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MASTER PLAN FOR THE CENTRAL SOUTH SULAWESI WATER RESOURCES DEVELOPMENT PROJECT

SUPPORTING REPORT (VOLUME 2)

PART TWO IRRIGATION AND AGRICULTURE

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CHAPTER I GENERAL

For the accurate grasp of present agricultural condition and clarification of constraints to be solved, field investigation and interview survey are carried out. Through the investigation and the survey, data and information are collected as follows ;

1) Soil
2) Climate
3) Land use
4) Irrigation and drainage systems
5) Farming Practice
6) Crop yield and production
7) Land tenure
8) Agricultural Support system
9) Marketing system and price
10) Farm economy
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The data and information are mainly obtained from the Governmental Authorities concerned such as the Agricultural Extension Service of South Sulawesi, Agricultural Extension Services of Kabupatens Sidrap, Soppeng, Bone and Wajo, Statistic and Census offices of Kabupatens Sidrap, Bone, Soppeng and Wajo, Central Research Institute of Agriculture in Bogor (CRIA), South Sulawesi Branch Research Station of CRIA in Maros, BAPPEDA office, IPEDA office, Soil Research Institute in Bogor, Indonesia People's Bank (BRI), Cooperative offices of Kabupatens of Sidrap, Soppeng, Bone and Wajo, Bupati offices, Livestock Service of South Sulawesi, Central Seed Station of South Sulawesi, Public Works Service of South Sulawesi, Irrigation Section offices of Kabupatens Sidrap, Soppeng, Bone and Wajo, Directorate of Irrigation in Bandung, Department of Meteorology and Geography.
Besides the field survey and the farmer's interview are made so as to confirm above data and obtain more practical information. List of data collected during survey period is shown in Table 1.1.

The objective area is about 8,000 Km^2 which is decided to comprise drainage basins of the Walanae, the Bila, the Boya, the Gilirang, etc. The investigation and studies for agricultural hydrology are carried out for the objective area. However the agricultural data collected are not compiled nor published by the basis of drainage basins but the administrative blocks of Kabupatens or Kecamatans. So four Kabupatens which comprise twentynine (29) Kecamatans are selected as the objective area for agricultural studies with exception of agricultural hydrology. Table 1.2 shows list of Kabupatens and Kecamatans. Fig. 1.1 shows location of kecamatans and kabupatens.

Agricultural data with emphasis on agricultural production are mostly available in kecamatan level for the period of 1969 to 1977 with exception of kabupaten Bone. These data fluctuate annually due to affection of annual rainfall. For the agricultural studies of present conditions, however, the data in 1977 are not used because the data in 1977 do not always indicate the representative year for analysis of present conditions. The average values during the period of 1974 to 1977 are used in this report.

With regard to existing irrigated lands, there are some uncertainty in their classification. The extent of irrigated lands are delineated on the basis of data provided by Irrigation Section offices. Furthermore confirmation of their extent is carried out by the analyses of data provided by Agricultural Extension Services and the field survey.

During the period of analyses of data some discrepancies of figures are found. In this case modification of these discrepancies of the data is done by estimate through the field survey, analyses of data, etc.

CHAPTER II POPULATION

According to the Statistical Yearbook of Indonesia 1976, the total population in South Sulawesi Province is estimated at 5,966,000 at the end of 1976, and 6,283,000 in 1978 with annual population increase rate of 2.6%.

In the objective area, the total population is estimated at about 1,055,600 or about 17% of that of South Sulawesi. Total number of household is estimated at about 184,000 with average number of families of 5.73 per household. The number of farm household is estimated at about 141,000 or 76.5% of total household, as shown in Table 2.1 in detail.

CHAPTER III SOIL

3.1 INTRODUCTION

Soils in the project area were surveyed by Soil Institute in Bogor headed by Mr. Soepraptohardjo in 1967. On the basis of the survey soil map was prepared on a scale of 1 to 500,000. In addition the Camming area in Kabupaten Bone (about 9,000 ha) was surveyed by P.T. Panca Bina Esa and Agriconsult Inc. in 1977 for the feasibility study of sugar cane project.

The soil survey carried out during this time aims at identifying major soils and their distribution and examining the adaptability of each soil for irrigation farming, referring to the available data mentioned above.

This report presents the procedure of the survey, the description of the major soils and land capability. The summary of the results for the survey is described in soil map and land capability map attached in the report.

3.2 PROCEDURE OF SOIL SURVEY

The field survey was carried out over the area of about 372,000 ha /1 by the use of topographic map of 1/25,000 scale and aerial photo of 1/25,000 scale /2. The soil profiles were observed in pits dug at the rate of one pit per about 2,000 ha and were described according to the standards defined in "Guideline for Soil Profile Description" of the Food and Agriculture Organization of the United Nations. The pits were dug to a depth of about one meter.

150 pits were dug out and 42 soil samples were taken from the representative soil horizons. These soil samples were analyzed in Hasanuddin University, Ujung Pandang. The items of analyses are pH value, cation exchange capacity, exchangeable bases, total nitrogen, available phosphate, total carbon, free iron oxides and soil particle distribution analysis. In addition, 270 soil samples were examined in pH value. The soil analyses were carried out mainly by the standard analyses method described in the 7th Approximation, USDA. The results of soil analyses are shown in table 3.1. Details are shown in Data Book.

3.3 SOIL CLASSIFICATION AND MAIN FEATURES OF THE MAJOR SOILS

According to the minutes of the Inception Report Meeting dated 21 Feb., 1979 soil classification in the project area has been carried out by the FAO/UNESCO soil classification system.

In the light of the morphological characteristics and the results of laboratory analyses, soils in the project area are classified into eleven soil units, namely, Eutric Fluvisols, Thionic Fluvisols, Dystric Gleysols, Chromic Vertisols, Orthic Luvisols, Chromic Luvisols, Ferric Luvisols, Ferric Acrisols, Dystric Nitosols, Rendzina and Lithosols.

/1 : Out of 372,000 ha, 250,000 ha was surveyed at a density of one pit per 2,000 ha.

/2 : Aerial photo was used mainly for interpretation of degree of drainage conditions in the land.

The area distributed by each soil group is summarized in Table 3.2 and its delineation is illustrated in Soil Map.

3.3.1 Eutric Fluvisols /1

Eutric Fluvisols mainly extend over the flat alluvial plains along the Bila, the Boya, the Walanae, the Cenranae, their tributaries and around Lake Tempe. Total area of these soils amounts to 109,000 ha or 29.3% of the surveyed area.

These soils develop from recent alluvial deposits having an ochric A horizon. These have a base saturation of 50% or more. These are not calcareous and are lacking a sulfuric horizon and sulfidic materials within 125 cm of the surface. Drainage conditions vary from place to place, ranging from well to poorly drained.

In general these soils are inmature with no predominant morphological characters. The sequence of the soils is A/C.

The effective solum depth of the soils is very deep. The thickness of A horizon is over 25 cm in general. A horizon is dark brown to graish brown with clay. Subsoils consist of clayey tenture. The structure is massive or fine to coarse blocky depending on location.

With regard to chemical properties, pH value shows over 6.0 for H_2O throughout the profile. The cation exchange capacity is over 20 me/100g. Major exchangeable base is calcium. Base saturation degree averages 60%.

At present most lands covered with these soils are under cultivation of paddy and provide the highest production of rice in the objective area.

The typical soil profile is shown below.

No. of soil pit : 11
Location : Desa Sengkang
Land use : Banana field

0 - 25 cm	Dark brown(10YR 3/3) clay; fine angular blocky structure; plastic; sticky; fine manganese mottles, diffuse smooth boundary.
25 - 50 cm	Dull yellowish brown (10YR 5/4) silty clay; fine subangular blocky structure; plastic; sticky; diffuse smooth boundary.
50 - 100 cm	Dull yellowish brown (10YR 4/3) silty clay loam; coarse subangular blocky structure; slightly plastic; slightly sticky.

/1 : Hydromorphic alluvials, grey alluvials, dark grey alluvials and brown grey alluvials in Indonesian National soil classification are provisionally classified in this group.

3.3.2 Thionic Fluvisols /1

The lands covered with Thionic Fluvisols extend over the swampy area with less than two meters above sea level along the coastal line. Total land area is 15,000 ha or 4%.

The main characteristics of the soils have a sulfuric horizon or sulfidec materials at less than 125 cm from the surface. At present some part of the land is used as fish ponds. Crystals of pyrite are found at dike of fish ponds of which materials are dug out from sub soil layer. The soils at dikes shows about 2 in pH value.

It is considered at present that economical use of agricultural crops in the soils is not able to be expected.

The typical soil profile is described as follows;

No. of soil pit : 16
Location : Babana Akolengan
Land use : Fish pond

0 - 35 cm Grayish yellow brown (10YR 4/2) clay; coarse blocky structure; very plastic, very sticky; prominent fine yellowish mottles (pyrites) smooth abrupt boundary.

35 - 55 cmt Dark brown (10YR 3/3); clay; coarse blocky structures; very plastic; very sticky.

3.3.3 Dystrict Gleysols /2

The land covered with Dystric Gleysols occupies the low lying or depressed area along the Cenranae rivers. During high flow season, the land covered with the soils plays an important role in natural storage reservoirs. Total area is 10,000 ha or 2.7% of the survey area.

The horizon sequence of the soils is AG/CG. The AG horizon has a thickness of over 25 cm with dark greenish gray (7.5GY 3/1). The soil texture is clay throughout the profile. Soil structure is massive to weakly sub-angular blocky.

As far as chemical properties are concerned, the soils have pH value of less than 5. The cation exchange capacity ranges from 25 to 30 me/100g. Base saturation degree is less than 50% in general. Main exchangeable base is Ca. Nutrient status is poor. The nitrogen content in the surface is about 0.17% which decreases in proportion to depth. In the light of soil features, farm management on the soils will require the provision of countermeasures for flooding and poor drainage, and application of proper fertilizations.

/1 : In Indonesian National soil classification, these soils provisionally hydromorphic alluvials.

/2 : In Indonesian National Soil classification, these soils provisionally humic gley soils.

The typical profile of the soil is shown below.

No. of soil pit : 27
Location : Desa Penrang
Land use : Swampy grass

0 - 40 cm	Dark greenish gray (7.5GY 3/1) clay; massive structure; very plastic; very sticky; few coarse rusty mottling; diffuse smooth boundary.
40 - 100 cm	Dark greenish gray (7.5GY 3/1) clay; weakly developed subangular structure; very plastic; very sticky; many fine rusty mottling.

3.3.4 Chromic Vertisols /1

Chromic Vertisols occupy the gently sloping land enclosed with flat plains and hilly lands. The soils extend over the sloping lands lying south of Lake Tempe and the Cenranae river. The land area amounts to 40,000 ha or 10.8% of the survey area.

The horizon sequence of the soils is A/C. These soils have characteristics of darkened surface (10YR 2/2) with clayey texture. The horizons of A and C show coarse blocky structure. Sometimes slickensides are found. It is strongly affected by the expansion and contraction of the soil mass with changes in moisture content. When the soils dry up, they become hard like rocks and cracks occur. Most cracks reach a depth of 50 cm from the surface.

As for chemical properties, pH value of these soils is about 6.5 ranging from 5 to 8 for H_2O. Cation exchange capacity shows 28 me/100g. Major exchangeable bases are Ca and Mg. Base saturation degree is over 50%.

Generally land covered with the soils are used as paddy cultivation whether provision of irrigation water is permitted. The soils are suitable for irrigation farming under proper fertilization and provision of irrigation drainage facilities.

The typical soil profile is described below.

No. of soil pit : 2
Location : Desa Sompe
Land use : Tobacco field

/1 : In Indonesian National Soil classification, these soils are provisionally dark gray and or gray grumusols.

0 - 30 cm	Brownish black (10YR 2/2) clay; massive structure; diffuse smooth boundary.
30 - 60 cm	Brownish black (10YR 3/1) clay; weak coarse blocky structure; very plastic; very sticky; few manganese and iron concretions; slickensides; diffuse smooth boundary.
60 - 100 cm	Brownish gray (10YR 4/1) clay; weak coarse blocky structure; very plastic; very sticky.

3.3.5 Orthic Luvisols /1

Orthic Luvisols extend over mainly the sloping or hilly land south of Lake Tempe and the Cenranae river. Total land area is 24,000 ha or 6.4% of the surveyed area.

The horizon sequence of the soils is A/Bt/C in general. The A horizon has brownish black (10YR 3/2) clay horizon with thickness of less than 20 cm in general. B horizon is a argillic horizon with brown (10YR 4/4) clay. Structure is fine subangular blocky through the profile.

With regard to chemical properties, pH value shows over 7.0 in general. Cation exchange capacity is over 20 me/100g. Base saturation degree is very high throughout the profile, showing over 60%. Major exchangeable bases are Ca and Mg.

Presently land covered with the soils are grown by polowijo crops.

3.3.6 Chromic Luvisols /2

Chromic Luvisols occupy the sloping and hilly lands lying south of Lake Tempe and the Cenranae river. Total land area is 104,000 ha or 28.0%.

The soils of this group have same natures and properties of Orthic Luvisols with the exception of strong brown to red agrillic B horizon. The B horizon has a hue redder than 7.5 YR in rubbed soils.

3.3.7 Ferric Luvisols

Ferric Luvisols extend over the flat and undulating land along the Walanae river between Ujung Lamuru and Palattae. Total land area amounts to 22,000 ha or 5.9%.

/1 : In Indonesian National Soil classification, these soils are provisionally classified into yellowish brown mediterranean soils.

/2 : In Indonesian National Soil classification, these soils are provisionally classified into brown and/or dark brown mediterranean soils.

The horizon sequence of this soil is also A/Bt/C in general. The A horizon has dark brown (7.5YR 3/4) loam or clay with thickness of less than 25 cm. The B horizon has yellowish brown clay with coarse mottles (7.5YR or 5 YR). Soil structures are fine to coarse subangular blocky structure. Generally the effective soil depth is shallow due to occurrence of sandstone or marl in shallow depth.

As for chemical properties, pH value shows 5 to 6. Cation exchange capacity is less than 24 me/100g. Base saturation degree in B horizon is over 50%. Major exchangeable bases are Ca and Mg.

At present lands covered with the soils are used as paddy cultivation in wet season and peanuts in dry season.

The typical soil profile is shown below.

No. of soil pit : 116
Location : Tolitali
Land use : Paddy field

0 - 15 cm	Grayish yellow brown (10YR 5/1) silty clay; medium subangular blocky structure; plastic; sticky; diffuse smooth boundary.
15 - 40 cm	Grayish yellow brown (10YR 5/1) clay; medium subangular blocky structure; plastic; sticky; reddish coarse mottling (5YR 3/2), diffuse smooth boundary.
40 - 60 cm	Yellowish gray (25Y 5/1) clay; subangular blocky structure; plastic; sticky; reddish coarse mottling (5YR 3/2); diffuse smooth boundary.
60 cm +	Gray (5Y 6/1) silty clay; plastic; sticky.

3.3.8 Dystric Nitosols /1

Dystric Nitosols extend over the well drained isolated high land near Camming. The total land area is 2,000 ha or 0.5%.

The soils have deep soil depth with an argillic B horizon. The horizon sequence of the soils is A/Bt. The soils have dark reddish brown (5YR 3/4) A horizon and more reddish B horizon (2.5YR 4/6). Soil texture is clay throughout the profile. Soil structure is well developed fine subangular blocky structure throughout the profile.

With regard to chemical properties, pH value is less than 5 for H_2O. Cation exchange capacity is low and shows less than 10 me/100g. Base saturation degree is about 40%. Major exchangeable base is Mg.

Presently, the lands covered with the soils are grown grass. The use of agricultural crops under this land will require especially proper fertilization under irrigation farming.

/1 : In Indonesian National Soil classification, these soils are provisionally reddish brown latosols.

The typical soil profile is described below:

No. of soil pit : 117
Location : Mattirowali
Land use : grass land

0 - 7 cm Dark reddish brown (5YR 3/4) silty clay; fine subangular blocky; plastic; sticky; diffuse smooth boundary.

7 - 17 cm Reddish brown (2.5YR 4/6) clay; fine subangular blocky; plastic; sticky; diffuse smooth boundary.

17 - 65 cm Dark reddish brown (5YR 3/6) clay; fine subangular blocky; plastic; sticky; Fe and Mn concretions; diffuse smooth boundary.

65 cm + Dull yellow brown (10YR 5/4) clay; fine subangular blocky structure; plastic; sticky; Fe and Mn concretions.

3.3.9 Ferric Acrisols /1

Ferric Acrisols occupy the hilly land lying north of the Cenranae and Lake Tempe. Total land area amounts to 29,000 ha or 7.8%.

The horizon sequence of the soils is A/Bt/C in general. The A horizon has dark brown (10YR 3/4) loam with thickness of less than 25 cm in general. The B horizon has yellowish brown (10YR 5/6) loam with prominent manganese concretions and many medium iron mottles. Structure is weakly developed subangular blocky structure. Soil texture varies from loam to clay depending on locations.

As for chemical properties, pH value shows less than 6 for H_2O. Cation exchange capacity is about 10 me/100g. Base saturation degree shows less than 50%.

The lands covered with these soils are used as paddy or upland crop cultivation at present. However these soils have gravel layers in shallow depth from the surface to some extent and in such case remain grass land.

The typical soil profile is shown below:

No. of soil pit : 23
Location : Mellengnge
Land use : paddy field

0 - 15 cm Dark brown (10YR 3/4) loam; fine subangular blocky; slightly plastic; slightly sticky; few fine iron mottles; clear smooth boundary.

/1 : In Indonesian National Soil classification, these soils are provisionally reddish brown and/or grey brown podzolic soils.

15 - 30 cm	Yellowish brown (10YR 5/6) loam; subangular blocky structure; slightly plastic; slightly sticky; prominent manganese concretions; many, medium iron mottles; slightly plastic; slightly sticky; diffuse smooth boundary.
30 - 100 cm	Dull yellow brown (10YR 5/3) loam; subangular blocky structure; slightly plastic; slightly sticky.

3.3.10 Rendzinas /1

Rendzinas mainly extend over the hilly land covered with limestone between Ujung Lamuru and Watampone. Total land area is 4,000 ha or 1.1%.

The horizon sequence of the soil is A/B/C or A/C. The soils have very shallow A horizon with silty clay, lying limestone. Structure is fine subangular blocky. The pH value shows 7 and base saturation is over 60%.

Owing to shallow effective soil depth, the soils are not suitable for irrigation farming.

Typical soil profile is shown below:

No. of soil pit : 10
Location : Barangranpae
Land use : grass land

0 - 15 cm	Brownish black (10YR 2/2) clay; fine subangular blocky structure; plastic; sticky, abrupt wavy boundary.
15 - 40 cm	Gobbly and gravelly layer composed of lime stone
40 cm +	Lime stone

3.3.11 Lithosols /2

Lithosols mainly occupy the hilly and mountainous land lying south of Lake Tempe. Total land area is 13,000 ha or 3.5%. These soils are limited in depth by continuous coherent and hard rock within 10 cm of the surface. These soils have no potential for use of agricultural crops.

3.4 LAND CAPABILITY

3.4.1 General

Many kinds of classification for land capability have been applied in Indonesia. The representatives are the standards of the United States, Department of Agriculture, the United States of Bureau of Reclamation, and Food and Agriculture Organization.

/1 : Rendzinas

/2 : Lithosols in Indonesian National Soil classification.

The basic concept of above classification systems are mainly to assess lands for irrigation projects in arid or semi-arid region, or to assess land productivity for common crops such as wheat, barley, rye, etc.,through soil conservation.

As described in Chapter 16, irrigation projects in the Master Plan aim to increase foodgrains with emphasis on rice for the self-sufficiency of foodstuff.

Plantphysiologically rice plants are water like plants. Their adaptability growing on soils is quite different from that of common crops such as wheat, barely, rye, etc.

Further most of possible areas to be irrigated from the standpoint of water sources extend over the lands where are readily used as paddy field at present.

Under the circumstances, introduction of land capability classification with emphasis on land assessment for paddy cultivation is considered to be practicable and suitable in the Master Plan study.

In view of above consideration, land capability classification system for paddy prepared by the Ministry of Agriculture, Forestry and Fisheries of Japan is considered to be most suitable for its introduction to the Master Plan study. In addition to land assessment for paddy, assessment is practiced for upland crops.

3.4.2 Specification of Land Capability Class

Land capability class is determined on the basis of the degree of inherent soil limitations, harzards and risk of soil damages for obtaining proper yield and carrying out proper irrigation farming. There are ten factors for assessment of land capability as follows;

(a) Thickness of surface soil
(b) Thickness of effective soil depth
(c) Content of gravel in surface soil
(d) Permeability of soils under submerged condition
(e) State of redox potentiality
(f) Wetness of land /1
(g) Inherent soil fertility
(h) Poisonous materials
(i) Hazard due to inundation
(j) Topography

Further factors from item d. to g. consist of several subfactors for assessment of the land and land assessment is evaluated by subfactors synthetically.

/1 : for upland crops only

The specifications of land capability class are explained as follows;

(a) Thickness of surface soil /1

Class	Paddy	Upland crop
Class I	more than 15 cm	more than 25 cm
Class II	less than 15 cm	25 - 15 cm
Class III	ditto	less than 15 cm
Class IV	ditto	ditto

(b) Thickness of effective soil depth /2

Class	Paddy	Upland crop
Class I	more than 50 cm	more than 100 cm
Class II	50 - 25 cm	100 - 50 cm
Class III	25 - 15 cm	50 - 15 cm
Class IV	less than 15 cm	less than 15 cm

(c) Contents of gravels in surface soil

Class	Paddy	Upland crop
Class I	less than 15%	less than 5
Class II	15 - 35%	5 - 15%
Class III	35 - 50%	15 - 35%
Class IV	more than 50%	more than 35%

(d) Permeability under submerged condition

As far as assessment for permeability under standing water in paddy field is concerned, its assessment is synthetically carried out on the basis of two sub-factors; soil texture of subsoil of 50 cm below ploughing layer and compactness of subsoil of 50 cm below ploughing layer.

/1 : Surface soil is defined as the soil depth which plant root can penetrate easily for absorbing moisture and nutrient, usually ploughing horizon.

/2 : Effective soil depth is soil depth upto base rock, hard pan, fragi pan or gravel layer which plant roots are not able to penetrate.

Class	texture /1	Compactness /2
Class I	very fine or fine	compact or medium
Class II	medium or coarse	compact or medium
Class III	medium or coarse	loose

(e) State of redox potentiality

Reduction of soils in paddy field is assessed by three sub-factors, content of readily decomposable organic matter, content of free iron oxides in surface soils and gleyzation syntherically.

Class	Content of readily decomposable organic matter /3	content of free iron oxides /4	gleyzation /5
Class I	low	High	weak or medium
Class I	low	low	weak or medium
Class I	medium	high	weak or medium
Class II	low	low	strong
Class II	medium	high-medium	strong
Class II	high	high	medium
Class III	medium	low	strong
Class III	high	high	strong
Class III	high	medium-low	medium-strong

/1 : very fine : Clay
fine : Clay loam
medium : Sandy or silty loam
coarse : sand

/2 : compact : more than 15 kg/cm^2 by hardness mater
Medium : 15-21 kg/cm^2 by hardness mater
loose : less than 12 kg/cm^2 by hardness mater

/3 : low : less than 10 mg NH4-N/100g
medium : 10 - 20 mg
high : more than 20 mg

/4 : high : more than 1.5% for dry soil
medium : 1.5 - 0.8%
low : less than 0.8%

/5 : weak : no gley horizon within 50 cm from the surface
medium : gley horizon exist within 50 cm
strong : gley horizon exists throughout profile or exists below ploughing layer.

(f) Wetness of land

This assessment factor is only applied to upland crops.

Class I	no hazard for overwetness or overdryness
Class II	slightly hazard for overwetness or overdryness
Class III	hazard for overwetness or overdryness
Class IV	considerable hazard for overwetness or overdryness

(g) Inherent soil fertility

Inherent soil fertiflity is assessed on the basis of cation exchange capacity and base saturation degree synthetically.

- for paddy

Class	Cation exchange capacity /1	Base saturation degree /2
Class I	high	medium
Class I	medium	high
Class II	high	low
Class II	medium	medium
Class II	medium	low
Class III	low	medium-low

- for upland crops

Class	Cation exchange capacity	Base saturation degree
Class I	high-medium	high-medium
Class II	high-medium	low
Class III	low	high

(h) Poisonous materials

Hazard due to poisonous materials such as sulfuric or sulfidic materials, saline, metals (Cr, Ni, Cu, Zn, As) is assessed.

/1 : high : over 20 me/100g
medium : 20 - 6 me/100g
low : less than 6 me/100g

/2 : high : over 50%
medium : 50 - 30%
low : less than 30%

for Paddy and upland crops

Class	Hazard
Class I	non
Class II	slight
Class III	medium
Class IV	severe

(i) *Risk of soil damages due to inundation*

Risk of soil damages due to inundation is assessed as follows;

Class I — no risk if rainfall with high intensity occurs

Class II /1 — Even if inundation occurs due to high rainfall intensity, excess water is drained out for a short period.

Class III/2 — Inundation continues for a long period if rainfall with high intensity occurs.

(j) *Topography*

Class	Paddy	Upland crop
Class I	less than 3^{o}	less than 3^{o}
Class II	less than 3^{o}	$3 - 8^{o}$
Class III	$3 - 8^{o}$	$7 - 15^{o}$
Class IV	over 8^{o}	over 15^{o}

3.4.3 Land Capability

Based on the specifications of land capability class mentioned in previous section 2, land capability class in the area is divided into four classes shown below ;

Class I - Very suitable for irrigation farming. Land has almost no limitations or hazards for crop production and/or risk of soil damage. They are regarded as either naturally fertile or of the greatest potentiality for crop production without any improvement practices. This class includes Eutric Fluvisols, Chromic Vertisols Orthic Luvisols, and Chromic Luvisols which have no limitation or hazards for crop production.

/1 : In general the lands with this class are found at depressed area in diluvial high land and depressed area along the natural levee.

/2 : The lands with this class are found the area enclosed with dyke and high land, the depressed area playing as a natural reservoir and low-lying land along the coastal line.

Class II - Suitable for irrigation farming. Land has some limitations or hazards and/or risks of soil damage, and some improvement practices are required for normal crop production. This class includes Eutric Fluvisols with class II in redox potentiality and inundation and Ferric Luvisols with class II in inherent soil fertiflity.

Class III - Marginally suitable for irrigation farming. Land has many limitations or hazards and/or risks of soil damage, and fairly intensive improvement practices are required. This class includes Eutric Fluvisols with class III in redox potentiality and inundation, Chromic Vertisols with class III in topography, Orthic Luvisols with class III in topography, Dystric Gleysols, Chromic Luvisols with class III in topography and/or effective soil depth, Dystric Nitosol with class III in inherent soil fertility and Ferric Acrisols with class III in topography and/or inherent soil fertility.

Class IV - Not suitable for irrigation farming. This class includes Thionic Fluvisols, Orthic Luvisols with class IV in topography, Ferric Luvisols with class IV in effective soil depth, Chromic Luvisols with class IV in topography, Dystric Nitosol with class IV in effective soil depth, Ferric Acrisols with class IV in effective soil depth and/or topography, Rendzinas and Lithosols.

The proportional extent of the area in each class is shown in Table 3.3.

CHAPTER IV CLIMATE

4.1 GENERAL

Climate in the objective area is characterized by tropical monsoons, having distinct dry and wet seasons. Climate in the area is largely affected with two different climatic patterns prevailing in the east and west coastal areas of South Sulawesi. The east mansoon predominant from May to June brings about the rainiest month in May in the east coastal area. Whereas, in the west coastal area, the rainiest month occurs in January due to the west monsoon prevailing from November to April. The objective area belongs to the transitional zone of such climate.

The rainfall data are available at 45 gauging stations in and around the objective area, but observation periods vary in each station and they are short.

Other meteorological data, such as temperature, relative humidity, sunshine, wind velocity and pan-evaporation are available at four stations in the objective area; Kanyuara, Sengkang, Ujung Lamuru and Camming, and at a station in east coastal area outside the objective area; Arasoe. The data cover for three to nine years except at Ujung Lamuru for one year.

The general climatic characteristics of the objective area are described hereunder and the monthly mean values of the meteorological elements used in irrigation planning are attached hereunder.

4.2 RAINFALL

The rainfall patterns in the area are broadly classified into four categories; eastern area, northern area, southern part of Lake Tempe and southern inland. The rainfall distribution patterns of the northern and southern inland areas are generally similar, showing the rainiest month in May and the driest month in September or October. The annual rainfall in those areas ranges from 2,000 mm to 1,500 mm. The wet season lasts from March or April to July. About 60% of rainfall occur during the wet season. This pattern is generally consistent with predominant pattern in the east coastal area with the distinctive dry and wet seasons.

The rainfall distribution in the southern part of Lake Tempe differs from other areas. Rainfall distributes almost evenly over a period of November to July. A shift of wet and dry seasons is not clear. Annual rainfall averages to approximately 1,600 mm.

The mean monthly rainfall used in the planning are as shown in Table 4.1.

4.3 TEMPERATURE

The annual mean temperature is ranging from 26°C to 27°C with little seasonal variation. Both the absolute maximum and minimum recorded at Camming in the dry month and are 32°C and 21°C, respectively. The daily fluctuation gets greater toward the inland and high altitude. Table 4.2 shows the mean monthly air temperatures.

4.4 RELATIVE HUMIDITY

The annual average relative humidity is high, 92% at Kanyuara and 75% at Camming. The monthly average reaches its maximum in June at Kanyuara and is approximately 95%. The minimum occurs at Camming in September, and is approximately 86%. The mean monthly relative humidity in the objective area is shown in Table 4.3.

4.5 SUNSHINE

Annual average sunshine percentage are 53% at Sengkang to 55% at Camming (6.4 hr/day to 6.7 hr/day). The monthly average sunshine hours, however, vary widely from 9.9 hr/day at maximum in dry season and to 4.2 hr/day at minimum in wet season. The monthly values used in irrigation planning are presented in Table 4.4.

4.6 WIND VELOCITY

The wind velocity is generally low. The annual average of wind velocity are in the range of 2.5 m/sec to 1.0 m/sec. The monthly mean wind velocity reaches its maximum at Kanyuara in September and is 2.7 m/sec. The minimum is 0.7 m/sec at Camming in August. The mean monthly wind velocity is as shown in Table 4.5.

4.7 EVAPORATION

The annual evaporation from the standard class-A pan observed in the objective area ranges from 1,600 mm (4.4 mm/day) at Camming to 2,100 mm (5.7 mm/day) at Kanyuara. The monthly average evaporation reaches its maximum in October at Kanyuara and is approximately 6.6 mm/day. The minimum occurs in May at Camming and is 3.6 mm/day. The mean monthly pan evaporation at the respective station are shown in Table 4.6.

Besides the above, the meteorological data at Arasoe are used in the irrigation planning they are presented in Table 4.7.

CHAPTER V LAND USE

5.1 GENERAL

The study of present land use in the objective area was carried out on the basis of topographic maps on a scale of 1/25,000. The lands are classified by eight (8) land use categories comprising paddy field, upland field, estate crop field, forest land, grass land, fish pond, swampy land and village land. These studies are mainly used agricultural hydrology and soil conservation studies. Besides data on land use at kecamatan levels are collected from Agricultural Extension Services Offices. These data are mainly used for agricultural studies including multi-cropping index, ratio of irrigated at kecamatan levels.

5.2 LAND USE IN THE OBJECTIVE AREA

Pattern of the land use in the objective area is closely corelated to topographic condition, soil conditions and water sources. The extension of paddy field is related to above conditions in particular.

The farm land comprising paddy field, upland area and estate crop area amounts to 314,000 ha or 41% of total land, and balance in nonfarm land such as forest land, grass land, fish pond, swampy land and village. The area of lands classified by land categories is summarized in Table 5.1 and illustrated in Land Use Maps. Details are explained in Data Book.

Paddy fields mainly occupy the alluvial plains along the major rivers such as the Walanae, the Cenranae, the Bila, the Boya, and their tributaries. Besides, paddy field extends over the undulating and steep land as many as possible whether slope is permitted, as the leftside of the Cenranae river. The total land of paddy field is 184,000 ha or 24%.

Upland area develops over the hilly land with steep slope and natural levels of major rivers. These lands are used under cultivation of maize, soybeans, peanuts, greenbeans, cassava, etc. The upland areas in hilly land are often eroded due to high rainfall intensity and truncated soils with low soil fertility are exposured. In such land, rotation systems under upland crops and Crotallaria are prevailing in view of soil fertility. The total land of upland area is 96,000 ha or 12.5%.

The lands covered with estate crops exist mainly in the surrounding area of villages. Major crops are coconut, and tobacco, followed by Kemiri, Kapok, Coffee, Pepper, etc.

Total land area is 33,000 ha or 4.4%.

Regarding forest land, the land extend over the mountain with elevations above 400 meters, lying north and west of Lake Tempe. The total land areas occupy 172,000 ha or 22.4%.

The grass land extends over the undulating land enclosed with flat plains and mountains. In the middle reaches of the Bila, the Boya and the Gilirang, such land is found in particular. The land is covered with alang-alang, turf and bushes. Sometimes soil erosions occur. The land still remains non-agricultural land due to shallow effective solum depth or no water resources. The total land area amounts to 232,000 ha or 30.2%.

Fish pond land develops over the narrow low lying area along the coastal line. The fisheries cultivation is practiced by blackish water under the use of tidal action. Shrimps are the prevailing products. The total land area is 800 ha or 0.1%.

Swampy lands extend over the low lying area along the Cenranae, the coastal line and the Tempe. The swampy land along the Cenranae, plays an important role in natural storage reservoir duing high flow season. The lands along the coastal line are covered with Thionic Fluvisols or acid sulphate soils, which have no agricultural potentials at present.

5.3 PRESENT CROPPING PATTERNS

The main crop grown in the objective area is paddy, followed by polowijo crops such as maize peanuts, soybeans, green beans, cassava and sweet potatoes. The actual cropping calenders from 1974 to 1977 for each crop are illustrated in Fig. 5.1 to Fig. 5.14. Paddy cultivation is concentrated in wet season and is limited in dry season. The cultivation pattern is strongly affected by distribution of rainfall. Furthermore the planted or harvested areas fluctuate largely year by year. The wet season paddy is planted at the onset of the monsoon, generally April or May and harvested at August or September. The dry season paddy is planted at the period of November or December and harvested at February or March. As far as polowijo crops are concerned, all these crops are grown without irrigation in both paddy field and upland field. In paddy field, these crops are planted at the time after harvest of wet season paddy, using soil moisture remained. In upland area, cultivation of polowijo crops is entirely dependent on the rainfall. These crops are mainly planted at the time just prior to the onset of the monsoon, February and March or October and November. There is also year to year variation of the area cultivated by these crops because of fluctuation of rainfall and its distribution pattern.

5.4 ACTUAL MULTI-CROPPING INDEX

As mentioned in Chapter 1, the study of actual multi-cropping index for the land is done for the area consisting of 29 kecamatans.

Presently about 159,450 ha of paddy field extend over the objective area as agricultural study on the basis of 29 kecamatans. Out of them, 36,410 ha or 23% are irrigated, comprising technical and semi-technical irrigation systems and balance rainfed area or village irrigation area. The ratio served with irrigation facilities varies considerably depending location. Kabupaten Sidrap is well served, 60%, followed by 45% for Soppeng, 8% for Bone and 4% for Wajo.

Total average of harvested area for paddy from 1974 to 1977 is estimated at 104,900 ha for wet season paddy and 29,500 ha for dry season paddy in 29 kecamatans. However there is year to year variation in harvested area. The ratio of harvested paddy area to total paddy field shows 66% for wet season paddy and 18% for dry season paddy for the objective area. It is considered that these low figures mainly result from drought damages due to uneven distribution of rainfall, flood damages and damages caused by pest and diseases. Basically, low figure in dry season paddy is due to shortage of available irrigation water.
Fig. 5.15 to 5.18 shows conditions of damages at Kabupaten level. /1
Based on the information from Agricultural Extension Services office and farmer's interview survey, the reason of damages for each Kabupaten are estimated at follows ;

		Sidrap	Bone	Soppeng	Wajo
1974	WSP/2	˙disease & insect	˙disease & insect ˙drought	˙disease & insect	˙disease & insect ˙flood
1975	WSP	˙flood ˙disease	˙disease & insect	˙flood	˙flood
	DSP/3	˙drought		˙drought	
1976	WSP	˙drought ˙disease & insect	˙drought	˙drought	˙drought
	DSP	˙drought		˙drought	
1977	WSP	˙drought ˙flood	˙drought ˙flood	˙flood ˙drought	˙drought ˙flood
	DSP			˙drought	

/1 : These figures are made on the basis of the data including other area than the objective area.
/2 : Wet Season Paddy
/3 : Dry Season Paddy

As shown above , drought damages for paddy cultivation are most important factor to be solved. It is also considered that these drought damages are accrued from following mechanism.Seeding or planting periods are entirely dependent on the onset of monsoons in rainfed paddy and fluctuates year by year. As described in Chapter 4, there is no rainfall in September in general and considerable year to year variation of rainfall in August occurs. When delay of the onset of monsoon (wet senson) and drought in August occur at the same time, the drought damages bring about. This tendency is particularly recognized in Kab. Wajo being mostly covered with rainfed area. In addition light to medium textured soils, covering considerable part of Wajo, is also considered to affect the damages. The ratio of harvested paddy area to total paddy field is summarized in Table 5.2 at kabupaten level and in Table 5.3 at kecamatan level, respectively. In comparison with the ratio served with irrigation facilities in Kabupaten Soppeng, the ratio of harvested area in dry season paddy is higher. This attributes to the fact that small stream intakes under village irrigation are possible during dry season. Because there are relatively abundant discharge in the small tributaries of which upperstream have much rainfall in dry season by the effect of the west monsoon.

Polowijo crops in the paddy field are not prevailing into the objective area. About 20 percentage of paddy field are under cultivation after harvest of wet season paddy. The low cropping ratio is considered to be accrued from poor drainage conditions due to high rainfall intensity and unstabilized or low price of polowijo crops. Actual multi-cropping index in paddy field is estimated at 1.06 for the agricultural study /1 area as shown in Table 5.3.

As for upland area, total land area amounts to 85,720 ha. The planted or harvested areas fluctuate year by year due to uneven distribution of rainfall. Average harvested area of polowijo crops from 1974 to 1977 shows 75,160 ha, of which about 60 percent is occupied by Kabupaten Bone. The actual multi-cropping index in upland area is estimated at 0.85 for the entire agricultural study area, ranging from 0.04 to 3.14 at kecamatan level.

/1 : Total harvested area / Total area

CHAPTER VI EXISTING IRRIGATION AND DRAINAGE SYSTEM

6.1 EXISTING FACILITY

6.1.1 General

In four Kabupatens, Sidrap, Soppeng, Wajo and Bone, there are 7 "Technical" irrigation systems, 36 "Semi-technical" irrigation systems and about 150 "Surface" or "Village" irrigation systems (so called "Desa Irrigasi"). Out of 36 semi-technical systems, two in Kab. Sidrap and one in Kab. Soppeng are not completed yet or under planning. The beneficial area of the existing technical and semi-technical irrigation systems is estimated based on the topographic maps on a scale of 1/25,000 and data and informations from DPUP Sul-Sel., three Irrigation Section Offices (PU Seksi Pengairan) and DIPERTA, as shown on Table 6.1.

Total beneficial area in four Kabupatens is estimated at approximately 57,800 ha; 39,400 ha of the technical irrigation systems and 18,400 ha of the semi-technical irrigation systems, which is equivalent to about 27% of total paddy field in four Kabupatens. There are about 17,800 ha of beneficial area of the Village irrigation systems in addition to the above. The Village irrigation system is, however, so primitive and tentative that area irrigated varies considerably year to year, especially in dry season, depending on rainfall as similar as rainfed culture.

Table 6.2 shows present beneficial area of respective technical and semi-technical irrigation systems in each Kecamatan. The beneficial area in the objective area is totaled at 36,424 ha or 23% of total paddy field area, 159,450 ha at present.

On Table 6.3, progress of irrigation development in four Kabupatens during recent five years since 1974 is estimated. The irrigation development in recent five years was mainly rehabilitation works of the old facilities and construction works of small secondary canal and tertiary outlets. Before completion of such rehabilitation works, it seems that old system was classified as "non-technical system" as Village irrigation system.

The technical and semi-technical irrigation systems have usually permanent intake structure, water distribution canals and permanent canal structures. Some of semi-technical systems have no permanent intake structures nor distribution canals but head-reach only. Major difference between the technical and semi-technical irrigation systems are dependent on the density of tertiary irrigation canals and drains as well as completeness of intake structures and off take structures to the secondary canals and tertiary canals, as shown on Table 6.4.

The canal density of main and secondary canals is almost same in both technical and semi-technical irrigation systems at about 6 m/ha. However, tertiary canal is approximately 25 m/ha of the Sadang System in Kab. Sidrap and 9 m/ha of other technical irrigation system while there are usually no tertiary irrigation canals in the semi-technical system.

There are no systematic drainage facilities in the objective area as well as other area in four Kabupatens, except drainage canal network in the Sadang irrigation system and few drainage canals in the other technical and semi-technical irrigation systems. Total length of drainage canal is only approximately 190 km consisting of 160 km or 12 m/ha in the Sadang system. Excess water in the cultivated land is usually drained through natural drains, streams and the rivers to the main drains in the objective area, the Walanae River, the Bila River, Lake Sidenreng, Lake Tempe and the Cenranae River.

Out of 43 technical and semi-technical irrigation systems, five technical and 22 semi-technical systems are supplying irrigation water to paddy field of 36,400 ha in the objective area as shown on Fig. 6.1. Present conditions of them are described hereinafter and summarized on Table 6.5.

6.1.2 Bila River Basin

On the North of Lake Tempe (the Bila River basin), there is existing paddy field of 25,850 ha along the Bila River and its tributaries, the Boya River, the Lancirang River, the Kalola River, etc. There are the following one technical system and three semi-technical systems of which total beneficial area is 8,700 ha or 34% of total paddy field in this area.

(1) Bulucenrana

Bulucenrana irrigation system is a technical system in Kab. Sidrap. irrigation water is diverted by a permanent weir which was constructed across the Boya River during 1930s and supplied on paddy field of 6,261 ha in Kec. Duapitue, Kab. Sidrap through the canals rehabilitated and maintained in good conditions since 1974. The catchment area of the Boya River is counted at 514 km^2 at existing intake site. As one of the rehabilitation works of the system, tertiary canals are improved year by year. However, approximately a half of low land is damaged so frequently by the flood of the Bila River and poor drainage of the Lancirang River at present.

(2) Lancirang

As one of the Sederhana project, rehabilitation works was completed by the end of FY 1975/76. Irrigation water is taken off from a distributary of the Lancirang River without weir. During the low water level in the tributary, irrigation area suffers often from dought damage, while even druing the wet season it is damaged due to flood and poor drainage. Although the catchment area of the Lancirang River is approximately 180 km^2, river discharge through a distributary is not utilized so effectively for irrigation. Irrigation area is 417 ha of which 292 ha is in Kab. Sidrap and 125 ha in Kab. Wajo.

(3) Belawa

This system is the biggest semi-technical system in Kab. Wajo. Irrigation water is taken from the downstream reach of the Bila River without weir across the river, when the water level is relatively high. The gate structure at intake is provided for the protection of inflow of the flood. However, this system is damaged so often due to flood of the Bila River. On the other hand, irrigable area is limited due to extreme drop of water level in the dry season. Beneficial area is 1,500 ha in wet season.

(4) Salodua

There are some small rivers originated in low hills on the east of Lake Tempe. The Salodua system is a semi-technical irrigation system diverting water from one of such small rivers, so called the Manumanu River of which catchment area is only 8 km^2. The irrigation area is 524 ha of paddy field extended over gentle slope on the east of Lake Tempe. Irrigation is limited in wet season only due to the negligible small discharge in dry season.

6.1.3 Lake Sidenreng Basin

On the North and West of Lake Sidenreng (Lake Sidenreng Basin), 19,700 ha of paddy field are extended within the objective area in Kab. Sidrap. Each two technical and semi-technical irrigation systems serve 14,828 ha or about 75% of them. Irrigation water of two technical systems are diverted from the rivers outside the objective area. Irrigation water of one semi-technical system is supplemented from a canal of one technical system.

(1) Bulutimorang

This system is one of the technical irrigation system in Kab. Sidrap. Irrigation water is diverted from the Rappang River of which catchment area is approximately 74 km^2 at existing intake site. The intake structure consists of fixed type permanent weir and intake gate. Irrigation area is 5,337 ha in rather high plain on the north of a secondary canal of the Sadang system.

(2) Sadang

The Sadang Irrigation system is the biggest technical system in the South Sulawesi diverting water from the Sadang River of which catchment area is 5,875 km^2 at intake site. The major works including construction of a movable dam across the Sadang River were completed by the end of World War II.

Rehabilitation works including construction works of drainage system, small secondary canals and inspection roads were carried out under the PROSIDA. In the objective area, the almost of such works were completed by the end of 1975. Total irrigable area of the Sadang system is 56,330 ha consisting of 36,770 ha in Kab. Pinrang and 13,560 ha of South system in Kab. Sidrap (left bank of the Sadan River) and 6,000 ha of North system (right bank) in Kab. Prirang under construction. Out of 13,560 ha of Kab. Sidrap, 8,050 ha is located in Lake Sidenreng basin in the objective area. Irrigation area in the Objective area is served with irrigation water through two major secondary canals; the Belawa canal running toward east and the Sidenreng canal toward south. At present, two pumping up sub-projects are proposed to irrigate higher land than the existing canal, in and beside the objective area.

(3) Bilokka

The Bilokka irrigation system is a semi-technical system with a fixed type permanent weir across the Bilokka River. Catchment area of the Bilokka River is approximately 50 km^2 at the intake site, Irrigation area is 931 ha of paddy field spread over gently sloping plain on the west of the Sidrap Canal of the Sadang system.

(4) Wattae

This system is one of the semi-technical system rehabilitated as a Sederhana Irrigation Project. The intake structure is a fixed type permanent weir across the Bilokka River in lower reach than inflow of excess flow in the Sidrap canal of the Sadang system. Water source is accordingly not only the surface flow of the Bilokka River but also excess of the Sadang system. Irrigation area is measured as 510 ha.

6.1.4 Lake Tempe Basin

On the west and south of Lake Tempe (Lake Tempe Basin), there are 10,600 ha of paddy fields in a flat and gently sloping plain along the rivers originated in western hills in Kab. Soppeng. Approximately 60% or 6,200 ha is served with irrigation water by two technical and four semi-technical irrigation systems in Kab. Soppeng. In addition to them a semi-technical system is proposed to be repaired as its canal system is seriously damaged and no water is supplied at present. Present conditions of those existing systems are briefed hereinafter.

(1) Latenreng

This system was classified as a village irrigation system named as Weronge system, of which irrigation area was 450 ha according to "Inventory of Irrigation Area in Kab. Soppeng" reported by an Irrigation Section Office (PU. Seksi Pengairan Soppeng-Wajo) on March 31, 1978. Since FY 1978/79, this system is listed as one of the semi-technical system with its irrigable area of 800 ha. This system has a permanent intake structure on the upstream of the Lajaroko River, a major tributary of the Batu-Batu River. However, most of the head reach canal along the skirt of hill are seriously damaged. No water is supplied from its intake at present. Only in rainy season, surface runoff from small water-shed flows into canals which maintained year to year by the inhabitant, and is used as irrigation water in the limited area. The canal system shall be repaired completely so that irrigation water will be supplied to the whole irrigable area.

(2) Lajaroko

Lajaroko system is one of the technical irrigation system in Kab. Soppeng of which a permanent intake structure was completed in 1922. Irrigation water is diverted from the Lajaroko River of which catchment area is 54 km^2 at intake site, and supplied through a main canal and secondary canals to the paddy field of 1,250 ha spread over flat plain on the west of Lake Tempe on the left bank of the Lajaroko and the Batu-Batu Rivers.

(3) Salobunne

Salobunne system is also technical irrigation system in Kab. Soppeng. Although a permanent intake structure was completed in 1922, distribution facilities are completed recently, Secondary canals and their related structures are completed by the end of FY 1976/77. Irrigation water is diverted from the Salobunne River, a tributary of the Batu-Batu River, of which catchment area is 49 km^2 at the existing intake site. Present irrigation area is measured at 2,100 ha of land extended over the gently rolling plain on the west of Lake Tempe along the Batu-Batu River, excluding some swampy area besige Lake Tempe.

According to PU Data, irrigable area is 3,500 ha including swampy area beside Lake Tempe. /1

(4) Toweleng

This system is a semi-technical system, which has a fixed type permanent weir on the Toweleng River. The Toweleng River has its catchment area of 32 km^2 at the intake site. Irrigation area is 450 ha.

(5) Leworang kiri and kanan

In the downstream of the Padangeng River, a fixed type permanent weir was constructed nearby Leworang village during 1930s and about 1,200 ha of paddy field along the left bank are irrigated. In 1975 intake gate at just upstream of the existing weir and distribution canals on the right bank of the Padangeng River were constructed to irrigate about 700 ha of paddy fields as one of the Sederhana Irrigation Projects. The catchment area of the Padangeng River is 118 km^2 at the Leworang intake weir site. The distribution canals on the left bank system, especially secondary and tertiary canals are not sufficient.

(6) Tinco

Although existing Tinco system is listed as a semi-technical irrigation system taking water from the Lawo River, it has no permanent intake structure. And, distribution facilities are very poor. A catchment area of the Lawo River is 64 km^2 at the existing intake site and present irrigation area is about 500 ha, though its irrigable area is extended over 1,500 ha or more.

6.1.5 Walanae River Basin Lower Reaches

On the South of Lake Tempe (Lower Reaches of the Walanae River Basin), approximately 14,000 ha of paddy field is spread over on flat and gently sloping plain along the Walanae Rivers and its small tributaries in Kab. Soppeng and Kab. Wajo. Out of 14,000 ha, 3,584 ha or about 25% is beneficial area of seven semi-technical irrigation systems in Kab. Soppeng. There are no technical irrigation systems in Kab. Wajo. Present conditions of those irrigation systems are described hereinafter.

(1) Talumae and Akampeng

On the south of Lake Tempe, about 1,500 ha of paddy field is irrigated by two semi-technical systems. One is Talumae of which beneficial area is 340 ha. And the other is Akampeng of 1,100 ha. The former is taking irrigation water by a permanent weir on down stream of the Lawo River. The latter is irrigated also by a permanent weir on the Belo River. Irrigable areas of both systems are not clearly divided but overlapped mostly in low land. An intake weir of Akampeng is damaged by a flood in 1975 and tentatively repaired with gabion. Not only repairing works of the damaged weir body but also extension works of weir apron are needed. /2

/1 : Item No.31 on Table 1.1.

/2 : Downstream of the Soppeng River

(2) Larange and Lagarigi

On the Awo River, a tributary of the Belo River, there are two permanent intake weirs. One is for Larange semi-technical system of which irrigation area is 1,000 ha. The other is Lagarigi semi-technical system for 200 ha. The catchment area of the Awo River is measured at 96 km^2 at Lagarigi intake weir. Both weirs are slightly damaged on their apron due to erosion of river bed materials.

(3) Cennae

With construction of a gabion weir across the Langkemme River near by Cennae Village, irrigation water is supplied for 214 ha. At present, distribution facilities are being constructed under the Sederhana Project and scheduled to be completed by the end of FY 1978/79. The catchment area of the Langkemme River is about 102 km^2 at the existing intake site.

(4) Paroto and Takku

On the small rivers originated in east low hills, there are two Sederhana Projects which were completed by the end of FY 1975/76. One is Paroto of which irrigation area is 270 ha. The other is Takku of 460 ha. Both systems have a permanent intake weir on respective rivers. A catchment area is 7 km^2 and 1.6 km^2 of the Paroto and Takku River, respectively. Usually no water is available during the dry season and even in the rainy season those facilities are not so effectively supplying water due to shortage of surface runoff.

6.1.6 Walanae River Basin Upper Reaches

In Southern Inland of the objective area (Upper Reaches of the Walanae River Basin), approximately 24,000 ha of existing paddy field is totals excluding paddy fields in Kab. Maros. Those are mainly laid on relatively gentle rolling plain along the Walanae River and its tributaries. Out of 24,000 ha, only 1,170 ha or 5% of it is covered by the following three existing semi-technical irrigation systems in Kab. Bone.

(1) Maradda

Maradda semi-technical irrigation system is located on the gently rolling plain in the most upstream river basin of the Walanae River. Intake structure has a fixed type permanent weir constructured across the Maradda River, a tributary of the most upstream of the Walanae River. Catchment area is 21 km^2. Irrigable area is measured at 430 ha. Facilities are maintained in good conditions.

(2) Bengo

Bengo semi-technical irrigation system is located on the right bank of the middle reach of the Walanae River. Water source is the Taka River which is a small tributary of the Walanae River originated in hills in the east. Catchment area of the Taka River is 21 km^2 at existing intake site. Irrigable area is measured at 500 ha of paddy field spread over gently sloping plain toward the Walanae River.

(3) Tadangjompi

This system is a semi-technical irrigation system rehabilitated as one of the Sederhana Irrigation Projects recently. A spring is used for the water source of this system. Irrigation area is measured at 240 ha paddy field spread over the slopes in a valley of the tributaries of the Walanae River on its middle reach.

6.1.7 Cenranae River Basin Lower Reaches and Gilirang River Basin

In the East of the objective area (Lower Reaches of the Cenranae River Basin and Giliran River Basin) approximately 65,000 ha of paddy field are spread over the vast rolling land along the Cenranae River, the Gilirang River and their tributaries. Development of irrigation project in this area was limited due to non-availability of the water source. Only each one semi-technical irrigation system was developed in Kab. Wajo and Bone in the Cenranae River Basin. Total beneficial area of them is 1,940 ha or 3% of paddy field in those basins. Present conditions of existing two irrigation systems are as follows:

(1) Bulupatira

This system is a semi-technical system in Kab. Wajo, rehabilitated as one of the Sederhana Irrigation Projects in FY 1975/76. The system has no weir. Two intake gates constructed on the bank of natural drain (stream in the paddy field) divert irrigation water to its irrigable paddy field of 240 ha.

(2) Unyi

Unyi semi-technical irrigation system is located on the flat plain along down stream reaches of the Cenranae River in Kab. Bone. Intake structure was a fixed type permanent weir constructed across the Unyi River which is a tributary in the most down stream reach of the Cenranae River with its catchment area of 136 km^2. However, it was washed out by flood in 1973. At present, fixed weir portion is repaired with gabion. Present irrigation area is measured at 1,700 ha of paddy field. When the sufficient water is available, it will be extensible to approximately 2,500 ha. The distribution facilities for 1,700 ha are maintained in fairly good conditions.

6.1.8 Water Sources of Existing Irrigation System

The Water sources for the existing irrigation systems in four Kabupatens are mainly surface runoff of the rivers in and out side of the objective area. Spring water is also used for small scale systems in Kab. Bone, but their beneficial area is limited. Total catchment area of water source used effectively is approximately 1,900 km^2 or 4.2 times of its irrigable area as shown on Table 6.6.

In Kab. Sidrap, approximately 70% of total beneficial area of existing facilities are irrigated with water from outside source of the objective area, especially from the Sadang of which project area in Kab. Sidrap is a half of total area irrigated in Kab. Sidrap. The other source of irrigation water in the objective area is in two basins originated from the northern mountainous region and the western hills.

The water source in Kab. Soppeng is mainly the small scale rivers; the Batu-Batu River, the Towelang River, the Padangeng River and the Lawo River originated in the western hills, and the Belo and the Awo Rivers originated in hills lying in the south of Kab. Soppeng. The catchment area of such rivers from the western hills and southern hills is about 30 to 100 km^2 at their debouching points. Besides, there are small rivers as the water source of irrigable area along bank of the Walanae River. Their catchment area is quite limited. Total catchment area of the water source in Kab. Soppeng is approximately 470 km^2 or 4.2 times of their irrigable area excluding about 100 km^2 of the Langkemme River of which irrigation area is only about 1/50 of its catchment area.

There are no big water sources used for existing irrigation systems in Kab. Wajo, expecting the Belawa system of which irrigation water is taken from the lower reach of the Bila River. Catchment area of the water source is estimated at only approximately 13 km^2 or 1.7 times of its irrigable area excluding about 1,350 km^2 of the Bila River for the Belawa system.

In Kab. Bone, most of the major irrigation systems is developed on the eastern plain along the coast outside the objective area, except the Maradda system at the upper reach of the Walanae River, the Bengo system in the middle reach of the Walanae River but its water source is small tributary, and the Unyi system at the lower reaches of the Cenranae River with a water source of the Unyi River.

6.2 WATER CONSUMPTION FOR PADDY CULTIVATION

Although there are approximately 217,000 ha of paddy field in total of 4 Kabupatens or 159,450 ha in 29 Kacamatans in the objective Area, harvested area as well as planted area of paddy varies year to year and season depending on the rainfall and its distribution patterns as estimated on Tables 6.7 to 6.10. Water consumption for paddy cultivation in each Kabupaten during recent four years is estimated on Tables 6.11 to 6.13 based on the prevailing cropping pattern and climate data. The result are shown on Table 6.14 in an average in each Kabupaten.

The table shows that:

(1) Annual total consumption in four Kabupatens reaches approximately 1,200 million m^3 of which 60% or 700 million m^3 dppends on rainfall and the remain, approximately 40% or 490 million m^3 is from irrigation.

(2) Approximately 300 million m^3 or 60% of irrigation water is supplied from the water sources outside the objective area, that is, water supplied from the sources in the objective area is only approximately 190 million m^3 which is about 3% of annual river runoff of the Cenranae at Sengkang (184 m^3/sec).

It is considered that one of the reasons of above fact is no utilization of not only the main stream of the Walanae, the Bila and the Cenranae Rivers including Lake Tempe and other lakes, but also the major tributaries excepting the Boya River where Bulucenrana weir was constructed and serves 6,261 ha of paddy field. Annual consumption of the Bulucenrana existing system is estimated at approximately 70 million m^3 which is about 8% of annual runoff of the Boya River; 26.6 m^3/sec as shown on Table 6.17.

6.3 AVAILABLE WATER FOR IRRIGATION DEVELOPMENT

The major river system in the objective area is composed of Lake Tempe, the Bila River, Lake Sidenreng, such small rivers originated in the western hills and flow into Lake Tempe as the Batu-Batu River, the Padangeng River and the Lawo River, the Walanae River and the Cenranae River which flows from Lake Tempe and to the bay of Bone. The Gilirang River located in the north-east of the objective area flows eastward to the bay of Bone directly.

The Bila River originated in northern mountainous area flows south into Lake Tempe. The river basin consists of four sub-basins of the Bila, the Boya, the Lancirang and the Kalola Rivers. The catchment area is approximately 370, 510, 100 and 140 km^2 respectively at their debouching points. Out of said four rivers, former two rivers are major sources of irrigation water in the land on the north of Lake Tempe. The river discharge is observed at Bila of the Bila River where catchment area is 379 km^2 since April, 1973. Mean monthly discharge is available during five years from the commencement of the observation. River runoff is averaged at 19.2 m^3sec as shown on Table 6.17 or approximately 600 million m^3 per annum.

River runoff of the Boya River is observed at Bulucenrana gauging station since October, 1975. Observed discharge does not include the discharge diverted by the existing irrigation facility. As no data of diverted water are available, water requirement in the existing irrigation system is estimated based on the prevailing cropping calendar as shown on Fig. 6.2, irrigated area in the beneficial area of the system (See Table 6.3), and the climate data at Kanyaura (Pan-evaporation) and Tanrutedong (Rainfall). The results are shown on Table 6.15 together with revised mean monthly discharge. In addition to above revision, mean monthly discharge before October, 1975 is estimated applying specific discharge of the Bila in respective month. Thus average runoff of the Boya River is estimated at 26.6 m^3/sec as shown on Table 6.17 or 840 million m^3 per annum. Total annual runoff of both rivers is estimated at approximately 1,400 million m^3. Approximately 26,000 ha of paddy field extended on the north of Lake Tempe will be served with said water sources.

On the north and west of Lake Sidenreng, there are no useful river basins in the objective area. Irrigation water for approximately 20,000 ha of land spread over flat plain in the north-west of the objective area will be supplied from water source of such big river basin outside the objective area as the Sadang River.

There are 6 rivers originated in western hills, that is, the Bilokka, the Batu-Batu, the Towereng, the Padangeng, the Lawo and the Langkemme Rivers of which catchment area is approximately 50, 100, 30, 110, 60 and 100 km^2 respectively at their debouching point. They flows into Lake Tempe through the plain consisting mainly of paddy field of approximately 22,200 ha extended on the west and south of Lake Tempe, except the Langkemme River which flows into the Mario River, a major confluent of the Walanae River. The existing irrigation systems diverting water such small rivers serve approximately 10,000 ha of land in total with independent small scale intake structures. Out of those six rivers, the Batu-Batu, the Padangeng, the Lawo and the Langkemme Rivers will be major sources of irrigation water. The river discharge of those four rivers have some correlations each other judging from the similar characteristics of the basin as shown on Fig. 6.4. Based on said correlation, mean monthly discharge is estimated for the Batu-Batu (before June, 1975), the Padangent (as an average specific discharge of the both Batu-Batu and Lawo Rivers) and the Lawo (before July, 1975) as shown on Table 6.16 and 6.17. According to Table 6.17, annual runoff of the Batu-Batu, the Padangeng, the Lawo and the Langkemme River is averaged at 4.1, 4.3, 2.8 and 4.2 m^3/sec. respectively or approximately 130 million, 140 million, 90 million and 130 million m^3 per annum respectively. /1

In addition to those small scale rivers, the Walanae main stream is the largest water source. The Walanae River is originated in the southern mountanous area, flows north through the central part of South Sulawesi, and joins to the Cenranae River at the mouth of Lake Tempe. The catchment area is approximately 2,680 km^2 at downstream of the confluence of the Mario River which is one of the major tributaries. River runoff of the Walanae is observed at three gauging stations, Ujung Lamuru, Lakibong and Cabenge. Based on them, mean monthly discharge at proposed Mong dam site is summarized on Table 6.17. Average discharge is estimated at 100 m^3/sec or approximately 3,200 million per annum.

On the upstream reaches of the Walanae River there are four major tributaries which are the Mario, the Batupute, the Menraleng and the Sanrego Rivers. The catchment area is 485, 185, 515, and 230 km^2 respectively at their confluence to the Walanae River. Out of them, the Sanrego River in the most upstream basin has relatively abundant discharge through out the year. Mean monthly discharge is observed at its debouching point where the catchment area is 176 km^2 since 1973, as shown on Table 6.17. The average discharge is estimated at 9.2 m^3/sec or approximately 290 million m^3 per annum.

Although several small rivers originated in southern low hills in the eastern area flows into the Cenranae River, they are not effective source of irrigation water for the paddy field extended over the gently rolling plain along the Cenranae River. The Walanae River will be only a water source on this area. On the other hand, there are no water source for the paddy field along the left bank of the Cenranae except Lake Tempe and the Cenranae itself.

The Gillirang River originated in northern hills flows east to the bay of Bone meandering through the gently rolling plain. The catchment area is approximately 220 km^2 at debouching point near by Watang Gillirang. River discharge is observed at Tarumpakkae gauging station where the catchment area is 300 km^2, since September, 1975, as shown on Table 6.17. As the average discharge at the gauging station

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/1 : River discharge of the Batu-Batu is revised as same methods as the Boya on Table 6.15.

is 20.8 m^3/sec or approximately 650 million m^3 per annum, annual discharge at debouching point is estimated at approximately 480 million m^3. However, variation of mean mothly discharge is considerably.

The average annual river runoff in respective rivers described above is summarized belows:

(Unit: 10^6 m^3)

	Wet Season	Dry Season	Annual
Bila River basin			
Bila at G.S.	381	224	605
Boya at intake	527	312	839
L. Tempe basin			
Batu-Batu at G.S.	63	66	129
Padangeng at Padangeng	63	73	136
Lawo at G.S.	38	50	88
Walanae River basin			
Sanrego at G.S.	154	136	290
Langkemme at G.S.	56	77	133
Walanae at Mong	1,597	1,557	3,154
Gilirang River basin			
Gilirang at G.S.	489	166	655

6.4 PRESENT PLANS OF IRRIGATION DEVELOPMENT

In the objective area, the government of Indonesia is studying the three irrigation projects, the Bila irrigation project, the Sanrego irrigation project and the Langkemme irrigation project under the Directorate of Irrigation. Present situations are as follows:

The Bila Irrigation Project

With construction of a intake weir at about 1 km north of Bila village, irrigation water will be diverted from the Bila river and served for about 9,000 ha of paddy field on the North of Lake Tempe. Water level at intake is planned at EL.30.00 m above mean sea level.

The following pre-investment studies and preparations were carried out before and on 1978;

(1) Preliminary Study for the Water Resources Development in the Central South Sulawesi, by O.T.C.A. (now J.I.C.A.) under technical assistance of the Government of Japan in 1974 (reported on July, 1974).

(2) Mapping work on about 13,000 ha of irrigable area by the Bila Project with a scale of 1/5,000 by WECON Ltd. under the finance of Directorate of Irrigation 1974/75.

(3) Geological survey and soil mechanical test for a proposed Bila Weir site, by TRICON P.T. under the finance of Directorate of Irrigation in 1975/76 (reported on September 1976)

(4) Agro-economic Survey in the Project area of Bila and Boya, the Survey Team of the Central South Sulawesi Water Resources Development Project in 1976/77 (reported on February, 1977)

(5) Hydrologic Data Collection and Guidance for Data Collection for the Central South Sulawesi Water Resources Development Project, by the Colombo Plan Experts dispatched by J.I.C.A. in 1976 (Report was summarized on March, 1977).

(6) Hydraulic Model Test on a proposed Bila Weir, by Directorate of Hydraulic Engineering (DPMA) in 1976/77 (reported on July, 1977).

(7) Geological Survey and Soil Mechanical Test for a proposed left main canal, by TRICON P.T. under the finance of Directorate of Irrigation in 1977/78.

The Sanrego Irrigation Project

In the southern inland of the objective area, it is planned to irrigate about 3,400 ha of paddy field along the Sanrego River, a tributary of the most upstream reaches of the Walanae River, with construction of a intake weir at about 4 km South of Sanrego village. Irrigation water will be diverted at EL.170 m from the Sanrego River.

The following pre-investment studies and preparations were carried out before and on 1978;

(1) Mapping work on about 10,000 ha of irrigable area by the Sanrego Project with a scale of 1/5,000, by WECON Ltd. under the finance of Directorate of Irrigation in 1972/73.

(2) Reconnaissance survey, on the Sanrego irrigation project, by WECON Ltd. in 1973/74 (Reported on February, 1974).

(3) Preliminary Study for the Water Resources Development in the Central South Sulawesi, by O.T.C.A. (now J.I.C.A.) under technical assistance of the Government of Japan in 1974 (Reported on July, 1974).

(4) Geological survey and soil mechanical test for a proposed Sanrego Weir site, by TRICON P.T. under the finance of Directorate of Irrigation in 1976/77.

(5) Hydrologic Data Collection and Guidance for Data Collection for the Central South Sulawesi Water Resources Development Project, by the Colombo Plan Experts dispatched by J.I.C.A. in 1976 (Report was summarized on March, 1977).

(6) Hydraulic Model Test for a proposed Sanrego Weir, by Directorate of Hydraulic Engineering (DPMA) in 1977 (Reported on July, 1977).

The Langkemme Irrigation Project

With construction of an intake structure across the Langkemme River, paddy field spread over the central part of the objective area will be irrigated. The study is just started, and irrigable area is not delineated yet as only the following pre-investment studies and preparations were carried out before 1978.

(1) Preliminary Study for the Water Resources Development in the Central South Sulawesi, by O.T.C.A. (now J.I.C.A.) under technical assistance of the Government of Japan in 1974 (Reported on July, 1974).

(2) Hydrologic Data Collection and Guidance for Data Collection for the Central South Sulawesi Water Resources Development Project, by the Colombo Plan Experts dispatched by J.I.C.A. in 1976 (Report was summarized on March, 1977).

(3) Mapping in the scale of 1/5,000 for irrigable area of the Langkemme project in 1977 under the finance of Directorate of Irrigation.

On the other hand, provincial office of public works of South Sulawesi proposes to rehabilitate the existing irrigation systems. The almost all of the existing systems listed on Table 6.1 have improvement programme of tertiary canal system and rehabilitation programme, especially such systems of damaged or primitive facilities as Latenreng, Tinco, Unyi, Jaling, etc. In addition to them, some pump-up irrigation plans are under study for the extension of the Sadang System in and around the objective area with scale of 1,000 to 2,000 ha unit.

Further, as small scale projects, approximately 150 village irrigation projects in four Kabupatens are proposed to be rehabilitated with construction of new gabion weirs and permanent intake structures during Third Five Year Development Plan to be commenced from 1979 F/Y. Beneficial areas of such village irrigation projects range from less than 10 ha to 850 ha of maximum size and totaled at about 18,000 ha. Those projects are planned to divert irrigation water from the small rivers and streams which have usually insufficient and unstable discharge even in rainy season.

CHAPTER VII FARMING OPERATION

7.1 RICE

Rice is the most important crop in the objective area, of which culture is simple and except for isolated instances, no mechanical equipment is used. Farming is carried out by labour intensive form from the stage of seeding to harvest. All members of family contribute their labour. Buffaloes or oxen provide motive power for land preparation.

In the objective area, high yielding varieties such as IR - 20, C4 - 64, IR - 26, IR - 28, IR - 30 have been widely spread over through the extension of BIMAS and INMAS programme and occupied over 70% of total paddy field as shown in Fig. 7.1. In addition new varieties, "CITARUM" and "ASAHAN" are recently introduced to some extent. Additionally local varieties such as Lotong Tanru, Banda Bulu, Korete, etc. have been applied in the objective area. The growing period is usually about 115 to 135 days for high yielding varieties and 150 to 170 days for local varieties.

Seed is selected from the last harvest or is provided through agricultural extension office. Seed is grown in nurseries covering about 1/20 to 1/25 of the field and remains in the nursery for 25 to 40 days before transplanting to the field.

Fertilizers and Agricultural chemicals are applied over the irrigated land through BIMAS and INMAS programme. Generally no fertilizers are applied in rainfed land including upland rice area. Dosage of fertilizers varies largely depending on locations. The estimated dosages per ha range from about 50 to 140 kg of urea and 5 to 80 kg of triple super phosphate. Application of agricultural chemicals is not always well extended in the objective area, inspite of considerable damages due to rice stem borer, leaf folder, case worm, leaf hopper, rice bug, tungro, grassy stunt, bacterial blight etc. The dosages range from 0.5 to 2 liters per ha. Major agricultural chemicals are Diaginan, Furadin and Sevin. The summary of the dosage in Kecamatan level is shown in Tables 7.1 and 7.2.

As mentioned previously, farm operation is carried out by man power except land preparation. Transplanting method is prevailed and direct sown method is not found. Fertilization and weeding are done one or two times during growing period. Harvest is carried out by sickles but "Ani-Ani" system remains in some part of Kabupaten Wajo and Bone. Labour requirement for farm operation is estimated on the basis of the field survey and farmer's interviews. Table 7.3 indicates the summary of labour requirement for paddy under upland rice area, rainfed area and irrigated land, respectively.

7.2 UPLAND CROPS

Major upland crops grown include maize, peanuts, soybeans, green beans, cassava and sweet potato. Their cultivation is also very simple. No fertilizers and no improved varieties are usually used. The major varieties of upland crops prevailing in the objective area are as follows;

Kind of Crops	Name of Varieties
Maize	BAKU BAKU, TOJANG KALI, IMPAIMPA, ADIN
Peanuts	GAJA, SCHWARZ-21
Green beans	BAKTI, PARIA, SIWALI
Soybeans	DAVROS, RINGIT, ORBA
Cassava	VALENKA, MAGI, MANTIGA
Sweet potato	LAMEPUTI, LAME KAMUNMU

Seed requirement per ha is 30 kg for maize, 100 kg for peanuts, 40 kg for soybeans, 25 kg for green beans and 11,000 stalks for cassava, respectively. Farming operation is entirely dependent on man power. Management work consists solely of weeding, which is done one or two times during growing period. Labour requirements for upland crops are estimated on the basis of field survey, of which results are summarized in Table 7.4.

CHAPTER VIII CROP YIELD AND PRODUCTION

8.1 YIELD SURVEY FOR PADDY

(1) Introduction

Yield survey for paddy was carried out during the period of 28th March to 4th April in 1978 in order to identify the defects hampering increase of unit yield of paddy at present. Yield survey was conducted for dry season paddy at 13 sites of paddy fields in Kabupatens Sidrap, Soppeng and Bone. Due to shortage of survey period simpler survey method was applied. Twenty (20) hills were selected from each sampling site. The average number of panicle per hill and average height of rice for 20 hills were computed. Out of 20 hills, a hill which has the nearest number of panicles per hill and height of plant to average value was selected as the representative hill for yield estimation. By the use of the representative hill, the number of panicles per m^2, the number of grains per m^2, the number of degenerated grains per panicle, the percentage of ripened grains, and the weight of 1,000 grains were analyzed and yield estimation was made. The method of analyses was practiced according to the method described in "CROP SCIENCE IN RICE" and outlined in Fig. 8.1. /1

The result of yield of paddy is summarized in Table 8.1.

(2) Defects to be Solved in Improvement of The Paddy Yield.

The most important factors for determination of paddy yield are considered to comprise percentage of ripened grains and number of grains per unit area. In general the percentage of ripened grains under normal conditions is about 85%. If the percentage of ripened grain amounts to less than 85%, improvement of rice cultivation should be paid to increase of this percentage in the first place.

Table 8.1 indicates that all samples with the exception of No.6 have the percentage of ripened grains less than 80%. It is considered that low percentage of ripened grains is due to adverse or unfavourable conditions during period from the panicle initiation stage to the final stage of flowering. It is also considered from the farmer's interview in each sampling site that the unfavourable conditions during above period are mainly composed of drought, damages caused by insect and diseases, and improper fertilization. Besides excessive number of panicles per unit area is also found.

/1 : S. Matsushima, Crop Science in Rice - Theory of Yield Determination and its application-, Fuji Publishing Co., Ltd., 1975.

Based on the above, countermeasures for increase of percentage of ripened grains are considered as follows;

- Sufficient provision of irrigation water.
- Prevention for excessive grain (spikelets) per unit area.
- Top-dressing with nitrogenous fertilizers at the full heading period.
- To provide sunny weather for 15 days just before heading and about 25 days just after heading
- Reduce of damages by insect and disease
- Creation of nice plant type
- To make plant root vigorous

Consequently the defects for increase of rice yield might be low percentage of ripened grains at present condition. Rice cultivation in the future projects should be paid on increase of percentage of ripened grains, taking into consideration countermeasures mentioned above.

8.2. YIELD AND PRODUCTION

Yield and production of major crops at present condition in the objective area are estimated after review of available data which are provided by Extension Services offices in four Kabupatens. Yield and production of major crops fluctuate largely year by year due to affectation by variation of annual rainfall, unexpected big damages by diseases and insects, etc. Consequently present yield and production are estimated as average value from 1974 to 1977 with the exception of Kabupaten Bone.

(1) Rice

Yield and production of paddy are presented in Table 8.2(1). As shown in the table, unit yields are generally low except for isolated instances. It is considered from the analysis of field survey that these low unit yields are mainly accrued from the following matters.

- Insufficient irrigation water in volume and in time
- Improper water control
- Low farm input
- Damages caused by pest and diseases
- Limited extent of proper farming

Average unit yield of paddy in the objective area is 3.0 tons/ha for wet season paddy, 4.3 tons/ha for dry season paddy and 1.5 tons/ha for upland rice. The yield varies depending on the land condition, among which Sidrap and Soppeng have higher yield in both seasons. Total productions of paddy in the objective area amount to 445,300 tons as dry stalk paddy, comprising 309,800 tons for wet season paddy, 125,600 tons for dry season paddy and 9,900 tons for upland rice.

The above data do not clarify unit yield of paddy on the basis of land categories such as irrigated paddy field and rainfed paddy field. It is applied in this report that unit yields under irrigated paddy field are estimated on the basis of yield for BIMAS and INMAS programme. The respective unit yields at kecamatan level are summarized in Table 8.2 (2). These data will be used for calculation of irrigation benefit, taking into consideration their past trend of yield.

(2) Upland Crops

Yield and production of major upland crops at kecamatan level are summarized in Table 8.3 to Table 8.7. The yields also fluctuate depending on locations. However since no fertilizers nor chemicals are used, the yield is generally low. Total productions of major upland crops are 45,000 tons for maize, 10,000 tons for peanuts, 2,000 tons for soybeans, 7,000 tons for green beans and 31,000 tons for cassava.

(3) Estate Crops

Yield and production of major estate crops at kecamatan level are shown in Table 8.8 to Table 8.14. These crops are grown under small holder system.

8.3 PAST TREND OF CROP YIELD

Past trend of unit yield for major crops was examined for the study of estimation on unit yield in without project in the future. The past trend is estimated on the basis of the theoretical curves, least squares line ($y = ax + B$) and exponential curve ($Y = ae^{bx}$). Besides, coefficient of corelation is also calculated. The results are summarized in Table 8.15 and Table 8.16. Details are explained in Data Book Part-Five.

As for paddy, the yield in irrigated land indicates positive tendency particularly in Kabupaten Sidrap and Soppeng. In contradiction to the above, most rainfed area has decreasing or no tendency of unit yield due to mainly the shortage of water.

With regard to upland crops, there is negative or no tendency in their unit yield. This is due to entire dependence on natural erratic rainfall distribution pattern and no application of farm inputs.

CHAPTER IX LIVESTOCK AND FOREST

9.1 LIVESTOCK

Livestock raising is not a main line of the agricultural activities in the objective area.

There are no large scaled livestock raizing in the area and most of livestock are raised by farmers in and around the paddy fields on a small scale. The livestock plays an important role in protein food supply and in provision of motive power and transportation measures. Raising of them is mainly dependent on straw of paddy, rice bran and broken rice as feed. Therefore production is geographically related to rice production.

Number of livestock in four Kabupatens related to the objective area is summarized in table 9.1.

As described in Chapter 5, lands covered with grass occupy 231,600 ha or 30.2% of the objective area.

For the development of livestock raising in the objective area, considerably large lands which appear suitable for livestock yard topographically extend over the area lying north of the Cenranae river and Lake Tempe, namely the upper reaches of the Bila, the Boya and the Gilirang. Some private enterprises have readily tried to develop livestock raising there. However the results seem to be less favourable than would be expected. The reasons of unfavourable results appear to be considered in view of physical matters as follows;

1. The lands are mainly covered with Ferric Acrisols. These soils have very low pH value, being less than 5 in general. Further effective soil depth of the soils is very shallow or shallow and considerable part of the lands is covered with sandy textured soils, which are subject to be damaged by drought.

2. The distribution of rainfall in the area is uneven and 3 months from August - October are generally dry months.

3. No dependable water sources with emphasis on river discharge.

4. Selection of suitable varieties of grass has not be carried out.

Provided that large scaled livestock development will be carried out in the area, considerably large investment for soil improvement, provision of soil erosion control measures, proper fertilization, establishment of transportation systems, etc., will be required. At present, livestock development does not appear to be carried out economically.

9.2 FOREST

According to the measurement of forest area on the basis of topographic map on a scale of 1/25,000, about 171,730 ha or 22.4% of the objective area is covered with forest.

Administratively, four Kabupatens related to the objective area have 330,354 ha of forest as follows;
These land are mostly public land. Out of these forest land, 293,000 ha is designed for prevention of soil erosion, the balance for production.

Kabupaten	Bone	:	162,995 ha
	Wajo	:	47,214 ha
	Soppeng	:	49,000 ha
	Sidrap	:	71,145 ha
			330,354 ha

Forest-products in 1977/78 are summarized in table 9.2. Most of the products are timbers, followed by rottan, Arenga palm, kemiri, bamboo, etc.

The government of Indonesia has made endeavour to prevent soil erosions. During period of Pelita II, reforestation for 11,800 ha and afforestation for 56,000 ha were carried out in four Kabupatens as follows ;

Reforestation (ha)

Sidrap	Bone	Soppeng	Wajo
2,550	5,306	3,685	20

Afforestation (ha)

Sidrap	Bone	Soppeng	Wajo
8,200	35,850	8,600	3,350

Under the programmes, varieties of trees such as Pinus Merkusi, Acacia Auriculiformis, Eucalyptus Deglupta, Acacia Decurens, Kemiri, Kaliandra, Ceiba Peitandra, Aleuritus Moluccana, etc. are used.

However, due to the shortage of budget and lack of trained staff in the authorities concerned, the expansion of these programmes are not more improved than would be expected. Further overgrassing and burning by local people are also one of the problems in forest and soil conservations.

CHAPTER X LAND TENURE AND HOLDING

According to the Land Reform Law as the Basic Agrarian Law No.5 of 1960, South Sulawesi Province is classified as the less crowded area. Then, the limitation of private ownership of farm land was enacted on 10 ha for paddy field and 12 ha for upland field. However, about 90% of total farm land is owned by less than 5 ha holding size owners as shown in Table 10.1.

Since the data on the present land holding in the whole objective area are not available, the data of Agricultural Census, 1973 was used for the study. As shown in Table 10.2, about 85% of total farmers are less than 2 ha of the holding size.

In the objective area, total farm land of 245,200 ha are cultivated by 140,858 farmers at present. Average farming size is estimated to 1.74 ha of which 1.13 ha or 65% is paddy field including rain-fed field. These farming size and proportion of paddy field are, of course, varied by each area and kecamatan. Kabupaten Sidrap is mostly occupied by paddy field, but Kabupaten Bone is shared by about half as shown Table 10.3 in detail.

About 94% of total farmers are owner farmer and partially owner farmers. Pure tenant farmer is only about 6% as shown in Table 10.2. Tenant charge prevailed in the objective area is mostly share cropping system of 50% of product in case of paddy.

CHAPTER XI AGRICULTURAL SUPPORT SYSTEM

11.1 GENERAL

South Sulawesi Province, one of the 27 Provinces in whole Indonesia, is administratively divided into 21 Kabupatens (Districts) and 2 Kota Madyas(Munincipalities), headed by "BUPATI" and "WALI KOTA" respectively nominated by the Governor of the Province. These Kabupatens and Kota Madyas are subdivided into 169 Kecamatans (Sub-districts) headed by "CAMAT" nominated also by the Governor. Under the Kecamatans, there are 1,136 villages (Desas) which are the basic units of administrative structure in Indonesia. Average number of Kecamatan per Kabupaten is counted about 7. One Kecamatan covers about 7 villages on an average in South Sulawesi Province.

The village chief (Kepala Desa), elected from among the people in the village every five years, has the responsibility of carrying out the following functions under the supervision and guidance of respective governmental authorities concerned.

- Agricultural development
- Public health and sanitation
- Public education
- Village welfare and security
- Encouragement of industries and co-operatives
- Construction, maintenance and repair of public transportation facilities

In the objective area, 4 Kabupatens, 29 Kecamatans and 203 villages are included.

11.2 BIMAS AND INMAS PROGRAMME

As for the agricultural development, the agricultural intensification programme so called "BIMAS (Bimbingan Massal) and INMAS (intensifikasi Massal) has been promoted by Indonesian Government in the irrigated area in order to facilitate production increase with coordination of all the efforts of agricultural support services so as to provide a "package" of agricultural inputs to the farmers since 1968.

Since 1973, for further development of the BIMAS and INMAS Programme, the Government has initiated to organize a village unit (Willayah Unit Desa) as the lowest executive unit of the Programme.

According to the Presidential Decree No. 4, 1973, the aims of establishing the village unit are ; a) to assure the realiation of agricultural product increasing programme, particularly food production effectively and efficiently, and b) to give the certainty to producer farmers in particular and village community in general, that they have the responsibilities not only to take part in increasing the said production, but also to raise their living standard and welfare.

Each village unit generally comprises 2,000 farmers in 6 villages, with 600 to 1,000 ha of irrigated paddy field and the following functions would be set up in each village unit ;

1) At least one Field Extension Workers (PPL) equipped with information appliances in order to diffuse the necessary information to the farmers in the village unit concerned.

2) Village unit branch of Indonesia People's Bank having the main function of BIMAS credit service within its service area that may consist of more than one village unit area.

3) Kiosk of village unit assigned to distribut farm inputs such as fetilizer, pesticides, seeds and farm machineries and tools, etc.

4) BUUD/KUD (Village Unit Executive Body/Village Unit Cooperative) having the function of processing and marketing of agricultural product. The BUUD is established as an economic institution in the form of co-operative which may constitute joint undertaking merger of agricultural co-operative found in the village unit area at its initial stage of growth, and be merged in one village unit co-operative (KUD) under the regulation of Ministry of Manpower, Transmigration and Co-operative in a certain period of time according to its progress.

Following to the direction of the policy, the Provincial Government has been initiated to establish the village units with other related institutions covering whole province since 1973. Total number of village unit in the Province is 620 in 1979 as shown in Table 11.1.

In the objective area, there are 190 village units with 90 BUUD/KUD, 86 KIOSK, 59 BRI and 181 Field Extension Workers. Average paddy field, especially irrigated paddy field and number of farm household per village unit are 741 ha, 192 ha and 741 respectively as shown in Table 11.2. As compared to the general standard of village unit, the village unit in the objective area is far exceeded on size, however on the aspect of functional institution, it has much rooms to be developed.

It would be recommended to develop the number and equipment of KUD and KIOSK for the successful implementation of the irrigation projects.

Under these executive organization, the BIMAS and INMAS Programme has been steadily developed, especially in the area where the irrigation facilities were well developed such as Kabupaten Sidrap. The area served by the BIMAS and INMAS Programme in the objective area is estimated at 35,000 ha for wet season paddy and 18,000 ha for dry season paddy respectively, of which the area under the BIMAS Package Programme is 22,900 ha for wet season paddy and 10,400 ha for dry season paddy as shown in Table 11.3. The proportion of the area served by the BIMAS/INMAS Programme in the objective area is estimated about 33% of whole harvested area for wet season paddy and 60% for dry season paddy.

At present, the BIMAS/INMAS Programme is served nearly maximum extent of irrigated paddy field in the objective area. Accordingly, it is indispensable to develop the new irrigated paddy field for the expansion of the served area of BIMAS/INMAS Programme.

11.3 RESEARCH

The research works of agriculture in Indonesia are centralized and undertaken by the Central Research Institute of Agriculture (CRIA) at Bogor in Java. There are 6 branch research stations in whole Indonesia, namely, East Java, West Java, South Kalimantan, West Sumatra, North Sumatra and South Sulawesi.

The South Sulawesi Branch Research Station of CRIA located at Maros about 50 km north from Ujung Pandang, consists of 7 Divisions and 2 Experimental Farms as shown in Fig. 11.1. The main Research Station has 146 ha of experimental field of which 110 ha is for rice experimental field. One of the Experimental Farms located at Lanrang, Kabupaten Sidrap, is mainly carrying out rice experimental works with 44 ha of experimental field. The other located at Gowa, is mainly undertaking upland crops such as maize, sorghum, peanut, soybean, sweet potato and cassava.

About 40% of experimental works are devoted to the experiment of rice such as variety test, fertilizer test, and test for control of pests and diseases on irrigated paddy. From 1979, the experiment for rain-fed paddy would be started as a new item responding to the importance of that in the actual local condition in whole Sulawesi.

For the execution of experimental works, about 60 senior technical staff are engaging with 220 personnel including administrative staff under the technical assistance of the International Rice Research Institute, in Philippines.

This Branch Research Station is playing an important role in technical aspect of increase of rice productivities through BIMAS Technical Team consisting of the experts from Hasanudin University, Provincial Agricultural Extension Service and South Sulawesi Branch Research Station.

11.4 EXTENSION SERVICE

In order to promote and accelerate extension education activities on field level by separating extension service with general agricultural administrative services, Agricultural Extension Service Development Programme has been launched in Indonesia since 1974. In the central government, the Agency for Agricultural Education, Training and Extension was established as one of the extraministerial bureaus under the Ministry of Agriculture. At the same time, in the provincial level, the establishment of Agricultural Development Center with the functions of adaptation tests of new recommended agricultural techniques and in-service training for extension workers in addition to the seed multiplication, has been promoted. In the field level, several Rural Extension Centers have been established as a base camp for extension education activities with the functions of preparation of extension programme, dissemination of agricultural information and training for leading farmers at the local level.

Following the basic policy, the Agricultural Extension Service Development Programme in South Sulawesi has also been developed year by year since 1974. Although an Agricultural Development Center is not formally decided yet, but the Rural Extension Centers have already commenced their daily works.

As illustrated on Fig. 11.2, the organization of Agricultural Extension Service in South Sulawesi is formed by two separate lines, i.e. administrative line and operational line under the supervision of Inspector of Provincial Agricultural Extension Service.

In the objective area, number of Rural Extension Center (BP2), Subject-Matter Specialist (PPS), Extension Supervisor (PPM) and Field Extension Worker (PPL) are 14, 4, 39 and 181 respectively as shown in Table 11.1 and 11.4.

The Subject-matter Specialist staying in each Kabupaten assists and advises about 10 Extension Supervisors of which 2 to 4 are working in Kabupaten office and remains are staying in the Rural Extension Center. 2 Extension Supervisors staying at each Rural Extension Center assist and advise about 10 Field Extension Workers.

Every Field Extension Workers are requested to visit a Key farmer in each working area of which 16 areas make one village unit, 4 days a week and 2 working area a day. Thus, each Key farmer would contact 10 progressive farmers and a progressive farmer would influence 20 farmers. Then finally one Field Extension Worker may affect 3,200 farmers totally.

The qualification of Field Extension Worker is graduate of Agricultural High School, and of Extension Supervisor is bachelor of science or more than 5 years experiences as Field Extension Workers.

At present, each Field Extension Worker in the objective area covers 1.05 village units, 1.12 villages, 1,430 ha of farm lands, and 780 farm households.

Taking the future agricultural development into consideration, it would be recommended that the practical rice cultivation technique of Field Extension Workers have to much raise up so as to judge and advise properly to the farmers timely in their own field.

11.5 SEED MULTIPLICATION

Provincial Seed Center located at Maros about 50 km North from Ujung Pandang is only one institute which produces stock seeds of new recommended varieties of paddy in South Sulawesi. The foundation seeds supplied from the Central Research Institute of Agriculture are multiplied to the stock seed at this Center. The Center distributes these stock seeds to 37 Seed Stations managed by

Kabupaten offices. These Seed Stations produce the extension seeds and distribute them to seed growers. The seed growers produce paddy seeds and distribute them through BUUD/KUD according to the BIMAS/INMAS programme.

The laboratory test for seed certification is carried out by only the Provincial Seed Center at the following standards; a) less than 13% of moisture, b) more than 98% of variety purity, c) more than 80% of germination rate and d) no insects and diseases. The result of the laboratory test conducted in this Center in 1978 showed that about 60% of 2,300 samples were satisfied and remains of 40% were unsatisfied.

In the objective area, total seed production is about 200 tons from 120 ha at present as shown in Table 11.5. Because of insufficient budget, much amount of product in these Seed Stations were spent for management cost. Further efforts are required for improvement of multiplied seed qualities in order to realize future agricultural development including irrigation Projects.

11.6 AGRICULTURAL CREDIT

The Indonesia People's Bank (BRI - Bank Rakyat Indonesia) is the state bank specialized in agricultural credit covering whole country. To provide loan service, especially BIMAS package loan, the Bank has established a broad network formed many regional offices, branch offices and sub-branch offices so called "Unit Desa BRI".

The Bank is authorized to finance BIMAS package credit for individual farmers. Besides, using own credit funds, the Bank provides the loan to various agricultural associations.

At Ujung Pandang, there is a Regional Office of Indonesia People's Bank (BRI) which covers South Sulawesi Province. Under the Regional Office, there are 23 Branch Offices and 210 village Unit BRIs.

In the objective area, number of Branch Offices and Village Unit BRI are 4 and 59 respectively.

The loan condition for BIMAS paddy is fixed on amount of loan by the kind of package with 7 months loan period and 1% per month of interest rate as shown in Table 11.6. Since 1978, INMAS package credit was newly commenced with the amount within between maximum and minimum decided by the Government as shown in Table 11.7. For upland crops, such as Maize, Soybean, Peanut, Green kidny bean, Sorghum, Cassava and Sweet potato, the BIMAS package loan is fixed as shown in Table 11.8.

The loan amount of BIMAS paddy has been steadily increasing and it was exceeded one billion Rp since 1976/'77 in whole South Sulawesi as shown in Table 11.9. At the same time, the amount of outstanding has also been increasing.

In the objective area, the proportion of outstanding has shown quite different pattern. One is low percent of around 20%

such as Kabupaten Sidrap and Soppeng which are blessed with irrigated paddy field. On the other hand, 60 to 70% or more high percent of outstanding are found in Kabupaten Bone and Wajo in which rainfed paddy fields are prevailed as shown in Table 11.10, 11.11, 11.12 and 11.13.

One of the main reason of high percent of outstanding in these area is unstable paddy productivity because of luck of irrigation facilities.

11.7 FARMER'S ORGANIZATION

Supplies of agricultural inputs, processing and marketing of farm products are primarily made through the establishment of co-operatives which had been promoted in the rural area by the Government through the Co-operative Offices in Kabupatens since 1945 when the Co-operative Act in Indonesia was enacted. Inspite of governmental efforts, the movement of co-operative has not been well developed yet, mainly because of weakness in management and shortage of operational fund.

In order to improve such stagnant condition of the co-operative movement, establishment of Village Unit Co-operative (KUD) has been introduced by the Government in the area adopted the BIMAS/INMAS programme since May 1973 when the Presidential Decree for Village Unit was enforced as mentioned previous chapter.

In the South Sulawesi, out of 620 Village Units, 345 or 56% of Village Units have established BUUD/KUD by 1978 as shown in Table 11.1.

In the objective area, 88 KUDs and 2 BUUDs were already organized by 1978, as shown in Table 11.14. It is only 47% of Village Units in the objective area. Besides, the number of members of BUUD/KUD is also extremely limited.

The total number of members including candidates is 32,000 farmers which occupy only 17% of total farm household as shown in Table 11.15.

The main processing facility owned by BUUD/KUD is rice mill. The number and capacity of existing rice mills owned by BUUD/KUD in the objective area are shown in Table 11.16. The total milling capacity is estimated at about 600 ton/hour.

From these figures, it is assumed that the present rice mills would be sufficient in both the capacity and number in the objective area, even after the completion of the proposed irrigation projects.

As for the Water User's Association, it is just started to organize the farmers cultivating irrigated paddy field under the guidance of Provincial Agricultural Extension Service in South Sulawesi since 1976/'77. Number of Water User's Association is only 32 in total with covering area of 12,000 ha at present as shown in Table 11.17.

In the objective area, number of Water User's Association is counted only 7 with 2,400 members and 3,500 ha of irrigated area as shown in Table 11.18.

11.8 RECOMMENDATION

Taking the future agricultural development into consideration, following improvements of agricultural support systems would be recommended;

1) To promote the establishment of KUD with KIOSK up to the same number of the village unit (190) at least in the proposed irrigation projects areas by the end of the construction of irrigation facilities of the respective irrigation project. Parallel with the establishment of KUD, the number of members of KUD should be expanded at least up to 60% of total number of farm household in each proposed irrigation project area.

2) To establish water user's association (P3A) in each irrigation block commanded by tertiary canal of respective proposed irrigation project comprising all the farmers in the beneficial area as the member of the P3A before the completion of construction works of each proposed project.

3) To strengthen the operation of seed multiplication of the Provincial Seed Center and Seed Stations in the project area with proper budget so as to be able to provide all the product for certified extension seed.

4) To raise up the practical rice cultivation technique of the Field Extension Workers through practical training conducted by the South Sulawesi Branch Research Station so as to be able to judge plant condition of rice and advice to the farmers properly and timely in their own paddy fields.

CHAPTER XII MARKETING

12.1 DISTRIBUTION OF AGRICULTURAL INPUTS

Distribution of fertilizers and agricultural chemicals is handled by PT. PUSRI which is governmental enterprise, in South Sulawesi Province.

PT. PUSRI appointed 6 enterprises as the Sub-Distributors in South Sulawesi in 1978/79, namely Fa. TAMANSARI, PT. TAWISON, PT. ADUMA NIAGA, PT. PANCA NIAGA, PT. PERTANI and PUSKUD.

According to the BIMAS/INMAS Programme, fertilizers and agricultural chemicals are supplied to 6 Sub-Distributors at Ujung Pandang by PT. PUSRI and then the Sub-Distributors provide necessary amount of fertilizers and agricultural chemicals to the retailers and/or BUUD/KUD at the local level.

The distribution price of agricultural input for agricultural intensification programme is set by the Government as the unit price in whole Indonesia. Distribution price in each level including farm gate with handling charge and other costs is illustrated on Table 12.1. As shown in this Table, fertilizer distribution price to farmers is 70 Rp per kg of TSP and Urea in 1978.

The amounts of farm input distributed in the objective area since 1974 to 1978 are shown in Table 12.2.

12.2 MARKETING OF OUTPUT

Main marketing farm products in the objective area is rice. The amount of marketing rice is varied annually according to the variation of the yield of rice produced in each year. However, the price of rice is stabilized by the Government.

The DOLOG South Sulawesi would purchase and sell the rice when the price of medium quality rice is down under the floor price or raised over the ceiling price at the central market of Ujung Pandang. In 1977/'78, the floor price and ceiling price were set to 110 Rp/kg and 127.5 Rp/kg respectively, but in 1978/79, they are changed to 119.5 Rp/kg and 140 Rp/kg respectively by the Government.

The surplus of paddy produced by the farmers is sold to KUD and/or middle men through brokers. Usually it is sold by the form of paddy, but in certain area, by the form of milled rice. Collected rice by KUD and/or middle men sold to DOLOG and/or wholesaler. Total surplus of rice in South Sulawesi is distributed to other rice deficit Provinces by DOLOG.

The number of warehouse for cereals in South Sulawesi handled by DOLOG is shown in Table 12.3. Present total capacity of warehouses in the objective area would be sufficient, however after the completion of irrigation projects, about 4 to 5 items of capacity would be required.

12.3 BALANCE OF SUPPLY AND DEMAND OF PADDY

As mentioned in Supporting Report Part-EIGHT South Sulawesi Province is one of the rice supply Province in Indonesia. In South Sulawesi Province, the objective area is also one of the rice supply region in total, but there are 12 kecamatans which the consumption of rice is estimated to be exceeded than supply amount at present as shown in Table 12.4.

12.4 FORECAST OF SUPPLY AND DEMAND OF RICE

The estimation of forecast of supply and demand of rice was worked out on the assumption of population increase rate of 2% per year, annual per capital consumption of rice of 130 kg, production increase forecasted by least square method based on the average production from 1974 to 1977 and seed and waste rate of 7.5%. The result is as shown in Table 12.5 and 12.6.

According to this estimation, the shortage of supply of rice in the command area of DOLOG of South Sulawesi would remain even in the year of 2000.

CHAPTER XIII FARM ECONOMY

According to the available data provided by the Agricultural Extension Service Offices in Ujung Pandang and Sidrap, Bone, Soppeng and Wajo Kabupatens, and the results of farm interviews, the present farm economic analysis was worked out.

The amount of the gross farm income is varied by average size farm of each kecamatan from about Rp. 12,000 to Rp. 643,000 as shown in Table 13.1. The main farm income is from paddy production which is occupied about 76% of the gross farm income on an average. However, the Kecamatan which the gross farm income of polowijo is exceeded than that of paddy is counted 7, out of 29 kecamatans.

The farming expense is also varied by each farm reflecting the difference of productivity, but on an average about one third of the gorss farm income is spent for farming expenses.

At present, the annual gross farm income of the typical size farmer in the objective area is estimated at about Rp. 238,280 as shown in Table 13.2.

In addition to the farm income, farmers get their income from non-farm activities such as temporary hired labour for the Sugar plantation, small holder's plantations and other big farmers, and other miscellaneous works such as fishing, trade and livestock, etc.

The farming expenses except family labour cost is around Rp. 83,540 on the typical size farmer. Accordingly, the net income is estimated at Rp. 225,380 which is nearly same amount of living expense as shown in Table 13.3.

CHAPTER XIV PROPOSED FARMING DEVELOPMENT

14.1 GENERAL

The basic concept for agricultural development in the objective area is stressed on the paddy cultivation, taking into consideration of the following.

- The Government of Indonesia made endeavour to increase production of food grains, with emphasis on rice, through in Pelita II. Following Pelita II, the Government has given high priority to agricultural programmes with attainment of self-sufficiency in foodstuff in Pelita III.

- The farmers in the objective area are familiar with paddy cultivation and also have strong intention of paddy cultivation under irrigation farming.

The details are explained in section 14.3 Selection of Crop.

14.2 PROPOSED LAND USE

As explained in Chapter 15, nine (9) irrigation projects comprising 81,000 ha of net irrigable area have been formulated. In the development plan, present farming dependent on rainfall will mostly be changed into year-round irrigation farming with completion of irrigation facilities and more intensive use of farm land for paddy cultivation will be introduced. These projects will also provide the basis for major increase in rice production. The area covered with these projects extends over nineteen (19) kecamatans among 29 kecamatans in the objective area, namely one kecamatan in kabupaten Sidrap, 4 kecamatans in Kabupaten Bone, 5 kecamatans in Kabupaten Soppeng and 9 kecamatans in Kabupaten Wajo. The extend of irrigable area is described in Table 15.2 in details.

By these irrigation projects, 7,320 ha of upland area and 56,170 ha of rainfed area will be changed into technical irrigation area. Furthermore 17,510 ha of irrigated land comprising 6,260 ha of technical irrigation area and 11,250 ha of semi-technical irrigation area will be completely changed into technical irrigation area. Accordingly rate of irrigation facilities for paddy field in the objective area will increase considerably from 0.23 at present condition to 0.59. The summary of land use is shown in table 14.1.

On the other hand, double cropping of paddy would be applied all over the area in principle. However all of total net irrigable area of 81,000 ha could not be grown under double cropping of rice because of the limited water source of irrigation supply and economical view point. Out of 81,000 ha, about 8,000 ha or 10 percent would remain the land with a single cropping of paddy. Consequently multi-cropping index for total net irrigable area would become 1.9.

As mentioned previously, profitability per ha for paddy is the highest in the agricultural study area. This tendency will certainly be expected to continue in the future taking into account present governmental policy for production of rice. Accordingly expansion of irrigated land cultivated by upland crops such as peanuts, soybeans, maize, etc., will not be expected to be made without drastic governmental promotion policy under DOLOG in terms of price specially.

Basically the land use pattern is not able to be converted without provision of irrigation facilities. The land use in the area with the exception of irrigated land (81,000 ha) will be obliged to remain as present one. However shifting culture proceeded on the steep land should be prohibited and forestation will be carried out in the land in view of soil erosions.

14.3 SELECTION OF CROP

Prior to framework of optimum cropping pattern in the future, selection of crop to be grown is carried out on the basis of condition of demand and supply, profitability for crops and intension of farmers in the objective area, of which details are explained below. As a result, paddy is selected as the most optimum crop for the irrigation projects in the Central South Sulawesi Water Resources Development Project.

(1) Agriculture is the mainstay of Indonesia's economy, accounting for about 31 percent of gross domestic product in 1976. The Government gives high priority to agricultural programmes, for which nearly 10 percent of all development expenditures have been targeted during Pelita II. The specific sectoral objectives of Pelita II include self-sufficiency in food grains by 1978/79. The rice production during the period of 1974 to 1977 gradually increased with annual rate of one percent. Total rice production in 1977 amounted about 15.9 million tons. /1

In spite of the increase of rice production, it could not catch up with the demand of rice during the period, due to the increase of population (annual growth rate about 2.4 percent) together with increase in rice consumption per capita induced by raised living standard. About 1.3 million tons of rice were imported on an average from 1974 to 1977. In 1977 2.0 million tons of rice were imported and about 500 million US dollars of foreign currency was spent for it. This fact indicates that rapid increase of rice production should be required for meeting the growing domestic demand in food grain as well as saving the foreign currency in national level.

/1 : The rate is estimated as following formula.

$$\frac{\text{Total rice production in 1977}}{\text{Total rice production in 1974}} \div 4 \text{ year}$$

(II) From the stand point of regional level in supply and demand of rice, South Sulawesi province is one of the rice supply province in Indonesia. The province has played an important base to supply rice through DOLOG of South Sulawesi to the area comprising North Sulawesi province, Central Sulawesi province, East Kalimantan province, Maluku province and Irian province. Based on the studies on forecast of supply and demand of rice in these provinces,the shortage of rice would be estimated to remain even in the year of 2000. This fact indicates that South Sulawesi province will become a more important key area on supply of rice to above provinces.

In South Sulawesi province, the objective area is also one of the rice supply region in total. However there are 12 kecamatans with emphasis on kabupatens Wajo and Bone of which consumption of rice is estimated to be exceeded than supply amount at present. Self-sufficiency of rice in these kecamatans would be urgently required.

(III) From the farmer's viewpoint, farmers in the objective area make their living from paddy cultivation, showing that gross income accrued from paddy occupies more than 75 percent of total gross farm income. The farmers in the objective area are familiar with paddy cultivation and have superior ability for irrigation farming. It is confirmed through farmer's interview that they have sufficient intention to produce paddy whether provision of available irrigation water were permitted.

(IV) With regard to price of rice, the ceiling price and floor price of rice are set every year by the Government and the price of rice is stabilized through DOLOG. It is expected that stabilization of price will be continued in the future. On the contrary, price of crops other than rice is not stabilized and consequently their income becomes unstable. Individual farmers do not want to cultivate single polowijo crop on a large scale because of dispersion of risk for farm management.

(V) The profitability of rice shows the highest on the basis of crop benefit cost evaluation which is presented in Chapter 17.

(VI) The consumption pattern in foodstuff has a tendency to change due to raised living standard. The consumption ratio of rice shows increasing and on the contrary the ratio of polowijo crops indicates to decrease.

14.4 PROPOSED CROPPING PATTERN

For determination of the most optimum cropping pattern, three alternatives are considered as follows :

Alternative 1 : double cropping of paddy per year

Alternative 2 : double cropping of paddy plus one polowijo crop

Alternative 3 : 2.5 times cropping of paddy per year.

However, Alternative 2 is not proposed as following reasons. The price of polowijo crops is not stabilized. Income from these crops is unstable, by which farmers don't want to cultivate them. Furthermore erratic much rainfall even in dry season occurs, which gives direct damages and root-rot for polowijo.

As for Alternative 3, this is the most intensive cropping pattern of paddy cultivation. Application of this pattern to the proposed project area will provide the highest irrigation benefit in three alternatives. However this intensive pattern is not prevailed in well irrigated land, in and around the objective area. Even in Saddang irrigation project which is the leading irrigation project in South Sulawesi province, double cropping of paddy per year is prevailed. Furthermore if the cropping pattern of alternative 3 is introduced, strict water control should be required. As described in Chapter 11, water user's association is,however,just started to organize the farmers cultivating irrigated paddy in 1976/'77 in South Sulawesi province. Number of water user's association in the objective area is counted only 7 with 2,400 members. It is not expected in view of above considerations that this intensive cropping pattern will be adopted to all the irrigated area proposed for a short period.

Consequently, double cropping of paddy per year is proposed to adopt to the irrigation project in the objective area.

Cropping calenders are studied taking into consideration of climate, irrigation water supplied from the rivers, agronomic characteristics, etc. The climate in the objective area is favourable for paddy cultivation in view of high temperature and sufficient sunshine duration. Double cropping of paddy can be done. Since there is no limiting factor for germination due to high temperature throughout the year, seeding of paddy can be practiced at any time. However setting of harvested period shall be considered so as to exclude the period with high rainfall intensity and long rainy days for the smooth operation of harvest and processing. Further plant-physiologically important factor for attaining high yield of paddy is how to increase the photosynthetic efficiency of the rice plant. Critical growth periods in terms of sunlight requirement are about 15 days just before heading and about 25 days just heading. The framework of cropping calender should be designed so as to get sunny weather during these periods as much as possible. Furthermore special attention in each irrigation project was paid on expansion of irrigable area much as possible, taking into account balance of consumptive use of rice plant and effective rainfall and river discharge to be used for irrigation water.

The proposed cropping pattern is shown in Fig. 14.1.

14.5 PROPOSED FARMING PRACTICE IN THE PROPOSED IRRIGATION PROJECTS

Proper irrigation farming is the most essential factor for realizing full exploitation of agricultural potentiality in the project areas. For the purpose high yielding varieties such as IR series and improved varieties made in Bogor will be introduced.

Proper amount of fertilizer and agricultural chemicals or proper farming practices will be applied in the project areas. Furthermore proper irrigation water control will be carried out. The design criteria for irrigation farming with project is summarized in Table 14.2.

With regard to farm mechanization, it is an important factor for agricultural development. In principle farm mechanization has advantages such as (1) Mechanization increases the productivity of labour. (2) The possibilities for multiple cropping put a premium on speedy harvesting and land preparation so that the next crop may be planted. Mechanization helps output by supplementing labour during peak season labour shortage when the demand for human labour exceeds the supply. (3) Power and equipment facilitate an increase in yields through more timely and effective farm operation. (4) Mechanization utilizes lands, labour, irrigation and other inputs efficiently. (5) Mechanization reduces the dependence on draught animals which have low productivity.

At present farm mechanization in South Sulawesi province has been gradually carried out in the field of rice processing and spraying of agricultural chemicals. Tractorization has not yet prevailed. For the smooth expansion of farm mechanization in South Sulawesi province, there remains sociological and technical problems encountered as follows;

(I) As mentioned in Chapter 10, average farm size is small and is 1.74 ha comprising paddy field and upland field. More than 96% of the total farmers have less than 3 ha. According to the report, number of farmers are apt to increase, which /1 appears further fragmentation of land. Furthermore conditions of unemployment are said to be 60 - 70% in rural area and 30% in urban area, and cheap labours for the agricultural sectors are available

(II) Land consolidation with emphasis on farm unit, farm roads and drainage facilities providing sufficient bearing capacity for efficient operation of farm machines which needed for the introduction of farm machines, is not yet carried out.

(III) There are some traditional social systems such as harvesting by ani-ani equipment.

(IV) The agricultural support systems needed for the introduction of farm mechanization are not yet developed.

(V) The price of farm machines is high and distribution systems of farm machineries including spare parts are poor.

/1 : South Sulawesi Regional Agricultural Development Planning IATA-140 project.

Under such circumstances, it seems that rapid introduction of farm mechanization for a short period is not practical in the objective area. It is partly possible that farm mechanization for farmers having larger farm size will be proceeded. In such a case research works for the introduction of farm mechanization should be done and mechanical training for extension workers also should be strengthened.

Generally speaking, introduction of farm mechanization for the entire objective area will be possibly done in the future conditions that labour force in the agricultural sectors will be shifted to the industrial sectors by the promotion of industrialization.

14.6 ANTICIPATED YIELD

Unit yields of farm crops are estimated both for future without project and future with project conditions.

For the determination of anticipated paddy yield with project, past data under BIMAS and INMAS programmes, data in provincial Seed Center and the results of yield survey are referred. Table 14.3 shows the recorded maximum unit yield of paddy at kecamatan level from 1970 to 1977. In particular the highest level of unit yield over 7 tons per ha is recognized in BIMAS area of which area is served irrigation water in principle. This fact indicates that provision of irrigation water with proper farming will realize exploitation of considerably high unit yield. Table 14.4 shows the results of unit yield of paddy in the seed center. Unit yield of all new high yielding varieties shows over 6 tons of dry stalk paddy per ha. Further over 10 tons of dry stalk paddy per ha in the objective area are recognized in the yield survey for paddy as described in Chapter 8.

Based on the above data, anticipated unit yield of paddy is conservatively estimated at 6 tons of dry stalk paddy in both wet and dry seasons. For the achievement of target yield, optimum farm inputs and practices proposed in previous section as well as strengthening of agricultural support systems are required.

Unit yields of farm crops without conditions are estimated on the basis of past trend of unit yield described in chapter 8. With regard to polowijo crops, the trend shows decreasing yield or no tendency of unit yield. The yield without project is set as same value of present unit yield. As for paddy yield, in the case that the coefficient of corelation between past time and unit yield is over 0.8, past trends are takne into consideration. The yields without project are summarized in Table 14.5.

14.7 CROP PRODUCTION IN FUTURE WITH AND WITHOUT PROJECT

Total production of farm crops is estimated by multiplying the anticipated yield with the future cultivation area. After the completion of nine irrigation projects production of paddy will increase 924,000 tons of dry stalk paddy or two times of the expected production on without project condition. The crop production estimated both for future with and without project conditions is summarized in Table 14.6 at irrigation project level and in Table 14.7 at kecamatan level.

CHAPTER XV IRRIGATION PLAN

15.1 WATER REQUIREMENT

15.1.1 Irrigation Requirement

(1) General

It is acknowledged that the consumptive use of water by crops can be expressed as the product of potential evapotranspiration calculated from climatic data or surface evaporation from the standard class - A pan and a crop coefficient. For the project study, the pan evaporation are used, since the climate data necessary for estimation of potential evapotranspiration cover for a comparatively short period for applying such widely used estimation methods as Penman, Hargreaves, Blaney-Criddle methods, etc.

Then, the irrigation water requirement for the objective area is estimated by the following procedure:

- Consumptive use by crop:

  Estimation of consumptive use of water by crops by the product of crop coefficient and the standard class - A pan evaporation.

- Net water demand:

  Addition of percolation water and water requirements for a nursery period and puddling works to the consumptive use of water.

- Net irrigation requirement:

  Deduction of effective rainfall from the net water demand.

- Gross irrigation requirement

  Addition of operation losses and conveyance losses to the net irrigation requirement; dividing the net irrigation requirement by the overall irrigation efficiency.

(2) Division of the Area

As explained in CHAPTER 4, the climate in the objective area differs in its pattern depending on the location and altitudes. To suit the difference, the objective area is divided into six sub-areas in estimation of the water requirement.

The division of the area and meteorological stations to provide necessary data are as follows:

Sub-area	Evaporation	Rainfall
1. Northern area	Kanyuara	Tanru Tedong
2. Southern area of Lake Tempe	Sengkang	Takallala and Watan Soppeng
3. Western area of Lake Tempe	Sengkang	Watan Soppeng
4. Eastern area	Sengkang	Sengkang
5. North eastern area	Sengkang	Sakkoli
6. Southern inland area	Camming	Maradda

(3) Consumptive Use of Water by Crops and Net Water Demand

(a) Crop coefficient of paddy

Crop coefficients of paddy were obtained from the results of field measurements. The time period for the measurements was limited to obtain adequate data. Then, they were supplemented by the experiment data obtained in the areas similar to the objective area.

In particular, reference is made to data of:

- Study on the Belitang Irrigation Project, conducted under the project titled "Land and Water Resources Development in South Eastern Sumatra" by FAO study team.
- Study on the Riam Kanan Irrigation Project, conducted by JICA.
- Study on the Luwu Irrigation Project by ILACO.
- Study on the Sadang Project.

The variances of the crop coefficient relative to the respective growing stages are shown in Fig. 15.2. The following show the average crop coefficient of paddy obtained from the said figures.

Percentage of growing stage (%)	0	10	20	30	40	50	60	70	80	90	100
Crop coefficient	0.80	0.85	0.96	1.10	1.22	1.32	1.35	1.30	1.16	1.00	0.70

Half-monthly period	First Month		Second Month		Third Month		Final Month
(days)	15	30	45	60	75	90	100
Average Coefficient	0.85	1.10	1.20	1.32	1.30	1.12	0.85

(b) Evaporation

In estimation of consumptive use of water by crop, the class - A pan evaporation is used. The following are the mean monthly evaporation at the respective meteorological stations.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kanyuara	165	169	178	169	179	147	161	174	188	204	192	166
Sengkang	176	179	183	153	148	119	136	169	194	200	180	169
Camming	130	137	140	129	111	124	120	136	131	166	143	135

(c) Puddling water requirements

The puddling water requirements are theoretically assessed by soil depth to be saturated and soil porosity. However, both vary from place to place. Accordingly the average paddling water requirements are estimated by the following assumptions.

(i) Depth of soil and porosity:

Surface soil : 20 cm , 50%
Sub soil : 10 cm , 50%

(ii) Vapour phase in soils after puddling : 5%

(iii) Soil moisture before water supply : 20%

(iv) Water to be supplied:

Water to be supplied to soil profile : 45 mm
Evaporation : 30 mm
Percolation : 15 mm
Standing water depth after puddling : 30 mm

Total .... 120 mm

This amount of water will be supplied gradually to fields one to two weeks before puddling works.

(d) Percolation

The field measurements as to vertical percolation rates were carried out by means of percolation cylindrical instruments together with measurements of crop consumptive use. The results show the average rate is 1 mm/day in both dry and wet seasons.

As regards horizontal percolation, it functions to supply water to lower adjacent fields. Thus, such percolation will not need to be considered in estimation of the overall irrigation requirements.

(e) Nursery water requirements

The water requirements for nursery beds are estimated under the following conditions:

(i) Area required for nursery bed : one twentieth of paddy field

(ii) Nursery period : 20 days

(iii) Required water for 20 days

Preparation of nursery bed	: 120 mm
evapotranspiration	: 100 mm
Percolation	: 20 mm
Total	240 mm (Say 12 mm/Project area)

Based on the proposed cropping patterns as presented in CHAPTER 14 and on the above values, the consumptive use of water and the net water demand are estimated for respective sub-areas. The results are as shown in Table 15.1.

(4) Net and Gross Water Requirements

(a) Effective rainfall

The rate of the effective rainfall to the total rainfall is largely affected by the rate of evapotranspiration, rainfall intensity, water supply management, field water holding capacity, etc. In this study, the rate of 70% to the monthly rainfall is applied, estimated under the assumption that the rainfall less than 5 mm is ineffective and the excess beyond 50 mm is also ineffective.

(b) Irrigation efficiency

Certain losses are unavoidable for conveying water and applying it to fields. Most of the irrigation canals of the Project are of unlined earth canal type, thus the relatively high conveyance loss is expected. The conveyance loss is assumed at 20% of the net water requirement. The operation loss depends on skill of water management, precise construction of facilities, etc. The operation loss is estimated at 15%. Therefore, the overall irrigation efficiency is 68%.

Based on the above figures, the net and gross water requirements are estimated. As it will be mentioned in the succeeding sections, the dependability of river flow to the project is studied by means of water balance between the available river flow and the irrigation requirements. Thus, the water requirements is estimated for the period of the last five years, for which the data on the river discharge are available.

The irrigation requirements of the respective sub-areas are as shown in Table 15.2.

(5) Design Water Requirement

The design water requirement for the irrigation system capacity is set at the maximum value within the unit diversion requirement estimated for the past five years as a safety value, since the available data for estimation of the probable value are limited.

The following are the design water requirements for respective sub-areas.

Area	Design water requirement (l/sec/ha)
Northen Area:	
Boya area	1.28
Others	1.31
Southern area of Lake Tempe	1.15
Western area of Lake Tempe	1.15
Eastern area	1.42
Northeastern area	1.39
Southern inland area	1.04

15.1.2 Drainage Requirement

(1) General

The drainage system is required to remove the excess water in the fields occurred from the strong rainfall storm and to create adequate conditions of drawdown in a harvesting period.

In general, the criteria for determination of the unit drainage requirement define the rainfall intensity with certain probability and a draining period necessary for remove of standing water up to a permissible water level. In the on-going irrigation project in Indonesia, the drainage requirements have been estimated by applying the different criteria to suit the physical and economical conditions of the sites.

For the Project Study, the design conditions are established in the following considerations. The design rainfall is to be the maximum daily rainfall with 20% probability of occurrence. The draining period is to be that the inundation water is removed within one day up to the level of 15 cm below the plant height.

(2) Unit Drainage Requirement

The drainage requirements are estimated for each sub-area in accordance with the division made in the estimation of the irrigation requirements, to suit the respective rainfall characteristics. In calculation of the drainage requirements, the following Rational Formula is applied.

$$R = \frac{C.I.}{T}$$

Where,

R = Unit drainage water requirement (l/sec/ha)

C = Peak runoff coefficient

I = Design rainfall ; the maximum daily rainfall with 20% probability of occurrence (mm/day)

T = Drainage period, 86,400 (sec)

As regards the peak runoff coefficient, it ranges commonly from 0.4 to 0.5 during the irrigation period. In the study the coefficient of 0.5 is used for the conservative value. The maximum daily rainfall with 20% probability of occurrence is estimated based on the daily rainfall data attached in the Data Book.

The following table shows the design rainfalls and the drainage requirements estimated for each sub-area.

Area	Rainfall Station	Design rainfall (Daily maximum with 20% probability) (mm/day)	Unit drainage water requirement (l/sec/ha)
1. Northern area	Tanru Tedong	150	8.6
2. Southern area to Lake Tempe	Takallala and Watan Soppeng	101 120	5.8 6.9
3. Western area to Lake Tempe	Watan Soppeng	120	6.9
4. Eastern area	Sengkang	110	6.4
5. Northeastern area	Paria	151	8.7
6. Southern inland area	Maradda	170	9.8

15.2 DESCRIPTION OF PROPOSED PROJECTS

15.2.1 General

(1) Basic Concept of Project Formulation

The objective of the irrigation development project is to increase in production of food grains with special emphasis on rice to attain selfsufficiency in foodstuff.

The farm land in the objective area comprises the paddy field of approximately 159,000 ha and the upland of approximately 86,000 ha as shown in Table 5.3. The existing paddy fields provided with irrigation facilities are limited to a lesser extent, averaging to 23% to the total paddy field. The cultivated area of paddy in the dry season, therefore, is limited, and even in the wet season the paddy cropping is sometimes damaged due mainly to uneven distribution of rainfall.

In planning the irrigation project in the area, it is first aimed at the stabilization of the paddy cultivation in the wet season and the increase in the paddy cultivation area in dry season.

For the sake of establishment of efficient irrigation systems, the objective area is divided into several sub-river basins that have the some extent of farm lands and dependable water sources. The following table shows the irrigable area extending in each sub-river basin. The irrigable land in the table includes the upland to be able to convert to a paddy field.

Sub-basin	Irrigable Land (ha)	Main Water Source	
		River	Catchment Area (Km^2)
Northern area	26,000	Bila river Boya river	370 510
North and West area of Lake Sidenreng	20,000	No dependable water source	
Western area of Lake Tempe	11,000	Batu Batu river Padangeng river Lawo river	100 110 60
Southern area of Lake Tempe	16,000	Langkemme river Walanae river	100 2,680
Southern inland	26,000	Sanrego river Batu Batu river Walanae river	180 180 1,200
Eastern area	45,000	Walanae river Lake Tempe	2,680 6,100
Northeastern area	23,000	Gilirang river	220
Total	167,000		

In the northern area, the Bila and Boya Rivers are considered as main water sources to supply the irrigation water to the area of 26,000 ha. The area lying along the Bila River is estimated at 12,000 ha. The annual and seasonal river discharge of the Bila is almost enough for the area. The Boya riverflow has been used for the existing Bulucenrana irrigation system covering 6,260 ha. The riverflow of the Boya is still able to supply the irrigation water to the other additional area.

In the southern part of this area, there are the existing Belawa and Lancirang irrigation systems. Their facilities, however, are substantially deteriorated. In the western part, there exist rainfed paddy fields having no dependable water source. In order to utilize the stable and abundant river water of the Boya for irrigation to those areas, the project will be formulated. The low-lying area along the coast of Lake Tempe in this area, approximately 2,500 ha, is sometimes inundated by the lake water, accordingly it is excluded from the irrigation plan.

On the north and the west of Lake Sidenreng, there exist flat plain and mild hilly areas of 20,000 ha which have been mostly irrigated by the Sadang riverflow. The built-up irrigation plan shows the further extension of the irrigation area for the hilly area by pumping schemes. Accordingly, the irrigation plan for the above area is excluded in the master plan.

In the western area of Lake Tempe, consisting mainly of paddy fields of 11,000 ha, main water source will be the Batu Batu, the Padangeng and the Lawo Rivers. The existing irrigation system covering 6,200 ha in total are served in the area diverted from independent small scale intake structures. In view of efficient water management and system operation, the existing system have to be unified. However, the existing systems locating in the upstream of the Batu Batu River are well operated at present except some canal system. Therefore except the above, through unification of the existing intake structures and improvement of the existing canal systems, and devleopment of rainfed areas, the efficient irrigation systems are formulated with the diversion water from the Padangeng and Lawo Rivers.

The main water sources in the southern area of Lake Tempe will be the Langkemme River originating from the western slopes and the Walanae River. From the geographical location of water sources, the Langkemme River is serviceable for the high terrace land of 5,000 ha. The water of the Walanae River will be delivered to the flat low area of 10,000 ha lying along the both banks. The diversion of the Walanae River water will be made from a multipurpose dam to be constructed on the Walanae. The low lying area along the coast of Lake Tempe is excluded from the irrigation plan due to inundation by the lake water rise.

In the southern inland, the main stream of the Walanae, the Sanrego River and the Batu Pute River, which are main tributaries of the upper Walanae, have the abundant volume of water. The undulating areas extending on the both banks of the Sanrego, 10,000 ha, can be economically irrigated by use of the Sanrego riverflow. As for the area of 6,000 ha lying along the Batu Pute River, there are no suitable locations of hydraulic structures, or even if any, the large scale and careful treatment of foundation is needed to cope with undesirable geological condition at the topographically possible sites.

Moreover, along the right bank of the upper Walanae, there exist rainfed paddy fields of 4,000 ha. For the irrigation to those areas, pumping schemes are needed lifting the water from the Walanae since the available flow in those areas originating from the eastern slopes is significantly small. The topography to ascend from the river bank of the Walanae necessitates long discharge pipeline to deliver the lifted water to the higher elevated area.

Such geologically and topographically unfavourable conditions for irrigation development result in the expensive construction. The economic aspects will fall in lows. It is considered unpracticable to formulate such development plans at the present. Therefore, those areas are not included in the master plan.

On the both banks of the Cenranae area in the eastern area, there exist the paddy fields of 20,000 ha and 25,000 ha on the right bank and the left bank, respectively. The area of 16,000 ha lying on the right bank will be irrigated by inter-sub basin diversion plan from a multipurpose dam to be constructed on the Walanae River. Whereas the left bank area extends from elevations of 100 m in high hilly lands near the watershed to the Gilirang River to elevations of 5 m in the low lying area near the Cenranae River, and they have no efficient water sources except Lake Tempe. In consideration of geographical locations of lake water and the area, a pumping scheme is inherently needed, and it will be a large and high head pump scheme to develop the whole area of 25,000 ha. Such pump scheme requires the huge amount of investment not only for pump equipment but also for its supports such as power supply system. High head pumping irrigation also requires high operation and maintenance cost. Such economic aspects compel to postpone the development of the whole area at the present stage. Therefore, the small scale pump scheme is studied as a pilot pump scheme in this area.

In the northeastern area, only the Gilirang River is a dependable water source. It is contemplated to develop the land and its water source to the maximum extent.

In the light of total available water, geographic location of water source and seasonal and annual distribution of riverflow of each river, the diversion plan are studied.

In principle, in case of gravity irrigation, the perenial irrigation is first looked for every sub-basins as far as total available water, topography and geology at a diversion site permit to introduce such irrigation plan. However, where the amount of irrigation requirements exceeds the available water supply in the sub-basin, the complete irrigation in the wet season and supplemental irrigation in the dry season are conceived to fully utilize the land and water resources in the basin.

As for the scale of the project, the appropriate project scale is carefully so determined that the efficient operation and maintenance can be assured in addition to the physical limitation of land and water availability.

Based on the results of the analysis of the data on hydrology, topography, soil, geology, etc., and of the study of the alternative plans, the following nine irrigation projects covering the area of 81,000 ha are proposed.

Location	Irrigation Project	Project Area (ha)	Irrigable Land (ha)
Northern area	Bila Irrigation Project Boya Irrigation Project	10,500	26,000
North and West area of Lake Sidenreng	No proposed	–	20,000
Western area to Lake Tempe	Padangeng Irrigation Project Lawo Irrigation Project	4,200 3,000	11,000
Southern area to Lake Tempe	Langkemme Irrigation Project Walanae Irrigation Project	5,000 10,200	16,000
Southern inland	Sanrego Irrigation Project	10,000	26,000
Eastern area	Walanae Irrigation Project Cenranae Irrigation Project	15,800 2,300	45,000
North eastern area	Gilirang Irrigation Project	10,000	23,000
Total		81,000	167,000

(2) Irrigation Area

The natural flow of the river occurs with large seasonal and annual fluctuations. The irrigation area, in particular in the dry season, is affected by the fluctuation in case of irrigation system with a natural flow intake. Further, in the objective area, the seasonal patterns of the riverflow do not necessarily coincide with those of the rainfall occurring in the irrigation area. It seems that correlation between the river discharge and the rainfall in the irrigation area is slight.

In consideration of the above hydrological fact, the area that can be irrigated by the riverflow are estimated for a series of water supply period by means of water balance between the available water supply and the demand.

Based on the irrigation water requirements estimated in Section (1) and the available water supply estimated in CHAPTER 6, the water balance study is made as shown in Tables 15.13 to 15.21, and the results are summarized in Table 15.22.

The following table shows the irrigation area for the respective proposed irrigation projects in terms of the average and minimum values.

Project	Project area (ha)	Irrigation area (ha)			
		Average		Minimum	
		Wet season	Dry season	Wet season	Dry season
Langkemme Irrigation Project	5,000	5,000	3,700	5,000	2,800
Bila Irrigation Project	10,500	10,500	6,800	10,500	4,800
Sanrego Irrigation Project	10,000	10,000	8,600	9,500	7,000
Lawo Irrigation Project	3,000	3,000	1,800	3,000	700
Boya Irrigation Project	10,000	10,000	9,800	9,800	9,100
Walanae Irrigation Project	26,000	26,000	26,000	26,000	26,000
Gilirang Irrigation Project	10,000	10,000	10,000	10,000	10,000
Padangeng Irrigation Project	4,200	4,200	4,200	4,200	4,200
Cenranae Irrigation Project	2,300	2,300	2,300	2,300	2,300
Total	81,000	81,000	73,000	-	-

The case studies and the proposed plan for the respective irrigation projects are described hereunder.

15.2.2 Langkemme Irrigation Project

(1) Delineation of the Project Area

The Langkemme Irrigation Project area lies in the southern area of Lake Tempe. There exist many small streams originating from the western mountainous slopes, among which the Langkemme River is the biggest stream with a catchment area of 100 km^2 at the intake site with possible geographical location as to the irrigation supply. Thus, it is contemplated to allocate the Lengkemme River water to those areas to assure the stable irrigation throughout a year.

The area is very long and narrow and is bounded with the Langkemme, the Lawo and the Laja Rivers on the north, south and east, respectively. The area is mainly composed of flat alluvial plain sloping at an average gradient of approximately 1/500 toward north to northeast. The elevation of the area ranges from 200 m at the southern edge near the Langkemme River and 20 m at the northern edge.

The climate of the area belongs to the pattern of the southern area of Lake Tempe as described in Chapter 4. The rainfall distributes fairly evenly over the area.

The water levels of the Langkemme River have been recorded for about four years at 0.8 km upstream site from the confluence of the Sero River. According to the records, in general, a high water season lasts from December to March and a low water season from August to October. However, even in the high water season the river-flow fluctuales considerably to large extent. The annual mean monthly flow is 4.3 m^3/sec and the minimum monthly flow was 1.4 m^3/sec in September 1976.

The water of the Langkemme River has been unused and discharged to the Walanae River with the exception of lesser usage of the small village irrigation scheme and hydropower.

(2) Scale of the Project

The potential irrigation area within the Langkemme area is delineated based on the topographic maps on a scale of 1:25,000 and on the results of soil and land capability investigations.

The gross and net irrigable lands are estimated at 5,500 ha and 5,000 ha respectively. To serve the irrigation water successfully to the area, the intake site is selected 5.5 km upstream of the confluence of the Sero river. The catchment area at the site is approximately 100 km^2.

In order to determine the prospective scale of the Langkemme irrigation project, the dependable water source of the Langkemme for 5,000 ha in net is assessed by means of water balance between the river flow and the irrigation water requirement for four years from May 1974 to February

The result indicates that the Langkemme River assures the complete irrigation during wet season for the irrigable area of 5,000 ha, however, the water supply during dry season is limited to 3,700 ha or about 74% of that in the wet season on an average. The details are shown in Table 15.13 and the results are summarized in Table 15.22.

The Langkemme River is very steep along the whole reach. In view of topography there is no suitable location to permit hydraulic structures for the water storage, to render more effective utilization of the river flow.

The two prospective intake weirsites are selected for the study, site-1 and site-2. The topographic survey and geological investigation were carried out on each site.

Both sites have the following advantages.

Site-1: The site-1 is located in a valley 5.5 km upstream from the confluence of the Sero River. The river bed elevation is 205 m. The river bed is underlain by the base rock of cemented tuff breccia. The width of the river is very narrow, approximately 40 m. The location provides suitable topography and geology for a low fixed type intake weir for the project. Whereas, it needs to construct a head reach of 200 m in length on a steep slope, and the access to the site is very limited.

Site-2: The site-2 is situated 200 m downstream from the intake site-1. On this location, the steep slope of the hill separates from a river course. The river bed elevation is 187 m and the width of the river is about 50 m. Geology at the site is the well cemented massive tuff breccia same as the site-1. In order to secure the water level of 200 m, however, this location necessitates to construct a high intake weir of 13 m in height in stead of a head reach.

Geological conditions of each site are as explained in Supporting Report Part Nine.

The general features of the intake weir at each alternative site are presented in Table 15.23 and cost comparison is made as shown in the same table.

The result of comparison indicates that the site-1 is more economical due mainly to the low cost accrued from a low intake weir. Consequently the intake structures will be constructed at the site-1 with a head reach.

(3) Proposed Project Works

Irrigation water of 5.8 m^3/sec at maximum is diverted from the Langkemme River at the proposed intake site into the project area of 5,000 ha through the intake structures, the head reach and the canal system.

The intake weir is a fixed type concrete weir founded on firm bed rocks. The crest elevation is set at EL.207 m. The scouring sluice will be provided on the left side of the weir to control the sedimentation. The intake structure will be constructed just upstream of the scouring sluice. The head reach will be constructed along an access road with a concrete box culvert covered with earth. It will be usable for operation of intake structures.

The irrigation canal system consists of a main secondary and tertiary canals and a number of quaternary canals. The existing Cennal irrigation system of 240 ha is incorporated into the proposed irrigation system. The main canal runs along the skirts of the western slopes and reaches near Watan Soppeng, diverting the water to secondary canals on the way. The secondary canals serve irrigation blocks bounded by natural streams.

The natural stream bound the irrigation blocks. They are used for drainage system. The tertiary drains in the tertiary system connect the natural stream with quaternary drains, which evacuate the excess water directly from the fields. The canal operation roads provide a function of farm roads. Thus, the operation roads are to be constructed so as to meet such requirement.

The proposed irrigation system of the project is presented in Fig.15.6 and the principal features of the project are as shown in Table 15.28.

15.2.3 Bila Irrigation Project

(1) Delineation of the Project Area

The Bila River gathers the runoff from the northern mountain region and meanders in the flat alluvial plain. The flat plain extending along the Bila is almost paddy fields under rainfed cultivation. To such area, the water of the Bila is to be supplied.

The area is bounded on the west by the Bila River and on the south by Lake Tempe. Along the edge of Lake Tempe, the existing paddy fields lie, however, they are annually inundated by the rise of Lake water. Such area inundated with probability of once in five years was excluded from the irrigable area. The elevation of the area ranges from 40 m at the head of the area to 9 m near Lake Tempe.

The area is characterized by two distinct seasons, wet and dry. The annual rainfall ranges from 1,600 mm to 2,000 mm of which about 60% occurs in the wet season from April through September. The meteorological data at Tanrutedong and Kanyuara area available for irrigation planning of the area. The general features of the climate prevailing in the area are explained in Chapter 4.

The water levels of the Bila River have been recorded for about five years at 9 km upstream site of the confluence of the Kalola River with a catchment area of 376 km^2. The records show that the high water season lasts from May to August and the low water season from December to March. The annual mean discharge is 19 m^3/sec and the minimum monthly flow recorded in the past five years was 2.4 m^3/sec in September 1977. The discharge of the Bila varies considerably not only from month to month but also from year to year.

The Bila River water has not been used for the irrigation purpose at the present and flows into Lake Tempe. During the wet season the flood water flows over the natural levels and occurs the flooding in the area.

(2) Scale of the Project

The Project area is delineated so as to contain the existing paddy fields as much as possible in due consideration of topography, soil and land capability in the area and of the prospective intake site. Topographically, the maximum extent of the irrigable area is 12,000 ha in net with water level of 40 m at its head. Table 15.4 shows the gross and net irrigation area limited from the topographic conditions, showing together with the present land use.

The scale of the project depends largely on the water intake methods, since the Bila River has abundant annual runoff to irrigate the maximum extent of the irrigable land in the area. Then, in order to determine a certain scale of the prospective project, the following alternative plans are conceived.

(a) Intake method without flow regulation

Case-1: A free flow intake site is selected 2 km downstream of the confluence of the River Betau (Site-A). This site has such advantages as large catchment area of about 376 km^2 and the nearest location to the irrigation area.
Adversely to the above advantages the river bed elevation is low and the river is wide. Thus, it is obliged to construct an expensive intake weir. Furthermore, topography around the site limits the intake water levels to EL.35 m at maximum. Consequently the maximum irrigation area is restricted to 10,500 ha.

Case-2: A weir site-B is looked upon the lower and narrower weir in the upstream reach. The site is situated 5.5 km upstream from site-A. In contrast with the favourable location for economical weir construction, the catchment area decreases to 287 km and the available water is limited for the irrigation of 10,000 ha.

(b) Intake method with flow regulation

Case-3: A dam is conceived at site-A. This site has the larger catchment area, i.e., the larger discharge compared with the other sites. This results in less storage volume required for commanding the same extent of the area. The dam plan is contemplated to serve the water to the maximum extent of the irrigable land, 12,000 ha throughout a year.

The required volume of storage for Case-3 dam plan is estimated as shown in Table 15.14 and based on them, the general features are determined as shown in Fig. 15.3. The general features of each case are presented in Table 15.24. The construction costs are estimated in Table 15.38. Based on the net incremental benefit, the economic comparison is made between the above three cases in terms of internal rate of return as shown in CHAPTER 17.

The result indicates that case-1 is most economical followed by case-2. As a result, the Bila irrigation project is contemplated with a natural flow intake method for an irrigation area of 10,500 ha.

The Directorate General of Water Resources Development proceeded in preparation of the design of irrigation development for this area with the concept of the natural flow intake. The master plan, however, defines higher potentiality of land and water resources in the area for irrigation development than the above plan. In view of the efficient and economical utilization of the resources, the above-mentioned Bila irrigation project is selected and formulated.

(3) Proposed Project Works

Irrigation water of 13.8 m^3/sec at maximum at the intake site is diverted from the Bila River into the project area of 10,500 ha.

The intake weir is a fixed type concrete weir founded on mud-stone. The crest elevation is set at EL.35 m. The scouring sluice is provided on the left side of the weir. The intake structures are provided just upstream of the scouring sluice. For an area locating on the right bank between the Bila and the Boya Rivers, about 1,200 ha, the water is delivered through a main body of the weir after taking in at the left bank intake.

The irrigation system comprises two main canals; left and right main canals, secondary and tertiary canals, and a number of quaternary canals. The existing Salodua irrigation system of 520 ha is incorporated into the proposed irrigation system. The left main canal with a water elevation of EL.35 m runs southwards along the skirts of eastern hills for approximately 42 km. The natural stream bounding the irrigation blocks will be used for secondary drains which introduce drainage water to the Bila River from the tertiary and quaternary drains in the tertiary system. The operation roads to be provided along the main and secondary canals will be usable for farm roads and they have to be constructed to perform such functions.

The proposed irrigation system of the project is presented in Fig.15.7 and the principal features of the project are as shown in Table 15.29.

15.2.4 Sanrego Irrigation Project

(1) Delineation of the Project Area

The Sanrego area is a comparatively vast area in the southern inland lying along the Walanae and the Sanrego Rivers. The area consists mainly of rainfed paddy fields, and upland fields to some extent. The river water of the Sanrego has not been used as yet for the purpose of irrigation. The Sanrego Irrigation Project is contemplated to serve the irrigation water to those area.

The area descends toward the Walanae River with different gradients from east, west and south sides. The project area will be bounded by the proposed main irrigation canals, which will run along such slopes. The results of the soil and land capability investigations indicate that the large area of the land extending in this area is suitable for paddy cultivation.

In making delineation of the project area in the wide area, the available riverflow of the Sanrego and the prospective intake site to make it usable are decisive.

The water level measurements data are available for five years with some lack of data. The measurement site is situated 15 km upstream of the confluence of the Walanae River with a catchment area of 176 km^2. The records indicate that comparatively constant discharges occur throughout a year, however a shift of the high water season and low water season is not stable. The annual mean monthly discharge is 9.2 m^3/sec and the minimum monthly discharge was occurred at 5.4 m^3/sec in September 1976.

The intake site is selected at 0.3 km upstream site from the gauging station with geology of outcropping bed rock and topography of narrow river width. Geology of the intake site is as explained in Supporting Report Part Nine.

(2) Scale of the Project

As mentioned in the above section, the extent of the irrigation area depends solely on the availability of the water source of the Sanrego River. In this context, the water balance between the river discharge and the irrigation water requirement is studied for five years for which the discharge data are available. The result is as shown in Table 15.15. It indicates that it is possible to irrigate an area of 10,000 ha during the wet season and of 8,600 ha in the dry season with the natural flow intake system.

On the other hand, the Directorate General of Water Resources Development proceeded in preparation of the design of irrigation development to the Sanrego area of 3,500 ha. As mentioned above, however, the water balance study between the Sanrego riverflow and irrigation demand indicates that the Sanrego river has higher potentiality for irrigation than that estimated in the above plan.

According to the result, the proposed plan is selected so as to secure efficient and effective resources utilization to the maximum extent practicable.

In consideration of a comparatively high dependability of irrigation throughout a year which is accured by stable discharges, and of no suitable locations for flow regulation due to steep topography of the river, the Sanrego irrigation project is formulated by introducing a weir intake plan.

(3) Proposed Project Works

Irrigation water of 10.4 m^3/sec at maximum at the intake site is diverted from the Sanrego River into the Project area of 10,000 ha.

The intake weir is a fixed type concrete weir founded on firm bed rock with the crest elevation of EL.170 m. The scouring sluice will be provided on the right side of the weir to control the sedimentation. The intake structures will be constructed just upstream of the scouring sluice. To divert the water to the left bank area, a syphon conduit is provided in the weir body

The irrigation canal system comprises two main canals; right and left main canals, secondary and tertiary canals and quaternary canals. The existing Maradda irrigation system of 430 ha is incorporated into the proposed irrigation system.

The right main canal commands an area of 7,700 ha with a length of 40 km. The left main canal serves with an area of 2,300 ha. The drainage system consists of secondary drains using natural streams and tertiary and quaternary drains to be provided in the tertiary system. The farm roads to be provided in the tertiary system connect to the canal operation roads.

The proposed irrigation system of the project is presented in Fig.15.8 and the principal features of the project are as presented in Table 15.30.

15.2.5 Lawo Irrigation Project

(1) Delineation of the Project Area and Project Scale

There exist many streams in the southern and western areas of Lake Tempe, originating from the western slopes. Among them the Lawo River is ranked as a middle scale river following to the Langkemme and the Padangeng Rivers. The Lawo area extends on the flat low land on the left bank of the Lawo and is contiguous to the existing Leworang irrigation system on the north. In this area an area of 500 ha is provided with existing Tinco irrigation system consisting of a temporary weir and canal system, however, the facilities are fairly poor in their conditions. Such existing system will be incorporated into the proposed irrigation system.

The area consists mainly of flat low land sloping at an average of 1:1,000 toward Lake Tempe. The elevation of the area ranges from 100 m at its head near Ompo village to 10 m at its lower end near Lake Tempe.

The water levels have been measured since July 1975. The gauging station is situated just downstream of the road crossing near Ompo village with a catchment area of 63 km^2. The discharge data available are limited only for two and half years. Thus, in planning the irrigation project the discharge data are supplemented by estimating a correlation of runoff between the Langkemme and Lawo Rivers, as shown in CHAPTER 6. According to such data, a high water season lasts from January to June and a low water season from August to November. The annual mean monthly flow is at 2.7 m^3/sec.

The soil and land capability investigations revealed that an area of 3,000 ha in net was suitable for paddy cultivation. In order to supply the water successfully to the area, the intake site is selected 0.6 km upstream of the road crossing at Ompo nearby the water level gauging station. The site is quite suitable for construction of a diversion weir, since firm rocks outcrop on the river bed as described in Supporting Report Part Nine, and the river width is narrow, about 40 m. At this site the irrigation water with the sufficient water elevations of 120 m will be assured by a low intake weir.

The water availability of the Lawo River is examined by means of the water balance between the river discharge and the irrigation requirement.

The result indicates that in the wet season the river water is dependable for irrigation to the area of 3,000 ha, however, in the dry season, the irrigation area is decreased to an area of 1,800 ha or 60% of that in the wet season on an average. The details are shown in Table 15.16.

The Lawo River is so steep that there are no locations suitable for regulating the excess flow in the wet season to augment the irrigation water in the dry season.

As a result, the Lawo Irrigation Project is contemplated to supply the water to the area of 3,000 ha through an intake with a diversion weir.

(2) Proposed Works

Irrigation water of 3.5 m^3/sec at maximum is diverted into the project area through the intake structures and canal system.

The intake structure is a fixed type concrete weir founded on sound bed rock with a crest elevation of 120 m. The intake structures consist of the said diversion weir, a scouring sluice on the left portion of the weir and an intake just in the upstream of the scouring sluice. The stilling basin is provided downstream of the weir to dissipate the excess energy of the water flowing over the weir.

The canal system consists of a main, secondary, tertiary and quaternary canals. The canal system of the existing Tinco irrigation system will be incorporated into the proposed irrigation system. The natural small stream bounds the irrigations blocks. They are used for drainage system. The tertiary drains connect the natural stream with quaternary drains which evacuate the excess water directly from the fields. The canal operation roads provide a function of farm roads. Thus, the operation road are to be constructed so as to meet such requirement.

The proposed irrigation system of the Project is presented in Fig.15.9 and the principal features of the project are as shown in Table 15.31.

15.2.6 Boya Irrigation Project

(1) Delineation of the Project Area and Project Scale

The Boya area extends on the right bank of the Boya River bounded on the north and west by the hilly slopes and on the south by Lake Tempe.

About 6,000 ha of the Bulucenrana irrigation system area is provided with fairly good irrigation facilities consisting of a diversion weir a main canal and secondary canals. Paddy cultivation is well practiced in the area. However, the tertiary system is lack at present. In addition, the southwestern part of about 2,000 ha is covered with the existing Belawa and Lancirang irrigation systems. Their facilities are, however, substantially deteriorated. On the western part, the rainfed paddy fields are existed. This area is not benefitted with such abundant riverflow as the Boya.

The low lying area located along Lake Tempe with the elevations less than 9 m is sometime inundated with lake water, therefore, such area is excluded from the project area.

The Boya Irrigation Project includes the improvement of such existing irrigation facilities and the extension of the irrigation area to make more effective utilization of the Boya River.

According to the soil and land capability investigations, the irrigable area in the Boya area is estimated at 10,000 ha in net as shown in Table 15.7.

The water levels of the Boya River have been recorded since October 1975 at the Bulucenrana gauging station which is located 1.5 km downstream of the existing Bulucenrana intake weir. The data cover only for 3 years with some lack. The limited discharge data are supplemented by estimating the correlation of the runoff pattern between the Boya and Bila Rivers. Furthermore adjustment of data on the discharge is made by adding the irrigation water consumption diverted to the Bulucenrana area. Then the available discharge is estimated as shown in CHAPTER 6.

The site of the intake structures for the project is selected at the existing weir site in view of topography and geology as explained in Supporting Report Part Nine. The intake capacity of the existing structures, however, has to be increased for diverting the water to the proposed project area of 10,000 ha.

In order to assess the availability of the river flow, the water balance between river flow and the irrigation water requirement is studied as shown in Table 15.17. The result shows the river flow is dependable for irrigation of the area of 10,000 ha in the wet season, and in dry season it is available for the area of 9,800 ha or 98% of that in the wet season on an average.

(2) Proposed Project Works

In order to divert the irrigation water to the high elevated area, the increase in the elevation of weir crest and the flow capacities of the existing intake and head reach is to be needed. The weir crest is raised up to EL.30 m from the existing crest elevations of 27 m. Irrigation water of 12.8 m^3/sec at maximum is diverted through an enlarged intake. The existing canal system of the Bulucenrana area is incorporated into the proposed irrigation system, offtaking the water at the head of the proposed main canal.

The proposed main canal runs along the skirts of the northern hills toward the west after passing the head reach. Then it turns to the south, and the Belawa and Lancirang existing system areas are served at the lower end of the canal.

The proposed irrigation system of the project is presented in Fig.15.10 and the principal features of the proposed project are presented in Table 15.32.

15.2.7 Walanae Irrigation Project

(1) Delineation of the Project Area and Project Scale

There exist narrow and long strips of paddy fields along both banks of the Walanae River, and adjacently to the right bank area, the flat land having no reliable water sources lies on the right bank of the Cenranae River. To serve the irrigation water to such areas, the Walanae irrigation project is contemplated with diversion of the abundant flow of the Walanae. The irrigation area is estimated at 10,200 ha in Walanae area and at 15,800 ha in the Cenranae area, based on the soil capability and topographic conditions. The details are as shown in Table 15.8.

In order to utilize and control the Walanae river effectively for irrigation development, flood control and hydropower development a multipurpose dam is contemplated at Mong site and at Walimpong site as an alternative. The required storage of dam for irrigation purpose is estimated at 122 x 10^6 m^3 based on the diversion requirement as shown in Table 15.18 and river maintenance flow. The details are presented in Table 15.19 (1) and (2).

In making the best choice of the multi-purpose dam plan, a comparative study is made with respect to the site and storage. In consequence of the study, the Walimpong dam plan is selected as shown in Supporting Report Part Six.

As for the water supply from the Walanae River basin to the Cenranae River basin, it is needed to pass the eastern hilly range. After passing the range, the Walanae river water is delivered to the flat area having the elevations less than 43 m. As compared with the other area, this geographical location of the Cenranae area of 15,800 ha or 61% of the Project area is decisive of hydraulic dimensions of the dam, requiring the water level of at least 56.0 m at an outlet of intake structures, in consideration of loss heads on conveyance.

(2) Proposed Project Works

An intake structure will be constructed on the right bank to divert water of 26.5 m^3/sec at maximum to a right main canal. The canal system consists of the said right main canal of 76 km a left main canal of 37 km, secondary canals tertiary canals and a number of quaternary canals. The right main canal runs on undulating hilly slopes for about 38 km toward north, and where the canal reaches a low hill, a tunnel will be constructed to pass hilly range for diversion of water of 22.4 m^3/sec to the Cenranae area. The length of the tunnel will be 2.3 km.

Irrigation water of 6.8 m^3/s is offtaken to the left main canal from the right main canal near village Mong, and conveyed to the left bank with a syphon type aqueduct supported by piers. After crossing the Walanae River the canal runs along the Walanae and reaches to the low-lying area near Lake Tempe.

The project irrigation system will incorporated such existing irrigation systems as Paroto 270 ha, Takku 460 ha, Bulupatira 240 ha located on the right bank of the Walanae, Unyi 1,700 ha on the right bank of the Cenranae, and Larenge 1,000 ha, Lagarigi 200 ha, Akanpen II 1,100 ha and Talumae 340 ha located in the left bank of the Walanae.

The proposed irrigation system of the project is presented in Fig.15.11 and the principal features of the Project are presented in Table 15.33.

(3) Alternative Development Plan of the Walanae Area

The irrigation development plan of the Walanae area of 26,000 ha is formulated as one component project of Walimpong multi-purpose dam plan. In view of effective and efficient utilization of the Walanae riverflow for irrigation, a dam regulation to assure the irrigation water to large extent, i.e., the large amount of irrigation benefit, is most prospective, even though the huge amount of investment for dam construction is needed.

However, the implementation schedule of the project is put behind in the overall development schedule, due to low economic index in terms of benefit-cost ratio. In this context, the following alternative plans are studied.

It is suggested in the previous report that the Walanae area is commanded by the Ludunge project for which the water is taken from Ludunge intake structures to be constructed near Mong village. However, the geographical location of the concerned irrigation area requires a high diversion weir of about 34 m at the above-mentioned site with a river bed elevation of 22 m. Moreover, the geological investigation of the Mong dam site conducted by the Team revealed the weak foundation conditions due mainly to high permeability and low bearing capacity. Those geological conditions necessitate adequate treatment on construction of a high diversion weir, then, fall in the expensive construction.

Accordingly, with regard to geology and topography along the Walanae rivercourse, the suitable site is extremely restricted. An alternative site for a diversion weir will be conceivable in the downstream of a road crossing near village Cabenge, because in other locations, the increase in the irrigable area is not expected even if the high weir is contemplated. At the site, a diversion weir should be of all movable gate type in order to protect the upstream area from submergence due to the increase in a flood water level. With diversion of water from an intake weir near Cabenge, the areas of 2,000 ha and 500 ha located on the respective left and right banks are irrigated, but they are limited to so small extent.

On the other hand, the Cenranae area is irrigated only by introduction of pumping schemes from the Cenranae River, in case the direct diversion of the Walanae riverwater is not assured. In consideration of topography of the area ascending from the river bank, the pump irrigation area is estimated at 1,500 ha and 3,000 ha with a pumping head of 15 m and 30 m, respectively.

In all cases, the irrigation area is extremely limited. Consequently, to effectively utilize the abundant water source of the Walanae River and the wide area extending around the Cenranae River, the Walanae dam regulation plan is vital for irrigation development of the Walanae project area.

15.2.8 Gilirang Irrigation Project

(1) Delineation of the Project Area and Project Scale

The Gilirang area is located in the northeastern area, extending from hilly terrace to low-lying areas near the sea coast along the Gilirang River. The area is mainly composed of rainfed paddy fields. The elevations of the area range from 30 m at its head near the village Watang Gilirang to 5 m from 30 m at its head near the village Watang Gilirang to 5 m at its lower end near the sea coast.

The climate of the area is a monsoon climate with two distinct seansons, rainy and dry. The annual rainfall averages to 2,000 mm of which about 70% is concentrated in the rainy season from April througn September.

The water level measurements have been conducted at Tarumpakkae with a catchment area of 300 km since September 1975. According to the records, the discharge of the Gilirang River varies considerably not only from month to month but also from year to year. The low flow occurs from November to March. The minimum monthly low flow recorded was 0.4 m^3/sec in February 1976. The mean monthly flow is 20.8 m^3/sec.

In formulating the irrigation development plan, the large fluctuation of the flow in volume and in occurrence restricts the project scale to a large extent, although the annual total runoff of the Gilirang river is large.

Accordingly, the following alternatives are conceived with regard to the intake methods and comparison is made to select the prospective development plan.

Case-1: Intake method without flow regulation

In order to utilize the natural flow to the maximum extent, a weir site is selected downstream as much as possible. The site is set northeast of the village Watang Gilirang with a catchment area of 220 km^2. At the site the river-flow is available for irrigation to an area of 4,800 ha in the wet season and 1,400 ha in the dry season as shown in Table 15.22.

To serve the water to the area of 4,800 ha, the water elevation of 20 m is needed at the weir site. The river bed elevation is 11 m and the ground elevation around the site is 18 m. Such topography requires all movable weir and flood protection dyke on the both banks. The construction will be made by so-called coupure method.

Case-2: Intake method with flow regulation

The riverflow of the Gilirang occurs with large seasonal and yearly fluctuation. In the water balance of case-1 between the riverflow and the water requirement as shown in the said Table 15.21 it is indicated that the irrigation area decreases to 1,400 ha in the dry season, or 29% of the irrigation area in dry season. In order to utilize the river water and lands effectively, the flow regulation plan with a dam is conceivable.

The sites suitable for a dam are investigated in the upstream reaches with regard to topography and geology. Geology of the site is as described in Supporting Report Part Nine. The most desirable site is selected 12 km upstream of the village Watang Gilirang having a catchment area of 157 km. The site stores and serves the water to an area of 10,000 ha in both rainy and dry season. The required storage is estimated at 110×10^6 m^3 as shown in Table 15.21 The storage capacity and reservoir area at the proposed dam site is presented in Fig. 15.4.

According to the above conditions, the general features of each case are determined as shown in Table 15.25. Based on the preliminary design, the cost estimates are made as in Table 15.43. In CHAPTER 17, the economic comparison between case-1 and case-2 is made. The result indicates that the case-2 is more economical than case-1 due mainly to the large increase in the irrigation area in the dry season.

(2) Proposed Project Works

The center cored fill type dam will be constructed in the upstream reaches with an catchment area of 157 km^2. The intake structure will be located on the right bank to divert the water of 13.9 m^3/sec at maximum and the non-gate controlled type spillway with crest length of 100 m will be constructed on the left bank to discharge the flood of 1,000 m^3/sec with probability of once in 1,000 years, estimated on the basis of the flood discharge shown in Supporting Report Part One.

The right main canal starts from the intake structure and runs along the Gilirang River for about 5 km and the canal offtakes the water to the left main canal. After branching, the left main canal crosses the river with a syphon type aquaduct.

The proposed irrigation system of the project is presented in Fig.15.12 and the principal features of the project are shown in Table 15.34.

15.2.9 Padangeng Irrigation Project

(1) Delineation of the Project Area and Project Scale

The Padangeng area is located in the western area of Lake Tempe along the both banks of the Padangeng River. The area lies in-between the proposed Lawo Irrigation Project area and the existing Salobunne irrigation system. In the lower reaches of the Padangeng River, the riverflow has been used for irrigation of the Padangeng Leworang irrigation left and right systems, having an area of 1,190 ha and 710 ha, respectively. On the north, the existing Towereng irrigation system with an area of 450 ha is located by use of the riverflow of the Towereng. The Padangeng Irrigation Project is aimed at to assure the stable water supply by unifying the existing systems and further extension of the area lying along the Padangeng River.

The irrigation area is estimated at 4,200 ha in total including the areas of the existing systems. The details are shown in Table 15.10.

To supply the water successfully to the areas, the intake site is selected 1 km southwest of the village Tajuncu with a catchment area of 107 km^2.

At present, although the flow of the Padangeng River has been used for irrigation to the area of 1,800 ha, the riverflow of the Padangeng does not necessarily serve the year round irrigation to the above area. Then, the flow regulation plan is considered together with the natural flow intake plan.

The following alternative cases are conceived with regard to intake methods.

Case-1: Intake method without flow regulation

In order to secure the sufficient water level and the adequate discharge, the intake site is selected 1.0 km southwest of village Tajuncu, having a catchment area of 107 km^2. At the site the riverflow is available for irrigation of an area of 4,200 ha in the wet season and 2,800 ha in the dry season as shown in Table 15.22.

The river bed elevation at the site is 29 m and the required water level at the head of the canal is 40 m. Therefore a weir with height of 11 m at maximum is needed.

Case-2: Intake method with flow regulation

In the water balance of case-1, the result indicates incomplete water supply in the dry season. In order to expand the irrigation area in the dry season to the full extent, the regulating dam is conceived.

The site for a dam is selected at the same site as case-1, since geology of the site is quite adequate for construction of dam as shown in Supporting Report Part Nine, consisting mainly of andesite and andesitic tuff breccia, and the river width is narrow.

The required storage of a dam is estimated at 9×10^6 m^3 as shown in Table 15.20. In consideration of the foundation condition and a narrow width of river course, a concrete gravity type dam is conceivable.

The general features of each case are presented in Table 15.26. The construction costs are estimated based on the preliminary design, as presented in Table 15.43. In CHAPTER 17, the economic comparison between case-1 and case-2 is made. The result indicates that the case-2 is more advantageous than case-1.

(2) Proposed Project Works

The concrete gravity type dam is constructed in the upstream reach of the Padangeng River at the site with catchment area of 107 km^2. On the central part of the dam a non-gate controlled overflow section is provided to discharge the flood of 720 m^3/sec with probability of occurence of once in 200 years, estimated on the basis of flood discharge shown in Supporting Report Part One.

The intake structures are sited on the left bank in view of topography on the main canal route. After diversion of water to the left main canal, the canal runs along the river for 1 km, and offtakes water to the right main canal. The right main canal crosses the Padangeng River with a syphon type aqueduct.

The existing canal systems of the Leworang and Towereng areas are incorporated into the proposed canal system.

The proposed irrigation system of the project is presented in Fig. 15.9 and the principal features of the project are as shown in Table 15.35.

15.2.10 Cenranae Irrigation Project

There exists the large area of approximately 25,000 ha on the left bank of the Cenranae River, consisting of undulating high elevated area of 20,000 ha, low land of 2,700 ha and flat land of 2,300 ha inbetween the above two areas. Although the soils are suitable for paddy cultivation, the area remains under the rainfed condition due to no sufficient and stable water sources. A pumping scheme is inherently needed for this area. The water source has to be sought for to Lake Tempe in order to secure the adequate water in quantity and quality for irrigation especially in the dry season.

In planning of pumping irrigation, the area is divided into two depending on the topography of the area; high elevated area and flat area. The flat area exists in the elevation less than 30 m and the high elevated area from EL.30 to EL.100 m contiguously to the watershed to the Gilirang River. The irrigation system of those areas will be separately networked, since the pump station has to be sited near the water source and irrigation area as much as possible.

In consideration of topography, a pump station for the flat area can be sited at the southern part of Sengkang on the left bank of the Cenranae. Whereas a pump station for the high land has to be sited on the north of Sengkang due to the required high head.

The former will be such a pumping scheme as to cover an area less than 6,000 ha with pumping head less than 30 m. However, the latter will be large and high pump scheme.

In operation of large scale high head pumps, the power source to meet its demand has to be assured by constructing the power line, and operation and maintenance costs are expensive. Thus, the economical aspect of high head pumping scheme is inherently low, therefore, the implementation programme of the project will fall far beyond the long-rang programme in the master plan.

Prior to the development of the high elevated area with introduction of a large scale pumping scheme, a pilot pumping scheme is needed for this area to obtain the experience in pump operation and pump irrigation farming. In this context, a small pump scheme for the area locating in the elevation less than 30 m is studied.

The pump station is sited on the left bank of the Cenranae at the southern edge of Sengkang. Geology of the site is as described in Supporting Report Part Nine. The distribution of irrigable area tends to sharply increase up to EL.15 m, gradually increase up to EL.30 m which is the maximum extent for irrigation from this pump site.

Therefore two cases with outlet water levels of 15 m and 30 m are conceived and economic comparison is carried out.

On the other hand, according to the flood control plan of Lake Tempe and the Cenranae River, which is discussed in the separate part, a barrage is proposed near the confluence of the Cenranae and Walanae Rivers to reserve the Lake water levels mainly for the purpose of fish cultivation in the lake. Therefore the intake has to be placed just upstream of the barrage and the pump station is connected with Lake Tempe by an inlet channel starting from it.

Water levels in Lake Tempe fluctuate largely from 9 m in a high and 3.5 m in a low with approximately 20% probability of occurence according to the past data. Furthermore, it is estimated that this tendency will continue even after the river improvement and flood control measures are provided. Based on this, the water level conditions are set and the general features of alternative two cases are determined.

As regards the power source, two power source; electric motors and diesel engines, are considered. In general the former is economical in respect of operation and maintenance and initial investment for equipment. However, the electric power is needed nearby the station to save the power line cost. The latter is easy for implementation since the availability of electricity is not directly related to operation. The equipment and operation cost, however, is expensive.

Therefore, the case of diesel engine driven pumps are compared. The alternatives are summarized as follows:

Case-1: Pumping head 15 m, on condition that when the electricity is made available in Sengkang, the power is supplied from a sub-station in Sengkang.

Case-2: Pumping head 30 m, on condition that when the electricity is made available in Sengkang, the power is also supplied from a sub-station in Sengkang.

Case-3: Pumping head 15 m, on condition that pumps are driven by diesel engines.

The general features of the plans are shown in Table 15.27 and the construction costs of each case are estimated as shown in Table 15.45. The economic comparison between each case is made in CHAPTER 17. The result indicates that case-1 is slightly economical.

As a result, the pump station with the rated head of 15 m, covering 2,300 ha, is introduced into the Cenranae Irrigation Project. The proposed irrigation system of the project is presented in Fig.15.13 and the principal features of the project are as shown in Table 15.36.

15.2.11 Other Irrigation Potential

The proposed nine irrigation projects covering 81,000 ha are identified and recommended to be brought about into the further investigation according to the schedule mentioned in Chapter V. Whereas, other than the proposed nine irrigation projects area are examined in the Master Plan Study as follows:

(1) Existing On-going Projects

In the irrigation planning of the master plan, it is contemplated to unify and reformulate the small scale existing irrigation systems into the reliable irrigation system with use of the large scale river system.

However, three systems covering 4,150 ha, which are located in the western area of Lake Tempe and served with the Batu Batu the Salobunne and the Lajaroko riverwater are well maintained and the extension is underway by the DPUP Sul Sel. Therefore, the present operation and maintenance should be continued and the extension should be completed in line with the built-up plan.

(3) Areas Commanded with Water from Other Basins

There are flat plain and mild hill of about 20,000 ha in north and west area of Lake Sidenreng of which three fourth is now irrigated with the Sadang riverflow. Further, two pumping-up irrigation projects for remaining reinfed area are planned by use of the water from the Sadang project canal. So these areas are expected to be irrigated by the Sadang Project.

(3) Small Scale Village Irrigation Projects

The DPUP Sul Sel intends the construction and improvement of the small scale village irrigation projects as much as possible within PELITA III, and has a plan for such small scale projects.

Those small scale systems are inherently dependent upon small streams and will not assure the reliable water supply, whereas the implementation is not costly and the quick yielding from implementation is expected. From short range public point of view, however, those projects are expected to contribute to some extent toward the promoting economic and social growth in the area. Such concerned areas should be carried out in line with built-up village irrigation project plans.

(4) Future Development

There are other irrigation potential in the areas located in the eastern area and in the southern inland in the objective area. Irrigation project for those areas, however, can not be expected to be implemented economically at the present stage because of huge construction costs for the project.

The high terrace of 25,000 ha extending on the left bank of the Cenranae has no reliable water sources except Lake Tempe. In view of geographical location of the area and the lake water, the high head pumping scheme is needed. Then, as a pilot pumping scheme for this area, the Cenranae Irrigation project covering 2,300 ha is proposed in the master plan. The development of the remaining area 22,700 ha is left to be postponed from the economic view point. When the experience on pumping irrigation is accumulated and the necessity arises, the pumping scheme for them will come out into the practice.

In the southern inland, there exist rainfed paddy fields beside the area included in the proposed Sanrego Irrigation Project. On the right bank of the upper Walanae River paddy fields of 4,000 ha are located in form of small blocks. The water source available for this area will be the Walanae River. Topographically pumping schemes are necessitated for each blocks, but the water delivery system is much costly.

Further along the Batu Pute river paddy fields of 6,000 ha exist, but the river course provides no desirable locations for headworks for irrigation in respect of topography and geology.

15.3 COST ESTIMATE

The construction cost is estimated based on the following assumptions and the past results of the construction or detailed estimates of irrigation projects similar to the project.

(1) The exchange rate used is:

US$1.00 = Rp.625

(2) Reference has been made to:

(a) Sadang project, South Sulawesi, for canals and tertiary system, 1979

(b) Way Rarem Irrigation Project South Sumatra, for canals, dam and tertiary system, December 1978.

(c) Wonogiri Irrigation Project, Central Jawa, for intake weir, canals and tertiary system, January, 1979

(d) Jatiluhur Extension and Cipamingkis Irrigation Projects, West Jawa, for intake weir and tertiary system, November 1978.

(3) Construction costs of main and secondary irrigation canals are estimated, based on the preliminary design of canal systems by the product of the lengths of sections and costs per unit of length which are derived from the above mentioned reference. The cost estimates of the tertiary system are based on costs per unit of area. The dam costs have been referred mainly to the Way Rarem Irrigation Project.

(4) The cost of land acquisition and compensation has been estimated for the area necessary for the diversion weir, main, secondary canals and tertiary system by classifying the area to be acquired into irrigated areas and non-irrigated areas.

(5) The contingency includes only the physical allowance. It is estimated by use of a certain rate to the total of civil work cost and land acquisition and compensation cost. The engineering services and administrative expenses are estimated by a certain rate to the above mentioned total amount.

(6) The annual operation, maintenance and replacement costs include the project operation cost consisting of staff salaries and other running cost, the materials and equipment cost necessary for maintenance and repair of the project facilities and replacement cost of mechanical and electrical works. The electric energy cost for pumping projects is based on the PLN's basic Tariff, and the replacement cost of pumping equipment is estimated so as to set a side the value at the end of its economic useful life of 20 years.

The construction costs of the proposed projects are summarized as follows and the details including alternatives are shown in Table 15.37 to 15.45.

	Proposed Irrigation Project	Construction Cost (10^3 US$)
(1)	Langkemme Irrigation Project	22,400
(2)	Bila Irrigation Project	42,000
(3)	Sanrego Irrigation Project	37,500
(4)	Lawo Irrigation Project	10,500
(5)	Boya Irrigation Project	23,900
(6)	Walanae Irrigation Project (Specific cost of Irrigation system)	104,400
(7)	Gilirang Irrigation Project	65,200
(8)	Padangeng Irrigation Project	20,900
(9)	Cenranae Irrigation Project	13,600

CHAPTER XVI PRICE PROSPECT FOR MAJOR AGRICULTURAL PRODUCTS

16.1 RICE

Indonesia is still rice import country. Recent five years about 1.4 million tons of rice on an average were imported every year and in 1977 the imported rice reached nearly 2 million tons as shown in following table.

(Unit: 1,000 tons)

1973	1974	1975	1976	1977	Average
1,863	1,132	693	1,301	1,973	1,392

Source : Statistical Pocketbook of Indonesia 1977/1978.

Considering the growth rate of population, per capita consumption and the increase rate of rice production, the shortage of rice in Indonesia will be continued in some extent.

The South Sulawesi Province is one of the main rice supply regions as mentioned previously and this position will also be continued.

A large part of additional production of about 500,000 tons of dry stalked paddy after the completion of proposed irrigation projects would be marketed in domestic market in Indonesia, as the substitute of import rice as referred to CHAPTER 12.4.

For the economic evaluation, therefore, the import substitution price forecast is adopted.

As shown in Table 16.1, the farm gate price of dry stalked paddy for the economic evaluation amounts to Rp. 133,000 per ton.

For the financial analysis, the farm gate price of dry stalked paddy is taken Rp. 59,400 per ton being based on market prices in Kabupaten Sidrap, Bons, Soppeng and Wajo and Ujung Pandang as shown in Fig. 16.1 and Table 16.2.

16.2 OTHER CROPS

Maize is the next main staple food crops in the objective area. The inhabitants usually eat white maize mixing with rice. The consumption amount is decreasing year by year due to increase of living standard, and amount of marketing is also limited in small local market.

Under these condition, the price of maize in the area is not directly related with international market price.

Therefore, for both the economic and the financial evaluation, the price of maize is estimated on the basis of the actual market price in Kabupaten Sidrap, Bone, Soppeng and Wajo as shown in Table 16.2.

Other main upland crops produced in the objective area such as cassava, sweet potato, peanuts, soy beans and green kindney beans, are also mainly self-consumption by farmers and only some amount of the crops is sold to local market.

Therefore, both economic and financial prices of these crops are estimated also on the basis of actual market prices as shown in Table 16.2.

CHAPTER XVII IRRIGATION BENEFIT

17.1 IRRIGATION BENEFIT

The land in the irrigation project areas is now mostly under insufficient seasonal irrigation or rainfed. The distribution pattern of rainfall shows uneven. Besides there is considerable year to year variation in precipitation. Consequently water shortages occur in dry season as well as even in wet season as described previously, which precludes significant crop yield and area expansion. The projects will provide sufficient irrigation and drainage facilities to the project areas. The project will thereby provide better land utilization as well as the basis for a major increase in crop yields.

In this master plan study, nine irrigation projects are selected as follows; Alternative study also are examined.

1) Langkemme irrigation project
2) Bila irrigation project (3 cases)
3) Sanrego irrigation project
4) Lawo irrigation project
5) Boya irrigation project
6) Gilirang irrigation project (2 cases)
7) Walanae irrigation project (2 cases)
8) Padangeng irrigation project (2 cases)
9) Cenranae irrigation project (2 cases)

These irrigation projects contain 19 kecamatans, out of 29 kecamatans in the objective area as follows;

<u>Kab. Sidrap</u>

1. Dua Pitue

<u>Kab. Bone</u>

2. Ajangale
3. Dua Boccoe
4. Libureng
5. Kahu

<u>Kab. Soppeng</u>

6. Lalabata
7. Liliriaja
8. Marioriawa
9. Marioriwawo
10. Lilirilau

<u>Kab. Wajo</u>

11. Tempe

12. Tanasitolo
13. Maniang Pajo
14. Belawa
15. Sabbang Paru
16. Pammana
17. Takkalalla
18. Majauleng
19. Sajoanging

The implementation of these irrigation projects will provide significant profits for regional economic development as well as public welfare of people.

(1) Estimate of Irrigation Benefit

Irrigation benefit to be expected is defined as the difference of primary profit from crops between future without project condition and future with project condition.

(2) Primary Profit Per Crops

On the basis of the estimated farm inputs and outputs, primary profit for each crop per ha is calculated both on future with and future without projects. The results of the calculation are summarized in Table 17.1 to Table 17.7. Details of production cost without project are shown in Table 17.8 to Table 17.13.

(3) Irrigation Benefits

Applying the primary profit per crop estimated above to the crop area, total primary profits accured from agricultural production in each irrigation project area are estimated both on without project and with project conditions. Based on this result the irrigation benefit is calculated. The irrigation benefit will come out immediately after completion of the construction of the projects. The benefit will be expected to increase linearly year by year. Based on the farmer's ability and knowledge for irrigation farming through field survey, the build-up period is applied to 3 years for Kabupatens Sidrap and Soppeng, and 5 years for Wajo and Bone. The irrigation benefit at full stage is summarized as follows;

(10^3Rp)

Name of Irrigation Project	Irrigation Benefit
Langkemme	2,876,676
Bila (case 1)	7,419,202
Bila (case 2)	6,310,993
Bila (case 3)	11,285,799
Sanrego	9,863,677
Lawo	1,224,628
Boya	2,693,415

to be continued

Name of Irrigation Project	Irrigation Benefit (10^3Rp)
Gilirang (case 1)	3,114,087
Gilirang (case 2)	9,819,723
Walanae (case 1)	23,439,664
Walanae (case 2)	19,177,914
Padangeng (case 1)	1,275,657
Padangeng (case 2)	1,834,442
Cenranae (case 1)	2,159,751
Cenranae (case 2)	6,198,651

Details are shown in Table 17.14 to Table 17.28.

However, since flood damages of less 1/5 probable flood remain in some areas in the Bila, Boya and Walanae irrigation projects, the expected crop damages by such floods will be reduced from irrigation benefit. The expected crop damages are estimated at Rp. 69,545 x 10^3 in case 3 (Bila), Rp. 68,969 x 10^3 in case 2 (Bila), Rp. 70,560 x 10^3 in case 3 (Bila), Rp. 316,542 x 10^3 in Boya, Rp. 625,273 x 10^3 in Walanae (case 1) irrigation project and Rp. 588,125 x 10^3 in Walanae (case 2) irrigation project. Consequently estimated irrigation benefits in three irrigation projects at full stage are shown below.

		(10^3Rp)
Bila	(case 1)	7,349,658
	(case 2)	6,242,024
	(case 3)	11,215,239
Boya		2,376,873
Walanae	(case 1)	22,814,391
	(case 2)	18,589,789

17.2 ECONOMIC EVALUATION

The economic evaluation is carried out through the internal rate of return (IRR). The economic internal rate of return for irrigation projects is calculated on the basis of estimated economic cost and the irrigation benefits. Table 17.29 shows summary of internal rate of return for each irrigation project.

All the conversions from Rupiah to US dollars are made at the exchange rate of Rp. 625 = US$ one. The project life for the economic evaluation is 50 years.

17.3 FARM BUDGET

From the farmer's point of view, the project evaluation was made through the analysis of typical size of owner farmer in the objective area.

In future, on the condition of without project and on the condition of full development stage after completion of construction works of the proposed Irrigation Projects, the gross farm income, farming cost, net farm income and reserve or capacity to pay were worked out as shown in Table 17.30, 17.31, 17.32 and 17.33.

The reserve of the farmer under with the Project condition would be about Rp. 212,170 (US$ 339 equivalent).

According to these analysis, it can be said that the Irrigation Project is quite beneficial for the farmers in the objective area.

For the comparative study of each kecamatan, on the condition of without project and with project, the gross farm income, farming cost and net farm income were also worked out as shown in Table 17.34 and 17.35.