N-value less than four (4) continues for more than ten (10) meters, it is classified as the poor ground. In this context, the alignment of floodway has been considered on the poor ground. These deposits will not have sufficient bearing capacity for foundation of flood protection facilities. Allowable bearing capacity of them is considered less than 5 (ton/m^2). If maximum load imposed by flood protection facilities is more than 5 (ton/m^2), pile foundation or other foundation treatments for them will be necessary. Besides, differential settlement might happen on the poor ground, and it leads to failure of embankment and structures constructed thereon.

2.2.2 Construction materials

(1) Materials for canal embankment

The canal embankment would be executed by maximum use of the in-situ materials excavated in canal section. The materials available along the canal route are classified into following four (4) groups:

(a) River terrace material

This is a fine soil and mainly consists of clayey sand and clay, and partly a mixture with sand and gravels. Terrace material consisting of clayey sand is observed on the right bank of Bila intake site, and the other consisting of clay on the right bank of the lower reaches of proposed Kalola dam site. It has average plasticity and medium dry strength. Its color in moist condition is dark grey, and partly a mixture with dark brown. The terrace material on the right bank of Bila intake site is suitable for materials of embankment, and that in the Kalola site is a little suitable.

(b) Alluvial material

This is a fine soil and mainly consists of silt and clay. This materials is usually distributed over the alluvial flat plain. Most of paddy cultivation are extended over this layer. It has average plasticity, but high dry strength. Its color in moist condition is dark grey or dark brown. Cracks due to drying shrinkage are usually observed in the deposit layer of this material. Their depth ranges from 20 cm to 40 cm. Thickness of the layer is occasionally over ten (10) meters.

(c) Residual soil material

This material is distributed near the foot of hills and hillsides. This is a mixture of brown colored silty clay or clayey sand and gravels. Gravels are subangular shaped and weathered. The content of gravel is not high, and roughly

estimated to be 20 to 30 percents by observation of test pits. Maximum diameter of gravels is less than 50 millimeters. Judging from the observation of test pits and exposed area, this material will be suitable for embankment. This is suitable rather than mixed materials not including gravels. But this material includes cobbles and sometimes boulders. Particle gradation over gravel is medium to poor and they are subrounded. Canal bank to be constructed by such a naturally graded material will not attain the sufficient level of impermeability. Cobbles in the materials should be dug out for ensuring stable embankment works.

(d) Teritary pliocene molasse material

This is a cohesive soil of weathered siltstone, conglomerate and sandstone. This is divided into clay, silty clay and clayey sand with gravels by the degree of weathering and rock kinds. Clay and silty clay have high plasticity and high dry strength. Their color in moist condition is dark grey with a mixture of light brown or dark blue. The other material consisting of clayey sand has average plasticity, and is liable to occur cracks due to drying shrinkage. Clay and silty clay are unlikely to happen cracks if embankment is executed under the well controled cndition.

(2) Embankment of alternative Bila intake

The available material for embankment around the alternative Bila intake site is classified into following four (4) groups:

(a) Terrace material

This consists of silt and clay and is a mixture of sand and gravels on some part. This material is distributed a flat plain of the right abutment and a foot of the slope of the left abutment. It has moderate plasticity and is stable for embankment. This is suitable for core materials of fill dams, and also for contact clay materials which are placed at a border between core and baserock or concrete for protection of leakage and piping.

(b) Residual soil material

This is a mixture of silty clay, clayey sand and gravels. But this material distributed on the hillside of thd left bank contains cobbles and sometimes boulders. Dam embankment to be constructed by such a naturally graded material will not provide sufficient result of impermeability. Cobbles and boulders should be dug out.

(c) Weathered baserock

This is a medium or highly weathered loose baserock of conglomerate and coarse sandstone. This is suitable for transition materials or randam materials because this is from semi-pervious to permeable material.

(d) Riverbed material

This is well-graded and it consists of sand and gravels originating from hard rock of gneiss, schist, sandstone and andesite. It scarcely contains silt and clay fraction. This material is suitable for filter and transition materials, and also used for concrete aggregates.

(3) Kalola dam

Terrace materials will be available for core materials of fill dam which deposit at the right bank of the lower reaches of dam site. The terrace deposits are composed of silty clay and clay, and partly sand and gravels. Besides highly weathered and moderately cemented baserock materials obtained from excavation for foundation of core zone will be used for transition and surface rock materials of fill dam. Also in the upstream of the dam site, alluvial deposits consisting of mainly clay are distributed on the paddy field. This materials are considered to be favourable for horizontal blanket materials.

(4) Material for floodway embankment

Floodway route is contemplated in the alluvial flood plain of paddy field. This alluvial flat plain is composed mainly of very soft clayey deposits. the floodway embankment will be executed by use of in-situ materials excavated in floodway section.

Material to be used for floodway embankment is alluvial material same as stated in the embankment material for canal. But this material has high plasticity and high dry strength. The layer of this deposit is the poor ground. Therefore, it is estimated that cracks due to drying shrinkage and differential settlement might happen near the top places of embankment.

Soils locating along the flood control embankment are the terrace deposit and a mixture of sandy silt, silt and clayey sand. This is suitable for flood control embankment. Riverbed deposits consisting of sand and gravels develop in places along the existing rivers to be controlled. These materials are not suitable for embankment, because embankment to be constructed by such a riverbed material will not provide sufficient impermeability. Besides these materials are weak in the resistance of piping by seepage water. Therefore, they should be dug out.

(5) Borrow pit materials

(a) Canal embankment

The borrowed area for obtaining the canal embankment material will be established along the canal route or on the places near the route. Fifteen representative sites for borrowed areas are selected within the distance of five hundred (500) m from the canal route and soil sampling and pits observation are carried out for them. According to the field observation, the materials available near the canal route are residual and molasse materials. Their distribution along the route is as shown below:

Longitudinal number	Available embankment material
1 to 5	Residual soil
5 to 15	Molasse soil
15 to 17	Terrace soil
17 to 22	Molasse soil

(b) Bila intake site

Terrace materials deposit widely and thick in the right bank. Available volumes are estimated to be two hundred thousand (m^3). In the left bank, residual soil materials deposit on the hillside. Estimated volumes are sixty thousand (m^3), but this borrow pit might be used both as earth dam and canal for embankment. Besides excavated materials for foundation of intake or earth dam are favourable for embankment.

(c) Kalola dam site

Terrace materials deposit in the downstream of the right bank of dam site. Estimated volumes are twenty-four thousand (m^3), but this borrow pit might be used both as fill dam and canal for embankment. Also in this site, excavated materials for foundation of core zone are much favourable for embankment.

(d) Floodway embankment and flood control embankment

The floodway embankment would be constructed by use of the materials excavated in floodway section. This is a fine soil and consists of silt and clay. It has high plasticity and high dry strength. Therefore, cracks due to drying shrinkage and differential settlement will be occurred happen at the top of embankment. Volumes for embankment will be sufficient by use of the excavated materials.

This consists of a mixture of sandy silt, silt and clayey sand and is the terrace deposits. Riverbed materials, however, will not be suitable for embankment, so they have to be dug out. Volumes for embankment will be sufficient by use of these terrace materials except river materials. Also river materials will be used for counter-weight materials and concrete aggregates.

(6) Concrete aggregates

The Bila and Boya rivers flow from north to south along the western boundary of the project area, and the Kalola river transverses the area from northeast to southwest. Many tributaries of the Bila and the Kalola rivers flow across the area mainly from east to west. Riverbeds of those rivers are thickly covered with sand and gravels, and partly cobbles. These riverbed deposits are favourable for the aggregates for concrete and wet masonry, and for the construction of gabions. But according to the results of grain size analysis shown in Fig. 2.3, riverbed materials except for those existing near the intake site of the Bila river and the upper stream from the Kalola dam site are covered with only sands and fine gravels.

Especially, most of riverbed materials of the lower reaches from the Kalola dam site and a many tributaries are only sand suitable for concrete fine aggregates. These riverbed materials are scattered in various places on meandering riversides, although the amount is small.

(a) Bila and Boya rivers

To examine the quality of gravel, the water absroption and specific gravity tests are performed on the samples taken from the riverbeds. The results are as shown below comparing with the standard requirement of ASTM.

Item	Tested data			ASTM standard requirement
	Lowest	Highest	Mean	
Water absorption	1.3	2.2	1.73	less than 3.0
Specific gravity	2.47	2.73	2.58	larger than 2.50

The results on both tests show the sufficient characteristics for the standard requirement of ASTM. In view of the quality of gravel, gravels from the Bila and Boya rivers are suitable for the aggregates for concrete, masonly and gabion. However judging from the results of grain and particle size analysis, they are used mainly for concrete coarse and fine aggregates. Classifications of aggregates available along the Bila and Boya rivers are as shown below.

River	Section	Classification of aggregate	Kind of material
Bila	BRM to RM-1	Coarse to Fine	Gravel, Sand (partly cobbles)
	RM-1 to RM-4	- do -	Gravel, Sand
	RM-4 to RM-5	Fine	Fine Gravel, Sand
Boya	RM-2 to RM-4	Coarse to Fine	Gravel, Sand

Remark: Points of the section are as shown in Fig. 2.1.

(b) Intake site of Bila river

As mentioned before, alternative Bila intake site is covered with well-graded materials consisting of cobbles, gravels and sand. This riverbed deposit is much suitable for the aggregates for concrete and wet masonry, and for the construction of gabion.

In the alternative intake site of Bila river, there exist cobbles and coarse gravels of which grain sizes are sufficient for masonry works for the construction of intake weir and related structures. The content of cobbles and coarse gravels would range from 20 to 35 percents. These cobbles and coarse gravels are of high quality and composed of hardrock of gneiss, schist, sandstone and andesite. Also there exist gravels and sands of which grain sizes are sufficient for concrete coarse and fine aggregates. They are of high quality, and the content of gravel and sand ranges from 65 to 80 percents.

Estimated volume of cobbles and coarse gravel available is about 5,000 m^3. Also coarse and fine aggregates for concrete are estimated to be 15,000 m^3 within the distance of one (1) kilometer from the intake site.

(c) Dam site of Kalola river

On the upper reaches of Kalola dam site, there exists a large amount of cobbles, gravel and sand of which grain sizes are sufficient for concrete fine and coarse aggregates of high quality. These volumes of concrete aggregates available in the upper reaches are estimated at about 10,000 m^3. Besides, on the tributaries originating from the eastern hills there exist riverbed materials usable for concrete aggregates.

2.3 Laboratory Test

2.3.1 Soil mechanical test

(1) General

To clarify mechanical properties of soil materials extending in the project area, laboratory tests were made for soil samples taken from the test pits dug along the alternative main canal route, the flood control embankment and floodway for the flood control planning. Test items and quantities are as shown in Section 2. The laboratory tests were conducted by the Government on September 1981 in Bina Marga Laboratory in Ujung Pandang, South Sulawesi with assistance of the Team.

The summary of test is given in Table 2.2. The details of test results are attached in Data Book. The results are described hereunder:

(2) Specific gravity test

The results of specific gravity test for soil particles are as summarized below:

Soil	Lowest	Highest	Mean
Canal			
Terrace soil	2.59	2.59	2.59
Alluvial soil	-	-	2.58
Molasse soil	2.54	2.68	2.61
Residual soil	2.58	2.63	2.61
Floodway and Flood control embankment			
Alluvial Soil	2.59	2.62	2.61
Terrace Soil	2.59	2.62	2.60

The mean values of specific gravity range from 2.58 to 2.61. Those values are slightly lower than the generally acknowledged value of inorganic soil (ranging 2.6 to 2.8). It seems that the insufficient boiling time during testing resulted in such low values.

(3) Grain size analysis test

All samples used for the grain size analysis are natural-graded soils. Their gradations coincide with their natural ones. However, they are considered to different from

their natural ones by the method of extraction of soils for grain size analysis. Therefore gradations would have to be synthetically judged from the test pits observation and the results of soil test. In this study, soils staying 4.76-millimeter sieve (#4) are classified into gravels. The result of grain size analysis test are briefly mentioned below.

(a) Terrace soil: This is classified into two (2) groups. The one is observed at the Kalola dam site and along both banks of existing rivers. This consists mainly of silt and clay. The total content of silt and clay ranges approximately from 69 to 84 percents, mostly being more than 60 percents. Sand content is 16 to 31 percents. The other is distributed at the right bank of the Bila intake site. This consists mainly of sand and silt and it is clayey. Sand content is 60 percents, and the total content of silt and clay is 40 percents. Silt content is usually higher than clay content. Both soils include gravels in small quantity.

(b) Alluvial soil: This is fine soil, and consists mainly of silt and clay, partly sand. The content of silt and clay is 80 percents, and sand content is 20 percents. Silt content is usually higher than clay content. This soil partly has gravels in small quantity.

(c) Molasse soil: This is mainly distributed along the canal route on the foot of hills and hillsides. This soil is divided into two (2) classes by the degree of weathering and the kind of parent rocks. The one is the soil including sand with its content of 46 to 60 percents and silt and clay with the content of 38 to 49 percents. This soil also includes gravels. The content is 1.0 to 6.7 percents. However, it is deemed to range from 5 to 15 percents of the total amount of this soil through soil survey. The other mainly consists of silt and clay. The total content of silt and clay is 76 to 91 percents. Sand content is 9 to 23 percents. This also includes gravels, but the content is negligible.

(d) Residual soil: This is a mixture of gravels, sand, silt and clay, judging from the profile observation at test pits and exposed area. According to the results of grain size analysis, gravel content is 0 to 39 percents. Sand content ranges from 31 to 41, and the total content of silt and clay varies widely from 31 to 63. Based on the result of observation at test pits and field investigation, natural talus soil seems to have 10 to 50 percents of gravel content.

(4) Water content test

The results of water content test are summarized below. The samples tested are those passing 4.76 millimeter sieve.

(Unit: %)

Soil	Water content		
	Lowest	Highest	Mean
Canal			
Terrace soil	30	33	32
Alluvial soil	-	-	36
Molasse soil	23	43	35
Residual soil	20	41	31
Floodway and Flood control embankment			
Alluvial soil	42	44	43
Terrace soil	15	40	30

As far as water content is concerned, no large difference is seen between these soils, expect for alluvial soil deposits along the floodway route with a little higher water content than others.

(5) Atterberg limit test

The results of atterberg limit test are summarized below. The samples tested are those passing 0.42 millimeter sieve.

(Unit: %)

Soil	Liquid limit			Plastic limit		
	Lowest	Highest	Mean	Lowest	Highest	Mean
Canal						
Terrace soil	45	60	53	20	23	21
Alluvial soil	-	-	42	-	-	17
Molasse soil	54	87	68	21	32	25
Residual soil	52	63	57	25	31	29
Floodway and Flood control embankment						
Alluvial soil	-	-	80	27	28	27
Terrace soil	52	68	60	27	31	29

The quality of fine-grained soil shows a little high plasticity, and especially alluvial soil deposits along the floodway route has high plasticity.

(6) Compaction test

The results of standard Proctor compaction test are shown below, in which mean values are indicated for all items.

Soil and location	γdmax (t/m³)	Wopt (%)	γd95 (t/m³)	WD95 (%)	Wn - Wopt (%)	Wn - WD95
Canal						
Terrace soil (C.R)	1.37	29.4	1.30	35.0	3.7	-1.9
Alluvial soil (C.R)	1.59	21.0	1.51	25.8	14.6	9.8
Molasse soil (C.R)	1.46	19.8	1.38	29.9	9.4	4.2
Residual soil (C.R)	1.51	25.0	1.43	28.7	3.4	-0.4
Floodway and Flood protection embankment						
Alluvial soil	1.36	30.2	1.27	34.0	13.7	9.9
Terrace soil	1.34	32.3	1.27	37.0	6.8	2.1

Remarks: γdmax; Maximum dry density
Wopt ; Optimum water content
γd95; Dry density to obtain 95 percents of γdmax
WD95 ; Highest water content to obtain 95 percents of γdmax
Wn ; Natural water content

(7) Shrinkage limit test

The results of shrinkage limit test are as shown below. Samples tested in the laboratory are three materials obtained from the canal route.

(Unit: %)

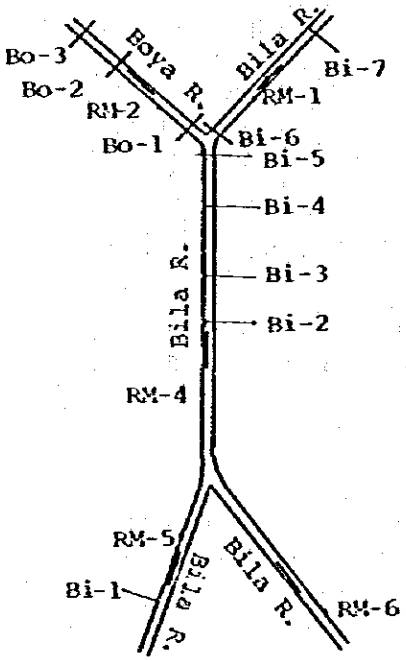
Location	Soil	Shrinkage limit test: Shrinkage limit	Shrinkage limit test: Shrinkage ratio
TP-2	Molasse soil	18.7	1.7
TP-4	Molasse soil	10.1	1.9
TP-7	Alluvial soil	11.7	2.0

From the results, it is assumed that molasse soil and alluvial soil deposit nearby TP-4 and TP-7 are a mixture of silt and clay.

2.3.2 Riverbed material test

To clarify mechanical properties of riverbed materials deposit of the Bila, Boya, Kalola and Lancirang rivers, water absorption, specific gravity and grain-size analyses are performed on the samples taken from the riverbeds.

The results of test are given in Table 2.3, and the summary of test data including the results obtained during the Master Plan is indicated in Table 2.4. The results in this investigations are as mentioned below.



(Unit: %)

Section	Content of gravel (no passing 4.76 mm sieve)
Bi-7 to RM-1 RM-1 to Bi-6	50 to 60
Bo-3 to Bo-2 Bo-3 to RM-2 RM-2 to Bo-1	40 to 50
Bi-5	60
Bi-5 to Bi-4 Bi-4 to Bi-3	40 to 45
Bi-3 to Bi-2 Bi-2 to RM-4 RM-4 to junction	10
Junction to downstream	0

The content of gravel decreases gradually toward the lower reaches of the rivers. Although gravel content of RM-4 in the test is 66 percents, it is reduced to 10 percents of the total amount of riverbed material, because the sampling for it was made in the curve in the river, then riverbed materials tested partly would have contained a large amount of gravel. The gravel content of RM-7 is also reduced to 10 percents by the above-mentioned reason. The riverbed materials of RM-5 and RM-6 consist of fine sand and silt, and each content is 50 percents.

3. ANALYSES

3.1 Soil Classification

From the results of grain-size analyses and atterberg limit test, the unified soil classification is made as follows:

(1) Canal route

(a) Terrace soil: Terrace soils tested in the laboratory are classified into two groups. One is SC group which is distributed in the right bank of Bila intake site. The other is CH group which is distributed in the downstream of the right bank of Kalola dam site.

(b) Alluvial soil: Alluvial soil is classified as CL. However, alluvial soil deposits observed in paddy field contain a little more amount of silt and clay than this soil test results. Therefore, natural alluvial soils would be classified as CL and CH.

(c) Molasse soil: Most of molasse soils are classified as SC and CH. The difference between SC and CH is from the degree of weathering and the kind of their parent rocks.

(d) Residual soil: Residual soils are classified as GC, SC and CH, respectively. As natural soils observed in the test pits and field contain some amount of gravels, they will be classified as G-C, GC and SC, but SC is dominant.

(2) Floodway and flood control embankment

Alluvial soil on the floodway route is classified as CH. Terrace soil on the route of the flood control embankment is classified as CH. As natural soil depositing along river banks contains some amount of sand and silt, they will be classified as SC and CL.

(3) Riverbed material

As atterberg limit tests for riverbed materials are not tested in the laboratory, soil classification is made by use of the results of grain size analyses and observation along the existing rivers. Riverbed materials of Bila river will be classified as GW, GP and SM as it flows downstream. Riverbed materials on the Boya, Lancirang and Kalola rivers will be classified as GW, CL and SP, respectively.

3.2 Stability of Slope

3.2.1 Conditions of stability analysis

(1) Embankment

To examine the stability of embankment slope, the shearing strength parameters; cohesion and angle of internal friction, are estimated based on the test results made by DOI.

Assumption of the shearing strength constant (for embankment)

Application of embankment	Soil	Shearing strength parameter: Cohesion C(t/m²)	Angle of internal friction ϕ(°)
Canal	Alluvial soil	2.5	0
	Terrace soil	2.5	0
	Molasse soil	3.0	0
	Talus soil	3.0	5
Floodway	Alluvial soil	2.5	0
Flood control embankment	Terrace soil	3.0	0

(2) Cut

The sounding tests are carried out on natural soils by means of a swedish sounding apparatus and a portable cone penetrometer. From these two tests, the undrained strength qu and the cohesion for zero angle of internal friction C are estimated by using following two equations:

$$qu = 0.0045\ Wsw + 0.0075\ Nsw$$

$$C = \frac{qu}{2} = \frac{1}{2} \cdot \left(\frac{qc}{5}\right) = \frac{qc}{10}$$

Remarks: qu; Unconfined compressive strength (kg/cm²)
Wsw; Load (kg)
Nsw; Half turning numbers per meter (times)
C; Cohesion (kg/cm²)
qc; Cone bearing capacity (kg/cm²)

However, as natural residual soils contain some amount of gravels, their angles of internal friction is not considered to be zero, judging from the results of soil test and profile observation at test pits. In view of the above, the following parameters are assumed for cuts of canal, floodway and flood control embankment, as follows

Assumption of the shearing strength constant (for cut)

Application of cut	Soil	Shearing strength parameter	
		Cohesion	Angle of internal friction
		$C(t/m^2)$	$\phi(^o)$
Canal	Alluvial soil	2.5	0
	Terrace soil	2.5	0
	Molasse soil	3.5	0
	Residual soil	3.0	5
Floodway	Alluvial soil	2.5	0
Flood control embankment	Terrace soil	3.0	0

3.2.2 Critical height of embankment

Based on the shearing strength parameters determined above, the critical height of embankment is calculated by using Tailor's method for the safety factor of 1.5. The results are as shown in Table 3.1.

According to the results of the calculation, the side slope of one (1) vertical in one and half (1.5) horizontal will suffice most cases to be encountered in constructing canal embankment with respect of materials and height of embankment.

In addition, the following cut slopes for different soil conditions are proposed.

Design angle of cut slope

Location	Soil or rock	Angle	Remarks
Canal	Soft soil	27° to 34° (1:2.0 to 1:1.5)	Alluvial, Terrace Molasse, and residual soil
	Medium to firm soil	34° to 45° (1:1.5 to 1:1.0)	Residual soil
	Weathered rock	34° to 45° (1:1.5 to 1:1.0)	Siltstone, Sandstone and Conglomerate
	Moderately to highly cemented rock	45° (1:1.0)	Siltstone, Sandstone and Conglomerate
Floodway and Flood Control Embankment	Soft soil	27° (1:2.0)	Alluvial soil Terrace soil

3.3 Leakage

(1) Leakage through canal embankment

According to the result of gradation, embankment with alluvial soil, terrace soil and molasse soil is assumed to have low permeability, being less than 1×10^{-6}(cm/sec). Embankment with residual soil is also expected to have low permeability, if cobbles larger than 10 centimeters are removed from embankment material, such as talus soil observed around the Bila intake left bank having about 10 percents to 20 percents of cobbles in volume.

Natural water contents for them are usually similar to the optimum water content. If the water content differs from the optimum water content, the low permeability will be ensured by watering or drying during embankment works.

(2) Leakage through embankment of floodway:

Embankment with alluvial soil is generally expected to have low permeability similar to the above. However, cracks due to drying shrinkage and differential settlement will occur and frequently cause leakage through embankment. Embankment with this material should be rolled enough with high degree of compaction.

(3) Leakage through flood control embankment

Embankment with terrace soil is also expected to have low permeability, if river deposits mainly composed of sand and gravels are not used for embankment. Further, these materials are considered to have low resistance to piping.

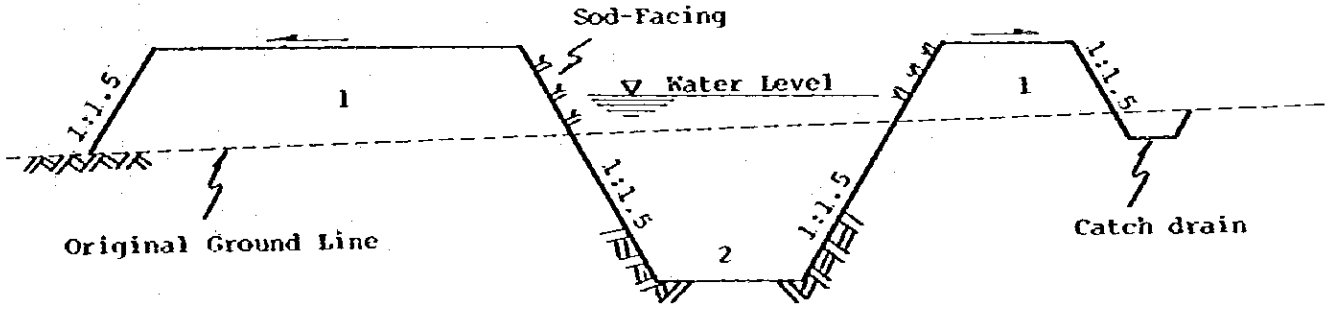
(4) Leakage through foundation of canal

According to the test pits observation, the values of permeability of the foundation of canal are estimated to range from 1×10^{-5} to 5×10^{-5}cm/sec, except for weathered sandstone, siltstone and conglomerate and partly of talus deposits of which foundations are anticipated to have high permeability. To prevent high leakage from these foundations, they should be covered with such impervious facings as wet stone masonry or clay for sloping portion.

3.4 Typical Section of Canals, Floodway and Flood Control Dike

(1) Typical section of canal

Based on the results of stability analysis of slopes, the following typical design section of canal is proposed:



(a) Embankment

Cobbles larger than 10 cm, are removed to prevent seepage from embankment material. If cobbles are encountered in canal excavation, they are used for the counterweight of the canal embankment or road-metal to get high resistance against sliding of outer slope. The embankment should be well compacted to keep high resistance against drying shrinkage, swelling and sliding.

The side slope of the canal above the full supply level should be sodded to protect canal facing from shrinkage and erosion.

(b) Excavation

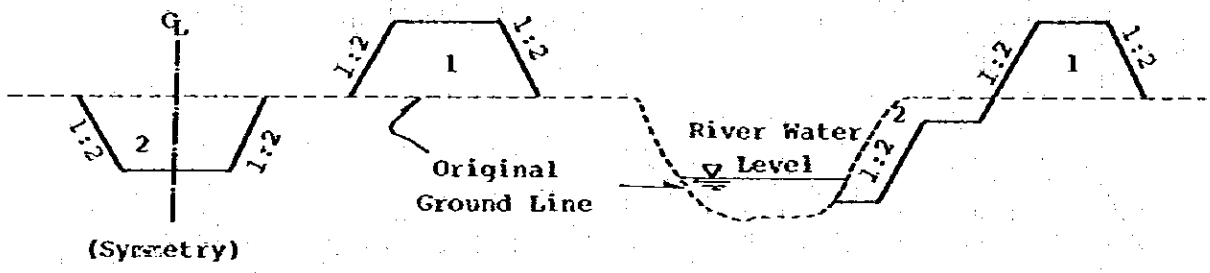
If the foundation of canal is much gravelly or porous and weathered, it should be covered with an impervious materials.

The catch drain should be provided along the foot of the embankment. At the boundary of the cut and the natural slope, the shoulder ditch is desired to be constructed to protect the cut slope from erosion.

(2) Typical sections of floodway and flood control embankment

Recommended sections of embankment and cut for floodway and flood control embankment are as shown below.

The slope of embankment and cut is determined to be one vertical in two (2) horizontal. This is based on that in case of floodway, the foundation is very weak and embankment materials are of the low shearing strength, and in case of flood control embankment, the height of cut slope including the height of bank slope is fairly high.



Flood Dike

Flood Control

(a) Embankment

Riverbed materials should be removed from embankment material to prevent seepage. These materials are used for the counterweight of flood control embankment to ensure high resistance against sliding of outer slope. The both embankment should be well compacted to ensure high resistance against drying shrinkage, swelling and sliding. The bank slopes above wetted perimeter should be sodded to protect facing from shrinkage and erosion. In addition, embankments should be constructed apart from excavation portion beyond influence of circular sliding.

(b) Excavation

As the foundation for floodway is very weak, protection measures for the bottom will be needed. Protection measures for cut slopes of flood control embankment is also needed.

Table 2.1 Swedish Sounding Test (1/2)

Location : Flood Way No.1 (1)
Sight condition : Paddy
Surface condition: Wet

Wsw	Na	D	L	Nsw	N	qu
(kg)	(times)	(m)	(cm)	(times/m)		(kg/cm2)
75	0	0.13	13	0	0	0.34
100	0	2.25	212	0	"	0.45
"	4.5	2.50	25	18	4	0.58
"	4	2.75	"	16	"	0.57
"	4.5	3.00	"	18	"	0.58
"	3	3.25	"	12	"	0.54
"	2.5	3.50	"	10	3	0.52
"	6	3.75	"	24	4	0.63
"	7	4.00	"	28	"	0.66
"	6	4.25	"	24	"	0.63
"	"	4.50	"	24	"	"
"	7	4.75	"	28	"	0.66
"	10	5.00	"	40	5	0.75
"	9	5.25	"	36	"	0.72
"	7	5.50	"	28	4	0.66
"	6	5.75	"	24	"	0.63
"	5	6.00	"	20	"	0.60
"	4.5	6.25	"	18	"	0.58
"	4	6.50	"	16	"	0.57
"	5	6.75	"	20	"	0.60
"	4.5	7.00	"	18	"	0.58
"	7	7.25	"	28	"	0.66
"	4.5	7.50	"	18	"	0.58
"	"	7.75	"	18	"	"
"	3	8.00	"	12	"	0.54
100	0	8.25	25	0	0	0.45
"	4	8.50	25	16	4	0.57
"	0	9.50	100	0	0	0.45

continue

	$\bar{N}$ = 3.4	$\bar{qu}$ = 0.58
	σN = 1.4	σqu = 0.08
	2.7 < N < 4.1	0.50 < qu < 0.62

Remarks: Wsw; Load

Na ; Number of times of half turn

D ; Penetrated depth

L ; Penetrated length

Nsw; Half turning numbers per meter ($Nsw = \frac{Na}{L} \times 100$)

N ; N-value (gravel sand or sandy soil) $N = 2 + 0.067Nsw$
(clay or cohesive soil) $N = 3 + 0.05Nsw$

qu ; Unconfined compressive strength
$qu = 0.0045Wsw + 0.0075Nsw$

Table 2.1 Swedish Sounding Test (2/2)

Location : Flood Way No.2 (1)
Sight condition : Paddy
Surface condition: Wet

Wsw (kg)	Na (times)	D (m)	L (cm)	Nsw (times/m)	N	qu (kg/cm2)
75	0	0.37	37	0	0	0.34
100	0	0.45	8	"	"	0.45
"	0.5	0.50	5	10	3	0.52
"	4	0.75	25	16	4	0.57
"	3.5	1.00	"	14	"	0.55
"	"	1.50	"	7	3	0.50
"	"	1.75	50	14	4	0.55
"	3	1.41	25	5	3	0.49
"	1.5	2.50	66	17	4	0.58
"	5	2.75	9	20	"	0.60
"	3.5	3.00	25	14	"	0.55
"	4	3.25	"	16	"	0.57
"	"	3.50	"	"	"	"
"	"	3.75	"	"	"	"
"	4.5	4.00	"	18	"	0.58
"	4	4.25	"	16	"	0.57
"	3.5	4.50	"	14	"	0.55
"	"	4.75	"	"	"	"
"	"	5.00	"	"	"	"
"	"	5.25	"	"	"	"
"	4	5.50	"	16	"	0.57
"	4.5	5.75	"	18	"	0.58
"	4	6.00	"	16	"	0.57
"	3.5	6.25	"	14	"	0.55
"	3	6.50	"	12	"	0.54
100	3	6.75	25	12	4	0.54
"	"	7.00	"	"	"	0.54
"	0	7.37	37	0	0	0.45
"	2	7.50	13	15	4	0.56
"	4	7.75	25	16	"	0.57
"	3.5	8.00	"	14	"	0.55
"	"	8.25	"	"	"	"
"	"	8.50	"	"	"	"
"	3	8.75	"	12	"	0.54
"	3.5	9.00	"	14	"	0.55
"	4	9.25	"	16	"	0.57
"	3.5	9.50	"	14	"	0.56

continue

$\bar{N}$ = 3.5 $\bar{qu}$ = 0.54
σN = 1.1 σqu = 0.05
$2.9 < \bar{N} < 4.0$ $0.52 < \bar{Qu} < 0.57$

Table 2.2 Summary of Soil Test (1/6)

Sample No.	Unit	TP 0R 1.4 - 2.0	TP 0L 0.5 - 1.2	TP1 0.5 - 1.6	TP1 1.6 - 2.5	TP1 0.5 - 2.5
Location		Alternative Main Canal Route	Alternative Main Canal Route	Alternative Main Canal Route	Alternative Main Canal Route	Alternative Main Canal Route
Gradation						
Gravel : +4.76 mm	(%)	0	0	38.6	2	6.1
Sand : 4.76 - 0.074 mm	(%)	60.3	36.8	30.5	40.3	40.5
Silt and Clay: -0.074	(%)	39.7	63.2	30.9	57.7	53.4
D 60	(mm)	0.149	0.061	4.750	0.130	0.14
D 50	(mm)	0.102	0.040	2.300	0.062	0.060
D 30	(mm)	0.043	0.018	0.070	0.010	0.012
D 10	(mm)	0.005	0.003	0.0012	-	-
Coeff of Unit	(Cu)	29.8	20.3	39.58	-	-
Coeff of Curv	(Cc)	2.5	1.8	0.9	-	-
Atterberg Limit						
Liquid Limit : WL	(%)	45.4	59.8	55.4	52.4	63.1
Plastic Limit: WP	(%)	19.8	31.3	25.3	31.2	27.4
Plastic Index: IP	(%)	25.6	28.5	30.1	21.2	35.7
Specific Gravity : Gs		2.59	2.61	2.62	2.60	2.63
Natural Water Content (Passing 4.76 mm): Wn	(%)	30.3	27.9	27.6	40.9	36.7
Specific Gravity for Quality of Gravel : G's		-	-	-	-	-
Water Absorption: W'	(%)	-	-	-	-	-
Compaction						
Opt. Water Content : Wopt	(%)	-	23.8	-	-	30.5
Max. Dry Density : γdmax	(g/cm^3)	-	1.54	-	-	1.39
γdmax. x 95 % : γdD95	(g/cm^3)	-	1.46	-	-	1.32
Water Content (dD95): WD95	(%)	-	26.9	-	-	35.2
Wn - Wopt	(%)	-	4.1	-	-	6.2
Wn - WD95	(%)	-	1.0	-	-	1.5
Shrinkage Limit: SL	(%)	-	-	-	-	-
Unified Classification		SC	CH	GC	CH	CH
Romarks		Terrace	Residual	Residual	Residual	Residual

Table 2.2 Summary of Soil Test (2/6)

Sample No.	Unit	TP2 0.3 - 1.4	TP3 0.8 - 1.4	TP4 1.0 - 1.8	TP4 1.8 - 2.0	TP5 1.5 - 2.0
Location		Alternative Main Canal Route	Alternative Main Canal Route	Alternative Main Canal Route	Alternative Main Canal Route	Alternative Main Canal Route
Gradation						
Gravel : + 4.76 mm	(%)	1	2.3	1.4	10.2	0
Sand : 4.76 - 0.074 mm	(%)	49.6	59.6	22.6	42.3	31.1
Silt and Clay: - 0.074	(%)	49.4	38.1	76.0	47.5	68.9
D 60	(mm)	0.130	0.180	0.042	0.147	0.050
D 50	(mm)	0.080	0.139	0.018	0.083	0.030
D 30	(mm)	0.030	0.043	-	0.032	0.006
D 10	(mm)	-	0.002	-	-	-
Coeff of Unit	(Cu)	-	90	-	-	-
Coeff of Curv	(Cc)	-	51	-	-	-
Atterberg Limit						
Liquid Limit : WL	(%)	56.3	53.7	80.6	58.6	60.4
Plastic Limit: WP	(%)	31.9	21.3	23.8	21.9	22.7
Plastic Index: IP	(%)	24.4	32.4	56.8	36.7	37.7
Specific Gravity : Gs		2.66	2.63	2.54	2.57	2.59
Natural Water Content (Passing 4.76 mm): Wn	(%)	40.5	35.0	38.2	33.5	33.1
Specific Gravity for Quality of Gravel : G's		-	-	-	-	-
Water Absorption: W'	(%)	-	-	-	-	-
Compaction						
Opt. Water Content : Wopt	(%)	30.6	19.1	24.6	-	29.4
Max. Dry Density : γdmax	(g/cm^3)	1.35	1.56	1.43	-	1.37
γdmax. x 95 % : γdD95	(g/cm^3)	1.29	1.48	1.36	-	1.30
Water Content (dD95): Wd95	(%)	36.5	22.0	32.0	-	35.0
Wn - Wopt	(%)	9.8	15.9	8.9	-	3.7
Wn - WD95	(%)	3.9	13.0	1.5	-	- 1.9
Shrinkage Limit: SL	(%)	18.7	-	10.1	-	-
Unified Classification		SC	SC	CH	SC	CH
Remarks		Molasse	Molasse	Molasse	Molasse	Terrace

Table 2.2 Summary of Soil Test (3/6)

Sample No.	Unit	TP6 0.6 - 1.4	TP7 1.6 - 2.0	TP8 1.4 - 2.0	TP9 1.0 - 1.5
Location		Alternative Main Canal Route	Alternative Main Canal Route	Alternative Main Canal Route	Alternative Main Canal Route
Gradation					
Gravel : + 4.76 mm	(%)	25.8	0	0	0
Sand : 4.76 - 0.074 mm	(%)	38.0	20.4	8.6	18.7
Silt and Clay: - 0.074	(%)	36.2	79.6	91.4	81.3
D 60	(mm)	1.810	0.034	0.020	0.024
D 50	(mm)	0.600	0.024	0.014	0.016
D 30	(mm)	0.054	0.010	0.0043	0.005
D 10	(mm)	0.0014	0.0024	-	-
Coeff of Unit	(Cu)	12.93	14	-	-
Coeff of Curv	(Cc)	1.2	1.2	-	-
Atterberg Limit					
Liquid Limit : WL	(%)	54.2	42	73	87.1
Plastic Limit: WP	(%)	28.9	17.4	28.8	23.9
Plastic Index: IP	(%)	25.3	24.6	44.2	63.2
Specific Gravity : Gs		2.58	2.58	2.68	2.58
Natural Water Content (Passing 4.76 mm): Wn	(%)	20.3	35.6	22.9	42.7
Specific Gravity for Quality of Gravel : G's		-	-	-	-
Water Absorption: W'	(%)	-	-	-	-
Compaction					
Opt. Water Content : Wopt	(%)	20.5	21.0	24.6	-
Max. Dry Density : γdmax.	(g/cm^3)	1.60	1.59	1.48	-
γdmax. x 95 % : γd95	(g/cm^3)	1.52	1.51	1.40	-
Water Content (d95): WD95	(%)	24.0	25.8	29.2	-
Wn - Wopt	(%)	- 0.2	14.6	- 1.8	-
Wn - WD95	(%)	- 3.7	9.8	- 6.4	-
Shrinkage Limit: SL	(%)	-	11.7	-	-
Unified Classification		SC	CL	CH	CH
Romarks		Residual	Alluvial	Molasse	Molasse

Table 2.2 Summary of Soil Test (4/6)

Sample No.	Unit	FW1 0.5	FW2 0.5
Location		Flood Way	Flood Way
Gradation			
Gravel : -4.76 mm	(%)	0	0
Sand : 4.76 - 0.074 mm	(%)	27	22.9
Silt and Clay: -0.074	(%)	73	77.1
D 60	(mm)	0.05	0.04
D 50	(mm)	0.027	0.028
D 30	(mm)	-	-
D 10	(mm)	-	-
Coeff of Unit	(Cu)	-	-
Coeff of Curv	(Cc)	-	-
Atterberg			
Liquid Limit : WL	(%)	79.5	79.8
Plastic Limit: WP	(%)	26.6	27.8
Plastic Index: IP	(%)	52.9	52
Specific Gravity : GS		2.60	2.59
Natural Water Content (Passing 4.76 mm): Wn	(%)	44.0	42.3
Specific Gravity for Quality of Gravel : G's		-	-
Water Absorption: W'	(%)	-	-
Compaction			
Opt. Water Content : Wopt	(%)	30.2	-
Max. Dry Density : Ydmax.	(g/cm^3)	1.36	-
Ydmax. x 95 % : YdD95	(g/cm^3)	1.29	-
Water Content (dD95): WD95	(%)	34	-
Wn - Wopt	(%)	13.7	-
Wn - WD95	(%)	9.9	-
Shrinkage Limit: SL	(%)	-	-
Unified Classification		CH	CH
Remarks			

Table 2.2 Summary of Soil Test (5/6)

Sample No.	Unit	ER1 0.5	ER2 0.5	ER3 0.5	ER4 0.5	ER5 0.5
Location		R. Bila	R. Boya	R. Bila	R. Bila	R. Bila
Gradation						
Gravel : +4.76 mm	(%)	0	-	-	0	-
Sand : 4.76 - 0.074 mm	(%)	11	-	-	16	-
Silt and Clay: -0.074	(%)	89	-	-	84	-
D 60	(mm)	0.032	-	-	0.050	-
D 50	(mm)	0.024	-	-	0.043	-
D 30	(mm)	0.012	-	-	0.030	-
D 10	(mm)	-	-	-	-	-
Coeff of Unit	(Cu)	-	-	-	-	-
Coeff of Curv	(Cc)	-	-	-	-	-
Atterberg Limit						
Liquid Limit : WL	(%)	52.4	-	-	68	-
Plastic Limit: WP	(%)	30.5	-	-	26.8	-
Plastic Index: IP	(%)	21.9	-	-	41.2	-
Specific Gravity : GS		2.62	-	-	2.59	-
Natural Water Content (Passing 4.76 mm): Wn	(%)	28.7	14.6	38.4	39.1	39.7
Specific Gravity for Quality of Gravel : G's		-	-	-	-	-
Water Absorption: W'	(%)	-	-	-	-	-
Compaction						
Opt. Water Content : Wopt	(%)	-	-	-	32.3	-
Max. Dry Density : γdmax.	(g/cm^3)	-	-	-	1.34	-
γdmax. x 95 % : γdD95	(g/cm^3)	-	-	-	1.27	-
Water Content (dD95): WD95	(%)	-	-	-	37	-
Wn - Wopt	(%)	-	-	-	6.8	-
Wn - WD95	(%)	-	-	-	2.1	-
Shrinkage Limit: SL	(%)	-	-	-	-	-
Unified Classification		CH	-	-	CH	-
Remarks						

Table 2.2 Summary of Soil Test (6/6)

Sample No.	Unit	ER6 0.5	ER7 0.7
Location		R. Kalola	R. Kalola
Gradation			
Gravel : +4.76 mm	(%)	-	0
Sand : 4.76 - 0.074 mm	(%)	-	17.7
Silt and Clay: -0.074	(%)	-	72.3
D 60	(mm)	-	0.04
D 50	(mm)	-	0.028
D 30	(mm)	-	0.012
D 10	(mm)	-	-
Coeff of Unit	(Cu)	-	-
Coeff of Curv	(Cc)	-	-
Atterberg			
Liquid Limit : WL	(%)	-	59.7
Plastic Limit: WP	(%)	-	29.3
Plastic Index: IP	(%)	-	30.4
Specific Gravity : Gs		24.3	22.3
Natural Water Content (Passing 4.76 mm): Wn	(%)	-	2.59
Specific Gravity for Quality of Gravel : G's			
Water Absorption: W'	(%)		
Compaction			
Opt. Water Content : Wopt	(%)	-	-
Max. Dry Density : Ydmax.	(g/cm^3)	-	-
Ydmax. x 95 % : YdD95	(g/cm^3)	-	-
Water Content (dD95): WD95	(%)	-	-
Wn - Wopt	(%)	-	-
Wn - WD95	(%)	-	-
Shrinkage Limit: SL	(%)	-	-
Unified Classification		-	CH
Remarks			

Table 2.3 Summary of Riverbed Material Test (1/2)

Sample No.	Unit	RM1 0.3	RM2 0.3	RM3 0.3	RM4 0.3	RM5 0.3
Location		R. Bila	R. Boya	R. Lancirang	R. Bila	R. Bila
Gradation						
Gravel : +4.76 mm	(%)	55.2	55.4	0	66.4	1.2
Sand : 4.76 - 0.074 mm	(%)	44.6	43.5	40.8	32.5	98.7
Silt and Clay: -0.074	(%)	0.2	1.1	59.2	1.1	0.1
D 60	(mm)	9.80	8.00	0.090	8.6	0.51
D 50	(mm)	6.50	6.00	0.060	7.2	0.44
D 30	(mm)	1.90	3.00	0.038	4.2	0.32
D 10	(mm)	0.50	0.60	-	1.02	0.22
Coeff of Unit	(Cu)	19.6	13.3	-	8.4	2.3
Coeff of Curv	(Cc)	0.7	1.9	-	2.0	0.9
Atterberg Limit						
Liquid Limit : WL	(%)	-	-	-	-	-
Plastic Limit: WP	(%)	-	-	-	-	-
Plastic Index: IP	(%)	-	-	-	-	-
Specific Gravity : Gs		-	-	2.56	-	2.66
Natural Water Content (Passing 4.76 mm): Wn	(%)	9.9	14.2	38.4	7.9	33.5
Specific Gravity for Quality of Gravel : G's		2.47	2.53	-	2.60	-
Water Absorption: W'	(%)	2.2	2.0	-	1.3	-
Compaction						
Opt. Water Content : Wopt	(%)	-	-	-	-	-
Max. Dry Density : γdmax.	(g/cm^3)	-	-	-	-	-
γdmax. x 95 % : γdD95	(g/cm^3)	-	-	-	-	-
Water Content (dD95): WD95	(%)	-	-	-	-	-
Wn - Wopt	(%)	-	-	-	-	-
Wn - WD95	(%)	-	-	-	-	-
Shrinkage Limit: SL	(%)	-	-	-	-	-
Unified Classification		GW	GW	CL	GW-GP	SP
Remarks						

Table 2.3 Summary of Riverbed Material Test (2/2)

Sample No.	Unit	RM6 0.3	RM7 0.3	BRM 0.3
Location		R. Bila	R. Kalola	R. Bila
Gradation				
Gravel : +4.76 mm	(%)	0.2	15.4	75.2
Sand : 4.76 - 0.074 mm	(%)	53.9	83.4	24.6
Silt and Clay: -0.074	(%)	45.9	1.2	0.2
D 60	(mm)	0.12	1.90	45
D 50	(mm)	0.09	1.40	25.6
D 30	(mm)	0.05	0.79	6.9
D 10	(mm)	-	0.43	0.8
Coeff of Unit	(Cu)	-	4.4	56.2
Coeff of Curv	(Cc)	-	0.8	1.3
Atterberg				
Liquid Limit : WL	(%)	-	-	-
Plastic Limit: WP	(%)	-	-	-
Plastic Index: IP	(%)	-	-	-
Specific Gravity : Gs		2.65	2.64	-
Natural Water Content (Passing 4.76 mm): Wn	(%)	36.5	13.6	9.5
Specific Gravity for Quality of Gravel : G's		-	-	2.73
Water Absorption: W'	(%)	-	-	1.44
Compaction				
Opt. Water Content : Wopt	(%)	-	-	-
Max. Dry Density : Ydmax.	(g/cm3)	-	-	-
Ydmax. x 95 % : YdD95	(g/cm3)	-	-	-
Water Content (dD95): WD95	(%)	-	-	-
Wn - Wopt	(%)	-	-	-
Wn - WD95	(%)	-	-	-
Shrinkage Limit: SL	(%)	-	-	-
Unified Classification		SM	SP	GW
Remarks				

Table 2.4 Summary of Gradation Analysis of Riverbed Materials

(Unit: mm)

River	Sampling Location (km)	Percentage of Weight Passing through the Sieve															Sampling Date
		50.8	38	25.5	19.1	12.7	9.52	4.76	2.00	0.841	0.480	0.177	0.149	0.074	D60	D30	D10	
Bila																		
Bi-1	-6.6 (R)			100	98.7	93.1	85.2	57.1	33.2	18.1	8.2	2.3	1.9	0.6	5.1	1.7	0.5	Oct. 1978
RM-5	-2.2 (R)						100	98.8	97.4	89.5	48.0	0.6	0.4	0.1	0.5	0.3	0.2	Spe. 1981
RM-6	-5.7 (L)						100	99.8	98.9	98.4	97.6	74.2	67.0	45.9	0.1	0.1	0.0	- do -
RM-4	5.4		100	97.7	93.5	82.0	66.7	33.6	13.3	8.1	6.5	2.7	2.3	1.1	8.6	4.2	1.02	- do -
Bi-2	7.1				100	98.8	97.2	88.9	71.6	49.5	32.5	15.8	10.7	2.5	1.3	0.4	0.1	Oct. 1978
Bi-3	10.4			100	92.6	82.5	74.6	55.5	39.4	25.4	6.6	0.7	-	0.1	5.5	1.2	0.5	- do -
Bi-4	15.5			100	97.2	83.8	75.1	57.8	39.4	30.1	18.1	1.8	1.3	0.3	5.2	0.9	0.3	- do -
Bi-5	17.2		100	96.1	89.1	71.3	60.1	38.2	23.1	14.1	3.4	0.3	0.1	0.0	9.5	3.0	0.7	- do -
Bi-6	17.4		100	95.6	89.0	77.8	69.6	48.9	32.1	23.4	11.5	0.9	0.6	0.1	6.8	1.6	0.4	- do -
RM-1	21.0	100	94.9	90.2	82.5	68.0	58.8	44.8	31.6	18.6	5.8	0.7	0.5	0.2	9.8	1.9	0.5	Sep. 1981
Bi-7	27.1		100	98.6	87.1	70.6	63.1	39.7	17.9	6.7	4.5	1.9	1.6	0.7	8.6	3.2	1.8	Oct. 1978
Boya																		
Bo-1	0.3			100	95.7	86.2	78.8	60.8	43.1	35.5	21.8	2.5	1.6	0.3	4.5	0.7	0.3	Oct. 1978
RM-2	2.5		100	95.3	92.1	82.0	70.0	44.6	21.2	11.7	8.8	2.9	2.4	1.1	8.0	2.0	0.6	Sep. 1981
Bo-2	7.5		100	98.4	87.9	75.6	67.2	48.9	34.6	25.6	14.4	2.5	1.7	0.5	7.2	1.3	0.3	Oct. 1978
Bo-3	12.0		100	88.7	81.2	69.5	62.7	48.7	32.0	12.9	3.2	1.0	0.9	0.4	8.4	1.8	0.7	- do -
Lancirang																		
RM-3	3.5							100	99.8	99.1	87.5	64.9	63.3	59.2	0.1	0.0	0.0	Sep. 1981
Kalola																		
RM-7	9.3				100	98.0	96.3	84.6	61.4	36.5	6.2	5.4	3.7	1.2	1.9	0.8	0.4	Sep. 1981

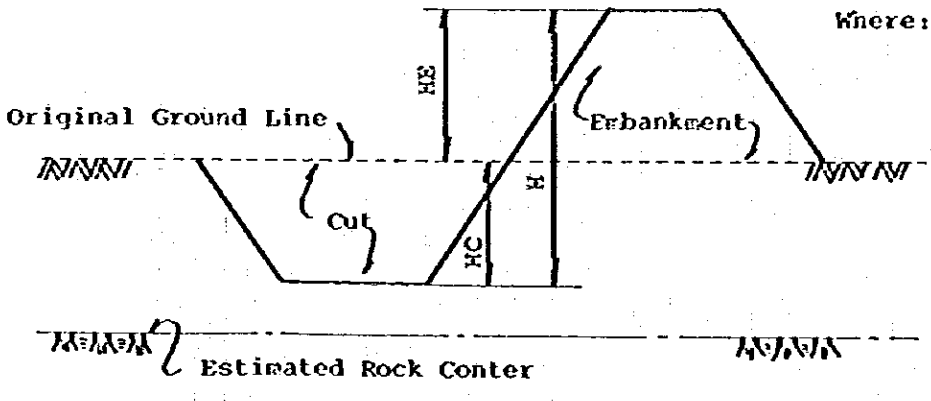
Remarks: RM-1 to RM-7; River Materials Sampled in this Study
Bi-1 to Bi-7, Bo-1 to Bo-3; River Materials Sampled in Master Plan

Location: (km); According to the longitudinal profile
(R) ; Right channel downstream of BI 0.0
(L) ; Left channel downstream of BI 0.0

Table 3.1 Required Slope Angle for Safety Factor 1.5

Application of Embank. and Cut	Soil	Height of Slope (m)	Angle of Slope	
Canal				
Embankment and Cut	Terrace soil	4	80	(1:0.17)
		5	53	(1:0.75)
		5.5	37	(1:1.33)
Embankment and Cut	Alluvial soil	4	80	(1:0.17)
		5	53	(1:0.75)
		5.5	28	(1:1.88)
Embankment	Mollasse soil	5	76	(1:0.25)
		6	53	(1:0.75)
		7	37	(1:1.33)
Cut		6	72	(1:0.32)
		7	53	(1:0.75)
		8	42	(1:1.11)
Embankment and Cut	Residual soil	7	62	(1:0.53)
		8	48	(1:0.90)
		9	40	(1:1.19)
Flood Dike				
Embankment and Cut	Alluvial soil	3	90	(1: -)
		4	85	(1:0.09)
		5	60	(1:0.58)
		5.5	25	(1:2.14)
Flood Control				
Embankment and Cut	Terrace soil	5	76	(1:0.25)
		6	53	(1:0.75)
		7	38	(1:1.28)
		8	30	(1:1.73)

Remark: Every section for analysis is assumed as shown below;



Where: H ; Height of Slope (m)
HE; Height of Embankment Slope (m)
HC; Height of Cut Slope (m)

H = HE + HC

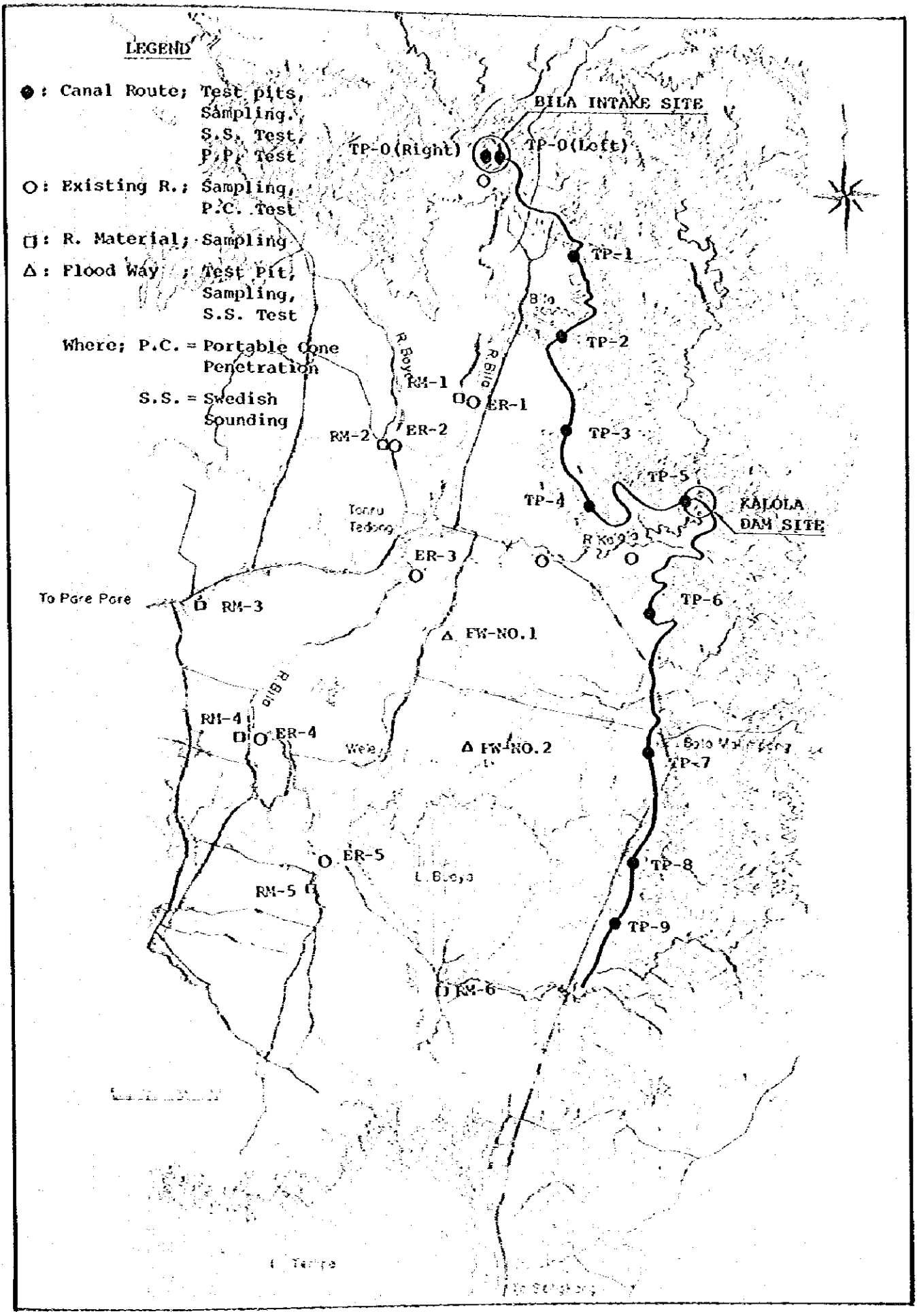
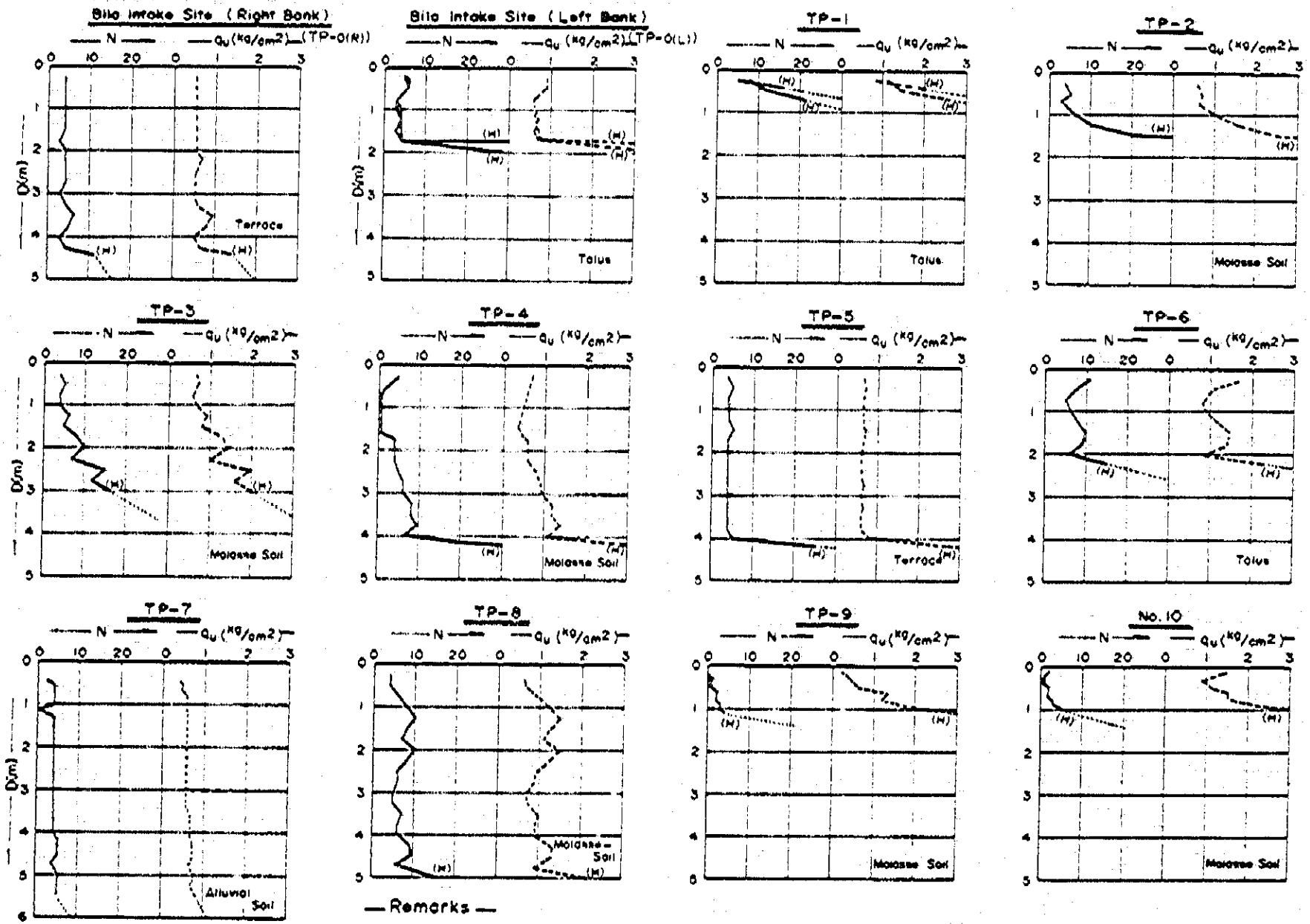


Fig. 2.1 LOCATION MAP OF SOIL MECHANICS SURVEY



— Remarks —

(1) Swedish Sounding Test : Bila Intake Site (Right & Left Bank) TP-1 — TP-8

(2) Cone Penetration Test : TP-9 , No.10

(3) TP— : Test Pit

(4) (H) : Hard Layer

(5) Surface Soil : Alluvial Fan Soil, Terrace, Talus, Molasse Soil.

Fig. 2.2 THE SUMMARY OF PENETRATION TEST (1/2)

LOCATION: EXISTING RIVER

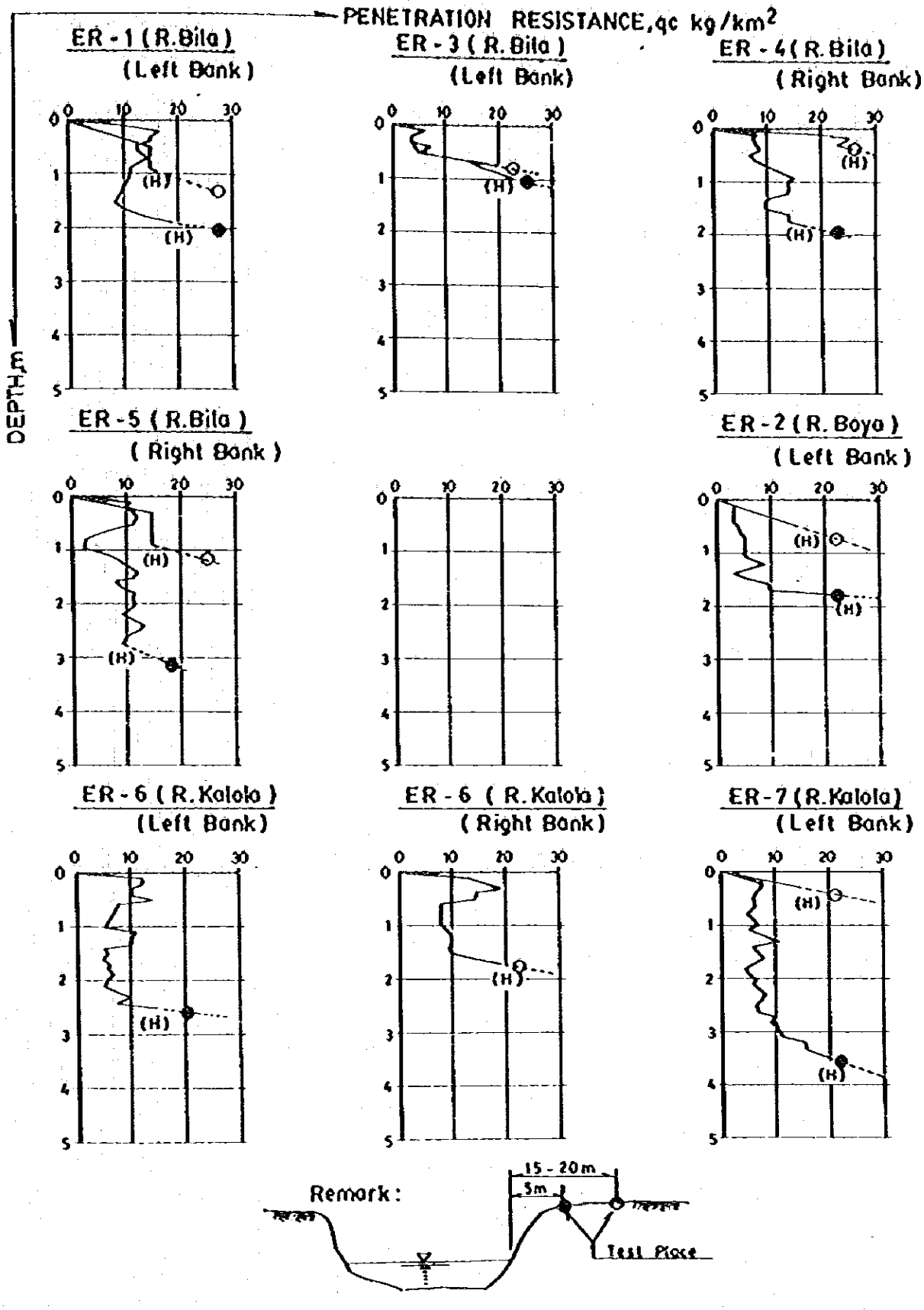


Fig. 2.2 THE SUMMARY OF PENETRATION TEST (2/2)

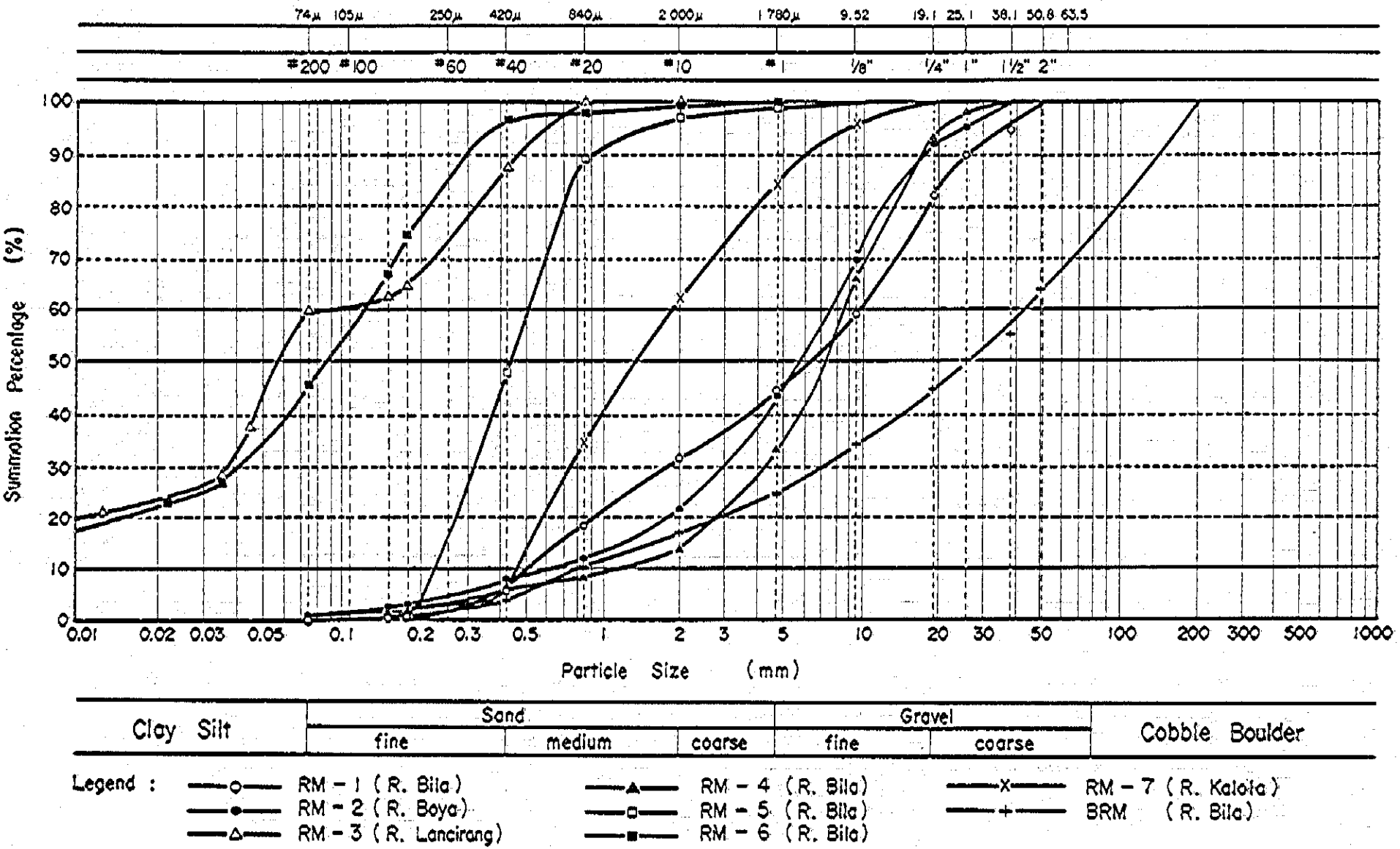


Fig. 2.3 PARTICLE SIZE ACCUMULATION CURVE OF RIVER MATERIAL

ANNEX - V

AGRICULTURE AND AGRICULTURAL ECONOMY

ANNEX-V AGRICULTURE AND AGRICULTURAL ECONOMY

CONTENTS

ANNEX-V AGRICULTURE AND AGRICULTURAL ECONOMY

1. GENERAL

The present studies of agriculture and agricultural economy in the project area were mainly designed for the purpose to measure the possible differences in agricultural production between conditions with and without the Bila Irrigation Project and to estimate the repayment capacity of the project-benefited farmers.

The main objectives of these studies are:

(1) to study the present status of agricultural production and rural economy in the project area,

(2) to find the optimum cropping patterns in the area and evaluate the development potential in agricultural production,

(3) to estimate the improvement of agricultural outputs and farmer's economy under the with-project condition, and

(4) to measure the irrigation benefits derived from the project and repayment capacity of the benefited farmers.

In order to clarify the prevailing agricultural conditions and the development potential, the following field investigation and data collection were made in and around the project area:

(1) present land use survey using aerial photographs and topographic maps scaled 1/25,000,

(2) collection of data and information on present agricultural production including crop being grown, present cropping pattern, crop yield and production, farming practices, etc.,

(3) yield survey on wet season paddy at representative paddy fields,

(4) data collection on current market flows and prices of agricultural commodities,

(5) farm economy survey for collecting more practical information on farming practices, farm inputs and farming expenses, and

(6) collection of data on existing agricultural support systems including agricultural extension, BIMAS/INMAS and INSUS programme, research, credit, farm inputs supplies and farmers' cooperatives.

The data and information were mainly obtained from the government authorities concerned such as Provincial Agriculture Extension Service, agriculture offices in Kab. Sidrap and Wajo, Central Research Institute of Agriculture (CRIA), Bogor, South Sulawesi Branch Research Station of

CRIA in Maros, Soil Research Institute in Bogor, BAPPEDA office, IPEDA office, DOLOG office, Indonesia People's Bank (BRI) of South Sulawesi Province and their branch offices in Kab. Sidrap and Wajo, and Bupati office, Census and Statistics office, Rural Extension Centers of Kab. Sidrap and Wajo. The data and information referred are listed in Table 1.1.

In parallel with such data collection, an extensive field investigation was made over about 20,000 ha of the study area and on the basis of the overall results of field investigation and preliminary results of data analysis, the farmer's interview were made on 46 representative farm households so as to confirm the data and information mentioned above and also to obtain more practical and realiable information on farm economy. In addition to these activities, yield diagnosis survey for wet season paddy was also carried out for the purpose to identify the defects hampering increase of unit yield of paddy under present condition.

2. PRESENT CONDITION OF AGRICULTURE

2.1 Location

The study area is located at about 210 km northeast along the national road from Ujung Pandang, the capital of South Sulawesi Province. It extends northwest of Sengkang, the capital of Kabupaten Wajo, and is approximately bounded by the Lake Tempe on the south and the Bila and Boya rivers on the west. The northern and eastern boundaries are skirted along the foot of hilly ranges. The total study area for the Project covers 20,000 ha in gross.

Administratively, the area comes under two (2) Kabupaten, Sidrap and Wajo, and covers four (4) Kecamatan viz., Dua Pitue of Kabupaten Sidrap, Tanasitolo, Maniangpajo and Belawa of Kabupaten Wajo. There exist 9 Desa and 48 Kampong. The administrative divisions are illustrated on Fig. 2.1.

2.2 Human Resources

The population in the study area is estimated at about 83,900 as of 1980 on the basis of the data collected from Bupati office and Census and Statistics office. The population growth rate is also estimated at about 1.2% per annum according to the same data from 1971 to 1980. The total working population is about 34,300 which corresponds to 40.9% of the total population, out of which 26,800 inhabitants are engaged in agriculture. The total number of household is about 15,400. The average size of family is 5.5 persons per household. The number of farm household is about 11,600 in total. It counts for about 75% of the total number of household. The details of present demographic condition in the study area are given in Table 2.1.

The demographic features in the study area are characterized by low rate of population growth and high rate of female population. The annual population growth rate of 1.2% is very low compared with the provincial average of 2.1% as shown in Table 2.2.

The population structure by age group is shown in Table 2.3 and Fig. 2.2. The rate of male population to the total population is 46.8%. This rate becomes lower to about 45.5% in the age group of 15 to 49, which is deemed to be effective agricultural labour force.

These figures seem to indicate that there is a considerable population outflow from the study area and most of them are temporarily working outside to supplement their livelihood with some off-farm income because of insufficient present crop income, especially in the dry season. The presumption has been evidenced by the farm economy survey.

2.3 Land Resources

The results of soil survey show that about 11,200 ha of irrigable lands suitable for paddy cultivation extend over the study area.

The soil of these lands are classified into 5 soil units, according to the FAO/UNESO system, i.e. Eutric Fluvisols, Eutric Gleysols, Eutric Regosols, Plinthic Acrisols and Perric Acrisols.

Eutric Fluvisols and Eutric Gleysols are suitable for irrigated paddy cultivation due to their general characteristics of flat topography, deep surface soils, heavy texture and easy water availability. Most of existing paddy fields are developed on these soil units. The drainage improvement of Eutric Gleysols will be essential. The total area of arable lands suitable for irrigated rice cultivation, which are covered by these two units, are about 11,200 ha.

Eutric Regosols, young sandy soils, extend along the Bila and Kalola rivers and their tributaries. These soils are mainly used for cultivation of upland crops and commercial crop trees. Plinthic Acrisols extend along the foot of the eastern hilly land. These soils are mainly used for perenial crops. Perric Acrisols develop over the eastern hilly lands. The soils have generally shallow gravelly surface soil. The land cover of these soils is mainly grass land. These 3 soil units are not suitable for irrigated rice cultivation.

This means that existing paddy fields have been developed to the possible extent and there is no unused arable lands to be newly reclaimed under the project.

2.4 Present Land Use

The present land use survey was carried out on the basis of aerial photographs and topographic maps scaled 1/25,000. The present land use in the study area are summarized as follows:

Land use category	Area (ha)	Proportional extent (%)
Paddy field	13,700	68.5
Upland field	700	3.5
Orchard	1,260	6.3
Forest/Grass land	3,800	19.0
Villages/others	540	2.7
Total	20,000	100.0

The lands in the study area are classified into 5 land use categories, comprising paddy field, upland field, orchard, forest/grass land and village/others.

The farmland comprising paddy fields, upland fields and orchards amounts to about 15,660 ha or 78.3% of the total area. Paddy fields occupy about 13,700 ha or 68.5% of the total area. It has been mainly developed to the possible maximum extent, even over the undulating land. However, most of paddy fields cultivated generally made under rainfed condition.

Upland fields of about 700 ha extend along the Bila and Kalola rivers and their tributaries in the study area, and are presently used for cultivation of maize, groundnuts, cassava, etc. Most of the orchards are sporadically located around the village areas and cultivated with banana, coconuts, clove, kapok, pepper, etc. The total area of orchards is estimated at about 1,260 ha. The remaining of about 4,340 ha is covered with forest, grass land, villages and others.

The details of present land use in the study area are given in Table 2.4 and also illustrated on Fig. 2.3.

2.5 Present Cropping Pattern

The main crop grown in the study area is paddy, followed by polowijo crops such as maize, groundnuts, greenbeans and soybeans. Other crops grown as adjunct to rice farming are coconuts, banana, clove, pepper, kapok, etc. They are generally grown in the upland and orchard areas of 1,960 ha, most of which are sporadically located around the village areas.

Most of the paddy fields are put under rainfed condition. The paddy cultivation is concentrated in the wet season and is very limited in the dry season. The polowijo crops are generally planted in the dry season. The cultivation pattern is generally affected by seasonal distribution of rainfall. The harvested and/or planted areas fluctuate year by year, depending on the available rainfall water. The wet season paddy is planted at the onset of the monsoon, generally in May and June, and harvested in August and September. The dry season paddy and the polowijo crops cultivation generally starts in October/November.

The average planted area of paddy, from 1976 to 1980, is 12,600 ha for wet season paddy and 820 ha for dry season paddy. These figures correspond to 92% and 6% of the total paddy field, respectively. The planted area of polowijo crops is about 3,600 ha on an average, corresponding to 26% of the paddy fields. The present multi-cropping intensity is estimated at 124%. Such low cropping intensity is basically attributable to shortage of available water.

The average harvested areas of paddy and polowijo crops from 1976 to 1980 are 10,800 ha for wet season paddy, 730 ha for dry season paddy and 3,500 ha for polowijo crops, respectively. The differences between planted and harvested areas are considered as the areas damaged by various causes like flood, drought, insects and rodents. The average damaged areas for same period, are 1,800 ha for wet season paddy; 90 ha for dry season paddy and 100 ha for polowijo crops.

The planted, harvested and damaged areas of crops are summarized as follows (see Table 2.5):

(Unit: ha)

Crops	Planted area	Harvested area	Damaged area
Wet season paddy	12,600	10,800	1,800
Dry season paddy	820	730	90
Polowijo crops	3,600	3,500	100

The damaged areas are classified as follows:

(Unit: ha)

Crops	Causes of damage			
	Flood	Drought	Insects/ rodents	Total area
Wet season paddy	870	580	350	1,800
Dry season paddy	-	50	40	90
Polowijo crops	-	100	-	100

The extensive agricultural survey has been made over the study area and it has been found that the crop rotation patterns adopted in the study area can be classified into four (4) major types. They are:

Cropping pattern	Cropping intensity (%)	Area (ha)
(1) Paddy - (fallow)	90 - 100	10,000
(2) Paddy - Paddy / Polowijo	100 - 120	700
(3) Paddy - Polowijo	125 - 150	2,800
(4) Paddy - Polowijo - Polowijo	150 - 175	200
Total	124 (Ave.)	13,700

The pattern (1) is predominant in the study area, accounting for about 73% of the paddy field. The pattern (2) is found in the semi-technical and Desa irrigation areas. Due to limited availability of dry season water, very limited areas can be planted with polowijo crops and dry season paddy. Pattern (3) is double cropping of paddy and polowijo crops under some irrigated condition. The cropping intensity is, however, still low. Pattern (4) is found on very limited areas of existing paddy fields around Lake Buaya where enough soil moisture is generally maintained due to higher groundwater level.

These present cropping patterns are summarized in Table 2.6 and illustrated on Fig. 2.4.

2.6 Farming Practices and Farm Inputs

The paddy cultivation is carried out by labour intensive form from the stage of seeding to harvesting. All the members of family contribute their labour to rice farming. Animal power, mainly oxen and buffaloes, is extensively used for land preparation. The use of agricultural equipment is not common.

The high yielding varieties have been widely spread over the area. The major varieties are IR42, IR38, IR36, IR28, etc. These new varieties are used on about 88% of the paddy fields, of which about 40% are IR42. The local varieties are still used on about 12% of the paddy fields mainly for home consumption and local marketing (see Tables 2.7 and 2.8).

Paddy seeds are selected from last harvest or are supplied from the seed centers at Tanru Tedong, Bontouse and Sakkoli. Paddy seeds are generally sown at rate of 25 to 30 kg per ha in the nursery which is prepared in the size of about 1/20 to 1/25 of the paddy field to be transplanted. The seedlings are generally grown for 20 to 25 days.

The field preparation, plowing and harrowing, is made before transplanting by using animal power. Transplanting is generally carried out by hand. Mutual exchange of labour among the farmers groups is common for transplanting. The random transplanting is common and the number of seedlings (hills) for transplanting is generally not many, being 10 - 16 per m^2.

The fertilizers and agro-chemical are widely used. The fertilizers being used are urea and triple superphosphate (TSP). The average dosages are 100 kg of urea and 50 kg of TSP per hectare. Potasium fertilizers are not generally used. Use of insecticides and rodenticides is common. Major insecticides are Dimecron and Diazinon. They are applied to the field by use of knapsack type sprayers. Zinc phosphate is widely used as rodenticide.

Harvesting is generally carried out by using sickles and the harvested paddy is dried on the ground surface of the paddy field.

The cultivation method of polowijo crops is very primitive. Neither fertilizers nor improved varieties are used.

The farm inputs and labour requirements for cultivations of paddy and polowijo crops under present condition are estimated on the basis of field survey, and are shown in Table 2.9.

2.7 Present Crop Yield and Production

(1) Result of paddy yield survey

The paddy yield survey was carried out during the period of August 12 to August 28, 1981 to identify the defects hampering the increase of paddy yields under present condition. The paddy sampling was made for wet season paddy at 59 sites of paddy fields in total, of which 37 samples were taken from the study area and 22 samples from the Sadang Irrigation Project area. The Sadang Irrigation Project, covering Kab. Pinrang and Sidrap, is a well-known irrigation project, sponsored by PROSIDA[1/], where modern irrigation rice farming has been practiced under full guidance of agricultural extension workers. The farmers in this area annually occupy the top ranks in the paddy yield contests of the South Sulawesi Province. The Sadang area is located at about 20 km west from the center of the Bila area and has almost same climatic and soil conditions. Examining the paddy yield in the Sadang area makes it possible to detect more clearly the defects of present paddy cultivation in the Bila area and also to collect the basic data for estimating the future paddy yield with the project.

The variety of paddy sampled is IR42, the dominant variety in the study area. About 80 - 120 hills were harvested at random at each sampling site. The average number of panicle per hill for the sample hills was calculated and about 20 hills were taken, as the representative hills, from the hills which have the nearest number of panicles per hill to the average value. The panicles of selected 20 samples were then separately cut off and only the panicles of each sample hill were weighed, and the average weight was computed. Out of 20 sample bundles of panicles, 3 samples which have the nearest weight to the average, were selected for laboratory analysis.

In the laboratory, the paddy samples were analysed in accordance with the method described in "Rice Cultivation for the Million[2/]", and the following yield components were determined:

(a) number of hills of per m^2
(b) number of panicles per hill

1/: PROSIDA; Proyek Irigasi I.D.A., a special branch formed within the Directorate General of Water Resources, for executing the rehabilitation programmes of the Irrigation Projects financed by the International Development Association (I.D.A.).

2/: S. Matsushima, Rice Cultivation for the Million, Japan Scientific Societies Press, 1980.

(c) number of grains per panicle
(d) percentage (%) of ripened grains
(e) 1,000 grain weight

In the laboratory, the representative hills taken from the sampling site were threshed by hand and all the rachis-branches were removed. The grains thus obtained were dried for 2 days under the shade. The dried grains were then put into a salt solution with 1.06 specific gravity and stirred for 1 min. By this operation the grains are well divided into two groups, i.e., a floating group and a sunken group. All the sunken grains can be taken as fully ripened grains and all the floating grains as non-ripened grains.

The floating grains were scooped out with net spoon and dried and counted. The sunken grains were also counted after taking them out of the salt solution by transferring the solution to another vessel by using a sieve and washing them well with water. Then, the number of grains per panicle was calculated by dividing the total number of grains, which is the sum of the number of floating grains and that of sunken grains, by the number of panicles of the representative hills.

The percentage of ripened grains is easily calculated by dividing the number of sunken grains by total number of grains.

It is considered that all the sunken grains represent the actual yield. The sunken grains were well dried upto the moisture content of 14% under the sun. The dried grains were then accurately weighed. The 1,000 grain weight was calculated by dividing the weight of dried grains by the total number of sunken grains. The grain yield of rice is the product of these yield components. The unit yield is expressed by the following equation:

$$\begin{aligned}\text{Unit Yield (ton/ha)} = {} & \text{Number of hills per } m^2 \\ & \times \text{Number of panicles per hill} \\ & \times \text{Number of grains per panicle} \\ & \times \text{Percentage of ripened grains} \\ & \times \frac{\text{Weight of 1,000 ripened grains}}{1{,}000 \text{ (conversion to one grain weight)}} \\ & \times \frac{10{,}000 \text{ (conversion to yield per ha)}}{1{,}000{,}000 \text{ (conversion to metric ton in weight)}}\end{aligned}$$

The results of paddy yield survey and analysis carried out by the Team in August/September, 1981 (wet season paddy) are given in Tables 2.10 and 2.11. The results of yield survey carried out by the Master Plan Team in March/April, 1978 (dry season paddy) are also given in Table 2.12.

The grain yield of rice can be increased through improvement of defects involved in each yield component.

In order to find the defects of the present paddy yield, the relation between unit yield and each of yield component was examined, (see Fig. 2.5 and 2.6). There is a clear correlation between unit yield and number of grains per m^2 (products of yield components, (a),

(b) & (c)) for both wet season paddy and dry season paddy. While, there is no correlation between unit yield and other yield components. Only percentage of ripened grains is generally low. The most important factors for increase of paddy yield in the study area are twofold i.e., (1) the number of grains per m^2 and (2) percentage of ripened grains. In general, the percentage of ripened grains under normal condition should be more than 80%. For improvement of rice cultivation, attention should be first given to the increase of this percentage.

The percentage of ripened grains is generally determinated during the period from the neck-node differentiation stage to the time 30 days after heading. Therefore, the causes for low percentage of ripened grains must have resulted from the some defects occurred during this period. The excessive number of panicles per m^2 (nos. of panicles per hill x nos. of hills per m^2) is also one of the reasons for the present low percentage of ripened grains. The methods for increasing the percentage of ripened grains are:

(a) to create favourable condition during the period from initiation of young panicles to heading,

(b) to prevent the production of an excessive number of spikelets,

(c) to make the rice plant head at the optimum time when good weather lasts for 15 days before heading and 20 days after heading,

(d) to apply nitrogenous fertilizers at full heading stage,

(e) to reduce damages caused by drought, flooding and deseases and pests after heading,

(f) to prevent the rice plant from lodging,

(g) to make the plant ripen before wet season starts (dry season paddy), and

(h) to select the varieties which yield a high percentage of ripened grains,

In the Bila area, the number of hills per m^2 ranges from 8.2 to 21.1 with an average of 13.6. This is too short compared with an average of 20.4 in the Sadang irrigation area. The regular planting with a space of 30 cm x 15 cm, which is the recommended farm practice under BIMAS/INMAS programme, will increase this number up to 22.2 hills per m^2. The other measures to increase the number of grains per m^2 are:

(a) to raise the healthy seedlings,
(b) to apply basal fertilizers before transplanting,
(c) to transplant in shallow depth, and
(d) to suppress the non-bearing and late-emerging tillers.

The problem is how the number of grains per m^2 can be increased without lowering the percentage of ripened grains. Reduction of emerging non-productive tillers is the key to solving this problem. The generation of non-productive tillers can be minimized by proper water management and fertilization, considering stages of plant growth.

The general guideline for improvement of rice cultivation is given in Fig. 2.7.

(2) Crop yield and production

The crop yield and production under present condition are estimated on the basis of production data obtained from agricultural offices and 9 Desa offices of 2 Kabupaten concerned. The yield and production largely fluctuate year by year due to wide variation of annual rainfall and unexpected damages caused by floods, insects and diseases. The present crop yields and production are therefore estimated to be the average from 1976 to 1980.

The average unit yield of paddy (died paddy) is 2.97 tons/ha for wet season paddy and 2.84 tons/ha for dry season paddy. The average yield of polowijo crops is 0.73 tons/ha. The present crop production in the Project area is summarized as follows:

Crops	Harvested area (ha)	Unit yield (ton/ha)	Production (ton)
1. Paddy	11,530	2.94	34,000
Wet season paddy	10,800	2.97	32,000
Dry season paddy	730	2.84	2,000
2. Polowijo crops	3,500	0.73	2,550
Maize	420	0.79	330
Groundnuts	640	0.77	490
Greenbeans	2,385	0.70	1,670
Soybeans	55	1.09	60

The detailed data concerning crop yields and production in the study area are given in Tables 2.13, 2.14 and 2.15.

2.8 Livestock Production

Livestock raising is not a mainline of agricultural activities in the study area. Most of livestocks are grazed on a small scale in and around the paddy fields. The number of livestock animals in the study area are summarized as follows (refer to Table 2.16):

(Unit: head)

Livestock	Total number	Per farm household
Cattle	10,730	0.93
Horse	1,460	0.13
Buffalo	5,970	0.52
Goat	2,050	0.18
Chicken	76,330	6.59
Duck	12,090	1.04

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

2.9 Marketing and Prices

The South Sulawesi Province is one of the largest rice surplus provinces in Indonesia. The total population in the province is about 5,800,000 in 1979/80. The paddy fields are about 520,000 ha in total. The total production of paddy is reported to be about 2,395,000 tons in 1979/80. On the contrary the total consumption is estimated at about 1,333,000 tons on the assumption that per capita consumption is 220 kg of paddy. The surplus of paddy is then about 1,060,000 tons (see Fig. 2.8). It is reported that the rice surplus conditions increasingly continue in the province.

The Kab. Sidrap and Wajo area, in which the study area is included, is also one of rice surplus regions in the province. The annual surplus is estimated around 400,000 tons in total, corresponding to about 38% of the total surplus rice of the province. Most of these surplus rice are transported to the rice deficit regions like Ujung Pandang and Pare-Pare, and even to other provinces. Under such demand-supply condition, the marketing channels of rice are well developed in the province.

In the study area, the total production of paddy is estimated about 34,000 tons. The total consumption of paddy for the total population of about 83,900, is estimated at about 18,000 tons on the assumption that per capita consumption is 220 kg of dried paddy. The annual surplus amount of paddy is estimated at about 16,000 tons and as shown in Table 2.17.

There are three channels of rice marketing in the study area, as shown in Fig. 2.9. The surplus of paddy produced by the farmers is generally sold to KUD and/or middle men through brokers. The paddy collected by KUD is sold to DOLOG after milling, while the paddy collected by middle men is generally transported to outside of the study area, especially to Ujung Pandang and Pare-Pare. About 95% of surplus paddy is marketed through these two channels. The remaining 5% of the surplus paddy is sold at local markets in and around the study area by small brokers and/or directly by farmers.

The present low production of polowijo crops has resulted from poor marketability together with large fluctuation of market prices. Such poor marketability is mainly due to poor quality of products. According to the results of farm economy survey, the best quality products of polowijo crops have no problem for marketing. However, strong government support is necessary for stabilization of market prices of polowijo crops.

The price of rice is generally controlled by the Government through DOLOG. In 1980/81, the floor price of milled rice is set at Rp.175/kg and the ceiling price at Rp.190/kg. When the market price is down under the floor price, DOLOG purchases the marketed rice and when the price is over the ceiling price, DOLOG sells its stock.

The market prices of major crops are estimated on the data obtained from the agriculture office and the census and statistic office, Kab. Sidrap and Wajo and summarized in Table 2.18 and are also illustrated on Fig. 2.10.

Market flow of major farm inputs such as fertilizers and agrochemicals is broadly divided into two flows; free market flow and controlled market flow. The former is for private estates, and the latter is for BIMAS/INMAS programs which is controlled by the Government. For the farmers under BIMAS/INMAS programs, distribution of fertilizer is mainly handled by P.T. PUSRI, and agro-chemicals and some farm implements are dealt by P.N. PERTANI, the government enterprise in the South Sulawesi Province.

The present farm gate prices of the farm products and the farm inputs in the study area are estimated based on the data obtained from the agricultural offices and through the farm economy survey, as shown in Table 2.19.

2.10 Present Agricultural Production Costs and Values

The studies on the present farming costs were made on the basis of data obtained from agricultural offices of Kab. Sidrap and Wajo and confirmed through the farm economy survey carried out in and around the study area.

The crop production cost comprises the expenses for (1) farm inputs like seeds, fertilizer and agro-chemicals, (2) labour (mainly family labour) and (3) indirect expenses for depreciation for farm houses, farm tools, interest on capital investment, taxes, etc.

The average present production costs are estimated at about Rp.139,600 per ha for paddy and at about Rp.60,400 per ha for polowijo crops, as shown in Tables 2.20 and 2.21.

The annual gross production value under present condition in the study area is estimated at Rp.3,652 million (US$5.8 million) as shown below.

Crops	Annual production	Unit price	Production value
	(tons)	(Rp/kg)	(10^6 Rp.)
1. Paddy	34,000	90	3,060
Wet season paddy	32,000	90	2,880
Dry season paddy	2,000	90	180
2. Polowijo crops	2,550	232	592
Maize	330	66	22
Groundnuts	490	400	196
Greenbeans	1,670	217	362
Soybeans	60	212	12
Total	-	-	3,652

The crop production cost under present condition totals Rp.2,110 million (US$3.4 million), and are summarized as follows:

Crops	Planted area	Unit production cost	Total production cost
	(ha)	(Rp/ha)	(10^6 Rp)
1. Paddy	13,420	-	1,877
Wet season paddy	12,600	139,900	1,763
Dry season paddy	820	139,300	114
2. Polowijo crops	3,600	-	233
Maize	432	33,300	14
Groundnuts	658	81,500	54
Greenbeans	2,453	66,200	162
Soybeans	57	60,700	3
Total	-	-	2,110

The annual net production value under present condition in the study area is then calculated at Rp.1,542 million (US$2.4 million) in total, by deducting the total production costs from the total gross production value, as shown in Table 2.22.

2.11 Land Tenure and Land Holding

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

In the study area, the size of average farms is 1.54 ha, out of which the paddy field accounts for 1.29 ha. This average size is smaller by 0.20 ha as compared with that of the whole province (1.74 ha). According to the IPEDA office of Kab. Sidrap and Wajo, about 48% and 26% of the farmers are owner farmers and partially owner farmers. Tenant farmers account for about 26% as shown in Table 2.23. Tenant systems are complicated but most of them are of share cropping. Tenant charge is generally about 50% of the total products.

Studies on the frequency distribution of the size of farms indicate that farmers with farmland less than 0.5 ha constitute about 42% of the total number of farmers in the study area, as shown in Table 2.24. As the crop incomes of these peasant farmers are not abundant and insufficient to maintain the livelihood of farmers, most of these farmers are engaged in various sideline business.

2.12 Farm Economy

In order to grasp economic activities of farmer in the study area, the farm economy survey was carried out for 46 samples of farm households selected by random sampling method.

At present, the average size farmers in the study area cultivate 1.54 ha of farmland, comprising 1.29 ha of paddy field and 0.25 ha of upland field, as shown in Table 2.25. Farmers in the study area get their income mainly from farming activities particularly from the paddy production, partly supplemented by sales of polowijo crops, as animal husbandry is not a mainline of agriculture in the study area and the income from the sales of livestock is very limited.

Total annual gross farm income is estimated at Rp.427,700 for the average size farmers. The farming expenses are estimated at Rp.68,800 on the average size farm. Accordingly, net farm income is estimated at Rp.358,900. The farm investments on livestock and farm equipment are not generally large in the study area.

According to the results of farm economy survey, the food expenses are most important in the living expenses, as shown in Table 2.26. The annual family living expenses is estimated at Rp. 358,400 in total for the average size family of 5.5 persons. The net reserve of the average size farmer is generally negligibly small as shown in Table 2.27.

3. AGRICULTURAL SUPPORT SYSTEM

3.1 General

The South Sulawesi Province, one of the 27 provinces in whole Indonesia, is administratively divided into 21 Kabupaten (Districts) and 2 Kota Madya (Municipalities), headed by "Bupati" and "Wali Kota" respectively nominated by the Governor of the Province. These

Kabupaten and Kota Madya are subdivided into 169 Kecamatan (Sub-districts) headed by "Camat" nominated also by the Governor. Under the Kecamatan, there are 1,136 Desa (Villages) which are the basic units of administrative structure in Indonesia. One Kecamatan covers about 7 Desa on an average in South Sulawesi Province.

The 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.

(1) Agricultural development
(2) Public health and sanitation
(3) Public education
(4) Village welfare and security
(5) Encouragement of industries and co-operatives, and
(6) Construction, maintenance and repair of public transportation facilities

The Kabupaten Shidrap and Wajo, where the study area are entirely covered, has 8 and 7 Kecamatan and 48 and 32 Desa, respectively. In the study area, 4 Kecamatan and 9 Desa are included.

3.2 BIMAS/INMAS and INSUS Program

As for the agricultural development, the agricultural intensification programs 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 1963.

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

According to the Presidential Decree No.4, 1973, the aims of establishing the village unit are: (a) to assure the realization of agricultural product increasing program, 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 have been set up in each village unit:

(1) At least one Field Extension Worker (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 distribute farm inputs such as seeds, fertilizer, agro-chemicals, farm machinery 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 Man-power, 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 units in the Province is 620 in 1979.

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

In the study area, there are 14 village units with 7 BUUD/KUD, 5 KIOSK and as shown in Table 3.1. As compared with the said general standard of village unit in the study area is far exceeded on size, however on the aspect of functional institution, it has much rooms to be developed. Under these executive units, the BIMAS and INMAS programs has been steadily developed.

The areas served by the BIMAS/INMAS programs in the study area are estimated at about 1,280 ha and 7,740 ha respectively as shown in Table 3.2. About 240 farmer's groups have been organized and about 30% of farmers are served by INSUS program. This low coverage in comparison with about 50% of the whole Indonesia in 1979/80 is mainly due to very fact that there are few notable technical and semi-technical irrigation facilities and insufficient agricultural supporting services in this area.

3.3 Research

The agricultural research work in Indonesia is 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 is located at Maros, about 40 km north from Ujung Pandang. This Branch Research Station has 146 ha of experimental fields of which 110 ha are for rice experimental fields. About 40% of experimental works are devoted to the experiment of rice such as variety test, fertilizer test and test for control of pests and diseases on irrigated paddy. 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, 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 Hasanuddin University, Provincial Agricultural Extension Service and South Sulawesi Branch Research Station.

There are two (2) sub-stations under the control of this Branch Researh station. One is located at Lanrang, Kab. Sidrap and is mainly carrying out the rice experiment with 44 ha of irrigated paddy field.

3.4 Extension Services

In order to promote and accelerate the agricultural extension activities , by the separating extension service from general agricultural administrative services, the Agricultural Extension Service Development Program has been launched in Indonesia since 1974. In the Central Government, the Agency for Agricultural Education, Training and Extension was established as one of the extra-ministerial bureaus under the Ministry of Agriculture. At the same time, in the provincial level, the establishment of the Agricultural Development Center has been promoted with the provision of functions of adaptation tests of new recommended agricultural techniques recommended by research institutions and in-services training for field extension workers. In the Kebupaten level, several Rural Extension Centers have been established as a base camp for extension education activities with functions of preparation of extension program, dissemination of agricultural information and training for leading farmers at the local level.

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

As illustrated on Fig. 3.1, the organization of agricultural extension service in South Sulawesi is formed by two separate lines, i.e. administrative line and operational line under the supervision of inspector of provincial agricultural extension service. The subject-matter specialist (PPS) staying in each Kabupaten assists and advices about ten (10) extension Supervisisors (PPM) of which two (2) to four (4) are working in Kabupaten office and the rests are staying in the Rural Extension Center (BPP) and assist and advise about ten (10) field extension workers (PPL).

Every field extension workers are requested to visit a farmers group in each extension area once a week. There are 16 extension areas under each village unit. The extension worker visits 4 extension areas a day and whole 16 areas during 4 days from Monday to Thursday every week, and receives training on Friday and Saturday. This system is called T.V. system (Training and Visit system).

In the study area, there are two Rural Extension Centers, B.P.P. Tanru Tedong and B.P.P. Anabanua, and total numbers of PPM and PPL are 3 and 13 respectively and cover 14 village units and 116 key farmers, as illustrated on Figs. 3.2 and 3.3.

Taking the future agricultural development into consideration, it is recommended that the practical rice cultivation techniques of field extension workers be much raised up so as to judge and advise properly and timely to the farmers on their Paddy fields.

3.5 Seed Multiplication

The Provincial Seed Center located at Maros about 40 km North from Ujung Pandang is only one institute which produces stock seeds of new recommended varieties of paddy in the South Sulawesi. The foundation seeds supplied from the Central Research Institute of Agriculture (CRIA) are multiplied to the stock seed at this Center. The Seed Center distributes these stock seeds to 37 seed stations managed by each Kabupaten office. There are 3 seed-stations in Kab. Sidrap and Wajo, and are located at Tanru Tedong, Bontouse and Sakkali. These seed stations produce the extension seeds and distribute them to seed growers. The seed growers produce paddy seeds and supply them to the farmers through BUUD/KUD according to the BIMAS/INMAS program. New variety of IR42 was first introduced to Kab. Sidrap in 1978 and Kab. Wajo in 1979, then this variety is used on greater than 40% of total paddy fields. This has evidenced good performances of the seed multiplication program.

3.6 Agricultural Credit

The Indonesia People's Bank (BRI - Bank Rakyat Indonesia) is the state bank specialized in agricultural credit covering whole country and has a broad network composed of many regional offices, branch offices and sub-branch offices (village unit BRI). The bank is authorized to finance BIMAS package credit for farmers. There are several kinds of BIMAS packages. The credit amount is fixed for each BIMAS package as shown in Tables 3.3 and 3.4. The loan condition is fixed at the interest rate of 1% per month and the repayment period of 7 months.

In the study area, there are one branch office and 4 sub-branch offices. The loan amount for BIMAS package has steadily increased and it exceeds Rp. 400 million in 1980/81 in the command area of said 4 sub-branch offices.

3.7 Farm Inputs Supply

Distribution of fertilizers is handled by P.T. PUSRI and agrochemicals is handled by P.N. PERTANI, the government enterprise in the South Sulawesi Province. According to the BIMAS/INMAS program, fertilizers and agro-chemicals are supplied to 4 sub-distributors appointed by P.T. PUSRI at Ujung Pandang and then the necessary amounts of such farm inputs are transported by sub-distributors to the retailers and/or KUD at the local level.

The distribution prices of these agricultural inputs are controlled by the Government. Distribution prices of Urea and TSP to the farmers are fixed at Rp. 70/kg at present.

3.8 Farmers Cooperatives

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

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

In the study area, 7 KUD have been organized so far. These KUD presently cover about 70% of the study area. The total number of KUD members including candidates is about 2,200, which corresponds to about 19% of total farm households in the study area.

3.9 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 (14) at least in the proposed irrigation projects area by the end of the construction of irrigation facilities. In parallel with the establishment of KUD, the number of members of KUD should be expanded to the maximum extent in project area,

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

(3) To raise up the practical rice cultivation technique of the Field Extension Workers (PPL) 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.

(4) To promote the BIMAS/INMAS and the INSUS programme in the project area through the expansion of grouping activities under adequate advise of PPL,

(5) To strengthen the operation of seed station in the project area so as to provide the project-benefited farmers with the necessary quantity of certificated extension seeds, and

(6) To strengthen the agronomic research on irrigated cultivation of paddy and to propagate the recommendable farming practices including new varieties to the farmers through the existing extension channels.

4. BASIC CONCEPT FOR DEVELOPMENT

4.1 Agricultural Constraints

Most of the project area are covered with well developed paddy fields. However, paddy cultivation is generally made under rainfed condition. Irrigation facilities are quite limited in this area. Although there are some Desa irrigation areas, most of the areas are not actually irrigated due to shortage of irrigation water. The cultivation pattern is, therefore, directly affected by seasonal distribution of rainfall. Paddy cultivation is concentrated in the wet season (April/May - August/September) and is very limited in the dry season. The areas under paddy cultivation fluctuate year by year, depending on available rainfall. The Bila area is surrounded with the existing irrigation areas like Sadang and Boya. Only the Bila area has been left behind for irrigation development. The development of the Bila water resources has long been desired by local inhabitants in this area.

There exist about 5,300 ha of imperfectly and poorly drained paddy fields in the project area. Most of them are located in the southwestern part of the project area, near the Lake Buaya and the Bila river. Although paddy is grown in such land, the unit yields are generally low mainly due to poor drainage condition.

In the wet season, road condition becomes muddy and it makes transportation of farm inputs and products so difficult, especially in the imperfectly drained areas and the poorly drained areas mentioned above. The present poor road condition also hampers agricultural activities in this area.

As far as cultivation technique concerned, there are much room for improvement. In the study area, agricultural extension services are not so active. The farmers are not very aware of modern rice farming.

All these constraints keep the present crop yields at low level, with an average unit yield of 2.97 tons/ha for wet season paddy and 2.84 tons/ha for dry season paddy.

The average size of farm in the project area is estimated at 1.54 ha of which 1.29 ha are paddy fields. The farm size is not so small compared with the provincial average of 1.13 ha for paddy field per farm household. However, the study on present farm economy shows present crop income is not sufficient to maintain the livelihood of the farmers, mainly due to low cropping intensity and low crop yields.

There is very limited availability of additional arable land to be newly reclaimed. It means that the farm size of average farmer can not be expanded, and even tends to become smaller with population growth. Under such circumstances, the crop income should be increased through the improvement of land productivity.

The constraints which hinder the improvement of land productivity, are mainfold as mentioned above. The decisive constraint among them is, however, lack of infrastructural facilities like perennial irrigation and drainage systems and farm road network.

4.2 Basic Concept for Development

The project aims at the increase in agricultural production and thereby improvement of the farmer's living standard in the Bila project area through exploitation of new water resources from the Bila and Kalola rivers as well as provision of prerequisite facilities for irrigation and drainage purposes. The project should also contribute to the realization of the government policy for equalization of social welfare in the Bila area and to saving of foreign exchange for imported rice. With this in view, the major concept for agricultural development in the Bila area would be as follows:

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

(2) Planted area of dry season paddy should be increased with year-round irrigation system and thereby total production of paddy be maximized.

(3) Special attention should be given to the increase in irrigation area upto the potential maximum area of 11,200 ha in conformity with Government policy for equalization, as well as for maximum total benefits.

(4) Present drainage condition should be improved to assure the healthy growth of paddy under irrigated condition.

(5) Present farm road network should be improved and the agriculture activities be made more active.

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

5. AGRICULTURAL DEVELOPMENT PLAN

5.1 General

The project area is considerably matured area for agricultural production under rainfed condition with a fixed crop rotation system. Under such condition, the agricultural economy of the area is rather stable and no significant improvement is made unless large scale irrigation project is implemented. The production techniques such as new varieties, more efficient use of fertilizers, prevention of pests and diseases as well as water management techniques are always changing and gradually progressing and certainly lead to change in agricultural production. These changes are, however, neglected in the estimation of possible changes attributable to the Bila Irrigation Project, partly because they have influence on both future conditions with and without the project and partly because the effect of these factors is generally insignificant under rainfed condition.

The future agricultural economy of the project area is forecasted on the conditions reflecting the changes attributable to the Project. Although the agricultural productivity in the Project area may gradually increase to a slight extent even under future without project condition, such changes are disregarded in the analysis of agricultural benefits.

5.2 Change in Land Use

As most of the lands to be covered by the Project are well-developed paddy field, there should be no major changes in kind of crops to be adopted in the area. The rice will remain as the most important crop.

Following the completion of the Bila Irrigation Project, all the paddy field in the Project area will be fully irrigated and more intensive use of the farmland will become possible. The Project will provide the farmers with good opportunities to expand the volume of their farm business.

The present condition of the paddy fields will change with the Project as follows:

(Unit: ha)

Description	Without Project	With Project
1. Gross project area	10,900	10,900
2. Irrigation/drainage canals and farm roads and field borders	600	1,100
3. Paddy fields	10,300	9,800
4. Net irrigation area	-	9,800
5. Area planted	10,300	9,800
6. Area harvested	9,490	9,800

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

5.3 Proposed Cropping Pattern

For formulation of future cropping pattern, the following basic principles which govern the selection of crops and cropping pattern under the Project, have been conceived:

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

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

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

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

In due consideration of the basic principles described above, rice and polowijo crops including green beans, groundnuts, maize and soybeans are selected in making alternative cropping patterns as the major crops.

Rice is the most profitable crop, among other possibly grown crops, under present economic situations. The farmers have long experience for rice cultivation and are likely to master the irrigated rice cultivation and to realize the maximum irrigation benefits under the Project. As Indonesia is still rice import country (annual import of rice is about 1.5 million tons), the increase of rice production will possibly contribute to foreign exchange saving.

Most of polowijo crops do not require much water compared with rice. The growth periods are relatively short. The polowijo crops could be grown in between two crops of paddy. The present low

production of polowijo crops has resulted from poor marketability together with large fluctuation of market prices. Such poor marketability is mainly due to poor quality of product. Generally, green beans, groundnuts, maize and soybeans are profitable and have large market outlet if quality is good enough. After completion of the Project, the polowijo crops could also be grown under the irrigated condition with proper farming practices and therefore it is anticipated that the best quality products are produced.

In order to determine the most optimum cropping pattern, 5 alternatives are considered as follows:

(1) Pattern A: Two crops of paddy a year (early - matured varieties)

(2) Pattern B: Two crops of paddy a year (medium - matured varieties)

(3) Pattern C: Four crops of paddy and one crop of polowijo in 2 years

(4) Pattern D: Three crops of paddy and two crops of polowijo in 2 years

(5) Pattern E: Paddy - Polowijo - Paddy (3 crops a year)

These 5 alternative cropping patterns are illustrated in Fig. 5.1. These alternative cropping patterns are prepared under careful studies on climatic condition, agronomic requirement for farming practices and seasonal water availability. The pattern B is the one proposed by the Master Plan Team and consists of two crops of paddy a year using medium matured varieties with growth period of 140 days per crop. The representative varieties are IR5, IR32, IR34, IR42 and most of local varieties. The pattern A is the modified pattern B, using early matured varieties with growth period of 110 days per crop like IR28, IR36 and IR50. The patterns C, D, and E are combinations including polowijo crops.

For determination of the most optimum pattern, comparative studies on these alternatives are made on the basis of profitability, water requirement and labour requirement for each alternative.

The profitability of each pattern, calculated by net production value per ha per annum, is shown in Table 5.1. The labour requirement for each alternative pattern is estimated on a 10 day basis and compared with available labour force of the average size farmer. The results are given in Fig. 5.2. Water requirement for each pattern is estimated as total farm water requirement per ha per annum under same assumption given in ANNEX VI. The results of the comparative studies are summarized as follows:

Alternative	Cropping Intensity	Profitability	Labour Requirement	Water Requirement
	(%)	(10^3Rp/ha)	(man-day/ha)	($10^3 m^3$/ha)
Pattern A	200	1,400.8	292.1	14.7
Pattern B	200	1,400.8	292.1	17.7
Pattern C	250	1,482.8	331.8	18.3
Pattern D	250	1,217.3	296.7	14.4
Pattern E	300	1,565.9	371.4	18.7

The net production values of each alternative pattern are given in Table 5.1. The pattern E is the most Profitable, followed by the pattern C and the pattern A and B. The pattern D is less Profitable.

The unit net production values per man-day of labour and per m^3 of irrigation water are calculated for each alternative pattern and are shown below:

Alternative	Unit profitability	
	Labour	Water
	(10^3Rp/man-day)	(Rp/m^3 of water)
Pattern A	4.80	95.3
Pattern B	4.80	79.1
Pattern C	4.47	81.0
Pattern D	4.10	84.5
Pattern E	4.22	83.7

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

For selection of most optimum cropping pattern, labour balance study was made; for this purpose, total workable population presently engaged in agricultural sector was first estimated at about 23,500 as shown in Table 5.2. The labour balance study has been made on the basis of this workable population, because there is no possibility to increase the workable population from outside the area due to almost same farming practices adopted in the surrounding areas.

The present extensive farming practices, with low inputs and therefore low output, would be changed to intensive one under irrigated condition. As the total cultivation areas would not change even in future, the unit available labour force per ha under the Project would, therefore, depend on the scale of the Project area, as shown in Table 5.2 and Fig. 5.3. If the Project area is fixed at smaller scale, more intensive cropping will become possible. On the contrary, if the Project area is maximized upto the potential maximum area of about 10,000 ha, only the pattern A, two crops a year, is practicable with the presently available labour force. As seen from Fig. 5.3, the potential maximum areas under each alternative cropping pattern will be estimated as follows:

Alternative	Cropping intensity	Peak labour requirement	Maximum adaptable area
	(%)	(man-day/ha)	(ha)
Pattern A	200	1.73	10,000
Pattern B	200	2.07	8,500
Pattern C	250	2.55	5,700
Pattern D	250	2.00	9,200
Pattern E	300	2.73	5,000

The annual net production values for each alternative pattern are also calculated on the basis of the maximum adoptable areas mentioned above. The pattern A will also bring about the largest values as shown below:

Alternative	Profitability	Maximum adoptable area	Annual net production value
	(10^3Rp/ha)	(ha)	(10^6Rp)
Pattern A	1,400.8	10,000	14,008
Pattern B	1,400.8	8,500	11,907
Pattern C	1,482.8	5,700	8,452
Pattern D	1,217.3	9,200	11,199
Pattern E	1,565.9	5,000	7,830

In the light of the basic principles for the future cropping pattern, the Pattern A is, among the possible alternative patterns, most applicable to the Project. The proposed cropping pattern, together with agro-climatic data, is illustrated on Fig. 5.4.

5.4 Proposed Farming Practices

In due consideration of the diagnosis results of paddy yield survey and also of growth stages of rice plant, the proposed farming practices are studied for the proposed cropping pattern (pattern A: double cropping of paddy). Details of the proposed farm operations are as follows (Fig. 5.5, to be referred):

(1) Seeding and nursery preparation

Early-matured high yielding varieties like IR28, IR36 and IR50 are proposed. The seed requirement is 30 kg per ha. Although the seed treatment is not commonly carried out at present, the paddy seeds to be used will have to be the certificated extension seeds and be selected by using a solution of 1.13 specific gravity before pre-germination. The selected seeds will also have to be disinfected by using adequate seed disinfectant like Benrate. Pre-germination practice is recommendable for increasing the germination percentage.

The nursery has to be prepared as flat as possible. The size of nursery is about 1/20 of the paddy field to be transplanted. Fertilization is essential. The recommendable dosage is 5 kg of Urea per ha. Careful water management is very important for healthy growth of seedlings. The nursery period is 20 days after seeding.

(2) Field preparation

The field preparation is carried out by animal power, at least 10 days before transplanting. Harrowing and puddling works are also required after plowing. The puddling is carried out by animal power. In the project area, there exist sufficient number of oxen and buffaloes for this purpose with 1.45 heads of cattle/buffalo per farm household at present.

(3) Transplanting

Transplanting is made by manual labour with a spacing of 30 cm x 15 cm, which makes the number of hills per m^2 to be 22.2, and planting 2 to 3 seedling per one hill is recommendable. In due consideration of close correlation between numbers of panicles per m^2 and unit yield for dry season paddy, more dense planting is recommendable for the dry season paddy. The irrigation water has to be drained just before transplanting so that transplanting in shallow depth is enforced for accerelating vigorous tillering. Irrigation water is taken into the field again after rooting.

(4) Fertilizer application

Proper application of fertilizer is essential for full exploitation of agricultural potential under irrigated condition. The soils of the project area are generally poor in plant nutrient, especially nitrogen and phosphate. These cheaical element have to be supplemented by fertilization. Considering the soil condition, the suitable fertilizers are urea, triple superphosphate (T.S.P) and potassium chloride (KCl). The total fertilizer requirement for sustaining the target yields would be 200 kg/ha of Urea, 50 kg of T.S.P. and 50 kg/ha KCl. The basic fertilizer application is 65 kg/ha of urea, 50 kg/ha of T.S.P. and 50 kg/ha of KCl when field preparation is practiced. Top dressing is made in 2 times, i.e., just before the maximum tellering stage of about 15 days after transplanting and at the spikelet defferentiation stage corresponding to 20 days before heading. The amount of fertilizer to be applied per ha is about 65 kg of urea at each top dressing time. In the paddy field where the percentage of ripened grains is low, top-dressing with the same dosage of urea at the full heading stage is often quite effective.

(5) Weeding

After transplanting, weeding is carried out in 3 times, depending the conditions of weed growth, by manual operations. For effective operation of weeding, it is recommended that the rotary weeder, being widely used in Java, be introduced in the area. At present, herbicides have been developed for weeding purposes, and their efficiency are

highly acceptable particularly for saving labour. However, as some kind of chemicals are harmful not only for humanbeings, but also to livestock production and the natural environment, careful selection of these chemicals must be made.

(6) Plant protection

As regards the plant protection, intensive application of insecticide is required for control of plant hoppers, stem borers, etc. Considering the life-cycle of these insects, 3 to 4 lit/ha of insecticides are required for 3 to 4 times application during one cropping season. In addition, it would be necessary to apply one lit/ha of fungicides for control of diseases and 100 gr/ha of rodenticide for ratting, for each cropping season. In selecting suitable insecticides and fungicides, chemical toxicity which directly or indirectly affects the humanbeing should be taken into consideration. On this context, carbonate and orgnophosphate, i.e., Diazinon, Sumithion, Dimecron, etc. are recommendable as insecticides and antibiotic chemicals, i.e., Kasumin, Kasuraboide, etc. as fungicides and Zinc Phosphate as rodenticide. It is recommended that plant protection works should be carried out in a systematic way through the farmer's cooperatives. Individual protection is not recommended because insects and diseases are not limited to the individual from which will be re-infected unless protection is undertaken on as wide an area as possible.

Basical plant protection, however, is to increase the healthiness of the plant. If the rice plant is quite healthy it would be hardly suffered from diseases and insect pests. In this sense, it is essential to make the leaves of the plant pale during the period from 43 days to 20 days before heading, as shown in Fig. 2.7, and furthermore to increase the healthiness of roots by practicing soil drying.

(7) Harvesting

Harvesting is carried out by manual labour. The harvested paddy is dried on the ground. In future, artificial dryers will have to be considered because a lot of harvested grains are presently damaged by unexcepted rains. For threshing, use of treadle thresher, instead of traditional hand threshing, is recommendable.

5.5 Anticipated Crop Yield and Crop Production

After completion of the Project, the present paddy yields (wet season paddy: 2.97 tons/ha, dry season paddy: 2.84 tons/ha) are stabilized and increased. The anticipated crop yields are estimated at 5.0 tons of dried paddy (gabah) per ha for both wet season paddy and dry season paddy under future with project condition. These unit yields are rather conservatively estimated on the basis of statistical data on crop yields obtained from the Provincial Agricultural Extension Service, South Sulawesi and the results of paddy yield survey carried

out by the Team. As seen from the Table 2.11, the paddy yield survey shows that the average unit yield of paddy in the Sadang irrigation area is 5.97 tons per ha. The unit yield for past 7 years from 1974 to 1980 in the Kecamatan Dua Pitue where the Bulu Cenrana irrigation project exists, average 5.11 tons per ha over the total area of about 55,000 ha. It is also reported that in the whole South Sulawesi, the average unit yield of paddy under INSUS program where irrigation facilities are provided, was 5.90 tons per ha in 1979/80. The anticipated unit yield of paddy under the Project is therefore rather conservative.

Based on the proposed cropping pattern, the cropped area, crop yields and total crop production under both "with project" and "without project" conditions are estimated as follows:

Crops	Without	With	Increment
1. Harvested area (ha)			
Wet season paddy	9,490	9,800	310
Dry season paddy	590	9,800	9,210
Polowijo crops	2,720	-	-2,720
2. Unit Yield (tons/ha)			
Wet season paddy	2.97	5.00	2.03
Dry season paddy	2.84	5.00	2.16
Polowijo crops	0.73	-	-
3. Production (tons)			
Wet season paddy	28,190	49,000	20,810
Dry season paddy	1,680	49,000	47,320
Polowijo crops	1,990	-	-1,990

The annual paddy production at full development stage would amount to 98,000 tons of dried paddy. The expected annual increment of paddy production would be about 68,000 tons as shown in Table 5.4.

5.6 Marketing and Price Forecast

(1) Marketing

Indonesia is still rice import country. In recent six years, about 1.5 million tons of rice were imported on an average as shown below:

(Unit: 10^3 ton)

1974	1975	1976	1977	1978	1979	Average
1,132	693	1,301	1,973	1,842	1,922	1,477

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

The South Sulawesi Province is one of the largest rice surplus provinces in Indonesia. Total production of paddy in the Province is estimated at about 2,395,000 tons in 1979/80, and on the contrary the total consumption is about 1,333,000 tons with the surplus of 1,062,000 tons. It is reported that the rice surplus conditions increasingly continue in the Province. The Project area is also one of the rice supply regions in the province. The annual surplus is estimated around 16,000 tons of dried paddy in total, 1.4% equivalence of the surplus rice of the province. Most of these surplus rice are transported to the rice-deficit regions, and even other provinces.

There are 7 provinces under the jurisdiction of South Sulawesi DOLOG, among which only the South Sulawesi Province produces the surplus rice; other provinces are subject to serious deficits of rice. The total deficit in all the jurisdictions of DOLOG is estimated at about 780,000 tons. With the completion of the project, about 72,000 tons of paddy would be marketed to these rice-deficit regions; this marketable amounts are equivalent to about 7% of the surplus-rice of the province.

The present capacity of rice mills will be insufficient for processing the increased paddy production at the full development stage of the project. Moreover, most of the existing milling facilities are one-pass system which simultaneously carry out two processes of husking and whitening and produce a lot of broken rice. The increase and improvement of these facilities have to be gradually made together with improvement of drying practices for attainment of better marketability.

(2) Price forecast

The market prices of milled rice, dried paddy and polowijo crops in Kab. Wajo and Sidrap, together with those in South Sulawesi, are shown in Table 5.5. The projected retail price of dried paddy to 1981 is calculated by using these past 5 years data. The projected retail prices of dried paddy in 1981 are Rp. 124,000/ton in Kab. Wajo, Rp. 124,040/ton in Kab. Sidrap and Rp. 143,480/ton in whole South Sulawesi.

For financial evaluation, the average projected farm gate price of dried paddy at Rp. 93,000/ton for Kab. Wajo and Sidrap in 1981 will be used. The market prices of polowijo crops largely fluctuate year by year, as shown in Fig. 2.10. The financial farm gate prices of polowijo crops are estimated based on the past 5 years data at Rp. 66,670/ton for maize, Rp. 443,840/ton for groundnuts, Rp. 262,550/ton for greenbeans and Rp. 197,780/ton for soybeans in 1981. The financial farm gate prices of farm products and farm inputs are summarized in Table 5.6.

The economic farm gate prices of farm products and farm inputs are calculated based on the projected international market prices forcasted by IBRD in the long term range for the period of 1981 to 1990, as summarized in Table 5.7.

The increased production of paddy after the completion of the Project would be marketed in domestic markets in Indonesia, as the substitute of import rice. In this meaning, import substitution price of paddy is forecasted for the economic evaluation. The economic farm gate price of dried paddy is thus estimated at Rp. 200,000/ton, as shown in Table 5.8.

The economic farm gate prices of polowijo crops are estimated at Rp. 113,400/ton for maize, Rp. 357,000/ton for groundnuts, Rp. 339,800/ton for greenbeans and Rp. 285,800/ton for soybeans. The details of the calculation are given in Table 5.9.

The economic farm gate prices of farm inputs, i.e., furtilizer, agrochemicals and others, are shown in Table 5.10.

5.7 Crop Production Cost

The crop production costs of paddy and polowijo crops are estimated for both future with and without project conditions. The present agricultural condition would not be changed significantly unless a new irrigation project could be implemented. For the estimation of production cost under without project condition, therefore only unit prices of production expenses are forecasted by using the economic farm gate prices of farm inputs, without changing the unit requirement for farm inputs and labour. The estimated crop production costs without project condition are about Rp. 224,500 per ha for wet season paddy, Rp. 205,400 for dry season paddy and Rp. 90,900 for polowijo crops.

After implementation of the Bila Irrigation Project, the crop production cost would increase upto about Rp. 294,500 per ha for wet season paddy, Rp. 304,700 for dry season paddy and Rp. 165,900 for polowijo crops. This anticipated increase is primarily attributable to the increase of expenses for fertilizers, agro-chemicals and labour.

The crop production costs under with and without project condition are shown in Tables 5.11, 5.12 and 5.13.

5.8 Net Production Values per Ha without and with Project

The annual net crop production value without project is estimated at about Rp. 389,000 (US$ 624/ha) per ha on the basis of the forecasted unit yields and prices of crops and production costs aforementioned. after completion of the Project, the annual net crop production value will amount to Rp. 1,401,000 (US$ 2,241/ha) per ha at the full development stage. The primary increased production value after the build-up period will be Rp. 1,011,000 (US$ 1,617/ha) per ha per annum. The details are given in Table 5.14.

6. IRRIGATION BENEFITS AND PAYMENT CAPACITY

6.1 Irrigation Benefits

The irrigation benefits of the Bila Irrigation Project are primarily derived from the increased crop production attributable to stable irrigation water supplies. These benefits are estimated as the difference of the annual net crop production values under future with and without the project conditions. The net production value is defined as the difference between the gross production value and the crop production cost. The crop production under future without project condition has been estimated on the basis of actual yields and production data in the past five years from 1976 to 1980. The crop area damaged by floods, drought, insects and rodents, which corresponds to about 8% of the total area is conservatively deducted from the crop planted area under without project condition.

The irrigation development for the whole Project area will be completed by the end of 1990. After about 5 years of build-up period, the full development stage will be attained in 1994. The increased crop production value at full development stage is estimated at Rp. 9,709 million (US$ 1,585/ha) per annum.

After the completion of the irrigation development, the existing about 400 ha of the paddy field in the reservoir area of the proposed Kalola dam are submerged under the reservoir water and become non-productive. These losses on account of the Project should be deducted from the aforementioned incremental crop production value with the project. These losses are estimated at approximately Rp. 157 million (US$ 25/ha) per annum.

The losses of farmland for project facilities totals about 500 ha. These losses or negative benefits are counted in the estimate of the primary incremental production value by deducting these areas from the paddy field under future with project condition.

The annual direct benefits amount to about Rp. 9,552 million (US$ 1,560/ha) at the full development stage of the Project, deducting the losses in the reservoir area. The detail of calculation is given in Table 6.1.

6.2 Farm Budget Analysis and Payment Capacity

For evaluating the Project feasibility from the viewpoint of the farmer's economy, farm budget analysis is made on the average size farm under both the future without and with project conditions, as shown in Table 6.2.

Payment capacity is the ability of farmers to bear the expenses required for development of irrigation facilities. Such capacity is measured by the increase of net disposable income which the project

benefited farmers can earn annually from the Project. With the completion of the Project, the net reserve of payment capacity increases from Rp. 1,190 to Rp. 302,810 (US$ 484) per annum at full development stage.

The increased net reserve would offer incentives for further development to the farmers, and the substantial payment capacity would enable them to pay some charges for irrigation water.

Table 1.1 List of References

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Table 2.1 Present Demographic Condition in the Study Area (1980)

Kab. Kec. Desa	Area	Total Population	Population		Total Household	Average Density	Average Family Size	Total Farm Household
			Male	Female				
	(Km^2)					(persons/Km^2)		
Kab. Sidrap								
Kec. Dua Pitue								
Tanru Tedong	35	16,346	7,590	8,756	2,981	467	5.5	2,127
Bila	102	9,994	4,773	5,221	1,779	98	5.6	1,570
Kab. Wajo								
Kec. Tanasitolo								
Nepo	28	11,319	5,284	6,035	2,085	400	5.4	1,153
Tancung	33	9,276	4,295	4,981	1,871	237	5.0	1,638
Lowa	48	6,552	3,056	3,496	1,257	137	5.2	962
Kec. Maniangpajo								
Anabanua	56	8,058	3,758	4,300	1,398	146	5.8	1,070
Kalola	77	4,647	2,231	2,416	726	60	6.4	537
Kec. Belawa								
Wele	34	8,083	3,830	4,253	1,494	236	5.4	1,076
Belawa	31	9,682	4,510	5,172	1,794	315	5.4	1,449
Total	444	83,957	39,327	44,630	15,385	190	5.5	11,582

Source: Desa offices in the study area.
Bupati offices and Census and Statistics offices, Kab. Sidrap and Wajo.

Remark: The figures include the data in and around the study area.

Table 2.2 Population Growth in the Study Area

Kab. Kec. Desa.	Year										Growth Rate (%)
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	
Kab. Sidrap											
Kec. Dua Pitue											
Tanru Tedong	14,492	14,522	14,612	14,666	14,739	14,931	15,245	15,367	15,417	16,346	1.13
Bila	7,800	7,825	7,916	8,063	8,164	8,725	8,974	9,078	9,166	9,994	1.28
Kab. Wajo											
Kec. Tanasitolo											
Nepo	9,900	8,750	8,984	9,102	9,384	10,036	10,215	10,619	11,474	11,319	1.14
Tancung	6,313	6,419	6,609	6,793	6,989	7,185	7,339	7,595	8,276	9,276	1.47
Lowa	5,193	5,267	5,583	5,610	5,747	5,962	6,064	6,098	6,175	6,552	1.26
Kec. Maniangpajo											
Anabanua	6,386	6,444	6,616	6,703	6,910	7,390	7,596	7,518	7,490	8,058	1.26
Kalola	2,109	3,051	3,132	3,173	3,271	3,498	3,578	3,501	3,460	4,647	2.20
Kec. Belawa											
Wele	6,576	7,207	7,222	6,460	7,196	7,563	7,587	7,581	7,242	8,083	1.23
Belawa	9,435	9,434	9,435	9,432	9,514	11,902	11,907	11,906	10,291	9,682	1.03
Total	68,204	68,919	70,109	70,002	71,914	77,192	78,505	79,263	78,991	83,957	1.23

Source: Desa offices in the study area.
Bupati offices and Census and Statistics offices, Kab. Sidrap and Wajo.

Remark: The figures include the data in and around the study area.

Table 2.3 Population by Age Group in the Study Area (1980)

Kab. Kec. Desa	0 - 14			15 - 49			50 -			Total Population
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
Kab. Sidrap										
Kec. Dua Pitue										
Tanru Tedong	3,412	3,555	6,967	3,456	4,428	7,884	722	773	1,495	16,346
Bila	2,263	2,094	4,357	1,977	2,508	4,485	533	619	1,152	9,994
Kab. Wajo										
Kec. Tanasitolo										
Nepo	2,616	1,629	4,245	2,153	3,048	5,201	515	1,358	1,873	11,319
Tancung	1,867	1,854	3,721	1,892	2,477	4,369	536	650	1,186	9,276
Lowa	1,611	916	2,527	1,170	1,918	3,088	275	662	937	6,552
Kec. Maniangpajo										
Anabanua	1,903	1,962	3,865	1,454	1,864	3,318	401	474	875	8,058
Kalola	1,087	1,086	2,173	854	1,072	1,926	290	258	548	4,647
Kec. Belawa										
Wele	1,872	1,707	3,579	1,509	2,049	3,558	449	497	946	8,083
Belawa	2,106	1,983	4,089	1,803	2,582	4,385	601	607	1,208	9,682
Total	18,737	16,786	35,523	16,268	21,946	38,214	4,332	5,898	10,220	83,957
(%)	(22.3)	(20.0)	(42.3)	(19.4)	(26.1)	(45.5)	(5.1)	(7.0)	(12.1)	(100.0)

Source: Desa offices in the study area.
Bupati offices and Census and Statistics offices, Kab. Sidrap and Wajo.

Remark: The figures include the data in and around the study area.

Table 2.4 Present Land Use in the Study Area

(Unit: ha)

Kab. Kec. Desa	Farm Land				Others		Total Area
	Paddy	Upland	Orchard, Estate crop	Total	Forest/ Grass-land	Village/ Others	
Kab. Sidrap							
Kec. Dua Pitue							
Tanru Tedong	1,455	30	35	1,520	110	105	1,735
Bila	2,995	65	335	3,390	1,010	60	4,460
Kab. Wajo							
Kec. Tanasitolo							
Nepo	290	90	100	480	300	75	855
Tancung	630	60	115	805	350	65	1,220
Lowa	1,660	125	120	1,905	360	45	2,310
Kec. Maniangpajo							
Anabanua	2,260	60	145	2,465	440	50	2,955
Kalola	1,930	40	275	2,245	830	25	3,100
Kec. Belawa							
Wele	1,925	90	50	2,065	150	50	2,265
Belawa	560	140	85	785	250	65	1,100
Total	13,700	700	1,260	15,660	3,800	540	20,000

Source: This table is elaborated base upon the data collected from each village offices and the interpretation of the aerial photos and the topographic maps on a scale of 1/25,000 taken by JICA in September, 1978.

Table 2.5 Planted, Harvested and Damaged Areas of Paddy and Polowijo Crops in the Study Area

(Unit: ha)

Crops	Planted Area	Harvested Area	Damaged Area
Wet Season Paddy			
1976	12,000	8,410	3,590
1977	12,770	9,530	3,240
1978	12,870	12,140	730
1979	12,330	11,700	630
1980	13,040	12,190	850
Average	12,600	10,800	1,800
Dry Season Paddy			
1975/76	800	680	120
1976/77	680	550	130
1977/78	990	900	90
1978/79	1,190	1,120	70
1979/80	430	400	30
Average	820	730	90
Polowijo Crops			
1976	1,090	985	105
1977	2,350	2,255	95
1978	3,740	3,670	70
1979	4,780	4,760	20
1980	5,980	5,770	210
Average	3,600	3,500	100

Source: Agriculture offices, Kab. Sidrap and Wajo Kec. and Desa offices in the study area

Table 2.6 Present Crop Rotation Patterns in the Study Area

Crop Rotation Pattern	Cropping Intensity	Area	Proportion
	(%)	(ha)	(%)
1. Paddy - (fallow) (1 crop a year)	90 - 100	10,000	73.0
2. Paddy - Paddy or Polowijo Crops (2 crops a year)	100 - 120	700	5.1
3. Paddy - Polowijo Crops (2 crops a year)	125 - 150	2,800	20.4
4. Paddy - Polowijo Crops - Polowijo Crops (3 crops a year)	150 - 170	200	1.5
Total	124 (Average)	13,700	100.0

Source: Agriculture offices, Kab. Sidrap and Wajo
Information collected from villege offices and the field survey

Table 2.7 Planted Areas by Different Paddy Varieties in Kab. Sidrap/Wajo (1979)

Varieties/Kecamatan	Dua Pitue		Tanasitolo		Maniangpajo		Belawa	
	W.S.P	D.S.P	W.S.P	D.S.P	W.S.P	D.S.P	W.S.P	D.S.P
1. High Yielding Variety (new)								
IR - 20	-	-	-	-	-	-	-	-
IR - 26	-	140	771	-	850	-	594	-
IR - 28	1,770	204	192	-	750	-	995	-
IR - 29	272	77	78	-	430	-	105	-
IR - 30	159	97	577	-	500	-	1,185	-
IR - 31	-	-	-	-	59	-	63	-
IR - 32	1,989	2,697	385	-	1,543	-	166	-
IR - 34	27	360	-	-	-	-	-	-
IR - 36	1,476	150	770	-	1,640	-	323	-
IR - 38	28	161	-	-	450	-	-	-
IR - 40	828	-	-	-	-	-	849	-
IR - 42	4,608	277	39	-	400	-	-	-
Sub-total	11,157	4,163	2,812	-	6,622	-	4,280	-
2. High Yielding Variety (old)								
IR - 5	-	-	-	-	-	-	-	-
Asahan	-	59	193	-	275	-	-	-
Citarum	2	50	192	-	650	-	20	-
Berantas	436	37	38	-	100	-	60	-
Seravu	241	31	114	-	43	-	5	-
Cisadane	-	-	-	-	-	-	-	-
C4 - 63	161	-	65	-	23	-	132	-
Sub-total	840	177	602	-	1,091	-	217	-
3. Local Variety								
B4 - 62C	283	-	-	-	-	-	157	-
Pulut	64	5	-	-	286	-	4,603	-
Sub-total	347	5	-	-	286	-	4,760	-
Total	12,344	4,345	3,414	-	7,999	-	9,257	-

Source : Agriculture offices in Kab. Sidrap and Kab. Wajo, 1980

Remarks: W.S.P = Wet Season Paddy
D.S.P = Dry Season Paddy

Table 2.8 Planted Areas by Different Paddy Varieties in Kab. Sidrap/Wajo (1980)

Varieties/Kecamatan	Dua Pitue		Tenasitolo		Maniangpajo		Belawa	
	W.S.P	D.W.P	W.S.P	D.S.P	W.S.P	D.S.P	W.S.P	D.S.P
1. High Yielding Variety (new)								
IR - 20	-	-	179	-	-	-	-	-
IR - 26	-	-	150	-	-	-	160	-
IR - 28	189	196	148	-	300	-	1,270	-
IR - 29	31	120	112	-	-	-	150	-
IR - 30	15	15	236	-	-	-	838	-
IR - 31	-	-	-	-	25	-	-	-
IR - 32	460	745	112	-	471	-	-	-
IR - 34	4	4	-	-	-	-	-	-
IR - 36	151	154	354	-	-	-	403	-
IR - 38	172	220	-	-	125	-	-	-
IR - 40	1,806	2,362	-	-	-	-	-	-
IR - 42	5,144	8,052	2,402	-	6,284	-	1,616	-
Sub-total	7,972	11,868	3,693	-	7,205	-	4,437	-
2. High Yielding Variety (old)								
IR - 5	-	-	-	-	-	-	-	-
Asahan	-	-	5	-	-	-	-	-
Citarum	19	19	-	-	33	-	-	-
Berantas	16	16	-	-	-	-	-	-
Serayu	16	16	-	-	-	-	-	-
Cisadane	-	-	3	-	14	-	15	-
C4 - 63	-	-	112	-	-	-	-	-
Sub-total	51	51	120	-	47	-	15	-
3. Local Variety								
B4 - 62C	-	-	-	-	-	-	-	-
Pulut	27	48	27	-	10	-	-	-
Sawe	-	-	99	-	-	-	101	-
Sub-total	27	48	126	-	10	-	101	-
Total	8,050	11,967	3,939	-	7,262	-	4,553	-

Source : Agriculture offices in Kab. Sidrap and Kab. Wajo, 1981

Remarks: W.S.P = Wet Season Paddy
D.S.P = Dry Season Paddy

Table 2.9 Unit Farm Inputs and Labour Requirement per Ha under Present Cultivation

Description		Paddy Cultivation		Polowijo Crops Cultivation			
		W.S.P./1	D.S.P./2	Maize	Groundnuts	Green beans	Soy beans
1. Farm Input							
(1) Seed (kg)		25-30	25-30	20-30	50-80	25-35	25-35
(2) Fertilizer	Urea (kg)	100	100	-	50	50	-
	T.S.P. (kg)	50	-	-	-	-	-
(3) Agro-Chemical	Insecticide (ℓ)	2.0	1.0	-	2.0	2.0	2.0
	Rodenticide (ℓ)	0.1	-	-	-	-	-
2. Labour (man/day)							
(1) Nursery Preparation		4.7	4.7				
(2) Plowing	(Land Preparation)/3	11.3	12.3	6.0	8.0	7.0	8.0
(3) Harrowing/Puddling		13.6	14.5				
(4) Transplanting	(Seeding/Planting)/3	25.7	25.7	4.0	6.0	10.0	6.0
(5) Weeding		11.9	14.5	14.0	20.0	20.0	20.0
(6) Fertilizer Application		3.0	2.0	-	1.0	1.0	-
(7) Chemical Application		3.0	2.0	-	4.0	4.0	4.0
(8) Harvesting		18.0	17.0				
(9) Threshing	(Harvesting)/3	14.0	12.3	14.0	22.0	22.0	22.0
(10) Drying		4.0	3.6				
(11) Transportation		9.2	8.0	3.0	3.0	2.5	2.5
(12) Water Management		1.5	2.0	1.0	1.0	1.0	1.0
Total		119.9	118.6	42.0	63.0	67.5	59.5
3. Miscellaneous							
Bags, mats, tools, etc.		about 12% of total production cost		about 10% of total production cost			

Remarks: /1 ; Wet Season Paddy
/2 ; Dry Season Paddy
/3 ; Work item for Polowijo crops cultivation

Source: Agriculture offices in Kab. Sidrap and Wajo
Data collected by the field survey

Table 2.10 Results of Paddy Yield Survey
(Bila Irrigation Area)

Sampling Place	Sample No.	Nos. of Hills per m^2	Nos. of Panicles per Hill	Nos. of Grains per Panicles	Total Nos. of Grains per m^2	1,000 Grains Weight (gr)	% of Ripened Grains	Unit Yield (ton/ha)
Kec. Dua Pitue								
Desa Tanru Tedong	B 1	10.3	23.3	98.2	23,567	21.3	76.1	3.82
	B 2	8.2	25.7	114.7	24,193	22.7	75.9	4.17
	B 3	11.0	22.3	92.5	22,690	21.2	68.8	3.31
Desa Bila	B 4	15.0	17.1	82.9	21,140	21.9	70.6	3.27
	B 5	18.6	15.7	96.9	28,297	20.4	38.2	2.21
	B 6	12.8	18.5	105.9	25,077	22.8	51.1	2.92
	B 7	16.3	21.3	67.1	23,296	20.8	67.3	3.26
	B 8	14.2	14.3	98.1	19,920	21.4	79.8	3.40
	B 9	15.3	14.2	88.5	19,228	22.0	76.1	3.22
Kec. Belawa								
Desa Wole	B10	9.2	29.9	82.0	22,557	21.5	67.2	3.26
	B11	10.9	18.3	95.6	19,069	21.6	83.9	3.46
	B12	10.6	22.9	99.8	24,225	22.0	79.8	4.25
	B13	10.3	23.6	75.3	18,303	21.8	64.5	2.57
	B14	11.5	20.9	74.9	18,002	20.2	78.3	2.85
	B15	14.6	15.6	82.8	18,858	21.8	80.2	3.30
Kec. Maniangpajo								
Desa Anabanua	B16	14.7	20.7	82.4	25,073	22.0	66.6	3.67
	B17	12.3	24.8	82.0	25,013	21.1	73.2	3.86
	B18	11.5	24.1	85.2	23,613	21.8	71.1	3.66
	B19	13.8	20.4	86.6	24,380	22.6	72.2	3.98
	B20	12.4	22.0	78.0	21,278	19.8	55.6	2.34
	B21	15.6	19.0	72.6	21,519	19.8	64.2	2.74
	B22	15.0	18.5	97.5	27,056	22.6	66.3	4.05
	B23	12.6	24.3	100.3	30,710	20.9	73.5	4.72
	B24	11.3	23.8	110.0	29,583	22.4	70.1	4.65
	B25	12.3	24.3	92.9	27,767	20.1	62.8	3.50
	B26	13.8	28.3	45.8	17,887	22.8	55.6	2.27
Desa Kalola	B27	12.3	20.1	88.3	21,830	21.9	77.5	3.71
	B28	15.0	14.0	90.3	18,968	21.7	92.0	3.78
	B29	14.4	21.9	82.3	25,954	23.1	75.7	4.53
	B30	11.2	24.9	110.2	30,732	22.0	69.2	4.68
	B31	12.3	17.6	69.0	14,937	22.6	75.0	2.53
	B32	12.6	18.1	81.9	18,678	21.3	73.2	2.91
	B33	18.5	20.0	70.2	25,974	21.7	68.3	3.85
	B34	19.6	22.8	62.0	27,706	21.1	52.9	3.09
Dec. Tanasitolo								
Desa Nepo	B35	16.6	19.5	90.1	29,165	20.8	56.3	3.43
Desa Tancung	B36	16.6	16.0	89.3	23,718	21.8	62.1	3.21
Desa Lowa	B37	21.6	11.3	101.4	24,177	22.8	79.1	4.36
Average		13.6	20.5	87.1	23,355	21.6	69.5	3.48

Table 2.11 Results of Paddy Yield Survey
(Sadang Irrigation Area)

Sampling Place	Sample No.	Nos. of Hills per m^2	Nos. of Panicles per Hill	Nos. of Grains per Panicle	Total Nos. of Grains per m^2	1,000 Grains Weight (gr)	% of Ripened Grains	Unit Yield (ton/ha)
Sadang Area	S 1	20.2	18.0	100.9	36,687	21.1	64.7	5.01
	S 2	19.5	18.7	94.8	34,567	22.0	79.0	6.01
	S 3	16.2	17.7	118.0	33,835	21.6	77.2	5.64
	S 4	17.8	15.0	112.1	29,931	21.1	70.3	4.44
	S 5	17.6	16.4	94.8	27,363	22.8	79.8	4.98
	S 6	19.2	18.3	108.0	37,947	19.8	81.3	6.11
	S 7	18.4	22.4	130.2	53,663	22.0	64.2	7.58
	S 8	19.8	19.1	118.0	44,625	20.7	73.0	6.74
	S 9	21.6	16.8	103.2	37,449	21.6	73.8	5.97
	S10	19.8	19.5	79.7	30,772	20.6	85.2	5.40
	S11	21.8	18.8	104.3	42,746	20.7	74.5	6.59
	S12	21.0	19.3	105.0	42,556	20.2	71.0	6.10
	S13	24.4	17.2	80.2	33,658	21.4	75.9	5.47
	S14	23.2	17.7	90.2	32,933	21.9	81.2	5.86
	S15	16.0	26.3	80.6	33,916	20.9	81.5	5.78
	S16	19.2	18.5	109.6	38,930	21.1	85.7	7.04
	S17	20.4	17.4	108.8	38,620	21.0	82.3	6.67
	S18	21.2	19.6	93.0	38,643	22.6	73.3	6.40
	S19	25.2	16.9	107.9	45,952	20.9	68.5	6.58
	S20	22.1	17.5	118.2	45,714	21.5	74.2	7.29
	S21	24.4	16.3	86.3	34,323	20.8	77.2	5.51
	S22	19.2	16.4	98.5	31,016	20.5	66.5	4.23
Average		20.4	18.3	101.9	37,538	21.2	75.5	5.97

Table 2.12 Result of Paddy Yield Survey
(Dry season paddy)

Variety	Sampling Place (Desa/Kecamatan)	Nos. of Hills per m^2	Nos. of Panicles per Hill	Nos. of Grains per Panicle	Total Nos. of Grains per m^2	1,000 Grains Weight (gr)	% of Ripened Grains	Unit Yield (ton/ha)
C4 - 63	Baru/Lalabata	15.2	10	61.4	9,333	21.5	69.2	1.39
IR - 30	Labessi/Marioriwawo	20.0	22	57.7	25,388	24.7	53.9	3.38
IR - 30	Galung/Liliriaja	17.3	26	115.9	52,132	21.1	73.6	8.12
IR - 32	Otting/Dua Pituc	18.8	20	75.8	28,501	23.7	77.6	5.23
Local 46	Otting/Dua Pituc	15.3	14	120.4	25,790	22.5	75.0	4.40
IR - 32	Lanairang/Dua Pituc	15.3	23	90.6	31,882	24.3	80.3	6.22
IR - 26	Baru/Lalabata	16.0	20	114.6	36,672	21.3	64.5	5.03
IR - 26	Baru/Lalabata	16.0	17	99.8	27,146	20.8	73.7	4.17
IR - 5	Patangkai/Lappariaja	13.4	21	67.3	18,938	21.9	77.0	3.21
IR - 5	Samaenre/Lappariaja	21.0	15	65.6	20,664	22.7	76.5	3.59
C4 - 63	Maddumpa/Lalabata	16.0	15	63.1	15,144	22.1	70.4	2.35
IR - 26	Attangsolo/Marioriawa	21.8	26	104.8	59,401	21.0	66.4	8.29
IR - 5	Jenreng Palie/Lappariaja	16.0	16	105.1	26,906	26.8	76.2	5.49

Source: Supporting Report (volume 2) of Master Plan for The Central South Sulawesi Water Resources Development Project, JICA, March 1980.

Table 2.13 Unit Yields of Paddy in the Study Area

(Unit: Dried Paddy ton/ha)

Kab. Kec. Desa	Wet Season Paddy						Dry Season Paddy					
	1976	1977	1978	1979	1980	Average	1975/76	1976/77	1977/78	1978/79	1979/80	Average
Kab. Sidrap												
Kec. Dua Pitue												
Tanru Tedong	2.66	2.63	2.66	2.85	3.88	2.94	2.91	2.93	2.95	2.95	3.67	3.07
Bila	1.82	2.67	2.67	2.88	3.91	2.79	3.07	3.00	2.95	2.95	3.62	3.11
Kab. Wajo												
Kec. Tanasitolo												
Nepo	+	1.93	2.26	3.02	3.30	2.63	+	3.25	1.56	3.60	2.88	2.82
Tancung	2.71	2.71	2.71	3.38	3.60	3.02	-	-	1.70	3.07	2.78	2.53
Lowa	2.58	1.91	3.23	3.46	3.86	3.01	-	2.58	1.79	3.19	3.30	2.71
Kec. Maniangpajo												
Anabanua	2.19	2.45	1.86	3.12	3.31	2.59	+	+	+	3.05	3.00	3.02
Kalola	2.35	2.19	2.65	3.45	3.67	2.87	+	+	+	-	2.75	2.75
Kec. Belawa												
Wele	2.97	2.80	3.59	3.82	4.18	3.47	2.14	2.69	3.30	3.07	-	2.80
Belawa	2.97	2.80	3.60	3.82	4.11	3.46	2.14	2.69	3.31	3.07	-	2.80
Average	2.53	2.45	2.80	3.31	3.76	2.97	2.57	2.86	2.52	3.12	3.13	2.84

Source: Agriculture offices, Kab. Sidrap and Wajo
Kecamatan offices, Dua Putue, Tanasitolo, Maniangpajo and Belawa

Table 2.14 Paddy Production in the Study Area
(1976 - 1980, Average)

Kab. Kec. Desa	Wet Season Paddy			Dry Season Paddy			Annual /1 Production (tons)
	Harvested Area (ha)	Unit Yield (tons/ha)	Production /1 (tons)	Harvested Area (ha)	Unit Yield (tons/ha)	Production /1 (tons)	
Kab. Sidrap							
Kec. Dua Pitue							
Tanru Tedong	1,150	2.94	3,380	345	3.07	990	4,370
Bila	2,360	2.79	6,860	40	3.11	120	6,980
Kab. Wajo							
Kec. Tanasitolo							
Nepo	230	2.63	610	10	2.82	30	640
Tancung	490	3.02	1,480	35	2.53	90	1,570
Lowa	1,310	3.01	3,950	55	2.71	150	4,100
Kec. Maniangpajo							
Anabanua	1,780	2.59	4,610	5	3.02	15	4,625
Kalola	1,520	2.87	4,370	5	2.75	15	4,385
Kec. Belawa							
Wele	1,520	3.47	5,280	120	2.80	340	5,620
Belawa	440	3.46	1,530	115	2.80	320	1,850
Total	10,800	2.97	32,070	730	2.84	2,070	34,140

Remarks: The paddy production is estimated based on the figures in Tables 2.5 and 2.13.

/1: Dried Paddy

Table 2.15 Harvested Area, Unit Yield and Production of Polowijo Crops in the Study Area
(1979 - 1980 average)

Kab. Kec. Desa	Maize			Groundnuts			Green beans			Soy beans		
	Harvested Area (ha)	Unit Yield (ton/ha)	Production (ton)	Harvested Area (ha)	Unit Yield (ton/ha)	Production (ton)	Harvested Area (ha)	Unit Yield (ton/ha)	Production (ton)	Harvested Area (ha)	Unit Yield (ton/ha)	Production (ton)
Kab. Sidrap												
Kec. Dua Pitue												
Tanru Tedong	44	0.77	33	18	0.65	12	460	0.62	285	-	-	-
Rila	92	0.76	70	42	0.68	29	470	0.79	371	-	-	-
Kab. Wajo												
Kec. Tanasitolo												
Nepo	5	0.97	5	4	0.93	4	45	0.71	32	-	-	-
Tancung	7	0.91	6	18	0.83	15	68	0.75	51	-	-	-
Lowa	18	0.81	15	8	0.87	7	280	0.79	221	-	-	-
Kec. Maniangpajo												
Anabunua	17	0.56	10	180	0.54	97	280	0.42	119	-	-	-
Kalola	36	0.56	20	5	0.69	4	248	0.42	105	55	1.00	60
Kec. Belawa												
Wele	143	0.81	115	205	0.96	197	390	0.91	355	-	-	-
Belawa	58	0.96	56	160	0.78	125	144	0.91	131	-	-	-
Total	420	0.79	330	640	0.77	490	2,385	0.70	1,670	55	1.09	60

Source: Agriculture Offices, Kab. Sidrap and Wajo
Kecamatan Offices, Kec. Dua Pitue, Tanasitolo, Maniangpajo and Belawa

Table 2.16 Population of Livestock in the Study Area (1980)

(Unit: head)

Kab. Kec. Desa	Cattle	Horse	Buffalo	Goat	Chicken	Duck
Kab. Sidrap						
Kec. Dua Pitue						
Tanru Tedong	1,812	277	330	82	15,361	-
Bila	1,041	246	1,081	57	7,838	-
Kab. Wajo						
Kec. Tanasitolo						
Nepo	239	197	212	449	4,420	1,037
Tancung	726	161	276	103	5,576	733
Lowa	632	22	569	48	1,873	571
Kec. Maniangpajo						
Anabanua	1,585	260	1,748	27	19,882	1,774
Kalola	896	157	1,586	112	8,160	976
Kec. Belawa						
Wele	1,792	7	120	85	5,434	-
Belawa	2,004	133	51	81	7,784	6,995
Total	10,727	1,460	5,973	2,053	76,328	12,086

Source: Livestock Services offices, Kab. Sidrap and Wajo

Remark: The figures include the data in and around the study area.

Table 2.17 Surplus and Deficit of Paddy in the Study Area

(Unit: ton)

Kab. Kec. Desa	Population	Production of Paddy			Consumption[1]		Surplus/Deficit	
		W.S.P.	D.S.P.	Total	Case 1	Case 2	Case 1	Case 2
	(persons)							
Kab. Sidrap								
Kec. Dua Pitue								
Tanru Tedong	16,350	3,380	990	4,370	2,940	3,600	1,430	770
Bila	9,990	6,860	120	6,980	1,800	2,200	5,180	4,780
Kab. Wajo								
Kec. Tanasitolo								
Nepo	11,320	610	30	640	2,030	2,490	-1,390	-1,850
Tancung	9,280	1,480	90	1,570	1,670	2,040	-100	-470
Lowa	6,550	3,950	150	4,100	1,180	1,440	2,920	2,660
Kec. Maniangpajo								
Anabanua	8,060	4,610	15	4,625	1,450	1,770	3,175	2,855
Kalola	4,650	4,370	15	4,385	840	1,020	3,545	3,365
Kec. Belawa								
Wele	8,080	5,280	340	5,620	1,450	1,780	4,170	3,840
Belawa	9,680	1,530	320	1,850	1,740	2,130	110	-280
Total	83,960	32,070	2,070	34,140	15,100	18,470	19,040	15,670

Remark: [1]: Per Capita Consumption of Dried Paddy = Case 1 ..... 180 kg/person/year
Case 2 ..... 220 kg/person/year

Table 2.18 Market Prices of Major Crops

(Unit: Rp./kg)

Crops	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1. Milled Rice										
Kab. Sidrap	33.50	46.25	54.12	82.88	77.18	95.79	98.27	117.67	144.96	173.00
Kab. Wajo	32.62	39.89	57.33	-	90.16	107.15	105.73	130.33	139.48	179.69
Sulawesi Selatan	36.54	49.56	67.84	86.43	93.95	112.54	115.25	128.88	164.50	207.77
2. Dried Paddy										
Kab. Sidrap	22.78	31.45	36.86	56.36	52.48	65.14	66.82	80.02	98.57	117.64
Kab. Wajo	22.18	27.13	38.98	-	61.31	72.86	71.90	88.62	94.85	122.19
Sulawesi Selatan	24.85	33.70	46.13	58.77	63.89	76.53	78.37	87.64	111.86	141.28
3. Maize										
Kab. Sidrap	17.00	25.15	23.69	46.53	44.67	85.14	51.21	44.58	78.75	83.02
Kab. Wajo	18.25	24.52	21.17	-	50.23	53.33	43.01	49.00	73.77	92.04
4. Groundnuts										
Kab. Sidrap	46.90	77.50	88.54	203.33	202.91	255.42	260.50	248.25	407.46	502.08
Kab. Wajo	49.08	78.00	88.62	-	161.59	205.83	219.25	260.50	417.00	572.92
5. Greenbeans										
Kab. Sidrap	50.50	74.53	90.50	156.90	201.40	262.83	234.17	219.58	360.63	275.75
Kab. Wajo	58.92	66.11	93.52	-	130.19	203.62	185.46	180.83	350.13	302.79
6. Soybeans										
Kab. Sidrap	-	-	-	144.00	160.00	-	-	-	-	-
Kab. Wajo	-	-	-	-	117.21	174.50	145.88	-	225.00	-

Source: Statistik Harga Hasil Pertanian Tanaman Pangan, 1981.

Table 2.19 Farm Gate Prices of Farm Products and Inputs at Kab. Sidrap and Wajo (1980)

(Unit: Rp./kg, lit)

Description		Price
1. Farm products		
Dried Paddy		90
Maize		66
Groundnuts		400
Greenbeans		217
Soybeans		212
2. Seed		
Dry Paddy		150
Maize		90
Groundnuts		324
Greenbeans		300
Soybeans		283
3. Fertilizers		
Urea		70
T.S.P. (Triple Super Phosphate)		70
KCl (Potasium Cloride)		70
4. Agro-chemicals		
Insecticide	Diazinon	1,230
	Sumithion	1,230
	Dimecron	1,230
	Seven 50 W.P.	1,230
Fungicide	Antracol	1,230
Rodenticide	Zink-phosphate	4,000
5. Labour		
Heavy Worker		1,000
Light Worker		750
Female Worker		500

Source: P.T. PERTANI, Ujung Pandang
Agriculture offices, Kab. Sidrap and Wajo
Farm economy survey in the Study Area

Table 2.20 Production Cost of Paddy under Present Condition

(Unit: Rp.)

Description	Unit Price	Wet Season Paddy		Dry Season Paddy	
1. Farm Input					
(1) Seed	Rp. 150/kg	35 kg	5,250	35 kg	5,250
(2) Fertilizers					
Urea	Rp. 70/kg	100 kg	7,000	100 kg	7,000
T.S.P.	Rp. 70/kg	50 kg	3,500	-	-
(3) Agro-chemicals					
Insecticide	Rp.1,230/lit.	2 lit.	2,460	1 lit.	1,230
Rodenticide	Rp.4,000/kg	0.1 kg	400	-	-
Sub-total			18,610		13,480
2. Labour Cost	(Rp./day)	(M/D)		(M/D)	
(1) Nursery Preparation	1,000	4.7	4,700	4.7	4,700
(2) Plowing	1,100	11.3	12,430	12.3	13,530
(3) Harrowing/Puddling	1,100	13.6	14,960	14.5	15,950
(4) Transplanting	1,000	25.7	25,700	25.7	25,700
(5) Weeding	1,000	11.9	11,900	14.5	14,500
(6) Fertilizer Application	450	3.0	1,350	2.0	900
(7) Chemical Application	1,000	3.0	3,000	2.0	6,000
(8) Harvesting	750	18.0	13,500	17.0	12,750
(9) Threshing	750	14.0	10,500	12.3	9,230
(10) Drying	750	4.0	3,000	3.6	2,700
(11) Transportation	500	9.2	4,600	8.0	4,000
(12) Water Management	450	1.5	680	2.0	900
Sub-total		119.9	106,320	118.6	110,860
3. Miscellaneous Cost (Equipment, tax etc.)	12% of (1+2)		14,970		14,960
Total (1+2+3)			139,900		139,300

Remarks: See Tables 2.9 and 2.19

Table 2.21 Production Cost of Polowijo Crops under Present Condition

(Unit: Rp.)

Description	Unit Price	Maize		Groundnuts		Greenbeans		Soybeans	
1. Farm Input									
(1) Seed		20 kg	1,800	65 kg	24,960	25 kg	7,500	30 kg	8,490
(2) Fertilizers									
Urea	Rp. 70/kg	-	-	50 kg	3,500	50 kg	3,500	-	-
(3) Agro-chemicals									
Insecticide	Rp.1,230/lit.	-	-	2 lit.	2,460	2 lit.	2,460	2 lit.	2,460
Sub-total			1,800		30,920		13,460		10,950
2. Labour Cost	(Rp/day)	(M/D)		(M/D)		(M/D)		(M/D)	
(1) Land Preparation	1,000	6	6,000	8	8,000	7	7,000	8	8,000
(2) Seeding	750	4	3,000	6	4,500	10	7,500	6	4,500
(3) Weeding	750	14	10,500	20	15,000	20	15,000	20	15,000
(4) Fertilizer Application	450	-	-	1	450	1	450	-	-
(5) Chemical Application	1,000	-	-	4	4,000	4	4,000	4	4,000
(6) Harvesting/Drying	500	14	7,000	24	12,000	22	11,000	22	4,000
(7) Transportation	500	3	1,500	3	1,500	2.5	1,250	2.5	1,250
(8) Water Management	450	1	450	1	450	1	450	1	450
Sub-total		42	28,450	63	45,900	67.5	46,650	59.5	44,200
3. Miscellaneous Cost (Equipment, tax etc.)	10% of (1+2)		3,050		7,680		6,090		5,550
Total (1+2+3)			33,300		81,500		66,200		60,700

Remarks: See Tables 2.9 and 2.10

Table 2.22 Annual Net Production Value under Present Condition in the Study Area

Crops	Planted Area (ha)	Harvested Area (ha)	Unit Yield (tons/ha)	Production (tons)	Unit Price (Rp./kg)	G.P.V. (10^6Rp.)	U.P.C. (Rp./ha)	T.P.C. (10^6Rp.)	N.P.V. (10^6Rp.)
Paddy	13,420	11,530	2.94	34,000		3,060		1,877	1,183
Wet season paddy	12,600	10,800	2.97	32,000	90	2,880	139.9	1,763	1,117
Dry season paddy	820	730	2.84	2,000	90	180	139.3	114	66
Polowijo Crops	3,600	3,500	0.73	2,550		592		233	359
Maize	432	420	0.79	330	66	22	33.3	14	8
Groundnuts	658	640	0.77	490	400	196	81.5	54	142
Greenbeans	2,453	2,385	0.70	1,670	217	362	66.2	162	200
Soybeans	57	55	1.09	60	212	12	60.7	3	9
Total	-	-	-	-	-	3,652	-	2,110	1,542

Remarks: Figures are estimated based on the past 5 years data obtained from Desa offices and the agricultural survey, as referred to Tables 2.5, 2.14, 2.19, 2.20 and 2.21.

/1; G.P.V.: Gross Production Value
/2; U.P.C.: Unit Production Cost
/3; T.P.C.: Total Production Cost
/4; N.P.V.: Net Production Value