REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

FEASIBILITY STUDY ON THE SANREGO IRRIGATION PROJECT

MAIN REPORT

MARCH 1983

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 Government of Japan decided to conduct a feasibility study on the Sanrego Irrigation Development Project and entrusted the survey to the Japan International Cooperation Agency (JICA). The JICA sent to Indonesia a study team headed by Mr. Tadashi SAKAMOTO from June 15, 1982 to January 14, 1983.

The team exchanged views with the officials concerned of the Government of Indonesia and conducted a field survey in the Project area. 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 Indonesia for their close cooperation extended to the team.

March, 1983

Keisuke Arita
President
Japan International Cooperation Agency,
Tokyo, Japan

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

Dear Sir,

LETTER OF TRANSMITTAL

We are pleased to submit the feasibility report on the Sanrego Irrigation Project in the Central South Sulawesi, the Republic of Indonesia, in accordance with the terms of reference issued by JICA. In the report, we fully incorporated the advices and suggestions offered by the Advisory Committee of JICA as well as the comments from the Indonesia Government Authorities concerned.

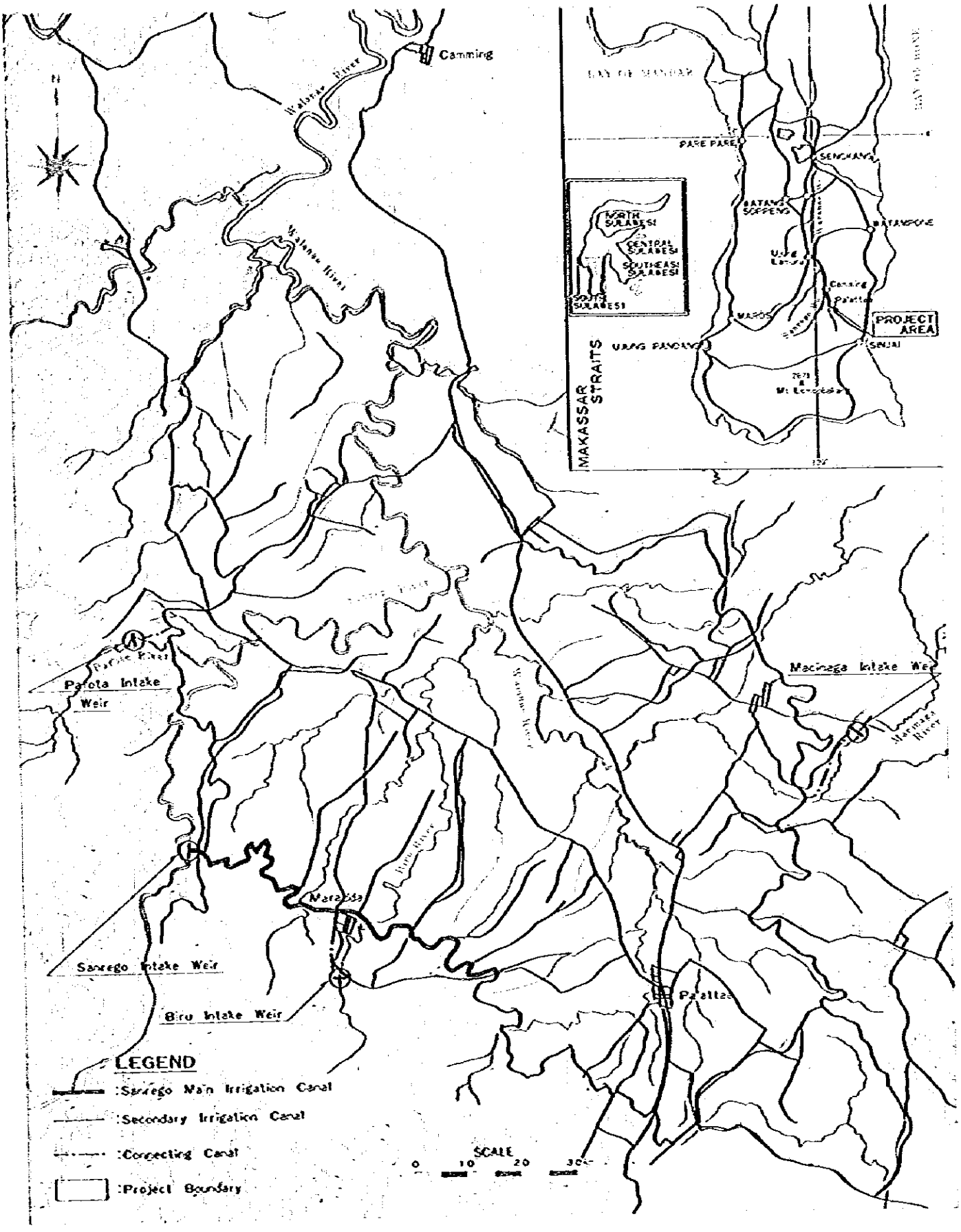
The development of the Sanrego area has long been desired by local inhabitants. The Government of Indonesia has also recognized the strong necessity of the regional development in this area and carried out the investigations and studies for the development plan since early 1970's. The Sanrego Irrigation Project is basically formulated through careful review of these previous studies with the principal aims of the increase of agricultural production and the improvement of farmer's living standards in the area.

The irrigation area is decided to be 8,000 ha in net through exploitation of irrigation water from the Sanrego river and three (3) tributaries namely, Parota, Biru and Macinaga. With implementation of the Project, the annual production would amount to about 60,000 tons of dried paddy at the full development stage of the Project. The increased amount of paddy production would substantially contribute to the regional economy in the Central South Sulawesi. The economic internal rate of return of the Project is estimated to be 15.1 percent and the Project is verified to be economically feasible. In view of the importance and need of the Project in the regional economy, we would recommend that the Project should be urgently implemented along the conclusion presented in this report.

In submitting this report, we wish to express our sincere appreciation and gratitude to the personnel concerned of JICA, the Embassy of Japan in Indonesia and the Indonesian Government Authorities concerned for the courtesies and cooperation extended during field surveys and studies.

T. Sakamoto

Tadashi SAKAMOTO
Leader of the Feasibility
Study Team on the Sanrego
Irrigation Project



LOCATION MAP

PRINCIPAL FEATURES OF THE PROJECT

Location	:	Kabupaten Bone, South Sulawesi
Project Area	:	Gross area 12,000 ha Net irrigation area 8,000 ha
Water Sources	:	Sanrego, Parota, Biru and Macinaga rivers
Project Facilities	:	- Sanrego intake weir - Parota, Biru and Macinaga intake weirs - Irrigation canals Main canal : 11.6 km Secondary canal : 97.5 km Connecting canal : 4.9 km - Canal structures Turnout : 100 nos. Drop : 64 nos. Chute : 7 nos. Aqueduct : 3 nos. Bridge : 26 nos. Cross drain culvert : 82 nos. Spillway : 2 nos. Junction : 3 nos. - Farm road : 127.2 km - Tertiary system : 8,000 ha
Project Cost	:	F.C. Rp15,895 million L.C. Rp20,414 million Total Rp36,309 million
Construction Period	:	8 years (1981/82 - 1988/89)
Annual Benefit	:	Rp7,155 million
Internal Rate of Return (IRR)	:	15.1%

SUMMARY AND RECOMMENDATIONS

BACKGROUND OF THE PROJECT

01. The Government of Indonesia has laid great emphasis on substantial increases in food production to attain self-sufficiency of foodstuff and high economic growth together with the achievement of national stability and equalization of social justice. Following the national development policy, South Sulawesi Province, one of the surplus rice producing provinces, has launched various development projects with the highest priority to the increase of foodstuff, especially rice, through the expansion of irrigation area and improvement of its efficiency.

02. In the Central South Sulawesi region, nine (9) viable projects were identified in the Master Plan for Water Resources Development formulated in 1980. Among them, the Sanrego Irrigation Project was given the first priority together with the Langkemme and Bila Irrigation Projects for early implementation under PELITA III.

03. The Sanrego area is located on the southeastern corner of the Central South Sulawesi and extends along upper reaches of the Walanae river and its major tributary, the Sanrego river in Kabupaten Bone. The Sanrago area is one of the most depressed regions in the Central South Sulawesi and its high potential for agricultural development remains unutilized. The development of the Sanrego water resources has long been desired by local inhabitants.

04. The Government has also recognized the strong necessity of the regional development in the Sanrego area and initiated the study and investigation for the Sanrego Irrigation Project commanding a net irrigation area of 3,456 ha since 1972. After examination of the development plan indicated by the Master Plan, the Government has modified its original irrigation plan covering an area of 3,456 ha to 8,071 ha. In response to the strong request for early implementation of the Project, the Government has prepared detailed designs for major irrigation facilities such as intake structures, main and secondary irrigation canals. The construction works of the intake weir was partly commenced in 1980.

05. In 1981, the Government has intended to review all the design works and improve them through further investigation and study up to the international standard in depth sufficiently enough for asking the foreign financial assistance, and has requested the Government of Japan the technical cooperation for the feasibility study on the Sanrego Irrigation Project. In response to the request from the Government, the Government of Japan decided to offer the technical assistance for the feasibility study on the Project. Based on the Scope of Works for the feasibility study agreed upon between the Government of Indonesia and the Government of Japan in March 1982, the feasibility study on the Project was commenced in June, 1982.

PRESENT CONDITION OF THE STUDY AREA

06. The study area is located at about 100 km northeast from Ujung Pandang, the capital of the province. The total gross area of 17,500 ha extends over the gently undulating alluvial plains developed along the Walanae and Sanrego rivers.

07. The total population in the study area is about 38,400 as of 1981, and increases at the rate of 2.3% per annum. The population comprises 48% of male and 52% of female. The total workable population in the age group of 15 - 49 years old is about 16,300. The total number of household is about 6,740, out of which 6,270 are engaged in agriculture.

08. The study area has comparatively complex topography descending toward the Walanae and Sanrego rivers with different gradients from east, west and south boundaries. The Walanae river passes through the study area from south to north. The Sanrego river runs from south to northeast in the area and joins the Walanae river at the northern part of the study area. Many small streams originating in the eastern, western and southern hilly ranges run in the study area and flow into the Sanrego and Walanae rivers. The average topographic gradient from south to north in the study area is approximately 0.5% and its altitude ranges from 170 m to 110 m.

09. The central undulating plains are mainly covered by unconsolidated silty to clayey terrace and alluvial deposits. The outskirts of the study area are mainly made up of gently sloping hill masses where the weathered basement rock is exposed directly underneath the thin residual soil. The basement rock is composed of strongly consolidated cretaceous hard shale and sandstone occuring in south-western area, consolidated middle tertiary tuff breccia, sandstone and siltstone in western area, and weakly and medially consolidated upper Tertiary tuff breccia and sandstone in eastern area. Geological investigation on the Sanrego intake and other major structures sites has revealed the favourable geological conditions of the foundation for the hydraulic structures to be constructed.

10. The soils of the study area are classified into seven (7) soil units, i.e., Eutric Gleysols, Eutric Fluvisols, Dystric Fluvisols, Pellic Vertisols, Eutric Nitosols, Dystric Cambisols, and Lithosols. The first four (4) soil units covering a total area of 11,800 ha are suitable for irrigated rice cultivation due to their general characteristics of gently undulating topography, moderate to deep surface soils, heavy texture and easy availability of water. Eutric Nitosols is marginal to irrigated rice cultivation. This soil unit covers 3,500 ha. The last two (2) units of 2,200 ha are not suitable for rice.

11. The climate in the study area is characterized by three seasons, dry, wet and transitional, according to the seasonal distribution of rainfall. The cease and onset of these seasons widely vary year by year. The wet season usually commences in April and lasts about four (4) months until July and is followed by the dry season from August to November. The transitional season generally starts in December and ends in March. About 80% of the annual rainfall of 2,100 mm concentrates between December thru July, while only 20% is distributed within the dry season.

12. The Sanrego river originates in the Mt. Bohonglangi of 1,980 m in altitude and flows down from south to northeast in the study area and joins the Walanae river at the northern part of the study area. The total length of the river is about 43 km from the originating point to the confluence with the Walanae river and the average gradient of upper reach is about 3% and lower reach 0.4%. The catchment area of the Sanrego river is 179.2 km^2 at the proposed intake weir site. The maximum monthly mean discharge of the Sanrego river is 14.6 m^3/sec in May and the minimum 5.6 m^3/sec in October. The annual average runoff is estimated at 331 x $10^6 m^3$. In the study area, there exist a number of small tributaries, out of which three (3) tributaries, namely, Parota, Biru and Macinaga have comparatively large catchment areas and are considered to be supplemental water sources for the Project. The total catchment area of these tributaries is 59.8 km^2. The dry season discharges of the tributaries are disregarded due to their negligible flow. The estimated average monthly mean discharge for the wet and transitional seasons from December to July is 2.9 m^3/sec for three tributaries.

13. There exists only one irrigation system in the study area, i.e., the Maradda semi-technical irrigation system commanding a net area of 250 ha located on the gently undulating plain in the southern part of the study area. The existing irrigation facilities are relatively well maintained by farmers themselves. Natural rivulets adjacent to paddy fields function as the main drainage canals in the system.

14. A provincial road runs through the study area leading from Ujung Lamuru to Sinjai via Camming and Pallatae. This road is gravel metalled and passable throughout the year. This road links to a major provincial road which leads from Ujung Pandang to Watampone, at Ujung Lamuru. A number of unpaved rural roads branch off from the above provincial road. Most of them are not jeepable during the rainy season due to the poor maintenance and no bridges across the rivers. The density of existing rural roads is still low.

15. The present land use in the study area is classified as follows:

Land Category	Area (ha)	Proportion (%)
Paddy field	9,000	51
Upland field	2,800	16
Grassland	3,900	22
Orchard/Forest	900	5
Village/others	900	5
Total	17,500	100

16. The wet season paddy is planted at the onset of the monsoon, from March to May, and harvested from July to September. The cultivation of dry season paddy and/or polowijo crops starts in November and December. The crop yields and production largely fluctuate year by year due to wide variations of annual rainfall and unexpected damages caused mainly by drought. The average unit yield and production of paddy for wet and dry seasons under the present condition during 1977 to 1981 are estimated as follows:

Crops	Planted Area (ha)	Harvested Area (ha)	Unit Yield (tons/ha)	Production (tons)
Wet season paddy	7,120	5,840	2.23	13,020
Dry season paddy	800	750	2.50	1,880
Polowijo crops				
Groundnuts	1,670	1,670	0.73	1,220
Greenbeans	80	80	0.40	30

17. The average size of farm is estimated at 2.36 ha, of which 1.42 ha are paddy fields. Farmers with small holding size less than 1.0 ha count for about 54% in the study area. The farm income of them is not sufficient for their livelihood. Most of them engage in various side-line business.

PROJECT FORMULATION

18. The Sanrego Irrigation Project aims at increasing crop production and thereby improving the living standard of the local inhabitants in the Project area through implementation of irrigation facilities. Maximum effective use of water and land resources, and introduction of improved irrigation farming are the most important key factors for the development of the Project area. With this in view, the basic concept for agricultural development would be:

- Maximization of irrigation area,
- Stabilization and improvement of wet season paddy,
- Expansion of planted area for dry season paddy and/or polowijo crops,
- Improvement of rural road networks, and
- Effective operation of existing agricultural institutions.

19. There exist two approaches to the Project formulation for irrigation development. The Master Plan indicates that the Sanrego river will serve the irrigation area of 10,000 ha in net out of 17,500 ha in gross. The irrigation plan prepared by DOI aims to irrigate an area of 8,071 ha in net out of 12,000 ha in gross. The DOI Plan area is included in the Master Plan area. Considering the basic concept for development, the irrigation area will be selected with a view to making maximum use of water and land resources endowed around the study area together with the regional socio-economic conditions.

20. The irrigable area is estimated based on the assessment of water resources, estimate of irrigation water requirement and water balance study. The assessment of water resources is made through the hydrological analysis for not only the Sanrego river but also three tributaries, i.e., Parota, Biru, and Macinaga, to make the maximum effective use of water resources for the Project.

21. The irrigation water requirement is studied based on the empirical prediction method. Percolation loss is measured in the field and is estimated at 2 mm/day both for the wet and dry season cropping. The nursery water requirement is estimated at 270 mm for the dry season paddy and 260 mm for the wet season paddy for a period of 25 days. The puddling water requirement is assessed at 200 mm for the dry season paddy and 190 mm for the wet season paddy under the condition that the puddling water is gradually supplied for 10 days. Effective rainfall is estimated by applying the daily water depth balance method using the rainfall data at Palattae, Maradda and Canning from 1974 to 1982. Conveyance and application losses are set at 20%, respectively, which result in 64% of the total irrigation efficiency. The unit diversion water requirement is estimated on 10-days basis with the dependability level of 80%.

22. The seasonal water balance study between the river discharge and the irrigation water requirement is conducted for the period from 1974 to 1982. The balance calculation is made by means of dividing the river discharge by the diversion water requirement on the daily basis and the average value for the critical low flow period of 10 days are taken as the irrigable area. The irrigable areas with irrigation dependability level of 80% are estimated for the following two (2) cases:

Water Source	Wet Season Paddy	Dry Season Paddy
(1) Sanrego river	6,300 ha	3,700 ha
(2) Sanrego river plus three tributaries	8,000 ha	4,000 ha

23. The present land use conditions in both areas covered by the Master Plan and the DOI Plan are:

(Unit: ha)

Land Use	DOI Plan		Master Plan	
	Gross	Net	Gross	Net
Paddy field	7,700	6,850	9,000	8,100
Upland field	1,700	480	2,800	1,900
Grass land	1,300	610	3,900	-
Orchard/forest	700	130	900	-
Village/other	600	-	900	-
Total	12,000	8,070	17,500	10,000

The both plans include the land reclamation works for development of new paddy fields: i.e., 1,220 ha for DOI Plan and 1,900 ha for Master Plan.

24. The soil unit identified in the both areas are:

(Unit: ha)

Soil Unit	DOI Plan		Master Plan	
	Gross	Net	Gross	Net
Suitable for irrigated rice				
- Eutric Gleysols	1,600	1,170	1,800	1,400
- Eutric Fluvisols	3,500	2,870	4,600	3,200
- Dystric Fluvisols	4,500	3,620	5,100	3,800
- Pellic Vertisols	300	270	300	200
Sub-total	9,900	7,930	11,800	8,600
Marginal for irrigated rice				
- Eutric Nitsols	1,100	140	3,500	1,400
Non irrigable				
- Dystric Cambisol	1,000	-	1,400	-
- Lithosol	-	-	800	-
Total	12,000	8,070	17,500	10,000

The marginal soils for irrigated rice occupy 1,400 ha in Master Plan area and only 140 ha in DOI Plan area.

25. The socio-economic conditions in the study area are as follows:

Available labour force: The labour balance study is made based on the available labour force forcasted as of 1990. The labour requirement analysis for the proposed cropping pattern shows that the maximum area, which can be put under intensive rice cultivation, will not be more than 8,000 ha as a whole, in terms of labour availability.

Beneficiary farmers: The village compounds are sporadically located mainly over the paddy field areas, and more than 90% of the total farm household are included in the area delineated by DOI. There is no meaningful difference between the two existing plans in number of the beneficiary farmers.

Neighboring sugar project: A large scale sugar project is now under consideration on the neighboring eastern areas of the irrigation area. The location of the planned sugar cane fields is mostly overlapped with the northern area of the irrigable land indicated by the Master Plan. The soils of these overlapped areas are marginal for irrigated rice and more suitable for sugar cane growing.

26. The potential maximum area for irrigation development is decided at 8,000 ha in net by superimposing the above study results. The most optimum development area will be determined within this potential maximum area by making the examination of economic viability for possible alternative plans. There exist no drainage problems in the area, except narrow strip lands along the rivers and streams. This fact does not affect the delineation of the most suitable irrigation area.

27. In order to determine the optimum scale of development, the following two (2) alternative cases are compared:

Case - 1: This aims to serve the irrigation area of 6,300 ha by the available water of the Santego river only with the modified irrigation system of the built-up DOI design.

Case - 2: This aims to serve the possible largest area of 8,000 ha by the available water of the Santego river and three tributaries with the irrigation system based on the built-up DOI design and new supplemental facilities for three tributaries.

With the elaborate technical and economic comparison, Case - 2 is selected as the most optimum development plan of the Project in view of:

- higher economic efficiency indicating the internal rate of return of 15.1%,
- commanding the potential maximum area of 8,000 ha,
- making more effective use of available designs of irrigation facilities conducted by DOI, and
- ensuring larger number of project-benefited farmers and larger amount of paddy production.

THE PROJECT

28. The proposed irrigation area of 8,000 ha comprises the existing paddy field of about 6,800 ha, and upland, orchard and grassland of 1,200 ha. With the Project, these lands will be fully irrigated and more intensive use of the farmlands will become possible.

29. As for the cropping pattern, four (4) alternatives are carefully studied from the viewpoints of profitability, labour requirement, water requirement, and water source. As a result, double cropping of paddy is selected. The anticipated unit yield of paddy is set at 5.0 tons of dried paddy per ha both for wet season paddy and dry season paddy using the empirical formula and referring the actual data obtained from the similar irrigation areas around the Project area.

30. The annual paddy production at the full development stage would amount to 60,000 tons of dried paddy. Out of them, it is expected that the marketable paddy would be about 44,530 tons per annum after deducting the increased local consumption and various losses.

31. The central feature of the Project is to supply irrigation water to the project area of 8,000 ha in net with the irrigation system based on the built-up DOI design and new supplemental facilities by utilizing the available water from the Sanrego river and three tributaries, i.e., Parota, Biru and Macinaga rivers. The facilities required for the Project include an intake weir on the Sanrego river, three small-scaled intake weirs on the tributaries, main and secondary irrigation canals, connecting canals, farm roads, their related structures, land reclamation works and tertiary systems.

32. The main features of the proposed project works are summarized as follows:

(i) Sanrego intake weir

Diversion weir

- Type of weir	Cascade type (wet stone masonry)
- Max. diversion discharge	12.91 m^3/sec
- Design flood discharge	820 m^3/sec (100-year flood)
- Crest elevation	EL 170.75 m
- Crest length of weir	40.0 m
- Height of weir	10.3 m (upstream) 12.5 m (downstream)
- Width of scouring sluice	4.0 m
- Width of intake structure	6.0 m

Closing dike

- Type of embankment	Homogeneous
- Crest elevation	EL 177.05 m
- Crest width	8.0 m
- Max. height	26.0 m
- Crest length	250.0 m

(2) Supplemental small-scaled intake weirs

Description	Name of Weir		
	Parota	Biru	Macinaga
- Type of weir	Tirol type	Overflow type	Tirol type
- Max. diversion discharge (m^3/sec)	1.40	0.93	0.40
- Crest elevation (m)	EL 156.3	EL 170.3	EL 150.8
- Crest length (m)	10.0	27.5	5.0
- Height of weir (m)	3.5	3.0	2.5
- Length of intake screen (m)	0.5	-	0.5
- Width of scouring sluice (m)	-	1.0	-

(3) Main and secondary irrigation canals and related structures

Description	Main Canal	Secondary Canal	Total
- Max. design discharge (m^3/sec)	12.91	6.20	-
- Canal length			
Unlined (km)	10.7	91.0	101.7
Lined (km)	0.9	6.5	7.4
- Related structures			
Trunout (nos.)	10	90	100
Drop (nos.)	-	64	64
Chute (nos.)	-	7	7
Aqueduct (nos.)	1	2	3
Bridge (nos.)	4	21	25
Cross drain culvert (nos.)	21	58	79

(4) Connecting canals and related structures

Description	Name of Canal			Total
	Parota	Biru	Macinaga	
- Max. design discharge (m^3/sec)	1.40	0.93	0.40	-
- Canal length (km)	1.0	1.4	2.5	4.9
- Related structures				
Spillway (nos.)	1	-	1	2
Bridge (nos.)	-	-	1	1
Cross drain culvert (nos.)	1	-	2	3
Junction (nos.)	1	1	1	3

(5) Farm roads

- Construction road	13.2 km
- Main canal inspection road	11.6 km
- Secondary canal inspection road	97.5 km
- Connecting canal inspection road	4.9 km

(6) Tertiary system

- Nos. of tertiary blocks	200 nos. (Max. 77 ha, Min. 11 ha)
- Tertiary irrigation canal	100 km
- Quaternary irrigation canal	480 km
- Tertiary drain	100 km
- Tertiary canal inspection road	100 km

(7) Reclamation works

- Upland	500 ha
- Grassland	600 ha
- Orchard	100 ha

33. The excavation works of coupure channel at the Sanrego intake weir site almost completed by the local contractor in 1982. The tendering for construction of intake weir itself including closing dike was also finished based on the local tender by the end of 1982 and the actual construction works are scheduled to be executed by the Government. The project implementation is, therefore, formulated that the Sanrego intake weir including closing dike will be constructed by the Government own budget and the remaining works, such as main and secondary irrigation canals, supplemental intake weirs on the tributaries, etc., will be executed with foreign financial assistance. The total construction period including the excavation works of coupure channel already commenced will be eight (8) years from 1981/82 to 1988/89.

34. On the basis of the current market price level in South Sulawesi as of 1982 and the price escalation factor at 7% for the foreign currency portion and 13% for the local currency portion per annum, the project cost is estimated to total Rp36,309 million consisting of Rp15,895 million for foreign currency and Rp20,414 million for local currency. The exchange rate used in the estimate is US$1.0 = Rp670 = ¥260. In this estimate, the physical contingency includes about 15% of the basic cost including the cost for engineering services.

ORGANIZATION

35. The Directorate General of Water Resources Development (DGWRD), the Ministry of Public Works would be the executing body for the Sanrego Irrigation Project. The Directorate of Irrigation (DOI) under the DGWRD would have the direct responsibility for project execution. To smoothly execute the Project, the project office would be established in the Provincial Office of Public Works, South Sulawesi. The project office would operate all the field works such as additional survey and investigation, detailed design and construction supervision, etc.

36. After completion of the construction works, the project operation and maintenance office would be organized under the regional irrigation office of the Provincial Public Works. The office would be responsible for operation and maintenance of all the project facilities from intakes to inlets of tertiary blocks. The office would be composed of one head office, three branch offices and eight field offices.

37. Before completion of the construction works of the Project, it would be recommended that a water users' association (P3A) be established in each tertiary irrigation block. Each P3SA would have an advisory group consisting of a chief of village, agricultural extension workers (PPL) and irrigation inspectors concerned.

ECONOMIC AND FINANCIAL EVALUATION

38. On the basis of the project cost and benefit, the internal rate of return (IRR) of the Project is calculated. In the calculation, the project benefit is estimated for only the direct benefit derived from the crop production with the irrigation development. The net direct benefit amounts to Rp7,155 million per annum at the full development stage. The economic cost is estimated at Rp22,668 million consisting of Rp11,466 million of foreign currency component and Rp11,202 million of local currency component.

39. The calculation of IRR is made based on 50 years of the project life starting from 1981/82. The result of economic evaluation indicates that the project is quite feasible with the IRR of 15.1%. The sensitivity analysis indicates that the Project is insensitive against the anticipated changes showing the IRR of 11.5% in case of 20% increase of cost and 20% decrease of benefit.

40. With completion of the project, annual net reserve or capacity to pay will be Rp482,100 for the average size farmer, Rp202,900 for the peasant farmer holding a land of 1.0 ha and Rp112,400 for the peasant farmer holding a land of 0.5 ha. The increased net reserve would offer incentives for further development to the farmers, and the substantial payment capacity would enable them to pay some charges for the Project.

41. The financial viability of the Project is evaluated with respect of farm economy. The farmer would have to pay some of the project annual cost. The annual O&M cost required for the project is estimated at Rp266 million which is equivalent to about Rp33,250/ha. This corresponds to about 16% of the payment capacity of the project benefited farmers. This prospective payment by the farmers would be the project revenue.

42. With the implementation of the project, the following socio-economic impacts are expected:

- Saving of foreign exchange for import of rice
- Demonstration effects of modern irrigation practices
- Increase of employment opportunity
- Improvement of quality of farm products and increase of marketability
- Improvement of rural development

RECOMMENDATIONS

43. The feasibility study made herewith on the Sanrego Irrigation Project concluded that the Project would be technically and economically feasible. The Project area has been left behind for irrigation development and the inhabitants in the area have waited for long time the early realization of the Project. With such background, it is strongly recommended that the Project should be implemented as early as possible.

44. The hydrological analysis in this feasibility study was made by the maximum use of available data obtained in and around the Project area. However, reliable data on hydrology are limited at present, especially on the tributaries. In order to confirm more detailed hydrological conditions in the area, the following observation networks are recommended to be urgently established:

(1) to install water level gauging stations in three tributaries, i.e., Parota, Biru and Macinaga, and also install rainfall gauging stations in their watersheds.

(2) to install rainfall gauging stations in the Sanrego river watershed.

(3) to strengthen observations at the existing two water level gauging stations in the Sanrego river.

(4) to conduct instantaneous discharge observations around the depressed area in the Sanrego river watershed.

45. The Sanrego river and three tributaries, namely Parota, Biru and Macinaga, are main water sources of the project. The total watershed of these rivers is about 23,900 ha, out of which only about 54% of the area is covered with forest and has been gradually depleted by unrestricted shifting cultivation and over-grazing of domestic animals. Such being the situation, it is strongly recommended that reforestation work should be promoted for conservation of land and water resources, so as to cover about 85% of the total watershed with forest areas.

46. The Sanrego Area Development Project prepared by CIDA aims at the integrated rural development of the Sanrego area covering some 25,000 ha of cultivated area. The development strategy is multiple-goal oriented in multiple sectors including agricultural production, marketing and post-harvest improvement, reforestation and regreening, infrastructural improvement and social development. The project components are manifold and well prepared. It is hoped that the CIDA project will largely contribute to the smooth operation running-in of the Sanrego Irrigation Project. Some minor duplications are, however, observed in both projects. It is recommended that close coordination be established among the authorities concerned for smooth implementation of both projects.

47. As for the institutional services to support the agricultural development, the CIDA project covers almost all of the necessary fields of agricultural services. The present plan of services, however, seems to be somewhat insufficient for supporting the irrigation development. If some modification could be made on the basis of the following additional requirements, more fruitful results would be expected:

- to promote the KUD activities including establishment of adequate number of new KUD,
- to organize the water users associations (P3A) over the irrigation area,
- to increase the extension workers and raise up their practical rice cultivation technique through field training,
- to promote the INSUS programme,
- to strengthen the seed multiplication, activities, and
- to promote the agronomic research on irrigated rice.

48. In order to facilitate the early realization of modern irrigation farming, it would be inevitable to establish a guidance organization responsible for promoting, guiding and assisting the farmers in various fields concerning the modern irrigation rice farming and on-farm development. With this in view, it is recommended that a pilot demonstration scheme should be established within the Project area as a key program for the successful implementation of the Project.

49. After completion of the Project, the paddy production will be increased to 60,000 tons per annum. The present state of post-harvest system is rather primitive and will not meet the future production. It is, therefore, recommended that the post-harvest improvement scheme be implemented in parallel with the project construction. The main features of the proposed scheme will comprise:

- establishment of new facilities for paddy processing,
- construction of new warehouses,
- provision of transportation facilities, and
- improvement of paddy collecting system.

SANREGO IRRIGATION PROJECT

MAIN REPORT

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ABBREVIATION AND GLOSSARY OF TERMS

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

ml	:	milliliter (= 1.0 cm^3)
lit, l	:	liter (= 1,000 cm^3)
cm^3	:	cubic centimeter
m^3	:	cubic meter

4. Weight

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

5. Time

sec	:	second
min	:	minute
hr	:	hour
d	:	day
yr	:	year

6. Other measures

%	:	percent
°C	:	centigrade
10^3	:	thousand
10^6	:	million
10^9	:	billion
cm/sec	:	centimeter per second
m/sec	:	meter per second
km/day	:	kilometer per day
m^3/sec	:	cubic meter per second
$m^3/sec/km^2$	:	cubic meter per second per square kilometer
lit/sec/ha	:	liter per second per hectare
ton/ha	:	ton per hectare
No. (Nos.)	:	number(s)
pc(s)	:	piece(s)

7. Technical terms

EL	:	elevation above mean sea level
H	:	height
W	:	width
WL	:	water level
FWL	:	flood water level
NWL	:	normal water level
LWL	:	low water level
Q	:	discharge
V	:	velocity

8. Currency

US$	:	US dollar
Rp	:	Indonesia rupiah
¥	:	Japanese yen

(US$1 = ¥260 = Rp 670)

9. Others

AARD	:	Agency for Agricultural Research and Development
ADC	:	Agricultural Development Center
BAPPEDA	:	Regional Development Planning Board
BAPPENAS	:	National Development Planning Board
BIMAS	:	Mass Guidance Program for self-sufficient in foodstaff
BPP	:	Rural Extension Center
BRI	:	Indonesian People's Bank
BUPATI	:	Chief of Kabupaten
BUUD	:	Villate Unit Executive Body
CRIFC	:	Central Research Institute for Food Crops
Desa	:	Village
DGWRD	:	Directorate General of Water Resources Development
DIPERTA	:	Ministry of Agriculture Provincial Agency for Logistic
DOLOG	:	Control of Major Food Products
DOI	:	Directorate of Irrigation
DPMA	:	Directorate of Hydraulic Engineering
DPP	:	Directorate of Planning and Programming
DPU	:	Department of Public Works
FAO	:	Food and Agriculture Organization
GDP	:	Gross Domestic Product
GRP	:	Gross Regional Product

INMAS	:	Mass Intensification Guidance Program for Paddy Production
INSUS	:	Special Intensification Guidance
IRRI	:	International Rice Research Institute
JICA	:	Japan International Cooperation Agency
Kabupaten	:	District
Kecamatan	:	Sub-district
KUD	:	Village Unit Agricultural Cooperative
MARIF	:	Maros Research Institute for Food Crops
PELITA (REPELITA)	:	Five-year National Development Plan
PMA	:	Institute of Hydraulic Section
PMG	:	Meteorology and Geophisics Center
PPL	:	Field Extension Worker
PPM	:	Extension Supervisor
PPS	:	Subject-matter Specialist
Propinsi	:	Province
Prop.SUL-SEL	:	South Sulawesi Province
PROSIDA	:	Irrigation Project financed by International Development Association
P3SA	:	Water Resources Planning and Development Project
REC	:	Rural Extension Center
Ulu-Ulu	:	Water Master
UNDP	:	United Nations Development Program
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
WHO	:	World Health Organizaton

CHAPTER I INTRODUCTION

1.1 AUTHORITY

This report is prepared in accordance with the "Scope of Works" dated March 16, 1982 for the Feasibility Study on the Sanrego Irrigation Project agreed upon between the Government of Indonesia (hereinafter referred to the Government) and the Japan International Cooperation Agency (hereinafter referred to JICA).

This Final Report presents the proposed plan of the Project using the new orthophoto map on a scale of 1/5,000 prepared in December, 1982 by JICA on the basis of careful review of previous studies, findings obtained through the field investigations and studies, and comments for the Draft Final Report offered from the Indonesian Authorities concerned.

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

1. MAIN REPORT

2. ANNEX VOLUME I

Annex-I	Meteorology and Hydrology
Annex-II	Geology
Annex-III	Soil Mechanics
Annex-IV	Soil and Land Classification
Annex-V	Agriculture and Agricultural Economy

3. ANNEX VOLUME II

Annex-VI	Irrigation and Drainage Plan
Annex-VII	Preliminary Design of Project Facilities
Annex-VIII	Construction Plan and Cost Estimate
Annex-IX	Project Evaluation
Annex-X	Watershed Management

4. ANNEX VOLUME III

Annex-XI	Drawings

1.2 PROJECT HISTORY

In early 1970s, the Government focussed on the comprehensive regional development in the Central South Sulawesi. To realize the development concept, the Government requested the Government of Japan to extend a technical assistance for the formulation of the master plan for comprehensive development in this region.

In compliance with the request from the Government, JICA, a government agency responsible for execution of the technical cooperation program in Japan, dispatched a preliminary survey team in 1973. The team concluded that a master plan is pre-requisite in advance of the formulation of new projects and made recommendation to the Government of Japan that basic data such as topographic maps and hydrological data should be urgently prepared for the master planning.

In accordance with the above recommendation, JICA further dispatched two Colombo Plan experts specialized in hydrology in 1976 for the collection of data required for the master plan study. In parallel with the hydrological data collection, JICA commenced an aerial photo mapping and prepared topographic maps on a scale of 1/25,000 in September, 1978.

Immediately after the provision of topographic maps, JICA dispatched a study team to the Central South Sulawesi region in order to prepare the master plan. The Master Plan Study Team executed the field survey during the period of about ten (10) months from September 1978 to June 1979, and after further intensive study in Japan, the team submitted the final report to the Goverement in March, 1980.

In the Master Plan, nine (9) viable projects are embodied for the regional economic development and the increase of public welfare of local inhabitants in the Central South Sulawesi. Among these nine (9) projects, the Sanrego Irrigation Project was given the high priority, together with the Langkemme and Bila Irrigation Projects, for early implementation from technical and socio-economic viewpoints.

While, the development of the Sanrego area has long been desired by local inhabitants. The Government has also recognized the strong necessity of the regional development in this area and initiated the preparatory works for the development plan with the irrigation area of 3,456 ha under its own budget since 1972. After examination of the development plan proposed in the Master Plan mentioned above, the Government has decided to expand its original irrigation plan covering an area of 3,456 ha to 8,071 ha. The detailed design of the irrigation system for the whole irrigation area of 8,071 ha except design of tertiary facilities was almost completed on July, 1982 by the Directorate of Irrigation (DOI) and the construction works of the intake weir were partly commenced since 1980 by the local contractors.

In 1981, the Government intended to review all design works and study up to the international standard in depth sufficiently enough for asking the foreign financial assistance, and requested the Government of Japan the technical cooperation for the Feasibility Study on the Sanrego Irrigation Project. In response to the request from the Government, the Government of Japan decided to offer the technical assistance for the Feasibility Study on the Project. In March 1982, JICA dispatched the Preliminary Survey Team for the Project and the "Scope of Works" for the Feasibility Study was agreed upon between the Government and JICA on March 16, 1982.

Based on the agreed "Scope of Works", the Feasibility Study on the Sanrego Irrigation Project was substantially commenced on June 15, 1982 upon arrival of the first group of the Study Team.

1.3 PREVIOUS STUDIES

The following surveys and studies relevant to the Sanrego Irrigation Project were carried out under the Japanese technical cooperation so far:

(1) Preliminary Study on the Water Resources Development in the Central South Sulawesi, OTCA, June 1974,

(2) Hydrological Data Collection and Guidance for Data Collection on the Central South Sulawesi Water Resources Development Project, JICA, March 1977,

(3) Topographic Mapping on a scale of 1/25,000, JICA, September 1978,

(4) Master Plan on the Central South Sulawesi Water Resources Development, JICA, March 1980, and

(5) Preliminary Survey on the Sanrego Irrigation Project, JICA, April 1982.

While, the Government made independent activities for the Project since 1972 and the major activities made so far are summarized as follows:

(1) Topographic Survey and Mapping covering about 10,000 ha on a scale of 1/5,000, 1972 - 1973,

(2) Field Reconnaissance and Preparation of Irrigation Development Plan, 1973 - 1974,

(3) Design of Major Irrigation Facilities, 1974 - 1975,

(4) Geological Survey and Soil Mechanical Test for the Proposed Sanrego Intake Weir, 1976 - 1977,

(5) Hydraulic Model Test for the Proposed Sanrego Intake Weir, 1977,

(6) Review and Updating of the Original Design on the basis of the Development Plan proposed in the Master Plan, 1980 - 1981,

(7) Detailed Design of Headworks, Intake Structure, Main and Secondary Canal Systems for the Irrigation Area of 8,071 ha, 1980 - 1982.

(8) Excavation Works of Coupure Channel at the Sanrego Intake Weir Site, 1980 - 1982, and

(9) Tendering for the Construction of the Sanrego Intake Weir and Closing Dike, 1982.

1.4 SCOPE OF WORKS

The "Scope of Works" for the Feasibility Study on the Sanrego Irrigation Project was agreed upon between the Government and the JICA Preliminary Survey Team on March 16, 1982. The objective of the study is consisting of two aspects presented below:

(1) to verify the technical and economic feasibility of the Project, and

(2) to undertake on-the-job training and transfer of knowledge of the Indonesian counterparts in the course of the survey and study.

The agreed "Scope of Works" is shown in Attachment-I of this report.

1.5 ACTIVITIES OF THE STUDY TEAM

The JICA Study Team arrived at Jakarta on June 15, 1982. After courtesy call to the authorities concerned, the Study Team submitted the Draft Plan of Operation. On June 17, the discussion on this report was held at P3SA, Jakarta between the Indonesian Authorities concerned and the Study Team, and the mutual agreement was arrived at between both sides on June 19. At that time, the Study Team was requested by the Government to pay special attentiaon to the built-up Indonesian Plan for the Project. The Study Team then visited the Directorate of Irrigation (DOI), Bandung to collect data and information on the built-up Indonesian design.

The Study Team marked a first step in the study area on June 22 and executed the field reconnaissance to grasp the outline of the present status of the study area. On the basis of the findings through the field reconnaissance and data collection, the Study Team prepared the Inception Report which presented the approach to the Project and the plan of operation. The Inception Report was submitted to the Government on July 7 and the meeting on this report was held at Jakarta on July 13. Through the discussion, the Inception Report was basically approved by the Government.

Following the approved plan of operation, the Study Team commenced the substantial survey, investigation and studies in the various fields relevant to the Project from the middle of July. At the beginning of September 1982, the Study Team compiled the Planning Criteria for the technical discussion with the Indonesian Authorities concerned. The Planning Criteria presented the outline of the present condition of the study area based on the findings obtained through the field investigation, and the study method and progress result of the basic matters for the development plan such as hydrology, irrigation water requirement and water balance study. The meeting on the report was held at Jakarta on September 17, and constructive comments and suggestions were raised during the course of the discussion for making further study of the Project.

On September 28, the JICA Advisory Committee for the Project arrived at Jakarta and stayed in Indonesia until October 10. During stay in Indonesia, the Advisory Committee made the field investigation in the study area and gave advices to the Study Team for further study of the Project. Based on the comments and suggestions offered by the Indonesian Authorities concerned at the meeting on the Planning Criteria, and advices from the Advisory Committee, the Study Team prepared the Interim Report and submitted it to the Government on November 8, 1982. The meeting on the Interim Report was held at Jakarta on November 16, 1982. Through the discussion, the basic project formulation proposed by the Study Team was basically agreed by the Government.

Following the comments and suggestions offered by the Indonesian Authorities concerned at the meeting on the Interim Report, the Study Team made further studies and compiled the Draft Final Report. On January 12, 1983, the discussion on the Draft Final Report took place at Jakarta between the Indonesian Authorities concerned and the Study Team at the presence of the Advisory Committee members dispatched by JICA. On the discussion, the Study Team was requested to finalize the Draft Final Report based on the new orthophoto map on a scale of 1/5,000 which was prepared at the end of 1982 by the JICA mapping team.

The Study Team prepared the Final Report based on the comments and requests for the Draft Final Report, and submitted it herewith in accordance with the "Scope of Works".

CHAPTER II BACKGROUND OF THE PROJECT

2.1 NATIONAL AND REGIONAL BACKGROUND

Indonesia having a territory of about 2 million km^2 with more than 14,000 islands is an agricultural country blessed with favourable natural conditions such as high temperature, plenty rainfall, large fertile lands, etc. Population in Indonesia is about 148 million in 1980 with density of 77 persons per km^2. About 18 million ha or 9% equivalence of land are being used for agriculture and about 60% of the total working population are engaged in agricultural sector including fishery and forestry. About 27% of Gross Domestic Product (GDP) in Indonesia comes from the agricultural sector as referred to Table 2.1.

To achieve the self sufficiency of food crops, especially rice, Indonesia has put the highest priority to the agricultural development and increase of rice production since PELITA I (1969/70 - 1973/74), the First Five-year National Development Plan, launched in 1969/70. The PELITA III (1979/80 - 1983/84) puts also stress on the higher economic growth together with the achievement of national stability and equalization of social justice. Concerning the water resources development sector of PELITA III, the increase of the food production especially for rice is raised as one of the top priority strategies in the national development policy to accomplish the national goals.

Following the national development policy, South Sulawesi Province, one of the surplus rice producing Provinces with 4th rank of rice production in Indonesia, has also launched South Sulawesi PELITA III. In the South Sulawesi PELITA III, the highest priority has been given to the increase of foodstuff, especially of rice. The expansion and improvement of the irrigated paddy fields are one of the government strategies for this target.

The Central South Sulawesi consisting of four (4) Kabupaten, i.e., Wajo, Sidrap, Soppeng and Bone, is graced with favourable natural condition for rice production. The region still remains as a representative rice granary at present. The surplus rice produced in the Central South Sulawesi has been supplied to the surrounding rice shortage areas and adjacent isles such as Kalimantan, Maluku, Irian Jaya, etc. The total distributed amount of surplus rice from this region is approximately 585,000 tons per annum on an average. However, this region has still much rooms for increase of rice production in view of the endowed land and water resources which have not been fully exploited yet.

Present agricultural land developed in the Central South Sulawesi is 344,000 ha, of which 47% or 160,000 ha are used for paddy cultivation. More than 75% of paddy field, however, is still put under rainfed condition. Only 23% of the paddy field is provided with irrigation system using only 3% of the endowed water resources of about 6 billion m^3.

The population density in the Central South Sulawesi is considerably high. Because of low employment opportunity during a period of dry season, seasonal out-migrations are recently increasing from the region mainly to the Kalimantan. To settle these employment issues seasonally caused in the region, job opportunity in agricultural section must be urgently and sharply increased especially during the dry season.

2.2 DEVELOPMENT PLAN IN CENTRAL SOUTH SULAWESI

2.2.1 Development Goals and Policies in the PELITA III

The development goals and basic policy for the South Sulawesi in the PELITA III are summarized below:

(1) Development goals

(a) Agricultural development mainly for the increase of food grains, and

(b) Industrial development depending upon development of electric power resources.

(2) Development policy

(a) To strengthen the role as rice belt in the east part of Indonesia and extend the technical irrigation area for rice production, and

(b) To establish the required condition for the industrial development on the basis of acquisition of electric power.

2.2.2 Master Plan for Water Resources Development

The Government has focussed her attention on the endowed land and water resources of the Central South Sulawesi region since early 1970's. To embody the development of these resources, a master plan for the water resources development in Central South Sulawesi was prepared in 1979 fiscal year. The Master Plan Study identified the goals for the water resources development in the Central South Sulawesi as follows:

(1) Increase of rice production
(2) Promotion of social and public welfare
(3) Improvement of each sector economy
(4) Hydropower development
(5) Up-filling of regional economic gap

On the basis of these development goals, various sectional projects were initially proposed and then, finally integrated into nine viable compound and multi-purpose projects, in due consideration of technical and economic relations among each sector as listed below:

(1) Bila-Boya Irrigation/Flood Control Project
(2) Langkemme Irrigation Project
(3) Lawo Irrigation Project
(4) Cenranae Irrigation Project
(5) Gilirang Irrigation Project
(6) Sanrego Irrigation Project
(7) Padangeng Irrigation Project
(8) Cenranae Flood Control Project
(9) Walimpong Multi-purpose Dam Project

Out of the above nine (9) viable projects, the highest priority was accorded to the Sanrego Irrigation project, together with the Langkemme and Bila Irrigation projects, for early implementation from technical and socio-economic viewpoints. The Master Plan concluded that these three (3) priority projects would function as a core project for the regional development in the Central South Sulawesi and strongly recommended that these projects should enter into implementation during the period of PELITA III.

2.2.3 Associated Development Projects in Sanrego Area

Three (3) major projects are in operation or are under construction or are planned for the Sanrego area which will, together with the Sanrego irrigation project, give an impact on the regional development of the area. These include the Lappo Ase paddy intensification scheme, a camming sugar production project and a integrated rural development project.

(1) Lappo Ase paddy intensification scheme

The Lappo Ase scheme is one of the agricultural support services provided by the Government for mass increase of rice production especially on rainfed paddy field area. Kabupaten Bone was one of three Kabupatens selected in 1981 for the Lappo Ase program. Under this program, new improved varieties like IR36, IR42 and IR50 were introduced to the area with a well sophisticated package including fertilizers and agro-chemicals and a credit plan making the package available to all the participant farmers. The technical assistance was also intensified to make the program more effective. In the Sanrego area, the Lappo Ase Program covered about 4,700 ha and 5,300 farmers participated in 1981.

(2) Camming sugar project

About 13,000 ha east of the Walanae river are planned for sugar cane plantation as shown in Fig. 2.1. The area envisaged is overlapped with the northern part of the study area. It has been agreed, however, that irrigation project would have the priority for land selection and an alternative area outside the irrigation project would be selected in order not to prejudice the irrigable lands to be earmarked for intensive paddy production. The Camming Sugar Project is now being constructed by P.T. PERKABUNAN XX, a government enterprise under the control of the Ministry of Agriculture. The Project is planned to have a factory with a daily capacity of 3,000 tons of cane and a maximum

plantation area of 13,000 ha. The construction of the Project will be gradually progressed and be completed by the beginning of 1984. The cane planting will be started on the land of 970 ha from the middle of 1983 and gradually expanded up to 8,700 ha by the year of 1991. The expansion of cane field up to 13,000 ha is still under the feasibility study.

(3) Integrated rural development project

The Sanrego area development project, a pilot project aiming at integrated rural development of the Sanrego-Walanae river valley, is sponsored by the Directorate Tata Kota and Tata Daerah and the Canadian International Development Agency (CIDA). The project covers some 25,000 ha of cultivated lands, and is expected to serve as a test and demonstration area for the development of a strategy that will be used eventually in the development of the whole valley. The strategy is multiple-goal oriented in multiple sectors including diversified crop production, marketing, extension, education, health and environment issues. The large scale irrigation development is not considered in the project because the Sanrego Irrigation Project is already prepared. The major project components include establishment of an agricultural development center for the Tappale area, a rural extension center for the Pallatae area, an industrial crop center for the Bonto Cani area, new paddy field development of 3,000 ha, rehabilitation of existing desa irrigation schemes for 400 ha, credit scheme for farm input supplies, improvement of local markets and marketing systems, improvement of sanitary conditions around the village compounds, construction of 7 dispensaries and deployment of health bus, rehabilitation of farm roads and reforestation and/or re-greening program on existing grasslands of 6,000 ha. The Sanrego area development project will be launched from the fiscal year 1983/84.

2.3 NEEDS OF AGRICULTURAL DEVELOPMENT

In order to realize the economic development plans, the South Sulawesi Province is divided into five (5) development sub-regions on the basis of the geographic conditions, development potentials and economic spheres, i.e., South, Central, East, West and North Development sub-regions. The Central South Sulawesi is located at the central part of both Central and East Development sub-regions. The Central South Sulawesi, an area of about 8,000 km^2, with its abundant land and water resources, is one of the main rice granaries not only in South Sulawesi but also in the East Indonesia.

The Sanrego area is located on the southeastern corner of the Central South Sulawesi and extends along upper reaches of the Walanae river and its major tributary, the Sanrego river in Kabupaten Bone. The Sanrego area is one of the most economically depressed regions in the Central South Sulawesi and its high potential for agricultural development remains unutilized. The farm income is still very low mainly due to low cropping intensity under rainfed condition. The crop yields are generally unstable and low. The development of the Sanrego water resources has long been desired by local inhabitants.

Under these circumstances, agricultural development especially on paddy cultivation with adequate irrigation facilities in the Sanrego area is inevitable for the attainment of equalization of socio-economic development in the Central South Sulawesi. The successful realization of irrigation development in the Sanrego area will much contribute to raising the level of living standard and public welfare of local inhabitants, together with the integrated rural development project mentioned in the previous section.

CHAPTER III PRESENT CONDITION OF THE STUDY AREA

3.1 LOCATION

The study area is located in the southeastern corner of the Central South Sulawesi apart about 100 km east by north from Ujung Pandang, the capital of South Sulawesi Province. It extends along upper reaches of the Walanae river and lower reaches of the Sanrego river which is a major tributary of the Walanae river. The gross area of the study area is 17,500 ha, which is covered by the Master Plan for the Central South Sulawesi Water Resources Development Project.

Administratively, the study area comes under four (4) Kecamatan of the Kabupaten Bone and covers 14 Desa as shown below:

Kecamatan	Desa
1. Kahu	1. Sanrego
	2. Biru
	3. Palakka
	4. Cenrana
	5. Balle
	6. Cakkela
	7. Labuaja
2. Libureng	8. Tappale
	9. Pitumpidange
	10. Polewali
3. Tonra	11. Paccing
	12. Massila
4. Salomekko	13. Masago
	14. Patimpeng

The administrative divisions are illustrated on Fig. 3.1.

3.2 HUMAN RESOURCES

The total population in the above-mentioned Desas which are partly or entirely covered by the study area, is 38,400 as of 1981. The population density is about 100 persons per km^2 on an average over the total area of 380 km^2. The population growth rate is estimated at about 2.3% per annum during the recent decade. The total workable population in the age group of 15 - 49 years olds is about 16,300 which corresponds to 43% of the total population. The population comprises 48% of male and 52% of female, showing the female rate of 1.09. In the age group of 15 - 49, the female rate become large, showing 1.35. The total number of household is about 6,740. The average size of family is 5.7 persons per household. The number of farm household is

about 6,270. It accounts for about 93% of the total number of household. The general feature of the demographic condition in shown in Table 3.1.

The present demographic condition is characterized by high female rate especially in economically active age groups and high rate of child population below 15 years of age. The former indicates that there is a considerable population outflow from the area and most of them seem to be working outside temporarily to supplement their livelihood with some off-farm incomes because of insufficient crop incomes especially in the dry season. This presumption has been evidenced by the farm economy survey. The high rate of child population will build a stable base of labour for area development if work opportunity is sufficiently provided.

3.3 NATURAL RESOURCES

3.3.1 Topography

The study area has comparatively complex topography descending toward the Walanae and Sanrego rivers with different gradients from east, west and south boundaries. The Walanae river passes through the study area from south to north. The Sanrego river runs from south to northeast in the area and joins the Walanae river at the northern part of the study area. Many small streams originating in the eastern, western and southern hilly ranges run in the study area and flow into the Sanrego and Walanae rivers.

Major part of the study area extends over the gently undulating alluvial plains and terraces created by the Sanrego and Walanae rivers, and partly lies in the hilly slopes near the east, west and south boundaries. The average topographic gradient from south to north in the study area is approximately 0.5% and its altitude ranges from 170 m to 110 m.

3.3.2 Geology

The study area is located in the Walanae Depression, which is formed of gently hilly area and gently undulating plains underlain by tuff breccia, alternation of weakly cemented mudstone and sandstone, coral limestone, and unconsolidated terrace and alluvial deposits.

In the study area, the central area enclosed with the Walanae and Sanrego rivers is made up of gently undulating plains, which is underlain by Neogene Molasse (poorly consolidated conglomerate, silt stone, sand stone and pumiceous tuff) and overlain by thick pleistocene terrace deposits.

The outskirts of the study area are mainly made up of gently sloping hill masses, ranging from 170 to 220 meters in altitude, where the weathered basement rock is exposed directly underneath the thin residual soil. The basement rock is composed of strongly consolidated cretaceous

hard shale and sandstone occuring in south-western area, consolidated middle tertiary tuff breccia, sandstone and siltstone in western area, and weakly medially consolidated upper tertiary tuff breccia and sandstone in eastern area.

The upper watershed of the Sanrego river is underlain by andesitic and basaltic lava associated with those pyroclastic rocks and intercalated with huge lanticular of reaf limestone formed from Eocene to middle Miocene. The area, with the exception of limestone area, is composed of steep mountains covered by thick reasidual soils. The height of hill masses increase gradually from about 300 meters to about 2,000 meters of Mt. Bohonglangi in the south. The area occupied by limestone masses shows a peculiar topography; all the peaks are flat or slightly inclined ranging from 500 to 800 meters in altitude and rarely covered by residual soil, and all the slopes make steep cliff with rocky surface. This limestone area makes a large basin enclosed with precipitous mountains.

The Sanrego intake weir site is located on the most south-western edge of the study area. The site is underlained by medially consolidated siltstone and sandstone formed of Miocene, covered with the unconsolidated alluvial terrace deposit and the riverbed deposit. The siltstone and sandstone are alternated. The silt stone is well laminated, therefore, many cracks are observed along the lamination. The unconsolidated deposit has about 8 meters in maximum thickness.

Most of the structures sites on the main and secondary canals show the outcrop of the basement rock at the river water level, but the basement is overlain by unconsolidated pleistocene terrace deposit.

The general geological condition in the study area is illustrated on Fig. 3.2. The geological strata are stratigraphically classified and given in Table 3.2 (for details, vide ANNEX - II).

3.3.3 Soils

The soils of the study area are classified into seven (7) soil units, according to the FAO/UNESCO soil classification system, i.e., Eutric Gleysols (Ge), Eutric Fluvisols (Je), Dystric Fluvisols (Jd), Pellic Vertisols (Vp), Eutric Nitosols (Ne), Dystric Cambisols (Bd), and Lithosols (I).

Eutric Gleysols (Ge) or Grey Alluvial and Greyish Brown Alluvial Soils in Indonesian system are formed from unconsolidated sediment materials in low-laying areas and/or in depressions. These soils are generally influenced by high groundwater tables, and therefore show hydromorphic properties. The effective soil depth is generally deep. The texture is generally clay to silty clay and the structure is massive. These soils are used for paddy cultivation at present. Although these soils are suitable for irrigated paddy cultivation, some drainage improvement will be required for sustaining the good yield. These soils occupy 1,800 ha in total or 10.3% of the study area.

Eutric Fluvisols (Je) or Brown Alluvial Soils mainly extend over the lower riverine terraces developed in between the Sanrego and Walanae rivers. These soils are developed on the semi-recent alluvial deposits and generally immature with no predominant morphological characteristics. The effective soil depth is generally deep. The soil texture is clay to loamy clay and the structure varies with location, ranging from structureless massive to weakly developed fine to medium angular blocky structure. The most of these soils are presently put under cultivation of rainfed paddy. These soils have generally good agricultural potential and are often intensitively used. The soils are suitable not only for irrigated rice but also for a wide range of crops. These soils occupy about 4,600 ha or 26.3% of the study area.

Dystric Fluvisols (Jd) or Low Humic Gley Soils occur on the higher riverine terraces of old alluvium, extending over the southern part of the study area. These soils are generally immature in profile development, with shallow to moderate soil depth. The soil texture is medium to fine in surface soil and fine in sub-soils. The soil structure is generally structureless massive to weakly developed fine angular blocky structure. Most of these soils are presently used for rainfed paddy cultivation. The soils are generally suitable for irrigated rice cultivation. Adequate fertilization and some measures to prevent the soil erosion like terracing and laying out of small plots will be needed for best use of these soils. These soils occupy 5,100 ha or 29.1% of the study area.

Pellic Vertisols (Vp) or Grey Grumsols develop over the higher riverine terraces extending on the middle western part of the study area. These soils have swelling clay properties which cause them to be sticky when soils become wet, and to be hard, dry and deeply cracked when dry. As a result, micro-relief so-called gilgai is developed at the surface. These "vertic" surface soils are not very deep, generally within 30 cm from the ground surface. The subsoils underlaying vertic surface vary with the location from gravelly to clayey alluvial deposits. The land covered with these soils are presently used for paddy cultivation. Adequate water supply is the key to utilization of these soils. These soils occupy 300 ha or 1.7% of the study area.

Eutric Nitosols (Ne) or Dark Reddish Brown Latosols develop on the pleistocene high terraces which extend mainly on the eastern part of the study area. These soils are originated from highly weathered dilluvial deposits. Most of these soils are left as grassland, and a very limited area is being used for cultivation of perennial crops. Agricultural potential of these soils is generally high for field crops. However, these are marginal to rice cultivation. Adequate fertilizer application will be essential for any kinds of land use. Eutric Nitosols occupy 3,500 ha or 20.0% of the study area.

Dystric Cambisols (Bd) or Brunizems occur on the isolated hills, which are sporadically found on the alluvial terraces. These soils are formed on the residual deposits. They have very shallow depth. The soil erosion is generally serious due to their steep topography. Most of the soils are presently used for orchard and/or cultivation of upland crops. These soils are not suitable for irrigated rice. These soils occupy 1,400 ha or 8.0% of the study area. Lithosols (I) cover

the most of western and southern mountains and the dissected foot hills. They are very shallow in depth and generally stony. These soils have almost no agricultural value.

The soil map in the study area is given on Fig. 3.3 (for details, vide ANNEX - IV).

3.3.4 Climate

In and around the study area, there are one (1) meteorological station and nine (9) rainfall gauging stations. The location and collected data of such stations are shown in ANNEX - I. Based on the available data mentioned above, the climatic condition of the study area is summarized as follows.

The study area is graced with favourable climatic condition for the growth of various crops, excepting the uneven annual and seasonal distribution of rainfall. The climate in the area is characterized by three seasons, dry, wet and transitional, according to the seasonal distribution of rainfall. The cease and onset of these seasons widely vary year by year. The wet season usually commences in April and lasts about four (4) months until July, and is followed by the dry season from August to November. The transitional season generally starts in December and ends in March.

The study area receives the average annual rainfall of about 2,100 mm. About 80% of the annual rainfall concentrates between December thru July, while only 20% is distributed within the dry season. The annual rainfall in the Sanrego river watershed averages about 2,850 mm.

The seasonal trend of temperature in the study area is characterized by its narrow variation. The annual mean temperature is 25.9°C, showing the maximum monthly mean of 27.0°C in November and the minimum monthly mean of 24.8°C in July.

The annual mean A-pan evaporation observed at Canning meteorological station reaches 1,570 mm, which corresponds to the daily mean of 4.3 mm. However, these records seem to be small. From calculation results of the potential evapotranspiration using the empirical prediction method, the annual mean A-pan evaporation in the study area is inferred to be about 2,000 mm or the daily mean of about 5.5 mm equivalence.

The relative humidity narrowly varies between the dry and wet seasons, about 83% on an average during the wet season and about 76% during the dry season. The lowest relative humidity occures in September or October, while the highest relative humidity, in June.

The annual mean percentage of sunshine is about 50% or 5.9 hr/day. The monthly mean sunshine hours range from 5.5 hr/day on an average in the wet season to 7.4 hr/day in the dry season.

The monthly mean wind velocity varies between 0.9 m/sec on an average during the wet season and 1.2 m/sec during the dry season, resulting in 1.1 m/sec in terms of annual mean.

3.3.5 Hydrology

(1) Stream flow of the Sanrego river

The Sanrego river is a major tributary of the Walanae river. The Sanrego river originates in the Mt. Bohonglangi of 1,980 m in altitude and flows down from south to northeast in the study area and joins the Walanae river at the northern part of the study area. The total length of the river is about 43 km from the originating point to the confluence with the Walanae river and the average gradient of upper reach is about 3% and lower reach 0.4%. The catchment area of the Sanrego river is 225 km^2 at the confluence with the Walanae river.

In the Sanrego river, two (2) automatic water level gauging stations are installed and these provide relatively reliable data on discharge of the Sanrego river. The monthly mean discharge at the proposed intake weir site with a catchment area of 179.2 km^2 is estimated on the basis of the recent ten (10) years records as follows (details are shown in ANNEX - I):

(Unit: m^3/sec)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
12.2	10.0	10.2	12.4	14.6	14.4	11.4	9.6	6.6	5.6	7.8	10.6	10.5

The maximum monthly mean discharge is 14.6 m^3/sec in May and the minimum 5.6 m^3/sec in October. The annual average runoff is estimated at 331 x $10^6 m^3$, corresponding to the runoff depth of 1,850 mm.

The flood discharge at the Sanrego intake weir site is estimated at 820 m^3/sec with 100-year return period based on the flood records and rainfall data.

(2) Stream flows of small tributaries

In the study area, there exist a number of small tributaries other than the Sanrego river, out of which three (3) tributaries, namely, Parota, Biru and Macinaga have comparatively large catchment areas and are considered to be supplemental water sources for the Project.

The Parota river is one of the tributaries of the Sanrego river and its watershed is located on the northwest of the Sanrego river watershed. The catchment area is estimated at 32.0 km^2 at the junction with the Sanrego river and 30.8 km^2 at the proposed intake weir site. The Biru river is a tributary of the Walanae river and flows down from south to north in the study area. The catchment area is measured to be 20.3 km^2 at the existing intake weir site constructed as the main facility of the Maradda semi-technical irrigation system. The Macinaga river is the upper reaches of the Baruttung river which is one of the tributaries of the Walanae river. The catchment area of the Macinaga river is measured to be 12.1 km^2 at the junction with the Baruttung river and 8.7 km^2 at the proposed intake weir site.

There are no hydrological records for the above tributaries. The discharge of each tributary is estimated based on the isohyetal map which is prepared by use of rainfall data in and around the study area, and the ratio of catchment area of each tributary and the Sanrego river. During the dry season, the discharge of each tributary is very small or almost zero judging from the field inspection and inquiries to villagers nearby. The estimated monthly mean discharges of three tributaries are summarized as shown below (See details in ANNEX - I):

(Unit: m^3/sec)

Tributary	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Parota	1.6	1.3	1.3	1.6	1.9	1.9	1.5	0	0	0	0	1.4	1.0
Biru	1.0	0.8	0.8	1.0	1.2	1.2	0.9	0	0	0	0	0.8	0.6
Macinaga	0.4	0.3	0.3	0.4	0.4	0.4	0.3	0	0	0	0	0.3	0.2

3.4 INFRASTRUCTURE

3.4.1 Irrigation/Drainage System

There exists only one irrigation system in the study area. The Maradda semi-technical irrigation system is located in the gently rolling plain in the southern part of the study area. The water source of the system is the Biru river which is one of the small tributaries of the Walanae river. The irrigation system consists of a permanent intake weir constructed across the Biru river with a catchment area of 20.3 km^2, and the main and secondary irrigation canals of about 5,000 m long with six diversion structures. These facilities were completed in 1934. There are no discharge data of the Biru river and also no measurement records on the intake water. The irrigation area is measured at about 250 ha. The existing irrigation facilities are relatively well maintained by farmers themselves. Natural rivulets adjacent to paddy fields function as the main drainage canals in the system.

3.4.2 Transportation and Communication

A provincial road runs through the study area leading from Ujung Lamuru to Sinjai via Camming and Pallatae. This road is gravel metalled and passable throughout the year. This road links to a major provincial road leading from Ujung Pandang to Watampone at Ujung Lamuru and plays a major role in the transportation in the study area. It takes about four (4) hours by car from Ujung Pandang to the study area by use of these provincial roads.

A number of unpaved rural roads branch off from the above provincial road. Most of them are not jeepable during the wet season due to the poor maintenance and no bridges across the rivers. The density of existing rural roads is still low. The insufficient rural road network and their poor maintenance limit the access to farmlands and hamper agricultural activities in the study area.

No telecommunication system has been installed at all in the study area. The system is not available even in the Kecamatan offices in the study area. Wire and wireless telecommunication system has been networked between major cities and Sinjai, the capital of Kabupaten Sinjai, which is located at about 30 km southeast from the study area.

3.4.3 Electricity and Water Supply

The study area is still isolated from rural electricity supply. In the study area, a few villages independently install the small scaled engine-driven generators. They are operated by the village cooperatives and their operations are generally limited only during night time.

The domestic water supply system has not been developed yet in the study area. The water for domestic use in the area mainly depends on the groundwater or the stream flows. A number of shallow wells have been made available in most of the villages.

3.5 AGRICULTURE

3.5.1 Land Use

The lands in the study area are classified into six (6) land use categories, comprising paddy field, upland field, orchard, grassland, forest, villages and others. The present land use in the study area is summarized as shown below:

Land Use Category	Area	Propotional Extent
	(ha)	(%)
Paddy field	9,000	51
Upland field	2,800	16
Orchard	600	4
Sub-total	12,400	71
Grassland	3,900	22
Forest	300	2
Village/others	900	5
Total	17,500	100

Paddy fields have been mainly developed on the alluvial plains and riverine terraces along the Walanae and Sanrego rivers and their tributaries. Upland fields of about 2,800 ha extend around the village areas, relatively elevated lands and slopes. These are presently used for cultivation of maize, groundnuts, cassava, sweet potato, etc. Orchards of about 600 ha are sporadically located around the village areas and isolated hills, and are cultivated with coconuts, banana, mango, candle-nuts, kapok, etc. The remaining of about 5,100 ha are grasslands, forests, villages and other.

The present land use in the study area is illustrated on Fig. 3.4.

3.5.2 Land Holding and Land Tenure System

In the study area, the size of farm averages 2.36 ha, out of which paddy field accounts for 1.42 ha. This average holding size is larger by 0.62 ha than that of the whole province. The total number of farm households is estimated at about 6,270, out of which about 95% or 5,990 households are holding their own farmlands. The distribution of land holding size over these land owner farmers is as follows:

Land Holding Size (ha)	Total Nos. of Farm Household
less than 0.5	1,902
0.5 - 1.0	1,312
1.0 - 1.5	918
1.5 - 2.0	764
2.0 - 5.0	625
more than 5.0	471
Total	5,992

The small farmers who own 0.1 to 1.0 ha of land occupy about 54% of the farmers. The crop income of these peasant farmers under rainfed condition is insufficient to maintain the livelihood of farmers, and most of these farmers are engaged in various sideline business. Tenant systems are complicated. Tenant charge is generally about 50% of total crop production.

3.5.3 Cropping Pattern

The main crop grown in the study area is paddy, followed by polowijo crops. Most of paddy cultivation are generally made under rainfed condition. The wet season paddy is planted at the onset of the monsoon, generally from March to May, and harvested from July to September. The cultivation of dry season paddy and/or the polowijo crops generally starts in November and December. In case of wet season paddy in 1977, the planted area was about 60% of the total paddy field, and the damaged area was about 50% of the total planted area. The damaged area is classified two cases; about 80% of drought damage and 20% of insects and rodents. Polowijo and upland crops are grown primarily for home consumption as a partial substitute for a complement to rice consumption. When the production of paddy is very low due to various damages, the planted areas of polowijo and upland crops are expanded not only to paddy and upland fields but also to orchard/estate crops fields and houseyards.

The average planted area, harvested area and damaged area of major crops in the study area, from 1977 to 1981, are summarized as follows:

Crops	Planted Area	Damaged Area	Harvested Area
Paddy	7,920	1,330	6,590
Wet season paddy	7,120	1,280	5,840
Dry season paddy	800	50	750
Polowijo Crops	1,750	-	1,750
Groundnuts	1,670	-	1,670
Greenbeans	80	-	80
Upland Crops	4,340	-	4,340
Maize	2,470	-	2,470
Groundnuts	1,440	-	1,440
Cassava	220	-	220
Sweet Potato	210	-	210

The present multi-cropping intensity on the paddy field is estimated at about 110% on an average. Such low cropping intensity is basically attributable to shortage of available water. The crop rotation patterns adopted on the paddy fields can be classified into three major types. They are:

Cropping Pattern	Cropping Intensity (%)	Area (ha)
(1) Paddy - Polowijo crops	90 - 120	8,600
(2) Paddy - Paddy	200	250
(3) Paddy - Polowijo crops or Paddy/Polowijo crops	200 - 250	150
Total	110 (Ave.)	9,000

The pattern (1) is predominant in the study area, accounting for about 96% of the paddy fields. The pattern (2), double cropping of paddy a year, is found in the Maradda semi-technical irrigation area and partly on the alluvial plains extending along the Walanae and Sanrego rivers and their tributaries, where the irrigation water is sufficiently available throughout the year. Pattern (3), triple cropping of paddy and/or polowijo crops, is practiced on the swampy paddy fields of very limited area along the small streams.

3.5.4 Farming Practices

The new high yielding varieties of paddy have been introduced in the area through the Lappo Ase Paddy Intensification Programme. The major varieties are IR32 and IR42, which are medium matured varieties with

growth period of 140 days per crop, and IR28 and IR36, which are early matured varieties with growth period of 110 days per crop. These new varieties occupy about 50 to 70% of the paddy fields. The local varieties are still used mainly for home consumption. Paddy seeds are selected from last harvest or are supplied from the seed centers. Paddy seeds are generally sown at the rate of 25 to 30 kg per ha on the nursery which is prepared in the size of about 1/20 to 1/25 of the paddy field to be transplanted. The seedings are generally grown for 20 to 25 days.

Transplanting is generally carried out by hand. The random transplanting is common and number of seedlings (hills) for transplanting is generally not many, being 10 to 18 per m^2. After transplanting, weeding is practiced one or two times by hand for each cropping season. The use of fertilizer and agro-chemicals is generally low except for the limited area under the BIMAS program. The average dosages of the BIMAS package are 100 kg of urea, 50 kg of T.S.P, 2 liter of insecticide and 2 kg of rodenticide per hectare. Potasium fertilizer is not generally used. Fertilizers are generally broadcasted by hand. Insecticide is applied to the field by use of knapsack type sprayers.

Harvesting is generally practiced in two methods depending on the varieties; one is the method of cutting all straws using sickles, which is applied for new high yielding varieties, and the other is the traditional method for local varieties, so-called "ani-ani", cutting only panicles. The harvested paddy is dried on the ground surface of the paddy field and/or near the houseyards.

The cultivation method of polowijo and upland crops is very primitive. Neither fertilizers nor improved varieties are used. On about 50% of the upland fields, intercropping with maize and groundnuts is practiced.

3.5.5 Crop Yield and Production

The crop yield and production under present condition are estimated on the basis of production data obtained from four (4) Kecamatan offices. These data indicate that the crop yield and production largely fluctuate year by year due to wide variation of annual rainfall and unexpected damages caused mainly by drought. The crop yield and production under present condition are, therefore, estimated to be average from 1977 to 1981.

The average unit yield of paddy (dried paddy) during recent 5 years is 2.23 ton/ha for wet season paddy and 2.50 ton/ha for dry season paddy. In 1981, the Lappo Ase programme was operated on about 4,700 ha in the study area. The average unit yield obtained through the Lappo Ase programme was 3.5 to 4.0 tons/ha. This spectacular increase was not only due to the Government special effort but also sufficient and well distributed rainfall during the wet season of 1981.

The unit yields and productions of polowijo and upland crops also fluctuate year by year and place by place, depending on availability of water. Since no farm inputs like fertilizers and agro-chemicals are used, unit yields are generally low. The average unit yields of polowijo and upland crops are 0.73 and 0.59 ton/ha of groundnuts, 0.40 ton/ha of greenbeans, 0.63 ton/ha of maize, 5.96 ton/ha of cassava and 3.26 ton/ha of sweet potato.

The average annual productions of paddy, polowijo and upland crops in the study area are summarized below:

Crops	Harvested Area (ha)	Unit Yield (ton/ha)	Production (tons)
Paddy	6,590		14,900
Wet season paddy	5,840	2.23	13,020
Dry season paddy	750	2.50	1,880
Polowijo Crops	1,750		1,250
Groundnuts	1,670	0.73	1,220
Greenbeans	80	0.40	30
Upland Crops	4,340		4,400
Maize	2,470	0.63	1,560
Groundnuts	1,440	0.59	850
Cassava	220	5.96	1,310
Sweet Potato	210	3.26	680

3.5.6 Livestock Production

Livestock raising is not a mainline of agricultural activities in the study area. The number of livestock animals within the boundaries of Desa under study is as follows:

(Unit: head)

Livestock	Total Number	Per Farm Household
Cattle	12,200	1.95
Buffalo	5,220	0.83
Horse	2,540	0.41
Goat	870	0.14
Fowl	26,710	4.26
Duck	2,350	0.38

Most of livestock are generally grazed on grassland and/or the paddy fields after harvest. No special feeding to them is practiced. The livestock plays an important role in farm operation and transportation as motive power, and also in protein food supplies. The livestock products are used for home consumption and also are sold from time to time to meet special expenses. Annual income from livestock is, however, of little significance to the Project. It will be excluded from project economy.

3.5.7 Marketing and Prices

In the study area, the most important food crop is rice. The total annual production of paddy is estimated at about 14,900 tons on an average from 1977 to 1981. The total consumption of paddy for total population of 38,400, is estimated at about 8,840 tons on the assumption that per capita consumption is 230 kg of dried paddy per annum. The annual surplus amount of paddy is, therefore, estimated at about 6,060 tons. The marketable surplus rice after deducting the home consumption, seed stock, handling and storing losses, is estimated at about 4,740 tons of dried paddy or about 3,100 tons of milled rice.

The surplus of paddy produced by the farmers is generally sold to KUD and/or middle men through brokers. The paddy collected by KUD is sold to DOLOG after milling, while the paddy collected by middle men is generally transported to outside of the study area. About 86% of surplus paddy is marketed through these two channels. The remaining 14% of the surplus paddy is sold at local markets in and around the study area by small brokers and/or directly by farmers.

The present low production and poor quality of polowijo and upland crops have resulted from poor marketability together with large fluctuation of market prices. Most of these surplus crops such as groundnuts and greenbeans are traded by middle men, and/or directly sold at local market by farmers.

The price of rice is generally controlled by the Government through DOLOG. When the market price is down under the floor price, DOLOG purchases the marketed rice and when the price is over the ceiling price, DOLOG sells its stocks.

The present farm gate prices of the farm products are shown below:

(Unit: Rp/kg)

Crop	Price	Crop	Price
Dried Paddy	85	Maize	70
Groundnuts	260	Cassava	65
Greenbeans	205	Sweet Potato	85

3.5.8 Present Agricultural Production Value

The gross crop production value under present condition is estimated at Rp2,064 million (US$3.1 million) as a whole in the study area as shown below:

Crops	Annual Production (tons)	Unit Prices (Rp/kg)	Production Value (10^6Rp)
Paddy	14,900		1,267
Wet season paddy	13,020	85	1,107
Dry season paddy	1,880	85	160
Polowijo Crops	1,250		324
Groundnuts	1,220	260	317
Greenbeans	30	205	7
Upland Crops	4,400		473
Maize	1,560	70	109
Groundnuts	850	260	221
Cassava	1,310	65	85
Sweet Potato	680	85	58
Total	-	-	2,064

The crop production cost under present condition totals Rp1,440 million (US$2.1 million), as summarized below:

Crops	Planted Area (ha)	Unit Production Cost (Rp/ha)	Total Production Cost (10^6Rp)
Paddy	7,920		1,000
Wet season paddy	7,120	125,000	890
Dry season paddy	800	138,600	110
Polowijo	1,750		168
Groundnuts	1,670	97,000	162
Greenbeans	80	70,000	6
Upland Crops	4,340		272
Maize	2,470	42,000	104
Groundnuts	1,440	91,000	131
Cassava	220	83,000	18
Sweet Potato	210	89,000	19
Total	-	-	1,440

The annual net production value under present condition in the study area is then calculated at Rp624 million (US$0.9 million) in total, by deducting the total production costs from the total gross production value.

3.5.9 Farm Economy

At present, the total number of farm households in the study area is at about 6,270, out of which about 95% or 5,990 households are land owner. The average size farmers cultivate 2.36 ha of farmland, comprising 1.42 ha of paddy field, 0.40 ha of upland and 0.54 ha of orchard field. The peasant farmers who own 0.1 to 1.0 ha of land occupy about 54% of total farmers. These farmers get their income mainly from farming activities particularly from the paddy production, partly supplemented by sales of polowijo crops. However, the present farm incomes of the farmers under rainfed field condition are insufficient to maintain the livelihood of farmers. Most of these farmers are engaged in various sideline business, such as carpenter, seasonal labour work and migration to Watanpone, Parepare and Ujung Pandang in the dry season. As animal husbandry is not a mainline of agriculture in the study area, income from the sales of livestock is very limited.

According to the statistical data and the farm economy survey, the average size of family is 5.7 persons per household. The result of farm budget analysis under present condition is summarized below (details are given in ANNEX - V):

Description	Average Size Farmer	Peasant Farmer	
Total Farm Land (ha)	2.36	1.00	0.50
Gross Income (Rp)	529,400	399,800	338,100
Farm Income	347,600	163,800	82,100
Farm Labour Income	54,500	70,800	76,800
Off-farm Income	127,300	165,200	179,200
Gross Out-go (Rp)	520,800	403,200	333,100
Farm Expenses	104,800	46,200	23,100
Living Expenses	416,000	347,000	310,000
Net Reserve (Rp)	8,600	6,600	5,000

The above farm budget analysis indicates that farm incomes of the average size and peasant farmers are insufficient to maintain their family living expenses. Even though the average size farmer earns about Rp181,800 or 34% of gross incomes from farm labour and off-farm business, the net reserve is generally negligibly small.

3.6 AGRICULTURAL SUPPORT SYSTEM

3.6.1 General

The South Sulawesi Province, one of the 27 provinces in whole Indonesia, is administratively divided into 21 Kabupaten (Districts) and 2 Kota Madya (Municipalities), headed by "Bupati" and "Walikota", respectively nominated by the Governor of the Province. These Kabupaten and Kota Madya are subdivided into 169 Kecamatan (Sub-districts) headed by "Camat" nominated also by the Governor. Under the Kecamatan, there are 1,136 Desa (Villages) which are the basic units of administrative structure in Indonesia. One Kecamatan covers about 7 Desa on an average in South Sulawesi Province.

The Kabupaten Bone where the study area is entirely covered, has 21 Kecamatan and 205 Desa. In the study area, 4 Kecamatan and 14 Desa are included.

3.6.2 BIMAS/INMAS and INSUS Programs

The agricultural intensification programs so-called "BIMAS" and "INMAS" have been promoted by the Indonesian Government in order to facilitate the crop production increase with coordination of all the "package" of agricultural inputs to the farmers since 1963. For further development of BIMAS/INMAS programs, the Government has initiated to organize a village unit (Wilayah Unit Desa) as the lowest executive unit of the Program since 1973. In general, each village unit comprises 2,000 farmers with 600 to 1,000 ha of irrigated paddy field and has the following agricultural support services:

(1) Extension services by Field Extension Worker (PPL),

(2) BIMAS credit services by village unit branch of Indonesian People's Bank (BRI),

(3) Farm inputs supply services by village unit KIOSK, and

(4) Cooperation processing and marketing by village unit cooperative (KUD).

In order to further promote the BIMAS/INMAS programs, special intensification program so-called "INSUS" has been launched since 1979. The INSUS program is a special form of BIMAS for farmer's groups which are voluntary organized by progressive farmers.

In the study area, there are 3 village units with 1 BUUD/KUD, 13 KIOSK. The areas served by the BIMAS and INMAS programs in the study area are estimated at about 825 ha and 985 ha, respectively in 1982. About 27 farmer's groups have been organized and about 75 farmers or 10% of the member are served by INSUS program. This very low coverage in comparison with about 50% of the whole Indonesia in 1979/1980 is mainly due to very fact that there are few notable technical and semi-technical irrigation facilities, and almost no sufficient agricultural supporting services in this area.

3.6.3 Research

The Maros Research Institute for Food Crops (MARIFC) is located at Maros, about 40 km north from Ujung Pandang. This MARIFC has 146 ha of experimental fields of which 110 ha are for rice experimental fields. About 40% of experimental works are devoted to the experiment of rice such as variety test, fertilizer test and test for control of pests and disease on irrigated paddy.

There are 2 branch experimental stations under the control of the MARIF. One is located at Lanrang, Kabupaten Sidrap and is mainly carrying out the rice experiment with 44 ha of irrigated paddy field. The other located at Gowa, is mainly undertaking upland crops such as maize, sorghum, groundnuts, etc.

3.6.4 Extension Service

The organization of agricultural extension service in South Sulawesi is formed by two separate lines, i.e. administrative line and operational line under the supervision of inspector of provincial agricultural extension service. The subject-matter specialist (PPS) staying in each Kabupaten assists and advises about ten (10) Extension Supervisors (PPM) of which two (2) to four (4) are working in Kabupaten office. The rests are staying in the Rural Extension Centre (BPP), and assist and advise about ten (10) field extension workers (PPL).

The greater part of the study area is under the BPP Palattae. The remainder part in Kecamatan Tonra is under BPP Mare. Total members of PPM & PPL under BPP Palattae and BPP Mare are 4 and 16, respectively, and in the study area, there are 3 village units and 112 key farmers.

3.6.5 Seed Multiplication

The provincial seed center located at Maros about 40 km north from Ujung Pandang is only one institute which produces stock seeds of new recommended varieties of paddy in South Sulawesi. The foundation seeds supplied from the Central Research Institute for Food Crops (CRIFC) are multiplied to the stock seed at this Center. The seed center distributes these stock seeds to 37 seed stations managed by each Kabupaten Office. There is one seed station located at Bengo in Kabupaten Bone. This station produces the extension seeds and distributes them to 8 seed growers covered about 30 ha of paddy and 20 ha of polowijo crops fields in 1981/1982. The seed growers produce paddy seeds and supply them to the farmers through BUUD/KUD according to the BIMAS/INMAS program. New varieties of IR42 and IR52 are introduced to Kabupaten Bone in 1980/1981 and these varieties are used more than 50% of total paddy fields.

3.6.6 Agricultural Credit

The Indonesia People's Bank (BRI-Bank Rakyat Indonesia) is the state bank specialized in agricultural credit covering whole country and has a broad network composed of many regional offices, branch

offices and sub-branch offices (village unit BRI). The bank is authorized to finance BIMAS package credit for farmers. There are several kinds of BIMAS packages. The load condition is fixed at the interest rate of 1% per month and the repayment period of 7 months.

In the study area, there are 1 branch office and 4 sub-branch offices of the Indonesian People's Bank (BRI). The loan amount for BIMAS package has steadily increased and it exceeds about Rp35 million in 1982 in the command area of said 4 sub-branch offices.

3.6.7 Farm Inputs Supply

Distribution of fertilizers is handled by PT. PUSRI and agro-chemical is handled by PN. PERTANI, the government enterprise in the South Sulawesi Province. According to the BIMAS/INMAS programs, fertilizers and agro-chemicals are supplied to 4 sub-distributors appointed by PT. PUSRI at Ujung Pandang and then necessary amounts of such farm inputs are transported by sub-distributors to the retailers and/or KUD at the local level. The distribution prices of these agricultural inputs are controlled by the Government. Distribution prices of Urea and TSP to the farmers are fixed at Rp70/kg and the agro-chemicals at Rp1,230/lit in 1981/1982.

3.6.8 Farmers Cooperatives

The main activities of Village Unit Cooperative (BUUD/KUD) are to purchase the farm products directly from farmers and to re-sell those to DOLOG. The other activities of BUUD/KUD are the supply of necessary inputs such as improved seeds, fertilizers, agro-chemicals, some farming instruments, and marketing of farm products.

In the study area, 1 KUD has been organized so far and total number of KUD members including candidates is about 770. The main processing facility owned by BUUD/KUD is rice-mill. The number of rice mill is counted for 65 and most of the rice mill have small capacities.

CHAPTER IV PROJECT FORMULATION

4.1 BASIC CONCEPT FOR DEVELOPMENT

The study area is one of the most depressed areas in agricultural productivity in the Central South Sulawesi. Most of the population in the study area are engaged in agriculture and related activities. In spite of high potentials for agricultural development, the study area has not been fully developed mainly due to the lack of irrigation facilities. At present, irrigation facilities are quite limited in the area and paddy cultivation is generally made under rainfed condition. Paddy cultivation is concentrated in the wet season and is very limited in the dry season. The areas under paddy cultivation fluctuate year by year, depending on available rainfall. As far as cultivation technique is concerned, there is much room for improvement. In the study area, agricultural extension services are not so active. The farmers are not well aware of modern rice farming.

All these constraints keep the present crop yields at low level, with an average unit yield of 2.2 tons/ha for wet season paddy and 2.5 tons/ha for dry season paddy. In addition to the above, the present poor road conditions except the provincial road in the study area make the transportation of farm inputs and outputs so difficult and also hamper agricultural activities.

The Sanrego Irrigation Project aims at increasing crop production and thereby improving the living standard of the local inhabitants in the Project area through implementation of irrigation facilities. Maximum effective use of water and land resources, and introduction of improved irrigation farming are the most important key factors for the development of the Project area. With this in view, the basic concept for development in the Project area would be as follows:

(1) Special attention should be paid to the increase in irrigation area by use of available water resources to the possible maximum extent,

(2) Unit yield and production of wet season paddy should be stabilized and improved through establishment of new irrigation system and introduction of irrigation farming practices,

(3) Total planted area of dry season paddy and/or polowijo crops should be increased with year-round irrigation system and thereby total crop production be maximized.

(4) Present rural road network should be improved and the agricultural activities be made more active, and

(5) Agricultural institutions, which support agricultural development, should be strengthened, especially in the field of agricultural extension services.

There exist two approaches to the project formulation for irrigation development in Sanrego area as mentioned in Chapter I, Project History. The Master Plan indicates that the Sanrego river will serve the irrigation area of 10,000 ha in net out of 17,500 ha in gross. The irrigation plan prepared by DOI aims to irrigate an area of 8,071 ha in net out of 12,000 ha in gross with the same Sanrego river flow. The DOI Plan area is included in the Master Plan area.

Considering the basic concept for the development, the irrigation area will be selected with a view to making maximum use of land and water resources endowed around the study area. In selecting the most suitable irrigation development area, the following principal factors are taken into consideration: (1) water resources, (2) land resources, and (3) regional socio-economic condition. The most optimum development area will be determined by super-imposing the study results of those principal factors.

4.2 ASSESSMENT OF WATER RESOURCES

4.2.1 Water Sources

The main source of irrigation water to be used for the Project will be the Sanrego river judging from the geographical distribution of the irrigation area and the water occurrence in volume and time of the Sanrego river flow. Three (3) major tributaries, namely, Parota, Biru and Macinaga rivers will be considered to be supplemental water sources for the project in addition to the Sanrego river.

In the Sanrego river, two (2) automatic water level gauging stations are installed and these provide relatively reliable data on daily discharge of the Sanrego river for recent nine (9) years from 1974 to 1982. While, there exist no hydrological data for the above three tributaries. The discharge of each tributary is estimated based on the isohyetal map which is prepared by use of rainfall records in and around the study area, and the ratio of catchment area of each tributary and the Sanrego river as mentioned in Chapter III (details are given in ANNEX - I).

4.2.2 Irrigation Water Requirement

The study on the irrigation water requirement is made based on the empirical prediction method using climatological data making cross-checking of the predicted values by actual field measurement of water consumption. The estimate of irrigation water requirement is made for a series of nine years from 1974 to 1982 to make assessment of the availsble irrigation water by means of seasonal water balance.

The consumptive use of water is estimated as a product of potential evapotranspiration with crop coefficients relating to crop growth stages. The modified Penman method is employed in predicting potential evapotranspiration for the reason of the accuracy and the data available for it.

Percolation loss is measured in the fields and is estimated at 2 mm/day both for the wet season and dry season cropping. The nursery water requirement is estimated at 270 mm for dry season cropping and 260 mm for the wet season cropping, respectively for a period of 25 days. The puddling water requirement is assessed at 200 mm for the dry season cropping and 190 mm for the wet season cropping, respectively, under the condition that the puddling water is gradually supplied for 10 days.

Effective rainfall is estimated by applying the daily water depth balance method using the rainfall data at Palattae, Maradda and Canning in the study area, under the following conditions: (i) water consumption rate in the field is the sum of percolation and consumptive use of water, (ii) average water holding capacity in the field is assumed at 50 mm, and (iii) intercepted loss of every rainfall is assumed at 2 mm.

Conveyance and application losses are set at 20%, respectively, which result in 64% of the total irrigation efficiency.

The seasonal irrigation water requirements for the above-mentioned period are estimated on 10-day basis. The details are given in ANNEX - VI.

4.2.3 Irrigable Area

The irrigation water requirements vary from year to year, and throughout the year. The discharge records of the Sanrego river made available for nine years since 1974 indicate the large fluctuation of the discharge. There is difference in time of occurence between the available water from the river and the irrigation water requirement. In order to estimate the irrigable area guaranteed by the river flow, the seasonal water balance study between the supply and the requirement is conducted for the period of 1974 to 1982, which is judged to be an average or somewhat dryer period in the long term rainfall fluctuation.

The balance calculation is made by means of dividing the river discharge by the diversion water requirement on the daily basis. In determination of guarantee irrigation area, it is assumed that the lack of water supply for a short period will not affect the successful crop yield in consideration of the effect of the standing water in the field. The acceptable period for the lack of water supply is assumed to be 5 days and the average values for the critical low flow period of ten (10) days are taken as the irrigable area guaranteed by the river flow.

The irrigable area is estimated for the proposed cropping pattern based on the water balance study with two (2) cases depending on the water sources for the Project as shown below (for details, see ANNEX - VI):

(Unit: ha)

Alternative	Irrigable Area with Irrigation Dependability Level of 80%	
	Wet Season Paddy	Dry Season Paddy
Case 1 Water source: Sanrego river only	6,300	3,700
Case 2 Water sources: Sanrego river & three tributaries	8,000	4,000

4.3 ASSESSMENT OF LAND RESOURCES

4.3.1 Present Land Use

The aerial photos scaled 1/10,000, which were newly made available through JICA in August 1982, were fully utilized for the present land use study. The areas of each land use category were measured on the basis of the topographic maps scaled 1/5,000 prepared by DOI for the DOI area and those scaled 1/25,000 prepared by JICA for Master Plan area. The land use conditions in both areas covered by the two existing plans are:

(Unit: ha)

Land Use	DOI Plan		Master Plan	
	Gross /1	Net /2	Gross /1	Net /2
Paddy Field	7,700	6,850	9,000	8,100
Upland Field	1,700	480	2,800	1,900
Grassland	1,300	610	3,900	-
Orchard/Forest	700	130	900	-
Village/Others	600	-	900	-
Total	12,000	8,070	17,500	10,000

/1: Gross area includes existing raods, rivers, high elevated lands which are not topographically irrigable, ffield boarders and lands to be used for new irrigation/drainage canals and farm roads.

/2: Net irrigation area.

The both plans include the land reclamation works for development of new paddy fields: i.e., 1,220 ha for DOI Plan and 1,900 ha for Master Plan.

4.3.2 Soil Suitability for Paddy

The soil units identified in the both areas are:

(Unit: ha)

Soil Unit	DOI Plan		Master Plan	
	Gross	Net	Gross	Net
Suitable for Irrigated Rice				
- Eutric Gleysols	1,600	1,170	1,800	1,400
- Eutric Fluvisols	3,500	2,870	4,600	3,200
- Dystric Fluvisols	4,500	3,620	5,100	3,800
- Pellic Vertisols	300	270	300	200
Sub-total	9,900	7,930	11,800	8,600
Marginal for Irrigated Rice				
- Eutric Nitosols	1,100	140	3,500	1,400
Non Irrigable				
- Dystric Cambisol	1,000	-	1,400	-
- Lithosol	-	-	800	-
Total	12,000	8,070	17,500	10,000

The marginal soils for irrigated rice occupy 1,400 ha in the Master Plan area and only 140 ha in DOI Plan area. Dystric Cambisol and Lithosols are not topographically irrigable and also are not suitable for irrigated rice due to their general features of shallow and stony soils.

4.4 ASSESSMENT OF SOCIO-ECONOMIC CONDITIONS

4.4.1 Available Labour Force

The total workable population in adult-man equivalent as of 1990 is forecasted to be about 21,000 which corresponds 3.12 man-day per household. The available labour force for paddy cultivation is estimated at 2.19 man-day per household deducting the labour requirement for farm operations on upland and orchard, household work and herding from the forecasted total workable labour force.

The labour balance study is made based on the above available labour force and the labour requirement analysis for the proposed cropping pattern shows that the maximum area, which can be put under intensive rice cultivation, will not be more than 8,000 ha as a whole, in terms of labour availability (details are shown in ANNEX-V).

Most of the areas covered by the both plans are privately owned, and are very scarce of the government land. The transmigrations could not be realistic and the available labour force would not be increased drastically under such situation.

4.4.2 Beneficiary Farmers

The village compounds are sporadically located mainly over the paddy field areas, and about 90% of the total farm household are included in the area delineated by DOI. There is no meaningful difference between the two existing plans in number of the beneficiary farmers.

4.4.3 Neighboring Sugar Project

A large scale sugar project is now under construction on the areas neighboring eastwards of the irrigation area. The project is planned to have a factory of 3,000 ton capacity a day and cane plantation field of 13,000 ha. The location of the planned sugar cane fields is mostly overlapped with the northern area of the irrigable land indicated by the Master Plan (see Fig. 2.1). The soils of these overlapped areas are marginal for irrigated rice and more suitable for sugar cane growing.

4.5 POTENTIAL AREA FOR DEVELOPMENT

The potential maximum area for irrigation development is decided, by superimposing the above study results, at 8,000 ha in net, which corresponds to the area delineated by DOI. The most optimum development area will be determined within this potential maximum area through assessment of water resources and water balance study and also by making an examination of economic viability for possible alternative plans.

4.6 DETERMINATION OF DEVELOPMENT PLAN

The water balance study indicates that the Sanrego river will supply the irrigation water only to the area of 6,300 ha with the irrigation dependability level of 80%, and the combination use of the Sanrego river and three tributaries, i.e., Parota, Biru and Macinaga rivers will cover the irrigable land of 8,000 ha. From the viewpoint of the labour availability, the maximum area under intensive rice cultivation will not be more than 8,000 ha in net as a whole. The land capability study identifies that the irrigable land of about 8,000 ha in net proposed by DOI consists of 6,800 ha of existing paddy field and 1,200 ha of upland, grassland and orchard. These upland, grassland and orchard will require the reclamation works for development of new paddy field.

There exist no drainage problems in the area, except narrow strip lands along the rivers and streams. This factor does not affect the delineation of the most suitable irrigation area.

In order to select the optimum development plan of the Project, preliminary technical and economical comparison is made for the following two (2) alternatives:

Alternative - 1: This aims to serve the irrigation area of 6,300 ha by the available water of the Sanrego river only with the modified irrigation system of the built-up DOI design.

Alternative - 2: This aims to serve the possible largest area of 8,000 ha by the available water of the Sanrego river and three tributaries with the irrigation system based on the built-up DOI design and new supplemental facilities for three tributaries.

The general features of the above alternatives are determined based on the preliminary design and are summarized as follows:

Description	Alternative - 1	Alternative - 2
Water Sources	Sanrego river	Sanrego river & three tributaries
Irrigation Area		
- Wet season paddy	6,300 ha	8,000 ha
- Dry season paddy	3,700 ha	4,000 ha
Project Facilities		
- Irrigation facilities	(1) Sanrego intake weir	(1) Sanrego intake weir
	(2) Main & Secondary canal system - Length: 97.9 km - Design discharge: 10.1 m^3/sec	(2) Main & Secondary canal system - Length: 109.1 km - Design discharge: 12.9 m^3/sec
	(3) Tertiary system 6,300 ha	(3) Small-scaled intake weirs on the tributaries - Number: 3
		(4) Connecting canals - Length: 4.9 km
		(5) Tertiary system 8,000 ha
- Farm road	13.2 km	13.2 km
- Reclamation work	-	1,200 ha

For the above alternatives, the preliminary economic evaluation is carried out to select the optimum plan for the Project in terms of the internal rate of return. The calculation condition and the result are shown below:

Description	Alternative - 1	Alternative - 2
Development Area (ha)	6,300	8,000
Condition of Comparison		
- Project life (years)	50	50
- Construction period (years)	8	8
- Build-up period to full development stage (years)	5	5-for existing paddy fields 8-for reclamation areas
Economic Cost and Benefit		
- Total economic cost ($\times 10^6$Rp)	19,632	22,668
- Annual net incremental benefit ($\times 10^6$Rp)	5,858	7,155
Internal rate of return (IRR) (%)	14.6	15.1

The economic evaluation indicates that Alternative-2 shows higher IRR of 15.1% than that of 14.6% of Alternative-1. Besides, Alternative-2 will ensure the irrigation for the possible maximum land of 8,000 ha making the maximum effective use of the water sources for the Project.

Consequently, the Sanrego Irrigation Project would be formulated so as to serve the irrigation area of 8,000 ha with the irrigation system based on the built-up DOI design and new supplementary facilities by utilizing the available water from the Sanrego river and three tributaries, i.e., Parota, Biru and Macinaga.

CHAPTER V THE PROJECT

5.1 AGRICULTURAL DEVELOPMENT PLAN

5.1.1 General

The Project area is considerably matured area for agricultural production under rainfed condition with a fixed crop rotation system. Under such condition, the agricultural economy of the area is rather stable and no significant improvement is made unless large scale irrigation project is implemented. The production techniques such as new varieties, more efficient use of fertilizers, prevention of pests and diseases as well as water management techniques are always changing and gradually progressing and certainly lead to change in agricultural production. These changes are, however, neglected in the estimation of possible changes attributable to the Sanrego Irrigation Project, because the effect of these factors is generally insignificant under rainfed condition.

5.1.2 Change in Land Use

After the implementation of the Project, the farmland within the Project area will be fully irrigated and more intensive use of the farmland will be come possible.

The present land use in the project area will change with project as follows:

(Unit: ha)

Description	Without Project	With Project
- Total area	12,000	12,000
- Non irrigable lands/1	2,900	2,900
- Gross irrigable area	9,100	9,100
- Field borders and lands to be used for new canal and farm roads	800	1,100
- Total net arable lands	8,300	8,000
- Net irrigation area	-	8,000
- Land use within net arable/ irrigation area		
- paddy field	7,050	8,000
- upland	510	-
- orchard	130	-
- grassland	610	-
Total	8,300	8,000

(Unit: ha)

Description	Without Project	With Project
- Area planted		
- paddy field	7,050	8,000
- upland	510	-
- orchard	130	-
Total	7,690	8,000
- Area harvested		
- paddy field	5,780/2	8,000
- upland	510	-
- orchard	130	-
Total	6,420	8,000

/1: villages, roads, rivers and the elevated lands.

/2: average rate of present crop damages in area is deducted.

The irrigation area of 8,000 ha with project comprises the existing paddy field of about 6,800 ha and upland, orchard and glassland of 1,200 ha. All these existing lands within the proposed irrigation area would be changed into the irrigated paddy fields under the Project.

5.1.3 Proposed Cropping Pattern

In selecting the proposed crops and cropping pattern to be adopted by the Project, the following basic principles are conceived:

(1) The crops and cropping pattern must create benefits for the farmers as well as the nation as a whole,

(2) The crops and cropping pattern must make optimum utilization of water to be supplied by the Project,

(3) The crops and cropping pattern should be practical with the limited number of family labour, and

(4) The crops and cropping pattern must conform with the existing social tradition and be acceptable to the farmers.

In due consideration of the basic principles described above, rice and polowijo crops including greenbeans and groundnuts are selected in making alternative cropping patterns as the major crops. With these concepts, four (4) alternatives are considered as follows:

(1) Pattern A: Double Cropping of paddy a year

(2) Pattern B: Wet season paddy and a combination of paddy and polowijo in the dry season

(3) Pattern C: Three crops of paddy and two crops of polowijo in 2 years

(4) Pattern D: Two crops of paddy and three crops of polowijo in 2 years

These alternative cropping patterns are prepared under careful studies on climatic condition, agronomic requirement for farming practices and seasonal water availability.

For determination of the most optimum cropping pattern, water balance study was firstly made through the water requirement calculation for each alternative pattern and assessment of the available water resources. According to the result of water balance study made on the basis of the Sanrego river flow and three major tributaries, the maximum irrigable areas for each pattern with 80% dependability are:

	Wet Season Paddy (ha)	Dry Season Paddy (ha)	Polowijo Crops (ha)	Cropping Intensity (%)
Pattern A	8,000	4,000	-	150
Pattern B	8,000	3,000	3,000	175
Pattern C	8,000	2,300	6,400	210
Pattern D	8,000	-	10,400	230

Based on these maximum irrigable areas for each pattern, profitability (net production value) and labour requirement for each alternative are calculated as follows:

Alternative	Profitability (10^3Rp/ha)	Labour Requirement (man-day/ha)	Water Requirement ($10^3 m^3$/ha)
Pattern A	1,112.6	217.4	13.8
Pattern B	1,110.4	231.8	13.9
Pattern C	1,129.7	251.8	14.5
Pattern D	1,021.6	253.6	13.4

As seen from the above table, the Pattern C is the most profitable followed by Pattern A and Pattern B. The Pattern D is less profitable. The unit net production values per man-day of labour and per m^3 of irrigation water are also calculated for each alternative pattern, as shown below:

Alternative	Unit Profitability	
	Labour	Water
	(10^3Rp/man-day)	(Rp/m^3 of water)
Pattern A	5.16	81.3
Pattern B	4.79	79.9
Pattern C	4.49	77.9
Pattern D	4.03	76.2

The pattern A will create the largest economic returns from unit irrigation water to be supplied by the Project and also from the unit labour to be spent for farming works under the Project.

The present extensive farming practices, with low inputs and therefore low outputs, would be changed to intensive ones under irrigated condition. As the total areas under cultivation would not physically change even in future, the unit available labour force per ha under the Project would depend on the scale of the Project area. If the project area is fixed at smaller scale, intensive cropping will become possible. On the contrary, if the project area is maximized up to the potential maximum area of about 8,000 ha, only the pattern A and pattern B, are practicable with the forecasted available labour force (See ANNEX - V). The potential maximum areas under each alternative cropping pattern will be estimated as follows:

Alternative	Peak Labour Requirement	Maximum Adaptable Area
	(man-day/ha)	(ha)
Pattern A	1.61	8,000
Pattern B	1.62	8,000
Pattern C	1.80	6,500
Pattern D	1.80	6,500