DIRECTORATE GENERAL OF
WATER RESOURCES DEVELOPMENT,
MINISTRY OF PUBLIC WORKS

JAPAN INTERNATIONAL
COOPERATION AGENCY
(JICA)

THE REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS

THE FEASIBILITY STUDY ON
THE GILIRANG IRRIGATION PROJECT

FINAL REPORT

ANNEX VOLUME II

JUNE 1995

# THE FEASIBILITY STUDY ON THE GILIRANG IRRIGATION PROJECT IN THE REPUBLIC OF INDONESIA

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NIPPON KOEI CO., LTD.

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# *ANNEX 5*

## *SOIL AND LAND USE*

# ANNEX 5 SOIL AND LAND USE

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# ANNEX 5 SOIL AND LAND USE

## 1. INTRODUCTION

This Annex describes the results of soil and land use study made both on the study area and the gross project area of the Gilirang Irrigation Project. The study area covers an area of 25,300 ha which was delineated in the First Stage Study to involve all possible area for the development. The Gross Project Area of 10,230 ha was delineated within the study area boundary in the Second Stage Study following the Interim result which clarified the possible irrigation area after examination and analysis made on exploitable land and water resources. The soil and land use survey was carried out based on the findings of the reconnaissance land resources survey of the study area given in the "Master Plan for the Central South Sulawesi Water Resources Development Project, Soil and Land Use Map (scale: 1/50,000), 1980, JICA". In the First Stage Study, topographic maps with a scale of 1/25,000 was utilized and major soil groups and their distribution and the suitability of each soil group for irrigation farming were identified at preliminary level. The land use map was also prepared based on this scale of map. In the Second Stage Study, topographic maps with a scale of 1/5,000 and aerial photos with a scale of 1/20,000 (shot at February, 1994) are referred. These maps and aerial photos were prepared by JICA for the present study. A total of 50 soil samples were collected in the Second Stage Study. Chemical and physical analysis of these samples were also carried out to obtain information for soil classification.

## 2. LAND-FORM AND SOIL

### 2.1 Land Form

From the physiographic point of view, the lands of the gross project area are approximately classified into 5 land form categories in the study area and 3 land-form categories for the gross project area. Land form units and their distribution are as shown below.

| Land Form Units | Study Area | | Gross Project Area | |
|---|---|---|---|---|
| | Area(ha) | % | Area(ha) | % |
| (1) Flat lowland of recent alluvium* | 1,700 | 6.7 | 1,500 | 14.7 |
| (2) Mangrove swamp belt | 1,200 | 5.7 | 0 | 0.0 |
| (3) Lower terrace of semi-recent alluvium | 7,900 | 30.9 | 6,100 | 59.6 |
| (4) Higher terrace of old alluvium | 14,200 | 55.6 | 2,630 | 25.7 |
| (5) Dissected hill and mountain | 300 | 1.2 | 0 | 0.0 |
| Total | 25,300 | 100.0 | 10,230 | 100.0 |

The flat lowland of recent alluvium is developed on the recent fluvial deposits from the surrounding terrace and hills, and mainly extends along the rivers and streams. In most of the lowland alluvial soils, the soil compaction and development of deep and wide cracks are observed during the reconnaissance survey in the dry season. The biggest crack reaches about 40 cm and 7 cm wide. This shrinkage of soil begins with the start of dry season; many big and deep cracks are developed along with the advance of dryness of soil, then surface materials fall into the mouth of cracks and deposit on the bottom, and the soil is then swollen again when water comes, thus the soil works a kind of action as is known as 'argillipedoturbation'. Soil profile observation certified the development of dark collared layer (umbric-like A horizon) which is considered to be the result of repeating special action of soil under the tropical dry and wet weather. This soil was classified as Vertisols.

The mangrove swamp is developed on the long and narrow coastal plain with a width of 1 to 4 km along the eastern border of the study area. This mangrove belt is excluded from the gross project area because of its hazard for irrigated agriculture. This soil is classified as Thionic Fluvisols.

The lower terrace of semi-recent alluvium extends mainly on the alluvial lands where the Gilirang river flows, and forms a convex topography between hill ranges with a gentle elevation towards the northern and southern hilly sides. The border between the lower terrace and the higher terrace of old alluvium is clear. This soil is also classified as Vertisols.

Most of the higher terraces of old alluvium extends in between the proposed canal routes. Some of the higher terraces of old alluvium drive into near the center of the alluvial plain like a wedge. The mother material of these terraces is the weathered Tertiary rock composed alternate of conglomerate, sand stone and mud stone. Soils developed on the hill surface are, therefore, the alternation of mud or gravel. Some land has mud surface and the other has gravel on the same hill. This difference is because of the alternation of the mother material.

One of the soil units on hill, the gravely soil has generally a very shallow surface layer of soil and composes solely of aquatic polished gravel. Gravel layer on/near the surface is sometimes utilized as a mine. This soil is classified as Eutric Regosols.

The mud soil with a fine texture occupies majority of the remaining hill soil. This soil has the Cambic B horizon. Gently sloped lands are widely reclaimed as the terracing paddy field and are suitable for paddy culture. This soil is classified as Eutric Cambisols.

The dissected erosion surface and mountains extends sporadically on the north western boundary of the study area. The land is not irrigable because of its steep slope and thin soil layer. This soil is classified as Lithosols.

## 2.2 Soil Survey

### 2.2.1 Procedure of soil survey

In the selected locations, 27 pits were dug to the depth of about 1 m and their profiles were surveyed according to the "Guideline for Soil Profile Description, FAO" and also "Guidebook for Examination and Description of Soils in the Field, NIAS, Japan". The locations of soil sampling sites are as shown in Table A.5.1 and Figure A.5.1.

### 2.2.2 Chemical and physical properties of soil

A total of 50 soil samples from 14 pits was collected from their profiles and was sent to the laboratory, Stasium Penelitian Tanah Maros (Maros Soil Research Institute) for chemical and physical analysis. The method of soil analysis is shown in Table A.5.2. Specification of 14 soil profiles is as follows:

| | Number of Sample | Soil Profile No. |
|---|---|---|
| 1) A fish pond bottom soil and a paddy soil adjacent to mangrove swamp | (2 soils) | 5, 6 |
| 2) Paddy soils of flat lowland | (4 soils) | 1, 10, 11, 12 |
| 3) Paddy soils of lower terrace | (7 soils) | 2, 3, 4, 7, 8, 9, 13 |
| 4) Paddy soils of higher terrace | (1 soil) | 14 |

The results of soil analysis are presented in Table A.5.3, and specific information on soil profiles obtained from 14 pits are tabulated in Table A.5.4.

2.2.3 Result of soil analysis

(1) Soil texture

Majority of soil samples from 14 sampling sites are with fine texture (HC), except for No. 5 (soils from a fish pond sole, SiL-SiCL), No. 7 (Mualla soil, SiC-SiCL) and No. 14 (Labempa soil, SiC-SiCL) soils. Almost all the remaining soils from 14 soil profiles are Heavy Clay. Sand content is comparatively rich in No. 3 (17-28 %) and No. 14 (14-17 %) soils. In consideration to the results of soil mechanical analysis, Mualla soil is not belong to the alluvial soil, but more likely to be the soil composing by weathering material of mother rocks.

(2) pH and EC

pH determination was carried out in two ways, in distilled water and in the n-KCl solution. pH values (in 1:2.5 distilled water suspension) of soil were generally high, especially for the lower soil layer (6.6-8.0), pH values in n-KCl are reasonable to those in the former. This finding shows that the alluvial deposits of the Gilirang river are affected by the calcareous rock of the nearby mountains.

EC values of No. 5 and 6 soils are unexpectedly high because those soils are affected by the tidal water (See also those of Na values and $SO_4$ values).

(3) Organic matter

Carbon and total nitrogen contents are rather rich in the surface layer than the lower layer. Soils from the lower reach of the Gilirang river in the gross project area are seemed to be rich in organic matter than those from the upper streams. Humus content in the surface layer is higher than the lower layer. Humus contents calculated from carbon content (x 1.724) are moderate as the ordinal tropical soils.

Nitrogen content of soils is comparative to the carbon content and the C/N ratio of soils are not so much different to the range of values from 9 to 13, which seemed similar from the paddy soils in the Temperate zone.

(4) Sulfate content

Ammonium acetate extractable sulfate content of soil is analyzed to consider the tidal effect on soils. High sulfate content is indicate whether the soil is affected by sea water or volcano. Results show that No. 5 and 6 soils are very high in sulfate content which is obviously indicate that these soils are salt affected. Other soils do not show any high value.

(5) Available P and P retention

Available P content of soil is normal or rather poor in the plowing layer, on the other hand, rather rich in lower layer of soil than surface.

Phosphate retention (or phosphate absorption coefficient) values are ranged 30-50 %, which suggest that these soils have not affected by volcanic materials at all.

(6) KCl extractable Al

Active Aluminium exist in acidic soils, the results showed that Al are not detected in these samples.

(7) CEC and Bases

Values of cation exchangeable capacity are generally high in alluvial soils. Especially for the existence of humus and the 2:1 type clay minerals, data shows that the No. 7 and 14

soils are comparatively lower than other alluvial soils. No 7 soil is taken from the site which is apart from the Gilirang river basin, and No. 14 soil is taken from higher terrace. Also a low CEC value is known on No 5 soil, but the soil is rather exceptional because this soil is taken from the bottom of fish pond.

Divalent exchangeable bases are generally rich in alluvial soils. On the other hand, salt affected soils (No. 5 and 6) are comparatively high in K and Na, but slightly lower in divalent cations.

(8) Base Saturation

All of the soil samples shows more than 50 % of the base saturation, 50 % line of the base saturation is very important as the border of "Eutric" and "Dystric" in soil classification. Some of them shows more than 100 %.

## 2.3 Soil Classification

By referring the information and findings so far procured, the soils of the gross project area are classified into 5 soil units, according to the FAO/UNESCO soil classification system. They are:

| | | Study Area | | Gross Project Area | |
|---|---|---|---|---|---|
| | Soil Unit | Area(ha) | (%) | Area(ha) | (%) |
| (1) (3) | Vertisols (Alluvium*) (V) | 9,600 | 37.9 | 7,600 | 74.3 |
| (4-1) | Cambisols (C) (muddy**) | 13,710 | 54.2 | 2,400 | 23.5 |
| (4-2) | Eutric Regosols (R) (gravely) | 490 | 1.9 | 230 | 2.2 |
| (2) | Thionic Fluvisols (Jt) | 1,200 | 4.7 | 0 | 0.0 |
| (5) | Lithosols (L) | 300 | 1.2 | 0 | 0.0 |
| | Total | 25,300 | 100.0 | 10,230 | 100.0 |

Remarks : Each soil is corresponding to the above table of land form categories.

* According to the recent version of the soil classification system, Eutric Gleysols (Ge) are included in the Eutric Fluvisols (Je). Fluvisols in the gross project area have very strong 'argillopedoturbic' properties and are suggested to classify as Vertisols.

** Hilly soils rich in polished gravel are classified as Regosols. Hilly soils with mud or fine textured soil is classified as Cambisols with Cambic horizons in profile.

(2) Thionic Fluvisols(Jt) extend originally over the flat alluvial plain under the mangrove swamp belt facing to the sea. Present width of the swamp belt is estimated about 1-4 km. Majority of the soil is used as fish pond. These soils contain an excess amount of various bases, therefore, EC is comparatively high. Furthermore, some of the acidic sulfur compound like, pyrite is developed in the lower layer of the soils. These soils have almost no potentiality for agriculture because of its strong acidity especially when soil becomes dry, and are excluded from the gross project area.

(1) and (3) are classified as Vertisols (Je). The soils extend mainly over the flat low land and lower terrace of alluvial plain. These soils are developed in recent alluvial deposit and generally immature with no predominant morphological characteristics. The effective soil depth is more than 50 cm and the water table is comparatively high in the flat lowland soil but it does not act as a hazard in the area. In general, these soils have A-(B)-C horizons, but paddy soils of the area have a special A horizon with dark collar, which is similar to the umbric A horizon. The soil texture is very fine as heavy clay. The soil structure is generally angular blocky but development of granular structure is common in the lower layer. As for chemical properties, pH values are neutral and slight alkaline in the lower layer, but those of the plowing layer is slightly acidic. The organic matter content of soil or C and N content is rather poor because high temperature under the tropical condition causes the consumption of soil organic matter. Phosphate retention or phosphate absorption coefficient is moderate as alluvial soils. These soils are adequate not only for rice culture

but also for a wide range of crops. The continuous cropping of paddy culture will become possible with the irrigation system. These soils occupy about 9,600 ha or 37. 9% of the study area and 7,600 ha or 74. 3% of the gross project area.

(4) Two kinds of soils derived from the geological stones of the hilly area or higher terrace of old alluvium. Regosols are developed from conglomerate containing a plenty of gravel. The land with these soils is therefore classified as lower capability land for agriculture. Regosols with abundant gravel in the surface distribute about 230 ha or 2.2 % of the gross project area. The area with these soils are utilized mainly as housing space and cashew nut cultivation.

Another hill soils on sand and mud stone are reclaimed as terrace field on the hilly slope and are used mainly for paddy culture. These soils are developed in old alluvium or dilluvium deposit and mature with a predominant $B_2$ horizon. Judging from a limited number of analytical result, the soil texture of these muddy soil is fine as silty clay, the soil structure is almost same as the alluvial soil, the constituency is sticky and plastic, but abundant iron mottling are observed to a deeper layer. As for chemical properties, pH value, organic C and total N, P available and retention (Phosphate Absorption Coefficient.) are comparatively low. Bases are rather rich, and base saturation exceeds 50 %. This soil is judged as Eutric Cambisols. These soils have also good potentiality to cultivate wide range of crops. Hill top on these soils are occupied by village and the muddy fields. The area of these soils is estimated at 13,710 ha or about 54.2% of the study area, and 2,400 ha or 23.5% of the gross project area.

The results of the present soil classification studies are illustrated on Figure A.5.2.

## 3. LAND CAPABILITY

### 3.1 Land Capability System

In considering the proposing future irrigation system, both paddy and palawija will occupy the main role in agriculture, the Japanese land classification standard for paddy and upland crops is judged for the suitable classification system of land capability for this study. The Japanese system is devised originally for paddy cultivation and its land classification criteria are detailed enough for land capability assessment on a feasibility study level. It is applicable for the classification of paddy field not only for paddy but also for upland crops under irrigated condition. However, after the reconnaissance survey in the dry season, it is suggested to amend a part of this system to make it more adaptable to the tropical soil study, by paying some consideration for the remarkable soil compaction and the development of cracking which occur in the dry season under the tropical condition.

In the Japanese system, lands are classified into 4 capability classes, i.e., I, II, III and IV. Each class is defined as follows:

(1) Class I: Land has almost no limitation for crop production and/or no risk of soil conservation. It is naturally fertile and has a great potential for crop production without any improvement practices of soils.

(2) Class II : Land has some limitations for crop production and/or some risks of soil conservation, and requires some soil improvement practices for normal crop production.

(3) Class III : Land has many limitations for crop production and/or is likely subject to risks of soil conservation, and fairly intensive improvement practices are required.

(4) class IV : Land has great natural limitations than these in class III, but can be utilized for cultivation of some specific crops under very careful management.

## 3.2 Specification of Land Capability Classification

In the Japanese system, there are 13 factors for assessment of land capability as shown below:

(1) thickness of top soil
(2) effective soil depth
(3) gravel content in top soil
(4) easiness of plowing
(5) permeability under the submerged condition
(6) state of redox potential
(7) wetness of land*
(8) inherent fertility
(9) content of available nutrient
(10) degree of hazard
(11) frequency of hazard
(12) slope*
(13) erosion
*: factors for upland crops only

The specification of land capability class are explained as follows:

(1) Thickness of top soil (code; t)

Top soil is the first horizon where plant roots can easily penetrate, and generally corresponds to the plowed layer. The classes are grouped according to the thickness of top soils as follows (when effective depth of soil (d) is placed to class IV, this factor also is placed to class IV);

| t | Class | | |
|---|---|---|---|
| | Paddy | Upland | Orchard |
| (cm) | | | |
| more than 25 | I | I | I |
| 25 - 15 | I | II | I |
| less than 15 | II | III | III |

(2) Effective depth of soil (code ; d)

Effective depth of soil is the depth up to bedrock, hard pan and gravel layer which plant roots can not penetrate. The classes are grouped according to thickness of the effective soil depth as follows;

| d | Class | | |
|---|---|---|---|
| | Paddy | Upland | Orchard |
| (cm) | | | |
| more than 100 | I | I | I |
| 100 - 50 | I | II | II |
| 50 - 25 | II | III | III |
| 25 - 15 | III | III | III |
| less than 15 | IV | IV | IV |

(3) Gravel content in top soil (code; g)

Gravel contents in top soil are expressed by the percentage of the exposed surface area of gravel on the soil profile, and are graded into the following classes:

| g | Class | | |
|---|---|---|---|
| | Paddy | Upland | Orchard |
| (%) | | | |
| less than 5 | I | I | I |
| 5 - 10 | I | II | I |
| 10 - 20 | I | II - III | I - II |
| 20 - 50 | I - II | III - IV | II - III |
| more than 50 | IV | IV | IV |

(4) Easiness of plowing(code: p)

Easiness of plowing largely depends upon the quantity and quality of clay and organic matter and moisture condition. In order to estimate the class of this factor, the following 4 sub-factors are used:

(a) Soil texture of top soil:

| | | content of clay | content of sand |
|---|---|---|---|
| 1. | coarse | less than 15 % | more than 85 % |
| 2. | medium | less than 15 % | less than 85 % |
| 3. | fine | 15 - 25 % | - |
| 4. | very fine | more than 25 % | - |

(b) Stickiness of top soil;

1. none and/or slightly sticky
2. sticky
3. very sticky

(c) Consistence when dry;

1. loose
2. hard
3. very hard

These sub-factors are combined altogether to determine capability classes as follows:

| sub-factors | | | Class | Criteria |
|---|---|---|---|---|
| a | b | c | | |
| 1 | 1 | (2)* | I | Easy to slightly |
| 2 | 2 | 2 | I | difficult |
| 3 | 2 | 2 | I | |
| 2 | 2 | 3 | II | Moderately difficult |
| 3 | 3 | 3 | II | |
| 4 | 2 | 3 | III | Very difficult |
| 4 | 3 | 3 | III | |

(5) Permeability under submerged condition (code: l )

This factor effects irrigation water requirement, soil temperature, and leaching of the nutrients or development of reduced condition of the soil. This standard factor is evaluated mainly by the combination of soil texture and the presence of compact layer within 50 cm from the surface, as sub-factors :

(a) Soil texture;

| | | content of clay | content of sand |
|---|---|---|---|
| 1. | very fine | more than 25 % | - |
| 2. | fine | 25 - 15 % | - |
| 3. | medium | less than 15 % | less than 85 % |
| 4. | coarse | less than 15 % | more than 85 % |

(b) Compactness;

1. compact : more than 14.0 kg/cm$^2$ by hardness meter
2. medium : 14.0 - 1.4 kg/cm$^2$ by hardness meter
3. loose : less than 1.4 kg/cm$^2$ by hardness meter

| sub-factors a | sub-factors b | Class | Criteria |
|---|---|---|---|
| 1 | 1 | I | Poorly to imperfectly permeable |
| 1 | 2 | I | |
| 2 | 2 | II | moderately to well permeable |
| 3 | 2 | II | |
| 3 | 3 | III | Well to excessively permeable |

(6) State of redox potential (code ; r)

This factor indicates the risk of root damage owing to the strong reduction of soil, resulting in low rice production. The following sub-factors are used for the evaluation of this factor.

(a) Content of easily decomposable organic matter in top soil;
1. low : less than 10 mg $NH_4$ -N/100 g
2. medium : 10 - 20 mg $NH_4$ -N/100 g
3. high : more than 20 mg $NH_4$ -N/100 g

(b) Content of free iron oxides in top soil:
1. high : more than 1.5 % for dry soil
2. medium : 1.5 - 0.8 %
3. low : less than 0.8 %

(c) Degree of gleyzation;
1. weak : no gley horizon within 50 cm from the surface
2. medium : gley horizon exists within 50 cm
3. strong : gley horizon exists throughout profile or exist below plowing layer

| sub-factors a | sub-factors b | sub-factors c | Class | Criteria |
|---|---|---|---|---|
| 1 | 1 | 2 | I | |
| 1 | 3 | 2 | I | None to weak |
| 2 | 1 | 2 | I | |
| 1 | 1-2 | 3 | II | |
| 1 | 3 | 3 | II | Moderate to strong |
| 2 | 1-2 | 3 | II | |
| 3 | 1 | 2 | II | |
| 2 | 3 | 3 | III | |
| 3 | 2 | 2 | III | Very strong |
| 3 | 1 | 3 | III | |
| 3 | 3 | 2 | III | |

(7) Wetness of land (code : w; wet condition, (w); dry condition)

This factor is only applied to upland and orchard. This factor is used for the estimation of wet or drought injury of upland crops and trees, and is evaluated by the combination of the following 3 sub-factors;

(a) Permeability;

1. high
2. medium
3. low

(b) Water holding capacity (evaluated by maximum water-holding capacity);

1. high : more than 80
2. medium : 80 - 40
3. low : less than 40

(c) Moisture condition

(2) dry*
1. slightly wet
2. moist
3. wet

| sub-factors | | | Class | Criteria |
|---|---|---|---|---|
| a | b | c | | (risk of drought or wetness) |
| 1 | 3 | (2) | (IV) | High possibility of drought |
| 1 | 3 | 1 | (III) | Possibility of drought |
| 1 | 2 | 1 | (II) | Low possibility of drought |
| 1 | 1 | 1 | I | None |
| 2 | 2 | 2 | II | Low possibility of over wetness |
| 1-3 | 1 | 3 | III | Possibility of over wetness |
| 3 | 2 | 3 | IV | High possibility of over wetness |

(8) Inherent fertility (code; f)

Inherent fertility is evaluated by the combination of the following 3 sub-factors;

(a) Nutrient holding capacity ( evaluated by CEC)

1. high : more than 20 meq/100 g
2. medium : 20-6 meq/100 g
3. low : less than 6 meq/100 g

(b) Nutrient fixation power (evaluated by coefficient of $P_2O_5$ absorption;

1. very low : less than 700
2. low : 700 - 1,500
3. medium : 1,500 - 2,000
4. high : more than 2,000

(c) Base status in soil (evaluated by base saturation degree);

1. good : more than 50 %
2. medium : 50 - 30 %
3. poor : less than 30 %

(i) For paddy

| sub-factors a | b | c | Class | Criteria |
|---|---|---|---|---|
| 1 | 1-2 | 2 | I | |
| 1 | 1-2 | 1 | I | Fertile |
| 1 | 1-2 | 3 | II | |
| 1 | 3-4 | 2 | II | |
| 2 | 1-2 | 2 | II | Medium |
| 3 | 1 | 2 | II | |
| 2 | 3-4 | 3 | III | |
| 3 | 2 | 2 | III | Infertile |
| 3 | 3-4 | 3 | III | |

(ii) For upland and orchard

| sub-factors a | b | c | Class | Criteria |
|---|---|---|---|---|
| 1 | 2 | 1 | I | |
| 2 | 1 | 2 | I | Fertile |
| 1 | 2 | 3 | II | |
| 2 | 1 | 3 | II | |
| 1 | 3 | 1 | II | Medium |
| 1 | 3 | 2 | II | |
| 1 | 3 | 3 | III | |
| 3 | 1 | 1 | III | Infertile |
| 2 | 4 | 2 | II-III | |

(9) Content of available nutrients (code: n)

Content of available nutrients in soil are closely related to the inherent soil fertility, and are evidently influenced to cultivation practices. The capability class is evaluated by the combination of the following sub-factors;

(a) Content of exchangeable calcium

1. high : more than 200 CaO mg/100 g
2. medium : 200-100 CaO mg/100 g
3. low : less than 100 CaO mg/100 g

(b) Content of exchangeable magnesium

1. high : more than 25 MgO mg/100 g
2. medium : 25-10 MgO mg/100 g
3. low : less than 10 MgO mg/100 g

(c) Content of available potassium

1. high : more than 15 $K_2O$ mg/100 g
2. medium : 15-8 $K_2O$ mg/100 g
3. low : less than 8 $K_2O$ mg/100 g

(d) Content of available phosphate

1. high : more than 10 $P_2O_5$ mg/100 g
2. medium : 10-2 $P_2O_5$ mg/100 g
3. low : less than 2 $P_2O_5$ mg/100 g

(e) Content of available nitrogen

1. high : more than 20 N mg/100 g
2. medium : 20-10 N mg/100 g
3. low : less than 10 N mg/100 g

(f) Content of available silica

1. high : more than 15 $SiO_2$ mg/100 g
2. medium : 15-5 $SiO_2$ mg/100 g
3. low : less than 5 $SiO_2$ mg/100 g

(g) Content of micro-elements (evaluated by the risk of deficiency;

1. none and/or weak
2. medium
3. serious

(h) Acidity (evaluated by pH)

| Paddy | Upland & Orchard |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 3 | 4 |

weak : more than 6.0
medium : 6.0 - 5.0
strong : 5.0 - 4.5
very strong less than 4.5

| Class | Criteria |
|---|---|
| I | High |
| II | Medium |
| III | Low |

(10) Degree of hazard (code : i)

This factor means limitation caused by the presence in excess of substances such as sulfur compounds, soluble salts, heavy metals, etc. Dependent sub-factors for this factor are as follows:

(a) Presence of harmful substances :

(i) Harmful sulfur compounds;

1. none
2. slightly
3. moderately
4. seriously

(ii) Salts content (evaluated by chlorine content as an indicator)

1. low : less than 0.1 % for dry soil
2. medium : 0.1-0.3 %
3. high : more than 0.3 %

(iii) Heavy metals

1. none
2. slightly
3. moderately
4. seriously

(iv) Irrigation water quality

| | Temp. (°C) | pH | Total N (ppm) | Salt Content (ppm) |
|---|---|---|---|---|
| 1. good | 20 | 6.0-7.5 | less than 1.0 | less than 500 |
| 2. medium | 20-15 | 4.0-6.0 or 7.5-8.5 | 1.0-5.0 | 500-2,000 |
| 3. polluted | 15 | less than 4.0 or more than 8.5 | more than 5.0 | more than 2,000 |

(b) physical hazard

Presence of bedrock, pan, compact layer or gravel layer that disturb root development within 50 cm of the surface, and difficult of their removal;

1. none
2. slightly difficult
3. very difficult

The class of this factor is decided by the lowest grade among the dependent sub-factors.

| Class | Criteria |
|---|---|
| I | None |
| II | Slightly |
| III | Moderately |
| IV | Seriously |

(11) Frequency of hazard (code : a)

This factor is mainly influenced by natural environmental condition. The class of this factor is determined by the combination of the following two dependent sub-factors:

(a) Risk of overhead flowing inundation;

| | |
|---|---|
| 1. none and/or rarely | no risk if rainfall with high intensity occurs |
| 2. moderately | even if inundation occurs due to high rainfall intensity, excess water is drained out in a short period |
| 3. frequently | inundation continuous for a long period if rainfall with high intensity occurs |

(b) Risk of land creep;

1. none and/or rarely
2. moderately
3. frequently

The class of this factor is determined by the lowest grade of two dependent sub-factors.

| class | Criteria |
|---|---|
| I | None to rarely |
| II | Moderately |
| III | Frequently |

(12) Slope (code: s)

This factor is applied to upland and orchard only. The class of this factor is decides by the combination of the following sub-factors;

(a) Natural slope as a main dependent sub-factors: 5 grades as shown in the following table.

(b) Direction of slope.

(c) Artificial slope.

| Incline of slope | | Class | |
|---|---|---|---|
| | | Upland | Orchard |
| (degree) | (%) | | |
| less than 3 | less than 6 | I | I |
| 3 - 8 | 6 - 14 | II | I-II |
| 8 - 15 | 14 - 28 | III | I-III |
| 15 - 25 | 28 - 47 | IV | II-III |
| more than 25 | more than 47 | IV | IV |

(13) Erosion (code : e)

The class of this factor is determined by the combination of the following sub-factors:

(a) Occurrence of rill or gully

| | Occurrence of rill | Occurrence of gully |
|---|---|---|
| 1. none | none | none |
| 2. rarely | rarely | none |
| 3. moderately | sometimes | none |
| 4. frequently | frequently | exist |

(b) Resisting power to water erosion;

1. strong
2. medium
3. weak

(c) Resisting power to wind erosion;

1. strong
2. medium
3. weak

| Class | Criteria |
|---|---|
| I | None or very slightly |
| II | Slightly |
| III | Moderately |
| IV | Seriously |

### 3.3 Land Capability

The land capability class is determined at the lowest class of the factors. Limitations on suitability of land due to 13 factors are indicated by use of codes like "t", "g", "d" either individually and collectively, taking No. 1 soil as an example.

| | Factor | code | Paddy | Upland |
|---|---|---|---|---|
| 1. | thickness of topsoil | t | I | II |
| 2. | effective soil depth | d | I | II |
| 3. | gravel content in top soil | g | I | I |
| 4. | easiness of plowing | p | II ( 4, 3, 3 ) | II ( 4, 2, 2 ) |
| 5. | permeability under sub-merged condition | l | I (1, 2 ) | - |
| 6. | state of redox potential | r | II (1, 2, 2 ) | - |
| 7. | Wetness of land | w | - | III (3,2,3 ) |
| 8. | inherent fertility | f | I (1, 1, 1 ) | I (1, 1, 1 ) |
| 9. | content of available nutrient | n | II (3, 2, 3, 1, -,-,-,1) | III (3,2,3,1, -,-,-,1) |
| 10. | degree of hazard | i | I (1, 1) | I (1, 1) |
| 11. | frequency of hazard | a | II ( 2, 1) | II (2, 1) |
| 12. | slope | s | - | I |
| 13. | erosion | e | - | I (1, 1, 1) |

Example : Land capability class : Paddy ; IIplrna, Upland ; IIIw
The result is shown as : II p l r n a/ III w.

With four (4) land classes for rice and upland crops and having 13 categories with each class, a great number of combinations of land class symbols is possible if much variation occurs. Actually, however, only different composite land class symbols are used for the arable lands, as shown below and also Figure A.5.3.

| | | Land capability class | Study Area ha | (%) | Gross Project Area ha | (%) |
|---|---|---|---|---|---|---|
| 1-1 | Vertisols | II a / II wa | 7,200 | 28.5 | 5,200 | 50.8 |
| 1-2 | Vertisols | II ra / III w | 1,700 | 6.7 | 1,700 | 16.6 |
| 1-3 | Vertisols | II lra / III w | 700 | 2.8 | 700 | 6.8 |
| 2. | Eutric Cambisols | II fe / III wfs | 13,710 | 54.2 | 2,400 | 23.5 |
| 3. | Eutric Regosols | IV tdg / III* | 490 | 1.9 | 230 | 2.2 |
| 4. | Thionic Fluvisols | IV i / IV wi | 1,200 | 4.7 | 0 | 0.0 |
| 5. | Lithosols | IVd / IV d | 300 | 1.2 | 0 | 0.0 |
| | Total | | 25,300 | 100.0 | 10,230 | 100.0 |

# 4 LAND USE SURVEY

## 4.1 Procedure of Land Use Survey

In the land use survey, three sets of maps and a series of aerial photos were used as follows:

1) Land use maps of the master plan (1/100,000),
2) Land use maps of 3 Kecamatan in Kabupaten Wajo scaling 1/25,000 (based on the JICA's topographic map with some amendments according to the field survey made by BAPPEDA, Kab. Wajo, 1989),
3) Aerial photographs of 1/20,000, and
4) Topographic maps of scaling 1/5,000.

## 4.2 Present Land Use

The present land use is illustrated on Figure A.5.4 and tabulated as follows :

| Land Use | Study Area | | Gross Project Area | |
|---|---|---|---|---|
| | Area (ha) | (%) | Area(ha) | (%) |
| Paddy Field | 15,800 | 62.5 | 8,020 | 78.4 |
| Upland | 1,000 | 4.0 | 670 | 6.5 |
| Orchard | 2,900 | 11.5 | 110 | 1.1 |
| Grass Land | 1,400 | 5.5 | 170 | 1.7 |
| Bush & Forest | 2,000 | 7.9 | 870 | 8.5 |
| Fish Pond/swamp | 1,200 | 4.7 | 0 | 0.0 |
| Village | 1,000 | 4.0 | 390 | 3.8 |
| Total | 25,300 | 100.0 | 10,230 | 100.0 |

About 86 % of the gross project area is utilized for agricultural purpose as paddy field, upland field and orchard. Remaining are grass land, bush & forest and villages. Fish pond/mangrove swamps in the study area is excluded from the gross project area. River and country roads are also estimated as 170 ha and are included in the category of village.

Most of the lowland area is reclaimed as paddy field and considerable amount of the slope is also utilized as terraced paddy field. Acreage of the paddy field is 8,020 ha or about 78.4 % of the gross project area. Most of the paddy field is rain-fed, although some fields with small extent have pump irrigation system using a river water. Cultivation of paddy is not stable year by year depending mainly on water availability and flood. Because of draught conditions during the dry season, single cropping paddy is a common cropping pattern in the paddy fields.

Major crop in the orchard are commonly mixed culture banana, coconuts, mango, orange, cacao and cashew nuts.

Bush and forest is developed in the mountain area and along the river and coastal area, some of the bushes nearby rivers are reclaimed as upland field and mixed cultured orchard. Various species of mangrove are grown as bushes in the coastal area, but majority of the mangrove swamps have already reclaimed as fish ponds for fish and shrimp culture.

Villages are generally developed along the road. In general, backyard of each house is occupied by the banana and fruit trees. Planted area surrounding the house are carefully excluded from the village area in this study.

## Reference


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2. Bureau of Agriculture, Sericulture and Horticulture, MAFF. : Present Status and Countermeasure of Arable Lands in Japan, 1979 ,Tokyo, ( In Japanese).

3. T. Hamazaki and A. G. Micosa : Land capability Classification in Japan - Productive Capability Classification of Land Based on Soil Survey -, Research Reports of Division of Environmental Planning, no. 7, (1991), National Institute of Agro-Environmental Sciences, Tsukuba, Japan.

4. FAO-UNESCO : Soil Map of the world, Revised / UN-Rome, 1990, Rome.

5. Jackson, M. L. : Soil Chemical Analysis, Prentice-Hall, Inc., Englewood Cliffs, N. J.,1958.

## Table A.5.1 .Soil Survey and Sampling Sites

| No. | Soil surveying site(kampung, desa) | Map | survey method | Sample number | soil | Remarks |
|---|---|---|---|---|---|---|
| 1 Pr-1-s | Laccori, Towalida | Ba | Profile obs'n , Sampling | 8, 9, 10 | V-1-a | Pf 8 m, Typical alluvial soil |
| 2 Pr-2-s | Marepi, Sakkoli | Ba | Profile obs'n , Sampling | 11, 12, 13 | V-1-a | Pf 9 m, Typical alluvial soil |
| 3 Pr-3-s | Sanpisanpie, Laerung | Ba | Profile obs'n , Sampling | 15, 16, 17, 18, 19 | V-1-a | Pf,12m, Typical alluvial soil |
| 4 Pr-4-s | Lawareng, Arajang | Ba | Profile obs'n , Sampling | 20, 21, 22 | V-1-a | Pf 33 m, Hillside alluvial soil |
| 5 Pr-5-s | Lawara, Radtae | Ja | Profile obs'n , Sampling | 23, 24, 25 | Jt-1-a | Fish pond 1 m, dried |
| 6 Pr-6-s | Jarang, Akajeng | Ja | Profile obs'n , Sampling | 26, 27, 28 | Jt-1-a | Pf 3 m, border of Ve, Jt |
| 7 Pr-7-s | Mualla, Asorajeng | Ja | Profile obs'n , Sampling | 29, 30, 31, 32 | V-1-a | Pf 9 m, alluvial or dilluvial |
| 8 Pr-8-s | Laputeng, Maminasae | Ba | Profile obs'n , Sampling | 33, 34, 35, 36 | V-1-a | Pf 17 m, Typical alluvial |
| 9 Pr-9-s | Sakkoli, Sakkoli | Ba | Profile obs'n , Sampling | 37, 38, 39, 40 | V-1-a | Pf 14 m, Typical alluvial |
| 10 Pr-10-s | Matrapassae, Salobulo | Sa | Profile obs'n , Sampling | 41, 42, 43 | V-1-a | Pf 4 m, Inundation area |
| 11 Pr-11-s | Cappabaracue, Akkotengeng | Sa | Profile obs'n , Sampling | 44, 45, 46 | V-1-a | Pf 2 m, Inundation area |
| 12 Pr-12-s | Padewakeng, Makmur | Ja | Profile obs'n , Sampling | 47, 48, 49, | V-1-a | Pf 3.4 m, Annual Flooding |
| 13 Pr-13-s | Allaporange, Padaelo | Ja | Profile obs'n , Sampling | 50, 51, 52, 53 | V-1-a | Pf 3 m, Inundation area |
| 14 Pr-14-s | Labempa, Abatireng | Ba | Profile obs'n , Sampling | 54, 55, 56, 57 | Cambisol | Pf 37 m, Hill soil |
| 15 Pr-1 | Lalesang, Maminasae | Ba | Profile obs'n, B | Cancell / analysis | V-1-a | Pf 25 m, Umbric A horison |
| 16 Pr-2 | Panrengnge, Tarumpakkae | Ba | Profile obs'n | Cancell / analysis | Cambisol | Grass 23 m, natural dike |
| 17 Pr-3 | Tawaroe, Makmur | Ja | Profile obs'n | Cancell / analysis | V1-a | Pf 6 m, No flood |
| 18 Pr-4 | Kalosi, Padaelo | Ja | Profile obs'n | Cancell / analysis | Cambisol | Grass land, mudrock origin |
| 19 Pr-5 | Benceng benceng, Bontobenteng | At | Profile obs'n | Cancell / analysis | V-1-a | Pf 10 m, Frequent flooding |
| 20 Pr-6 | Totakki, Akkotengeng | Sa | Profile obs'n | Cancell / analysis | V-1-a | Pf 2 m, Inundation area |
| 21 Pr-7 | Mario, Doping | Ja | Profile obs'n , B | Cancell / analysis | V-1-a | Pf 16 m, gently undulating |
| 22 Pr-8 | Lasipae, Sakkoli | Ba | Profile obs'n , B | Cancell / analysis | V-1-a | Pf 36 m, hill skirt |
| 23 Pr-9 | Tochiban, Doping | Ja | Outcrop, B | Cancell / analysis | Cambisol | Grass land 7 m, lower hill |
| 24 Pr-10 | Sakkoli, sakkoli | Ba | Profile obs'n | Cancell / analysis | Regosol | Forest slope, 50 m Gravelly rock |
| 25 Pr-11 | East of Polewalie, Gilirang | Ba | Profile obs'n | Cancell / analysis | Regosol | Hill, Meadow 75 m |
| 26 Pr-12 | Arajang, Gilirang | Ba | Profile obs'n, B | Cancell / analysis | V-1-a | Pf, 30 m, border |
| 27 Pr-13 | Paleonro, Paleonro | Ba | Profile obs'n, B | Cancell / analysis | V-1-a | Pf, 25 m, alluvial soil |

At--Attapange, Ba--Bacubacue, Ja--Jalang, Sa--Salobulo. (Titles of 1/25,000 scale map)

V-1a : Vertisols, fine textured, level to gently undulated.
Jt-1a : Thionic Fluvisols, fine textured, level to gently undulated.
Cambisol-1-a : Cambisols, medium textured, level to gently undulated.
R-2b : Regosols, med-coarse textured / gravel, rolling to hilly.
L : Lithosols, Unweathered Gravels, hilly. (no indication on the table)
Pr-s : Profile- Soil Pits;14---Scale of pit ; 1x1x1 m
Pr- : Supplemental observation of Soil by pit ---
B : Boring by soil augar.
Tentative Soil Name(Cambisol, Regosol)
Number of Analytical samples start from 8 to 57 (50)

## Table A.5.2 Methods of Soil Analysis

| Items | Brief Specification |
|---|---|
| -Sample preparation | Spreading soil samples on the appropriate clean paper in the clean and quiet room, dusty room is not preferable. The breaking up of aggregates by careful pounding, sieving through a 2 mm sieve, The sieved fraction (< 2 mm) is used for further analysis. |
| -Particle size analysis | Hydrometer method--shaking overnight with sodium hexametaphosphate / sodium carbonate and shaken at 40 r.p.m. : measuring silt + clay (0-50 micron) and clay (0-2 micron) with a hydrometer after 40 seconds and 2 hours respectively, sand fraction (50-2,000 micron) is obtained by subtracting the sum of silt and clay from 100 %. |
| -pH and EC | pH and EC are routinely measured on a suspension with a soil water ratio of 1 : 2.5, the suspension is prepared by placing 10 g of fine earth and add 25 cc of distilled water. pH-KCl is also measured in the same manner but using n-KCl solution instead of water. |
| -Organic Carbon | Walkley and Black method (Black 1965) |
| -Total Nitrogen | Kjeldahl digestion method. |
| -Available Phosphorous | Olsen-method.(pH > 6). |
| -Ph'ate Absorption Capacity | PAC or P retention is determined by the decrease of phosphate after immersion of soil in 2.5 % $(NH_4)_2HPO_4$ solution adjusted pH 7.0 for 24 hrs. at the room temperature, the decrease of phosphate in mg per 100 g dry soil is reckoned to PAC. |
| -Cation Exchange Capacity | CEC is determined by successive leaching of the soil with 1 mol, $NH_4OAc$ acetate of pH 7.0. |
| -Exchangeable cations | Extraction of 1: 2.5 soil and 1 mol $NH_4OAc$ (pH 7.0), or leachate of CEC is used. Determination of Na, and K by flame photometer and that of Ca and Mg is by Atomic Absorption Spectrophotometer method. |
| -Exchangeable Al | 1 : 10 soil-N KCl solution and 4 % NaF solution is used. Both exchangeable Al and H can be determined at a time. |
| -$NH_4OAc$ Extractable $SO_4$ | Gravimetric determination of $BaSO_4$ after titration of soil with 10 % $BaCl_2$. (Richard 1954). |

## Table A.5.3 (1/2) Result of Soil Analysis

| Sample No. | Sub No. | Location/layer | Depth | Texture (%) | | | | EC (1:5) | pH (1:2.5) | | Organic matter | | | NH4OAc Extr | Available P | P Retension | KC-Ext | Exchangeable Cations (me/100g) | | | | | CEC | Base |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sand | silt | Clay | | | H2O | n-KCl | C | N | C / N | SO4 | Olson | | Al | Ca | Mg | K | Na | sum | | Saturation |
| | | | cm | | | | | ms / cm | | | (%) | (%) | | (ppm) | (ppm) | (%) | me | me | me | me | me | me | me | (%) |
| 1 | 1 | Lakkoli / Ap | 0 - 15 | 1 | 22 | 77 | H C | 0.18 | 5.9 | 4.9 | 1.66 | 0.16 | 10 | 0.71 | 9 | 36.07 | 0 | 22.81 | 13.24 | 0.7 | 0.27 | 37.02 | 47.2 | 78.4 |
| 2 | 2 | Lakkoli / Au | 15 - 38 | 1 | 22 | 77 | H C | 0.20 | 7.1 | 5.6 | 1.33 | 0.12 | 11 | 0.35 | 12 | 33.8 | 0 | 28.54 | 14.51 | 0.67 | 0.26 | 43.98 | 47.03 | 93.5 |
| 3 | 3 | Lakkoli / B1 | 38 - | 2 | 20 | 78 | H C | 0.38 | 7.1 | 5.8 | 1.06 | 0.1 | 10 | 0.14 | 27 | 31.71 | 0 | 28.88 | 14.4 | 0.61 | 0.27 | 44.16 | 45.1 | 97.9 |
| 4 | 1 | Marepi / Ap | 0 - 10 | 6 | 19 | 75 | H C | 0.08 | 5.9 | 4.9 | 1.28 | 0.14 | 9 | 0.4 | 13 | 35.48 | 0 | 11.88 | 11.45 | 0.31 | 0.25 | 23.89 | 31.43 | 76.0 |
| 5 | 2 | Marepi / A | 10 - 23 | 6 | 49 | 45 | Si C | 0.08 | 7.3 | 5.3 | 1.37 | 0.12 | 11 | 0.7 | 18 | 34.18 | 0 | 15.74 | 13.47 | 0.29 | 0.24 | 29.74 | 34.94 | 85.1 |
| 6 | 3 | Marepi / Ap | 23 - 32 | 7 | 41 | 52 | H C | 0.1 | 7.4 | 5.7 | 1.1 | 0.11 | 10 | 0.1 | 28 | 36.18 | 0 | 16.49 | 13.77 | 0.27 | 0.3 | 30.83 | 35.15 | 87.7 |
| 7 | 4 | Marepi / Ap | 32 - 85 | 10 | 48 | 42 | H C | 0.1 | 7.3 | 5.7 | 0.5 | 0.05 | 10 | <.001 | 32 | 32.21 | 0 | 13.95 | 12.96 | 0.27 | 0.26 | 27.44 | 30.87 | 88.9 |
| 8 | 1 | sampisampie / Ap | 0 - 10 | 17 | 36 | 47 | H C | 0.08 | 5.9 | 4.7 | 1.1 | 0.1 | 11 | 4 | 12 | 43.16 | 0 | 8.48 | 5.46 | 0.45 | 0.19 | 14.58 | 25.11 | 58.1 |
| 9 | 2 | sampisampie / Aum | 10 - 24 | 15 | 38 | 47 | H C | 0.08 | 6.1 | 4.9 | 1.16 | 0.11 | 10 | 4 | 16 | 35.2 | 0 | 10.07 | 7.14 | 0.31 | 0.19 | 17.71 | 26.26 | 67.4 |
| 10 | 3 | sampisampie / A12 | 24 - 32 | 20 | 37 | 43 | Li C | 0.08 | 6.6 | 5.8 | 0.66 | 0.06 | 11 | 1.25 | 21 | 33.16 | 0 | 10.54 | 8.51 | 0.27 | 0.18 | 19.5 | 24.49 | 79.6 |
| 11 | 4 | sampisampie / A2 | 32 - 48 | 28 | 27 | 45 | Li C | 0.13 | 7.8 | 6.8 | 0.44 | 0.04 | 11 | 1.65 | 36 | 31.2 | 0 | 12.3 | 11.69 | 0.33 | 0.12 | 24.44 | 28.6 | 85.5 |
| 12 | 5 | sampisampie / B1 | 48 - | 21 | 28 | 51 | H C | 0.13 | 7.6 | 6.8 | 0.34 | 0.03 | 11 | 0.36 | 47 | 31.15 | 0 | 11.7 | 10.91 | 0.25 | 0.11 | 22.97 | 36.34 | 63.2 |
| 13 | 1 | Lawareng / Ap | 0 - 16 | 5 | 42 | 53 | H C | 0.1 | 6.4 | 4.8 | 0.96 | 0.1 | 10 | 0.82 | 14 | 45.16 | 0 | 17.99 | 9.93 | 0.52 | 0.2 | 28.64 | 37.9 | 75.6 |
| 14 | 2 | Lawareng / Aum | 16 - 33 | 4 | 39 | 57 | H C | 0.18 | 7.2 | 5.9 | 0.98 | 0.09 | 11 | 0.35 | 41 | 40.17 | 0 | 27.25 | 13.65 | 0.64 | 0.53 | 42.07 | 42.68 | 98.6 |
| 15 | 3 | Lawareng / B1 | 33 - 95 | 1 | 55 | 54 | Si C | 0.13 | 7.1 | 5.9 | 0.36 | 0.03 | 12 | 0.35 | 37 | 40.15 | 0 | 27.89 | 13.14 | 0.49 | 0.58 | 42.1 | 46.07 | 91.4 |
| 16 | 1 | Lawara / A1 | 0 - 15 | 11 | 62 | 27 | Si L | 4.43 | 7.7 | 5.4 | 0.8 | 0.08 | 10 | 54 | 7 | 36.01 | 0 | 4.48 | 9.73 | 1.34 | 9.36 | 24.91 | 15.66 | 159.1 |
| 17 | 2 | Lawara / A2 | 15 - 35 | 8 | 59 | 33 | Si C L | 7.58 | 7.8 | 5.6 | 1 | 0.09 | 11 | 74 | 16 | 32.11 | 0 | 3.37 | 8.42 | 1.24 | 7.57 | 20.6 | 17.57 | 117.2 |
| 18 | 3 | Lawara / B1 | 35 - 95 | 6 | 60 | 34 | Si C L | 9.3 | 8 | 6 | 0.65 | 0.06 | 11 | 89 | 22 | 32.69 | 0 | 4.2 | 9.93 | 1.55 | 10.24 | 25.92 | 16.64 | 155.8 |
| 19 | 1 | Pasar Jalang / Ap | 0 - 16 | 0.5 | 45.2 | 54.3 | H C | 12 | 7.4 | 5.4 | 1.16 | 0.11 | 10 | 48 | 5 | 35.49 | 0 | 7.66 | 13.77 | 2.54 | 12.91 | 36.88 | 35.41 | 104.2 |
| 20 | 2 | Pasar Jalang / A1 | 16 - 28 | 0.5 | 45.6 | 53.9 | H C | 12.75 | 7.2 | 4.9 | 0.26 | 0.02 | 13 | 55 | 8 | 32.65 | 0 | 7.77 | 13.49 | 2.43 | 12.49 | 36.18 | 38.1 | 95.0 |
| 21 | 3 | Pasar Jalang / B1 | 28 - 90 | 4 | 30 | 66 | H C | 16.75 | 7.8 | 5.8 | 0.22 | 0.02 | 11 | 49 | 11 | 31.72 | 0 | 8.05 | 13.64 | 2.75 | 12.6 | 37.04 | 33.26 | 111.4 |
| 22 | 1 | Mualla / Ap | 0 - 10 | 6 | 52 | 42 | Si C | 0.13 | 5.7 | 4.5 | 0.96 | 0.1 | 10 | 0.03 | 8 | 37.7 | 0 | 8.14 | 6.74 | 0.37 | 0.13 | 15.38 | 18.16 | 84.7 |
| 23 | 2 | Mualla / Aum | 10 - 22 | 8 | 58 | 34 | Si C | 0.13 | 7.2 | 5.4 | 0.78 | 0.08 | 10 | <.001 | 17 | 32.16 | 0 | 10.59 | 8.17 | 0.99 | 0.2 | 19.95 | 17.76 | 112.3 |
| 24 | 3 | Mualla / B1 | 22 - 63 | 9 | 52 | 39 | Si C | 0.33 | 7.5 | 6.4 | 0.44 | 0.04 | 11 | <.001 | 35 | 31.18 | 0 | 19.13 | 11.89 | 2.26 | 0.42 | 33.7 | 18.86 | 178.7 |
| 25 | 4 | Mualla / C | 63 - 95 | 10 | 66 | 24 | Si C L | 0.38 | 7.5 | 6.6 | 0.35 | 0.03 | 12 | <.001 | 69 | 30.7 | 0 | 17.46 | 10.9 | 2.13 | 0.36 | 30.85 | 18.96 | 162.7 |

## Table A.5.3 (2/2) Result of Soil Analysis

| Sample No. | Sub No. | Location/layer | Depth | Texture (%) | | | | EC(1:5) | pH ( 1 : 2.5 ) | | Organic matter | | | NH4OAc Extr | Available P | P Retension | KC-Ext | Exchangeable Cations (me/100g) | | | | | CEC | Base |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sand | Silt | Clay | | | H2O | n-KCl | C | N | C / N | SO4 | Olson | | Al | Ca | Mg | K | Na | sum | | Saturation |
| | | | cm | | | | | ms / cm | | | (%) | (%) | | (ppm) | (ppm) | (%) | me | me | me | me | me | me | me | (%) |
| 26 | 1 | Laputeng / Ap | 0 - 12 | 4 | 48 | 48 | HC | 0.13 | 6.3 | 4.8 | 1.06 | 0.1 | 10.6 | 0.11 | 7 | 49.52 | 0 | 10.16 | 7.51 | 0.42 | 0.07 | 18.16 | 31.88 | 57.0 |
| 27 | 2 | Laputeng / Aum | 12 - 22 | 4 | 44 | 52 | HC | 0.13 | 6.8 | 5.2 | 1.16 | 0.1 | 11.6 | 0.7 | 18 | 47.44 | 0 | 21.32 | 12.9 | 0.51 | 0.34 | 35.07 | 40.75 | 86.1 |
| 28 | 3 | Laputeng / B1 | 22 - 65 | 4 | 48 | 48 | HC | 0.15 | 7.4 | 5.3 | 0.72 | 0.06 | 12 | 0.1 | 24 | 45.65 | 0 | 25.23 | 13.13 | 0.56 | 0.49 | 39.41 | 42.9 | 91.9 |
| 29 | 4 | Laputeng / C | 65 - 100 | 3 | 45 | 52 | HC | 0.2 | 7.5 | 5.4 | 0.66 | 0.05 | 13.2 | 0.1 | 24 | 46.7 | 0 | 27.46 | 13.16 | 0.85 | 0.47 | 41.94 | 47.46 | 88.4 |
| 30 | 1 | Sakkoli / Ap | 0 - 12 | 1 | 49 | 50 | HC | 0.1 | 6.1 | 4.7 | 0.96 | 0.1 | 9 | 0.55 | 6 | 40.21 | 0 | 17.31 | 12.5 | 0.49 | 0.26 | 30.56 | 44.3 | 69.0 |
| 31 | 2 | Sakkoli / Aum | 12 - 22 | 2 | 37 | 61 | HC | 0.13 | 6.6 | 4.8 | 1.06 | 0.1 | 10 | 0.11 | 16 | 35.26 | 0 | 23.04 | 14.04 | 0.56 | 0.44 | 38.08 | 47.1 | 80.8 |
| 32 | 3 | Sakkoli / Aum | 22 - 62 | 3 | 36 | 61 | HC | 0.15 | 6.7 | 4.8 | 0.66 | 0.06 | 11 | <0.001 | 19 | 35.3 | 0 | 21.58 | 13.31 | 0.58 | 0.33 | 35.8 | 47.73 | 75.0 |
| 33 | 4 | Sakkoli / B1 | 62 - 100 | 4 | 36 | 62 | HC | 0.23 | 7 | 4.8 | 0.41 | 0.04 | 10 | <0.001 | 23 | 31.62 | 0 | 24.54 | 13.69 | 0.56 | 0.37 | 39.16 | 48.96 | 80.0 |
| 34 | 1 | Matrapassae / Ap | 0 - 8 | 2 | 36 | 62 | HC | 0.1 | 5.9 | 4.9 | 1.83 | 0.18 | 10 | 0.05 | 10 | 38.21 | 0 | 15.99 | 10.54 | 0.57 | 0.49 | 27.59 | 37.26 | 74.0 |
| 35 | 2 | Matrapassae / Aum | 8 - 28 | 1 | 42 | 57 | HC | 0.1 | 7.2 | 5.9 | 1.12 | 0.1 | 11 | 0.11 | 18 | 36.44 | 0 | 24.08 | 12.24 | 1.24 | 0.26 | 37.82 | 39.66 | 95.4 |
| 36 | 3 | Matrapassae / B1 | 28 - 100 | 2 | 41 | 57 | HC | 0.13 | 7.4 | 5.9 | 0.78 | 0.07 | 11 | 0.07 | 22 | 35.26 | 0 | 23.83 | 11.4 | 1.72 | 0.24 | 37.19 | 38.9 | 95.6 |
| 37 | 1 | Cappabaracue / Ap | 0 - 7 | 1 | 36 | 63 | HC | 0.1 | 5.6 | 4.5 | 2.08 | 0.23 | 9 | 0.01 | 6 | 43.08 | 0 | 16.99 | 11.48 | 0.84 | 0.34 | 29.65 | 37.35 | 79.4 |
| 38 | 2 | Cappabaracue / Aui | 7 - 13 | 1 | 40 | 59 | HC | 0.48 | 6.1 | 5 | 1.21 | 0.12 | 10 | 0.2 | 14 | 42.9 | 0 | 20.98 | 12.78 | 0.3 | 1.64 | 35.7 | 38.51 | 92.7 |
| 39 | 3 | Cappabaracue / B1 | 13 - 100 | 1 | 59 | 40 | SiC | 0.53 | 6.7 | 4.7 | 0.89 | 0.08 | 11 | 0.1 | 21 | 43.05 | 0 | 17.59 | 13.17 | 0.3 | 1.44 | 32.5 | 40.05 | 81.1 |
| 40 | 1 | Padewakeng / Ap | 0 - 12 | 1 | 29 | 70 | HC | 0.13 | 5.7 | 4.3 | 1.83 | 0.2 | 9 | 0.6 | 6 | 38.16 | 0 | 10.39 | 9.47 | 0.46 | 0.27 | 20.59 | 34.54 | 59.6 |
| 41 | 2 | Padewakeng / Aum | 12 - 40 | 1 | 37 | 62 | HC | 0.15 | 5.5 | 4.1 | 0.86 | 0.08 | 11 | 0.1 | 11 | 37.18 | 0 | 11.14 | 9.36 | 0.18 | 0.44 | 21.12 | 22.58 | 93.5 |
| 42 | 3 | Padewakeng / B1 | 40 - 100 | 1 | 48 | 51 | HC | 0.35 | 6.6 | 4.4 | 0.71 | 0.06 | 12 | 0.13 | 16 | 39.4 | 0 | 11.49 | 7.44 | 0.1 | 0.78 | 19.81 | 23.69 | 83.6 |
| 43 | 1 | Allaporange / Ap | 0 - 12 | 1 | 31 | 68 | HC | 0.08 | 5.9 | 4.2 | 1.06 | 0.1 | 10 | 0.1 | 8 | 37.42 | 0 | 9.4 | 6.58 | 0.36 | 0.34 | 16.68 | 31.91 | 52.3 |
| 44 | 2 | Allaporange / Aum | 12 - 23 | 1 | 21 | 78 | HC | 0.08 | 5 | 4.5 | 1.11 | 0.1 | 11 | 0.1 | 12 | 36.5 | 0 | 12.19 | 9.06 | 0.7 | 0.28 | 22.23 | 32.92 | 67.5 |
| 45 | 3 | Allaporange / B1 | 23 - 68 | 2 | 31 | 67 | HC | 0.1 | 6.6 | 4.8 | 0.85 | 0.07 | 12 | 0.42 | 16 | 36.18 | 0 | 12.86 | 9.91 | 0.45 | 0.2 | 23.42 | 35.62 | 65.7 |
| 46 | 4 | Allaporange / B2 | 68 - 100 | 3 | 17 | 80 | HC | 0.2 | 7.1 | 5.3 | 0.47 | 0.04 | 12 | 0.6 | 22 | 32.36 | 0 | 13.65 | 10.31 | 2.44 | 0.3 | 26.7 | 41.39 | 64.5 |
| 47 | 1 | Labempa / Ap | 0 - 11 | 15 | 42 | 43 | SiC | 0.05 | 5.8 | 4.5 | 1.44 | 0.13 | 11 | < 0.001 | 12 | 41.56 | 0 | 8.5 | 6.05 | 0.4 | 0.35 | 15.3 | 23.25 | 65.8 |
| 48 | 2 | Labempa / Aum | 11 - 24 | 17 | 44 | 39 | SiCL | 0.05 | 6.5 | 5.7 | 0.72 | 0.06 | 12 | < 0.001 | 15 | 40.16 | 0 | 10.8 | 8.85 | 0.36 | 0.18 | 20.19 | 23.02 | 87.7 |
| 49 | 3 | Labempa / B1 | 24 - 45 | 17 | 47 | 36 | SiCL | 0.05 | 7 | 6.2 | 0.67 | 0.06 | 11 | < 0.001 | 18 | 40.12 | 0 | 10.4 | 8.03 | 0.4 | 0.16 | 18.99 | 21.4 | 88.7 |
| 50 | 4 | Labempa / B2 | 45 - 90 | 14 | 45 | 41 | SiC | 0.06 | 7.1 | 6.1 | 0.12 | 0.01 | 12 | < 0.001 | 21 | 38.13 | 0 | 12.75 | 11.12 | 0.43 | 0.16 | 24.46 | 29.52 | 82.9 |

## Table A.5.4 (1/11) Soil Profile Description

### 1. Lacoli, Desa, Towalida

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 1, Pr-1-s, Soil number: 8, 9, 10. |
| Date : | 14 Sept. 1994 |
| Soil Name : | Vertisol |
| Sampling Site: | About 150 m south of Lacoli, 700 m south and then turn to SE 1.5 km more. from the Cirawalie junction on the road about 2 km east of Bacubacue on the PLLIII. Left side of Gilirang river, flat land |
| Location : | Kampung Lacoli, Desa, Towalida, Kec.Manianpajo. |
| Topography : | Alluvial plain of Gilirang river |
| Elevation: | 8 m |
| Slope : | In the flat land but slight slope down to south. |
| Parent material : | Alluvium of Gilirang river. |
| Drainage Condition : | Good. |
| Method of Soil Survey: | 100 cm digging. |

Profile Description

| | | |
|---|---|---|
| Ap | 0 - 15 cm | Gray (7.5 Y 4/1) with iron mottling of reddish brown (2.5 YR 4/8). Heavy clay. Very low organic matter containing. Very compact, 27-33. Angular blocky structure. Very sticky and plastic. Abundant fine roots. |
| Au1 | 15 - 35/8 cm | Brownish gray (10 YR 4/1). Heavy clay. Very low organic matter. Moderately hard, 13-20. Angular blocky structure, very sticky and plastic, abundant fine roots. |
| C | 35/38- cm | Grayish olive (7.5 Y 5/2). Heavy clay. Very low organic matter. Loose compact, 12-15. Angular blocky structure very sticky and plastic, rare fine roots. |

### 2. Marepi, Desa Sakkoli.

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 2, Pr-2-s, Soil number , 11, 12, 13, 14 |
| Date : | 14 Sept., 1994 |
| Soil Name : | Vertisol |
| Sampling Site : | About 100 m north-east from the Marepi bridge on the road from Sakkoli to Salobulo left side of the Gilirang river & Marepi, flat land. |
| Location : | Kampung Marepi, Desa Sakkoli, Kec. Manianpajo. |
| Topography : | Alluvial plain of Gilirang river |
| Elevation : | 10 m. |
| Slope : | Almost flat, but slightly slope down to south. |
| Parent material: | Alluvium of Gilirang river. |
| Drainage Condition : | Good. |
| Land Use : | Paddy field, stabs are remained |
| Method of Soil Survey : | 85 cm digging. |

## Table A.5.4 (2/11) Soil Profile Description

Profile Description

| | | |
|---|---|---|
| Ap | 0 - 10 cm | Brownish gray (7.5 YR 4/1) with iron mottling of brown (7.5 , YR 4/6) Clay. Very low organic matter containing. Medium compact , 17-24. Angular blocky structure, with some iron mottling. Very sticky and plastic. Abundant fine roots. |
| Au1 | 10 - 23 cm | Olive black (5 Y 3/1). Clay loam. Very low organic matter. Medium compact ,20-23. Angular blocky structure w/some iron mottling, slightly sticky and very plastic, some fine roots. |
| Au2 | 23 - 32 cm | Grayish olive (5 Y 4/2). Clay. Very low organic matter. Medium compact, 19-22. Granular with blocky structure very sticky and plastic, some fine roots. |
| C | 32 - 85 cm | Gray (5Y 5/1). Heavy clay. Very low organic matter. Loose compact, 14-17. Angular blocky structure, moderately sticky and plastic, rare or no root. |

### 3. Sanpisanpie, Desa, Laerung.

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 3, Pr-3-s. Soil number 15, 16, 17, 18, 19. |
| Date : | 15 Sept., 1994 |
| Soil Name : | Vertisol |
| Sampling Site: | About 50 m from the edge of hill from Tarumpakkae on the road from Attapange to Sakkoli, right side of Gilirang river flat land |
| Location : | Kampung Sanpisanpie, Desa, Laerung, Kec. Majauleng. |
| Topography : | Alluvial plain of Gilirang river |
| Elevation : | 17.7 m |
| Slope : | Almost flat. but slight slope to south-east. |
| Parent material: | Alluvium of Gilirang river. |
| Land Use | Paddy field, stabs are remained |
| Drainage Condition : | good. |
| Method of Soil Survey : | 75 cm digging. Boring : 75 cm to 95 cm |

Profile Description

| | | |
|---|---|---|
| Ap | 0 - 10 cm | Yellowish gray (2.5 Y 5/1)/brown mottling(7.5 YR 4/6). Clay. Very low organic matter containing. Very compact , 23-32. Angular blocky structure, with iron mottling. Moderately sticky and plastic. Abundant fine roots. |
| Au1 | 10 - 24 cm | Brownish gray (10 YR 4/1) / brown mottling (7.5 YR 4/6). Heavy clay. Very low organic matter. Very hard, 30-35. Angular blocky structure, moderately sticky and very plastic, some fine roots. |
| Au2 | 24 - 32 cm | Brown gray (10 YR 4/1). Clay. Very low organic matter. Medium compact, 17-21. Angular blocky structure moderately sticky and very plastic, rare fine roots. |

| | | |
|---|---|---|
| C | 32 - 48- cm | Yellowish Gray (2.5Y 5/1). With mottling of Olive yellow, (5 Y 6/3). Heavy clay. Very low organic matter. Loose compact, 14-16. Angular blocky structure, very sticky and plastic, no or rare root. |

## 4. Lawareng, Desa, Gilirang

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 4, Pr-4-s, Soil number 20, 21, 22. |
| Date : | 15 Sept., 1994 |
| Soil Name : | Vertisol |
| Sampling Site: | About 100 m south of the village 2 km right from the branch on the road from Gilirang village to the dam site, right side of Gilirang river, flat land |
| Location : | Kampung, Lawareng, Desa, Gilirang, Kec. Maniangpajo. |
| Topography : | Alluvial plain of Gilirang River |
| Elevation : | 17.7 m |
| Slope : | Almost flat, but slight slope to south-east. |
| Parent material: | Alluvium of Gilirang river. |
| Land Use | Paddy field, stabs are remained |
| Drainage Condition : | Good. |
| Method of Soil Survey : | 95 cm digging |

Profile Description

| | | |
|---|---|---|
| Ap | 0 - 16 cm | Dark Blue gray (5 BG 4/1)/ Red Brown mottling(5 YR 4/6). Heavy Clay. Very low organic matter containing. Medium compact, 17-22. Angular blocky structure, with abundant iron mottling. Very sticky and plastic. Abundant fine roots. Deep cracks are developed. |
| Au1 | 16 - 33 cm | Gray (5 YR 4/6) / Red Brown mottling (5 YR 4/6). Clay, lack of organic matter. Loose compact, 15-17. Blocky structure, very sticky and plastic, some fine roots. reductive. |
| C | 33 - 95 | Dark Gray Yellow (2.5Y 4/2), heavy clay, no organic matter Loose compact, 11-16. Angular blocky with small mottling of iron. |

## Table A.5.4 (4/11) Soil Profile Description

### 5. Lawara, Desa, Doping

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 5, Pr-5-s, Soil number , 23,24,25 |
| Date : | 19 Sept., 1994 |
| Soil Name : | Fluvisol, Thionic |
| Sampling Site : | About 50 m aprt from the end of the road to east from Raddae on the road from Doping to Jalang, dried bottom of the fish pond. |
| Location : | Kampung, Lawara, Desa, Doping, Kec.Sajoanging. |
| Topography : | Alluvial plain, but accreted land for fishpond |
| Elevation : | 0 m. |
| Parent material: | Alluvial deposit of river or sea. |
| Slope : | Flat. |
| Land Use | Fish pond, but already drained up at sampling. |
| Drainage Condition : | Good. |
| Method of Soil Survey : | 100 cm digging. |

Profile Description

| | |
|---|---|
| A1 0 - 15 cm | Brownish gray (10 YR 5/1) with abundant iron mottling of Bright brown (7.5 YR 5/6). Heavy Clay. Very low organic matter containing. Compact, 18-27. Blocky structure, with abundant iron mottling. Very sticky and plastic. Abundant fine roots. |
| A2 15 - 35 cm | Gray (7.5 Y 6/1). Bright Yellow brown (10 YR 6/8) and Brownish black(2.5Y 3/1). Heavy Clay. Very low organic matter. Loose compact, 15-18. Angular Blocky structure with some iron andblack (Mn) mottling, very very sticky and plastic, some fine roots. |
| B1 35 - cm | Gray (7.5 Y 6/1). Bright Yellowish Brown (10 YR 6/8) andBrownish Black (2.5 Y 3/1). Heavy Clay. Very low organic matter. Loose compact, 9-13. Angular blocky structure, with iron and yellowish mottling, very sticky and very plastic, some black roots. |

### 6. Jalang, Desa, Akajeng

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 6, Pr-6-s, Soil number , 26, 27, 28 |
| Date : | 19 Sept., 1994 |
| Soil Name : | Fluvisol, Thionic |
| Sampling Site : | About 200 m south from the Jalang pasar, on the road from Doping to Jalang. On the end of the paddy fields, 1-2 m upper from the fish ponds, this field was newly reclaimed from the mangrove vegetation . |
| Location : | Kampung, Jalang, Desa, Akajeng, Kec. Sajoanging. |
| Topography : | Alluvial plain, but accreted land for fishpond |

## Table A.5.4 (5/11) Soil Profile Description

| | |
|---|---|
| Elevation | 1 m |
| Parent material: | Alluvium of river or sea. |
| Slope : | Flat. |
| Land Use : | Fish pond, but already drained up at sampling. |
| Drainage Condition : | Good. |
| Method of Soil Survey : | 100 cm digging. |

Profile Description

| | | |
|---|---|---|
| A1 | 0 - 16 cm | Dry, with big cracks(max: 3 cm wide, 30 more cm deep). Gray (10 Y 4/1) with abundant iron mottling of Brown (7.5 YR 4/6). Clay. Very low organic matter containing. Compact, 26-30. Blocky structure, with abundant iron mottling. Very sticky and plastic. Abundant moderate and fine roots. |
| A2 | 16 - 28 cm | Brownish black (2.5 Y 3/1). Heavy Clay. Very low organic matter. Loose compact, 11-12. Blocky structure with some iron mottling, very sticky and plastic, many fine roots. |
| B1 | 28 - cm | Gray (5 Y 4/1). Heavy Clay. Very low organic matter. Loose compact, 6-8. Blocky structure, with iron mottling, very sticky and very plastic, many black roots. |

### 7. Mualla, Desa, Asorajang

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 7, Pr-7-s, Soil number 29, 30, 31, 32. |
| Date : | 19 Sept., 1994 |
| Soil Name : | Vertisol |
| Sampling Site : | Turn left from the village of Mualla on the road from Doping to Jalang, and proceed about 500 m north-west on the rough road. a slight slope to the river Mualla. Alluvium of R. Mualla |
| Location : | Kampung Mualla, Desa, Asorajang, Kec. Majauleng. |
| Topography : | Alluvial plain of Mualla river |
| Elevation | 9 m |
| Parent material: | Alluvium of River Mualla. |
| Slope : | Flat.. |
| Land Use : | Paddy field, paddy stabs remained. |
| Drainage Condition : | Good. |
| Method of Soil Survey : | 95 cm digging. Water table about 6 m. |

Profile Description

| | | |
|---|---|---|
| Ap | 0 - 10 cm | Dry, with cracks. Yellowish gray (2.5 Y 4/1) with bright brown mottling(7.5 YR 5/6). Heavy clay. Very low organic matter containing. Compact, 22-28. Blocky structure, with iron mottling. Moderately sticky and plastic. Abundant fine roots. |

## Table A.5.4 (6/11) Soil Profile Description

| | | |
|---|---|---|
| Au1 | 10 - 22 cm | Dark grayish yellow (2.5 Y 3/1). Clay. Very low organic matter. Compact, 28-29. Angular blocky structure with some iron mottling, slightly sticky and very plastic, abundant fine roots. |
| Au2 | 22 - 63 cm | Gray (5 Y 6/1) and bright yellowish brown (10 YR 6/8), loam. Very low organic matter. Medium compact, 19-21. Angular blocky structure with some iron mottling. Slightly sticky and plastic plastic. Some fine roots. |
| C | 63-95 cm | Gray (5 Y 6/1) and Bright brown (7.5 YR 5/6). Loam. Very low organic matter. Medium compact, 17-21. Angular blocky structure with iron mottling in stripes. very slightly sticky and some plastic, no root. Especially abundant sparkling grass-like materials found. |

### 8. Laputeng, Desa, Maminasae

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 8, Pr-8-s, Soil number 33, 34, 35, 36. |
| Date : | 20 Sept., 1994 |
| Soil Name : | Vertisol |
| Sampling Site: | About 50 m west from the Mosque on the end of the road left from the junction just after the bridge of Tarumpakkae. Alluvium of Gilirang river. |
| Location : | Kampung Laputeng, Desa, Maminasae, Kec. Maiangpajo. Near the bench mark 1G 16. |
| Topography : | Alluvial plain of Gilirang river |
| Elevation : | 5 m |
| Parent material: | Alluvium of Gilirang river. |
| Slope : | Flat. |
| Land Use | Paddy field, paddy stabs remained. |
| Drainage Condition : | Good. |
| Method of Soil Survey : | 100 cm digging. Water table about 5 m. |

Profile Description

| | | |
|---|---|---|
| Ap | 0 - 10/12 cm | Gray (5 Y 5/1) with yellow brown mottling(10 YR 5/8). Heavy clay. Very low organic matter containing. Very compact, 30-33. Angular blocky structure with iron mottling. Very sticky and plastic. Abundant fine roots. |
| Au1 | 10/12 - 22 cm | Olive black (5 Y 3/1). Heavy clay. Very low organic matter. Compact, 27-30. Angular blocky structure with some iron mottling, very sticky and plastic, abundant fine roots. |
| Au2 | 22 - 57/65 cm | Gray (5 Y 4/1) and Yellowish brown (10 YR 5/8). Clay. Very low organic matter. Medium compact, 20-22. Angular blocky structure with some iron and black mottling. Slightly sticky and very plastic, very low fine roots. |
| C | 57/65-100 cm | Gray (7.5 Y 4/1). Heavy clay. Very low organic matter. Loose compact, 17-18. Angular blocky structure. very sticky and plastic, a little fine roots. |

## Table A.5.4 (7/11) Soil Profile Description

### 9. Sakkoli, Desa, Sakkoli

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 9, Pr-9-s, Soil number 37, 38, 39, 40. |
| Date : | 20 Sept., 1994 |
| Soil Name : | Vertisol |
| Sampling Site: | Turn down from Bacubacue on the road from Atapange to Salobulo, and walk about 800 m to south from Bacubacue, Alluvium of Gilirang river . |
| Location : | Kampung Sakkoli, Desa, Sakkoli, Kec. Sajoanging. |
| Topography : | Alluvial plain of Gilirang river |
| Elevation : | 14 m |
| Parent material: | Alluvium of Gilirang river. |
| Slope : | Flat. |
| Land Use | Paddy field, paddy stabs remained. |
| Drainage Condition : | Good. |
| Method of Soil Survey : | 100 cm digging. Water table about 3 m. |

Profile Description

| | | |
|---|---|---|
| Ap | 0 - 12 cm | Gray (5 Y 5/1) with brown mottling(5 YR 4/6). Heavy clay. Very low organic matter containing. Very compact, 28-34. Blocky structure with abundant iron mottling. Very sticky and plastic. Abundant fine roots. |
| Au1 | 12 - 22 cm | Black (10 YR 2/1). Heavy clay. Very low organic matter. Compact, 27-28. Angular blocky structure with no iron mottling, very sticky and plastic, abundant fine roots. |
| Au2 | 22 - 57/62 cm | Brownish black (10 YR 3/1). Heavy clay. Very low organic matter. Loose, 12-16. Angular blocky structure with no iron mottling. Very sticky and plastic, few fine roots. |
| C | 57/65-100 cm | Gray (7.5 Y 5/1). Heavy clay. Very low organic matter. Loose, 12-17. Blocky structure with granular characteristics. Very sticky and plastic, few fine roots. |

### 10. Matrapassae, Desa, Salobulo

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 10, Pr-10-s, Soil number 41, 42, 43. |
| Date : | 21 Sept., 1994 |
| Soil Name : | Vertisol |
| Sampling Site : | Turn to right at Salobulo town from Atapange and turn again at the junction about 700 m from Salobulo, and go along about 2 km more to south-east, very near to the Gilirang river. Alluvium of Gilirang river . |
| Location : | Kampung Matrapassae, Desa, Salobulo, Kec. Sajoanging. |
| Topography : | Alluvial plain of Gilirang river |
| Elevation : | 4 m |

## Table A.5.4 (8/11) Soil Profile Description

| | |
|---|---|
| Parent material: | Alluvium of Gilirang river. |
| Slope : | Flat. |
| Land Use | Paddy field, paddy stabs remained. |
| Drainage Condition : | Good. |
| Method of Soil Survey : | 100 cm digging. Water table about 3 m. |

Profile Description

| | |
|---|---|
| Ap 0 - 8 cm | Gray (5 Y 5/1) with bright brown mottling(2.5 YR 5/8). Heavy clay. Very low organic matter containing. Very compact, 32. Blocky structure with abundant iron mottling. Very sticky and plastic. Abundant fine roots. |
| Au1 8 - 28 cm | Gray (7.5 Y 5/1). Heavy clay. Very low organic matter. Compact, 27-28. Blocky structure with common iron mottling, very sticky and plastic, abundant fine roots. |
| C 28-100 cm | Gray (5 Y 5/1) with brown iron mottling (7.5 YR 4/6). Heavy clay. Very low organic matter. Medium compact, 18-20. Angular blocky structure with some iron mottling. Very sticky and plastic, a little fine roots. |

### 11. Cappabaracue, Desa, Akkotengeng

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 11, Pr-11-s, Soil number 44, 45, 46. |
| Date : | 21 Sept., 1994 |
| Soil Name : | Vertisol |
| Sampling Site : | Near the end of the Gilirang river, about 100 m east from Babana on the road Toduma to Cappabaracue. Alluvium of Gilirang river . Frequently inundated by flood. |
| Location : | Kampung Cappabaracue, Desa, Akkotengeng, Kec. Sajoanging. |
| Topography : | Alluvial plain of Gilirang river, near the sea. |
| Elevation: | 2 m. |
| Parent material: | Alluvium of Gilirang river. |
| Slope : | Flat. |
| Land use | Paddy field, paddy stabs remained. No palawija. |
| Drainage Condition : | Good. |
| Method of Soil Survey : | 100 cm digging. Water table about 3 m. |

Profile Description

| | |
|---|---|
| Ap 0 - 7 cm | Gray (7.5 Y 5/1) with bright brown mottling (7.5 YR 5/8). Heavy clay. Very low organic matter containing. Loose compact, 10-12. Granular structure with abundant iron mottling. Very sticky and plastic. Abundant fine roots. |

## Table A.5.4 (9/11) Soil Profile Description

| | | |
|---|---|---|
| Au1 | 8 - 13 cm | Gray (7.5 Y 5/1) with bright brown mottling (7.5 YR 5/8). Heavy clay. Very low organic matter. Medium compact, 21-24. Angular blocky structure with common iron mottling, very sticky and plastic, abundant fine roots. |
| C | 13-100 cm | Gray (5 Y 5/1). Heavy clay. Very low organic matter. Medium compact, 18-20. Granular structure with some stickiness and with iron mottling. Very sticky and plastic, some fine roots. |

### 12. Padewakeng, Desa, Makmur

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 12, Pr-12-s, Soil number 47, 48, 49. |
| Date : | 22 Sept., 1994 |
| Soil Name : | Vertisol |
| Sampling Site : | About 3 km north from Togege crossing and 1 km east from Bacubacue (smoller village on the SW corner of the map Salobulo scalled 1/25,000), a stream side paddy field about 200 m south from the village Alluvium of Gilirang river . Frequently inundated by flood. |
| Location : | Kampung Padewakeng, Desa, Makmur, Kec. Sajoanging. |
| Topography : | Alluvial plain of Alupange river. |
| Elevation : | 3 m. |
| Parent material: | Alluvium of Gilirang river. |
| Slope : | Flat. |
| Land Use | Paddy field, wilted paddy remained. No yield because of delayed transplanting and the following dry weather. Planning of palawija. cultivation after the October rain, if any. |
| Drainage Condition : | Good. |
| Method of Soil Survey : | 100 cm digging. Water table about 10 m. |

Profile Description

| | | |
|---|---|---|
| Ap | 0 - 12 cm | Gray (7.5 Y 5/1) with brown mottling (7.5 YR 4/6). Heavy clay. Very low organic matter containing. Very compact, 27-34. Angular blocky structure with abundant iron mottling. Very sticky and plastic. Abundant fine roots. |
| Au1 | 12 - 40 cm | Gray (7.5 Y 4/1) with brown mottling (7.5 YR 4/6). Heavy clay. Very low organic matter. Very compact, 30-32. Angular blocky structure with common iron mottling, very sticky and plastic, abundant fine roots. |
| C | 40-100 cm | Gray (7.5 Y 4/1) with dark reddish brown (5 YR 3/3). Heavy clay. Very low organic matter. Medium compact, 23-24. Angular blocky structure with iron and black mottling. Very sticky and plastic, some fine roots. |

## Table A.5.4 (10/11) Soil Profile Description

### 13. Allaporange, Desa, Padaelo

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 13, Pr-13-s, Soil number 50, 51, 52, 53. |
| Date : | 23 Sept., 1994 |
| Soil Name : | Vertisol |
| Sampling Site : | About 800 m north from the junction of the village Allaporange which is 1 km east from Togege crossing,and go down about 100 m to west. Alluvium of Gilirang river . Frequently inundated by flood. |
| Location : | Kampung Allaporange, Desa, Padaelo, Kec. Sajoanging. |
| Topography : | Alluvial plain of Gilirang river, lowland area. |
| Elevation:: | 3 m |
| Parent material: | Alluvium of Gilirang river. |
| Slope : | Flat. |
| Land Use | Paddy field, paddy stabs remained. No palawija |
| Drainage Condition : | Good. |

Method of Soil Survey : 100 cm digging. Water table about 3 m.

Profile Description

| | | |
|---|---|---|
| Ap | 0 -12 cm | Gray (7.5 Y 5/1) with bright brown mottling (7.5 YR 5/8). Clay. Very low organic matter containing. Very compact, 31-33. Angular blocky structure with abundant iron mottling. Very sticky and plastic. Abundant fine roots. |
| Au1 | 12 - 23 cm | Brownish black (7.5 Y 5/1) and brown mottling (7.5 YR 5/8). Heavy clay. Very low organic matter. Compact, 25-27. Angular blocky structure with common iron mottling, very sticky and plastic, abundant fine roots. |
| Au2 | 23-68 cm | Reddish gray (2.5 YR 4/1). Heavy clay. Very low organic matter. Loose compact, 13-14. Granular structure with some stickness and with iron mottling. Very sticky and plastic, some fine roots. |
| C | 68-100 cm | Olive yellow (5 Y 6/4). Heavy clay. Very low organic matter. Loose compact, 10-13. Granular structure with some stickiness and with iron mottling. Very sticky and plastic, no fine roots. |

### 14. Labempa, Desa, Abatireng

Information of soil & Sampling site

| | |
|---|---|
| Profile Number : | 14, Pr-14-s, Soil number 54, 55, 56, 57. |
| Date : | 27 Sept., 1994 |
| Soil Name : | Cambisol, Eutric |
| Sampling Site: | The 7 th terrace down from the road about 100 m east from the Labempa junction on the road north to Gilirang. Old alluvium reclaimed in 1930 as paddy field . |

## Table A.5.4 (11/11) Soil Profile Description

| | |
|---|---|
| Location : | Kampung Labempa, Desa, Abatireng, Kec. Maniangpajo. |
| Topography : | Hills complex of muddy and gravely stone |
| Elevation : | 37 m. |
| Parent material: | weathered material of mud rock. |
| Slope : | Terrace on the slope (1.3/8 = 9.23 degree). |
| Land Use | Paddy field, paddy stabs remained. No palawija. |
| Drainage Condition : | Good. |
| Method of Soil Survey : | 90 cm digging. Water table about 3 m. |

Profile Description

| | | |
|---|---|---|
| Ap | 0 - 11 cm | Yellow brown (2.5 Y 5/3) with bright brown mottling (7.5 YR 5/8). Heavy clay. Very low organic matter containing. Very compact, 32-33. Angular blocky structure with abundant iron mottling. Very sticky and plastic. Abundant fine roots. |
| Au1 | 11 - 24 cm | Dull yellow brown (10 YR 5/3) with black mottling (10 YR 1.7/1). Clay loam. Very low organic matter. Compact, 24-28. Angular blocky structure with common iron mottling, very sticky and plastic, abundant fine roots. |
| B1 | 24-45 cm | Dark grayish yellow (2.5 Y 5/2). Gravel-containing clay. Very low organic matter. Medium compact, 23. Angular blocky structure with some 10 % gravels and with iron mottling. Very sticky and plastic, some fine roots. |
| B2 | 45-90 cm | Gleyish olive (5Y 6/2) with Orange (7.5 YR 6/8) iron mottling. Heavy clay. Very low organic matter. Medium compact 19-22. Angular blocky structure with iron mottling. Very sticky and plastic, rare fine roots. |

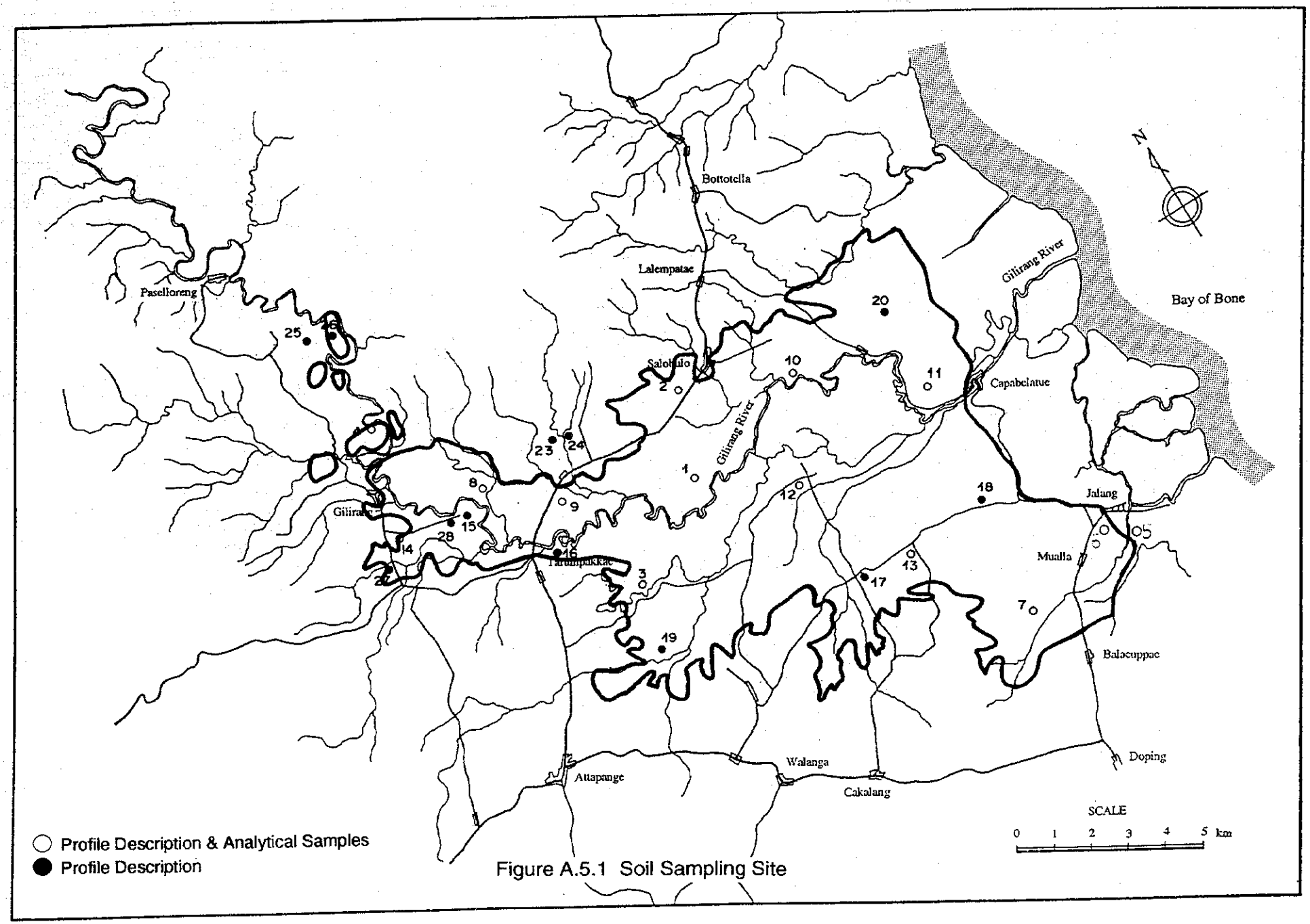



Figure A.5.1 Soil Sampling Site

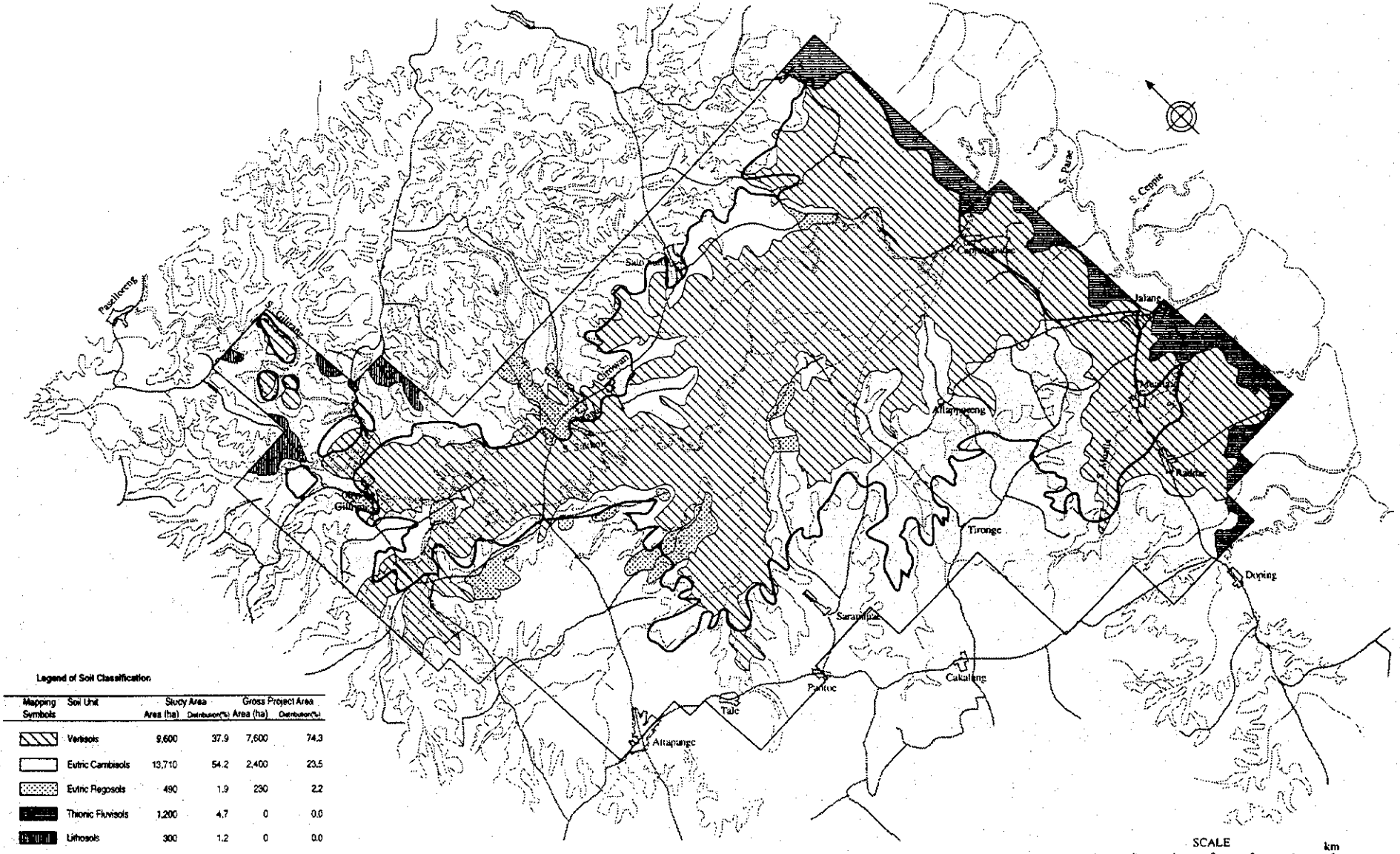



Figure A.5.2 Soil Map

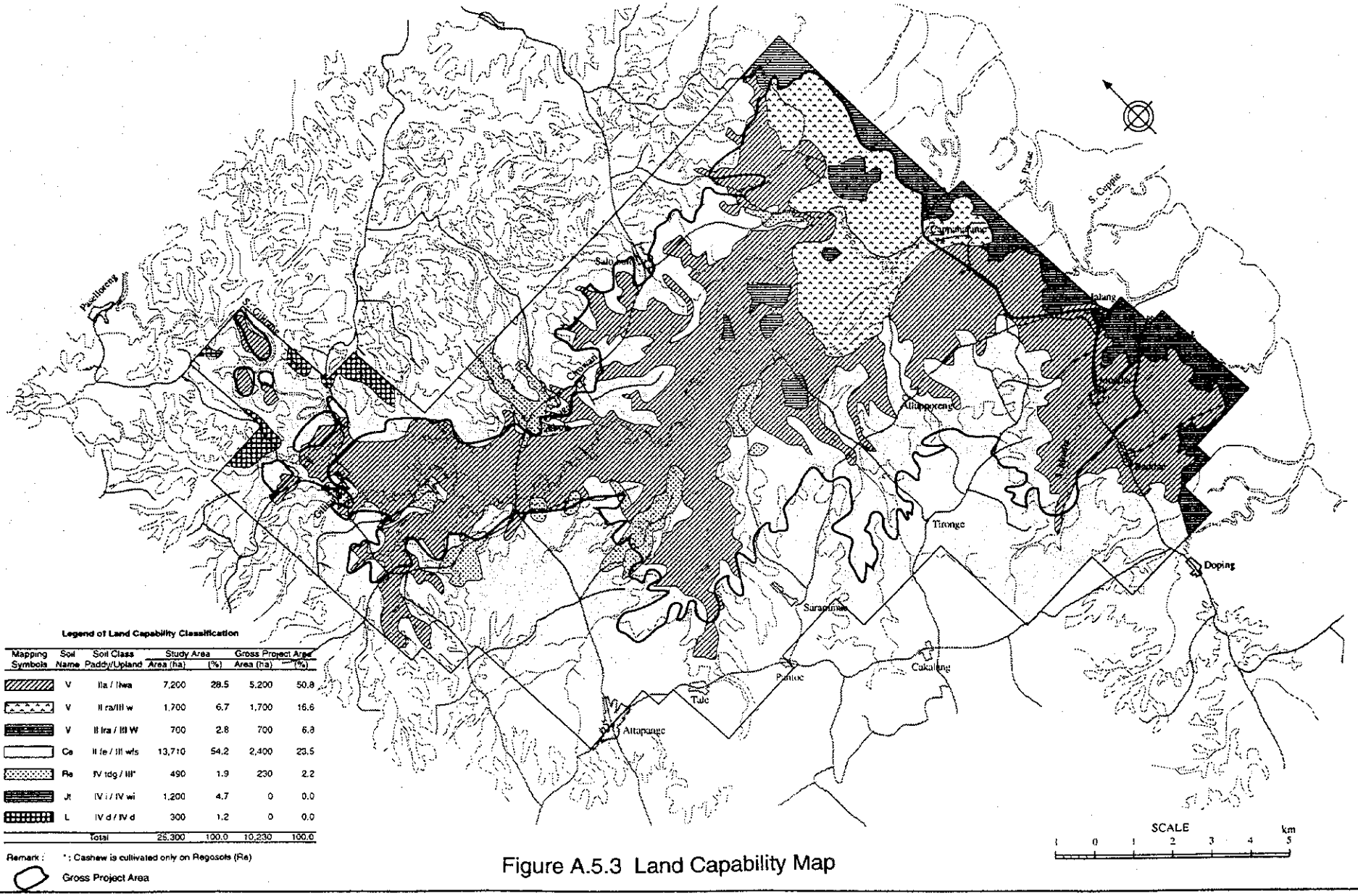
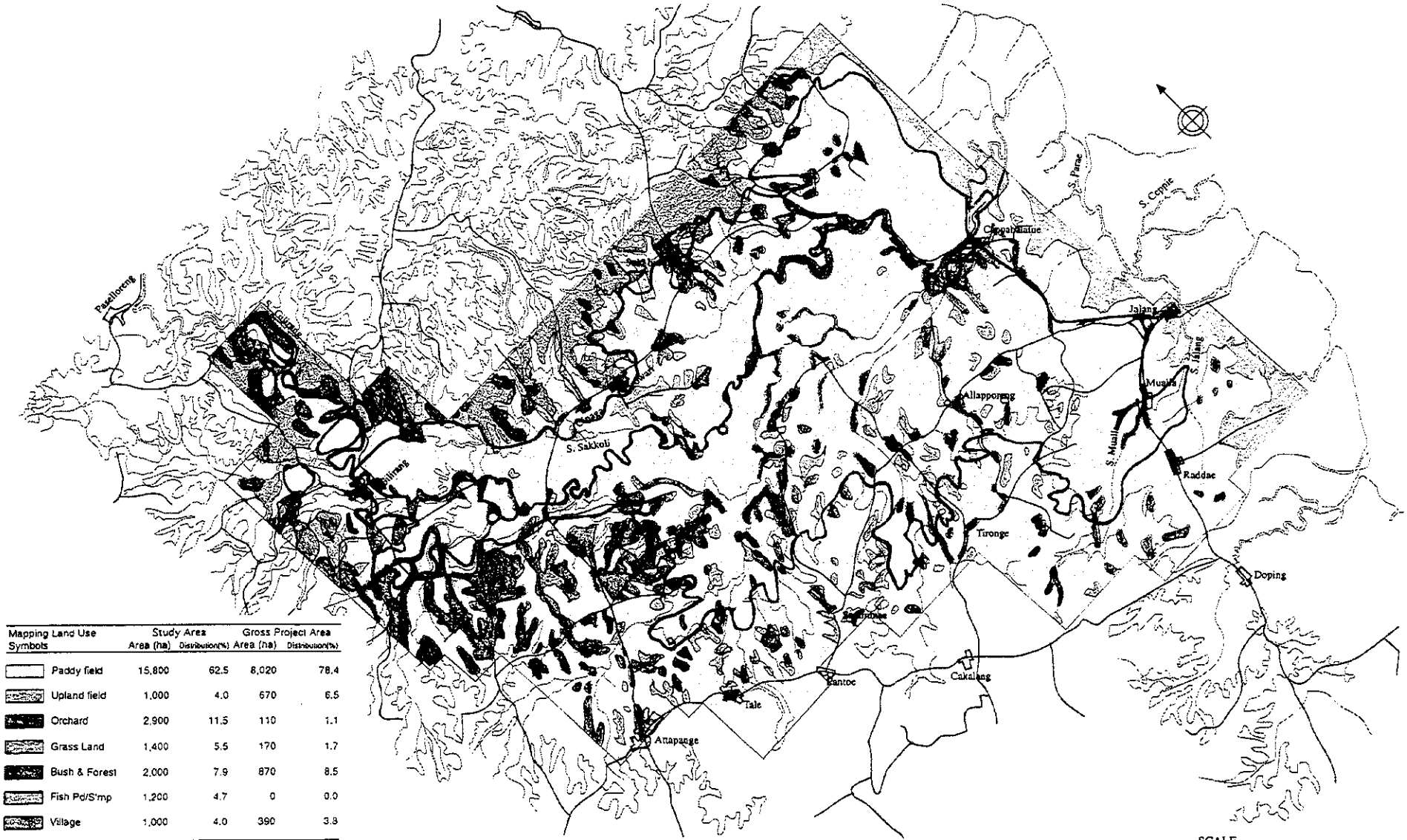



Figure A.5.3 Land Capability Map




| Mapping Land Use Symbols | Study Area Area (ha) | Distribution(%) | Gross Project Area Area (ha) | Distribution(%) |
|---|---|---|---|---|
| Paddy field | 15,800 | 62.5 | 8,020 | 78.4 |
| Upland field | 1,000 | 4.0 | 670 | 6.5 |
| Orchard | 2,900 | 11.5 | 110 | 1.1 |
| Grass Land | 1,400 | 5.5 | 170 | 1.7 |
| Bush & Forest | 2,000 | 7.9 | 870 | 8.5 |
| Fish Pd/S'mp | 1,200 | 4.7 | 0 | 0.0 |
| Village | 1,000 | 4.0 | 390 | 3.8 |
| Total | 25,300 | 100.0 | 10,230 | 100.0 |

Gross Project Area

Figure A.5.4 Present Land Use

# *ANNEX 6*

## *AGRICULTURE AND AGRO-ECONOMY*

# ANNEX 6 AGRICULTURE AND AGRO-ECONOMY

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# ANNEX 6 AGRICULTURE AND AGRO-ECONOMY

## 1. GENERAL

This report gives a full account of the general background to the agricultural development plan, the present agricultural and agro-economic condition in the study area of a gross area of 25,300 ha including farm land, forest, village, etc. and the proposed agricultural development plan for the project area having a net irrigable area of 7,000 ha.

The data and information in this study were provided by the following government authorities and private enterprise concerned. List of reference and data used in the study are presented in Table A.6.1.

1) Provincial Public Works for Water Resources Development (Dinas PU Pengairan), South Sulawesi.
2) Cabang Dinas PU Pengairan, Kabupaten Sidrap.
3) Ranting Dinas PU Pengairan, Sengkang.
4) BAMUS Office, Kabupaten Sidrap.
5) BAPPEDA Provincial and Kabupaten Offices, South Sulawesi and Wajo.
6) Provincial and Kabupaten Agricultural Service Offices, South Sulawesi and Wajo.
7) Provincial and Kabupaten Statistic Offices, South Sulawesi and Wajo.
8) Rural Extension Centres (BPP), Kecamatan Sajoanging, Majauleng and Maniangpajo.
9) Kabupaten Cooperative Offices, Kab. Wajo.
10) Kabupaten Livestock Office, Kab. Wajo.
11) Kabupaten Fruit Tree Office, Kab. Wajo.
12) DOLOG Office, Kab. Wajo.
13) Camat Offices, Kecamatan Sajoanging, Majauleng and Maniangpajo.
14) Rural Development Office (BANGDES) and Dharma Wanita Offices, Kabupaten Wajo.
15) Branch Research Station for Food Crops, Maros.
16) Indonesian People's Bank, Kab. Wajo.
17) KUD Offices, Kecamatan Sajoanging and Majauleng.
18) PT. PUSRI, Sengkang.
19) PT. PERTANI (PERSERO), Sereang.

Aside from the data collection, field reconnaissance and household interview surveys were carried out so as to confirm the collected data with more practical information. The outline of the household interview survey are as follows. The Team reviewed all of these data obtained through the survey and used fully into the study on the agriculture and agro-economy in and around the study area. The result of household survey is presented in Table A.6.2.

1) Questionnaire, Enumerator and Period of Survey

   A questionnaire includes the following survey items.

   a) Family size and labour force
   b) Land holding size and land tenure
   c) Crop production
   d) Farming practices and farm inputs
   e) Farm gate prices and production cost
   f) Livestock raising and farm machinery
   g) Marketing
   h) Off-farm income
   i) Living expenses
   j) Farmers' intention for cropping pattern
   k) Domestic water and electric supply
   l) Farmers' intention for pump irrigation

   The accuracy of data regarding the question items mentioned in the above is limited

as the information depends on the respondent's memory. Interview to farmers and data processing by computer were carried out by IKIP under the supervision of the study team. The field works were implemented at September 1994.

2) Sample Size

The number of samples to be required for the household survey in the study area was calculated at 246 samples, based on the following formula[1]. The survey was carried out to 250 samples, and these were selected randomly from 5 villages (Padaelo, Sakkoli, Mamminase, Akotengeng and Bottobenteng) in the study area.

$$n >= \frac{\{Za \times a/X\}^2}{e^2}$$

| | | | |
|---|---|---|---|
| Where | n | : Number of sample | |
| | a | : Critical rate | 5% |
| | $e$ | : Acceptable error margin | 5% |
| | Za | : Confidence coefficient[2] | 1.96 |
| | a/X | : Coefficient of variation[3] | 0.40 |

# 2. GENERAL BACKGROUND

## 2.1 National Socio-Economy

### 2.1.1 Land and Population

The Republic of Indonesia is located between latitude 6° 08' north and 11° 15' south, and between longitude 94° 45' and 141° 05' east with an area of 1.92 million km$^2$. The Indonesia comprises a great diversity of culture and languages in an archipelago consisting of about 13,700 islands stretching over a distance of 5,200 km from east to west.

In 1992, the total population of the country was about 186.5 million with a population density of about 97 persons/km2, which had increased at an average growth rate of 1.98% per annum during the period from 1987 to 1992. The economically active population in the whole country was estimated to be about 78.5 million in 1991. Of these, 97.4% are working population.

### 2.1.2 National Economy

Basic indicators for the national and regional economies are presented in Table A.6.3. The Gross Domestic Product (GDP) is Rp. 227,160 billion in 1991 at current market prices. The per capita GDP is approximately Rp. 1.25 million or US$ 641. GDP in real terms increased at the rate of 6.7% p.a. during the past four years from 1987 to 1991. Of the GDP in 1991, about 21% is derived from the manufacturing sector followed by 20% form the agricultural sector and 17% from the trade (wholesale and retail trade and restaurants). The share of the agriculture sector in GDP declined from about 45% in 1970. This is because of considerably higher growth in other sectors.
A distortion arises in the Indonesia's economy, due mainly to recent rapid growth in other sectors particularly in the manufacturing sector. For instance, labour productivity in agriculture sector is lower than other sectors, reflecting the agriculture sector's small share in GDP and

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1 Dennis J. Casley and Denis A. Lury, Monitoring and Evaluation of Agriculture and Rural Development Projects, The World Bank, 1985.
2 From normal distribution table (two-sided test).
3 The required sample size is largely affected by the degree of $\alpha/X$, and this figure varies by each question items. In this survey, the sample size was decided on the basis of $\alpha/X$ of paddy yields which show a high variance, and it was estimated at 0.4, based on the previous survey of the Bila Irrigation Project.

large share in employment. As of 1990, labour productivity is Rp. 0.52 million/labour/year in the agriculture sector, while that is Rp. 1.37 million/labour/year in all sectors.

### 2.1.3 Agriculture

Agriculture is still mainstay in Indonesia's economy. This sector represents about 20% of GDP and employs 41.1 million or 54% of the labour force in 1991. The sector has an important role in non-oil merchandise trade, with major agricultural exports accounting for 48% of the value of non-oil exports in 1989/90. Food crops account for 58% of agricultural GDP followed by non-food crops for 13% and Livestock for 11% in 1991.

Production is dominated by small farmers. The average farm size of small farmers varies from 0.5 to 0.7 ha in Java and 1 to 3 ha outside Java. The important food crops grown by small farmers are rice, maize, cassava, sweet potatoes, groundnuts and soybeans. Livestock is usually raised in mixture with food crops and secondary crops (palawija in Indonesian term). Poultry, beef cattle and dairy cattle are the livestock commonly raised by small farmers. Fishery is also an important agricultural commodity which is as well dominated by small fishermen. The important fish produced by small fishermen are shrimp and prawn, milk fish, tuna and skip jack.

Table A.6.4 shows the production of major crops in the country. The relatively high rate of growth in agricultural production during the period from 1983 to 1990 was largely due to record paddy production which increased at an annual rate of 3.2% and to reach from the level of 37.5 million (1983-1985) to 43.9 million tons/year (1988-1990). This excellent production performance was attributable to almost all the major factors of the production which jointly influenced; i.e., favourable weather, expanded and improved irrigation facilities, introduction of high yielding varieties along with the supply of fertilizers and other related farm inputs stimulated by other better farming practices. Cash crops such as rubber, palm oil, coconuts, and coffee are major export crops. The exports of rubber and coffee are particularly important.

Paddy is the most important crop as the staple food of Indonesia and the Government's efforts have went into increasing its production. Owing chiefly to the expansion of irrigated paddy field and the increased use of improved high yielding varieties and fertilizers through the crop intensification programme, paddy production has increased at rate of about 3% per annum on average over the past 7 years from 1983 to 1990, as mentioned above. However, the recent paddy production from 1991 shows downward trend. According to the JICA study team[4], they have estimated the demand and supply of paddy in the future as shown below. The details are shown in Table A.6.5.

Demand and Supply Forecast for Paddy

| | | 1993 | 1998 | 2003 | 2008 |
|---|---|---|---|---|---|
| 1) Supply | ($10^6$ tons) | 47.3 | 51.3 | 53.4 | 54.1 |
| Annual Growth Rate | (%) | | 1.6 | 0.8 | 0.3 |
| 2) Demand | ($10^6$ tons) | 48.7 | 53.7 | 58.1 | 61.9 |
| 3) Balance | ($10^6$ tons) | -1.4 | -2.4 | -4.6 | -7.8 |

Source: The Study for Formulation of Irrigation Development Program in the Republic of Indonesia, JICA, August 1993.

A result indicate that the Indonesia will increase annual domestic demand over its paddy production by about 4.6 million tons in 2003 and 7.8 million tons in 2008. Unless the paddy production will increased, the commutative paddy deficit from 2003 to 2008 will exceed 30 million tons. It may be said that the increase in paddy production through continuous expansion of irrigation area and powerful extension of crop intensification programs will be necessary to meet the domestic demand increasing along with population growth.

[4]The Study for Formulation of Irrigation Development programme in the Republic of Indonesia, JICA, August, 1993.

## 2.2 Regional Socio-Economy

### 2.2.1 Land and Population

The South Sulawesi Province is located in the southern part of Sulawesi island, and has an area of 62,480 $km^2$. The total population in 1992 was estimated at about 7.18 million with population growth of 1.4% on an average from 1987 to 1992 (see Table A.6.3). The population density was about 115/$km^2$ in 1992. In 1991, the economically active population in the province was estimated to be 2.58 million, and unemployment rate was 2.7% which is almost same with the average rate of the whole country.

### 2.2.2 Regional Economy

The Gross Regional Domestic Product (GRDP) in South Sulawesi Province is Rp. 5,282 billion in 1991 at current market prices. This amount of GRDP accounts for about 2.3% of Indonesia's GDP, while the provincial population accounts for 3.9% of Indonesia's total population. The per capita GDP in the province is about Rp. 0.75 million or US$ 383 which is only about 60% of that of the Indonesian average. GRDP in real terms increased with the rate of 9% p.a. during the past four years from 1987 to 1991. The agriculture sector accounts for about 42% of GRDP followed by 19% for the trade (wholesales and retail trade and restaurants) sector and 8% for the manufacturing sector.

### 2.2.3 Agriculture in South Sulawesi Province

The agriculture sector is the largest economic sector in South Sulawesi province. The sector contributes about 42% of the provincial GRDP and provides employment to more than 60% of the labour force. Food crops account for 42% of agricultural GRDP followed by fisheries (20%), non-food crops (13%) and Livestock (10%). The share of fisheries sub-sector is considerably large in the provincial GRDP comparing with that in the Indonesia's GDP, while the shares of estate crops and forestry are smaller.

Table A.6.6 shows the crop production in South Sulawesi Province from 1988 to 1992. In the provincial agriculture sector, paddy is the most important commodity. Paddy harvested area is about 856,000 ha or nearly 60% of the total harvested area of major annual crops in the province in 1992. Paddy production reached to 4.34 million tons with a growth rate of 6.5% during 1982 - 1992 period. According to the results of recent study made on rice supply and demand balance in each province (The Study for Formulation of Irrigation Development Program in the Republic of Indonesia: FIDP, 1993, JICA), rice surplus of South Sulawesi Province is about 643,000 tons (989,000 tons in paddy equivalent) in 1990. These figures show that about 23% of paddy production in the province is transported to other rice deficit provinces to fill the rice demand of population.

The role of South Sulawesi Province in supplying of rice to other provinces would become more important in the future. Again according to the FIDP study, 100,500 ha of new irrigation system development is proposed in South Sulawesi Province during Repelita VI - VIII (1994/95 - 2008/09) period to maintain the self-sufficiency in rice in Indonesia as shown below:

Target Development Area for Paddy Production in South Sulawesi Province

(Unit: 1,000ha)

| | Repelita VI | Repelita VII | Repelita VIII | Repelita IX | Total |
|---|---|---|---|---|---|
| New Construction | 12.5 | 53.8 | 34.2 | - | 100.5 |
| Extension | 0.2 | 2.5 | - | - | 2.7 |
| Rehabilitation | 15.2 | - | - | - | 15.2 |
| Ground water | 2.5 | 3.0 | 3.0 | 2.0 | 10.5 |
| Small Scale | 37.5 | 37.5 | - | - | 75 |

Remarks: Repelita VI (1994/95-1998/99), Repelita VII (1999/00 - 2003/04), Repelita VIII (2004/05 - 2008/09), Repelita IX (2009/10 - 2013/14)

## 2.3 Agricultural Development Policy in the Fifth and Sixth Five Year Development Plans

The Government's major objectives for the agriculture sector during the sixth five-year development (Repelita VI; 1994/95 - 1998/99) period are to:

1) sustain the established self-sufficiency of food to meet domestic requirements, increase diversification of products and improve quality of production,
2) increase production meeting the needs of industry and expanding agricultural exports,
3) increase farmers' incomes and living standards and expand the employment and business opportunities,
4) promote a more balanced distribution of economic opportunities, regional development, land settlement and land development including rational planning of land development to keep the prime agricultural land in the future infrastructure and industry development, and
5) contribute to the health and better nutritional status of the population through diversification of types of foodstuff.

For the irrigation sub-sector development, major objectives during Repelita VI are to:

1) expand the irrigation schemes so as to get a more balanced water use and ensure the water conservation, protect the production areas and prevent devastation of floods and drought, and to support the utilization of new agricultural fields,
2) increase irrigated agriculture so as to maintain the water resources and irrigation schemes.
3) promote a more harmonized development in coordination with other water-consuming-sectors such as settlement and industry, river maintenance, hydro-electric power and tourism.
4) strengthen maintenance and rehabilitation in the irrigation schemes through heightening of farmers ability and participation.

# 3. PRESENT CONDITION IN THE STUDY AREA

## 3.1 Population and Labor Force

The study area comes under Kabupaten (District) Wajo, South Sulawesi Province and extends over three Kecamatan (Sub-district), i.e. Sajoanging, Majauleng and Maniangpajo. In the Study area, there are 19 Desa (village) comprising nine (9) Desa in Kec. Sajoanging, five (5) Desa in Kec. Majauleng and another five (5) Desa in Kec. Maniangpajo. These 19 Desa involved in the study area are listed in Table A.6.7.

The population in the 19 Desa is about 53,400 within the total territory of 531 km$^2$ in 1992. An average population density is estimated to be 101 persons/km$^2$ ranging from 28 persons/km$^2$ in Desa Paselloreng in Kec. Maniangpajo to 248 persons/km$^2$ in Desa Rumpia in Majauleng. The population growth in the related three Kecamatens shows negative figures of -1.39% p.a. on an average during 1988-1992 period (-2.19% in Kec. Sajoanging, -3.66% in Kec. Majauleng and 2.73% in Kec. Maniangpajo). The total households in the study area are about 11,000. Average family size is 4.86 persons of which 2.85 persons or about 58% are estimated to be workable population. The demographic conditions in 19 Desas related to the study area are presented in Table A.6.8.

The figures mentioned in the above include all of the occupation. On the other hand, from the result of the Household Survey which was carried out to only farmers, the farmers' population in the study area in 1994 was estimated to be about 33,000 persons with 6,400 households, as shown below.

Demographic Conditions in the Study Area

| | | | |
|---|---|---|---|
| 1) | Gross study area | (ha) | 25,300 |
| 2) | Total paddy field*1 | (ha) | 15,000 |
| 3) | Average holding size of paddy field | (ha/household) | 2.34 |
| 4) | Number of farm household | (household) | 6,400 |
| 5) | Average family size | (person/household) | 5.14 |
| 6) | Number of farm population | (person) | 33,000 |
| 7) | Age distribution | | |
| | 65 and over | (%) | 2.6 |
| | 50 - 64 | (%) | 12.9 |
| | 15 - 49 | (%) | 53.1 |
| | 0 - 14 | (%) | 31.4 |
| | Total | (%) | 100.0 |
| 8) | Labor force per a household*2 | (person/household) | 3.1 |

*1 Gross paddy field x 95% = 15,800 HA X 0.95 = 15,000 ha (excluding roads etc.)

*2 Average family size x (age distribution between 15 and 49 + 50% of age distribution between 50 and 60) = 5.14 persons x (53.1% + 6.5%) = 3.1 persons/household

The average size of family averages 5.14 persons per household. As for the age distribution, 31.4 % of total population are fourteen (14) years old and under, and only 2.6 % are sixty five (65) years old and over. The family labour force per a farm household was estimated to be 3.1 persons.

## 3.2 Land Holding and Land Tenure

From the result of the household survey, the average land holding size in the study area is estimated at 2.95 ha, out of which paddy field accounts for 2.34 ha. This average size is larger than that of Kab. Wajo (2.33 ha) and the whole province (1.34 ha).

| | | Own (ha) | Rented-In (ha) | Rented-Out (ha) | Net Holding (ha) |
|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (1)+(2)-(3) |
| 1) | Irrigated sawah | - | - | - | - |
| 2) | Rainfed Sawah | 1.27 | 1.27 | 0.20 | 2.34 |
| 3) | Upland | 0.04 | - | - | 0.04 |
| 4) | Tree crops land | 0.38 | 0.01 | - | 0.38 |
| 5) | Grass land | 0.07 | - | - | 0.07 |
| 6) | Others | 0.14 | 0.01 | 0.04 | 0.11 |
| | Total | 1.90 | 1.29 | 0.24 | 2.95 |

The survey result indicates that a half of paddy fields is cultivated by tenant farmer, while almost all upland and tree crops lands are managed by owner farmers.

## 3.3 Cropping Pattern and Farming Practices

### 3.3.1 Cropping Pattern

Cropping seasons prevailing in the study area are divided into two, i.e. wet season cropping and dry season cropping. Cropping patterns are largely influenced by the availability of water and those commonly differ among land use categories as follows:

1) Rainfed paddy field
   a) Single cropping of paddy
   b) Paddy - Palawija
2) Irrigated Paddy Field (pump irrigation schemes)
   a) Paddy - Paddy
3) Upland Field
   a) Single cropping of Palawija

Cultivation of paddy is predominant in the wet season in the paddy fields. Nearly 100% of wet season paddy is cultivated under rainfed conditions even in the pump irrigation schemes. Palawija crops usually grown in the dry season, although the area extent is small. Major palawija crops in the study area are groundnuts, mungbeans, maize and soybeans. In the upland field, palawija crops are cultivated both in the wet and dry seasons.

The present cropping patterns in the paddy fields (15,000 ha in net)[5] in the study area are illustrated in Figure A.6.1 based on data and information obtained from the agricultural services in Kab. Wajo and related three Kecamatans and farmers. As seen in the figure, three types of cropping patterns are commonly practiced in the study area. The extent of these cropping patterns is estimated as follows:

| | | | |
|---|---|---|---|
| Type I | : | Single cropping of Paddy | 12,340 ha |
| Type II | : | Paddy - Paddy | 480 ha |
| Type III | : | Paddy - Palawija | 1,430 ha |
| | | Total | 14,250 ha |

Note: An assumed 5% of damaged area due to drought, flood and pest/diseases are deducted from the above figures.

The cropping area in the paddy field in the study area is thus calculated as follows:

| | |
|---|---|
| 1) Wet season paddy | 14,250 ha |
| 2) Dry season paddy | 480 ha |
| 3) Dry season palawija | 1,430 ha |
| Total | 16,160 ha |
| (Multi-cropping intensity: 113%) | |

### 3.3.2 Farming Practices

Based on the data from Kabupaten and Kecamatan Agricultural Services, BPP offices and the household survey, farm input level is estimated both for paddy and palawija as shown in the

[5] Gross paddy field x 95% = 15,800 ha x 0.95 = 15,000 ha (excluding roads etc.)

following table.

Farm Inputs per Ha for Paddy and Palawija

| | | Paddy | | | | | |
|---|---|---|---|---|---|---|---|
| | | Wet*1 | Dry*2 | Maize | Mung-beans | Soy-beans | Ground-nuts |
| 1) Seed | (kg) | 30 | 30 | 20 | 20 | 40 | 120 |
| 2) Fertilizers | | | | | | | |
| - Urea | (kg) | 183 | 183 | - | - | 25 | 40 |
| - TSP | (kg) | 32 | 32 | - | - | 100 | 60 |
| - KCl | (kg) | 3 | 3 | - | - | 25 | - |
| - ZA | (kg) | 54 | 54 | - | - | - | - |
| 3) Agro-chemicals*3 | | | | | | | |
| - Liquid type | (lit.) | 0.48 | 0.48 | - | - | 1.5 | - |
| - Powder type | (kg) | 1.1 | 1.1 | - | - | - | - |
| 4) Labor | (man-day) | | | | | | |
| - Family Labour | | 57.3 | 60.3 | 76.0 | 36.0 | 45.0 | 49.0 |
| - Hired Labour | | 24.9 | 24.9 | - | 19.6 | 24.5 | 32.0 |
| 6) Animal Power | (day) | 2.04 | 2.04 | 4.35 | 5.22 | 5.22 | 12.43 |
| 7) Mech. Power | (day) | 2.03 | 2.03 | - | - | - | - |

*1 Rainfed paddy *2 Irrigated by pump *3 Mainly insecticides
Source: 1) Household Survey, JICA Study Team, 1994
2) Laporan Analisa Usahatani Padi, Palawija dan Hortikultura 1993/94, Dinas Pertanian tanaman Pangan, Propinsi Sulawesi Sulatan.

Farm inputs for paddy are examined to be advanced with the application of considerable amounts of fertilizers and agro-chemicals. Input supplies for palawija cultivation are generally small compared with those for paddy, except for vegetable cultivation. Typical farming practices in the study area are given below.

(1) Paddy

The improved variety of PB 42 has been widely introduced throughout the area, and it is now dominant in the study area making up almost all of the planted area. Local varieties are still cultivated mainly for home consumption and local marketing. These varieties are selected from the last harvest or supplied from PT. PERTANI.

Paddy seeds are generally sown at rate of 25 to 30 kg per ha in the nursery which is prepared in the size of 1/20 to 1/25 the paddy field to be transplanted. Seedlings of improved varieties as well as those of local varieties are transplanted when 20-25 days old. Transplanting is carried out by hand, and the number of hills for transplanting is 20/$m^2$. The land preparation, plowing and paddling is carried out before transplanting using both animal and mechanical powers.

The fertilizers being used in the study area are urea, triple superphosphate (TSP) and ammonium sulphate (ZA). The average dosages are 183kg, 32kg and 54kg per hectare, respectively. A little potassium chloride (KCl) is commonly used among the farmers. All TSP and a half of urea and ZA are supplied as a basal dressing two to three days before transplanting, and the remaining fertilizers are as a top dressing 30-40 days after transplanting. Weed control is effectively carried out manually on two to three occasions per crop. Spraying of insecticides by knapsack type sprayer is common practice, and its dosage averages 0.48 lit./ha.

Harvesting is mostly carried out by using sickles for improved varieties and ani-ani for local varieties. The harvested paddy is immediately threshed, and is dried mainly at home yards. Exchange of labour among the farmers is common for transplanting, and harvesting is carried out under contract base. Part of land preparation have been carried out by machine. These days extension of mechanical plowing is remarkable, instated of animal power.

Transportation of harvested paddy from field to home yard is one of the farming problems because of no farm road. A lot of farmers' effort has been paid to its transportation with a considerable amount of cost which is estimated to be Rp.13,000/ton.

(2) Palawija and Vegetables

A wide range of palawija crops is grown in the study area. Soybean is the second most important crop and others are mungbeans and groundnuts. Maize and string beans are also cultivated in limited area. These palawija crops are cultivated mainly in the paddy field after wet season paddy.

No or one plowing is common, and seeding is done manually by using a stick. Seed rate ranges between 20 and 40 kg/ha. Urea and TSP are supplied for soybean and groundnuts, and no fertilizer is common for mungbeans and maize cultivation. The dosage of insecticides is estimated to be 1.5 lit./ha soybeans, and almost no spraying of herbicides is common practices for other palawija crops. Two to three times of weeding are carried out by hand. Harvesting is carried out manually, and processing and drying are done at home yards.

## 3.4 Agricultural Production

The study on the present crop yields was made based on the data and information collected from Statistic Office of Kab. Wajo, Kabupaten Agriculture Services and the Household Survey in 1994. The data of former two offices are shown in Tables A.6.9 and A.6.10. Crop yield levels from different data sources are summarised as follows:

(Unit: ton/ha)

| | Kab. Data *1 | Kec. Data *2 | HHS *3 |
|---|---|---|---|
| 1) Paddy | 3.81 | 4.80 | 3.00 |
| 2) Maize | 2.00 | 2.02 | 1.30 |
| 3) Cassava | 11.17 | 10.86 | n.a |
| 4) Sweet potatoes | 6.78 | 6.56 | n.a |
| 5) Groundnuts | 1.58 | 1.99 | 1.10 |
| 6) Mungbeans | 0.90 | 0.83 | 0.80 |
| 7) Soybeans | 1.35 | 1.96 | 0.90 |

Note: *1: 5 years average of Kab. Wajo for 1988-1992 period (see Table A.6.9)
*2: 5 Average of the three Kecamatans 1988-1992 period (see Table A.6.10)
*3: Household Survey, JICA Study Team, 1994.

The result of Household Survey which was carried to 250 samples indicates lower yields as compared with that of data obtained from the Statistic Office and Kabupaten Agriculture Services. The data of these offices are the result of crop cutting surveys. In the data, non-sampling error (sampling bias) on the selection of target plots/points for the survey is considered to be involved and optimistic estimation of yields might have been resulted. The present crop yields and production in the study area were therefore estimated on the basis of the Household Survey, as shown below.

Crop Production in the Study Area

| | Harvested Area (ha) | Yields (ton/ha) | Production (ton) |
|---|---|---|---|
| 1) Wet season paddy | 14,250 | 3.0 | 42,800 |
| 2) Dry season paddy | 480 | 4.0 | 1,920 |
| 3) Palawija*1 | 1,430 | 0.9 | 1,300 |

*1 Average yield of groundnuts, mungbeans and soybeans.

Crop production in the study area has often suffered serious damage from drought. For instance, the drought in 1992-1993 inflicted considerable damage on the paddy cultivation in three Kecamatans related to the study area, as shown in Table A.6.11. About 20% of total planted area was not harvested due to drought damage. Palawija crops have also sustained a great deal of damage from drought.

## 3.5 Livestock Raising

The livestock grazed in the study area are cattle, water buffaloes, goats, sheep, chicken, and ducks. These numbers in the study area are summarized as follows.

Raising Head of Livestock

| Livestock | Head per Farm Household |
|---|---|
| Cattle | 0.31 |
| Water Buffaloes | 0.67 |
| Caw | 0.44 |
| Horses | 0.25 |
| Goats/Sheep | 0.14 |
| Chicken | 9.11 |

Source: Household Survey, JICA Study Team, 1994.
Agricultural Census 1993, Statistical Office, Kab. Wajo

Livestock raising in the study area is not a mainline of agricultural activity, and most livestock are grazed on a small scale in and around the farm land and home yard, except for one private company[6]. Annual income derived from livestock raising is of little significance to the farm economy. As far as livestock raising in the area is concerned, however, it plays an important role not only in farm operation but also in protein food supplies for local people. The cattle and water buffaloes are usually utilized as motive power in land preparation, and live goads, sheep, chicken and eggs are sold in the local markets or used for home consumption. In addition to the above livestock, horses have also been raised by both farmers and non-farmers, and utilized as an important transportation measure of farm products.

## 3.6 Crop Budget and Farm Economy

### 3.6.1 Crop Budget

In order to grasp the profitability of crops at present, crop budget analyses for each crop grown in the study area were made on the basis of data obtained from agricultural offices and the Household Survey. The result of analyses is summarized as follows, and the details are presented in Table A.6.12.

(Unit: Rp.1,000/ha)

| Crops | Gross Income | Production Cost | Net Return |
|---|---|---|---|
| Wet season paddy*1 | 960 | 700 | 260 |
| Dry season paddy*2 | 1,280 | 774 | 506 |
| Maize | 500 | 383 | 117 |
| Mungbeans | 552 | 339 | 213 |
| Soybeans | 855 | 512 | 343 |
| Groundnuts | 1,100 | 857 | 243 |

*1 Rainfed paddy *2 Pump irrigation.
Note: 1) Land rent is excluded from this analysis.
2) Net returns indicate financial value and not economic value.

The paddy cultivation irrigated by pump shows a good return as compared with that of rainfed paddy. It means that irrigation has a noticeable effect to increase net return of paddy. The soybean has also a good return. These days this cultivation accounts for a half of palawija area.

6 PT. BMT (Bina Mulia Ternak) is now raising about 3,000 heads of cattle in the hilly and mounten areas in Kecamatan Maniangpajo, but its period is only in the wet season and raising density per ha is very low.

### 3.6.2 Farm Economy

The living standard of farmers in the study area is analyzed as follows, based on the Household Survey. The details are shown in Table A.6.13. The result indicate farm budget of a typical farmer having average holding size of paddy field of 2.34 ha.

(Unit: Rp.1,000)

| Item | Rainfed Area | Pump Irrigation Area |
|---|---|---|
| 1) Gross Income | 3,037 | 5,840 |
| - Farm Income | 2,624 | 5,427 |
| Paddy | 2,246 | 5,241 |
| Palawija | 192 | - |
| Perennial crops | 186 | 186 |
| - Off-farm Income | 237 | 237 |
| - Others | 176 | 176 |
| 2) Gross Outgoing | 2,804 | 4,348 |
| - Production Cost | 1,564 | 3,108 |
| - Living Expenses | 1,237 | 1,237 |
| Food | 718 | 718 |
| Other than food | 519 | 519 |
| - Loan Repayment | 3 | 3 |
| 3) Net Reserve | 233 | 1,492 |

As the result of analysis, the characteristics of farmers' economy in the study area may be summarized as follows:

1) More than 70% of the gross income are derived from paddy production, and source from upland perennial crop productions is limited.
2) Four (4) to eight (8) % of the gross income is derived from off-farm income consisting of wages earned from non-farm activities, remittance from families working in urban areas or in other rural areas, etc.
3) The food expenses amount to 58% of total living expenses.
4) The net reserve of rainfed farmers is negligible small, while farmers having pump irrigation system have a good balance over Rp.1.5 million per annum.

Overall, it may be concluded that farmers' economy in the study area remains at the subsistence level and the farmers under the rainfed farming have no or a little re-investment funds for improvement of their farming activities by themselves.

## 3.7 Marketing and Prices

### 3.7.1 Overview

Paddy is the most important marketing crop in South Sulawesi Province as well as in the study area. According to the result of JICA study made on supply and demand balance of rice (the study for FIDP in 1993), annual amount of surplus in South Sulawesi Province is about 643,000 tons in 1990, and this amount of surplus takes the third place among 82 provinces in Indonesia as shown below:

The Highest Five Rice Supplying Provinces in Indonesia (1990)
(Unit: tons)

| | Province | Supply | Demand | Balance |
|---|---|---|---|---|
| 1) | Central Java | 4,602,966 | 3,685,214 | 917,752 |
| 2) | East Java | 4,824,854 | 3,929,310 | 895,544 |
| 3) | South Sulawesi | 1,835,312 | 1,192,315 | 642,997 |
| 4) | West Sumatra | 964,361 | 745,351 | 219,010 |
| 5) | South Kalimantan | 575,468 | 399,409 | 176,059 |

Source: FIDP report, 1993

Further in the same JICA study, the flow of rice marketing by sea cargo inside Indonesia is examined as seen in the following table. Although inland transportation is not expressed, dynamics of rice flow among islands is largely grasped by reading the table. The amount of net export from Sulawesi island is about 273,000 tons, and only South Sulawesi Province has a positive balance among four provinces in Sulawesi island.

Loading and Unloading of Rice at Ports in Indonesia (1988-90 average)
(Unit: tons)

| Island/Province | Loading | Unloading | Balance |
|---|---|---|---|
| Sumatra | 54,871 | 617,247 | -562,376 |
| Java | 905,719 | 119,882 | 785,837 |
| Bali, NT & Timim | 65,901 | 116,739 | -50,838 |
| Kalimantan | 5,415 | 460,664 | -455,249 |
| Sulawesi | 368,113 | 95,413 | 272,700 |
| - North Sulawesi | (11,849) | (61,554) | (-49,706) |
| - Central Sulawesi | (4,984) | (12,244) | (-7,260) |
| - South Sulawesi | (350,791) | (3,912) | (346,879) |
| - S.E. Sulawesi | (488) | (17,702) | (-17,214) |
| Maluku & IJ | 10,902 | 93,229 | -82,327 |
| Indonesia | 1,410,920 | 1,503,173 | -92,253 |

Source: FIDP report, 1993

Rice surplus from South Sulawesi is transported to other rice deficit provinces and playing an important role in fulfilling their local demands. Major provinces receiving rice from South Sulawesi Province are Jakarta, East Kalimantan, West Kalimantan and other provinces in Sulawesi island according to data from DOLOG South Sulawesi as shown in Table A.6.14.

### 3.7.2 Marketing of Agricultural Products

The institutional framework for implementing intervention in the market of food crops with objectives of fostering production and expanding farm incomes comprises of BULOG (National Logistics Agency) at national level and DOLOG (Regional Logistics Deport) at provincial level. Under the DOLOG, Sub-DOLOG at Kabupaten level is supposed to purchase selected food crops including paddy/rice, soybeans and maize in the producing areas providing storage facilities for collection. Under the marketing system of DOLOG, KUDs play an important role as village collection centers.

Among 23 Kabupaten in South Sulawesi Province, Kab. Wajo produces the second highest rice surplus of about 144,300 tons (about 222,000 tons of paddy) after Kab. Sidrap as seen in Table A.6.15. There are three channels in paddy/rice marketing from farmers to consumers as shown in Figure A.6.2. The surplus from farmers is sold to KUDs and/or middle men through brokers. The paddy collected by KUDs is sold to Sub-DOLOG usually after milling, while the paddy collected by middle men is generally transported to outside of the Kabupaten, mainly to Ujung Pandang and Pare Pare. Most of surplus is marketed through these two channels. Small amount of surplus is sold at local markets in and around the study area by small brokers and/or directly by farmers. According to data from Sub-DOLOG in Kab. Wajo, collection made by KUDs-DOLOG line in Kab. Wajo is about 15,500 tons (in terms of rice) or about

11% of the Kabupaten's surplus. The marketing of products produced in the study area is summarized as follows.

(Unit: %)

| | Paddy | Palawija | Vegetables |
|---|---|---|---|
| KUD | 1.2 | - | - |
| Brokers | 95.6 | 66.4 | 1.6 |
| Local Market | 2.4 | 10.7 | 7.2 |
| Others | - | - | 0.4 |
| No Sale | 0.8 | 22.9 | 90.8 |

Sources: Household Survey, JICA Study Team, 1994.

Almost all surplus paddy and about 70% of palawija crops produced in the study area are handled by brokers. KUDs have stagnate marketing activities. This is attributable mainly to credit problem, and BRI has stopped KUT which is financial source of KUDs for handling of paddy. As for the palawija crops, although the production in the area is not so big at present, its marketing system is already settled. Vegetables are consumed by farmers and the surplus products are sold to local market either by the farmers themselves or through brokers in order to get cash incomes.

### 3.7.3 Distribution of Farm Inputs

There are two companies for supplying farm inputs. One is the PT. PERTANI (PERSERO) and another is PT. PUSRI. The former handle all of farm inputs including seeds, fertilizers and agro-chemicals, while the latter is fertilizers only. The PT. PERTANI has a branch office at Sereang, Kabupaten Sidrap and a branch office of PT. PUSRI locates at Sengkang, Kabupaten Wajo. The farm inputs supply in the project area is covered by these two branch offices.

Distribution of the inputs to the farmers is done through Kiosk of KUD or distributors located in rural areas. The farmers can purchase these farm inputs from KUD or distributors. Presently, no serious constraints for farm input supply exist in the project area in general. The input supply is usually depend on self-financing of farmers. Input supply under credit of intensification program is not common in the province.

As for seed supply, the Food Crop Agricultural Service Office (see Fig A.6.4) has also supplied to the farmers, and all seeds handled by this agency are marketed through the extension system. The farmers who want to have seeds contact at first with PPL or directly BPP (regional extension office). The agricultural service offices at Kabupaten level collect those orders and arrange its supply. In South Sulawesi Province, there is a seed center located at Maros, and this center is responsible for those production.

### 3.7.4 Prices of Farm Inputs and Outputs

Market prices of major crops are estimated on the basis of the data obtained from the Agricultural Offices, the Statistic Offices, Kab. Wajo and the household survey. These prices are as shown in Table A.6.16, together with prices of farm inputs.

As the Government agency, DOLOG is responsible for price stabilization of rice and principal palawija in the market. DOLOG generally purchases these crops when the market price fall below the floor price, and when the price is over the ceiling price, DOLOG sells its stock. At present, DOLOG in Kabupaten Wajo has controlled only price of rice.

## 3.8 Processing and Storage Facilities

The processing and storage facilities for paddy/rice are fairly well arranged in Kab. Wajo as

well as in the study area. The number of rice mills in Kab. Wajo is 350 of which 88 are located in the study area as shown in Table A.6.17. About 95% of mills are private ones both in Kab. Wajo and study area, and KUDs operates only the remaining 5% of mills. The total milling capacity is estimated at about 357,700 tons in Kab. Wajo and 77,700 tons in the study area as shown below:

Rice Milling Capacity in the Study Area and Kab. Wajo (1992)

| | Study Area | | | Kab. Wajo | | |
|---|---|---|---|---|---|---|
| | (No.) | (ton/day) | (ton/Yr) | (No.) | (ton/day) | (ton/Yr) |
| KUD | 4 | 25 | 7,300 | 18 | 63 | 18,396 |
| Private | 84 | 242 | 70,664 | 332 | 1,162 | 339,304 |
| Total | 88 | 266 | 77,672 | 350 | 1,225 | 357,700 |

Note: 292 days of annual operation days are assumed for estimate of annual milling capacity.

Since annual paddy production in Kab. Wajo is about 355,000 tons on an average in recent five years, the above estimated milling capacity is assessed to be sufficient and possible to mill all the paddy production in Kab. Wajo.

Storage capacity of the existing warehouses is 35,000 tons in the study area and 130,500 tons in Kabupaten Wajo, as shown in Table A.6.17. These available capacities are assesed comparing with the required storage capacity for wet season paddy which production requires peak storage capacity.

Present Storage Capacity Comparing Required Storage Capacity

| | | Study Area | Kab. Wajo |
|---|---|---|---|
| 1. Existing Storage Capacity | (ton) | 35,000 | 130,500 |
| 2. Marketable Surplus | | | |
| a) Wet season production | (ton) | 42,800 | 305,300 |
| b) Farm population | (Pm) | 33,000 | 269,500 |
| b) Per capita consumption *1 | (kg) | 242 | 242 |
| d) Total consumtion | (ton) | 8,000 | 8,000 |
| e) Marketable surplus | (ton) | 34,800 | 24,100 |
| 3. Required Storage Capacity | | | |
| a) Marketable surplus | (ton) | 34,800 | 24,100 |
| b) Period for collection | (day) | 45 | 60 |
| c) Period for shipping | (day) | 120 | 120 |
| d) Required capacity*2 | (ton) | 21,800 | 120,000 |
| 4. Balance (1-3.d) | (ton) | 13,200 | 10,500 |
| (1/3.d x 100) | (%) | 160.6 | 108.8 |

*1 Assuming that farmers keep their paddy for their annual home consumption including use for seeds and losses.
*2 (3.a / 3.b)-(3.a / 3.c) x 3.b

As seen in the table above, the existing storage capacity in the study area is sufficient to store all the marketing surplus and is about 1.6 times larger than the present required capacity. In kabupaten Wajo, the existing capcity is about 9 % larger than the present required capacity. warehouses.

## 3.9 Fishery

Preliminary examination on fish culture has been made following the request of DGWRD, although this is out of scope of the study and no fishery expert is assigned to the JICA Study Team. The objective of examination at this interim report stage is to clarify the present status of fish culture in brackish water pond which is extended over the downstream of the Gilirang

river. Further examination will be made in the second stage study so as to estimate water requirement for the existing fish culture in brackish water pond.

As given in Table A.6.18, fish culture in brackish water pond is the most important fishery sub-sector in 3 Kecamatan related to the study area, and accounts for about 81% of total production value of the fishery sector. In terms of per capita production value, brackish water pond accounts for Rp. 0.98 million followed by marine fishery (Rp. 0.16 million) in 3 Kecamatan related to the study area.

Brackish water pond extends along the coast of Bay of Bone. As shown in Table A.6.19, its total area is about 4,385 ha in Kec. Sajoanging which only has coast among 3 Kecamatan related to the study area. Production from brackish water pond is about 4,750 tons with 1.08 tons/ha of unit yield in 1992. This amount of production accounts for 43% of the total production in Kab. Wajo and 4.6% in that of South Sulawesi Province. During 1988-1992 period, annual increase of area, production and unit yield is calculated at 6.3%, 12.4% and 0.9%, respectively. The number of brackish water pond establishments (or fish farmers) in 1992 is about 580 with a small annual increase of 2.7% during 1988-1992 period. On an average in 1992, production value per establishment is estimated at Rp. 22.6 million in brackish water pond sub-sector.

According to the information from the fishery services of Kab. Wajo, major species cultivated in brackish water pond are milk fish and shrimp (black tiger). Mixed cropping of these two species is common practice under extensive farming. Double cropping is also common; the first season is from April to September, and the second season is from October to March. Damage is sometimes done to the fish culture in the brackish water pond due mainly to high temperature of water and high density of sea water. According to the information from fish farmers, no production is performed in two crop seasons among five crop seasons on an average. Fresh water from rivers is essential to the shrimp farming, but not so important for the milk fish farming.

## 3.10 Agricultural Support Services

### 3.10.1 Institutional Structure for Agricultural Development

Agriculture development has long been the priority government policy in Indonesia and number of government and non-government institutions have been organized to support the development at various administrative levels. The institutional structure of supporting system for food crop agriculture development is established placing the BIMAS as the central coordination institution as shown in Figure A.6.3.

The other key agencies for agricultural development in the province are Provincial and Kabupaten Food Crop Agricultural Service Offices (DINAS). The Provincial Office comprises of an administration section and seven subdivisions (Sub-DINAS) of planning, food crop production, horticulture crop production, farm management, plant protection, extension and aerial development. The organizational structure of the Provincial Food Crop Agricultural Service Office is illustrated in Figure A.6.4.

### 3.10.2 Mass Guidance Agricultural Intensification Programme (BIMAS Program)

BIMAS Program is of the strongest administrative supporting services for agricultural development in Indonesia. The objectives of the program are to accelerate agricultural development through the establishment of group guidance program. Since the first trial of BIMAS Program was implemented, the program has been steadily developed in the whole country and the program itself has been modified and improved year by year. The latest program is the super group guidance intensification program called SUPRA INSUS Program

implemented in the selected provinces since 1987. The introduction of the SUPRA INSUS Program to the South Sulawesi was commenced in 1987.

BIMAS Program presently implemented in South Sulawesi is SUPRA INSUS, INSUS and INMUM. The objective crops of the program include paddy, palawija crop and vegetables, however, priority crops at present are paddy, maize and soybeans. SUPRA INSUS is applied for the unit of a number of farmer groups in the same irrigation system with areas of 15,000 to 35,000 ha. INSUS is a program for a farmer group and INMUM is for individual farmers.

For successful implementation of the BIMAS Program, BIMAS Committee chaired by Governor and BIMAS Daily Executive Committee chaired by chief of regional agricultural office are organized at provincial. At Kabupaten, Kecamatan and village level, BIMAS coordination committees chaired by head of respective administration unit is also organized for strong support for the implementation of BIMAS Program.

### 3.10.3 Agricultural Research

The agricultural research in Indonesia is organized under the Agency for Agricultural Research and Development (AARD). Under the Agency, research activities on food crops are undertaken by six research institutes coordinated by the Central Research Institute for Food Crops (CRIFC, Pusat Penylitian Tanaman Pangan) in Bogor and research on horticulture crops is centralised and carried out by the Lembang Horticulture Research Institute (LEHRI) in Lembang, West Java. The research on industrial or estate crops is coordinate by the Research and Development Centre for Industrial Crops (RDCIC) in Bogor.

Each research institute on food crops has a national mandate for the research and development of specific commodities or land types as follows;

| Research Institute/Location | Major activities |
|---|---|
| 1) Bogor Research Institute/W.Java (BORIF) | - Fundamental research |
| 2) Sukamandi Research Institute/W.Java (SURIF) | - Wetland crops (mainly rice) |
| 3) Malang Research Institute/E.Java (MARIF) | - Secondary crops (palawija crops) |
| 4) Sukaramai Research Institute/W.Sutra. (SARIF) | - Rainfed crops (in moist climate) |
| 5) Maros Research Institute/ S.Sulawesi (MARIF) | - Rainfed crops (in dry climate) |
| 6) Banjarbaru Research Institute/S. Kali. (BARIF) | - Tidal swamp |

Agricultural research in South Sulawesi Province is covered by the Maros Research Institute located about 40 km north from Ujung Pandang. The main activities are to execute experimental work under the instruction and supervision of CRIFC, and to collect information from extension services on the technical problems associated with the farming practices of local farmers.

The technology development by the research institute is formulated into "packages" of improved technology and envisaged to be transferred to extension service through Food Crop Agricultural Service Offices and Estate Crop Service Office of different levels. The extension services then transfer the package technology to farmer levels through guidance to key farmers. However, in the present technical research and development system, all the results obtained through research activities in the province are firstly reported to the central institute and considerable time is required for the findings to reach extension service levels.

The establishment of system to strengthening relation between research-oriented institutions and production-oriented institutions is to be examined, in which solutions or technical guidance identified through research activities to problems encountered in fields are immediately transferred to farmer levels. Therefore, the strengthening of access to research organization by the agencies concerned with technical guidance and extension service is to be envisaged.

### 3.10.4 Extension Services

One of the strongest supporting arm for implementation of BIMAS Program is agricultural extension service. Agricultural extension service in Indonesia is supported by the central government, Ministry of Agriculture. Budget and personal management of extension service in the whole Indonesia are carried out under the responsibility of the Secretariat of BIMAS Committee. Technical recommendation and guidance are prepared by Director General of Food Crop Agriculture on food crops, Director General of Livestock on animal husbandry, Director General of Estate Crops on estate crops and Director General of Fisheries on fishery, respectively. Extension methods and training for extension workers are under the responsibility of Agency for Agriculture Education, Training and Extension. For smooth operation of extension service, Forum on Agricultural Extension Coordination is organized among above mentioned authorities concerned.

At the provincial level, Provincial Secretariat of BIMAS Committee is in change of budget arrangement and personnel management of agricultural extension service. Technical recommendation and guidance are prepared by respective service office of province under the Regional Agricultural Office in province.

At the Kabupaten level, Kabupaten BIMAS Office under the direct control of the Provincial Secretariat of BIMAS Committee is in charge of budget arrangement and personnel management of extension service including Rural Extension Centre (BPP). Technical recommendation and guidance are prepared by service offices of Kabupaten under the technical guidance of service office of province. In general, chief of Food Crop Agriculture Service Office of Kabupaten is appointed as the chairman of BIMAS Daily Execution Coordination Committee and the chairman of Forum on Agricultural Extension Coordination of Kabupaten simultaneously.

Agricultural extension staffs are consisting of two kinds, namely, Subject-matter Specialist (PPS) and Field Extension Worker (PPL). PPS is working at provincial level office or stationed in Kabupaten. PPL is stationed at Kabupaten BIMAS office, BPP and WKPP (service area of PPL). Extension services to farmer level are carried out by extension staffs in BPP. There are 130 BPPs established in South Sulawesi. The extension service area covered by each BPP differs, but about 10,200 ha or 7,600 farm households per BPP in average. The number of BPPs in Kab. Wajo is five of which three are located in the related three Kecamatan, Sakkoli, Doping and Anabanua. The service area per BPP in Kab. Wajo is larger than that of provincial average; about 15,700 ha or 11,100 farm households per BPP in average.

The number of PPLs in the province totals about 1,800 of which about 73 % is PPLs for food crops and 16 % is for estate crops. Extension activities employed in the province include daily activity of PPL, training course for chives of farmer groups, demonstration plot operation, field visits, radio broadcasting, cultivation trial, publication, etc. Among these, major activities are the first three.

Daily activities of extension worker are carried out under the training and visit (TV) system. Working area (WKPP) of each PPL is divided into 16 farmer group areas with one key farmer each as a leader of farmer group. Each PPL has to visit every key farmer group twice a month, two groups a day and WKPP four days a week. In addition, PPL is requested to attend BIMAS Daily Execution Coordination Committee (POSKO) at farmer group level held once two weeks as technical adviser.

Training course for chives of farmer groups are held at provincial level and at Kabupaten levels. The training course of provincial government is held three or four times a year in general and participants to the course are selected chives of farmer groups . The number of training courses held in Kabupaten differs depending on districts, however the course is held at least once a year.

| | BPP (Person) | PPS (Person) | PPM (Person) | PPL (Person) | No. of Kontak Tani (No.) | No. of Demo Farm (No.) |
|---|---|---|---|---|---|---|
| 1) Three Kecamatans Related to the Study Area | 3 | - | - | 24 | 287 | - |
| 2) Kabupaten Wajo | 5 | 3 | - | 82 | 864 | - |

Source: Agricultural Service Office, Kabupaten Wajo.

In addition to the above activities, the Government is now carrying out the extension by the use of mas media such as radio and television broadcasting as below.

1) SIARAN PEDESAAN (Radio Programme on Agricultural Extension)

- Every morning (30 min.)
- Contents: Information on new varieties, advanced practices, pests and diseases information, marketing, experience of KUD activities, and its introduction, etc.

2) KUTAK POS (Television Programme on Agricultural Extension)

- Regular programs: Every two weeks
- Special/specific programs: Once/1-2 months
- Contents: Almost same with that radio program.

This is ideal system. The farmers can receive easily latest and various information through this system. As for television, their holding number is a little at present, but it is now spreading over the area. After the completion of the project, a lot of farmers will have television along with the improvement of their living standard. In this case, they will have more detailed information visually.

As indicated above, the extension system in the province is considered to be fairly well established. However, technical background of extension staffs and extension materials are limited particularly for palawija and vegetable crops and accordingly extension activities for these crops are weak in general. Although training for PPL are held by the Provincial Food Crop Agriculture Service Office, BPP (once two weeks) and other agencies concerned, for PPLs chances to brash up their technology are considered to be limited at present. In addition, the recommended technology is principally consisting of production technique and other essential technology or know-how including post harvest, farm mechanization, farm management and marketing aspects are not sufficiently provided.

### 3.10.5 Agricultural Credit

#### (1) Bank Indonesia

Within the institutional credit structure, Bank Indonesia (BI) performs the central banking functions and supervises the Government commercial banks, private banks and development banks. BI provides liquidity credits to the banks for general working capital operations as well as for special investment programs and loans made to development projects undertaken by the government agencies of state-owned corporations.

In 1983, a financial sector reform program was set into affect. The principle of the program was deregulation of financial market, liberalization of interest rates for loan and deposits and phased reduction of subsidized credits. As a part of the program, the Government has launched a new package of policy in January 1990 called PAKJAN.

Through the policy package of PAKJAN, improvement of the credit system has been pursued by gradually phasing out the share of BI liquidity credits, while maintaining the role of banks in encouraging self-sufficiency in food, promoting cooperatives and investments, and simplifying

interest rate structure. Moreover, the policy package is aimed at ensuring the availability of credit for small scale business and cooperatives. Through this policy, the subsidiary credit schemes are being reduced from 23 to four credit schemes. The credit policy emphasises promoting i) productive, ii) labor intensive investment and iii) non-oil/gas export as well as iv) developing the business activities of the economically weak groups and cooperatives in the rural areas. Under the PAKJAN policy package, the following three liquidity credit systems remain in the agriculture sector:

1) Credit to farmers (called Kredit Usaha Tani: KUT) is only available to finance rice/food crops intensification scheme through any banks with the consent of BI, although only Bank Rakyat Indonesia (BRI), state-owned commercial bank, extended this credit previously. The amount of KUT is set based on the real need of the farmers whereas it was based on a fixed amount per hectare.

2) Cooperative credit is extended by the handling banks with a 75% capital share from BI for the subjected loan users of the members of primary cooperatives and KUDs . The interest rate to the cooperative members is based on the prevailing market rates.

3) Food stock and sugar procurement credit is extended only to BULOG for financing food stock and sugar procurement business. The credit is fully financed by BI.

In addition to the above, there are credit schemes which are financed by use of the banks' own resources and classified as the general credits. It is to be noted that there is no institutional credit scheme for the investment purposes for the cooperatives. The general scope of KUT and Cooperative credit is summarized in Table A.6.20.

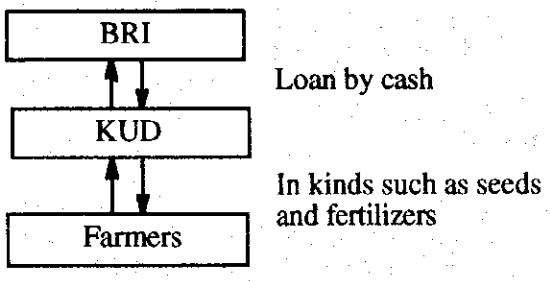
(2) Indonesian People's Bank

The Indonesian People's Bank (Bank Rakyat Indonesia (BRI)) is the state bank specializing in agricultural credit covering the whole country, and authorized to finance the credit of crop intensification programs for qualified individual farmers. In order to provide an efficient loan service, BRI has established a broad network consisting of regional offices, branch offices and sub-branch offices (BRI Unit Desa or Village Unit BRI).

For the agricultural credit till 1984, it had been extended to the farmers through the BRI Unit Desa under the BIMAS package system which decides the size of loans based on the conditions in each region and possible cropping seasons. The BIMAS credit was a short term loan over a period of seven (7) months with a monthly interest of 1 %. In 1981, the Government strengthened the BIMAS credit by introducing INSUS program which is lent to the farmers' group. Each INSUS had a area of more than 25 ha and irrigation facilities own by a group of farmers who eager to improve their farms. In 1985, in accordance with the Memorandum No.18 of the Minister of Agriculture (January 31, 1985), the BIMAS package system was replaced by new credit system. It is "Keredit Usaha Tani (KUT)" as mentioned in preceding section. At present, there are 3 kinds of credits[7]; i.e., i) KUT, ii) KUPEDES, and iii) KPP. These outlines are as follows.

[7] In addition, there were KIK and KMKP credits untill 1990. KIK was a Government credit program especially for small investment which is applied to land development programs where new paddy fields are to be constructed as well as KMKP. This credit was financed by cash with an interest of 1.0 % per month, and had the repayment period of 4 years. KMKP had formed a link in the chain of the Land Development Project (see 3.10.8), and its object was to promote on-farm development of the farmers' group.

1) KUT is loaned to the farmers through KUD under the following system.




A characteristic of this loan is free credit system through a reliable KUD as an intensification credit channel, whereby the farmers can obtain a loan which is not limited by the package loan like that BIMAS/INSUS, and therefore according only to their requirement. The loan condition to KUD is as follows:

| | |
|---|---|
| Interest | : 14% per annum |
| Repayment period | : 12 months |
| Grace period | : None |

BRI has given an incentive to KUD. Namely, KUD can take 1 % of interest adding the above 14% from the farmers. The recent movement of loan in three Kecamatans related to the study area are as shown below. BRI, Kab. Wajo said that no KUT has been released to KUD not only in these three Kecamatans but also in the whole Kabupaten since 1991.

Movement of KUT in Three Kecamatans related to the Study Area.

(Unit: Rp. million)

| | Sajoanging | | Majauleng | | Maniangpajo | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Loan | Repay-ment | Loan | Repay-ment | Loan | Repay-ment | Loan | Repay-ment | % |
| 1985/86 | - | - | 14.0 | 14.0 | 18.6 | 18.6 | 32.6 | 32.6 | 100.0 |
| 1987/88 | 32.5 | 11.0 | 44.6 | 20.5 | 51.7 | 8.9 | 128.8 | 40.4 | 31.4 |
| 1988 | 219.5 | 67.8 | 197.5 | 58.2 | 153.9 | 119.3 | 570.9 | 245.3 | 43.0 |
| 1988/89 | 12.5 | 5.8 | - | - | - | - | 12.5 | 5.8 | 46.4 |
| 1989 | 127.3 | 78.8 | 60.0 | 48.0 | 55.0 | 55.0 | 242.3 | 181.8 | 75.0 |
| 1990 | 149.6 | 120.2 | 73.9 | - | 68.3 | 55.4 | 291.8 | 175.6 | 60.2 |
| Total | 541.4 | 283.6 | 390.0 | 140.7 | 347.5 | 257.2 | 1,278.9 | 681.5 | 53.3 |

Source: BRI, Kab. Wajo.

2) KUPEDES is general credit for rural area and lent directly and individually to the enterprises of trade, agriculture, industry, services, and employee. The farmers also can utilize this credit, if reliable KUD is not available. The loan condition and total loan amount in Kab. Wajo in the past ten years are as follows.

Loan Condition

| | |
|---|---|
| Interest | : 18% per annum |
| Repayment period | : 2 years for "Exploitasi" (Operation Funds) |
| | : 3 years for "Investasi" (Investment Funds) |
| Grace period | : None |

Progress of Loan (1984-1994)

| | |
|---|---|
| Total amount loaned | Rp.24,206 million |
| Repayment amount | Rp.19,947 million |
| Repayment ratio | 82.4% |

Remaining loan amount by each sector

| | (Persons) | (Rp. million) |
|---|---|---|
| - Agriculture | 507 | 1,180 |
| - Industry | 107 | 126 |
| - Trade | 845 | 1,457 |
| - Services | 79 | 127 |
| - Employee | 1,118 | 1,369 |
| Total | 2,656 | 4,259 |

3) KPP was pre-financing credit for working capital of enterprises. KUD can utilize this loan for handling of agricultural products.

| | | |
|---|---|---|
| Loan Condition | | |
| Interest | : 16 % per annum | |
| Repayment period | : 1 year | |
| Grace period | : None | |
| Progress of Loan (1989-1994) | | |
| Total amount loaned | 79 KUDs | Rp.3,445 million |
| Repayment amount | 58 KUDs | Rp.2,873 million |
| Repayment ratio | | 83.4 % |

In Kecamatan related to the study area, BRI has operated three Village Unit Branch Offices (BRI Unit Desas) located at Jalang, Attapange and Anabanua, respectively. A total of seven KUDs is also organized in the study area. However, credit programs are inactively operated in the study area, and no credit has been disbursed to the farmers and KUD in Kabupaten Wajo, since in 1991/92 season. The Provincial Agriculture Services Office, South Sulawesi and PT. PUSRI, Sengkang said that this is only to Kabupaten Wajo, and the farmers and KUDs in other Kabupatens have still received the agricultural credits services from BRI. Major reasons of such inactive credit are attributable to the poor repayment capability of farmers with their attitude to its loan repayment. In addition, the following reasons will be considered:

1) Although they have a large farming size which is estimated to be 2.34 ha of paddy field, a half of area is leased land and they must pay a considerable amount of land rent which accounts for 50% of its gross income. They have no enough to repay loan because of such high land rent.

2) It seems that the farmers' repayment capability is poor, because their crop yields are very low and unstable situation. Intensification program basically aims to production increase in irrigated areas with supply of optimum level of farm inputs, but rainfed field is the majority in the study area where institutional support is insufficiently available. In addition, smaller farm input levels are usually made in rainfed farming, because it does not always guarantee the harvest. Under such situations, the yields of paddy however around the 3 tons/ha and they hesitate to repay loan.

3) Crop production in the study area has often suffered serious damage from drought, and those yields has fluctuated largely from year to year. Under such situation, the farmers always can't spare the expenses to repay loan.

At present, BRI has a plan on lending of agricultural credits to KUDs in Kabupaten Wajo from 1994/95 crop season, though it is only to excellent KUDs as a trial. To settle such problems, it is necessary to increase and stabilize their crop yields and production.

### 3.10.6 Agricultural Cooperative

According to the Law on basic regulations for cooperatives enacted in 1967, the Government has been promoting the establishment of a multipurpose primary agricultural cooperative "Koperasi Unit Desa (KUD) at the village level to support agricultural development. A village-level development unit of about 600 ha to 1,000 ha of lowland rice field may be represented by a KUD. In South Sulawesi, 496 KUDs have already been established, of which 28 KUDs are located in Kab. Wajo and 7 KUDs are available in the study area. The status of KUDs in

Kabupaten Wajo and three Kecamatans related to the study area is presented in Table A.6.21. The total number of KUD members is 4,622 or about 50% of the total farm households in the study area. This average rate of membership is almost same with that in the whole Kab. Wajo (39%).

Figure A.6.5 shows the typical organizations of KUD in the study area. KUD comprises a congress, board, adviser, audit and executing body headed by a manager. These are summarized as follows.

1) Congress (General Meeting): The congress is held basically once per year, and all of the activities, account and its auditing reset are reported to the members.

2) KUD Board: The board comprises five (5) members; chairman, vice chairman, secretary, vice secretary and treasurer. The board is responsible for appointment of a manager, supervising to the executing body, preparation of basic management and operation plan, and arrangement of congress.

3) Executing Body: Executing body consists of several business units/sections, and these are differ in KUDs depending on their management policies. Those basic units which exist commonly in all KUDs are three (3) units of KUT, handling of paddy and collecting of electric charge. The KUT unit has also a function on selling of farm inputs such as fertilizers and agro-chemicals. In the most case, KUDs are a collecting agency of PLN and a selling agency of PT. Pusuri. Apart from these basic units, some KUDs have several business units such as rice milling, handling of cloves and rental service of irrigation pump.

KUD has four financial sources; i) handling charge of paddy from DOLOG, ii) handling margin of farm inputs from PT. Pusuri, iii) collecting margin of electric charge from PLN, and iv) KUT margin from BRI. In addition, they have some profits from other business mentioned above. In general, KUD activities have shown a good performance, based on these financial sources. In the case of KUDs in the study area, however, they have financial problems, because almost all KUDs have the background that stagnate agricultural production. Even though cooperatives are well established institutionally, it can't be expected to achieve a good progress without development of their economic background.

KUD activity has a nation-wide scale, and a federation has been established by each administrative level, as shown in Figure A.6.6. To the KUD, the Cooperative Office (Kantor Departemen Koperasi dan PPK) has given various supports such as training of leaders, financial support and legal services.

### 3.10.7 Cooperatives and Associations related to the Project

The agricultural development activities in the rural area are closely connected with the social and cooperative activities other than agriculture. As such activities in the study area, there are the Village Community Resilience Board (Lembaga Ketahanan Masyarakat Desa, LKMD) and the Household Skills Education (Pendidikan Kesejahteraan Keluarga, PKK).

LKMD is established only by each Desa, and its chairman is Kepala Desa (village chief). The objectives are to activate and strengthen village community and to improve social life and welfare. The organizational structure is presented in Figure A.6.7. Under three leaders (a chairman and two vice chairmen), this board has various activities; i.e., education, environment, economic and cooperative development, health and family planning, sports, social welfare, and so on. As one of them, LKMD also support the activities of cooperatives and associations such as KUDs and water user's associations (P3A) which will be established after the completion of the Project.

PKK is the women's association and an organization nation-wide in its scope. Main objective of PKK is to promote participation of women in public affair with improvement of their social

position. As shown in Figure A.6.8, the organizational structure of PKK is established in administrative level. In addition, PKK in Desa consists of three group levels, i.e., Dasa Wisma (a group of 10-20 households), Rukun Tetangga (RT) including several Dasa Wismas, Rukun Warga (RW, several RTs). The wives of administrative chives of each level have been appointed automatically as the chairmen of PKK of those levels. Leaders of groups in Desa is elected from the members. The Dharma Wanita which belongs in the Bangdes (Rural Development Office) of Kabupaten and Province supports to PKKs in their activities. LKMD has also given assistance to PKK at Desa level.

All of the women including unmarried persons are member of PKK with few exceptions, and PKK has various activities such as cooking and sewing classes, promotion of cottage industry, campaign for enlightenment of women's health and sanitation, and so on. These funds have been covered by the government agencies which are concerned with those activities, because PKK has no fixed financial source. For instance, the Dinas Kesehatan (Provincial Public Health Office) has some financial supports to the PKK activities on women's health and sanitation.

### 3.10.8 On-Farm Development Services

For construction of irrigation facilities, the responsibility of DPU is limited basically to up to the secondary canal and part of tertiary canal (50m from turnout structure). On-farm development within the tertiary irrigation block such as tertiary canals below 50m from turnout, quaternary canals, farm ditches, and land reclamation of fields is left to the farmer's hand. This farmers' on-farm development has usually delayed in its commencement, because of the lack of farmers' funds, inadequate local leaders and insufficient technique. In order to promote and facilitate the construction of on-farm facilities, the Land Development Project (LD Project)[8] was introduced by the Ministry of Agriculture in 1979.

The LD Project consists of two components; i.e., the establishment of the pre-finance loan for working capital (KMKP) and the Small Investment Credit. Other than credit services, the Government also assists the farmers free of charge by providing survey, design, guidance and supervision for construction works of the on-farm development. The LD Project had been implemented originally to both the areas in the PU irrigation system and non-PU system. However, these days the LD Project has been implemented mainly to the areas without PU projects, and PU has constructed almost all irrigation facilities including on-farm facilities to make sure for avoiding problems mentioned above and accelerating irrigation project. The Bila and Langkeme irrigation projects which are now under the construction by PU, South Sulawesi Province have also included those on-farm facilities.

## 3.11 Social Infrastructure

### 3.11.1 Road

The roads in the study area are classified into three (3) categories; Provincial, Kabupaten, and Desa roads. The first one is maintained by Dinas PU Bimanarga, the second by PUD (Pekerjaan Umum Daera), and the last by the responsibility of each Desa authority. The details of the road condition and their location are shown in Table A.6.22 and Figure A.6.9.

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[8] The Director General of Food Crop Agriculture (GDFCA) is responsible for the implemetation of the LD Project, and as its executing agency, UPP (Unit Pelaksana Proyek) has been organized in each province. The main tasks of UPP are as follows: i) dissemination of information concerning the LD Project; ii) assistance to farmers in obtaining pre-finance loans; iii) investigation of candidate areas for the LD Project; iv) supervision and control of the survey, design and construction of land reclamation to be done by the contractor and/or farmer's group; v) assistance to the agrarian services in issue of land certification; vi) transportation of pre-financing loan into KIK; and vii) monitoring of all UPP activities and preparation of report to DGFCA. Under the supervision of DGFCA, a leader of the LD Project has been appointed at the central office (Jakarta) and in each province. The Project Leaders at the provincial level decide two operational areas of UPP; the land reclamation area of about 1,000 ha and the investigation area of about 2,000 ha to be developed within two years.

1) Provincial road

Three (3) provincial roads are networked in the study area. The first one passes Paria, Attapange and Sakkoli, connecting Sengkang and the study area, with a total length of 20.5 km within the study area (the distance from Sengkang to Paria is 23.5 km ). The second one starts Sengkang and extends to the study area through Anabanua, Poleonro and Truntpakkai. The length of this road within the study area totals 3.8 km. Those two (2) roads are asphalt-paved and well maintained. The third one runs from north to south along the eastern part of the study area via Jalang and Doping with a total length of 22.0 km. This road was recently promoted to the provincial road and is now under up-grading works.

2) Kabupaten road

There are three (3) Kabupaten roads in the study area, i) Attapange - Doping (16 km), ii) Jalang - Tobulelle (13.7 km), and iii) Paria - Pleonro - Gilirang (10.5 km). All Kabupaten roads are paved at low grade and poorly maintained, but they are nearly all weathered. According to the Kantor PUD, all these Kabupaten roads have been included in the maintenance program in 1994/1995.

3) Desa road

Main Desa roads in the study area are summarized as shown in the following table. All these Desa roads are unpaved and under very poor condition, passable only by 4WD vehicle in the rainy season. Importance of the roads is however very high for the local farmers activities even at present.

| Passage Village | Length (km) |
|---|---|
| 1. Gilirang - Arajang | 5.5 |
| 2. Pntoe - Sarammae - Allapporeng | 8.3 |
| 3. Bottodonga - Benceng-2 - Padewakeng | 9.5 |
| 4. Sarammae - Bacubacue | 5.5 |
| 5. Laerung - Bottodonga | 3.5 |

### 3.11.2 Electricity

Distribution line of 20 Kv are networked in and around the study area and electrification service covers almost all villages along the Provincial and Kabupaten roads in the study area, as shown in Figure A.6.9. The user's percentage among available villages is only 32 % so far, and the service for the remaining villages along Desa roads has been programmed in 1994/95, as shown in Table A.6.23.

### 3.11.3 Water Supply

The people in the study area generally depend on wells and rain fall for their drinking and domestic water. Almost all houses have their concrete storage tanks with a capacity of 1 m3, together with a roof catch for water harvesting. However the people are faced difficulties in getting clean water. In the eastern area along the coast such as Doping and Akkajeng, they are confronted with salty problems, and buy drinking water at cost of Rp.150 / 20 litres for their daily use. The people in the upper stream of the Gilirang river, are getting their daily water by digging holes at riparian side.

There are four (4) government authorities related to rural water supply; Ciptakarya, PDAM, Dinas Kesehatan, and Bangdes. Their activities are summarized as follows.

| Organization | Related Ministry / Local Government | Activity |
|---|---|---|
| 1. Ciptakarya | Public Works | Planning and construction for water supply by deep well with pump and pipe line to some extent area. |
| 2. PDAM *1 | Kabupaten | Operation and maintenance for the rural water supply system |
| 3. Dinas Kesehatan | Public Health | Water supply by shallow well with/ without hand pump |
| 4. Bangdes *2 | Kabupaten | Supporting villages including construction of wells |

*1: Perusahaan Daerah Air Minum
*2: Pembangunan Desa

(1) Piped water supply

Piped water supply systems have been developed since 1985 in the study area by Ciptakarya. There are five (5) systems at present; the system of Attapange is operated by PDAM collecting a water charge of Rp.250/$m^3$, the other four (4) systems are supposedly operated by each Desa authority without collecting water charge, but they have ceased operation at present due to luck of operation and management technique. It is therefore scheduled that the operation and management for the remaining four (4) systems will be transferred to PDAM in the near future.

The system in Attapange was constructed in 1985 and has 250 of beneficial families. It is equipped with 5 lit./sec. of pumping capacity and six (6) km of two (2) to four (4) inches pipe line in total length. The water source of the system is a spring with a checkdam in Tengnga. Pumping unit is operated for five (5) hours per day. The PDAM has an extension plan of the system, targeting further 200 beneficiary families providing with 10 km of pipe line and additional deep well. Table A.6.24 shows the existing rural water supply and Figure A.6.9 illustrates the location of the supply system.

(2) Well

In the study area, there are 36 wells supported by the Provincial Public Health Office and 13 wells by the Provincial Rural Development Office . They are deep tube wells with hand pump and shallow dug wells with or without hand pump depending on the hydro-geological conditions. An officer of Public Health said that clean drinking water is very important to reduce diarrhoea disease which is very popular in the study area, and one well per 10 families is at least required for the local people. Because of the budgetary constraints, however total number of well in the study area is far below the minimum requirement.

## 3.12 Major Constraints to Agricultural Development

The major constraints to the agricultural development identified are as follows:

1) Water shortage is the most serious constraint hampering crop production. Since irrigation facilities are limitedly available in the study area, single cropping of wet season paddy is predominant. Due mainly to uncertainty of water availability, crop productivity is low even in wet season paddy. Development of irrigation facilities so as to supply stabilized water is essentially required in the study area.

2) There exist about 800 ha of imperfectly and poorly drained paddy fields in the study area. Most of them are located in the low-lying lands of the study area, close to the coast. Although paddy is grown in such land, the unit yields are generally low due mainly to poor drainage condition.

3) Poorly arranged rural road network prevents smooth transportation of farm input and output. For example, farm gate prices of paddy are higher in locations close to the paved roads, while those are lower in remote areas for which proper roads are not available. According to the farmers' interview survey, paddy prices was Rp. 225/kg in Desa Arajang and Rp. 250 in Desa Doping.

4) Under the above condition, population outflow from the study area occurs with the increase rate of -1.39% p.a. on an average during 1988 - 1993 period. In Kab. Wajo and South Sulawesi as a whole, the population increase during the same period is -0.42% and 1.42%, respectively. A lack of inheritor of farm households is one of the big problems not only in the study area, but in Kab. Wajo as a whole, according to the information from Kabupaten Agriculture Service in Wajo.

5) Heavy textured soils distributed over the study area will be the constraints to the agricultural development, particularly to palawija cultivation. These soils present difficulties in land and seed bed preparation and require higher labour inputs for the farming operation. Further, these soils in lowland areas may restrict the cultivation of crops intolerant of water logging in the wet season.

6) Although the agricultural supporting system is considerably well arranged in South Sulawesi Province as well as in the study area, its further activation is required particularly for extension services. Since the institutional support has been provided intensively to the farmers in irrigation areas, activities of supporting services in the rainfed farmers are comparatively weak.

# 4. AGRICULTURAL DEVELOPMENT PLAN

## 4.1 Objectives and Basic Concepts for Agricultural Development

The project aims at the increase in agricultural production and thereby improvement of the farmers living standard in the Gilirang area through exploitation of new water resources from the Gilirang river as well as provision of prerequisite facilities for irrigation and drainage purposes. The project should also contribute to the realization of the government policy for equalization of social welfare and to the sustenance of self-sufficiency of food crops and improvement of its quality. With this in view, the major concepts for agricultural development in the Gilirang Irrigation Project are as follows:

1) Unit yield and production of wet season paddy should be stabilized and improved through establishment of new irrigation system and introduction of irrigation farming practices.
2) Planted area of dry season crops should be increased with year-round irrigation system.
3) Special attention should be paid to the increase in irrigation area up to the potential maximum area in conformity with government policy for equalization, as well as for maximum total benefits.
4) Present drainage condition should be improved to assure the healthy growth of paddy under irrigated condition.
5) Present farm road network should be improved and the agriculture activities be made more active.
6) Agricultural institutions, which support agricultural development should be strengthened, especially in the field of agricultural extension services.

## 4.2 Proposed Land Use

After completion of the Project, most of the farm field in the area will be fully irrigated and more intensive use of the farmland will become possible. The proposed future land use in the Project area is summarized as follows, and the details are shown in Table A.6.25.

(Unit: ha)

| Description | Present Condition | | Net Project Area | |
|---|---|---|---|---|
| | Gross Project Area | Net Project Area | With Project | Without Project |
| 1) Paddy Field | 8,020 | 7,220 | 7,000 | 7,220 |
| 2) Upland Field | 670 | | | |
| 3) Orchard | 110 | | | |
| 4) Grass Land | 170 | | | |
| 5) Bush/Forest | 870 | | | |
| 6) Village and Others | 390 | | | |
| 7) Irrigation/drainage canals, and farm roads | - | - | 220 | - |
| Total | 10,230 | 7,220 | 7,220 | 7,220 |

The land use patterns can not basically be changed without provision of irrigation development, and the land use in the surrounding areas which will not be incorporated in the Project area will have to remain as it is.

## 4.3 Proposed Cropping Pattern

### 4.3.1 Selection of Crops

The study on selection of proposed crops was made in parallel with the alternative study on the optimum cropping pattern. As a result of study, rice would be taken as the suitable crop to be introduced in the Project area, taking into account the natural adaptability, profitability, marketability, farmers' intention and development policy of the provincial government.

1) Natural Adaptability

Over 70% of land in the gross project area is covered by the Eutric Vertisols. This soil has a physical characteristic that the soil become very hard when dry up, and the field crack lengthwise and crosswise over the surface with a depth of 20-30 cm. For the crop cultivation at this soil, the rice is suitable as compared with the upland crops. The rice which is cultivated under submerged condition has no problem on such specific soil. From the stand point of "right crop for right land", it is recommended to cultivated rice in the field covered by this soil.

2) Profitability of Crops

The profitability of rice under the irrigated condition is higher than other food crops such as maize, mungbeans, soybeans, groundnuts and cassava. Considering the subsistence level of the farmers' living standard in the area, the introduction of rice cultivation will produce a good result in improving their living standard. Moreover, the price of rice has been controlled and stabilized by the Government, and this stabilized price would also bring a good result in maintaining improved living standard.

3) Demand and Supply of Rice

The increase in rice production in recent year has much relieved the shortage of rice supply in the whole country. Such successful increase in rice is mainly attributable to the Government's efforts that went into the expansion of the irrigated area and the extension of crop intensification programs. As mentioned in the preceding section, it

is expected that Government's efforts will be continued in order to meet the domestic demand for rice increasing along with population growth.

4) Farmers' Intention

Through the Household Survey to 250 farmers in the area, it was confirmed that they have a strong intention to cultivate rice, whenever provision of irrigation water is permitted.

5) Agricultural Development Policy of South Sulawesi Province

As a basic agricultural development policy of South Sulawesi Province, the provincial government has stated that annual surplus paddy would be increased to one million tons, and to achieve this target, the following six Kabupatens were nominated as its major production bases; i) Bone, Soppeng, Wajo, Sidrap, Pinrang, and Luwo. These are called "BOSOWA SIPILU", and the government's development efforts for increasing rice production are now going into these six Kabupatens. Kabupaten Wajo is also included in this area, and is expected to play an important role for increasing its production. In coincide with this policy, the Project introduce rice as a main crop, and be increased its production as much as possible.

As for palawija crops, soybeans, groundnuts and mungbeans are recommended, taking into account the promotion of crop diversification. The common palawija crops grown in the area at present are these three crops, and farmers have a superior ability in those cultivation. The soybeans have high profitability as well as rice as shown in Table A.6.27. Soybeans have a big domestic demand, which have been imported, and the introduction of this crop will contribute to the saving of foreign exchange.

On the other hand, although vegetables including chillies have the highest profitability more than rice, it will be not recommended, except for a small scale cultivation. Since vegetables have no price and no marketing controls, these cultivation on a large scale would much involve a risk, especially for fresh vegetables, owing to fluctuation of price depending on demand and supply conditions and limited market in South Sulawesi Province. Therefore, production of vegetables under the future with project condition would be recommended to 10% of total palawija crops.

### 4.3.2 Alternative Study on Cropping Pattern

Within the framework of the above development concepts, a comparative study to several conceivable cropping patterns is made in order to select optimum pattern in the Project area. The following three cropping patterns so as to select the most attractive pattern for the Project and to decide the optimum pattern (see Figure A.6.10):

a) Type A : Paddy - Paddy
b) Type B : Paddy - Palawija - Paddy
c) Type C : Paddy - Palawija - Palawija

The study is made to these three alternatives, taking into consideration the national and regional agricultural development policies, economic and financial return to the project, farmers intention and crop cultivation technology. Assuming that each crop can be cultivated fully, economic and financial net returns of each types are estimated as follows.

| | | Type A | Type B | Type C |
|---|---|---|---|---|
| Cropping Intensity | | | | |
| - Wet Season Paddy | (%) | 100 | 100 | 100 |
| - Dry Season Paddy | (%) | 100 | 100 | - |
| - Palawija | (%) | - | 100 | 200 |
| Economic Return | | | | |
| - Wet Season Paddy | (Rp.1,000/ha) | 1,558 | 1,558 | 1,558 |
| - Dry Season Paddy | (Rp.1,000/ha) | 1,580 | 1,580 | - |
| - Palawija | (Rp.1,000/ha) | - | 697 | 1,394 |
| Total | (Rp.1,000/ha) | 3,183 | 3,835 | 2,952 |
| Financial Return | | | | |
| - Wet Season Paddy | (Rp.1,000/ha) | 1,078 | 1,078 | 1,078 |
| - Dry Season Paddy | (Rp.1,000/ha) | 1,091 | 1,091 | - |
| - Palawija | (Rp.1,000/ha) | - | 783 | 1,566 |
| Total | (Rp.1,000/ha) | 2,169 | 2,952 | 2,644 |

The result of the study may be concluded as follows:

1) The pattern of Type A (paddy-paddy) results the second highest economic return. If irrigation water is insufficient to maintain Type B pattern, Type A is to be recommendable. Water requirement in this pattern is less than that in Type B. Paddy is more suitable than common palawija to the soil conditions in the study area, and all the farmers are aware of paddy cultivation. From socio-economic viewpoint, this pattern is also justifiable, since South Sulawesi is one of the large rice granaries in Indonesia supplying about 643,000 tons (in 1990) of rice to the regions with rice deficit, and this role of South Sulawesi will become more important in the future. In addition, the study area is one of the strategic paddy development areas in the provincial agriculture development plan of South Sulawesi. However, this pattern does not satisfy the recent government policy of crop diversification.

2) The cropping pattern of Type B (paddy-palawija-paddy) is the most attractive pattern. The highest priority should be given to Type B in the selection of proposed cropping pattern, as far as water is available. More than 60% of farmers have intention to introduce this cropping pattern after irrigation development according to the Household Survey as shown in the following table. In the selection of palawija crops, however, attention should be paid to the heavy textured soils because of its lower permeability.

Farmers' Intention for Cropping Pattern

| Cropping Pattern | No. of Answers (%) |
|---|---|
| Paddy - Palawija/Vegetables - Paddy | 62.4 |
| Paddy - Paddy | 36.0 |
| Paddy - Palawija/Vegetables | 1.2 |
| Paddy | 0.4 |

Source: Household Survey, JICA Study Team, 1994.

3) The Type C pattern is less attractive than other two types. However, water requirement is to be smallest in this pattern. In case that only this pattern is possible to introduce, because of a little potential of water resources, high value crops should be introduced to a certain extent instead of common palawija crops. Under this cropping pattern, improvement of farmers economy to the levels in other irrigation schemes in South Sulawesi is not expected to be achieved, if no high value crops are involved in the proposed cropping patterns.

As the result of alternative study, it is proposed to introduced the cropping pattern of Type B (Paddy + Palawija + Paddy). Paddy is the most profitable crop among other possibly grown crops, except for vegetables such as chillies and tomatoes, as mentioned earlier. The farmers have a long experience for rice cultivation and can realize the maximum irrigation benefits under the project. Palawija crops do not require much water in comparison with paddy. The palawija crops have relatively short growth periods, and could be grown after paddy or in between two