

REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF
WATER RESOURCES DEVELOPMENT

# FEASIBILITY STUDY ON THE LANGKEMME IRRIGATION PROJECT

## MAIN TEXT

MARCH 1981

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

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# PREFACE

The Government of Japan, in response to a request from the Government of the Republic of Indonesia, decided to conduct a feasibility study on the Langkemme Irrigation Project, one of the priority projects identified in the Master Plan implemented in 1978/79 fiscal year, and entrusted the study to the Japan International Cooperation Agency. The Agency organized a feasibility study team headed by Mr. H. Yamamoto of Nippon Koei Co., Ltd. and dispatched the team to the project site to carry out the feasibility study from July, 15 to December, 25 in 1980.

The report presented hereby has been compiled based on the results of surveys and studies undertaken in the field as well as on the discussions which took place between the Indonesian Authorities concerned and the Team. I sincerely hope that this report will substantially contribute to the regional development in the Central South Sulawesi as well as the implementation of this project.

Finally, I wish to express my heartfelt gratitude to the authorities and officials concerned in the Republic of Indonesia for the assistance and cooperation extended to the team, without which could not have been completed so successfully.

March, 1981

Keisuke ARITA
President
Japan International Cooperation Agency

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

Dear Sir,

LETTER OF TRANSMITTAL

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

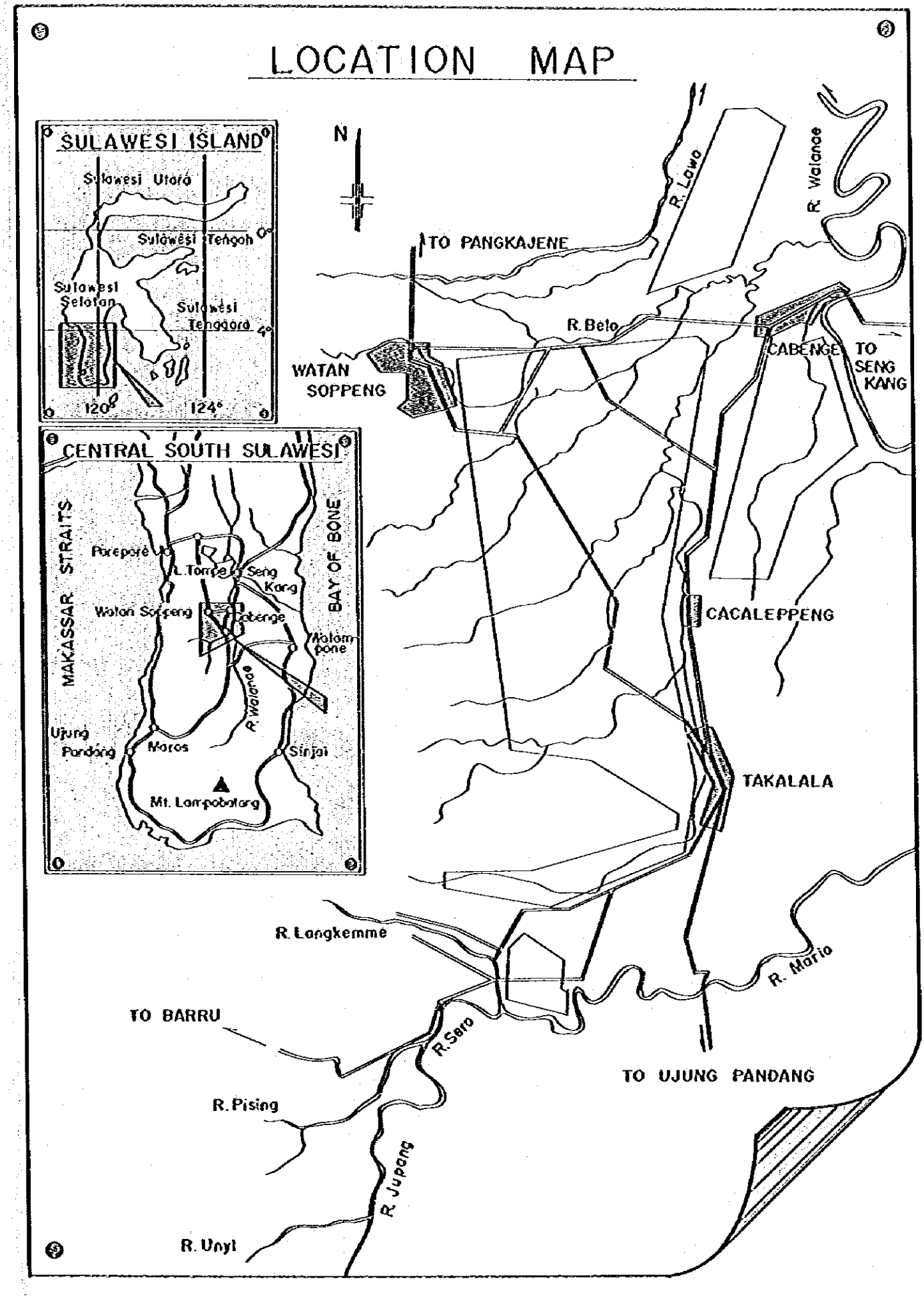
The project is basically formulated for the sharp increase of agricultural production and the improvement of farmers' living standards in the Langkemme area of 6,400 hectares through exploitation of irrigation water resources. With implementation of the project, the annual production would amount to about 77,000 tons of dry stalk paddy and about 9,000 tons of polowijo crops at the full development stage of the project. The increased amount of agricultural products would substantially contribute to the regional economy in the Central South Sulawesi region. The economic internal rate of return of the proposed project is estimated to be 14.7 percent and the project is verified to be economically feasible. In view of the importances and needs of the project in the regional economy, we would recommend that the project will be soon 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 your Agency, the Embassy of Japan in Indonesia and the Authorities concerned of the Government of Indonesia for the courtesies and cooperation extended us during our field surveys and studies.

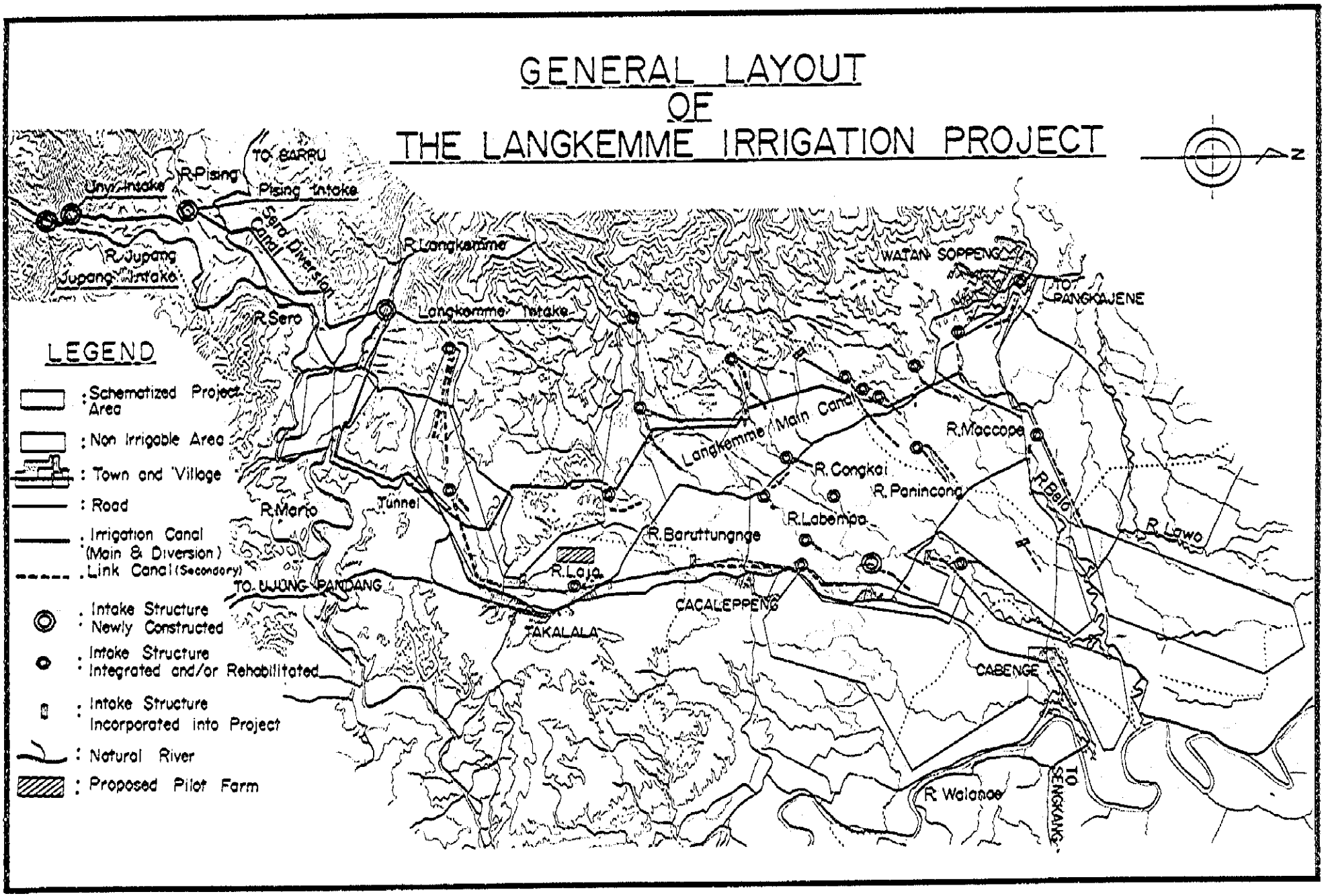
Very truly yours,

Hiroshi Yamamoto

Hiroshi YAMAMOTO
Leader of The Survey Team for
the Langkemme Irrigation Project


LOCATION MAP
SULAWESI ISLAND
Sulawesi Utara
Sulawesi Tengah
Sulawesi Selatan
Sulawesi Tenggara
120°
124°
4°
N
CENTRAL SOUTH SULAWESI
MAKASSAR STRAITS
BAY OF BONE
Parepare
L. Tempe
Seng Kang
Watan Soppeng
Cabenge
Malompone
R. Walanae
Ujung Pandang
Maros
Sinjai
Mt. Lampobatang
TO PANGKAJENE
R. Lawo
R. Walanae
R. Belo
WATAN SOPPENG
CABENGE
TO SENG KANG
CACALEPPENG
TAKALALA
R. Langkemme
R. Mario
TO BARRU
R. Sero
TO UJUNG PANDANG
R. Pising
R. Jupang
R. Unyi

# GENERAL LAYOUT OF THE LANGKEMME IRRIGATION PROJECT



## SUMMARY

### BACKGROUND OF THE PROJECT

01. Dispite the remarkable increase of rice production in the past, Indonesia has not attained the self-sufficiency of rice due to the sharp increase of population together with the increase of per-capita rice consumption. In recent five years, about 1.4 million tons of rice have been imported on an average. The Government has, therefore, made great effort to increase the rice production in the country. The expansion and improvement of irrigated paddy field is one of the Government strategies for the attainment of self-sufficiency in foodstuff.

02. A master plan is prepared and nine feasible projects are identified. The Langkemme Irrigation Project is given the first priority for the feasibility study. The project plays an important role of a pioneer for the implementation of the remaining eight projects.

03. The seasonal outmigration is accelerated there year by year because of low employment opportunity. The farm size is rather small, and the farm economy is still depressed in the region despite relatively high production yield of rice. The increase of rice production is essential in this region to much improve the depressed farm economy.

04. The region is habitually subject to drought damages. The water resources developed so far in this region are still only 3% equivalence of the endowed resources. While, about 41% of the total land resources thereabout are developed for agriculture; about half of them are used for paddy cultivation. Only 23% of the paddy fields are provided with irrigation system. The shortage of the irrigation system is a major constraints for the full exploitation of agriculture in this region.

### SELECTION OF THE PROJECT AREA

05. The project area has been selected within the existing paddy fields. The total area is about 8,000 ha in gross, which comprise the area proposed in the master plan and the existing semi-technical irrigation area being operated by the Local Government.

### PROJECT AREA

06. The project area of 6,400 ha in net extends on the left bank of the Walanae river and is bounded by the Lawo river in the north, the Mario river in the south and the foot of hilly ranges in the west. The whole project area is administratively located under the Kabupaten Soppeng.

07. The total population is about 89,000, as of 1979, and increases at the rate of 1.0% per annum. The number of household totals about 16,100, out of which about 12,600 are engaged in agriculture.

08. Arable lands of about 15,000 ha extend over the study area. Among them, about 9,700 ha are suitable for rice cultivation and developed for paddy field at present. The remaining lands are developed for upland crops due mainly to undulating topography, shallow soil depth and limited water availability. In addition, some land resources unsuitable for agricultural production extend in the surrounding area. The development of these land resources should refrain in view of soil and land conservations.

09. The catchment area of the seven tributaries of the Walanae river, the Langkemme river and the Sero river extends approximately 104 $km^2$, 104 $km^2$, and 335 $km^2$, respectively. The annual runoffs of these rivers widely fluctuate year by year. The annual mean runoffs of respective rivers are estimated as,

| | |
|---|---|
| Seven tributaries | 114 million $m^3$ (1,140 mm equivalence) |
| Langkemme river | 115 million $m^3$ (1,150 mm equivalence) |
| Sero river | 410 million $m^3$ (1,240 mm equivalence) |

10. The project area slants from the southwest to the northeast with a topographic gradient of about one percent. Its altitude ranges from 200 to 10 m. Northern part of the project area is relatively flat and developed for paddy field.

11. The climate in the project area is characterized by shorter dry season and longer wet and transitional seasons. The cease and onset of the both seasons widely vary year by year. About 85% of the annual rainfall of 1,550 mm concentrates between November thru July. The max. consecutive drought of 84 days has been recorded in the project area in the recent 5 years. The annual pan evaporation never otherwise exceeds annual rainfall in the project area.

12. Base rock in the study area is mainly composed of Andesites, coral limestone and weakly cemented sediments. The Andesites cover most of mountains and hilly ranges extending the western part of the project area. The coral limestone is broadly distributed at the skirt of the mountains and hilly ranges covered by the Andesites. The sediments are spottily scattered in and around the Desa Watu and Labessi.

13. Forty eight (48) small scaled irrigation schemes are developed in the project area, comprising forty four (44) Desa irrigation schemes and four (4) DPU semi-technical irrigation schemes, depending their irrigation water resources on the seven tributaries of the Walanae river. Most of the Desa schemes still remain non-technical level. The density of the existing canal networked in these schemes is as low as about 30 m/ha on an average. Sixty six (66) intakes are constructed in the tributaries to irrigate the forty eight (48) existing schemes. Among them, only eleven (11) intakes are perennial masonry weirs.

14. Provincial roads are well-networked around the project area. A district road traverses across somewhere center of the project area. The full spans of these roads are asphaltpaved and all-weathered. Unpaved rural roads are networked between villages. Most of them are not jeepable even during dry season. The density of existing farm roads is still low, resulting in limiting the access to farm land. The Port Pare-Pare plays leading role of the export of agricultural product and the import of agricultural inputs in and around the project area.

15. No tele-communication system is available in the project area. Two micro power stations are being operated at the Kampung Cennae and Cabenge by PLN. Most of the villages locating in the project area independently install small scaled engine-drive generators; most of them are operated by cooperatives or private sectors. No domestic water supply system is developed in the project area. Each village in the project area depends its domestic and potable water mainly on the ground water.

16. Paddy cultivation in the project area is concentrated in the wet season and it is extremely limited in the dry season because of the exhausted water sources. The cultivation pattern is directly affected by the seasonal distribution of rainfall. The planting and/or harvesting areas widely fluctuate year by year, depending on endowed rainfall and available water resources in the tributaries.

17. In the wet season from April to July, almost all of the paddy fields are planted with paddy. While, in the transitional season from November to February, only about 65% of the existing paddy fields is cultivated with paddy under irrigated condition. In dry season from August to October, almost all of the paddy fields are left fallow. Unit yield of paddy in the project area is not very low, showing the average yields of 4.60 tons/ha for wet season paddy and 4.75 tons/ha for dry season paddy. But there is still much room for further improvement.

18. The cultivation of polowijo crops is quite limited in the project area due to shortage of irrigation water. Since the polowijo crops are cultivated mostly under rainfed condition without use of any improved farm inputs, the unit yields of polowijo crops are generally low.

19. The size of farms is generally small in the project area. It is estimated at 1.03 ha of which only 0.61 ha is the paddy fields. The study on present farm economy shows that crop income from such small farmland is not sufficient to maintain the livelihood of the farmers. Under such circumstances, the crop income of such small farmers can be improved only through the improvement of land productivity.

THE PROJECT

20. The project aims at increasing the agricultural production and also improving the farmers living standards in the Langkemme area through exploitation of new water resources in the Langkemme and Sero river systems as well as up-grading of the existing irrigation systems. The basic concept for agricultural development would be;

- Stabilization and improvement of wet season paddy,
- Expansion of planted area for dry season paddy,
- Maximization of cropping intensity,
- Introduction of polowijo crops, and
- Effective operation of existing agricultural institutions.

21. In order to realize the concepts on agricultural development above mentioned, the following concepts for irrigation development are envisaged;

- Water resources in the seven tributaries would be developed through the rehabilitation of the existing schemes,
- All of the existing schemes would be incorporated into the proposed irrigation system as a tertiary system,
- Supplemental water resources would be exploited in the Langkemme and Sero river systems, and
- No technical drainage system would be developed within the scope of this project.

22. After the completion of the project, all the paddy fields in the project area would be up-graded from non-and/or semi-technical level to technical irrigation level and a year-round irrigation is practiced all over the project area. As for cropping pattern, four alternative patterns are carefully studied from the viewpoints of profitability, labour requirement and water requirement. As a result, a triple cropping, paddy - polowijo - paddy, is selected. The anticipated yield of paddy is 6.0 tons of dry stalk paddy per ha. Unit yields of polowijo crops are rather conservatively estimated at about 70% of experiment results at Bogor: they are 2.0 tons/ha for maize and each 1.2 tons/ha for groundnuts, greenbeans and soybeans. After the completion of the project, paddy production increases to about 29,000 tons per annum.

23. The project depends its irrigation water resources on the seven tributaries, the Langkemme river and the Sero river. The dependable minimum discharges in these river systems are estimated by 10-day basis as listed below,

| | |
|---|---|
| Seven tributaries | 0.5 $m^3$/sec |
| Langkemme river | 1.2 " |
| Sero river | 0.9 " |

24. Irrigation water requirement is calculated by 10-day basis during a period of 1975 to 1979 on the basis of the meteorological records and the proposed cropping pattern. The maximum unit requirement of 1.26 l/sec/ha is estimated on late January 1978.

25. A water balance calculation is made by 10-day basis from 1975 to 1979 between the dependable water resources and the seasonal irrigation requirement. Making reference to the outcomes of the calculation, the maximum diversion discharge of 2.5 $m^3$/sec would be proposed at the Langkemme canal and the Sero diversion system, respectively.

## PROPOSED PROJECT WORKS

26. Forty three (43) of existing intakes would be integrated and rehabilitated. About 40 km of the link canal would be aligned to join the integrated Desa irrigation schemes. All of the existing canal systems would be provided with division boxes. Some amount of desilting works would be undertaken in the existing canal systems.

27. The Langkemme intake weir would be proposed at about 500 m upstream of the existing Cennae intake. About 30 km of main canal would be aligned along the skirt of hilly ranges. The max. capacity of 5.0 $m^3$/sec would be given to the main canal to supplement irrigation water for 6,400 ha of the whole project area. A tunnel of about 700 m would be disposed to intersect hilly range, and some crossing structures would be spanned to traverse the seven tributaries.

28. Three intake weirs would be proposed on the Jupang, Unyi and Pising rivers, the tributaries of the Sero river. The max. discharge of 2.5 $m^3$/s would be diverted at these intakes into the Sero diversion canal of about 15 km long. The canal lies across two tributaries and many rivulets. Many crossing structures would be proposed along the full alignment of the canal. The water conveyed by the canal would be discharged into the Langkemme main canal.

29. The main features of proposed project works are summarized as follows,

| Work Item | Main Features |
|---|---|
| WORK DIVISION - I | |
| i) Integration and rehabilitation of existing weir | - 19 Nos. of Tirol type weir, 3 Nos. of fixed type weir |
| ii) Link Canal | - Total length of approx. 34 km, |
| iii) Up-grading tertiary system (to Semi-technical level) | - 2,900 ha net irrigable areas, |

| Work Item | Main Features |
|---|---|
| **WORK DIVISION - II** | |
| i) Langkemme intake weir | - Fixed type and cobble masonry,<br>- Crest length of 37.5 m, and weir height of 4.0 m<br>- Intake discharge of 2.5 $m^3/s$. |
| ii) Langkemme main canal | - Total length of approx. 30 km,<br>- Design discharge ranging between 5.0 $m^3/s$ and 0.80 $m^3/s$. |
| iii) Link canal | - Total length of approx. 2 km,<br>- Design discharge ranging between 0.1 $m^3/s$ and 0.9 $m^3/s$, |
| iv) Tunnel | - Total length of 720 m |
| v) Related structures | |
| a) Aqueduct | - 1 No., Reinforced concrete box barrel<br>- Design discharge of approx. 3.0 $m^3/s$. |
| b) Inverted syphon | - 3 Nos., Reinforced concrete box barrel,<br>- 3 Nos., Reinforced concrete pipe<br>- Design discharge ranging between 2.9 $m^3/s$ and 0.8 $m^3/s$. |
| c) Turnout | - 15 Nos.,<br>- Design diversion discharge ranging between 0.06 $m^3/s$ and 0.4 $m^3/s$. |
| d) Others | - Culverts, spillways, checks, and release structures, cross drain, etc. |
| vi) Up-grading work (to technical level) | - 4,500 ha of net irrigable area, |
| **WORK DIVISION - III** | |
| i) Jupang intake weir | - Tirol type weir of cobble masonry,<br>- Crest length of 38 m in total, and<br>- Design intake discharge of 1.9 $m^3/s$ |
| ii) Unyi intake weir | - Gabion weir,<br>- Crest length of 29 m, and<br>- Design intake discharge of approx. 0.5 $m^3/s$ |

| Work Item | Main Features |
|---|---|
| iii) Pising intake weir | - Gabion weir,<br>- Crest length of 25 m, and<br>- Design intake discharge of 0.5 $m^3/s$ |
| iv) Sero diversion canal | - Total length of 14.9 km,<br>- Design discharge of 2.5 $m^3/s$. |
| v) Related structure | |
| a) Aqueduct | - 3 Nos., Reinforced concrete box barrel<br>- Design discharge ranging between 1.92 $m^3/s$ and 2.5 $m^3/s$. |
| b) Others | - Culverts, cross drains, offtakes, etc. |
| vi) Link canal | - Total length of 3.6 km |

30. About five (5) years of the total construction period would be recommendable for the whole project works. Major works such as weirs, intake structures, and crossing structures would be constructed by heavy construction machinery. The remaining minor works would be possibly undertaken by manpower so as to increase employment opportunity in and around the project area.

31. The project cost is estimated to be US$34.6 million or Rp.21,609 million equivalence by financial basis; it consists of US$14.5 million of foreign currency and US$20.1 million equivalence of local currency.

## ORGANIZATION AND MANAGEMENT

32. The project office for the Langkemme irrigation would be set up in the DPU, South Sulawesi. The office would manage all the project works. A base camp would be settled in the project site to effectively undertake the field works.

33. With the completion of construction works, an operation and maintenance office would be organized for the Langkemme Irrigation Project under the Regional Irrigation Office, Soppeng and the office bears responsibility of the O/M of the whole irrigation system from the intake weirs down to the tertiary turnouts. The office would be composed of one head office, two branch offices and three field outposts.

34. Existing water master (Ulu Ulu) system would be reorganized into water users' association, so-called P3A. The executing body of the association would be composed of distribution supervisor, liason and gate-keepers. The supervisor would be democratically elected by the representatives of beneficial farmers. In principle, the association would be set up at tertiary block level, but, in the extended tertiary block exceeding about 150 ha, it would be set up at sub-tertiary block level.

PROJECT EVALUATION

35. The economic cost is estimated at Rp.13,563 million or US$21.7 million equivalence, consisting of US$10.0 million of foreign currency component and Rp.7,313 million or US$11.7 million equivalence of local currency component. The cost for operation and maintenance of the project would be about US$0.47 million equivalent per annum. The direct project benefits at the full development stage would be US$6.1 million equivalent per annum. The internal rate of return is calculated at about 14.7%. The project is technically sound and economically feasible.

36. With completion of the project, the net reserve or capacity-to-pay of the average farmers would increase from Rp.1,800 to Rp.197,600 per annum at the full development stage. The increased reserve would offer incentives for further development to the formers.

37. Total amount of foreign currency portion plus some amount of local currency portion would be loaned by international financing agency. The annual repayment of the loan would be subsidized by the Government. The O/M cost for the main system of the project would be also covered by the annual Government budget. These subsidies would be, however, compensated through increases of tax income and savings of foreign exchange for import of rice.

38. With the completion 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
- Development of fish culture
- Improvement of rural environment
- Supplimentary irrigation water supply to the scattered areas along the Sero diversion canal
- Improvement of operation and maintenance of existing Desa irrigation schemes.

## RECOMMENDATION

39. The Langkemme Irrigation Project is verified herewith to be technically sound, and economically and financially feasible through this study. It is, therefore, recommended that the Project should be soon implemented along the conclusion of this study.

40. Supplemental surveys and investigations would be required for the next stage of the project. In order to ensure the early commencement of the construction works, these surveys and investigations should be carried out as early as possible.

41. Reforestation work is essential for the water and land conservation in the watersheds of the Sero river and the seven tributaries of the Walanae river. The work should be implemented as a series of the reforestation program in this region which is envisaged by the Authorities concerned.

42. Meteoro-hydrological stations are sparsely located in the watersheds relevant to the project. Their networks should be substantially and urgently improved for the design works and O/M of the project.

43. The agricultural development proposed in the project would require advanced farming and careful water management practices. To smoothly transfer such practices to the farmers, a pilot farm shold be established in the project area.

44. Mechanized farming might be gradually introduced in the project area in the future. Then, the road networks should be further improved by a special fund for the smooth extension of the agricultural mechanization.

45. INSUS program is recently prevailing and much significant in and around the project area. Therefore, the said program should be further encouraged in the project area.

46. Effective use of the exploited water resources is essential for the operation of the project. Modernized water users' association should be possibly set up based on the existing Ulu-Ulu system in advance of the commencement of the project operation.

47. Polowijo crops are introduced in the project for crop diversification. Cultivation practices of the polowijo under irrigated condition should be researched and propagated to the farmers through the existing extension channels.

48. The present capacity of rice mills installed in the project area is sufficient for the increased crop production. But almost all of the milling plants are of one-pass system. These plants should be improved for attainment of better marketability.

49. Fishculture would provide the farmers with good opportunity to enlarge their farm business. The potential of fishery development should be investigated and studied in and around the project area.

50. The proposed canal system is graced with a potential of small scaled hydropower generation. Micro hydropower development in the canal system should be implemented as an associated scheme in the future. The generated power is available for processing, mechanized farming, irrigation, etc.

51. The tail of the project area is habitually subject to inundation. The farmers thereabout always pay attention to their cropping calendar to avoid the inundation. Substantially, the inundation can be eliminated by the Walanae flood control project formulated in the Master Plan.

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## Glossary of Terms and Abbreviation

### 1. Local Administrative Organization

| | | |
|---|---|---|
| Kabupaten (Kab.) | : | District |
| Kecamatan (Kec.) | : | Sub-district |
| Desa | : | Village |
| Bupati | : | Chief of Kabupaten |
| Camat | : | Chief of Kecamatan |
| Kepala Desa | : | Chief of Desa |

### 2. Organization for Irrigation and Agricultural Development

| | | |
|---|---|---|
| DPU | : | Ministry of Public Works |
| DGWRD | : | Directorate General of Water Resources Development |
| P3SA | : | Sub-directorate of Planning and Programming |
| PLN | : | Public Corporation of Electricity |
| BRI | : | Indonesia People's Bank |
| BIMAS/INMAS | : | Mass Guidance for Self-sufficiency in Food |
| DOLOG | : | Provincial Rice Purchasing Agency |
| BUUD/KUD | : | Village Unit Executive Body/Agricultural Cooperative Organization |
| P3A | : | Water User's Association |
| BPP | : | Rural Extension Center |

### 3. Other Local Terms

| | | |
|---|---|---|
| Polowijo | : | Second Crops, Planted after Harvest of Wet Season Paddy |
| Pelita I | : | First Five-Year Development Plan |
| Pelita II | : | Second Five-Year Development Plan |
| Pelita III | : | Third Five-Year Development Plan |
| PPL | : | Field Extension Worker |
| PPM | : | Extension Supervisor |
| PPS | : | Subject Matter Specialist |

### 4. Area and Volume

| | | |
|---|---|---|
| $m^2$ | : | square meter |
| ha | : | hectare |
| $km^2$ | : | square kilometer |
| l | : | liter |
| $m^3$ | : | cubic meter |
| t | : | ton |

5. Derived Measures based on the Same Symbols

| | | |
|---|---|---|
| $m^3$/sec | : | cubic meter per second |
| t/ha | : | ton per hectare |
| $m^3/km^2$ | : | cubic meter per square kilometer |
| mm/day | : | millimeter per day |
| l/sec/ha | : | liter per second per hectare |
| l/day | : | liter per day |
| $m^3/km^2$/year | : | cubic meter per square kilometer per year |
| meq/100g | : | milli-equivalent per 100 gram of soil |
| km/sec | : | kilometer per second |
| $kg/cm^2$ | : | kilogram per square centimeter |
| cm/sec | : | centimeter per second |
| $t/m^3$ | : | ton per cubic meter |
| $t/m^2$ | : | ton per square meter |

6. Electric Measures

| | | |
|---|---|---|
| kV | : | kilovolt |
| kW | : | kilowatt |
| kWh | : | kilowatt-hour |
| MW | : | megawatt |
| kVA | : | kilovolt ampere |
| Hz | : | Hertz |

7. Currency

| | | |
|---|---|---|
| US$ | : | United States Dollars |
| Rp | : | Rupiah |

US$1 = Rp 625

8. Others

| | | |
|---|---|---|
| % | : | percent |
| No. | : | number |
| Nos. | : | numbers |
| vs. | : | versus |
| MSL | : | Mean Sea Level |

# CHAPTER I INTRODUCTION

## 1.1 AUTHORITY

This report is prepared in accordance with the "Scope of Works" of the Feasibility Study on the Langkemme Irrigation Project agreed upon between the Government of Indonesia (referred to the Government, hereinafter) and the Government of Japan, on February 28, 1980.

This report presents the results of the field investigation and intensive study in the project area and the subsequent study in Japan carried out by the Survey Team on the basis of the comments raised by the Indonesian Authorities concerned and the advices and suggestions offered by the Advisory Committee of the Japan International Cooperation Agency (referred to JICA, hereinafter).

## 1.2 PROJECT HISTORY

The Government has focussed on the comprehensive regional development in the Central South Sulawesi in early 1970s. To realize the development during a period of the Third Five Year Development Plan, so-called PELITA III, the Government requested the Government of Japan to extend a technical aid for the formulation of the Master Plan for comprehensive development in this region.

In compliance with the request, JICA dispatched a preliminary survey team in 1973. The said team concluded that a Master Plan is prerequisite in advance of the formulation of new projects and recommended that basic data such as topographic maps and hydrological data should be urgently prepared for the implementation of the master plan.

In accordance with the recommendation, the JICA further dispatched two hydrologists as Colombo Plan Experts in 1976 in order to collect the data required for the coming study. In parallel with the data collection, the JICA commenced an aerial photo mapping and prepared the topographic maps on a scale of 1/25,000 on September, 1978.

After the preparation of the basic data such as topographic maps and hydrological data, JICA dispatched a survey team headed by Mr. T. SAKAMOTO of Nippon Koei Co., Ltd. to the Central South Sulawesi in order to prepare the Master Plan. The study team executed the field survey in the objective area during the period of about ten (10) months from September 1978 to June 1979 and submitted the final report to the Government on March 1980.

In the Master Plan, nine viable projects are embodied for the regional economic development and the increase of public welfare of local people in the Central South Sulawesi. These projects comprise various sectors such as irrigation, flood control, multi-purpose water resources development and their combinations. Among these projects, the Langkemme Irrigation Project was given the first priority for implementation from technical and socio-economic viewpoints.

In accordance with the conclusion of the master plan study, the Government decided to promote the realization of the Langkemme Irrigation Project under the PELITA-III and further requested the Government of Japan the technical cooperation for the feasibility study on the said project in early 1980. In response to the request of the Government, the Government of Japan decided to offer the technical assistances for the feasibility study on the said project as a part of technical cooperation program for Indonesia.

On February 1980, the JICA dispatched a preliminary survey team for the Langkemme Irrigation Project headed by Mr. K. KIMURA, an official from the Ministry of Agriculture, Forestry and Fishery, Japan. The team discussed on the Scope of Works for the Feasibility Study on the Langkemme Irrigation Project with the Government. Then, the said Scope of Works were agreed on with some amendments between the team and the Government. Based on the agreed "Scope of Works", the Feasibility Study on the Langkemme Irrigation Project (referred to as the Study hereinafter) substantially commenced in the middle of July 1980, upon arrival of the first group of the team.

## 1.3 PREVIOUS STUDIES

The previous studies undertaken so far, relevant to the Langkemme Irrigation Project, are compiled in the following reports:

i) Preliminary Study for the Water Resources Development in the Central South Sulawesi, by OTCA, June 1974,

ii) Hydrologic Data Collection and Guidance for Data Collection for the Central South Sulawesi Water Resources Development Project, by JICA, March 1977,

iii) Master Plan for the Central South Sulawesi Water Resources Development by JICA, March 1980, and

iv) Preliminary Survey on the Langkemme Irrigation Project by JICA, May 1980.

In advance of the commencement of the Feasibility Study, these reports are carefully studied to prepare the development plans for the project. The data and information compiled in these reports are referred to for the preparation of this report.

## 1.4 SCOPE OF WORKS

### 1.4.1 Objectives

As specified in the Scope of Works, the study comprises two major work programs as presented below:

Program 1 : to verify the technical soundness and economic feasibility of the project, and

Program 2 : to undertake transfer of knowledge to the Indonesian counterpart personnel through effective on-the-job training in the course of the survey and study.

### 1.4.2 Study Area

The study area covers grossly about eight thousand (8,000) ha, extending on the left bank of the Walanae river and it is bounded by the Lawo river in the north, the Mario river in the south, and the skirt of western hilly ranges.

### 1.4.3 Scope of Works

The activities undertaken by the Team comprise the field works and office works in the project site. Both works cover the following contents:

(1) Field works

- Further collection and review of the data relevant to the project in addition to the data collected through the previous studies, and
- Execution of the field investigation and survey relevant to the project formulation.

(2) Office works

- Planning and study on the land use, irrigation/drainage, tertiary development and the relevants, including their possible alternatives.
- Preparation of the design of the irrigation/drainage and tertiary development including the drawings and cost estimate.
- Economic and financial evaluation for the project including the estimate of the project benefits, and
- Assistance for preparation of the implementation program of the project.

## 1.5 ACTIVITIES IN THE FIELD

On the basis of the careful review of the previous studies and the findings obtained through the field reconnaissance, the Team envisaged the "approach to the project" and "plan of operation for the study",

and compiled them in the Inception Report. The discussion on the report was held at the P3SA office, Jakarta, Directorate General of Water Resources Development on middle of August 1980. The approach to the project and the plan of operation proposed by the Team was basically approved by the Government through the discussion. Strictly following the approved approach to the project and the plan of operation, the Team carried out the substantial surveys, investigations and studies relevant to the project.

In the course of the study, weekly meeting between the Team and the counterparts group had been regularly held every Monday to coordinate their activities and to smoothly execute the field works. Work progress, weekly schedule and technical matters encountered in the field works had been mainly reported and discussed in the meeting.

The transfer of knowledge to the counterpart personnel was made basically through on-the-job training. In addition, group-wise technical seminars was held by the member of the Team as proposed in the plan of operation.

At the end of October, 1980, the Survey Team compiled an interim report and submitted it to the Government in accordance with the Scope of Works. The interim discussion for the feasibility study was held between the Indonesian Authorities and the Survey Team on November 7, 1980 at the BAPPEDA office, Ujung Pandang, at the presence of the Advisory Comittee dispatched by JICA. Through the discussion, some comments and requests were offered by the Indonesian Authorities concerned. Subsequently, the Survey Team made supplemental studies to fulfil the comments and requests and compiled herewith the draft final report at the end of the field survey.

# CHAPTER II BACKGROUND OF THE PROJECT

## 2.1 NATIONAL ECONOMIC BACKGROUND

Indonesia is located in the tropical zone having a territory of about 2.0 million $km^2$ and a population of about 130 million. The natural conditions are much favourable for agricultural production. About 14 million ha or 7% equivalence of land are being used for agriculture and nearly 60% of the population are engaged in agricultural sector.

In 1969, Indonesia launched out the First Five Year Development Plan, so-called "PELITA I" aiming at reconstruction of the national economy. In 1960's, the annual growth rate of GDP was only about 2% but the growth rate increased to about 7% per annum during this period. In the final year of the PELITA I (1974), the growth rate was as increased as 8.2%.

The agricultural sector, a mainstay of the Indonesian national economy sharing about 40% of the GDP, increased at the annual rate of 4% during the period of the PELITA I. With the exception of 1972 which was the droughtest year in the recent decade, the rice production during the PERITA I recorded a high average annual growth rate of 3.5% due to the improved production yield and the increased harvesting area. The total rice production in the final year of the PELITA I reached to the level of 15.4 million tons.

Despite of the remarkable increase of rice production during the period of the PELITA I, Indonesia could not attain the self-sufficiency of rice due to the sharp increase of its population together with the increase of per-capita rice consumption brought on through the betterment of the living standard all over the people in this country. The annual import of rice reached to high level of one million tons in the final year of the PELITA I.

Following the PELITA I, the Second Five Year Development Plan (PELITA II) started in the 1974/75. This plan was drafted with the aim of the increase of the annual GDP at an average annual growth rate of 7.5% or the increase of 44% by the final year of the Plan. In the PELITA II, high priority has been given to the development of agricultural sector as well as the PELITA I. It has been so planned that the share of the agricultural production in the GDP would be 36% in the final year of the Plan, assuming the production would increase to the annual growth rate of 4.6%.

The sectorial objectives of agriculture strongly advocated in the PELITA II are to attain the self-sufficiency of staple food grains, casting particular emphasis on the increase of production yield of rice through extension of irrigated agriculture. The attainment of rapid growth of the agricultural sector was one of the basic strategies of the Government of Indonesia under the PELITA II which successfully terminated in 1978/79.

Following the PELITA II, the Third Five Year Development Plan (PELITA III) launched out in 1979/80 mainly campaigning further high economic growth, achievement of national stability and equalization of social justice. The Plan was issued at the targets of annual economic growth rate of 6.5%, annual per capita national income increase of 4.5% and population increase ratio of less than 2%.

Annual imported amount of rice in Indonesia was recorded at approximate 1.4 million tons on an average during the period of recent five years. The insufficiency of rice in this country mainly attributes to the unstable climatic conditions, the shortage of irrigation facilities, and agricultural support services. The sharp increase of production yield of rice and the stabilization of its production are essential for Indonesia to attain the self-sufficiency of rice.

## 2.2 REGIONAL ECONOMIC BACKGROUND

The Central South Sulawesi is graced with favourable natural conditions for rice production. The region still remains a representative rice granary at present. The surplus rice produced thereabout has been exported to the surrounding rice-shortage area and the adjacent isles such as East Kalimantan, Maluku, Irian Jaya, etc. through inter-inslar trade. The total supply of surplus rice from this region has recently amounted to approximate 280,000 tons on an average. According to the study on forecast of the supply and demand of rice in Indonesia, the insufficiency of rice would still remain even in the year of 2,000. Hence, the Central South Sulawesi will maintain the status of rice granary for whole Indonesia.

In spite of a wellknown granary in Indonesia, the Central South Sulawesi is subject to habitual damages caused by shortage of irrigation water. The river basin in the Central South Sulawesi is endowed with an enormous water resources amounting to about 6 billion $m^3$. But the resources developed so far are as small as only 3% equivalence of the endowed resources.

While, the land resources endowed in the region are also potential for irrigation development. Lands of about 320,000 ha or 41% equivalence of the total land resources in the Central South Sulawesi have been developed for agriculture. Out of the developed arable land, about 160,000 ha, 51% equivalence, are used for paddy cultivation. Only 23% of the paddy field is provided with irrigation system and the remainings are still under rainfed condition. The shortage of irrigation system surely limits to attain full exploitation of agriculture in this region.

The population density in the Central South Sulawesi is considerably high. Especially the southern part of this region is densely populated; the Kecamatan Lalabata under the Kabupaten Soppeng has the largest population of 64,000 in this Kabupaten and its density amounts to 172 persons per $km^2$. Seasonal outmigrations are

accelerated year by year from the region to the Kalimantan, because of low employment opportunity during a period of dry season. To settle these employment issues seasonally caused in the region, job oppotunity in agricultural production must be urgently and sharply increased especially during a period of dry season, in parallel with the promotion of internal migration.

## 2.3 NEEDS OF IRRIGATION DEVELOPMENT

In the PELITA II successfully terminated in 1978 fisical year, the South Sulawesi is divided into four development areas as mentioned below, according to the local economic condition:

i) South Development Area

Ujung Pandang is a core of this area as a service centre to whole East Indonesia. The area is highly depressed,

ii) West Development Area

Pare-pare is a centre of this area. The area is the highest rice production belt in this province and exports considerable amount of rice to the other provinces,

iii) East Development Area

Watampone is a centre of this area. The area produces upland crops as well as paddy. The population density is considerably high, and

iv) North Development Area

Palopo is the biggest city in the area. This area is comparatively blessed with forest and mineral resources, and endowed with land resources for expansion of rice production area.

The Central South Sulawesi belongs to the East Development Area and administratively comes under four Kabupaten, i.e., Wajo, Bone, Soppeng, and Sidrap. Among them, the Kabupaten Soppeng and Sidrap are graced with much favourable conditions for rice production. The Kabupaten Sidrap has recently reached to the highest level of rice production in this development area, owing to the year-round irrigation water supply from the large scaled Sadang project which has been implemented under the PELITA I and II.

While, paddy fields extending in the Kabupaten Soppeng, another rice granary in the East Development Area, are partly covered by non-technical level Desa irrigation system which has not fully functioned irrigation water supply. The rice production in the Soppeng area is, therefore, unstable, because of habitual damages of droughts, floods, etc. In order to attain a higher level of rice production, the Soppeng area is also looking forward modernized irrigation development which has recently completed in the Sadang Irrigation Project.

As stipulated in the PELITA II, the Central South Sulawesi is an eligible area for crop diversification including rice and various industrial crops. The Sadang irrigation project, however, plays a role of pioneer for mono-culture of paddy in the Sidrap area. Another pioneer project would be urgently needed for the diversified agriculture in the Soppeng area.

The size of farmers in the Soppeng area is small compared with the average of the Central South Sulawesi and the density of agricultural population in the area is extremely high. In view of farm economy, the farmers in the Soppeng area earn their incomes mainly from farming activities with emphasis on rice production and are partly supplemented by off-farm activities at present. Because of high density of the population and the small sized land holding, the farm incomes are still low despite of high production yield of rice in and around this area. The net reserve of the average farmers in the area are negligible small. Under these circumstances, the increase of rice production through irrigation development in the Soppeng area is surely inevitable for the improvement of the depressed farm economy. There surely exist pressing needs for new irrigation development in the Soppeng area. The development would orient an agriculture in the densely populated, small holding sized, and relatively well-developed area.

## 2.4 DEVELOPMENT PLAN IN CENTRAL SOUTH SULAWESI

### 2.4.1 Development Goals and Policies in THE PELITA III

The shortage of available water resources is one of the major constraints for the regional development in the Central South Sulawesi. The development goals and basic policy for the South Sulawesi stipulated in the PELITA III are as summarized below:

i) Development goals

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

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

ii) Development policy

   a) To strengthen the role as a 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.

### 2.4.2 Master Plan for Water Resources Development

The government of Indonesia has focussed her attention on the endowed land and water resources in this region since early 1970's. To embody the development of these resources in this region, a master plan for the water resources development in Central South Sulawesi was prepared in 1979 fiscal year. The Master Plan study supplys the goals for the water resources development in the Central South Sulawesi as mentioned below:

i) Increase of rice production
ii) Promotion of social and public welfares
iii) Improvement of each sectorial economy
iv) Hydropower development
v) Up-filling of regional economic gap

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

i) Bila-Boya Irrigation/Flood Control Project
ii) Langkemme Irrigation Project
iii) Lawo Irrigation Project
iv) Cenranae Irrigation Project
v) Gilirang Irrigation Project
vi) Sanrego Irrigation Project
vii) Padangeng Irrigation Project
viii) Cenranae Flood Control Project
ix) Walimpong Multi-purpose Dam Project

A long-range development schedule would be required for the implementation of the whole projects identified in the Master Plan. Three stage-wise developments were recommended in the Master Plan on the basis of the economic feasibility and the socio-economic viewpoints, a shown below:

| | | |
|---|---|---|
| i) | Stage - I : | Langkemme Irrigation Project<br>Bila-Boya Irrigation/Flood Control Project |
| ii) | Stage - II : | Sanrego Irrigation Project<br>Lawo Irrigation Project<br>Gilirang Irrigation Project |
| iii) | Stage - III : | Walimpong Multipurpose Dam Project<br>Cenranae Irrigation Project<br>Padangeng Irrigation Project |

The Master Plan concluded that the Langkemme Irrigation Project, incorporated in the Stage - I together with the Bila-Boya Irrigation/Flood Control Project, would function a core project for the regional development and it had no technical and socio-economic constraints for the implementation at all. Furthermore, the Master

Plan strongly recommended that both the Langkemme and the Bila-Boya Project should enter into implementation during the period of the PELITA III at latest.

With such economic backgrounds and development needs, the Langkemme Irrigation Project located at the Soppeng area was given a first priority for earlier implementation among the nine viable projects and assigned a leading role of pioneer for the diversified agriculture and substantially contributes to the attainment of the targets under the PELITA III.

## CHAPTER III SELECTION OF THE PROJECT AREA

The study area stipulated in the Scope of Works is broadly bounded by the Walanae river on the east, the Lawo river on the north and the Mario river on the south. The western part of the area is skirted by the foot of low mountain ranges extending westward of the study area. The study area of about 13,000 ha includes nearly 7,000 ha of three scattered arable lands requested by the Government, in addition to the gross irrigable area of about 6,000 ha delineated in the master plan (see Fig. 3.1).

Area-1 is located at the right bank of the Langkemme river and covered with about 100 ha of rainfed paddy field. The area is geographically on a river terrace developed along the Langkemme river and topographically forms a slender strip extending along the river bank of the Langkemme river and steeply slants toward the riverside.

Area-2 covered uplands of about 3,500 ha is located at the southeastern part of the study area. Most of the area extend on the hilly lands developed on limestones and are topographically sharply undulating and mainly covered with forests and bushes. In recent years, considerable extent of the area has been reclaimed for cropping. The reclaimed lands are seriously subject to erosion on account of sandy texture, shallow soil depth, sharply dissected topography, etc. Almost all of the area are topographically hardly irrigable, as far as its irrigation water resources will depend upon the Langkemme Irrigation Project.

Area-3 is located at the northeastern part of the study area and covers paddy field of about 3,500 ha. The area occupies a recent alluvial flats extending between the Walanae and the Laja river. About 2,000 ha of semi-technical irrigation scheme have been developed in this area, depending its water resources on the Laja river. Relatively blessed with stable water sources, the scheme partially attains triple cropping of paddy in a year.

The altitude in the Area-1 ranges from 220 m to 170 m above MSL. The area is topographically not irrigable as far as it is commanded by the Langkemme intake weir to be proposed for the project. However, Sero diversion canal, which is discussed in the succeeding chapter, would be aligned along the elevated periphery of the area and linked with the Langkemme irrigation system. The irrigation water conveyed by the diversion canal from the Sero river system is capable of feeding the narrow strip of the area. Thus, the area would be deemed an indirect beneficiary area.

The sprawls of reclaimed land over the Area-2 must be restricted in the future in view of soil and land conservations. The area would be excluded out of the project area on account of its steep and sharply undulating topography and low land capability.

Most of the Area-3 are covered with semi-technical irrigation schemes which are provided with full irrigation networks. Release some amount of irrigation water from the proposed main canal into upper reach of the Laja river, and large amount of the project return is reaped in the area with small amount of investment for betterment of existing irrigation facilities. In this context, the Area-3 would be incorporated in the project area as far as irrigation water resources are allowable.

Finally, the project area would be delineated within the gross paddy field of 8,000 ha, comprising 6,000 ha proposed in the master plan and 2,000 ha of the semi-technical area in the Area-3, taking into account the dependable water resources in and around the project area.

# CHAPTER IV THE PROJECT AREA

## 4.1 LOCATION

The project area is located at about 130 km northeast along the provincial road remote from Ujung Pandang, the capital of South Sulawesi Province. It extends due southward of Watan Soppeng, the capital of the Kabupaten Soppeng, slenderly from north to south astride the provincial road and is approximately bounded by the provincial road from Takalala to Sengkang on the east, the Lawo river on the north and the mario river on the south. The western boundary is skirted along the foot of hilly ranges extending westward. The total net irrigable area is delineated to be 6,400 ha, out of the total gross area of about 8,000 ha.

Administratively, the area comes under four Kecamatans of the Kabupaten Soppeng, viz. Lalabata, Liliriaja, Marioriwawo, and Lilirilau, and covers 13 Desa and 31 Kampung. The administrative divisions are illustrated in Fig. 4.1.1.

## 4.2 HUMAN RESOURCES

The population in the project area is estimated at about 89,000 as of 1979, on the basis of data collected from the Bupati Office. The population growth rate is also estimated at about 1.0% per annum, according to the same data from 1972 to 1979.

The total working population is about 42,000 which corresponds to 47.2% of the total population, out of which about 25,700 inhabitants are engaged in agriculture. The total number of household is about 16,100. The average size of family is 5.53 persons per household. The farm household accounts for about 80% of the total number of households.

The demographic features in the project area are characterized by low rate of population growth and high rate of female population. The population in the South Sulawesi has increased at an annual rate of 2.1% during the recent decade. The annual growth rate of 1.0% in the project area is very low as compared with the provincial average. The rate of male population to the total population is 48.8% in the project area. In the age group of 20 to 49 years, this rate shows only 45.3%. These facts seem to indicate that there is a considerable population outflow from the project area and most of them are working outside of the area. This presumption has been evidenced by the farm economy survey; the farmers in the project area supplement their livelihood with some off-farm incomes because of insufficient crop income.

## 4.3 NATURAL RESOURCES

### 4.3.1 Land Resources

The results of soil survey carried out over the study area inclusive of the surrounding areas show that about 9,700 ha of arable lands suitable for paddy cultivation extend over the study area. The soils of these lands are Eutric Fluvisols, Pellic Vertisols and Eutric Gleysols. Most of these lands are presently under rice cultivation.

In addition, about 3,000 ha of upland fields occupy the south-eastern parts of the study area. The soils of the upland area are Calcalic Luvisols developed on coral limestones, and are not suitable for rice cultivation due to undulating topography, shallow soil depth, stoniness and limited water availability. These lands are presently used for cultivation of upland crops.

Regosols, young sandy soils, extend along the Walanae river and its tributaries. The total area of these soils is about 2,500 ha. Most of these lands are under cultivation of tobacco and groundnuts. The total arable lands in and around the study area are thus estimated at approximately 15,000 ha, of which the land suitable for rice cultivation is only 9,700 ha.

The lands in the surrounding areas are generally covered with Lithosols which are not suitable for agricultural production. These lands are presently covered with low productive forests and bushes. In recent years some parts of the forests and bushes have been gradually reclaimed for shifting cultivation of upland crops, resulting from the limited availability of arable land and large number of farm population. Further extensive development of these lands surely cause serious erosion problems. In view of soil and land conservation, the development of these non-productive lands should be limited and the maximum use of existing arable land should first be envisaged.

### 4.3.2 Water Resources

#### (1) The Langkemme river

The Kesi and Lairi rivers, two major tributaries of the Langkemme river, originate in the Mt. Niniconang of 1,474 m in altitude, and flow down about five km, joining many small tributaries. After their confluence in the vicinity of the Kampung Pangempange, both rivers change their names into the Langkemme river. The Langkemme river further flows down about 12 km to join the Sero river at about one km downstream from the bridge spanning over the Langkemme river near the Kampung Cennae and debouches into the Mario river.

Total watershed of the Langkemme river system extends to 104 $km^2$ at the site of the bridge as illustrated in Fig. 4.3.1. An automatic gauging station is installed close to the bridge and has been operated since 1974. It provides relatively reliable data on runoff of the Langkemme river.

Mean annual runoff of about 115 million $m^3$ or 1,100 mm runoff equivalence is estimated at the said gauging station on the basis of the recent five years' records. The annual runoff in the Langkemme river widely fluctuates year by year; the maximum annual runoff of 185 million $m^3$ was recorded in 1977 and the minimum of 75 million $m^3$ in 1976.

The seasonal runoff fluctuation is also much wide in the Langkemme river. The runoff within three months between August thru October is only equivalent to 14% of the total runoff. The drought discharge usually occurs in August, September, or October and the 10-day minimum discharge is estimated at about 1.2 m3/sec on the average of the recent five years. The water resources in the Langkemme river have been developed only for the small scaled Cennae Irrigation Project of about 200 ha.

(2) The Sero river

The Sero river system comprises two major tributaries, i.e., Jupang and Pising as shown in Fig. 4.3.1. The Jupang river covering the largest watershed of 298 $km^2$ in the Sero river system originates in Mt. Malempang and Tratak of about 1,350 m in altitude and drifts down about 30 km from south to north. The Pising river has a watershed of 37 $km^2$ and originates Mt. Dua of 996 m in altitude. It flows down about 10 km from west to east to join the Jupang river in the vicinity of the Kampung Limpotenge. After the confluence of the Jupang and Pising rivers, the stream changes its name into the Sero river and meanders about three km to join with the Langkemme river.

In the Sero river system, one water level gauging staff has been installed at about 0.5 km downstream from the confluence of the Jupang and Pising rivers since 1975. The data recorded at the gauging staff is likely to be unreliable because of the poor maintenance.

The annual runoff in the Sero river system widely fluctuates year by year. Mean annual runoff of 410 million $m^3$, 1,240 mm runoff equivalence, is estimated at the site of the gauging station. The maximum annual runoff of 580 million $m^3$ was estimated in 1977 and the minimum of 290 million in 1978.

The seasonal runoff fluctuation is much wider in the Sero river as well as in the Langkemme river. The runoff during the period of the drought season is estimated to be only 7% of the total runoff. The drought discharge occurs in August or September, and the 10-day minimum discharge is estimated to be about 0.9 m3/sec on the average of recent five years. No spacious land resources favourable for irrigated agriculture extend in the lower basin of the Sero river.

(3) Seven Tributaries of the Walanae River

The seven tributaries of the Walanae river originate in the hilly ranges extending westward of the project area and flow down along shallow vales. After debouching into foot of hills, the tributaries extend their stretches across the geological fan to confluence with the main stream of the Walanae river. The entire watershed of the seven tributaries sums to 104 $km^2$ at the skirts of hilly ranges as shown in Fig. 4.3.1.

As for the seven tributaries, no data are available on the runoff. The runoff of each tributary during wet season seems to be as stable as that of the Langkemme river, depending on the better geological condition and water conservation in its watershed. The annual runoffs of seven tributaries are estimated in connection with the runoff of the Langkemme river based on discharge measurements in the tributaries undertaken in the course of this study and recorded discharge in the Langkemme gauging station.

Mean annual runoff of 114 million $m^3$ is expeted in the entire watershed of the seven tributaries. The maximum annual runoff of about 180 million $m^3$ might occure in 1977; the minimum one of 70 million $m^3$, in 1976.

The seasonal runoff fluctuation is also wide in the tributaries as well as in the Langkemme river. The runoff during a period of drought season might amount to only about 9% of the total annual runoff. The drought discharge occurs in August or September and the 10-day minimum discharge is estimated at about 0.5 m3/sec on the average of recent five years.

The water resources endowed in the tributaries covering the watershed of 104 $km^2$ have been highly developed for small scaled irrigation schemes. About 8,000 ha of paddy fields under these schemes depend its irrigation water on the tributaries. From the size of the watershed of the tributaries and the total area of the schemes, the water resources required for the irrigation are far exceeding the available water resources in the tributaries.

On the basis of the records of water gauging stations and field data obtained through the simultaneous discharge measurement, annual runoffs of the Langkemme and Sero rivers and the tributaries of the Walanae river are estimated by 10-day basis, as shown in Fig. 4.3.2.

## 4.4 PHYSICAL FEATURES

### 4.4.1 Topography

The project area is topographically divided into three areas. Northwestern part of the project area is a vast fan created by the small tributaries of the Walanae river originating in the western hilly ranges. The fan is sharply slanting from southwest to northeast with a

topographic gradient of about 1%. Its altitude ranges from 200 m to 30 m above MSL. Small scaled terraces sprawl out from the hillside to northeastward.

Northeastern part of the project area is a recent alluvial flat shaped by the Walanae river. The flat is topographically gentle and has been highly developed for paddy fields. Its altitude varies between 30 m to 10 m above MSL.

Southern part of the project area is narrow strips or river terraces developed in the vales of the Langkemme river and the upstream of the Laja river. The strips reveal steep topography with a gradient of 20%. Its altitude ranges from 170 m to 100 m above MSL. The strips are mainly covered with narrow terraced paddy fields.

### 4.4.2 Climate

The project area is graced with favourable climatic conditions for the growth of various crops, excepting the uneven annual and seasonal distribution of rainfall. The seasonal trend of temperature in the project area is characterized by its narrow variation. The maximum monthly mean temperature of 29.2°C occurs in October, whereas the minimum of 24.8°C, in July. The maximum monthly mean temperature during the dry season ranges from 25.3°C to 29.2°C, while during the wet season, it varies between 24.8°C and 29.0°C. The annual mean temperature is 27.3°C.

The climate in the project area is also characterized by three distinctive seasons, dry, wet, and transitional, according to the seasonal distribution of rainfall. The cease and onset of these seasons widely vary year by year. This variation is one of the climatic constraints for the agriculture in the project area. The wet season usually commences in March and lasts about five months until July and is followed by shorter dry season from August thru October. The transitional season usually starts in November and ends in February. About 85% of the annual rainfall of about 1,550 mm concentrates between November thru July, while the remaining only 15% is distributed within the shorter dry season. The maximum consecutive drought of 84 days is recorded from August, 27 to November, 18 in 1977. The droughts frequently hamper a stable agricultural production under rainfed condition.

The annual mean A pan-evaporation of 1,988 mm is estimated on the basis of the records in the Sengkang Meteorological Station. The maximum monthly mean A-pan evaporation of 303 mm or the daily mean of about 10 mm equivalence occurred in October, 1977 and the minimum of 109 mm or the daily mean of about 3.5 mm equivalence, in June, 1980. The annual A-pan evaporation always exceeds annual rainfall. Irrigation is essential for the stable agricultural production in the project area.

The annual mean relative humidity is recorded in the Sengkang Meteorological Station. The relative humidity narrowly ranges between the dry and wet seasons, about 75% on an average during the dry season and about 79% on an average during the wet season. The lowest relative humidity occurs in September, together with the considerable high temperature, while the highest relative humidity, in April, together with relatively low temperature.

The east monsoon prevails over the project area during wet season. The monthly mean wind velocity varies between 3.6 km/hr and 9.7 km/hr, resulting in 6.7 km/hr in terms of annual mean.

Annual mean percentage of sunshine is estimated at 53% or 6.4 hr/day at Sengkang Meteorological Station. The monthly mean sunshine hour widely ranges from 9.9 hr/day in dry season to 4.2 hr/day in wet season. The sunshine hour is directly concerned with the unit production yield of the paddy in the project area.

### 4.4.3 Soils

The soils in the study area are classified into seven soils units, according to the FAO-UNESCO soil classification system, i.e., Eutric Fluvisols (Je), Pellic Vertisols (Vp), Eutric Gleysols (Ge), Calcalic Luvisols (Lk), Eutric Regosols (Re), Rendginas (E) and Lithosols (I). The studies for land capability classification are also made on the basis of the standard described by the Ministry of Agriculture, Forestry and Fishery of Japan. The soil map is prepared as given in Fig. 4.4.1. Major characteristics and capability class rating of each soil unit are outlined as follows:

Eutric Fluvisols (Je) mainly extend over the flat alluvial plain along the Langkemme river and small streams accrossing the project area from west to northeast. This soil group is developed on recent alluvial deposits and is generally immature with no predominant morphological characteristics. The effective soil depth is generally deep. The surface soils have dark brown to graish brown silty clay. Subsoils are generally yellowish brown coloured heavy clay. The most of these soils are presently put under cultivation of paddy. They are very suitable for irrigated rice farming. These soils occupy about 3,630 ha or 18.2% of the study area.

Pellic Vertisols (Vp) develop over the undulating alluvial lands enclosed with flat plains and hilly lands. The soils have the gray or black heavy clayey surface soils formed on calcareous alluvium. 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 results, micro-relief called gilgai is developed at the surface. This "vertic" surface soils are not very deep, generally within 30 cm from the ground surface. The subsoils underlaying vertic surface vary with the locations, from gravelly to clayey alluvial deposits. The lands covered with these soils are presently used for paddy cultivation. Adequate water supply is the key to the utilization of

Vertisols. Where irrigation is practiced, these soils are very suitable for paddy cultivation. These soils occupy 5,730 ha in total or 28.7% of the survey area.

Eutric Gleysols (Ge) are poorly drained soils, in low-lying areas and in depressions, that are influenced by high groundwater tables and therefore show hydromorphic property. The soils have a reducing condition in the lower part of the soils that is continuously saturated with water. The sub-soils are therefore grayish blue in general, with some orange or reddish spots. The soils structure is massive to weakly developed sub-angular blocky. These soils are continuously cropped to rice. Because their inherent fertility is generally low, proper irrigation and fertilization will be essential. These soils occupy 370 ha or 1.8% of the survey area.

Calcalic Livisols (Lk) are found in the hilly lands mainly on limestones. The soil depth is variable depending on topographic position. The horizon sequence of the soils is A/Bt/C in general. The soils have well developed argillic B horizon (clay accumulation). Most of Calcic Luvisols are presently used for cultivation of upland crops. They have a moderate inherent fertility but are not intensively used owing to some specific limiting factors of topography, soil depth, stoniness and water availability. The total area of these soils is about 2,990 ha or 14.9% of survey area.

Eutric Regosols (Re) are very young soils, almost no horizon differentiation, which are found along the Malanae river and on the alluvial terraces along the streams in the project area. The soil texture is generally very sandy throughout the profile. Most of Regosols are presently used for cultivation of tobacco and groundnuts. Regosols retains little water. The total area of the soils is about 2,480 ha or 12.4% of the study area.

Rendzinas (E) are formed on calcareous rock materials and extends over the south eastern hilly lands. They are stony soils and have hardly any agricultural value. These soils occupy 530 ha or 2.6% of the study area.

Lithosols (I) extend over rolling hilly lands and mountaneous areas. These soils are mineral soils less than 10 cm thick over hard rock. These soils have no agricultural value. These lands are about 4,270 ha in total or 21.4% of the study area.

### 4.4.4 Geology

Base rocks in the project area and the relevant watersheds are mainly composed of limestone, andesitics, coral limestone, and sedimentary rocks originated in the Tertiary. In the lowlying project area, these base rocks are usually covered with fan and terrace deposits originated in the Quarternary.

The limestone mainly distributed in the watershed of the Pising river, a tributary of the Sero river. The watershed discloses the oldest geology in and around the project area. The limestone out-cropped in the watershed assumes dark milky white and is much massive, hard and well-compacted.

The andesitic originated in the Oligocene and/or Miocene composes the base rocks in the hilly ranges extending westward the proposed main canal route. It comprises andesite, tuff and tuff-breccia. The andesite is relatively homogenious and hard, assuming dark grey to dark green. The tuff and tuff-breccia are generally soft and less coherent as compared with the andesite. These andesitics are considerably massive without any obvious bedding and relatively less weathered.

The coral limestone originated in the Pliocene and/or Pleistocene is broadly distributed at the skirt of the mountain, hilly areas covered with andesitics, and the project area developed for paddy field. It generally assumes yellowish, fossiliferous, and relatively hard, but it is likely to be rather porous and much permeable. In fact, many springs are fed by the seepage water out of the area covered with the coral limestone.

The sedimentary rocks are sporadically distributed in the gently slanting slopes and the low hillsides. It comprises poorly cemented mudstone, sandstone and conglomerate, sometimes interbedding a skinbed of tuffs. Most of their dips usually disclose nearly horizontal, excepting sharp dips cropped out in the vicinity of the confluence of the Langkemme and Sero rivers.

In the flat plain, the base rock mainly composed of the coral limestone are covered with alluvial fan, diluvial terrace, talus, and residual deposits. They are soil-mechanically classified into CH, GC, and SC. The subsurface layer along the main canal route is relatively firm and consolidated. No weak alluvial layer exists in the project area. The geological feature in the study area is illustrated in Fig. 4.4.2.

## 4.5 INFRASTRUCTURE

### 4.5.1 Irrigation/Drainage System

Forty eight (48) small scaled irrigation schemes have been developed in the project area of 6,400 ha comprising 44 Desa irrigation schemes and four DPU semi-technical irrigation schemes. The Desa and DPU schemes cover about 4,300 ha, 2,100 ha respectively as shown in Table 4.5.1 and Fig. 4.5.1. The Desa irrigation schemes are further divided into two categories in terms of grade of irrigation facilities, namely, non-technical and semi-technical level. Thirty four (34) schemes among them still remain non-technical level covering 2,900 ha and remaining 10 schemes have been up-graded to the semi-technical level, covering about 1,400 ha. The definition of the grade of irrigation system is given in ANNEX-II, CHAPTER IV.

(1) DPU semi-technical irrigation schemes

Among four DPU semi-technical irrigation schemes, Cennae scheme of about 200 ha is located at the left bank of the Langkemme river, close to the southern boundary of the project area. The scheme depends its irrigation water resources upon the main stream of the Langkemme river. A micro hydropower station of about 50 kw has been installed together with the scheme. The scheme is provided with a gabion intake weir and a head reach which are commonly used for hydro power generation.

Akampeng-II DPU semi-technical irrigation scheme of about 870 ha, the largest existing irrigation scheme in and around the project area, extends the northwest of Cabenge. The scheme mainly depends its irrigation water resources on the lower reach of the Belo river, the largest tributaries relevant to the project area and supplementarily on the drained water from upper areas irrigated by the Lawo river system. A masonry intake weir with a sand sluice is installed in the vicinity of Kampung Akampeng. But it is considerably deteriorated at present.

Lalange DPU semi-technical irrigation scheme of 700 ha is located on alluvial flats extending between the Walanae river and the provincial road from Takalala to Sengkang. The scheme has been recently rehabilitated and up-graded to semi-technical level. Its irrigation water resources depend on the Laja river. Concrete intake weir with a sand sluice has been constructed in the vicinity of Kampung Cacalempeng.

Lagarigi DPU semi-technical irrigation scheme of about 330 ha is located near the Kampung Cabenge, astride the provincial road from Cabenge to Watan Soppeng. Its irrigation water resources depend on the Labempa river, a tributary of the Laja river. Perennial masonry intake weir with a sand sluice has been constructed near the Kampung Cangadi; it is relatively better maintained.

In these DPU semi-technical irrigation schemes some reaches of main canal are lined with pebble masonry and/or concrete. Most of the canal networked in the scheme still remain unlined but relatively better maintained. The density of canal system ranges from about 20 m/ha to 30 m/ha. Natural rivulets adjacent to paddy fields function main drainage canal in these schemes. No technical drainage system has been developed in these schemes (see Table 4.5.2).

(2) Desa irrigation schemes

In addition to these four DPU semi-technical irrigation schemes, 44 Desa irrigation schemes have been developed so far in the project area, covering about 4,300 ha of paddy field. The size of these Desa irrigation schemes ranges from 10 ha to 500 ha.

These schemes depend their irrigation water resources on the seven tributaries of the Walanae river. Sixty six (66) intake weirs have been constructed along the said tributaries to divert irrigation water

into these irrigation schemes. Eleven (11) intakes among them are perennial ones constructed with masonry and/or concrete and the remains are ephemeral ones constructed with stones ripraps and/or humble gabions.

These intakes contribute to effective use of the limited water resources in the tributaries; the drained water from paddy field in the upper area returns adjacent tributaries and is offtaken at the weir provided for the lower Desa irrigation schemes. Thus, all of the tributaries fulfill dual functions of irrigation/drainage canals. No exclusive drainage facilities has been developed in the Desa irrigation schemes.

All of the canals aligned in the Desa irrigation schemes are unlined and most of them are heavily silted. The density of irrigation canal networks is considerably low, resulting in plot-to-plot irrigation practices to large extent of paddy fields (see Table 4.5.2). The paddy fields of only about 70 ha still remain under rainfed condition in the project area at present mainly on account of topography and shortage of available irrigation water resources.

### 4.5.2 Transportation and Communication

Three provincial roads are networked in and around the project area. The trunk line among them extends about 250 km from Ujung Pandang to Pare Pare by way of Cabenge, Sengkang, and Pangkajene. It traverses the project area from south to north and plays a major role of the transportation around the project area. A supplement provincial road of about 60 km long branches off from the trunk line at Cabenge, passes by the northern boundary of the project area, stretches northward by way of Watan Soppeng and links with the trunk line at Pangkajene. The full span of the both provincial roads are asphalt-paved and year-roundly better maintained. Another provincial road also branches off from the trunk line at Takalala and extends to Barru, about 60 km remote from Takalala, across the Langkemae river and beyond the pass in the western ranges. A pavement work has recently started near Takalala but most of the road are poor maintained and unjeepable during wet season at present.

In addition to the provincial roads, a district road of about 10 km long traverses across somewhere centre of the project area and links Watan Soppeng to Takalala. The full span of the road has been asphalt-paved and better maintained as well as the trunk line of the provincial road. This road provides a function of main farm road to transport agricultural products and inputs.

A number of unpaved rural roads are networked between hamlets scattered in the project area. Most of them are not jeepable even during dry season. The density of existing farm roads is still low. The insufficient farm road networks and their poor maintenances limit the access to farm lands and hamper agricultural mechanization in the project area.

A domestic airport available for jetliner has been operated in Ujung Pandang, about 130 km far from the project area. Garuda Indonesia Airways, a national carrier and some domestic airways establish daily services between Ujung Pandang and other major cities.

The port Ujung Pandang and Pare Pare are located at about 130 km and 80 km, respectively far from the project area. The port Pare Pare plays a leading role of the export of the agricultural products in the project area at present. The port has a capacity to receive ships of medium draft.

Wire and wireless tele-communication system has been networked between major cities and Watan Soppeng, the capital of Kabupaten Soppeng. So far as the project area is concerned, no tele-communication systems have been installed at all. The system is not available even in the Kecametan offices in the project area.

### 4.5.3 Electricity and Water Supply

A micro hydropower station of 50 kw under PLN is located at the left bank of the Langkemme river close to the Kampung Cennae. The intake structure of the station is commonly used with the Cennae DPU semi-technical irrigation scheme.

The station has been operated about 14 hrs per day on an average during wet season by discharging excess water of the Cennae irrigation scheme. Actually however, its operation is sometimes limited less than five hrs per day even during wet season. The station has never generated throughout droughty season owing to the depleted flow in the Langkemme river. A engine-driven generator is installed to supplement electricity supply during the drought season. The electricity generated in the station is transmitted to Kampung Cennae and Takalala. In the Kampung Cabenge, an engine-driven generator has been also operated by the PLN.

A number of other Kampung locating in the project area also independently install small scaled engine-driven generator. Most of them are operated by cooperatives or private sectors. Their operation are limited during night time.

In Watan Soppeng, four engine-driven generators with total capacity of 1,400 kw have been operated by the PLN. The electricity supply in Watan Soppeng is also limited within night time as well as in the project area because of high operation cost and low demands in the daytime.

The urban area of Watan Soppeng is covered by a modernized municipal water supply system, the water resources of which depend on the Soppeng river. The domestic water supply system has not developed at all in the project area. Each village in the project area mainly depends its domestic and potable water on ground water. A number of shallow wells have been dug in each village by grouped village people.

## 4.6 PRESENT CONDITION OF AGRICULTURE

### 4.6.1 Present Land Use and Cropping Pattern

In the study area, the existing paddy fields of 6,400 ha have been delineated for the project. Most of the selected paddy fields are already well developed and are presently served by three types of irrigation system, as previously mentioned, i.e.;

| | |
|---|---|
| Desa non-technical area | 2,900 ha |
| Desa semi-technical area | 1,400 ha |
| DPU. semi-technical area | 100 ha |
| Total | 6,400 ha |

The main crop grown in the project area is paddy, followed by polowijo crops such as maize, groundnuts, greenbeans and soybeans. Other crops grown as an adjunct to rice farming are banana, coconuts, cassava, tobacco, clove, pepper, kapok, etc. They are generally grown in the upland areas.

The paddy cultivation is concentrated in the wet season and is limited in the dry season. The cultivation pattern is generally affected by seasonal distribution of rainfall. The areas harvested and/or planted fluctuate year by year, depending on the available water. The wet season paddy (1st paddy) is planted at the onset of the monsoon, generally in April and May, and harvested in August and September. The dry season paddy (2nd paddy) is planted during the period from November to January and harvested from February to April. Such prolonged planting period for the dry season paddy is attributable to the shortage of available irrigation water.

The average harvested area of paddy, from 1975 to 1979, is 6,138 ha for wet season paddy and 4,153 ha for dry season paddy. These figures correspond to 96% and 65% of the total paddy field, respectively. It is considered that the paddy fields unused are basically due to shortage of available irrigation water. The polowijo crops are generally planted after harvest of wet season paddy. The planted area of polowijo crops is, however, quite limited to only 350 ha or 5% of the total paddy field. This low percentage of planting is also mainly due to shortage of available water. Thus, the present multi-cropping intensity is estimated at 166% on an average.

The extensive agricultural survey has been made in the project area and it has been found that, on account of differences in the degree of irrigation, the crop rotation patterns adopted in the project area can be classified into five major types (See Fig. 4.6.2). They are:

| | Patterns | Cropping Intensity (%) | Area (ha) |
|---|---|---|---|
| I. | Paddy - paddy - paddy (3 crops a year) | 260 - 300 | 70 |
| II. | Paddy - paddy (High cropping intensity) | 180 - 200 | 2,080 |
| III. | Paddy - paddy (Low cropping intensity) | 130 - 180 | 3,370 |
| IV. | Paddy - polowijo - paddy (3 crops a year) | 260 - 300 | 140 |
| V. | Paddy - polowijo (2 crops a year) | 100 - 120 | 740 |
| | Total | 166 (ave.) | 6,400 |

The pattern I is found in some of the DPU semi-technical irrigation area where the irrigation water is sufficiently available throughout the year. The pattern IV is practiced mainly in the upstream areas commanded by Desa irrigation system. In these areas, dependable water sources are small streams and therefore available water for irrigation is extreamly decreased in the dry season. Due to limited availability of dry season water, very limited areas mainly in upstream areas can be planted with polowijo crops in the dry season. Pattern II is double cropping of paddy under sufficiently irrigated condition. The cropping intensity is 180 - 200%. The Pattern III is same as Pattern II, but cropping intensity is lower due to limited availability of irrigation water in the dry season. The Pattern V is found in lower parts of existing irrigation schemes where irrigation water is not always available. These cropping patterns are illustrated in Fig. 4.6.1.

### 4.6.2 Farming Practices

Paddy is the most important crop in the project area. The paddy cultivation is carried out by labour intensive form from the stage of seeding to harvesting. All members of family contribute their labour to the paddy cultivation. Animal power, buffaloes and oxen, is extensively utilized for land preparation. The use of mechanical equipment is not common, except for spraying of agro-chemicals.

In the project area, improved high-yielding varieties have been widely spread over through the extension of BIMAS program and occupied over 80% of the total paddy fields. The most predominant variety is IR36, the early-matured high yielding variety, which was introduced in

1977 and has been widely spread over the area. The introduction of this variety enables the farmers to grow paddy twice in the limited period of about seven months. Furthermore, it enables the introduction of triple cropping in the project area, provided irrigation water is available.

The fertilizers and agro-chemicals are widely used under the BIMAS programe. The farmers are very much aware of effects of these inputs and of proper application methods. The fertilizers being used in the project area are urea and triple super phosphate (TSP). The average dosages are 100 kg/ha of urea and 50 kg/ha of TSP for semi-technical area. Potasium fertilizers are not generally applied. Use of insecticides and rodenticides is common. Major insecticides are Diazinon and Sumithion. They are applied to the field by use of knapsack type sprayers. Zinc phosphate is widely used as rodenticide. Fungicides, Kasumin and Furadin, are recently introduced to the area for the prevention of blast diseases.

As for polowijo crops, cultivation method is very primitive. Neither fertilizers nor improved varieties are used. Unit yields of polowijo crops are generally low.

### 4.6.3 Crop Yield and Production

Yield and production of major crops under present condition in the project area are estimated on the basis of production data obtained from agriculture offices in four Kecamatan. The yields and production largely fluctuate year by year due to wide variation of annual rainfall and unexpected damages caused by insects and diseases. The present crop yields and production are therefore estimated at the averaged values from 1975 to 1979.

The production record of paddy in past five years is shown in Table 4.6.1. The averaged unit yield of paddy (dry stalk paddy) is 4.60 tons/ha for wet season paddy and 4.75 tons/ha for dry season paddy. The results of paddy yield survey carried out by the Team in August/September, 1980 (wet season paddy) are given in Table 4.6.2. In the yield survey, 22 paddy fields were selected at random for sampling, and laboratory analysis of 22 samples are made for determination of yield components. The results of yield survey carried out by the Master Plan Team in March/April, 1979 (dry season paddy) are also given in Table 4.6.3.

There is a clear correlation between unit yield and number of grains per $m^2$ for dry season paddy. While, there is no clear correlation, for the wet season paddy. Only percentage of ripened grains is generally low.

The present paddy yields in the project area are not very low. Nevertheless, it is considered from the results of yield survey that the present unit yields still remain at low level by following unfavourable conditions:

For wet season paddy

i) Insufficient irrigation water in volume throughout the growth period

ii) Improper water control at individual farm especially at the panicle formation stage

iii) Damages caused by insects and diseases, especially blast disease, and

iv) Relatively heavy application of fertilizers in early stage of growth (over-grown of panicles)

For dry season paddy

i) Insufficient irrigation water, especially during early stage of growth

ii) Improper water control at individual farm

iii) Low level of farm inputs application, and

iv) Insect damages, especially stem borers

The unit yields and production of polowijo crops also fluctuate year by year and place by place, depending on availability of water. Since no farm inputs like fertilizers and chemicals are used, unit yields are generally low. The average unit yields of polowijo crops are 0.79 ton/ha of maize, 0.81 ton/ha of groundnuts, 0.83 ton/ha of greenbeans and 0.67 ton/ha of soybeans. The average annual production of paddy and polowijo crops is summarized as shown below:

| Crops | Planted Area (ha) | Unit Yield (ton/ha) | Production (tons) |
|---|---|---|---|
| Wet season paddy | 6,138 | 4.60 | 28,280 |
| Dry season paddy | 4,153 | 4.75 | 19,770 |
| (total) | (10,291) | (4.66) | (48,050) |
| Polowijo crops | | | |
| - Maize | 329 | 0.79 | 259 |
| - Groundnuts | 12 | 0.81 | 10 |
| - Greenbeans | 7 | 0.83 | 6 |
| - Soybeans | 2 | 0.67 | 1 |
| (total) | (350) | ( - ) | ( - ) |

### 4.6.4 Livestock Production

Livestock raising is not a mainline of agricultural activities in the project area. Most of livestocks are grazed on a small scale in and around the paddy fields. The number of livestock animals in and around the project area are summarized as follows:

| Livestock | Total Number (head) | per Farm Household (head) |
|---|---|---|
| Horse | 6,179 | 0.48 |
| Cow | 16,916 | 1.32 |
| Buffalo | 264 | 0.02 |
| Goat | 3,544 | 0.03 |
| Fowl | 146,009 | 11.36 |
| Duck | 39,021 | 3.04 |

Source: Livestock Services Office, Kab. Soppeng, 1980

The livestock plays an important role in farm operation and transportation as motive power, and also in protein food supplies. Annual income from livestock is, however, of little significance to the project as well as farm economy. It can be excluded from project economy.

### 4.6.5 Processing and Marketing

Rice is the main marketing farm product in the project area. The annual marketed amount of rice is estimated at about 37,000 tons. There are three channels of rice marketing in the project area. 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 project area, especially to Ujung Pandang and Pare Pare. About 80% of surplus paddy is marketed through these two channels. The remaining 20% of the surplus paddy is sold at local markets in and around the project area by small brokers and/or directly by farmers.

The price of rice is generally controlled by the Government through DOLOG. In 1980/81, the floor price of milled rice is set at Rp. 175/kg and the ceiling price at Rp. 190/kg. 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 stock.

There exist about 370 rice mills in and around the project area. Most of these rice mills are privately owned. The average capacity of these rice mills is about 650 kg per hour. The annual working days are estimated at 120 days on an average. The total amount of paddy processed in and around the project area is about 28,000 tons per annum. In general, most of existing milling fcilities are of one-pass system (simultaneous husking and whitening) and produce a lot of broken rice.

### 4.6.6 Present Agricultural Production Value

The studies on the present farm economy are made on the basis of the data and informations obtained from the agriculture office, Kab. Soppeng, and the results of farm interview.

The gross production value under present condition is estimated at Rp. 4,586 million (US$7.3 million) as shown below:

| Crop | Annual Production (tons) | Unit Price (Rp/kg) | Production Value ($10^6$Rp) |
|---|---|---|---|
| Wet Season Paddy | 28,280 | 95 | 2,687 |
| Dry Season Paddy | 19,770 | 95 | 1,878 |
| (total) | (48,050) | 95 | (4,565) |
| Polowijo Crops | | | |
| - Maize | 260 | 60 | 16 |
| - Groundnuts | 10 | 300 | 4 |
| - Greenbeans | 6 | 250 | 1 |
| - Soybeans | 1 | 250 | - |
| (total) | ( - ) | - | 21 |
| Total | - | - | 4,586 |

The farming expenses are varied by kind of crops and degree of irrigation. The detailed estimates of present unit farming expenses per ha are given in ANNEX-I, CHAPTER II. The crop production cost under present condition totals Rp. 1,243 million (US$2.0 million) for 6,400 ha of paddy field as summarized below:

| Crops | Planted Area (ha) | Unit production Cost (Rp/ha) | Total production Cost ($10^6$Rp) |
|---|---|---|---|
| Wet Season Paddy | | | |
| - Semi-technical area | 3,320 | 127,000 | 422 |
| - Non-technical area | 2,818 | 105,000 | 296 |
| Dry Season Paddy | | | |
| - Semi-technical area | 2,225 | 134,000 | 298 |
| - Non-technical area | 1,928 | 113,000 | 218 |
| Polowijo crops | | | |
| - Maize | 329 | 23,000 | 8 |
| - Groundnuts | 12 | 79,000 | 1 |
| - Greenbeans | 7 | 56,000 | - |
| - Soybeans | 2 | 56,000 | - |
| Total | - | - | 1,243 |

The annual net production value under present condition is then calculated at Rp. 3,343 million (US$5.3 million) in total, by deducting the total production costs from the total gross production value.

### 4.6.7 Land Tenure and Land Holding

The size of farms in the South Sulawesi, as measured by the cultivated area per farm household, is generally small because of the limited availability of arable land and large number of farm population. According to the agricultural census taken in 1973, the average size of farms is about 1.74 ha of which 1.13 ha is paddy field.

In the project area, the size of farms averages 1.03 ha, out of which paddy field accounts for 0.61 ha. This average size is smaller by 0.71 ha as compared with that of the whole province. According to the IPEDA office of Kab. Soppeng, about 65% of total farmers is owner farmers and partially owner farmers. Tenant farmers account for about 35%. Tenant systems are complicated but most of them are of share cropping. Tenant charge is generally about 50% of total products.

Studies on the frequency distribution of the size of farms indicate that farmers with farm land less than 0.5 ha constitute about 40% of the total number of farmers in the project area. As the crop incomes of these farmers are not abundant and insufficient to maintain the livelihood of farmers, most of these farmers are engaged in various side-line business.

### 4.6.8 Farm Economy

At present, the average size farmer in the project area cultivates 1.03 ha of farm land comprising 0.61 ha of paddy field and 0.42 ha of upland field, out of which only 0.50 ha of paddy field are within the project area. The annual gross farm income of this average farmer is estimated at about Rp. 445,500. The farming expenses are estimated at about Rp. 86,600 on the average size farm. Accordingly, net farm income is estimated at Rp. 358,900 which are nearly same amount to living expenses as shown in Table 4.6.4.

### 4.6.9 Present Water Charge

Farmers are required to make two different kinds of payment for their irrigation water. One is the payment to "Ulu-Ulu" (water distributor) for daily operation and maintenance. It is generally paid in kind, and on an average, it amounts about 1% of crop production. The other is the "special desa tax" for amortization of capital expenditures. It varies desa by desa, reflecting the difference of the capital investments, but on an average, about Rp. 2,000 of the desa tax are lived on member farmers for every cropping.

In addition, there is a traditional custom called "Gotong Royong" in which all the member farmers have to contribute their labour for betterment of irrigation facilities. According to the results of farm interview, every farmer spends about five days annually for this "Gotong Royong". The annual charges of irrigation water paid by farmer are then estimated at about Rp. 15,000 per ha in total or 2.1% of annual crop income per ha.

## 4.7 AGRICULTURAL SUPPORT SYSTEM

### 4.7.1 General

The South Sulawesi Province, one of the 27 provinces in whole Indonesia, is administratively divided into 21 Kabupaten and two Kota Madya, headed by "Bupati" and "Wali Kota", respectively, nominated by the Governor of Province. These Kabupaten and Kota Madya are subdivided into 169 Kecamatan headed by "Camat" nominated also by the Governor. Under the Kecamatan there are 1,136 Desa which are the basic units of administrative structure in Indonesia.

The Kabupaten Soppeng, where the project area is entirely covered, has five Kecamatan and 34 Desa. In the project area, four Kecamatan and 13 Desa are included.

Kepala Desa (chief of Desa), elected from among the people in the village every five years, has the responsibility of agricultural development in each desa unit as well as public health, education, village welfare and security, and other public works.

### 4.7.2 BIMAS and INMAS Program

The agricultural intensification program so called "BIMAS" and "INMAS" has been promoted by the Indonesian Government in order to facilitate the crop production increase with coordination of all the efforts of agricultural support services and so as to provide a "package" of agricultural inputs to the farmers since 1963. For further development of BIMAS/INMAS program, the Government has initiated to organize a village unit (Wilayah Unit Desa) as the lowest executive unit of the Programe since 1973. It is said that 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:

i) Extension services by PPL (Field Extension Worker)

ii) BIMAS credit services by village unit branch of Indonesia People's Bank (BRI)

iii) Farm inputs supply services by village unit Kiosk, and

iv) Cooperation processing and marketing by village unit cooperative (KUD)

In the project area, there are 13 village units with six KUD, 13 Kiosk, six branches of BRI and 14 PPL. The average hectarage of irrigated paddy field and the average number of farm household per a village unit are 402 ha and 989 farm households, respectively. As compared with the said general standard of village unit, those in the project area are far intensified in size.

Under these executive units, BIMAS/INMAS program has been steadily developed in the project area. The area served by BIMAS/INMAS program in the project is estimated at about 2,800 ha or 46% for wet season paddy and 2,200 ha or 53% for dry season paddy.

In order to further promote the BIMAS program, Special Intensification Program (Intensifikasi - Khusus) so-called "INSUS" has been launched since 1979. The INSUS program is the special form of BIMAS for farmer's groups which are voluntarily organized by the progressive farmers. There is no special BIMAS package for the farmers groups under INSUS program. Each farmer's group can decide and apply any form of package with the advise of PPL, who visits the farmer's group once a week. In the project area, about 120 farmer's groups have been organized and about 20% of farmer's are served by the INSUS program.

### 4.7.3 Research

Agricultural research work in Indonesia is undertaken by the Central Research Institute of Agriculture (CRIA) at Bogor in Java. There are six branch stations under CRIA in whole Indonesia. The branch station in South Sulawesi is located at Maros, about 40 km north from Ujung Pandang. This branch station has 146 ha of experiment fields of which 110 ha are rice experiment fields. There are two sub-stations under control of this station. One is located at Lanrang, Kab. Sidrap and is mainly carrying out rice experiment with 44 ha of irrigated paddy field. The other located at Gowa is mainly undertaking the agronomic experiment of polowijo crops. The Maros branch station plays an important role in technical aspects for promotion of BIMAS/INMAS Program.

### 4.7.4 Extension Services

In order to accelerate the agricultural extension activities, by separating the extension service activities from general agricultural administrative service, the Agricultural Extension Service Development Program has been launched in Indonesia since 1974. In the Central Government, the Agency for Agricultural Education, Training and Extension was established as one of extra-ministerial bureaus under the Ministry of Agriculture. In the provincial level, the establishment of the Agricultural Development Centers has been promoted with the provision of functions of adoption tests of new agricultural techniques recommended by research institutions and in-service training of field extension workers. In Kabupaten level, the establishment of several Rural Extension Centers has been accelerated for improvement of field extension services.

In the project area, there are two Rural Extension Centers, located at Malanroe and Pattojo. The center at Malanroe has the function of extension program, dissemination of new agricultural techniques and training for leading farmers. The Pattojo center is carrying out the demonstration work of recommendable agricultural operations. They have recently started the demonstration of irrigated polowijo cultivation.

### 4.7.5 Seed Multiplication

The stock seeds of recommended varieties of rice in the South Sulawesi are produced at the provincial seed center located at Maros by using the foundation seeds supplied from CRIA at Bogor. The seed center distributes these stock seeds to 37 seed stations managed by each Kabupaten office. These seed stations produce the extension seeds and distribute them to selected seed growers. The seed growers produce paddy seeds and supply them to the farmers through BIMAS/INMAS program.

In the project area, there exists a seed station with five ha of irrigated paddy field at Malanroe. The rice variety, IR36, was first introduced to this station in 1976 and this variety is now used on greater than 60% of total paddy fields. This has evidenced good performances of this station and other agricultural support services.

### 4.7.6 Agricultural Credit

Bank Rakyat Indonesia (the Indonesia People's Bank) 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. The loan condition is fixed at the interest rate of 1% per month and the repayment period of seven months.

In the project area, there are one branch office and six sub-branch offices. The loan amount for BIMAS package has steadily increased and it exceeds Rp. 300 million in 1979/80 in the project area.

### 4.7.7 Farm Inputs Supply

Distribution of fertilizers and agro-chemicals is handled by PT. PUSRI, the governmental enterprise in the South Sulawesi Province. According to the BIMAS/INMAS program, fertilizers and agro-chemicals are supplied to six sub-distributors appointed by PT. PUSRI at Ujung Pandang and then the 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 Rp.70/kg at present.

### 4.7.8 Farmers Cooperatives

Farm inputs supplies and processing and marketing of farm products are primarily made through the establishment of cooperatives (BUUD/KUD) which have been promoted by the Government through the Cooperative Office in each Kabupaten since 1945 when the Cooperative Acts in Indonesia was enacted. In spite of government efforts, however, the cooperative movement has not been well developed mainly because of weakness in management and shortage of operational fund.

In order to improve such stagnant condition of cooperative movement, establishment of Village Unit Cooperative (KUD) has been promoted since 1973 when the President Degree for Village Unit was enforced, as previously mentioned.

In the project area, six KUD have been organized so far. These KUD presently cover about 70% of the project area. The total number of KUD members including candidates is about 5,100, which correspond to about 40% of total farm households in the project area. As for the irrigation water management, the traditional "Ulu-Ulu" system is still predominant in the project area. There exists only one water user's association (P3A), covering only 530 ha with 285 members.

# CHAPTER V THE PROJECT

## 5.1 AGRICULTURAL CONSTRAINTS

### 5.1.1 Summary on Current Situation

#### (1) Agriculture

The Langkemme Irrigation Project area of 6,400 ha in net is completely covered with well-developed paddy field. There exist 44 small scaled Desa irrigation and four DPU irrigation schemes, covering over 99% of the existing paddy field. These schemes mainly depend their irrigation water on the small tributaries of the Walanae river.

Paddy cultivation in the project area is concentrated in the wet season and it is extremely limited in the dry season because of the exhausted water sources. The cultivation pattern is directly affected by the seasonal distribution of rainfall. The planting and harvesting areas widely fluctuate year by year, depending on endowed rainfall and available water resources in the tributaries of the Walanae river. In the wet season from April to July, almost all of the paddy fields are planted with paddy. While, in the transitional season from November to February, only about 65% of the existing paddy fields is cultivated with paddy under irrigated condition. The remaining paddy fields are under cultivation of polowijo or fallow. Most of paddy fields are not used for cropping during the dry season from August to October.

Improved high yielding varieties of paddy have been widely spread over the project area through extension of BIMAS/INMAS program. Although unit yield of paddy in the project area is not very low showing the average yields of 4.60 tons/ha for wet season paddy and 4.75 tons/ha for dry season paddy, there will be still much room for further improvement.

The cultivation of polowijo crops is quite limited in the project area owing to shortage of irrigation water. Since the polowijo crops are cultivated mostly under rainfed condition without use of any improved farm inputs, the unit yields of polowijo crops are generally low.

The size of farms in the project area is generally small because of the limited availability of arable land and a large number of farm population. The average size of farms is estimated at 1.03 ha of which only 0.61 ha is the paddy fields. The study on present farm economy shows that crop income from such small farmland is not sufficient to maintain the livelihood of the farmers. Under such circumstances, the crop income of such small farmers can be improved only through the improvement of land productivity.

#### (2) Irrigation

Paddy fields of about 8,000 ha extending in and around the project area are covered with small scaled irrigation systems, so called Desa

irrigation scheme and DPU irrigation scheme. The irrigation water resources of these schemes are mainly dependent upon seven tributaries of the Walanae river, the total catchment area of which extends to 104 $km^2$. The water resources endowed in the tributaries widely fluctuate year by year according to the fluctuation of annual rainfall in the watershed of the tributaries. In the light of the ratio between the area being irrigated by the tributaries and the total catchment area of the tributaries, the shortage of irrigation water is extremely serious in and around the project area. To effectively use the limited water resources, water irrigating upper schemes and then drained into adjacent tributary is repeatedly used in the lower irrigation schemes which are provided with an exclusive intake structure along the lower reach of the tributaries.

The existing irrigation systems in the project area still remain low level, consisting of about 3,000 ha of non-technical level and 3,500 ha of semi-technical level. Ephemeral cobble weirs are constructed in the non-technical Desa irrigation schemes. The weirs have been periodically washed away during flood season and reconstructed by farmers themselves, so called "Gotong Royong". Meanwhile, perennial cobble masonry and concrete weirs are also constructed in the Desa and DPU semi-technical schemes, but most of them are considerably deteriorated owing to poor maintenance.

The density of existing irrigation canals networked in respective existing schemes is assessed to be about 30 m per ha on an average. Despite serious shortage of irrigation water, inequitable water distribution has been practiced in the existing schemes due to the low density of the canal networks. Most of the canals networked in the existing schemes are heavily silted because of poor maintenance.

The seven tributaries fulfil the function of main drainage canals in addition to the function of irrigation water sources of existing schemes. No technical drainage system has been developed so far in each scheme, since each scheme is topographically graced with better drainage condition.

### 5.1.2 Constraints

The project area has been recently created as one of rice granaries in the South Sulawesi region. Nevertheless, the land productivity thereabout still remains to be much improved due mainly to shortage of irrigation water, lack of perennial irrigation system, shortage of agricultural inputs, improper water management and ineffective application of agricultural inputs and insufficient agricultural support services. The decisive constraints among them are shortage of irrigation water resources and lack of perennial irrigation system.

## 5.2 BASIC CONCEPT FOR DEVELOPMENT

The project aims at increase of agricultural production and thereby improvement of the farmer's living standard in the Langkemme project area through exploitation of new water resources from the Langkemme and Sero rivers as well as up-grading of existing irrigation systems. The major concept for agricultural development would be as follows:

i) Unit yield and production of wet season paddy should be stabilized and improved through proper supplementary irrigation and introduction of improved irrigation farming,

ii) Total planted area of dry season paddy must be increased with year-round irrigation systems and thereby total production of paddy be maximized,

iii) Cropping intensity should be increased to the maximum extent to make maximum use of newly exploited water resources,

iv) Special attention should be given to crop diversification in conformity with government policy, and

v) For effective operation of the project, the existing institutions for agricultural support services should be maintained and strengthened.

In order to realize the proposed agricultural development in success, the following basic concept for irrigation development is envisaged:

i) The water resources endowed in the tributaries would be effectively used throughout the rehabilitation works of the existing Desa irrigation and DPU semi-technical irrigation schemes. In these works, all of the existing schemes would be up-graded to technical level upon completion of the project,

ii) The existing Desa irrigation and DPU semi-technical irrigation schemes would be incorporated in the project as they are and be given a function of tertiary blocks under the proposed irrigation system,

iii) Supplemental water resources development would be made in the river systems adjacent to the project area to stabilize the cultivation of wet season paddy and to increase the cropping intensity during dry season, and

v) No technical drainage system would be developed with this project to effectively use the limited water resources to be exploited for the project.

## 5.3 AGRICULTURAL DEVELOPMENT PLAN

### 5.3.1 Assumptions

The production techniques such as new varieties, 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 changes in agricultural production. These changes, however, are neglected in the estimation of possible changes attributed to the Langkemme Irrigation Project, partly because they have influence on both with and without the project and partly because the effect of these factors is generally so insignificant.

It is considered that the future agricultural economy of the project area with the Langkemme Irrigation Project is in the conditions reflecting the changes attributable to the project. The forecast on the changes of agricultural condition would be made under the following assumption that:

i) The existing paddy field in the project area is up-graded from non- and/or semi-technical level to fully technical level,

ii) The construction of the project is completed according to schedule, and

iii) The agricultural productivity in the project area gradually increases to a slight extent under future without-the-project condition, but it is disregarded in the analysis of agricultural benefits.

### 5.3.2 Change in Land Use

Following the completion of the Langkemme Irrigation Project, all of the paddy fields in the project area are up-graded to the technical irrigation paddy fields and more intensive use of the farmland becomes possible.

As most of the project area have more or less been under irrigation and the lands covered by the project are well-developed paddy field, there should be no major changes in kind of crops to be adopted in the project area except the increase of cropping area. The rice still remains as the most important crop.

There are no additional arable lands to be newly reclaimed under the project. In view of the unavailability of additional arable land and population growth, the size of farms can not be expanded, and even tends to become rather small. According to the results of farm economy survey, the average size farmer who cultivates a total of 1.03 ha including 0.61 ha of paddy fields earns only equivalent to his living expenses. Under these circumstances, the only possibility to enlarge the farm income is to increase the cropping intensity. The project provides the farmers with good opportunities to expand the volume of their farm business.

The land use patterns can not basically be changed without provision of irrigation development. The land use in the surrounding areas, not incorporated in the project is obliged to remain as it is. However, shifting cultivation of upland crops being proceeded on the southeastern hilly lands should be restricted and afforestation would be required for prevention of soil erosion.

### 5.3.3 Cropping Pattern

The adequate supply of irrigation water within the project area inevitably leads to certain change of crops and cropping pattern. However, it is difficult to forecast how the farmers of the project area change their cultivation of crops. Despite differences of opinion, the following principles which should govern the selection of crops and cropping patterns under the project, have been generally accepted among the authorities concerned:

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

ii) The crops and cropping pattern must make maximum utilization of water to be supplied by the project,

iii) The crops and cropping pattern must conform with the existing social traditions and be acceptable to the farmers, and

iv) The crops and cropping pattern should be practical with the limited number of family labour.

On the basis of the four principles described above, four alternatives for future cropping pattern are considered as follows:

| | | | |
|---|---|---|---|
| i) | Pattern A | : | Paddy - Polowijo - Paddy (three crops a year) |
| ii) | Pattern B | : | Two crops of paddy a year |
| iii) | Pattern C | : | Paddy - Paddy - half Paddy |
| iv) | Pattern D | : | Four crops of Paddy and one polowijo in two years |

These four alternatives are illustrated in Fig. 5.3.1. For determination of the most optimum cropping pattern, comparative studies on these alternatives are made on the basis of profitability, water requirement, and labour requirement for each alternative pattern. The results of the comparative studies are summarized as follows:

| Alternatives | Profitability /1 ($10^3$Rp/ha) | Labour Requirement /2 (man-days/ha) | Water Requirement /3 ($10^3m^3$/ha) |
|---|---|---|---|
| Pattern A | 1,268 | 371.4 | 14.9 |
| Pattern B | 1,050 | 292.1 | 14.0 |
| Pattern C | 1,215 | 363.5 | 16.7 |
| Pattern D | 1,159 | 331.8 | 14.4 |

The pattern A is the most profitable, followed by the pattern C. Other patterns are less profitable. The results of balance study on labour requirement and available family labour force show that all the alternative patterns are possibly carried out by average size family. The pattern A is of water saving type, as compared with the pattern C. Hence, the pattern A would be proposed to be under the project.

These comparative studies were explained to the representatives of local farmers and agricultural extension workers with the presence of Bupati (Chief of Kabupaten Soppeng) and his agricultural staff on Sept. 3, 1980. In this meeting, the pattern A is recognized as the most acceptable pattern to the farmers.

The proposed cropping pattern is illustrated, together with agro-climatic data, in Fig. 5.3.2. In the project area, there is no limitation for germination of seeds throughout year, blessed with relatively constant temperature. Setting of harvest period should be, however, so considered that the rainy periods are excluded for the smooth operation of harvesting and processing. The framework of cropping calender is also designed so as to expand the irrigable area as much as possible, taking into account the results of preliminary water requirement study. In order to ensure the proposed triple cropping a year, early matured varieties like IR28 and IR36 have to be used.

The proposed cropping pattern is not possibly introduced during the construction period. The proposed pattern is gradually adopted after completion of the Langkemme main canal when sufficient water becomes available from the Langkemme and Sero rivers. Double cropping of paddy is provisionally practiced until irrigation water exploited in the new water source is available.

/1 : Net production value per ha per annum
/2 : Unit labour requirement per ha per annum
/3 : Total diversion requirement per ha per annum

### 5.3.4 Proposed Farming Practices

The paddy cultivation is practiced mainly by manual operations with use of small farming equipment such as knapsack type sprayer, treadle thresher, winnower, etc. Ploughing and puddling are carried out by use of draft power. In the project area, there exist sufficient number of oxen and buffaloes for this purpose. The rapid introduction of farm machinery is not recommendable because of undulating topography, small size of farm land, large number of farm population, lack of farm access, etc.

Proper application of fertilizer is essential for full exploitation of agricultural potential under irrigated condition. The soils of the project area are generally poor in plant nutrients, especially nitrogen and phosphate. These chemical elements have to be supplemented by fertilization. Considering the soil condition, the suitable fertilizers are Urea, triple super phosphate (TSP), and potassium cloride (KCl). The fertilizer requirement for sustaining the target yields would be 200 kg/ha of Urea, 50 kg/ha of TSP and 50 kg/ha of KCl.

As regards the plant protection, intensive application of insecticides would be required for control of plant hoppers, stem borers, etc. Considering the lifecycle of these insects, 3 to 4 l/ha of insecticides would be required for 3 to 4 times applications during one cropping season. In addition, it would be necessary to apply one l/ha of fungicides for control of diseases, for each cropping season. It is recommended that plant protection works should be carried out in a systematic way through the farmer's cooperatives. The design criteria of the proposed farming for paddy are given in Table 5.3.1.

As for polowijo cultivation, the present primitive methods have to be improved with use of improved varieties, fertilizers and agro-chemicals under irrigated condition. Farm inputs for polowijo crops would be same as the amounts recommended in BIMAS package. The design criteria of the proposed farming for the selected polowijo crops are prepared on the basis of the data obtained from Central Research Institute for Agriculture, Bogor, and Agriculture Office in Kab. Soppeng (see Table 5.3.2).

### 5.3.5 Anticipated Yields and Crop Proudction

The present paddy yields in the project area are relatively high as compared with those in other areas. However, due to unstable irrigation water supply, the unit yields fluctuate year by year. After completion of the project, the paddy yields are stabilized and increased through improvement of irrigation practices and further expansion of agricultural support services. The present low yields of polowijo crops are much improved by irrigation and use of farm inputs.

The anticipated crop yields are estimated as follows:

| Crops | Without Project (ton/ha) | With Project (ton/ha) |
|---|---|---|
| Wet season paddy | 4.60 | 6.0 |
| Dry season paddy | 4.75 | 6.0 |
| Polowijo crops | | |
| - Maize | 0.79 | 2.0 |
| - Groundnuts | 0.81 | 1.2 |
| - Greenbeans | 0.83 | 1.2 |
| - Soybeans | 0.67 | 1.2 |

These anticipated crop yields are rather conservatively estimated on the basis of past five years production data and results of yield survey. As seen from Table 5.3.3, the present average yields in Kecamatan Marioriwawo, where irrigation water is relatively abundant, already exceed over six tons/ha. The results of yield survey also show that unit yield of all the improved varieties averages over six tons/ha. The maximum yield recognized in the yield survey shows over nine tons/ha. It is reported that the average unit yield of paddy under "INSUS" program exceeded over seven tons/ha in 1979/80. The anticipated unit yield of paddy under the project is therefore rather conservative. The anticipated unit yields of polowijo crops are estimated, on the basis of experiment data from CRIA at Bogor, at about 70% of average crop yields of their experiments.

The planted area for each polowijo crop is not fixed due to various uncertain factors such as farmer's intension, marketing prospects, price forecast, etc. In the cropping pattern, therefore, the area to be planted with polowijo crops is to be equally allocated to four selected polowijo crops, i.e., maize, groundnuts, greenbeans and soybeans. The anticipated annual production of these polowijo crops is thus estimated at about 3,200 tons of maize and about 1,900 tons each of other polowijo crops.

The annual paddy production at the full development stage would amount to 76,800 tons of dry stalk paddy. The expected annual increment of paddy production would be about 29,000 tons (Table 5.3.4, to be referred). The total annual production of the four kinds of polowijo crops at the full development stage would sharply increase to about 8,960 tons. The incremental production of these crops would be about 8,680 tons, deducting the current annual production of about 280 tons all over the project area.

### 5.3.6 Marketing and Price Forecast

#### (1) Marketing

The South Sulawesi Province is the largest rice surplus province in Indonesia. Total production of paddy in the Province is estimated at about 1.72 million tons in 1978, and on the contrary the total consumption is about 1.44 million tons with the surplus of 0.28 million tons. It is reported that the rice surplus conditions increasingly continue in the province. The project area is also one of the rice supply regions in the Province. The annual surplus is estimated around 37,000 tons in total, 13% equivalence of the surplus rice of the province. Most of these surplus rice are transported to the rice-deficit regions, like Kab. Bone and Wajo, and even other provinces.

The DOLOG in South Sulawesi administrates seven provinces, among which only the South Sulawesi Province produces the surplus rice; other provinces are subject to serious deficits of rice. With the completion of the project, about 60,000 tons of paddy would be marketed to these rice-deficit regions; this marketable amounts are equivalent to about 21% of the surplus-rice of the Province.

The present low production of polowijo crops has resulted from poor marketability together with large fluctuation of market prices. Such poor marketability is mainly due to poor quality of products. According to the results of farm economy survey, the best quality products of polowijo have no problem for marketing. In the project area, the polowijo crops are grown under irrigated condition with proper farming practices and therefore it is anticipated that the best quality products are produced. Although there are no marketing problem, strong government support is essential for stabilization of market prices of polowijo crops.

#### (2) Price Forecast

Indonesia is still rice import country. In recent five years, about 1.4 million tons of rice were imported on an average as shown below:

($10^3$ tons)

| 1974 | 1975 | 1976 | 1977 | 1978 | Average |
|---|---|---|---|---|---|
| 1,132 | 693 | 1,301 | 1,973 | 1,842 | 1,388 |

Considering the growth rate of population, per capita consumption and increase rate of rice production, the shortage of rice in Indonesia is continued as a whole. It is reported, however, that the South Sulawesi Province continuously remains a rice supply region.

The increased production of paddy after the completion of the project would be marketed in domestic markets in Indonesia, as the substitute of import rice. In this meaning, import substitution price of paddy is forecasted for the economic evaluation. The economic farm gate price of dry stalk paddy is thus estimated at Rp. 120,000 per ton, as shown in Table 5.3.5. For the financial analysis, the farm gate price of dry stalk paddy is estimated at Rp. 106,000 per ton on the basis of market price in Kab. Soppeng.

The market prices of polowijo crops largely fluctuate year by year, as shown in Fig. 5.3.3. For the evaluation of project benefits to arrive at a stable level, the price of rice, which is rather stable under government control, is adopted as a basis for adjusting the prices of polowijo crops. The details of the calculation are given in ANNEX-I, CHAPTER II. The adjusted farm gate prices of polowijo crops are estimated at Rp. 92,000/ton for maize, Rp. 351,000/ton for groundnuts, Rp. 310,000/ton for greenbeans and Rp. 328,000/ton for soybeans.

### 5.3.7 Production Cost

The direct production costs of proposed crops are estimated for both future without project and future with project conditions. The production costs without project are estimated on the basis of those under present condition. As mentioned in chapter 5.3.1, the present agricultural condition does not change significantly unless the new irrigation project is implemented. For the estimation of production costs without project, therefore, only unit prices of production expenses are forecasted by using general prices index of major commodities in the South Sulawesi, without changing the unit requirement for farm inputs and labour.

After the Langkemme Irrigation Project is completed, the crop production costs increase as shown in Table 5.3.6. The average increase of production cost is 83.4% per ha per year. This anticipated increase is primarily attributable to the increase of cropping intensity per ha. The increase of production costs per ha per crop is only 1.7% on an average. This small increment is attributed to the increase of expenses for seeds, chemicals and labour.

### 5.3.8 Net Production Value With and Without the Project

The net crop production value without project is estimated at approximately Rp. 4,044 million (US$1,011/ha) per annum on the basis of the forecasted unit prices of crops and production costs aforementioned. It is assumed that crop yields and production are same as those under present condition.

After completion of the project, the net crop production value amounts to Rp. 8,135 million (US$2,034/ha) per annum at the full development stage. The details are given in Table 7.2.1.

## 5.4 IRRIGATION AND DRAINAGE DEVELOPMENT

### 5.4.1 Water Sources

The irrigation water resources of the project would be dependent on three river systems adjacent to the project area, viz., seven tributaries of the Walanae river, the Langkemme and the Sero river. The water resources endowed in the tributaries would be firstly exploited through integration of the existing ephemeral intake structures and amendment of the existing canal systems in the Desa irrigation schemes. Subsequently, substantial irrigation water resources would be developed in the Langkemme river with the construction of the Langkemme irrigation canal system, and further supplemental water resources would be developed in the Sero river system with the construction of the Sero diversion canal system. The dependable minimum discharges by 10-day basis in these three rivers are evaluated as follows, based on the records of recent five years.

| | | |
|---|---|---|
| i) | Tributaries | 0.5 $m^3$/sec. |
| ii) | Langkemme river | 1.2 $m^3$/sec. |
| iii) | Sero river | 0.9 $m^3$/sec. |

### 5.4.2 Irrigation Water Requirement

Averaged value estimated by three empirical formula i.e. Penman, Hargreaves and Radiation is applied for the calculation of consumptive use after cross-checked by the records of A-class pan measured at the Sengkang meteorological station, about 30 km northward of the project area. The maximum potential evaporation of 5.0 mm/day occurs in October and the minimum of 3.1 mm/day, in June.

Field measurement on percolation loss is made by twin cylinders under irrigated condition in the course of this study. The data obtained through the measurement range from 1.0 mm/day to 2.0 mm/day. On reference to the field data, the percolation loss of 2.0 mm/day is incorporated in the calculation of irrigation requirement.

Effective rainfall during growing period of paddy is estimated by the daily water depth balance method based on the recent five years' rainfall records. While, effective rainfall during a growing period of polowijo is estimated by the USDA-SCS method. The annual effective rainfall is estimated at about 815 mm on an average, consisting of 715 mm for paddy and 100 mm for polowijo. It is equivalent to about 45% of total annual rainfall. The details are given in ANNEX-II, CHAPTER IV.

The puddling water requirement of 120 mm is applied for the calculation of irrigation requirement in due consideration of fine texture and impervious layer of the soils covering all over the project area. Water requirement for nursery period of paddy is also estimated on the assumption that 5% of transplanting paddy field would be used for nursery bed.