system is poorly developed. PLN's generating capacity of 100 MW is too small to supply 10×10^6 people and industries. PLN intends to construct 700 MW of power stations and 150 KV transmission line of 1,000 km in length by 1995, projecting power demand to be 1,460 GWh in PLN system by 1990.

THE PROJECT

22. The project is formulated with the main concepts of:

(1) increase and stabilization of yield and production of the rainy season paddy through supply of irrigation water, proper drainage improvement and introduction of improved irrigation farming,

(2) introduction of diversified cropping pattern including the rainy season paddy, dry season paddy and Polowijo through provision of year-round irrigation,

(3) increase of agricultural production by opening up new agricultural lands in the areas which have favorable physical conditions for agricultural development,

(4) improvement of living standard and more equitable distribution of income and welfare of the people,

(5) Successful settlement of transmigrants through irrigation and agricultural development, and

(6) generation of hydroelectric power in maximum use of regulated outflow of the Lake Ranau and the proposed reservoirs to be created.

23. The project area covers about 116,000 ha in gross, of which about 68,300 ha of net irrigable area are delineated taking into account the land suitability, topography, present land use and the Government's policy for

development. From the viewpoint of project development sequence, the project is divided into three development areas. The Muncak Kabau area with a net irrigable area of 10,700 ha extends along the right bank of the Komering river between Muncak Kabau and Betung. The Lempuing area has a net irrigable area of 13,100 ha extending along the left banks of the Macak and the Lempuing rivers. The Tulangbawang area covers a net irrigable area of 44,500 ha extending along the left banks of the Kanan and the Tulangbawang rivers between the confluence of the Umpu river with the Pisang river and Menggala.

24. For the future agricultural development in the project area, two cropping patterns are recommended taking into account the agro-climatic conditions, farm holding size and the Government's agricultural development program in the project area. The rainy season paddy will exclusively be grown in the whole project area in every cropping pattern. In order to maximize the yield and profit, the improved high-yielding and tasty varieties will be introduced under the project. For both cropping patterns, crop diversification including paddy, peanuts, soybeans and maize is intended in the project area.

25. After implementation of the project, the following crop yields and products are expected.

Crops	Yield (tons/ha)	Production (10^3 tons)			
		Muncak Kabau Area	Lempuing Area	Tulangbawang West Sub-area	Tulangbawang East Sub-area
Rainy season paddy	4.0	42.8	52.4	125.2	28.8
Dry season paddy	4.5	32.1	39.3	93.9	21.6
Peanuts	1.3	2.3	2.9	6.8	7.8
Soybeans	1.3	2.3	2.9	6.8	-

26. From the farmer's viewpoint, the financial evaluations for the cases of "with project" and "without project" are made for two typical farmers, i.e. 2.0-ha farm holder and 5.0-ha farm holder as follows:

(unit; 10^3 Rp.)

Description	2.0-ha Farm Holder						5.0-ha Farm Holder	
	Muncak Kabau Area		Lempuing Area		Tulangbawang West Sub-area		Tulangbawang East Sub-area	
	With Project	Without Project	With Project	Without Project	With Project	Without Project	With Project	Without Project
Gross income	1,521	472	1,525	478	1,528	300	2,356	343
Farm outgo	1,132	469	1,021	474	1,085	299	1,309	342
Balance or capacity to pay (US$)	389 (622.2)	4 (5.8)	504 (805.9)	4 (6.6)	443 (708.0)	1 (1.1)	1,047 (1,675.3)	1 (1.6)

27. After implementation of the project, about 39,600 ha of forest and alang-alang areas in the project area; 5,200 ha in the Muncak Kabau area, 5,100 ha in the Lempuing area and 29,300 ha in the Tulangbawang area, will be reclaimed for the agriculture use. These areas are considered to be accepted for transmigration of about 3,500 families in the Muncak Kabau area and 3,400 families in the Lempuing area, and resettlement of 19,500 families in the Tulangbawang area.

28. The irrigation water requirements for the project are estimated for the proposed cropping patterns. Effective rainfall with 80% probability of exceedence of the drought year is taken into account for the calculation. Canal conveyance efficiency and operation efficiency are estimated to be 85% and 60% respectively, which make combined efficiency of 51%. The total diversion requirements at the head of the respective development areas are 14 m^3/sec for the Muncak Kabau area, 17 m^3/sec for the Lempuing area and 49 m^3/sec for the Tulangbawang area.

29. In the Feasibility Study on the Komering-I Irrigation Development Project made by JICA in 1981, the economic comparisons of the integration of both intakes for the Belitang Proper area and the Muncak Kabau area into the intake system of the Komering-I project was made on the preliminary basis. In this study, however, both economic comparisons were made without considering the possibilities of micro-hydropower developments which can be conceived harnessing the water head difference between the proposed canal water level in the Komering-I system and the proposed intake water levels of the respective development areas, if the integrated intake systems are applied to these development areas. Moreover, both economic comparisons made in the feasibility study were made for the provision of free intake only without construction of diversion weir on the Komering river in the case of individual intake from the Komering river. However, the study on the watershed management shows that the sediment loads in the Komering river carries big amount of sediment loads to its downstream, but after completion of the dams in the upper reaches of the Komering river, most of the sediment loads would be checked by the dams. This will cause the degradation of the Komering river bed in the downstream, resulting in the lowering of river water levels at the intake sites for the Belitang Proper area and the Muncak Kabau area. This phenomenon will adversely affect the free intake practices at these intake sites, and it may be concluded that the construction of diversion weirs is required for both areas in order to keep the design intake water levels. Taking into account the above alteration of the conditions for the economic comparisons, another comparative study is needed. The results of the economic comparison for both areas show that the diversion method of the irrigation water required in the area from the Komering-I system is less attractive as compared with the direct diversion method of the irrigation water through its own intake structure, even if the benefit of the micro-hydropower scheme is counted in the comparison. The result of economic comparison will further be justified, if the electric supply from the hydropower schemes contemplated in the upper reaches of the Komering river is considered for the rural electrification instead of the said micro-hydropower stations, because the upper Komering hydropower schemes can be developed more economically than the micro-hydropower schemes. Therefore, the direct diversion

systems through their own intake structures are taken up as the proposed intake system for both areas.

30. In order to develop the above total irrigation areas, the following irrigation and drainage facilities are required.

- Dams 3 Nos.
- Headworks 1 No.
- Irrigation canals (down to tertiary canals)
  - Muncak Kabau area 410 km
  - Lempuing area 470 km
  - Tulangbawang area 1,870 km
- Drainage canals (down to tertiary drains)
  - Muncak Kabau area 380 km
  - Lempuing area 460 km
  - Tulangbawang area 1,760 km
- Inspection roads
  - Muncak Kabau area 410 km
  - Lempuing area 470 km
  - Tulangbawang area 1,870 km

31. Through the study on the Komering watershed management, it may be concluded that about 43% of the upper Komering river basin and V- or U-shaped valleys along the Komering tributaries would be under serious conditions against the erosion. The annual total sediment loads in the Komering river are estimated to be 4.6 million m^3, which correspond to 1,070 m^3/km^2/year. Due to construction of the dams in the upper reaches of the Komering river, most of the sediment discharge will be checked, and the river bed variation in the downstream of the river will occur to some extent. According to the preliminary assessment, the degraded depth is in the order of 1.7 m at Kurungan Nyawa and 1.0 m at Muncak Kabau.

32. The Ranau regulating dam, Komering No.1 dam, Komering No.2 dam and Muaradua dam are proposed in the upper stretch of the Komering river. With the total storage capacity of 474 x 10^6 m^3 of these dams, the water requirement in the existing and proposed irrigation area as well as the Lebak area can be met allowing certain discharge for other water uses.

33. In order to supply power to the South Sumatra and Lampung Provinces, hydropower development is contemplated as an integral part of the storage development in the upper stretch of the Komering river. Principal feature of the proposed dam and power facilities is as shown below:

	Ranau	Komering No.1	Komering No.2	Muaradua
Catchment area (km^2)	508	1,056	1,165	2,866
Reservoir high water surface (El. m)	542.3	420.0	252.5	140.0
Active storage capacity (10^6 m^3)	200	120	4	150
Water head (m)	112	144	67	16
Installed capacity (MW)	83.7	108.0	35.7	23.8
Annual energy (GWh)	151	474	230	149

34. Total project cost is estimated to be US$1,187.88 million, comprising US$198.25 million for the dams, US$686.3 million for irrigation development schemes, and US$303.33 million for hydropower schemes, of which breakdown is shown below.

Items	Costs ($US10^3$)
(1) Dam	198,250
- Ranau regulating dam	3,280
- Komering No. 1 dam	83,760
- Komering No. 2 dam	51,840
- Muaradua dam	59,370
(2) Irrigation Development Schemes	686,300
- Perjaya weir	15,500
- Komering-1 scheme	208,800
- Muncak Kabau scheme	63,900
- Lempuing scheme	85,100
- Tulangbawang scheme	313,000

Items	Costs (US$10^3)
(3) Hydropower Scheme	303,330
- Ranau power scheme	99,470
- Komering No. 1 power scheme	93,910
- Komering No. 2 power scheme	44,690
- Muaradua power scheme	65,260
Total	1,187,880

35. The economic feasibility of project is evaluated in terms of economic internal rate of return for irrigation development schemes and hydropower schemes. The project annual incremental benefits used in the evaluation are as follows:

Items	Annual Incremental Benefits (US$10^3)
1. Irrigation Development Schemes	136,200
- Komering-I	45,300
- Muncak Kabau	14,600
- Lempuing	17,300
- Tulangbawang	59,000
2. Hydropower Schemes	90,750
- Ranau	20,060
- Komering No. 1	43,480
- Komering No. 2	16,820
- Muaradua	10,390
Total	226,950

The economic internal rate of return (EIRR) for each irrigation development scheme and hydropower scheme is summarized below:

	EIRR
1. Irrigation Development Schemes	
- Komering-I	15.1%
- Muncak Kabau	14.3%
- Lempuing	13.1%
- Tulangbawang	11.9%
- Overall	13.3%
2. Hydropower Schemes	
- Ranau	14.4%
- Komering No. 1	23.7%
- Komering No. 2	13.4%
- Muaradua	10.5%
- Overall	16.8%
3. Whole Project Case	14.6%

36. The development priority is assessed mainly referring to the value of economic internal rate of return for the irrigation development. In addition, socio-economic condition and existing infrastructural conditions are also taken into consideration for the assessment. As for the hydropower development, the assessment is made from economic, financial and technical viewpoints. As a results, the following development sequence is recommended:

(1) Irrigation Development

Stage - I ; Komering - I area
Stage - II ; Muncak Kabau area
Stage - III ; Lempuing area
Stage - IV ; Tulangbawang area

(2) Hydropower Development

Stage - I ; Ranau scheme
Stage - II ; Komering No. 1 scheme
Stage - III ; Komering No. 2 scheme
Stage - IV ; Muaradua scheme

8. RECOMMENDATION

1. Hydrological analysis is made based on the up-dated data and information, but these are still insufficient for providing reliable results due to certain interruption of the measured results of river runoff. In view of vital importance of meteorological and hydrological data of the water resources development, therefore, it is recommended that a concrete control system for the observation and measurement at the meteorological and hydrological stations be established immediately, and training of the stuffs for these stations is on urgent need.

2. The pre-feasibility study on the water resources development of the upper Komering reveals and confirms that the project provides the promising development potentials in the irrigated agriculture of about 68,300 ha and the hydropower of 251,200 kW in the installed capacity. In order to promote these promising development schemes, it is recommended that the feasibility study be made as the follow-up study at the earliest convenience. Particularly for the hydropower development, the proposed scale is best so far based on the information available at this stage. However the scale of these facilities should be more elaborated in the stage of feasibility study. Especially, survey to identify reregulating dam sites for the Komering No. 2 and Muaradua power station should be carried out for more advantageous power development.

3. Water balance study is made so as to grasp the maintenance flow to the downstream of the Komering river taking into account the rough water requirements for irrigation, municipal use and navigation in the downstream area of the Komering. However, the river flow network in the downstream is very complicated, because the Komering river is connected to the Organ river by five channels near Kayuagung, and around

70% of the Komering river flow is discharged into the Organ river. For the establishment of the development plan in the lower Komering river basin, therefore, an elaborate master planning should be made including the Organ river basin.

4. According to the preliminary study made this time, about 43% of the upstream basin of the Komering is in erodable condition. For the preparation of proper watershed management program, further detailed study is recommended to be carried out based on the survey recommended in Chapter 5 hereof.

1. INTRODUCTION

1.1 AUTHORITY

This report is prepared in accordance with the Article 4 (2) in the Scope of Works for Feasibility Study on the Upper Komering River Basin Development Project (hereinafter referred to as "the Project") in the Republic of Indonesia agreed upon between the Government of the Republic of Indonesia and the Government of Japan.

This report presents the activities and the results of field survey and pre-feasibility study on the water resources development in the upper Komering river basin undertaken by the study team of JICA and their counterparts from the Government of Indonesia.

1.2 PROJECT HISTORY

The economic growth of Indonesia during the period of the First and Second Five-Year Development Plans (Repelita I & II) was quite impressive. The agricultural production, particularly food, however, had not kept pace with its increased demands due to increasing of population and rising of living standard of the people, resulting in import of rice, about 1.9 million tons in 1979 and other crops. In the Repelita III, substantial increases in food production over a wide range of crops are envisaged. The increase of rice production is projected at an average rate of 3.3% and the increase of other secondary crop productions at 5 to 7% per annum.

In the mean time, the Government of Indonesia has laid a great emphasis on promotion of transmigration to outer islands like Sumatra in order to relieve population pressure in the densely populated islands, through which the Government intends to raise the production of foodstuff and to accelerate economic development in the less densely populated areas towards a more balanced development of the regions.

Based on the above background, the development of the upper Komering river basin was taken up as one of the promising development plans, and the following activities have been taken so far.

(1) The Belitang Extension Project was formulated in 1970 within the framework of the Land and Water Resources Development in South Sumatra by the Government of Indonesia with the assistance of FAO/UNDP. The reconnaissance investigation for the project was carried out by FAO in 1972, and its results justified the irrigation development of 48,000 ha in the Belitang area and hydropower development of 128 MW in the upper reach of the Komering. Meanwhile, the Government of Indonesia conceived the development of 33,000 ha in the Tulangbawang area by diverting irrigation water from the Komering river.

(2) The Government of Indonesia requested the Government of Japan to extend technical aid for the feasibility study of the above project including the Tulangbawang area. In response to the request, the Government of Japan decided to provide the technical services for the study as a part of technical cooperation program of the Government of Japan.

(3) Prior to the feasibility study, JICA despatched a Contact Mission to the site from November to December 1978 to conduct the preliminary survey and to prepare the scope of works for the feasibility study. JICA further despatched a Scope of Works Mission to Indonesia in July 1979 to exchange their views with the Government of Indonesia regarding the draft Scope of Works prepared by the Contact Mission.

(4) In accordance with the Scope of Works, JICA first despatched an aerial photo survey team to the project area from August to November 1979 to take aerial photographs on a scale of 1:20,000 over 81,000 ha of the area and to prepare topographic maps on a scale of 1:5,000 for 30,000 ha of the priority area.

(5) After the above despatch, JICA further despatched a comprehensive study team to the site from the middle of September to the end of December 1979 for the field survey and the preparation of Interim Report which described their finding and the result or preliminary study on the project. The draft final report of the comprehensive study was submitted to the Government of Indonesia in April 1980. The study revealed that the project would provide the promising development potentials for the irrigation of around 120,000 ha and hydropower of 216 MW. The study further revealed that around 37,300 ha would be selected as the priority area for the irrigation development, and the feasibility study would proceed to this area.

(6) In July 1980, JICA despatched an Advisory Committee Mission to Indonesia to make field inspection in the feasibility study area and to exchange their view with the Government of Indonesia regarding the extent of the feasibility study to be carried out in 1980/81. As the result, it was concluded that the feasibility study on the irrigation development of 37,300 ha in the Komering-I project area would be carried out together with the aerial photo mapping on a scale of 1:5,000 for the area of 135 km^2 extending over the western half of the northern part of the project area in 1980/81.

(7) Following the above conclusion, JICA despatched a feasibility study team to the site in the middle of July 1980 to initiate the field survey. The team had completed field survey and preliminary study by the end of October 1980, and the Interim Report was submitted to the Government of Indonesia in mid-November 1980.

(8) Immediately after the despatch of the feasibility study team from the end of July 1980, an aerial photo mapping team was despatched to the site and the team completed the field survey by mid-September 1980. The map was prepared and submitted to the Government of Indonesia in March 1981.

(9) The Draft Final Report of the feasibility study on the Komering-I project was submitted to the Government of Indonesia in March 1981. Taking into account the comments on the draft report forwarded by the Government of Indonesia, the Final Report of the feasibility study was prepared by the team and submitted to the Government of Indonesia in June 1981.

(10) According to the Scope of Works concluded between the Government of Indonesia and the Government of Japan in July 1979, JICA despatched a pre-feasibility study team to the project site from the end of June to the end of September 1981 for the field survey and the transfer of knowledge to the Indonesia counterpart personnels. The team has completed and the submitted the Interim Report to the Government of Indonesia by the end of September 1981. The Interim Report describes the team's findings and the results of preliminary study on the project.

(11) Taking into account the comments made by the Government of Indonesia on the Interim Report, the Draft Final Report on the pre-feasibility study was prepared by the team and submitted to the Government of Indonesia in December 1981.

(12) Further taking into account the comments on the Draft Final Report from the Government of Indonesia, the Final Report of the pre-feasibility study was prepared by the team and submitted to the Government of Indonesia in March 1982.

1.3 OBJECTIVE OF THE STUDY

The objective of the study is to carry out the pre-feasibility study on the water resources development of the upper Komering river basin with particular emphases on the irrigation development of about 68,300 ha in the Muncak Kabau, the Lempuing and the Tulangbawang areas, and the hydropower development of some 251 MW in the upper Komering river. In particular, water balance study of the Komering river in view of irrigation development is one of the main tasks of the study. The Scope of Works agreed mutually between the Government of Indonesia and the Government of Japan is attached to this report as "APPENDIX".

1.4 ACTIVITIES OF THE STUDY TEAM

The activities of the study team broadly consist of field survey and the pre-feasibility study of the project. The field survey includes:

(1) socio-economic survey,

(2) meteorological and hydrological survey,

(3) topographic survey,

(4) soil survey,

(5) geological survey,

(6) soil mechanical survey,

(7) irrigation and drainage survey,

(8) construction material survey,

(9) agricultural and agro-economic survey,

(10) electric power investigation, and

(11) watershed management survey.

The pre-feasibility study includes:

(1) establishment of regional agricultural development concept,

(2) formulation of agricultural development plan,

(3) formulation of hydro-power development plan,

(4) study on watershed management,

(5) preliminary design of project facilities,

(6) project cost estimate,

(7) project evaluation, and

(8) preparation of project implementation schedule.

The Interim Report, which described major findings, preliminary views and provisional conclusions reached by the end of field survey, had been submitted to the Government of Indonesia by the end of September 1981. A Draft Final Report was submitted in December 1981 for the review by the Government of Indonesia. The report described the optimum scale, appropriate time of implementation, preliminary estimate of investment cost and economic viability of the proposed irrigation development schemes and hydropower development schemes in the context of the long term water resources development. The Final Report, which was prepared taking into account the comments made by the Government of Indonesia on the Draft Final Report, was submitted to the Government in March 1982.

The advisory committee member of the project, the team member engaged in the study and the counterpart personnels provided by the Government of Indonesia are listed in Table 1.1 and their activities are illustrated in Fig. 1.1.

2. GENERAL ECONOMIC BACKGROUND

2.1 LAND AND POPULATION

The land area of Indonesia amounts to about 2 million km^2 with more than 14,000 islands. Indonesia is comparatively well endowed with land resources, and abundant opportunities, particularly in the outer islands, exist for more extensive or intensive land use. The greater part of the land area is, however, covered with forest. Only about 18.3 million ha were cultivated in 1979, corresponding to about 9% of the total lands. About 8.9 million ha or 49% of the cultivated lands are planted with paddy. Out of remaining areas of 9.4 million ha, 5.9 million ha are cultivated with upland crops of maize, cassava, soybeans, groundnuts, etc., and 3.5 million ha are cultivated with perennial crops of rubber, coconut, coffee, oil palm, cloves, tea, sugarcane, etc. (See ANNEX-V)

The land areas of the South Sumatra province and the Lampung province amount to about $103x10^3km^2$ and $33x10^3km^2$ respectively. About 75% in the South Sumatra province and about 68% in the Lampung province are still covered with forest. The cultivated lands including perennial crops are about 1,084,000 ha in the South Sumatra province and about 752,000 ha in the Lampung province respectively.

Total population of Indonesia is estimated to be about 148 million (77 persons/km^2) in 1980, of which around 92 million (420 persons/km^2) are populated in Java, bringing about intense population pressure. The annual population growth rate is projected to be 2% during the Repelita III period, so that the total population will reach about 151 million by the end of 1983. About 70% of the working population is engaged in agriculture including fishery and forestry.

Total population of the South Sumatra province is estimated to be about 4.6 million (45 persons/km^2), and that of the Lampung province to be about 4.6 million (139 persons/km^2) respectively in 1980. The following table shows the land, population and its growth rate of Indonesia, two provinces of South Sumatra and Lampung and three Kabupatens of OKU, OKI and North Lampung.

Land and Population

Item	Area (km^2)	Pupulation (1980) (10^3persons)	Population Density (persons/km^2)	Growth Rate (1973-1980) %
Indonesia	1,919,443	148,349	77	2.33
South Sumatra Prov.	103,688	4,630	45	3.32
Lampung Prov.	33,307	4,624	139	5.82
Kab. OKU	11,133	750	67	3.73
Kab. OKI	21,658	584	27	2.62
Kab. North Lampung	19,368	882	46	8.61

According to the Repelita III, the annual population growth rate in the country is projected to be 2%, which is lower than the present population growth rate. The growth rates of population in both South Sumatra province and Lampung province are remarkably high particularly in the Lampung province. This is mainly attributable to the increase of transmigrants from the densely populated islands. With respect to the economically active population, about 70% of the total working population in Indonesia, about 70% in the South Sumatra province and about 76% in the Lampung province are now engaged in agriculture sector according to the statistics in 1980.

2.2 NATIONAL AND REGIONAL ECONOMY

The economic growth of Indonesia during the past six years has been impressive. The Gross Domestic Product (GDP) had increased from Rp. $6,735 \times 10^9$ or US$129 per capita in 1973 to Rp. $30,661 \times 10^9$ or US$338 per capita in 1979, corresponding to about 23% of annual increase rate. The following table shows the share of GDP in the economic structure (for details, refer to ANNEX-V).

GDP of Indonesia, South Sumatra Province and Lampung Province in 1979

Item	Indonesia		South Sumatra		Lampung	
	(Rp.10^9)	(%)	(Rp.10^9)	(%)	(Rp.10^9)	(%)
Agriculture, Forestry & Fishery	9,145	29.8	209	24.9	328	52.3
- Farm food crops	5,365	17.5	98	11.7	115	18.3
- Non-farm food crops	1,112	3.6	54	6.5	-	-
- Estate crops	624	2.0	1	0.1	164	26.2
- Livestock	550	1.8	22	2.6	5	0.8
- Forestry	942	3.1	20	2.4	34	5.4
- Fishery	552	1.8	13	1.6	10	1.6
Mining	5,172	16.9	200	23.8	1	0.1
Manufacturing	2,825	9.2	169	20.2	45	7.2
Electric, Gas & Water Supply	130	0.4	3	0.3	1	0.1
Cosntruction	1,843	6.0	23	2.8	8	1.3
Commerce	5,601	18.3	118	14.0	140	22.3
Transportation & Information	1,383	4.5	41	4.8	34	5.4
Finance	641	2.1	8	0.9	6	1.0
Immovable Property	906	2.9	14	1.6	20	3.2
Governmental Service	2,180	7.1	43	5.1	36	5.8
Other Services	835	2.8	13	1.6	8	1.3
Total	30,661	100.0	841	100.0	627	100.0
Per Capita GDP (US$)	(338)		(307)		(251)	

As shown in the above table, the agricultural output accounted for about 30% of GDP in 1979, which played outstandingly a dominant role on the economy of Indonesia. A substantial portion of the revenue came either directly or indirectly from agriculture. Furthermore, approximately 23% of total value of the export in 1979 came from agriculture.

The GRPs in both South Sumatra province and Lampung province were Rp. 841,000 million and Rp. 627,000 million respectively, corresponding to US$307 per capita in the South Sumatra province and US$251 per capita in the Lampung province in 1979.

Both export and import values in recent years had substantially increased as shown in the following table. The export value had increased at an annual rate of about 36% from 1973 to 1979, while the import value had increased at an average annual rate of about 18% in the same period.

Export and Import of Goods

(Unit: US$10^6)

	1973	1974	1975	1976	1977	1978	1979
Export	3,211	7,426	7,103	8,546	10,853	11,643	15,590
Import	2,729	3,842	4,770	5,673	6,230	6,690	7,202

Out of the total export, the export of crude oil had remarkably increased recently, resulting in the substantial surplus of the trade balance. The export value of agricultural products occupied about 23% of the total export value in 1979, which came mainly from the perennial crops such as rubber, coffee and oil palm.

2.3 AGRICULTURE

Agriculture in Indonesia has played an important role in its economy. The agricultural active population in Indonesia was 35,300,000 or about 66% of the national active population of 53,400,000 in 1979. Average farm family size was 5.0 persons, and farm size excluding estates was about 0.99 ha/household in 1976 (for details, vide ANNEX-V).

The following table shows the cultivated lands and production of major crops in 1979.

Item	Area Cultivated (10^3 ha)			Production (10^3 tons)		
	Indonesia	South Sumatra Province	Lampung Province	Indonesia	South Sumatra Province	Lampung Province
Rice	8,850	402	242	17,918	502	337
Maize	2,575	9.3	54.2	3,305	6.9	72.9
Cassava	1,418	19.4	98.4	13,330	175.0	1,007.6
Soybeans	764	5.7	6.2	674	4.2	15.4
Peanut	490	15.6	5.5	418	12.2	5.4
Sweet Potato	278	8.3	16.8	2,044	39.6	1,020

Rice is the main staple food in Indonesia. The rice production had remarkably increased at an annual rate of 4.4% during the period from 1970 to 1979. The rice production in the South Sumatra province and the Lampung province has increased at an annual rate of about 4.0% and about 5.1% during the period from 1970 to 1979 respectively. This rapid increase of production is considered mainly attributable to the yield increase brought about by the Government's intensification program on rice cultivation mainly in Java and Bali and the substantial increase of cultivation area in the outer islands. However, its total production could not keep pace with its increasing demand resulting from the rapid population growth and the increase of per-capita consumption. The following table shows the total production of rice and its quantity imported in recent years in Indonesia.

Total Production of Rice and Its Quantity Imported

(Unit: 10^3 tons)

Year	1972/73	'73/74	'74/75	'75/76	'76/77	'77/78	'78/79	'79/80	'80/81
Rice Production	13,182	14,607	15,276	15,185	15,845	15,876	17,502	17,918	-
Rice Imported	1,230	1,225	1,132	670	1,509	2,308	1,800	1,922	1,213

Irrigated paddy cultivation is a long-practiced and well-understood art in Indonesia. Java has more irrigated area than any other islands, and relatively high proportion of the paddy-cultivated area is under irrigation. The following table shows the paddy-cultivated area by the irrigation category in 1973 for Java and in 1977 for the South Sumatra province and the Lampung province.

Paddy-Cultivated Area by Irrigation Category

(Unit: 10^3 ha)

Item	Under Irrigation			Non-Technical	Tidal	Rain-fed	Total Paddy
	Technical	Semi Technical	Total				
Java	1,446	524	1,970	544	73	859	3,446
South Sumatra Province	17.1	17.1	34.2	21	152.6	76.5	284.4
Lampung Province	53.0	7.7	60.7	21.8	18.6	44.8	145.9

Irrigated paddy lands in the South Sumatra province are only about 12% of its total paddy lands in 1977 and about 42% in the Lampung province, while that in Java Island is as high as about 57% of the total paddy lands in Java.

The research works on agriculture are conducted through centralized networks under the direction of the Central Research Institute of Agriculture, Ministry of Agriculture, located at Bogor in West Java. There are six branch research stations conducting various agronomic research works throughout the whole Indonesia.

One of the most important factors on the production increase is introduction of improved seeds of crops. There established seven seed centers in the whole Indonesia; two in Sumatra, four in Java and one in Sulawesi, in order to maintain the purity of high yield seed of paddy. Out of two seed centers in Sumatra, one seed center is located at Belitang in the project area.

Agricultural extension services are conducted by the Provincial Agricultural Extension Office under the guidance of the Ministry of Agriculture.

According to the data collected, the area under the BIMAS/INMAS programs in 1979 had gradually increased and reached as much as two times of those in 1970. The total area under the BIMAS/INMAS programs was about 3.6 million ha or about 43% of the total paddy fields in Indonesia in 1973 and about 4.4 million ha or 50% in 1979 respectively.

The Bank Rakyat Indonesia (BRI); Indonesian People's Bank, which was established in 1896 and is the main source of farm credit services, is the authorized bank for the provision of BIMAS credit to farmers. Besides, BRI provides the loans to various farmers' associations, small industries, fisheries and small holder estates for the plantation of coconut and rubber. Since 1973, BRI has provided more services to each village for more intensive agricultural development.

2.4 ELECTRICITY

Indonesia has much potential for the generation of electricity. There are significant deposits of oil, natural gas and coal and the potential of hydropower. However, Indonesia has by far the lowest per-capita production of electricity amongst the ASEAN countries as shown below.

(Unit: kWh)

Countries	1974	1976
Indonesia	27	31
Malaysia	510	591
Philippines	316	337
Thailand	191	240
Singapore	1,740	2,020

Source: ESCAP Statistical year book 1977

The supply of electricity in Indonesia is concentrated in the cities and urban areas. As for the South Sumatra province, only 26% of population or less than 20% of household even in Palembang are served with electric power supply. Negligible power supply system is provided in the rural areas in spite of much demand of electric supply from the waiting consumers.

2.5 THE THIRD FIVE YEAR DEVELOPMENT PLAN (REPELITA III)

Following the Second Five Year Development Plan (Repelita II) which has been successfully completed in March 1979, the Government of Indonesia set forth the Third Five Year Development Plan (Repelita III) for the period from 1979/80 to 1983/84.

Repelita II put main stresses on expanding of employment opportunities, raising of income level, a more equitable distribution of income, a more even distribution of gains of development among the various regions, provision of adequate supplies of basic human needs, improvement of nutritional status of the population and enhancement of quality of life.

Repelita III is a continuation and enhancement of the previous plan, and has the following major objectives:

(1) to raise the living standards and levels of knowledge of the Indonesian people.

(2) to strive for a more equitable distribution of walfare of the whole population, and

(3) to lay a strong foundation for the next stage of development.

For the successful implementation of Repelita III, the plan will pursue a balance among the three elements of the development strategy, namely, equal opportunity of development, high economic growth and national stability. In this context, the following economic growth is expected during the Repelita III period:

(1) real economic growth rate of about 6.5% per annum,

(2) per-capita gross domestic product of about 4.4% per annum, and

(3) population growth of about 2% per annum, which means that the total population is expected to reach 151 x 10^6 persons in 1983.

Regarding the agricultural development sector, the plan envisages the raise of the agricultural productivity, and will provide more food for the growing population and raw materials for industry as well as foreign exchange and employment opportunities. The agriculture in Repelita III will contribute directly to improvement of the welfare of the population, promotion of industrial growth and a more balanced development of the regions. In this context, the plan envisages the substantial increase in food production over a wide range of crops. It is projected to grow rice production at an average annual rate of 3.3% and secondary crops at 5 to 7% per annum.

In order to increase the food production, the first priority in the plan is given to the water resources development for which the following irrigation development are contemplated:

		Area (ha)
i)	Rehabilitation and improvement of existing systems	536,000
ii)	Construction of new systems	700,000
iii)	Tidal swamp irrigation	400,000
iv)	Expansion and rehabilitation	600,000
v)	Swamp area reclamation	135,000
	Total	2,371,000

The transmigration program was also included in Repelita III as one of the major development activities. The plan emphasizes the urgency of relieving population pressure in the densely-populated islands as well as accelerating economic development in the less densely-populated areas. In Repelita III, the transmigration program aims to settle 500,000 families in 250 settlements located in Sumatra, Sulawesi, Kalimantan and Irian Jaya.

3. THE PROJECT AREA

3.1 LOCATION

The Upper Komering River Basin Development project area of 167,000 ha in gross (105,000 ha in net irrigable area) is situated in both southeastern part of the South Sumatra province and northern part of the Lampung province. The objective area for this pre-feasibility study has a gross area of 116,000 ha (68,300 ha in net irrigable area) which exclude the Komering-I area of 51,000 ha in gross (36,700 ha in net irrigable area). This study area is hereinafter called as the "project area".

The project area consists of three development areas, i.e. Muncak Kabau area, Lempuing area and Tulangbawang area, and surrounds both Belitang Proper area and Komering-I area. The Muncak Kabau area, 16,900 ha in gross (10,700 ha in net irrigable area), extends along the right bank of the Komering river between Muncak Kabau and Betung. The Lempuing area has a gross area of 19,400 ha (13,100 ha in net irrigable area) extending along the left banks of the Macak river and the Lempuing river; from the Betung-Petanggan road up to the big swamp area extending along the Lempuing river. The Tulangbawang area covers a gross area of about 80,300 ha (44,500 ha in net irrigable area) extending along the left banks of the Kanan river and the Tulangbawang river between the confluence of the Umpu river with the Pisang river and Menggala. Administratively, the Muncak Kabau area and the western part of the Lempuing area belong to the Kabupaten OKU of the South Sumatra province, whereas the eastern part of the Lempuing area belongs to the Kabupaten OKI of the South Sumatra province. Whole Tulangbawang area is included in the Kabupaten North Lampung of the Lampung province.

3.2 INFRASTRUCTURE

Main transport facilities linking the project area to the prospective market places of Palembang and Tanjung Karang/Telukbetung are roads and railway. The trunk road linking Palembang to Tanjung Karang/Telukbetung running through the project area is asphalt-paved and relatively well

maintained. Along the main canal of the Belitang Proper area, a well-maintained paved road provides important transportation activities for marketing of agricultural inputs and outputs. Menggala; the nearest main city of the Tulangbawang area, is connected by an asphalt-paved road to the said trunk road at Gunungsugih. There are many several village roads connecting the trunk road to villages, and village to village within the project area, most of which are unpaved and often impassable in the rainy season due to poor maintenance.

At present, a lot of farm products, particularly rice and banana, are transported from Kurungan Nyawa and Betung to Palembang using the Komering river mainly during the rainy season. The Tulangbawang river has played an important role as main transportation route for the riparian people.

The project area is still isolated from either rural electricity supply and telecommunication service system, though the economic and social benefits of rural electrification and telecommunication service would be significant in a general sense from village welfare and security.

Educational facilities and services for primary school in the project area are rather adequately provided at each village. The number of school illiterates has shown rapid decreasing tendency in recent years.

Medical services in the project area are inadequate and far below the desirable standard. There is an acute shortage of doctors, dentists and nurses, and health facilities and medical equipment. The ratio of population to major health facilities is extremely low.

3.3 NATURAL RESOURCES

3.3.1 Topography

A large portion of the Muncak Kabau area is covered by alluvial plain. This alluvial plain includes the narrow strips of natural levees along the Komering river, and holds the hillocks in the center. The waste swales occur extensively in the northern part of the said alluvial plain. Furthermore, almost flat peneplain lies in the east side of this area and

is deemed to be the extension of the northwest peneplain of the Komering-I project area. The ground elevation of the irrigable area ranges from 30 to 60 m.

The Lempuing area geographically consists of peneplains, river terraces, alluvial plains, natural levees and swales. The alluvial plain had been formed by the old Komering river or its branches, and can be deemed to be the extension of the Belitang Proper area. The Komering river and its branches had also formed many natural levees on the alluvial plain. The peneplains extend over both western and eastern parts of the area sandwiching the said alluvial plain. The river terraces occupy the narrow and low-lying terrain between the alluvial plain and the east peneplain. The swales extend over the northern part of the area. The irrigable area lies on the elevation from 20 m to 50 m.

The Tulangbawang area can geographically be sub-divided into three terrains, i.e. the gently undulating peneplains, the waste swales and the narrow but clearly defined alluvial plains. The peneplains occupy a low hill area extending from west to east in the area. The swales occupy in the eastern part of the area; mainly along the left bank of the Tulangbawang river. The alluvial plains are partly observed on the Tulangbawang river bank. The ground elevation of this area ranges from 30 m to 60 m.

The map on a scale of 1:50,000 (25-m contour interval) prepared by Indonesian Government in 1976 covers the total project area. Only the Muncak Kabau area is covered by the map on a scale of 1:50,000 (5-m contour interval) prepared by FAO/UNDP in 1972. In the course of the comprehensive study in 1979, JICA took aerial photographs on a scale of 1:20,000 over 110,000 ha of the area which include whole Muncak Kabau area, one-fifth of the Lempuing area, a half of the Tulangbawang area and the area along the Upper Komering river for 1-km width on both banks.

3.3.2 Geology

(1) General geology

The upper Komering river basin is situated in the northeastern wing of the Barisan mountain range which forms the backborn of Sumatera island and extends for some 1,650 km from the northern Aceh in the north to Semangko bay in the south. The basin is divided topographically and geologically into six belts running parallel to the Barisan, forming a wide zonal structure from southwest to northeast as follows:

Zone	Name	Width (km)	Altitude (m)	Geology	Proposed Facilities
(1)	Barisan mountain range	-	> 1,000	N-Gr,Ya	-
(2)	Ranau depression	5	400-600	Rt	Ranau P/S
(3)	Hilly mountain land	10	400-800	Tl,Rt	K-1,K-2 dam & P/S
(4)	Undulating hilly land	25	150-300	Tl,Bl,Rt,Tr	Muaradua dam
(5)	Garba mountain range	15	300-800	P-Gr,Mes,Oa	--
(6)	Lower undulating hilly land	25	150 >	Plm	Intake weirs & canal

Note: P/S-(power station), K-1(Komering No.1), K-2(Komering No.2)

The geological strata distributing in the basin are stratigraphycally classified into the following succession:

- Quaternary
  - Holocene
    - River-bed Deposit
    - Young Volcanic Products(Ya) - andestic lava
  - Pleistocene
    - Terrace Deposit(Tr)
    - Ranau Tuff(Rt)
      - acid volcanic ash
      - welded tuff
- Tertiary
  - Pleiocene — Palembang Formation(Plm) - sandstone, mudstone
  - Miocene
    - Telisa Formation(Tl) - sandstone, marl, shale
    - Baturaja Limestone(Bl)
    - Old Andesite(Oa)
    - Granite(N-Gr)
- Mesozoic — Cretaceous
  - Granite(P-Gr)
  - Garba Series(Mes) - slate

The Selabung river originates from the Lake Ranau situated in zone-(2); Ranau depression, and flows down for about 20 km northwestward along the depression forming a narrow and deep gorge in the welded tuff which filled up the depression. The Selabung river joins the Baru river and makes a right angle turn toward the northeast at about 1-km upstream of the Komering No.1 dam site. The Komering No.2 dam site is located in the northeastern margin of zone-(3); hilly mountain land, in which the Selabung forms a strip of terrace-like bench and a narrow ravine dissecting the welded tuff. Then, the Selabung river flows down northeastward through zone-(4); undulating hilly land, which is mainly underlaid by the Tertiary sedimentary rocks, as a consequent valley until the Muaradua dam site. The Muaradua dam site is located just downstream of the confluence with the Saka river, from which the Komering river begins.

(2) Site Geology

Geological explorations by means of 1) surface geological mapping, 2) vertical electric sounding and 3) core drilling and permeability test in site were carried out in the proposed Komering No.1, Komering No.2, and Muaradua dam sites and also in the Ranau power station site. In addition, the geology of the foundation for the main canals was investigated by digging test pits, and mechanical tests on the soil samples collected from the test pits were also carried out. The results of investigation are summarized as follows (for the details, refer to ANNEX-III and IV):

a) Komering No.1 dam site: The site geology consists mainly of welded tuff covered by acid volcanic ash and underlain by the Tertiary sedimentary rocks. Welded tuff crops out in the slope of valley below EL. 410 m, forming steep and/or occasionary overhanging cliffs. Vertical block joint system is developed over the welded tuff at the interval of 2 m to 3 m, together with the horizontal joint system inclining gently towards the upstream. Welded tuff consists of white-colored massive and moderately hard rock. Volcanic ash is of white-colored soft layer covering welded tuff over the terrace which is widely developed along the Selabung valley with relative height of 90 m to 100 m and width of 200 m to 300 m in both banks. The Tertiary sedimentary rocks consisting of very weathered mudstone are found in the bore-hole K1-1 at depth of 98 m together with

the old talus deposit which consists of well consolidated sandy clay and angular to semi-rouded gravels with thickness of 8.7 m. In this hole, the total thickness of welded tuff is about 84.3 m. The base of welded tuff (EL. 334 m in the bore-hole KI-1) is situated at 16 m below the river bed of the Selabung (EL. 350 m). Therefore, the base of dam may be founded on the welded tuff.

As for the foundation of dam, welded tuff is of relatively soft rock, and has rather low shearing strength. Therefore, the fill-type dam might be suitable for this site, though a dense grout curtain is required due to relatively high permeability of welded tuff (Lu = 7 to 18) and existence of the old talus deposit.

b) Komering No.2 dam site: This site is also composed of thick welded tuff which forms a steep cliff along the gorge dissected by the Selabung, and underlain by the Tertiary sedimentary rocks. In the river-bed of the Selabung near the dam site, calcarious sandstone and marl layers in very hard and well compacted condition were seen in places. These layers are assumed to be the Telisa formation of Tertiary and covered by the welded tuff with interbedding volcanic ash at the boundary.

As for the foundation of dam, welded tuff in this site seems to be highly compacted and may allow the construction of concrete gravity dam, but the existence of boundary between welded tuff and Tertiary sedimentary rocks induces an anxiety on bearing capacity and permeability of inter-bedding materials in the boundary. The type of dam is determined to be a concrete gravity type, though it should be re-studied on the basis of results of on-going boring investigation.

c) Muaradua dam and power station site: This site is geologically composed of sedimentary rocks of Telisa formation mainly consisting of coarse-grained sandstone intercalated with conglomerate and mudstone layers. Telisa formation in the damsite dips 15° - 20° southwestward, namely dipping

from downstream to upstream, and from left to right bank. Sandstone layer is composed of alternation of well compacted arkosic sandstone and loosely compacted fine to medium grained tuffaceous sandstone, with thickness of unit layer in 0.3 m to 0.7 m. Terrace deposit consisting of soft sandy clay with rounded-cobble-sized gravel covers the Telisa formation thinly, generally within 3 m in thickness, but widely over the site. As for the dam foundation, bearing capacity of sedimentary rocks of Telisa formation in this site might not be enough for a high concrete dam due to loosely compacted condition of the alternation of sandstone. Permeability of the sedimentary rocks is assumed to be less than $K = 1 \times 10^{-4}$ cm/sec according to the results of water pressure tests carried out in bore-holes.

d) Ranau power station-site: This site is located in the margin of hills of andestic volcanic products bounding on the high and wide terrace of the Selabung river. The high terrace extends along the Selabung river with a width of about 200 m, and is composed of welded tuff covered with sand and gravel of terrace deposit with a thickness of 14 m in the maximum. The underground power station will be located in the andestic volcanic products, and a tailrace tunnel will be constructed through andestic volcanic products and welded tuff. As for the soundness of the bedrocks, many joint systems are predicted, though the rock itself is rather compacted.

e) Main canal routes: The project area is broadly classified into two regions of hilly area and paddy field area. The hilly area is mostly composed of cohesive soil, and the paddy field area is composed of consolidated clay and unsolidified sand. The soils in both areas seem to have sufficient bearing capacity as foundation of the related structures. The seepage through the wetted perimeter of canal does not seem to be serious in the hilly area and may not require any special treatment for canal construction. In the paddy field area, canal lining will be required in sandy zone where the seepage would be rather high.

f) Rock material: The possible quarry sites will be able to be found in the area of andestic volcanic products being distributed in the Ranau depression forming foreland of the Barisan mountains. It is difficult to fix the sites at present due to thick covers of volcanic ash.

g) Core of embankment material: For the construction of the Muaradua dam; combined type, enough quantity of embankment material is expected from the site near Kerbang; 2.5-km north-east from the dam site, and the hillock located at 5-km north-east from the dam site. As for the construction of the Komering No.1 dam; rockfill type, enough quantity of core material, though this material needs mechanical improvement by mixing the crushed welded tuffs, would be expected from the right bank of the Selabung river, particularly in the upstream area from the dam site.

h) Sand and gravel: Sand and gravel are available along every reach of the Komering river near the Muaradua dam site, and their quantities will be enough for construction use. There found sand and gravel deposits in the Selabung river, particularly within the reach from 4 km to 2 km downstream from the Komering No.2 dam site. As for the construction of Komering No.1 dam, very limited amount of sand and gravel materials is available in the Selabung river near the dam site. It is therefore necessary to carry the materials from the downstream of the river or to exploit the quarry site near the dam site.

3.3.3 Soil

The soil survey is carried out in 225,800 ha, and the soil classification is made according to the national soil classification system of Indonesia. The soils in the surveyed area are classified into five Great Groups, namely, Podzolic Soils, Alluvial Soils, Hydromorphic Soils, Gley Soils and Organic Soils. The study for land suitability is carried out applying the Framework for Land Evaluation, FAO. About 90% of the lands are suitable for irrigation farming. Descriptions of the soils and the land suitability are given as follows:

(1) Soil classification

Podzolic Soils extend widely on the gently undulating peneplain in each development area. They have deep to moderately deep effective soil depth under well-drained condition. These soils are deficient in the essential plant nutrients and have strong acid soil reaction throughout

the profile. Soil erosion is remarkable on fallow lands. The total area covered with these soils is 184,400 ha or 81.6% of the total survey area.

Alluvial Soils occur on the river terrace and the natural levees in the Mucak Kabau area and the Lempuing area. They are moderately deep to shallow, and their topography is flat to nearly flat. The content of plant nutrients is commonly low. The total area is 1,700 ha or 0.8% of the total survey area.

Hydromorphic Soils extend over the various lands, i.e. natural levee, alluvial plain, depression and peneplain. They are rather deep and have hydromorphic properties within 50 cm below land surface. The total area is 16,700 ha or 7.4% of the total survey area.

Gley Soils develop extensively on the alluvial plain, the narrow flat valley and the depression in each development area. External and internal drainage conditions are very poor. Groundwater table is high in the wet season and throughout the year in some areas. The total area is 23,000 ha or 10.2% of the total survey area.

Organic Soils occupy the depression in a limited scale. They have an accumulated layer of plant remnants decomposed to some extent. They are saturated with water throughout the year and lie waste. The soils are non-suitable for irrigation farming.

The five Great Groups are furthermore classified into 11 Sub-groups. Their acreage and proportional extent are shown in Table 3.1.

(2) Land suitability classification

Land suitability is categorized into four classes, i.e. Highly suitable (S1), Moderately suitable (S2), Margenally suitable (S3) and Currently non-suitable (N1) according to the grading of limiting factors of soil fertility, soil acidity, effective depth of soil, topography, drainability, workability, inundation and erosion hazard.

The acreage and proportional extent of each land suitability class are shown in Table 3.2.

3.3.4 Climate

The project area is located in low latitudes and belongs to the equator climate zone. The project area is affected by tropical monsoons, having dry and rainy seasons. The rainfall data are available at 35 gauge stations in and around the area, but those observation periods vary from station to station and are often interrupted. Other meteorological data such as evaporation, relative humidity, temperature, sunshine and wind velocity are available at three stations in and around the area; Belitang, Banding Agung and Menggala. The data covers four to twenty years.

Average annual rainfall in the project area is about 2,630 mm at BK-IX, of which about 80% fall during the rainy season from October to May. The remainings fall during four months of the dry season from June to September.

The mean temperature in the flat land ranges from 26°C to 28°C with little seasonal variation. Both the daily maximum and minimum temperatures recorded at Belitang are 36.50°C and 17.0°C respectively. The annual average relative humidity is about 81% at Belitang, where the monthly average reaches its maximum in January; approximately 83%, and the minimum occurs in September; approximately 77%. Annual average sunshine duration at Belitang is about 5.2 hr/day. The monthly average sunshine hours, however, vary from 6.2 hr/day at maximum in May and to 4.0 hr/day at minimum in January. The wind velocity is generally low. The monthly averages of wind velocity are in the range from 2.3 km/hr to 3.2 km/hr. The annual pan evaporation observed at Belitang is 1,680 mm (4.6 mm/day). The monthly average evaporation reaches its maximum in March; approximately 5.0 mm/day. The minimum; 4.2 mm/day, occurs in June.

Table 3.3 summarizes the main features of climate in the project area, and the further details are presented in ANNEX-I.

3.3.5 Hydrology

(1) Stream Flow of the Komering River

The Komering river has a catchment area of 4,260 km^2 at Martapura. In its uppermost reach, the Lake Ranau is located. It is only the large water body that can serve as a natural reservoir and supplies water to downstream throughout the year. The water surface area is approximately 127 km^2 at water surface elevation of 542.0 m above mean sea level. The Komering river originates from this lake.

The monthly average discharge of the Komering river reaches its maximum in April; approximately 292 m^3/sec. The minimum occurs in September; approximately 136 m^3/sec. The seasonal patterns of the stream flow of the Komering river at Martapura and the Lake Ranau are as follows (for details, vide ANNEX-1):

Mean Monthly Stream Flow (m^3/sec)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Martapura	236	254	238	292	252	189	147	136	135	141	181	235	203
Banding Agung	19	20	20	21	21	19	17	16	16	16	18	18	18

The maximum discharge at Martapura was recorded as 1,438 m^3/sec in June 1980, and minimum discharge was 39.0 m^3/sec in October 1972.

(2) Flood Analysis on the Komering River

The probable peak discharge with a respective return period at Martapura is calculated using 11 annual peak discharge data observed during the period from 1971 to 1981 and shown in the following table.

Probable Peak Discharge
(by Gumbel Method)

(Unit: m^3/sec)

Return Period	at Martapura $A = 4,260\ km^2$
2	917
3	1,046
5	1,190
10	1,372
15	1,474
20	1,546
30	1,646
50	1,771
100	1,939
200	2,107
1,000	2,497

The flood with a 1,000 - year return period is also calculated at each proposed dam site for the use of dam design. The calculated results are shown in the following table.

Design Flood at Each Dam Site

Location	Catchment Area (km^2)	Design Flood (m^3/sec)
Ranau	508	44
Komering No. 1	1,056	1,414
Komering No. 2	1,165	1,489
Muaradua	2,866	2,166

(3) Water quality

In order to check the water quality of the Komering river, water sampling was carried out at 4 locations, i.e. Kayuagung, Kangkung, Banding Agung and Tanjung Raja, in 1979. A study of the chemical properties of water showed that the water could be used for irrigation. For drinking, however, the water was needed to be filtered to remove evaporated residue, and he boiled thoroughly to destroy all micro-organism which may exist in the water, judging from the amount of $KMnO_4$ demand.

3.4 LAND USE AND AGRICULTURE

3.4.1 Human Resources

The project area is administratively composed of nine Kecamatans (Sub District) in Kabupaten OKU and one Kecamatan in the Kabupaten OKI in the South Sumatra province and four Kecamatans in the Kabupaten North Lampung in the Lampung province. The area and population as well as density in each Kecamatan in 1980 are tabulated below (for details, see ANNEX-V).

Name of Kecamatan	Kabupaten	Area (km^2)	Population	Density (person/km^2)
Banding Agung	OKU	2,365	44,100	19
Pulau Beringin	OKU	730	19,200	26
Muaradua Kisam	OKU	870	18,400	21
Muaradua	OKU	1,143	59,400	52
Simpang	OKU	500	41,400	83
Martapura	OKU	501	54,400	108
Buay Madang	OKU	1,060	151,000	142
Belitang	OKU	800	105,400	132
Cempaka	OKU	885	91,000	103
Kayu Agung	OKI	1,339	82,000	61
Bahuga	North Lampung	394	32,000	81
Pakuan Ratu	North Lampung	1,158	16,000	14
Menggala	North Lampung	2,399	47,000	20
Tulangbawang Tengah	North Lampung	1,130	41,000	36
Total		18,639	791,000	42

The proposed irrigation development area is located within three Kecamatans, i.e. Buay Madang, Cempaka and Kayu Agung in the South Sumatra province and four Kecamatans, i.e. Bahuga, Pakuan Ratu, Menggala and Tulangbawang in the Lampung province.

Since 1950, the so-called Belitang Area extending in the said two Kecamatans; Buay Madang and Cempaka in the Kabupaten OKU in the South Sumatra province and the Kecamatan Bahuga in the Lampung province has played an important role on the settlement of transmigrants mainly from Java island. The following table shows the comparison of population in the Belitang Area between 1971 and 1980.

Kecamatan	1971			1980			Annual Increase Rate
	Population	Family	Density (person/km²)	Population	Family	Density (person/km²)	(%)
Martapura	34,220	7,600	68	54,400	12,080	108	5.29
Buay Madang	112,920	22,580	107	151,000	30,200	142	3.28
Belitang	74,990	17,850	94	105,400	25,090	132	3.85
Cempaka	71,980	12,850	81	91,000	16,250	103	2.64
Bahuga	17,450	3,180	44	32,000	5,830	81	6.97
Total	311,560	64,060	85	433,800	89,450	119	3.75

As seen in the above table, the Kecamatan Buay Madang is much densely populated and followed by the Kecamatan Belitang. More than 90% of the population is considered to be engaged in agriculture and its related activibies.

3.4.2 Present Land Use

The following table shows the land use conditions in the project area in 1979, and further details are presented in ANNEX-V.

Present Land Use in the Project Area

(Unit : ha)

Sub-Area	Paddy Field	Upland Field	Ladang/1	Perennial Crops	Alang-Alang	Forest	Village	Others/2	Total
Muncak Kabau Area	2,850	940	1,130	300	760	7,670	1,690	1,560	16,900
Proportion (%)	16.6	5.6	6.7	1.8	4.5	45.3	10.0	9.3	100.0
Lempuing Area	4,900	1,020	1,580	500	2,900	5,600	1,500	1,400	19,400
Proportion (%)	25.3	5.3	8.1	2.6	14.9	28.9	7.7	7.2	100.0
Tulangbawang West Sub-area	190	950	2,500	100	9.100	35,630	70	1,800	50,340
Proportion (%)	0.3	1.9	5.0	0.2	18.1	70.8	0.1	3.6	100.0
Tulangbawang East Sub-area	120	4,300	8,900	900	2,700	11,970	30	1,040	29,960
Proportion (%)	0.4	14.3	29.7	3.0	9.0	40.0	0.1	3.5	100.0
Total	8,060	7,210	14,110	1,800	15,460	60,870	3,290	5,800	116,600
Proportion (%)	6.9	6.2	12.1	1.5	13.3	52.2	2.8	5.0	100.0

Note: /1 Shifting cultivation land.
/2 Others includes swales, wet lands, canals, roads and small rivers.

(1) Muncak Kabau Area

This area; about 16,900 ha in gross, is located along the right bank of the upper Komering river. The area is relatively flat with some undulating lands. Total paddy lands cultivated in the area are about 2,900 ha or 17% of total lands of the development area under rainfed condition. About 2,100 ha of uplands corresponding to about 12% of the total lands are mainly cultivated with upland paddy, maize, cassava and peanuts. The perennial crops such as coffee, rubber and fruits are mainly planted in the levee lands of the Komering river and some in the farmers' home yards. The forest lands are mostly covered with secondary forest which covers about 7,700 ha.

(2) Lempuing Area

This area extends over 19,400 ha in gross located along the left bank of the Macak river and the Lampuing river, and has been rapidly developed for the settlement of the transmigrants from densely populated islands recently. Total paddy lands in the area are about 4,900 ha or 25% of the total lands and are cultivated under rain-fed condition. About 2,600 ha or 13% of the total lands are mainly cultivated with upland crops such as upland paddy, maize, cassava, soybeans and peanuts. Some perennial crops are also planted in approximately 500 ha in this area. Some shifting culture and alang-alang occupy about 2,900 ha of the lands. The forest lands of about 5,600 ha are mostly covered with secondary forest.

(3) Tulangbawang Area

The area covers about 80,300 ha in gross extending along the left banks of the Kanan river and the Tulangbawang river. Virtually, negligible lands of around 300 ha are cultivated with paddy, and around 16,700 ha are cultivated with various upland crops such as upland paddy, maize, cassava and peanuts. Perennial crops are planted mostly in the levee lands and some in home yard. Alang-alang area occupies about 11,000 ha, and about 47,600 ha or 63% of the total area are still covered with primary or secondary forest.

3.4.3 Present Cropping Pattern and Farming Practices

At present, the following cropping patterns are predominant in the project area (vide Fig. 3.1 through 3.4).

(Unit: ha)

Crop	Cropping Pattern			
	Type I	Type II	Type III	Type IV
Rainfed paddy	0.89	0.96	0.19	-
Upland paddy	0.06	0.10	0.20	0.65
Upland crops	0.41	0.34	0.44	0.63
Perennial crops	0.10	0.10	0.10	0.20
Alang-alang or forest	0.29	0.25	0.82	3.59
Farm size	1.75	1.75	1.75	4.75
Crop intensity	0.91	0.93	0.55	0.47

Rain-fed paddy cultivation in the cropping pattern Type I commences from the middle of October; onset of the rainy season. The planting period of paddy is extended over about three months. Because of recent introduction of the improved varieties, the growing period of paddy has been shortened from that of the local varieties. The harvesting lasts from the middle of February to May. Upland paddy is planted in some elevated lands from the beginning of October to December and harvested from February to April. Upland crops such as maize, soybeans, peanuts, cassava and sweet potato are planted in the project area normally during the rainy season taking crop rotation system introduced by farmers themselves. The cropping pattern Type I is practiced predominantly in the flat lands in the Muncak Kabau area. The rain-fed paddy area occupies about 60% of the total cultivated lands. Average farm size under this cropping pattern is estimated to be about 2.0 ha including 0.25 ha of home yard.

The cropping pattern Type II prevails in the Lempuing area where the transmigrants from Java and Bali have settled recently. The each transmigrant has been given 2.0 ha, of which 1.75 ha are cultivation lands. Out of 1.75 ha approximately 0.96 ha on an average is cultivated with paddy under rain-fed condition from October to May. The growing period of paddy is about four months. The remaining area of about 0.54 ha is planted

with upland crops and some perennial cash crops. The Type II pattern is predominant in the flat and some elevated lands.

The cropping pattern Type III is predominant in the western part of the Tulangbawang area (Tulangbawang west sub-area), where spontaneous transmigrants are mainly settled. The spontaneous transmigrants mainly cultivate upland crops and some perennial crops. As for the rice cultivation, each farmer in this area cultivates less than 0.2 ha of rainy season paddy on an average in the limited lowlands. Upland crops such as upland paddy, maize, cassava, soybeans and peanuts are mainly planted in the uplands and ladang area. Large parts of the lands are still covered with forest or alang-alang.

The cropping pattern Type IV prevails in the eastern part of the Tulanbawang area (Tulangbawang east sub-area), where newly settled farmers have been provided for 5 ha of lands under the governmental transmigration program form 1976/1977 to 1979/80. Each farmer cultivates about 0.65 ha for upland paddy, about 0.6 ha for upland crops and some perennial crops. The cultivation practices are still conventional. Negligible amounts of fertilizer and chemicals are applied. The varieties of crops seem to be unimproved. Perennial cash crops and orchard are planted in some elevated lands and levee lands along the Tulangbawang river without applying any fertilizer and agro-chemicals.

3.4.4 Crop Yield and Production

Present yields of crops in the project area are rather low except for the paddy cultivated under the BIMAS/INMAS programs. The following table shows the average crop yields in the project area (for details, refer to ANNEX-V).

Crop	Yield (t/ha)	Remarks
Rainy season paddy (with BIMAS/INMAS)	2.8	Dry paddy
Rainy season paddy (without BIMAS/INMAS)	2.0	Dry paddy
Upland paddy	1.2	Dry paddy
Cassava	6.8	Fresh roots
Maize	1.0	Grain
Peanuts	0.7	Grain
Soybeans	0.6	Grain

The production of major crops in the project area is estimated based on the results of farm economy survey and data collected from the Kecamatan Offices.

The following table shows the present crop production estimated in each area.

(Unit: tons)

Crop	Muncak Kabau Area	Lempuing Area	Tulangbawang West Sub-area	Tulangbawang East Sub-area
Rainy season paddy	6,020	10,000	400	240
Upland paddy	240	610	240	3,720
Total paddy	6,260	10,610	640	3,960
Polowijo	6,430	7,050	2,140	11,420

3.4.5 Farm Inputs

In the project area, a few amounts of fertilizer and agro-chemicals are applied for paddy cultivation but not used for other crops at present. Although good seeds of crops are essential to keep yield high, the farmers in the project area commonly use their own seeds. Fertilizer application is very limited, ranging from 10 kg/ha to 30 kg/ha of urea and 5 kg/ha to 15 kg/ha of triple super phosphate (TSP). Agro-chemicals of about 1 to 2 lit/ha of Diazinon against insects and about 100 g/ha of Zink-phosphate against rats are also applied.

3.4.6 Labor Requirements

The labor requirements for cultivation of various crops are estimated as follows:

	Rainy Season Paddy	Upland Paddy	Maize	Cassava	Peanuts	Soy-beans
Present labor requirements (men/days)	165	132	55	75	65	55

Greater parts of the work for farming are commonly done by family labor except for land preparation which is done by animal power. "Ani-ani" system is still prevailing in the project area for harvesting.

3.4.7 Livestock

Livestock raising in the project area is incidental to the basic farm management at present. The number of livestock raised in the project area is estimated based on the results of farm economy survey and the data collected from the Kecamatan Offices and shown below.

(Unit: heads)

	Muncak Kabau Area	Lempuing Area	Tulangbawang	
			West Sub-area	East Sub-area
Cattle	680	450	280	780
Buffalo	30	250	160	100
Goat	930	550	250	320
Sheep	-	250	-	-
Pig	-	-	-	-
Chicken	7,300	32,500	6,500	23,700
Duck	2,600	3,000	500	1,000
No. of large animal per farmer	0.22	0.14	0.44	0.18
No. of large animal per ha/1	0.19	0.12	0.38	0.20

Note: /1 paddy field + upland field

Cattles and buffaloes are playing an important role at present in preparation of lands. The number of cattles and buffaloes is aobut 0.2 head per household, which is too short to prepare the lands within a limited time. Livestock products are not so substantial source of income in the area at present. Poultry products are mainly for home consumption to get animal protein and to some extents in local markets.

3.4.8 Farm Budget

The present farm budgets of typical farmers are analysed for the respective cropping patterns, and the results are summarized in the following table.

	Unit	Cropping Pattern			
		Type I	Type II	Type III	Type IV
Family size	Nos	5.8	5.1	5.5	5.1
Farm size	Nos	1.75	1.75	1.75	4.75
Gross Income					
Farm income	Rps	327,500	327,100	180,000	229,000
Livestock income	"	24,000	27,400	31,000	15,700
Miscellaneous	"	68,700	72,100	52,000	52,000
Total	"	420,200	426,600	263,000	296,700
Outgo					
Farming cost	Rps	24,400	24,700	16,200	20,300
Livestock cost	"	2,500	2,800	3,100	1,600
IPEDA tax, etc.	"	4,700	2,500	1,500	0
Family living expenses	"	386,500	394,300	241,800	274,300
Total	"	418,100	424,300	262,600	296,200
Surplus	Rps (US$)	2,100 (3.4)	2,300 (3.7)	400 (0.6)	500 (0.8)

As shown in the above table, the surplus of typical farmer is extremely low. The increase of income through the improved farming is indispensable for improvement of their living standards.

3.5 AGRICULTURAL SUPPORT SERVICES

3.5.1 Extension Services

Extension services to the farmers are carried out by PPLs (field extension worker) under the supervision of the Agricultural Service Office in Kabupaten through PPSs (Subject Matter Specialist) and PPMs (Extension Supervisor). In the project area, six PPMs command seven Kecamatans; Buay Madang, Cempaka, Kayu Agung, Bahuga, Pakuan Ratu, Tulangbawang Tengah and Menggala in which 51 PPLs provide the extension services to the farmers through 436 Kontak-tanis (Leading farmer). The service area of one PPL is about 1,600 ha of farmlands on an average. Although personal contacts are effective to stimulate the farmers to improve their farming, only limited farmers benefit from the services due to acute shortage of trained extension workers. Reinforcement of the extension services is eagerly required.

3.5.2 Seed Multiplication

Only one provincial seed center; Belitang Seed Centers, is located within the Belitang Proper Area for the production of seeds of paddy. Foundation seeds of paddy are supplied from CRIA to this Center through the Agricultural Extension Service Office of the South Sumatra province. The stock seeds of paddy produced at the Center are distributed to seed stations (BALAI BENIH) managed by Mura and Liot District Agricultural Offices and the authorized seed growers. Some seeds are also distributed to the some unauthorized seed growers. The seeds thus produced are distributed to the farmers involved in the BIMAS/INMAS programs as well as common farmers through BUUD/KUD (Village Farmers' Cooperative). The amount of paddy seeds produced is still insufficient to distribute fully to the farmers in the project area. Further efforts are required for the establishment of a well-organized seed multiplication system.

3.5.3 Credit

BRI provides loan services to the rural sector and BIMAS credit activities through its branch and sub branch offices. The Baturaja, the Kayuagung and the Kotabumi branch offices cover the Muncak Kabau, the Lempuing and the Tulangbawang areas respectively.

The average paddy-cultivated area under the BIMAS program in recent five years was about 14,000 ha in the Kabupaten OKU, about 4,000 ha in the Kabupaten OKI and about 10,000 ha in the Kabupaten North Lampung respectively, which correspond to only about 30% of the total paddy lands in the OKU, about 5% in the OKI and about 45% in the North Lampung respectively.

One of the serious problems in the BIMAS credit is low repayment of the credit, i.e. about 49% in the Kabupaten OKU, 40% in the Kabupaten OKI and 43% in the Kabupaten North Lampung respectively. Particular consideration should be given to this fact to improve the present farmers' credit situation (see details in ANNEX-V).

3.5.4 Cooperative

There are seven BUUD/KUDs in the Muncak Kabau area, five in the Lempuing area and two in the Tulangbawang area respectively. These numbers correspond to only 11% of the total villages in the Muncak Kabau area, 7% in the Lempuing area and 3% in the Tulangbawang area. Each BUUD/KUD is operated under the guidance and supervision of the District Agricultural Cooperative Union. The major activities of BUUD/KUD are both supply of farm inputs to farmers and purchase of farm outputs from the members on time. As the BUUD/KUD plays an important role in providing various services for farmers to achieve a successful implementation of agricultural development, it is desired that the further establishment of BUUD/KUDs as well as strengthening of their activities is required before the completion of the project.

Other co-operatives such as KIOS, BRI unit village and rice mills are also organized throughout the project area, especially in the Tulangbawang area but very limited numbers.

3.5.5 Marketing and Prices

Surplus of paddy produced by farmers is mostly marketed through the two channels; DOLOG/KUD and itinerant grain buyers. DOLOG/KUD markets the rice and functions for the stabilization of price of rice under the Government control. Because of very limited capacity of DOLOG/KUD stores for rice in the project area, however, the share of quantity of rice purchased by DOLOG/KUD is insignificant. Furthermore, the storage capacity of farmers' own stores is also quite limited. Accordingly the farmers are often compelled to sell the rice to the itinerant merchants at the harvest time with comparatively low unit price. The seasonal fluctuations in farm gate price of paddy is relatively high due to an inadequate marketing system, i.e. transportation and storage facilities. In this context, it is desired that DOLOG/KUD should be provided with a sufficient storage capacity.

Regarding the upland crops, the farmer sells those products through either itinerant merchants or weekly markets in general. Limited farmers sell chicken and other livestock products at the local markets, but the amount marketed is insignificant.

The floor price and ceiling price are set at Rp. 156/kg and Rp. 195/kg in the South Sumatra province in 1979/80, and Rp. 120/kg and Rp. 195/kg in the Lampung province in 1980/81 respectively. The floor price and ceiling price in Jakarta are set at Rp. 195/kg and Rp. 237/kg in 1981/82.

The seasonal fluctuation in farm gate prices of farm products is relatively high due to inadequate marketing system, poor transportation facilities and limited storage facilities. The following table shows the present farm gate prices of major farm products and inputs prevailing in the project area (see details in ANNEX-V).

Item	Unit Price/1 (Rp./kg or lit.)	Remarks
Rice	200	
Paddy	115	Dry paddy
Maize	60	
Cassava	25	
Soybean	320	
Peanut	380	
Rubber	200	
Coffee	650	
Urea	80	
TSP	80	
Insecticide & Fungicide	1,200	

/1: Present farm gate prices

3.5.6 Transmigration and Resettlement

According to the Transmigration Offices in both South Sumatra province and Lampung province, the total number of migrants during past 31 years from 1950 to 1980 were about 57,000 and 74,000 families respectively. Out of the above families, about 46% and 16% in the South Sumatra province and about 36% in the Lampung province were settled in the Kabupaten OKU, the Kabupaten OKI and the Kabupaten North Lampung respectively. More than 95% of the total number of transmigrants in the Kabupaten OKU were settled in the Belitang Area. In the Tulangbawang area, about 4,500 families were settled in the north of Menggala from 1976/77 to 1979/80. In order to implement the settlement program successfully, the Government provides 1.25 ha of land preparation, certain quantities of infrastructures and living accommodations as well as commodities and farm inputs, etc. to the new settlers.

In the Lampung province, the population increase is quite high; 5.8% a year on an average for the past ten years, mainly due to the increase of population of transmigrants from the densely populated islands like Java and Bali. These transmigrants, particularly the spontaneous ones, settled in forest areas and deteriorated the forest lands to great extent.

Taking these facts seriously, the Lampung Provincial Government has decided not to receive any transmigrant, and instead, to promote the resettlement program for the spontaneous transmigrants who have settled in the forest areas.

According to the resettlement program, about 35,000 families are scheduled to be resettled in the Kabupaten North Lampung from 1981 through 1984 (see details in ANNEX-V). The Government will provide to the resettlers almost the same public facilities and subsidies as those for general transmigrants.

3.6 EXISTING IRRIGATION AND DRAINAGE SYSTEM

3.6.1 History of Irrigation and Drainage Development in the Upper Komering Basin

The first activity for the irrigation development in the upper Komering river basin is the construction of irrigation facilities in the Belitang Proper Area with a net irrigation area of 20,600 ha. The development program for this area was formulated in 1936 as a transmigration project, and its implementation was carried out from 1939 to 1942. The major works completed in this period were an intake structure, main canal up to BK-IX, secondary canals and the related structures. After seven-year suspension, the construction work was resumed from 1950, and around 66 km of main canal, 39 km of secondary canals and around 100 km of secondary drainage canals have been completed so far. Construction of the tertiary and quaternary canals are left to the farmers.

Meanwhile, the Government of Indonesia, giving a high priority to the agricultural development in the South Sumatra, requested the technical assistance from the UNDP/Special Fund for the planning of full development, and its agreement was concluded with the UNDP. The FAO was designated as the executing agency. The Plan of Operation of the project entitled "Land and Water Resources Development in South Eastern Sumatra" was signed by the Government, the Special Fund and FAO on December 23, 1970. Following the agreement, FAO carried out the reconnaissance investigation from 1971 to 1976 and prepared three reports, i.e. Technical Report 1,

"Land, Water and Forestry Resources", Technical Report 2, "Socio-economics, Land Tenure and Agricultural and Fisheries Production" and Technical Report 3, "Land and Water Resources Development in Southeast Sumatra, Indonesia, Plan of Development". Furthermore, FAO prepared the Feasibility Report on "Belitang Proper Irrigation Project", the Planning Report on "Belitang Extension Area Agricultural Development Project" and the Feasibility Report on "Tjintamanis Agricultural Development Project" in 1974. In 1980 JICA completed the survey and prepared the Comprehensive Study Report on "Upper Komering River Basin Development Project" (Draft Final). Following this study, JICA also carried out and prepared the Feasibility Report on "Komering-I Irrigation Development Project in the Upper Komering River Basin" in 1981.

In addition to the above major activities, the Government has successfully carried out the following irrigation or reclamation developments:

	Project Name	Project Scale	Work Completed
1.	Pila Ranau (irrigation)	63 ha	Construction
2.	Rantau Nipis (irrigation)	625 ha	Survey and design
3.	Damar Pura (irrigation)	100 ha	Survey and design
4.	Purus Bunga Mayang (irrigation)	550 ha	Survey and design
5.	Lebak Datuk (reclamation)	1,200 ha	Construction
6.	Lebak Semendawai (reclamation)	13,500 ha	Construction
7.	Lebak Sukaraja (reclamation)	100 ha	Survey and design
8.	Lebak Terentang (reclamation)	120 ha	Construction
9.	Tiang Bilik (reclamation)	618 ha	Construction

3.6.2 Present Conditions of Irrigation System and Its Operation and Maintenance

Other than the Belitang Proper Area, there is no technical irrigation and drainage system in the upper Komering basin. The Belitang Irrigation Office, under the control of the Public Works of South Sumatra province, is being directly engaged in the operation and maintenance of the existing irrigation system in the Belitang Proper Area. This office is also controlling the rehabilitation works of the canal system and construction of additional structures. The office is staffed by 55 persons comprising

one project manager, three irrigation technicians, one construction technicians, four administrative staffs, five chiefs of gate operators and 38 gate operators.

The canal system can supply water only to 6,500 ha in the dry season (32% of the total Proper Area) and 17,000 ha in the rainy season (83% of the total Proper Area) in 1980. This shortage of irrigation water supply is mainly due to the reason why the raising of water level with stoplog at 8K-I; for the irrigation of the elevated lands in the Proper Area, gives less hydraulic gradient in the headreach portion accelerating silt deposition in the canal and results in less discharge in the canal.

No systematic irrigation rotation system is being applied at present in this project area. At the request from the farmers through gate operator, the water is released to the fields. When more requests are made by farmers at a time, those farmers are grouped into two, and three-day rotation is applied between the two groups. No water charge is collected from the farmers.

Mal-drainage, particularly along the Macak and the Belitang rivers and the inner lowlands, is another negative condition for the agricultural development. As mentioned in the section 3.6.1 hereof, the office has constructed around 100 km of secondary drainage canals, but these canals are not so well functioning because of absence of tertiary drainage canals.

The project office had spent around Rp. 30,000,000 (equivalent to US$0.4/ha) for repair and maintenance of the facilities in 1979/80. This amount seems not enough for proper maintenance of the system.

3.7 POWER MARKET

The public power supply systems in the South Sumatra and Lampung provinces are poorly developed compared with potential power demand. Against an estimated population of 10×10^6, PLN has only 100 MW of generating capacity. Except those of 71 MW in Palembang and 16 MW in Tanjung Karang, power systems are isolated. In 1980/81, PLN generated 255 GWh of energy. There are 200 MW of private power and many consumers are in the waiting list of PLN. Reflecting the shortage of power, the annual growth rate has been more than 20% in most towns in recent years.

Under these circumstances, electrification of these provinces is one of the most important objectives in Repelita II and III. PLN intends to construct 700 MW of power stations and 150 kV transmission line in a length of 1,000 km by 1995. PLN projected that 1,460 GWh of PLN powers generation would be necessary by 1990.