SUMMARY OF LABORATORY TEST RESULTS

	Sample No. (Depth)	TP－13 0.60～1.00	TP－13 1.80～2.00	TP－14 0.60～1.00			
	Unit Weight ρ_t g/cm³	1.643	1.638	1.716			
	Dry Density ρ_d g/cm³						
	Gs ρ_s g/cm³	2.570	2.560	2.570			
	Wn %	37.29	37.40	31.08			
	e						
	Sr %						
		—	—	—			
Gradation	Gravel 2～75mm %						
	Sand 75μm～2mm %	15.00	10.00	26.00			
	Silt 5～75μm %	52.00	56.00	48.00			
	Clay 5μm未満 %	33.00	34.00	26.00			
	U_c						
	U_c'						
Consistency	WL %	61.00	62.30	46.70			
	WP %	29.10	26.59	24.20			
	Ip	31.90	35.71	22.50			
	Index Propenty	CH	CH	CL			
Compaction Test	E	100	100	100			
	Wopt (%)	—	31.55	—			
	γd (g/cm³)	—	1.403	—			
Direct Shear Test	c kgf/cm²	0.261	0.260	0.230			
	φ	21°	22°	22°			
	c' kgf/cm²						
	φ'						
Consolidation	C_c	0.307	0.374	0.349			
	Cv (cm²/sec)						
	Mv (cm²/kg)						
	Permeability Test						
	k (cm/sec)	—	8.464X10⁻⁷	—			

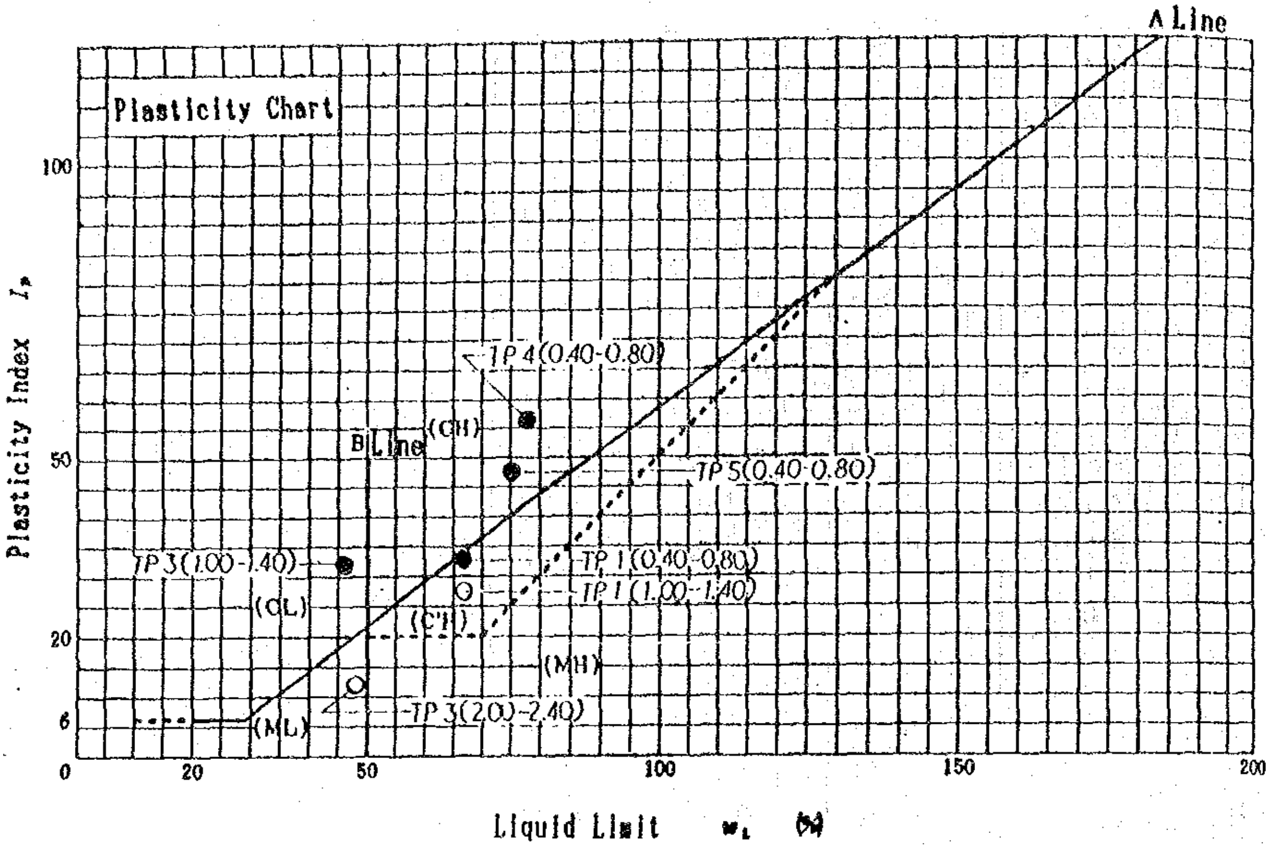
Fig. 9(6) Summary of Laboratory Test Results(6)

SUMMARY OF LABORATORY TEST RESULTS

	Sample No. (Depth)	TP－14 1.60～2.00	TP－15 0.60～1.00	TP－15 1.60～2.00		
	Unit Weight ρ_t g/cm³	1.669	1.628	1.463		
	Dry Density ρ_d g/cm³					
	Gs ρ_s g/cm³	2.580	2.550	2.565		
	Wn %	32.53	38.44	58.25		
	e					
	Sr %					
Gradation	Gravel 2～75mm %	—	—	—		
Gradation	Sand 75μm～2mm %	45.00	30.00	28.00		
Gradation	Silt 5～75μm %	39.00	37.00	45.00		
Gradation	Clay 5μm未満 %	16.00	33.00	17.50		
Gradation	U_c					
Gradation	U_c'					
Consistency	WL %	39.00	51.75	47.75		
Consistency	WP %	22.40	16.58	25.64		
Consistency	IP	16.60	35.17	22.11		
	Index Propenty	CL	CH	CL		
Compaction Test	E	100	100	100		
Compaction Test	Wopt (%)	22.08	—	26.15		
Compaction Test	γd (g/cm³)	1.530	—	1.480		
Direct Shear Test	c kgf/cm²	0.168	0.200	0.100		
Direct Shear Test	φ	20°	20°	20°		
Direct Shear Test	c' kgf/cm²					
Direct Shear Test	φ'					
Consolidation	C_c	0.282	0.292	0.306		
Consolidation	Cv (cm²/sec)					
Consolidation	Mv (cm²/kg)					
	Permebility Test					
	k (cm/sec)	1.880×10^{-5}	—	1.514×10^{-4}		

Fig. 9(7) Summary of Laboratory Test Results(7)

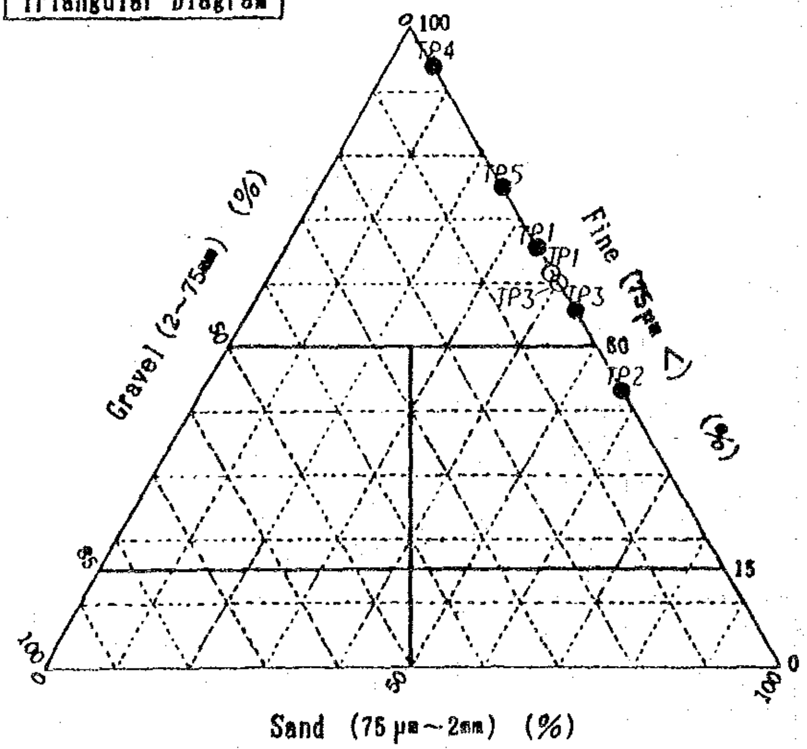
Fig.10(1) Index Propensity(1)



A Line: $I_p = 0.73(w_L - 20)$

B Line: $w_L = 50$

Triangular Diagram



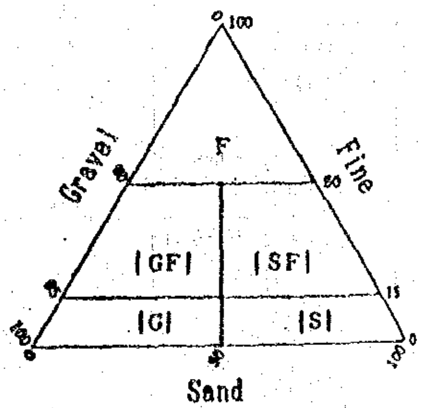
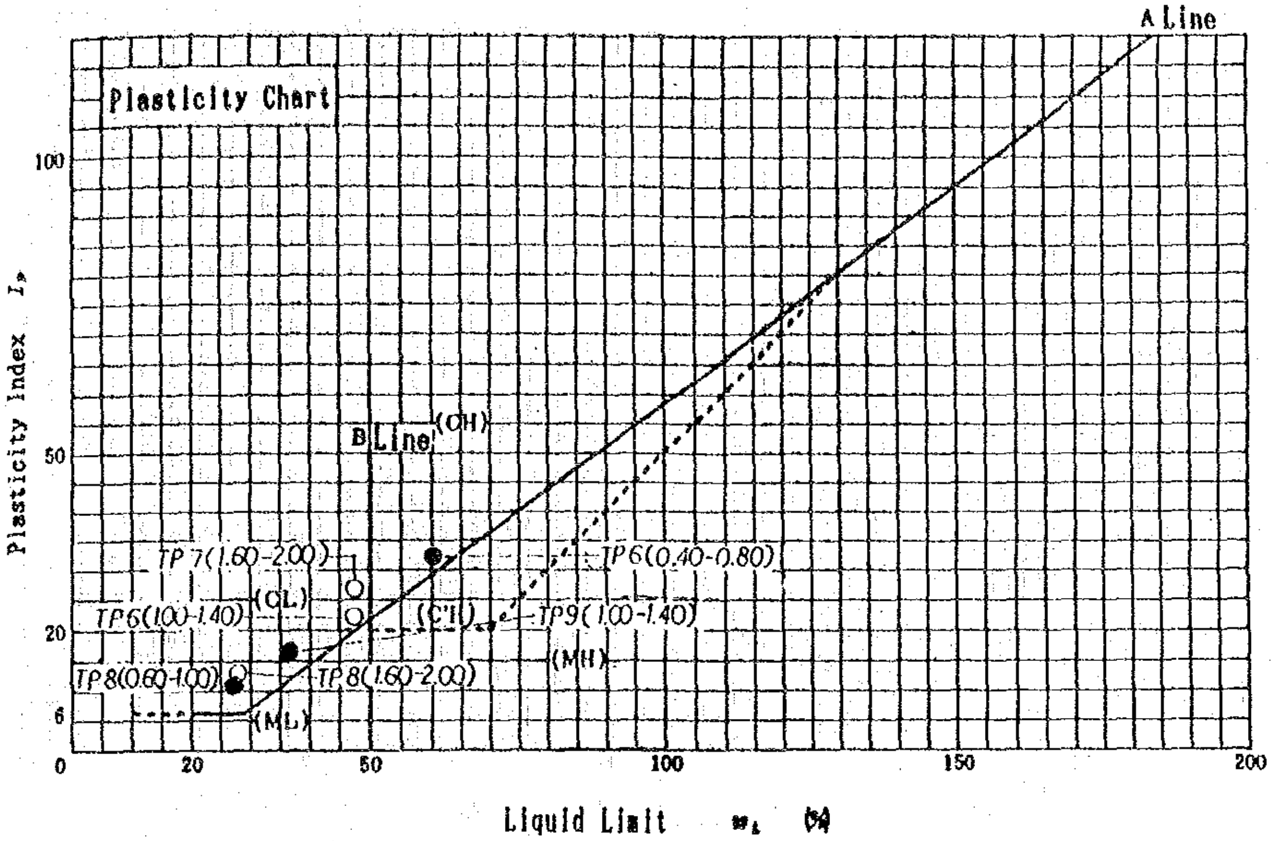
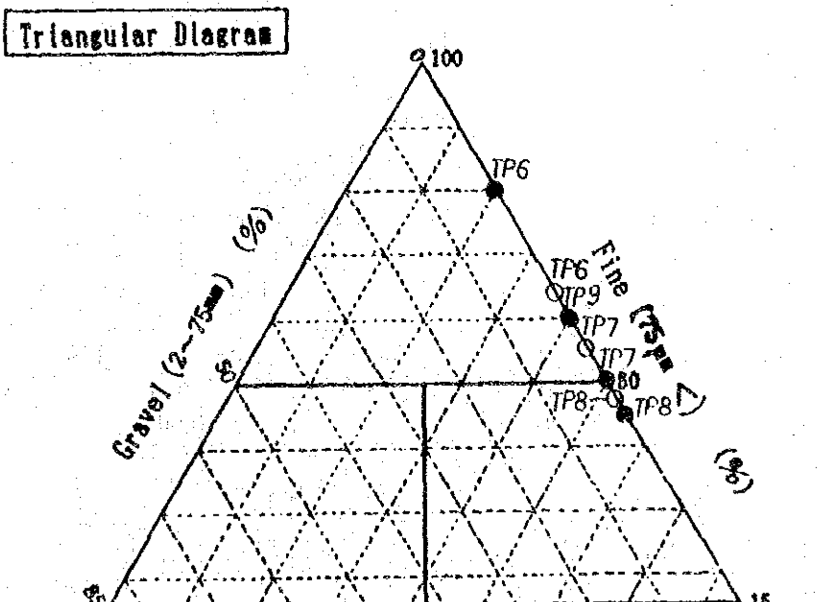


Fig.10(2) Index Propensity(2)



A Line: $I_p = 0.73(w_L - 20)$

B Line: $w_L = 50$



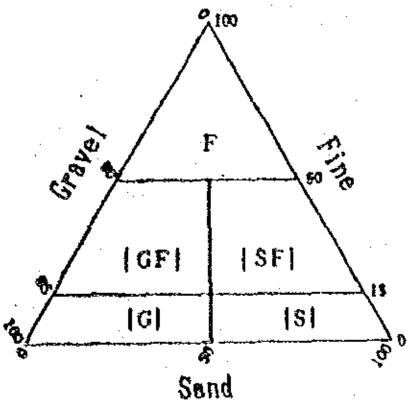
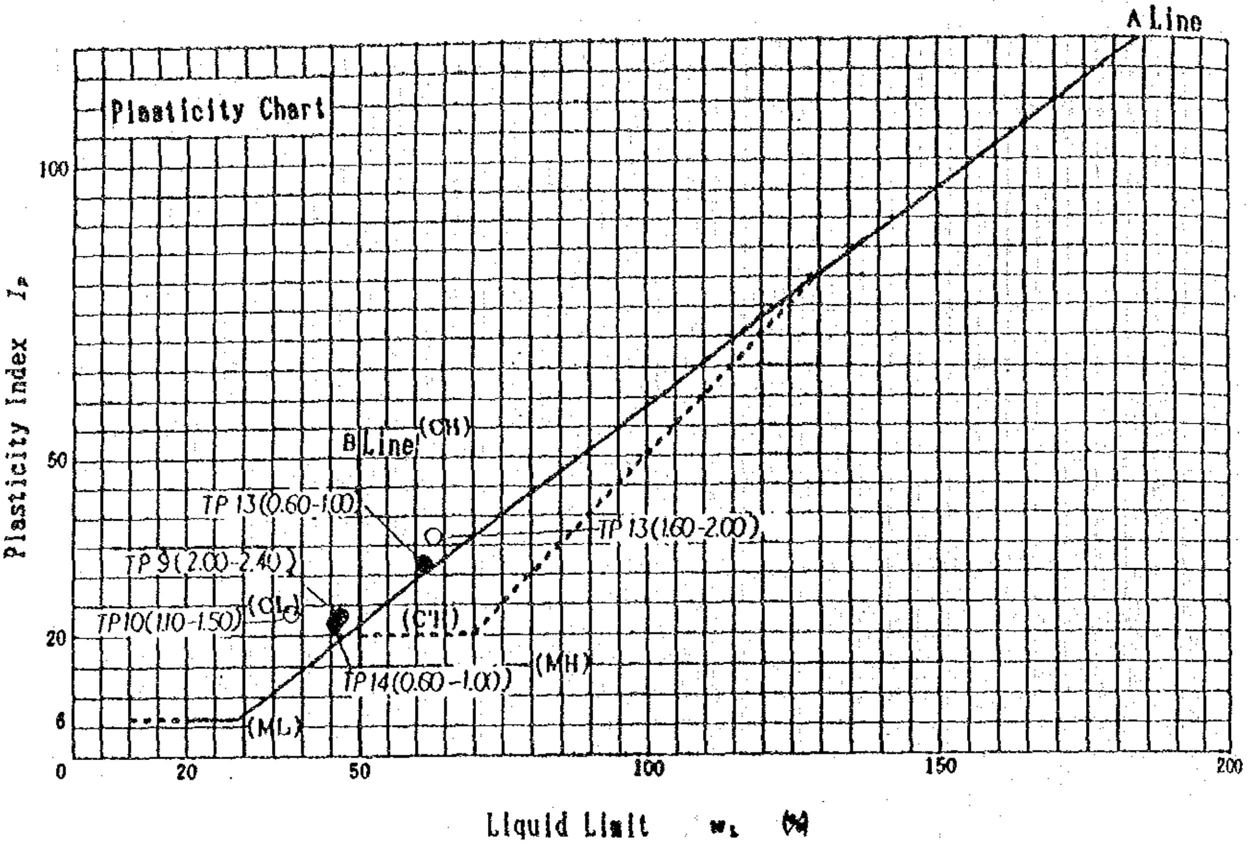
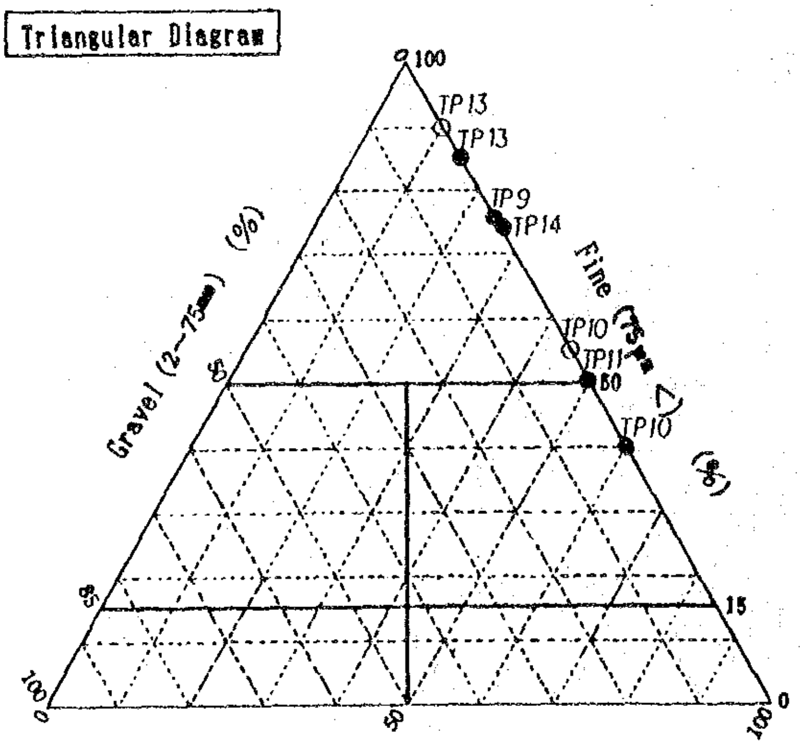


Fig.10(3) Index Propensity(3)



A Line: $I_p = 0.73(w_L - 20)$

B Line: $w_L = 50$



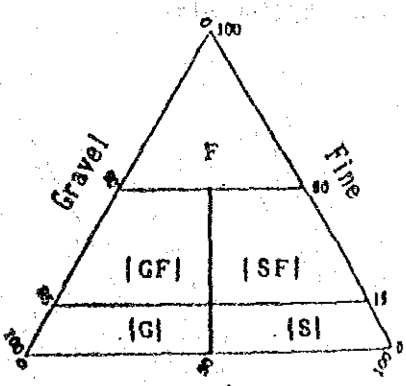
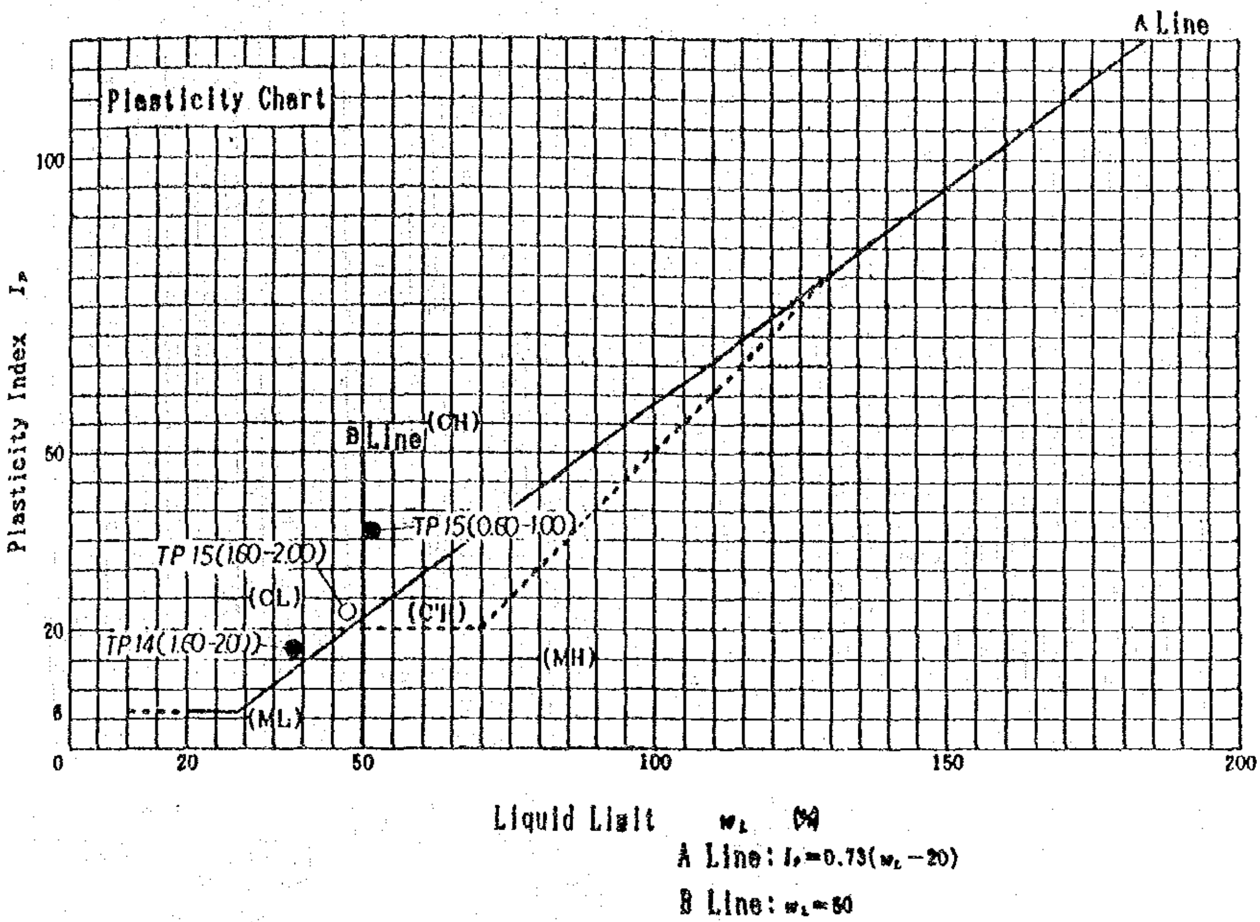
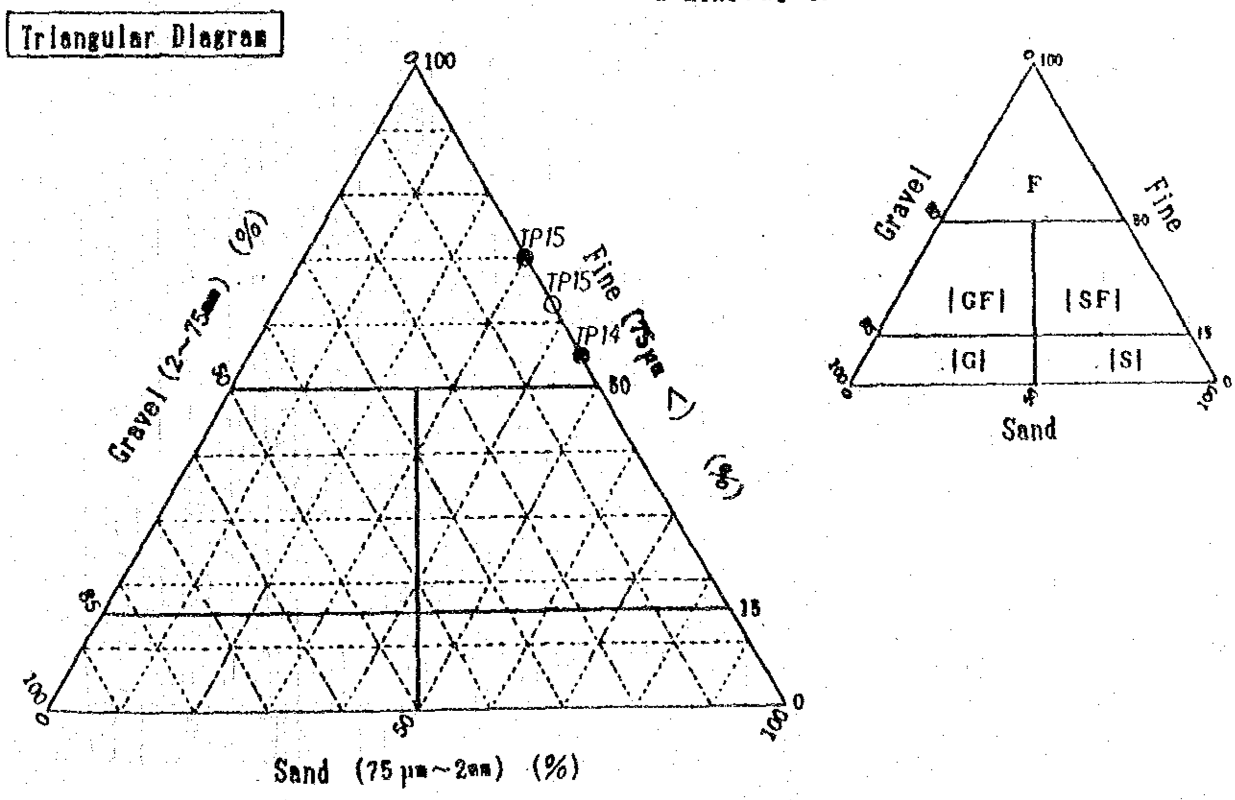
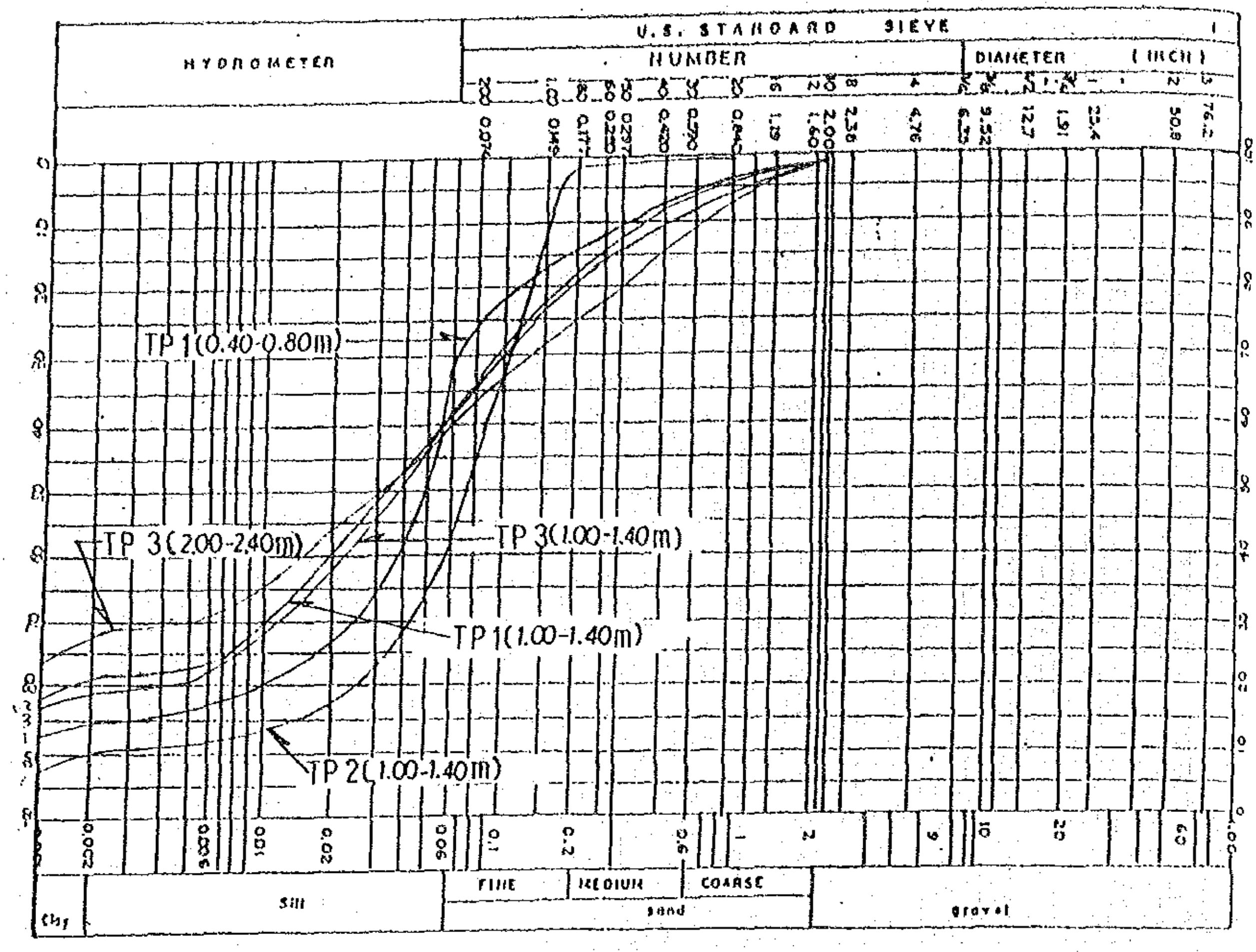


Fig.10(4) Index Propensity(4)







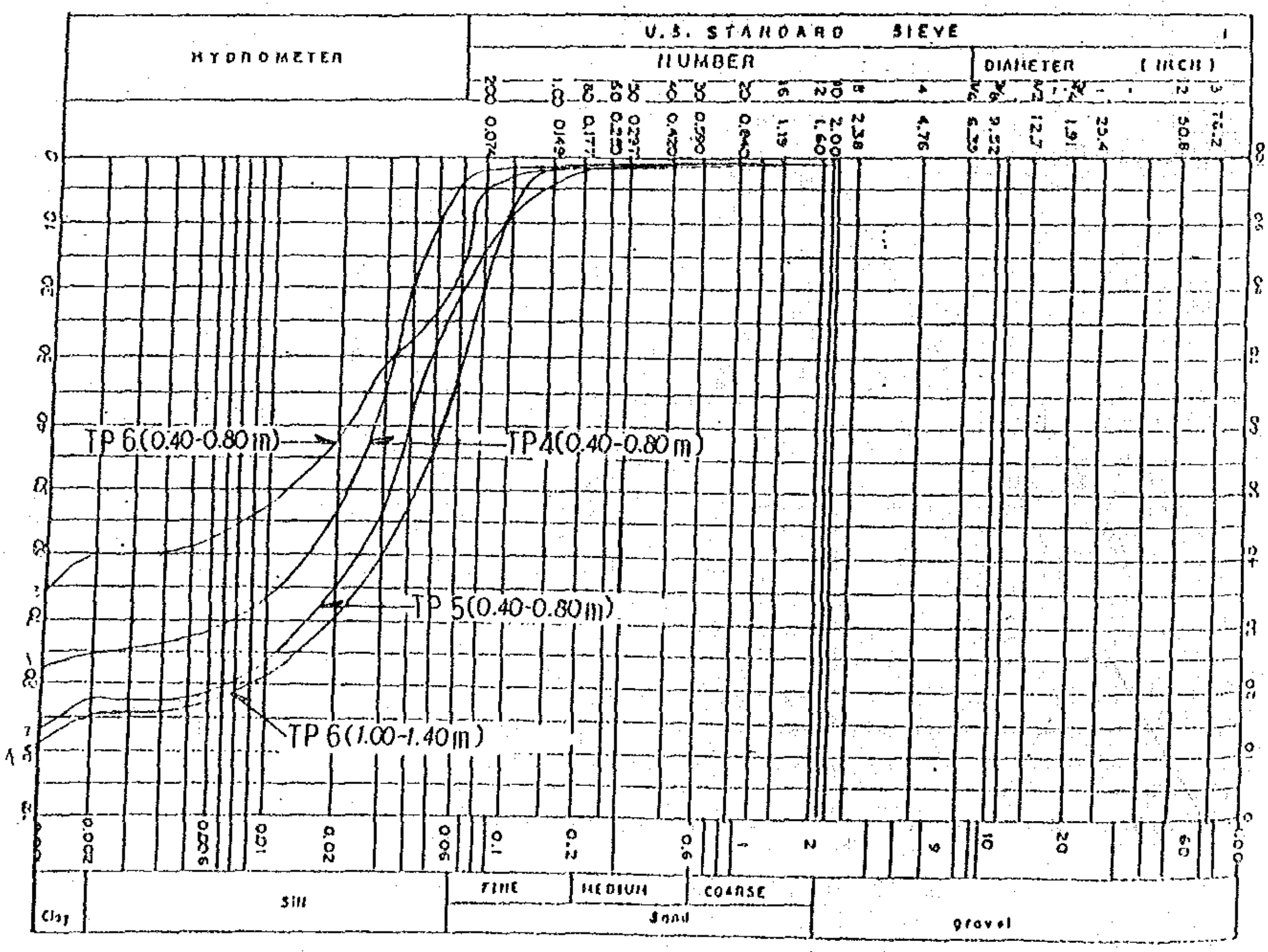
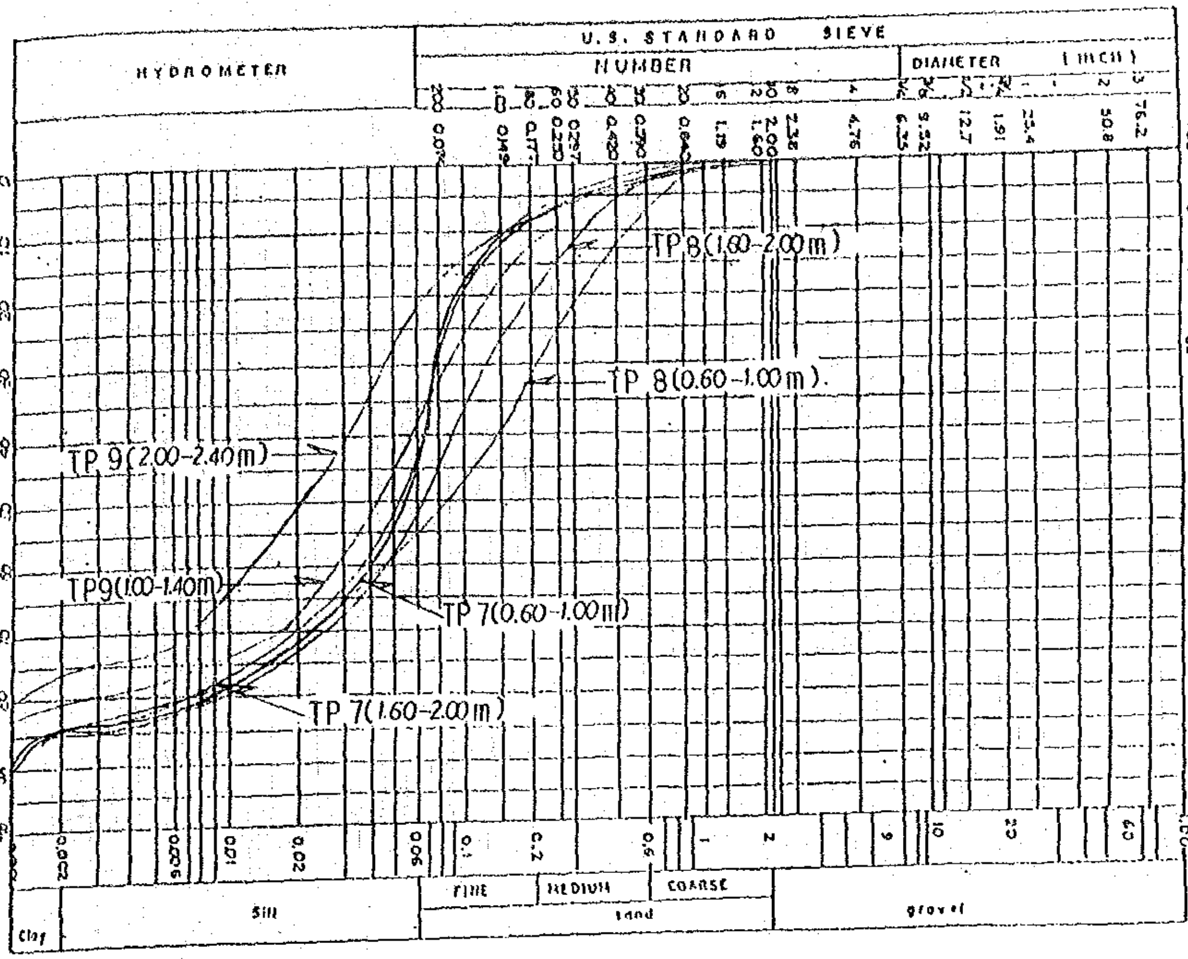


Fig.11(1) Grain Size Analysis(1)



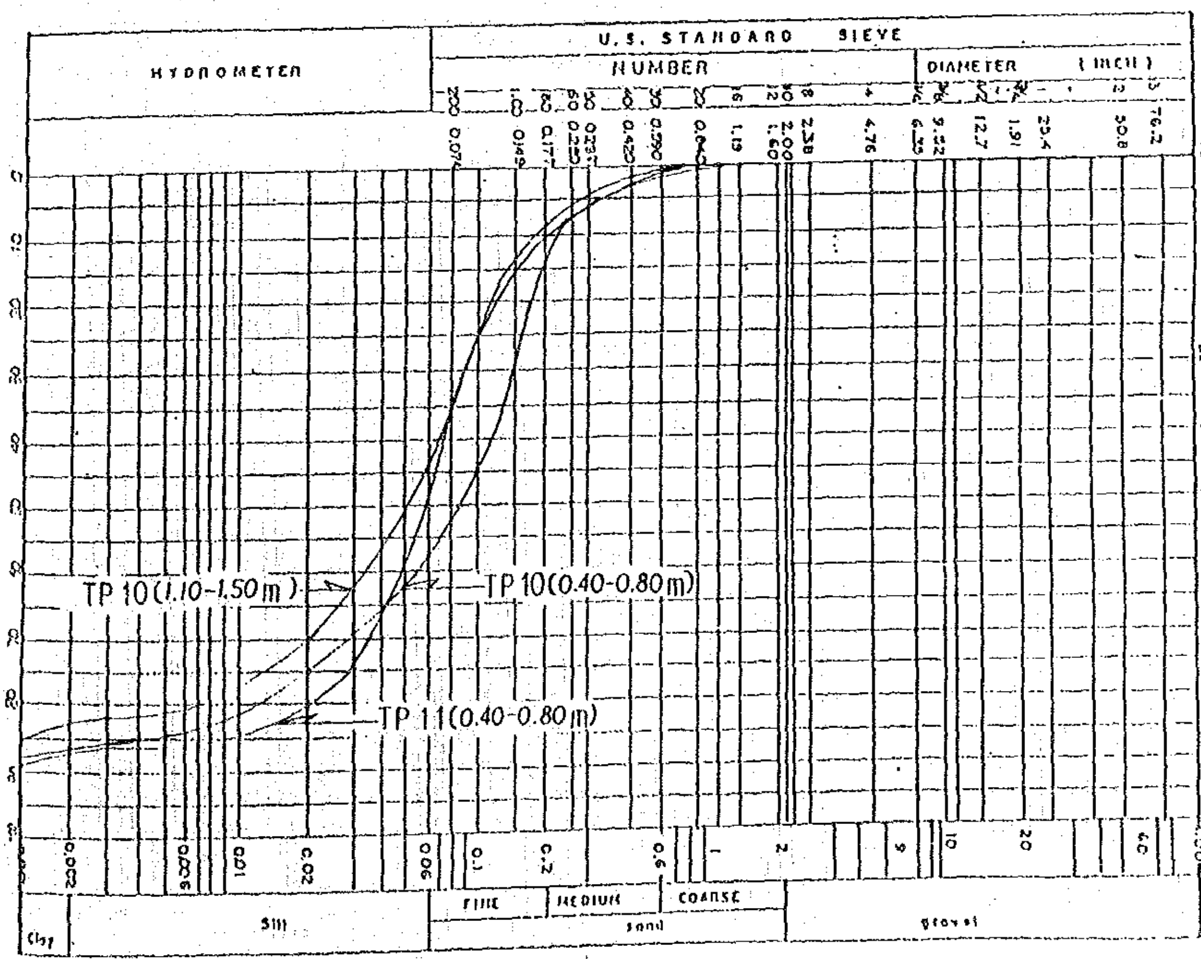
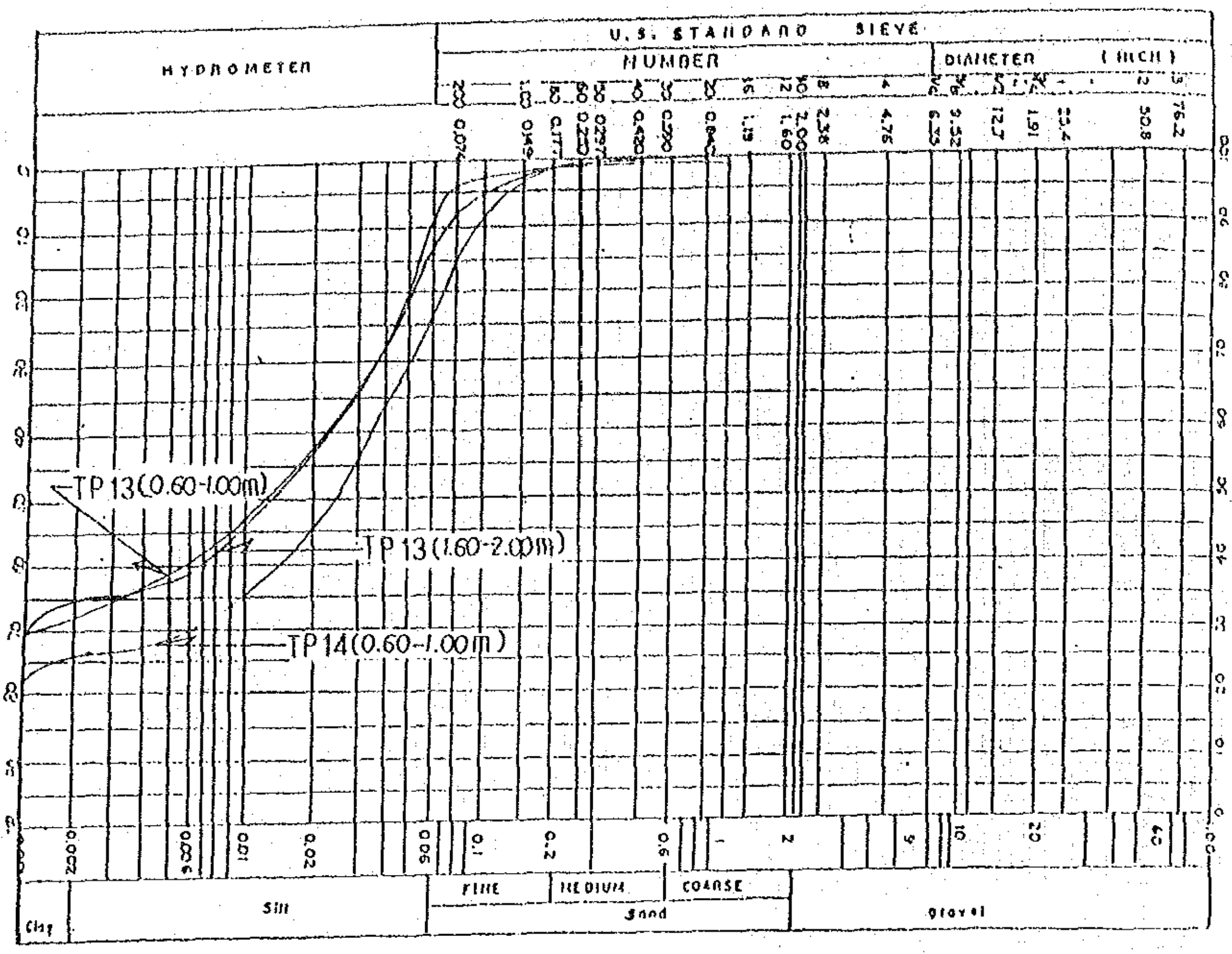


Fig.11(2) Grain Size Analysis(2)



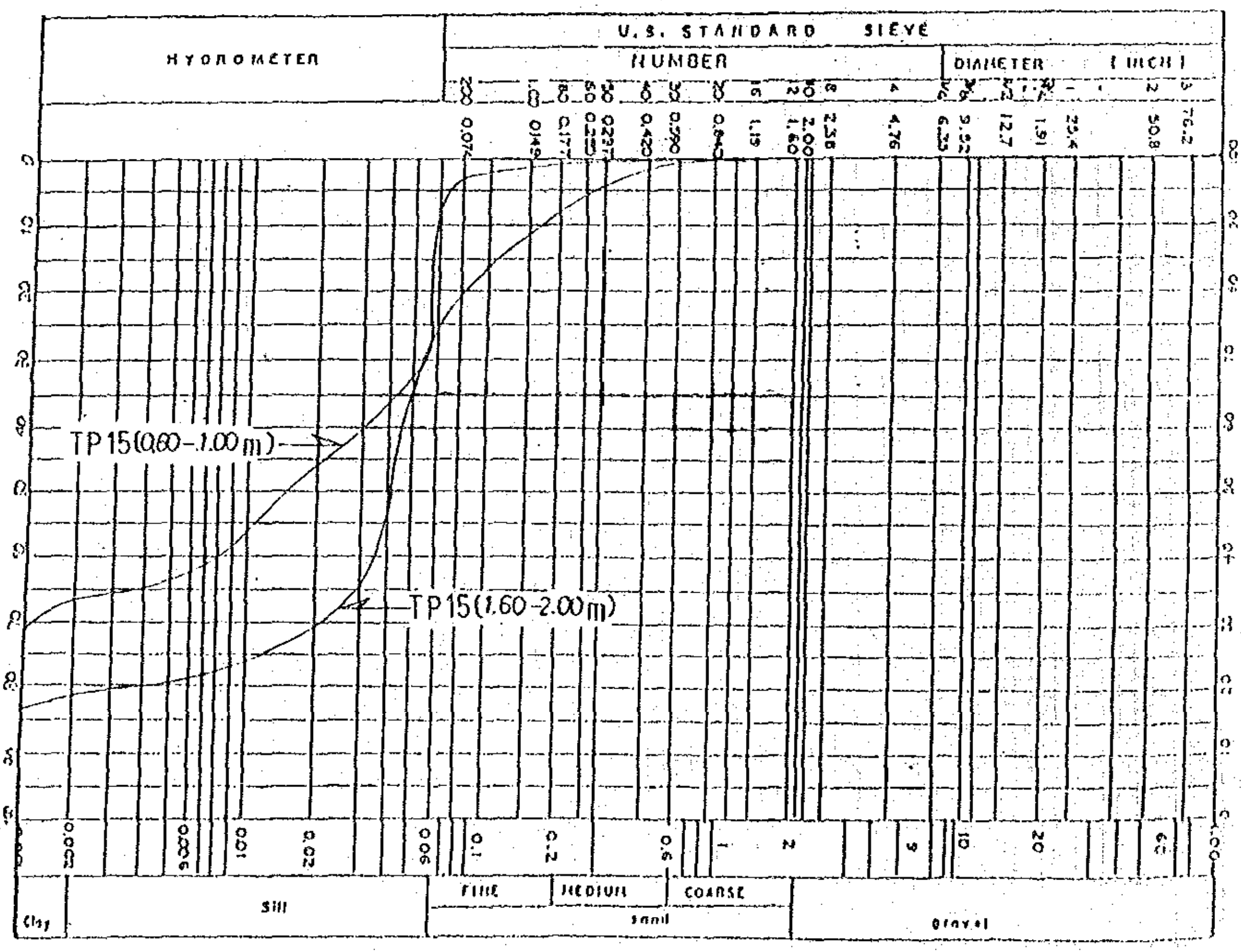
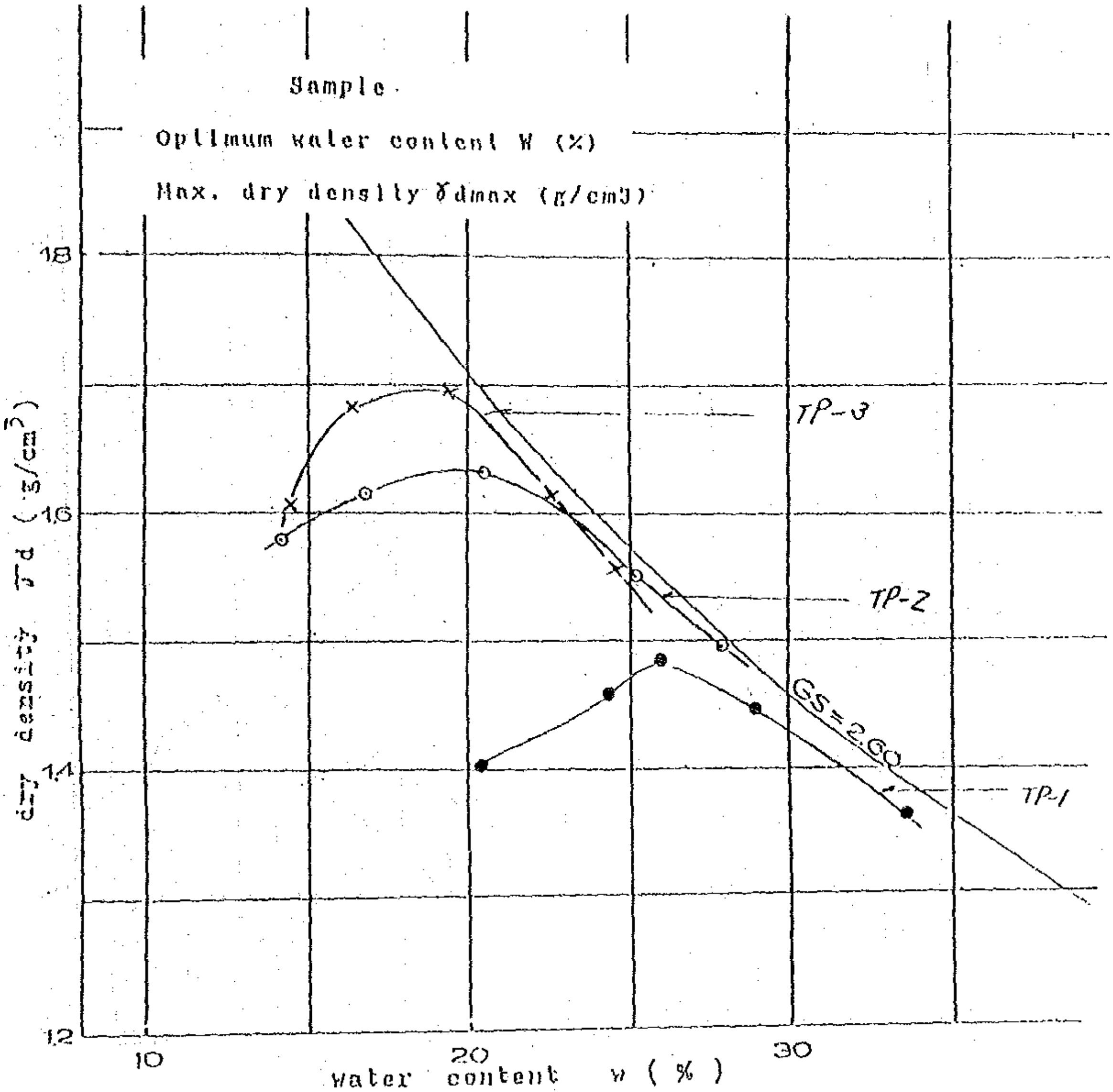


Fig.11(3) Grain Size Analysis(3)



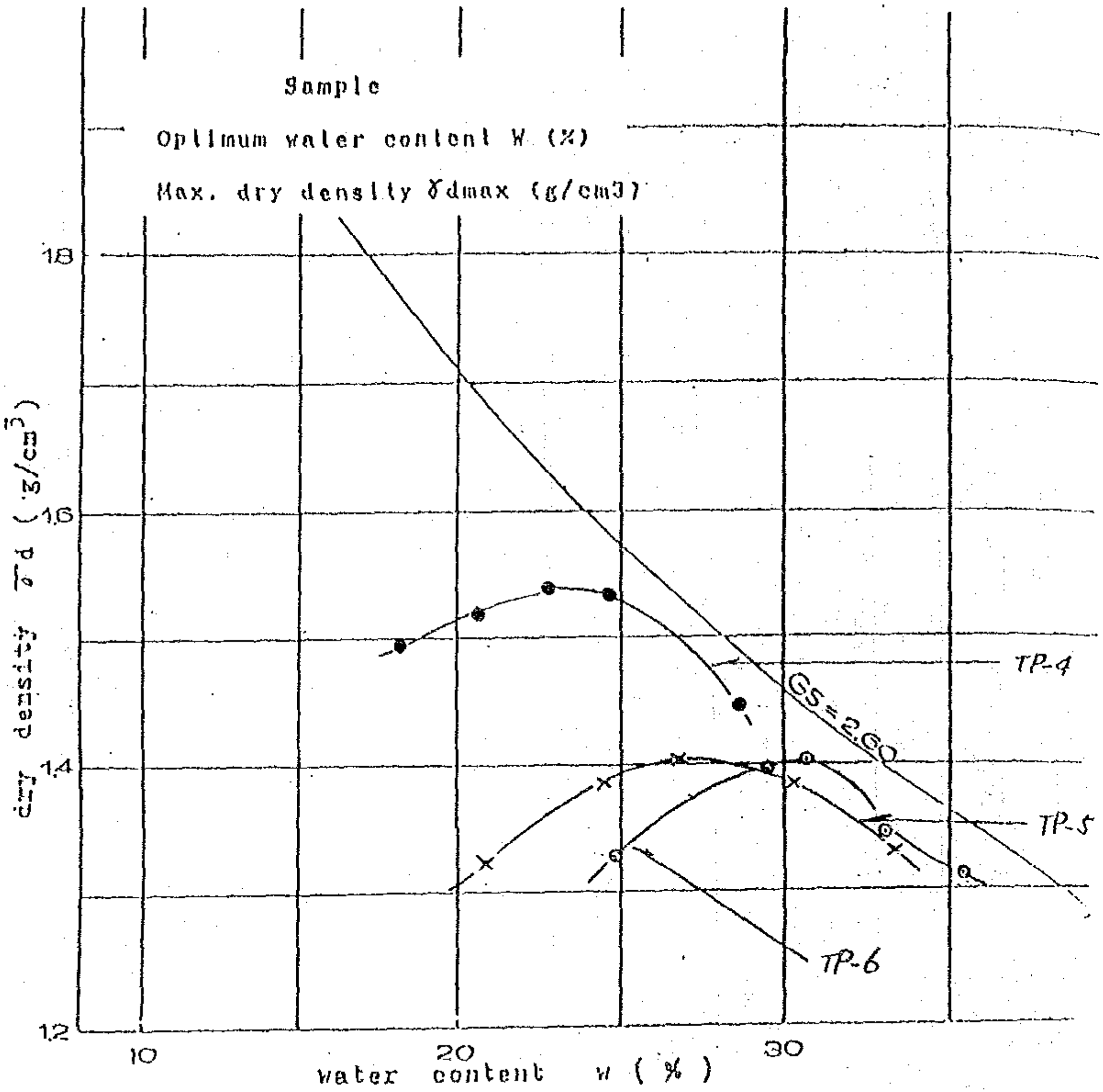
Relative equations for dry density γd g/cm³ degree of saturation S% water content w%, is shown as below

$$\gamma d = \frac{Gs \cdot \gamma w}{1 + \frac{w \cdot Gs}{S}}$$

where Gs ; Specific gravity
γw ; unit weight of water = 1 g/cm³
this equation corresponds to zero air void curve when S is 100%

Sample	TP－1	TP－2	TP－3	
Wopt (%)	26.55	20.91	19.67	
γd max (g/cm³)	1.475	1.632	1.691	

Fig.12(1) Comaction Test Results(1)



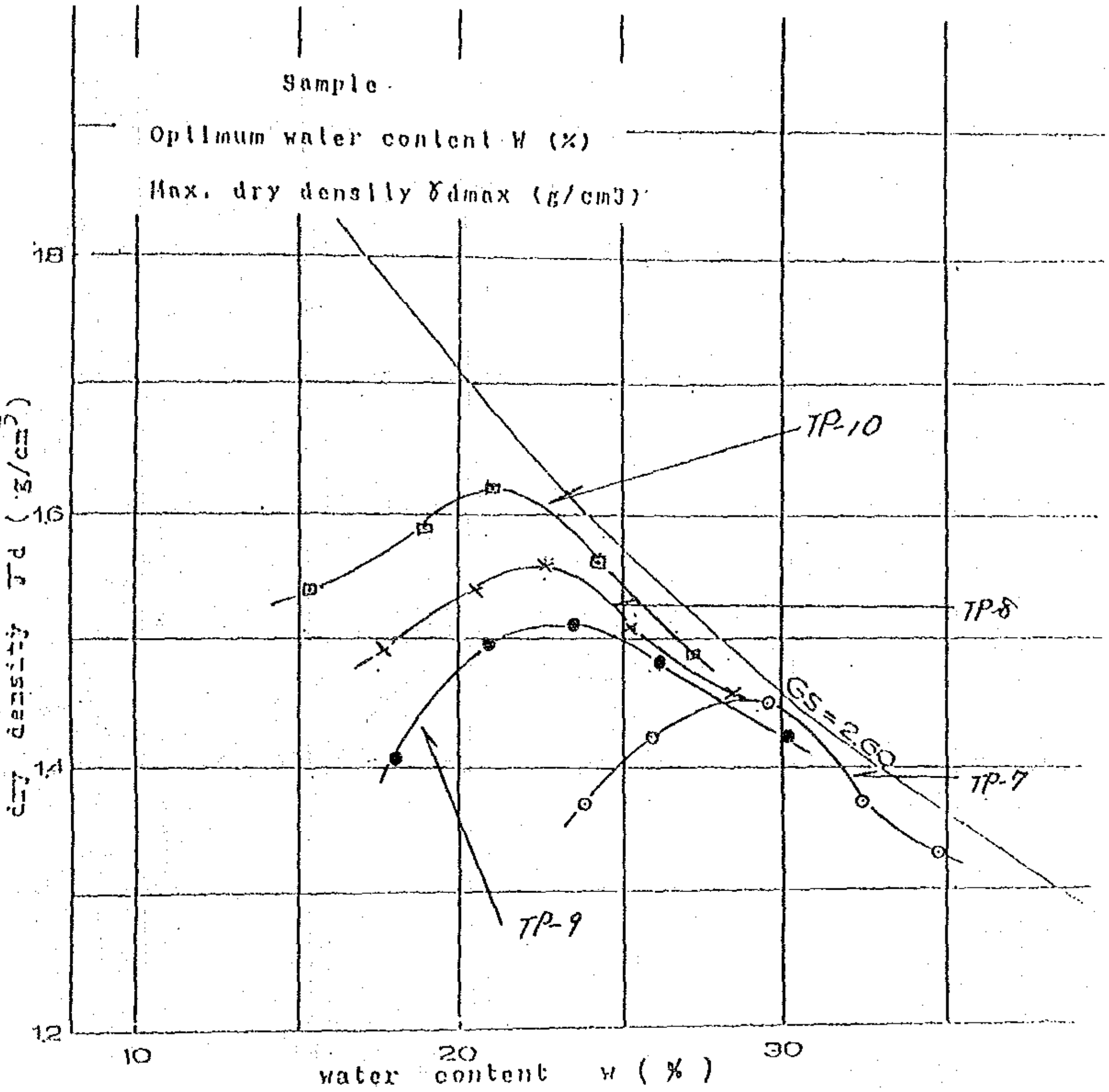
Relative equations for dry density γ_d g/cm^3 degree of saturation S% water content w%, is shown as below

$$\gamma_d = \frac{G_s \cdot \gamma_w}{1 + \frac{w \cdot G_s}{S}}$$

where Gs ; Specific gravity
γ_w ; unit weight of water = 1 g/cm^3
this equation corresponds to zero air void curve when S is 100%

Sample	TP－4	TP－5	TP－6	
Wopt (%)	22.87	27.39	30.69	
γd max (g/cm³)	1.539	1.402	1.404	

Fig.12(2) Comaction Test Results(2)



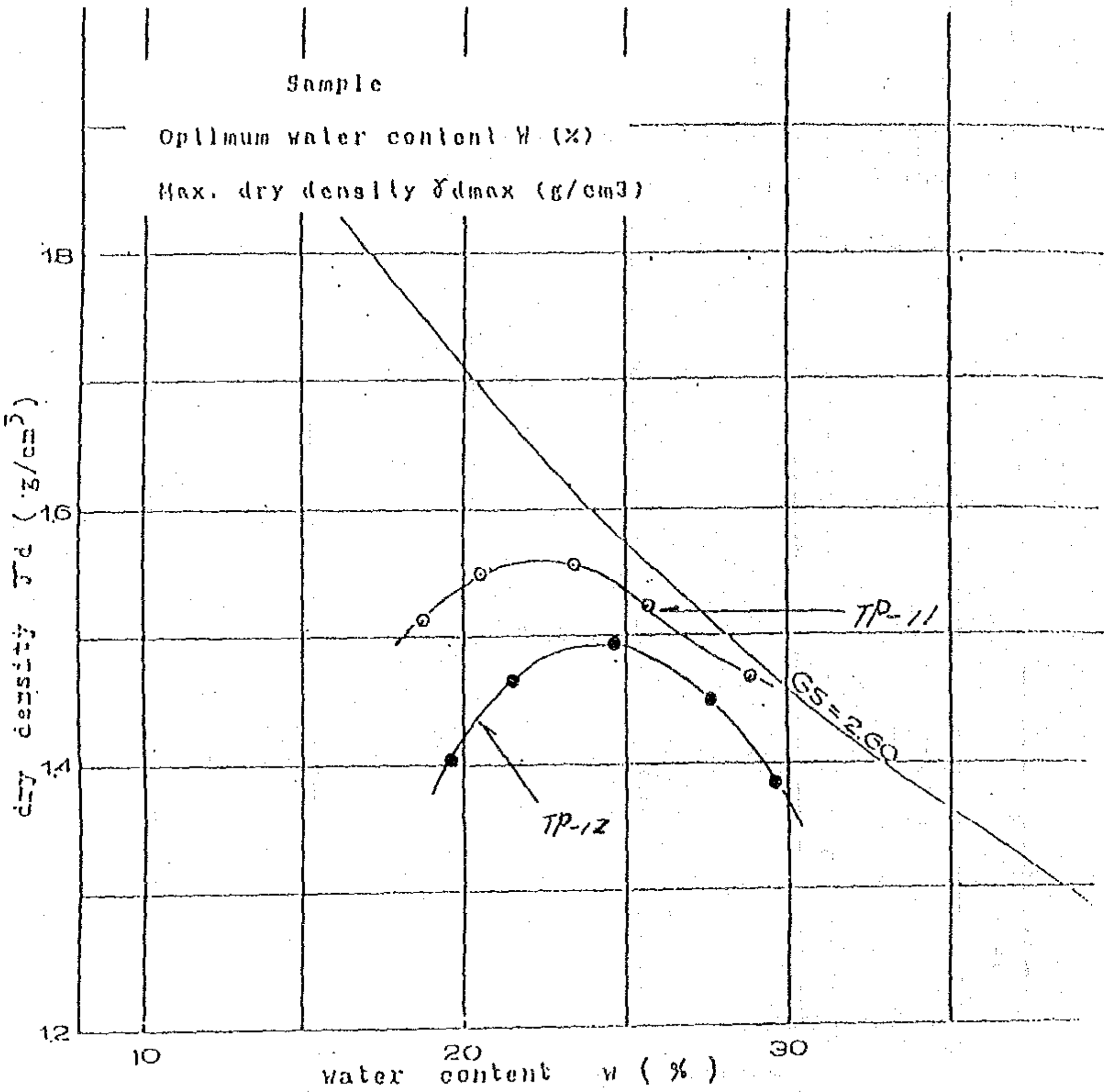
Relative equations for dry density γd g/cm^3 degree of saturation S% water content w%, is shown as below

$$\gamma d = \frac{Gs \cdot \gamma w}{1 + \frac{w \cdot Gs}{S}}$$

where Gs ; Specific gravity
γw ; unit weight of water = 1 g/cm^3
this equation corresponds to zero air void curve when S is 100%

Sample	TP－7	TP－8	TP－9	TP－10
Wopt (%)	29.37	22.90	23.66	21.39
γd max (g/cm³)	1.450	1.553	1.510	1.620

Fig.12(3) Comaction Test Results(3)



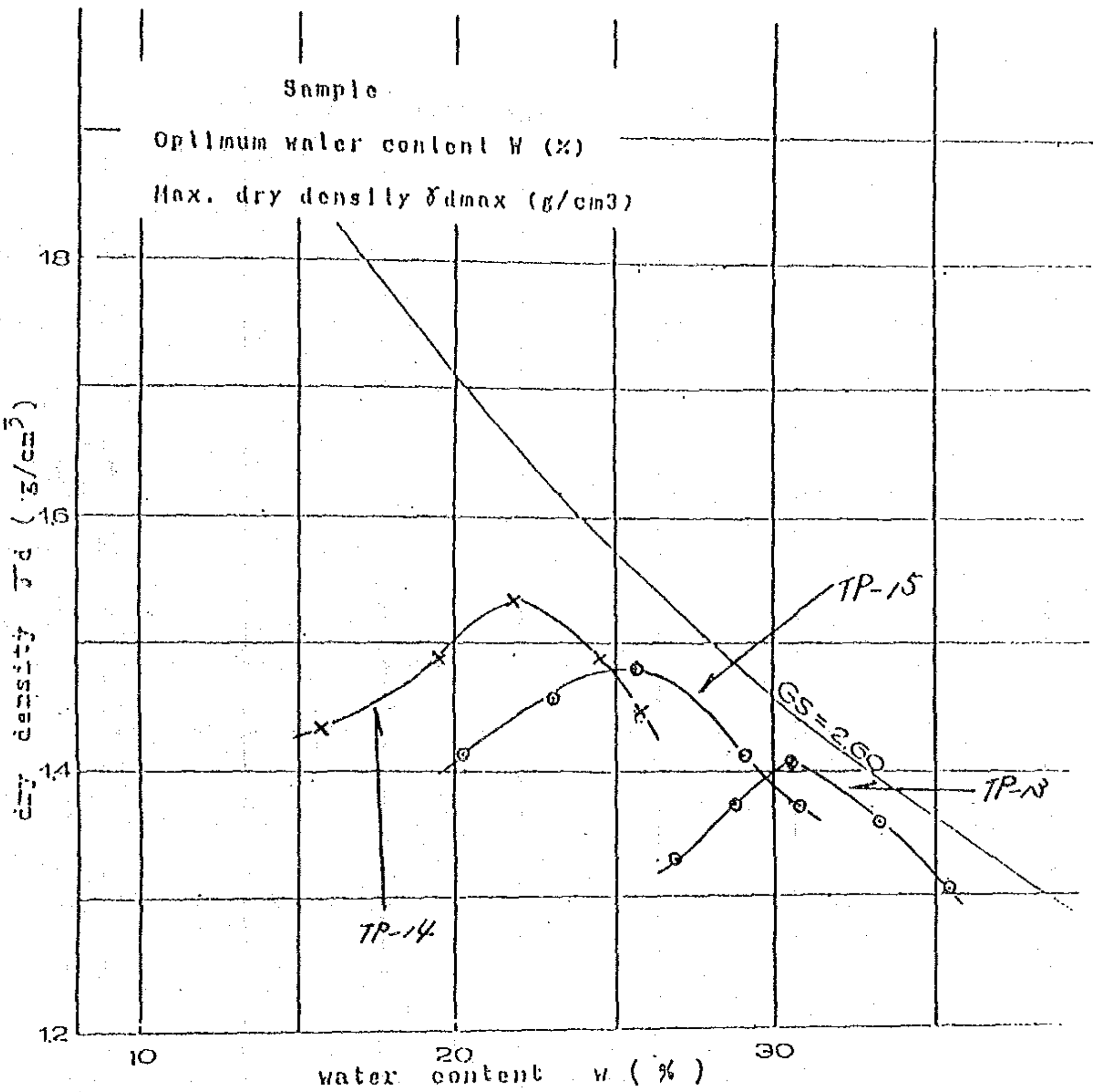
Relative equations for dry density γd g/cm³ degree of saturation S% water content w%, is shown as below

$$\gamma d = \frac{Gs \cdot \gamma w}{1 + \frac{W \cdot Gs}{S}}$$

where Gs ; Specific gravity
γw ; unit weight of water = 1 g/cm³
this equation corresponds to zero air void curve when S is 100%

Sample	TP－11	TP－12		
Wopt (%)	23.38	24.90		
γd max (g/cm³)	1.560	1.495		

Fig.12(4) Comaction Test Results(4)



Relative equations for dry density γ_d g/cm³ degree of saturation S% water content w%, is shown as below

$$\gamma_d = \frac{G_s \cdot \gamma_w}{1 + \frac{w \cdot G_s}{S}}$$

where Gs ; Specific gravity
γw ; unit weight of water = 1 g/cm³
this equation corresponds to zero air void curve when S is 100%

Sample	TP－13	TP－14	TP－15	
Wopt (%)	31.55	22.08	26.15	
γd max (g/cm³)	1.403	1.530	1.480	

Fig.12(5) Comaction Test Results(5)

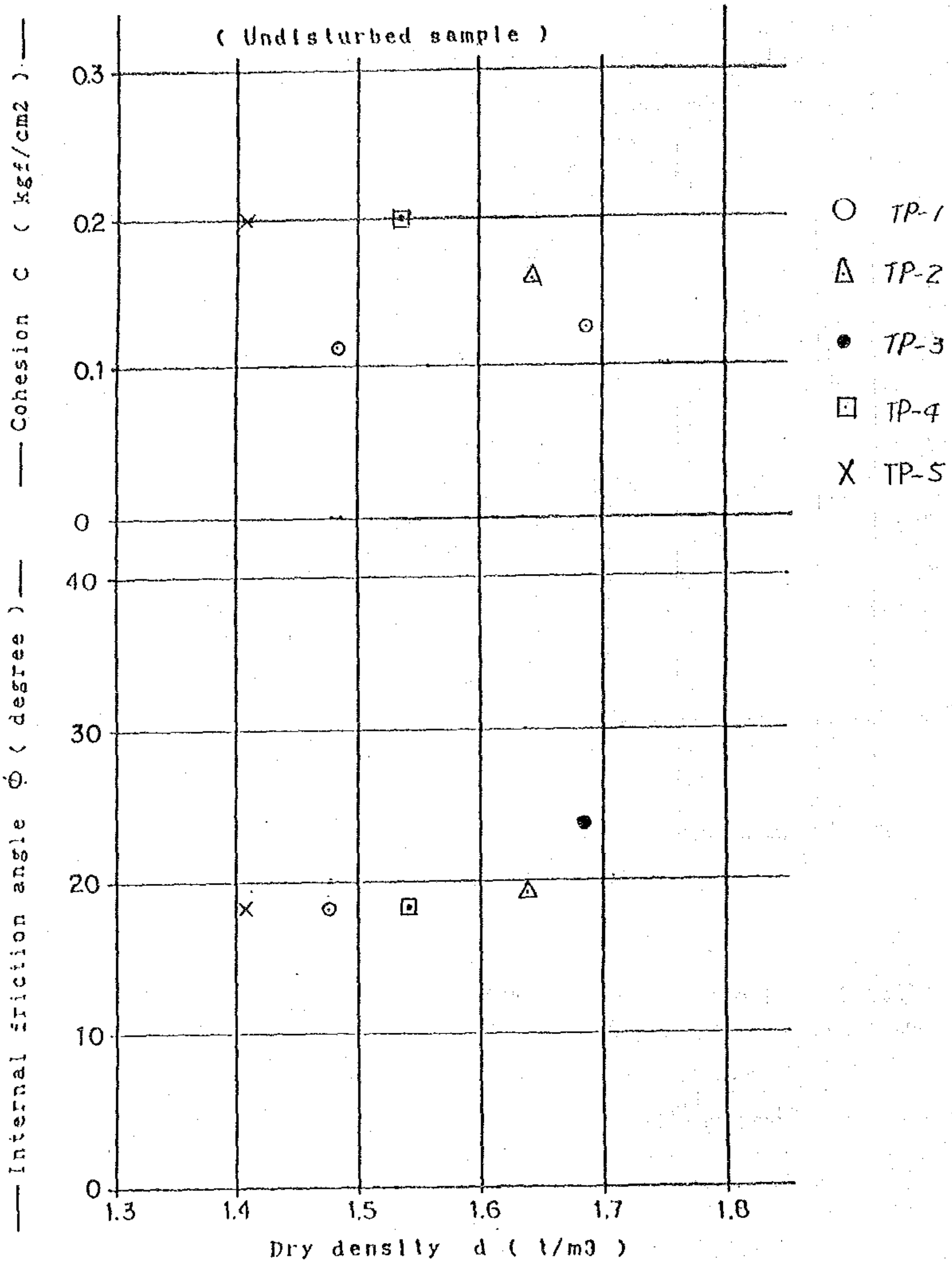


Fig.13(1) Direct Shear Test Results(1)

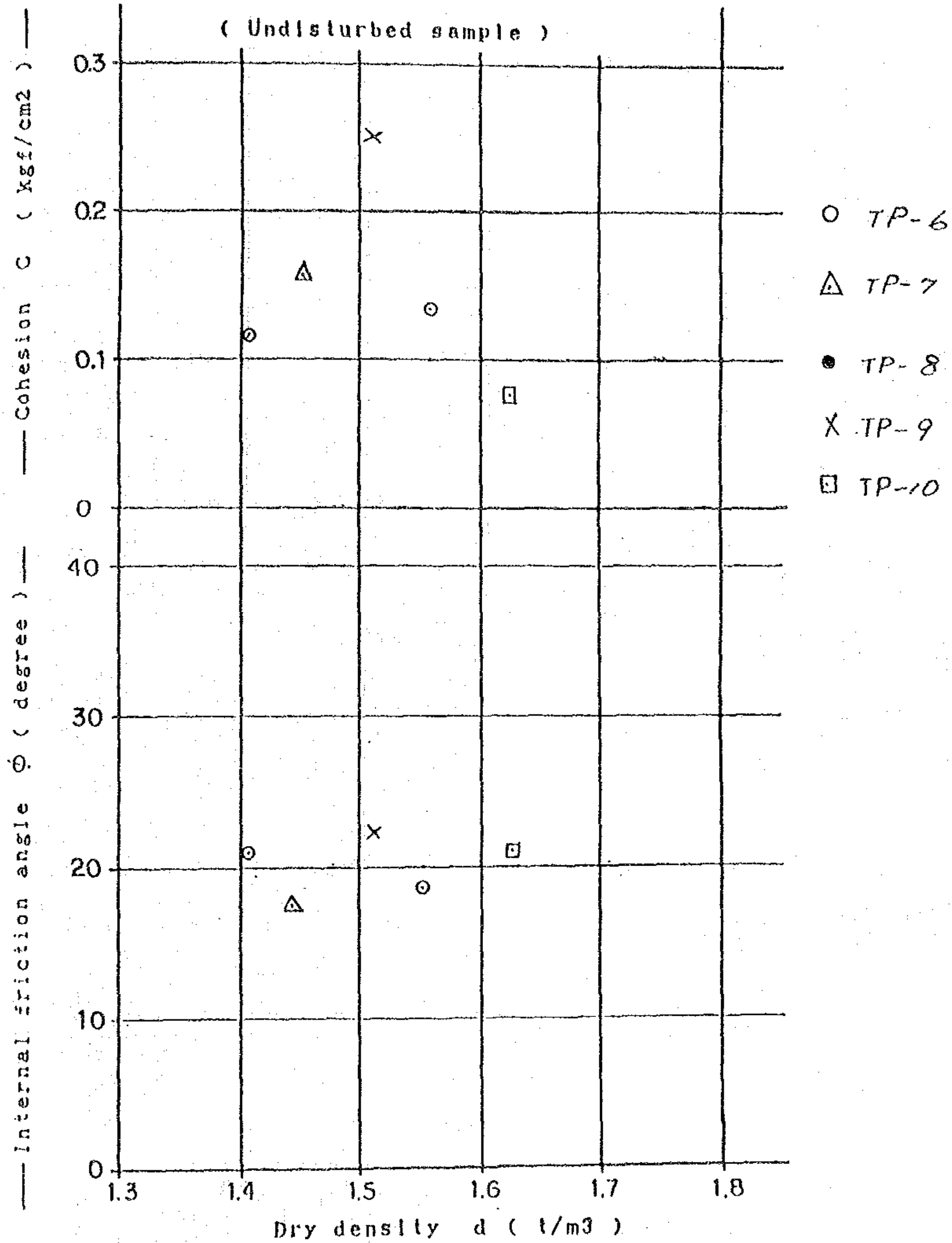


Fig.13(2) Direct Shear Test Results(2)

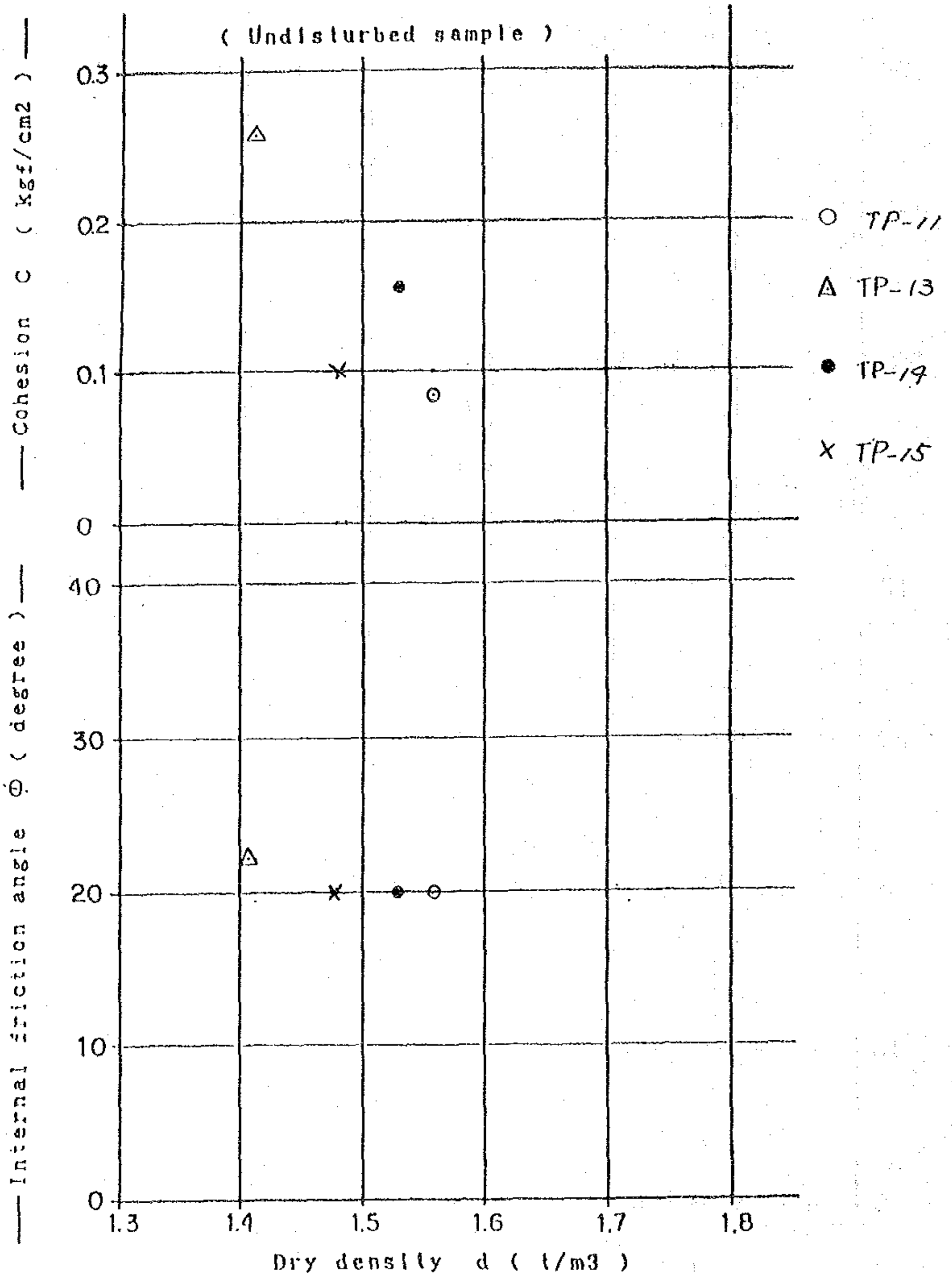


Fig.13(3) Direct Shear Test Results(3)

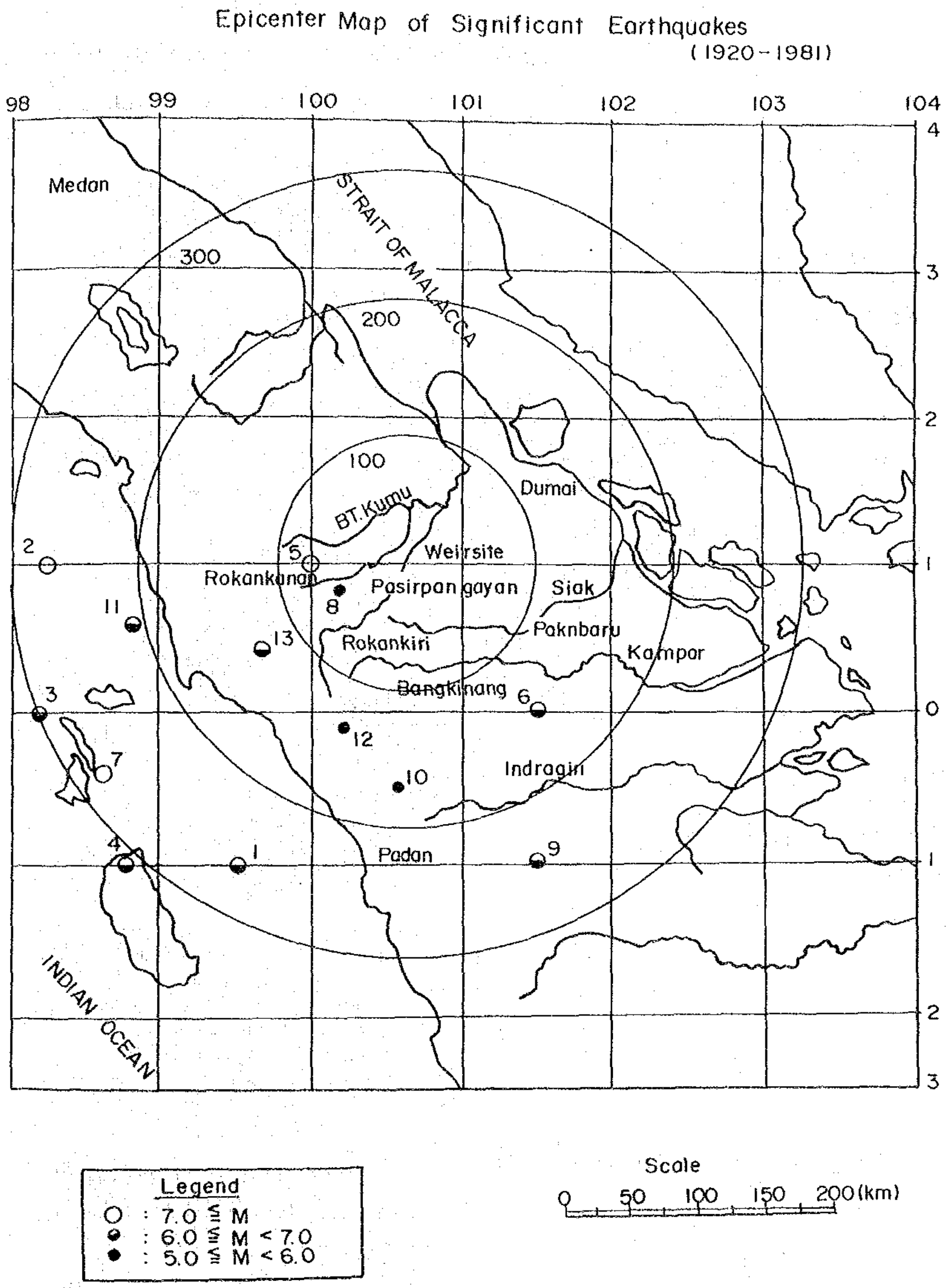
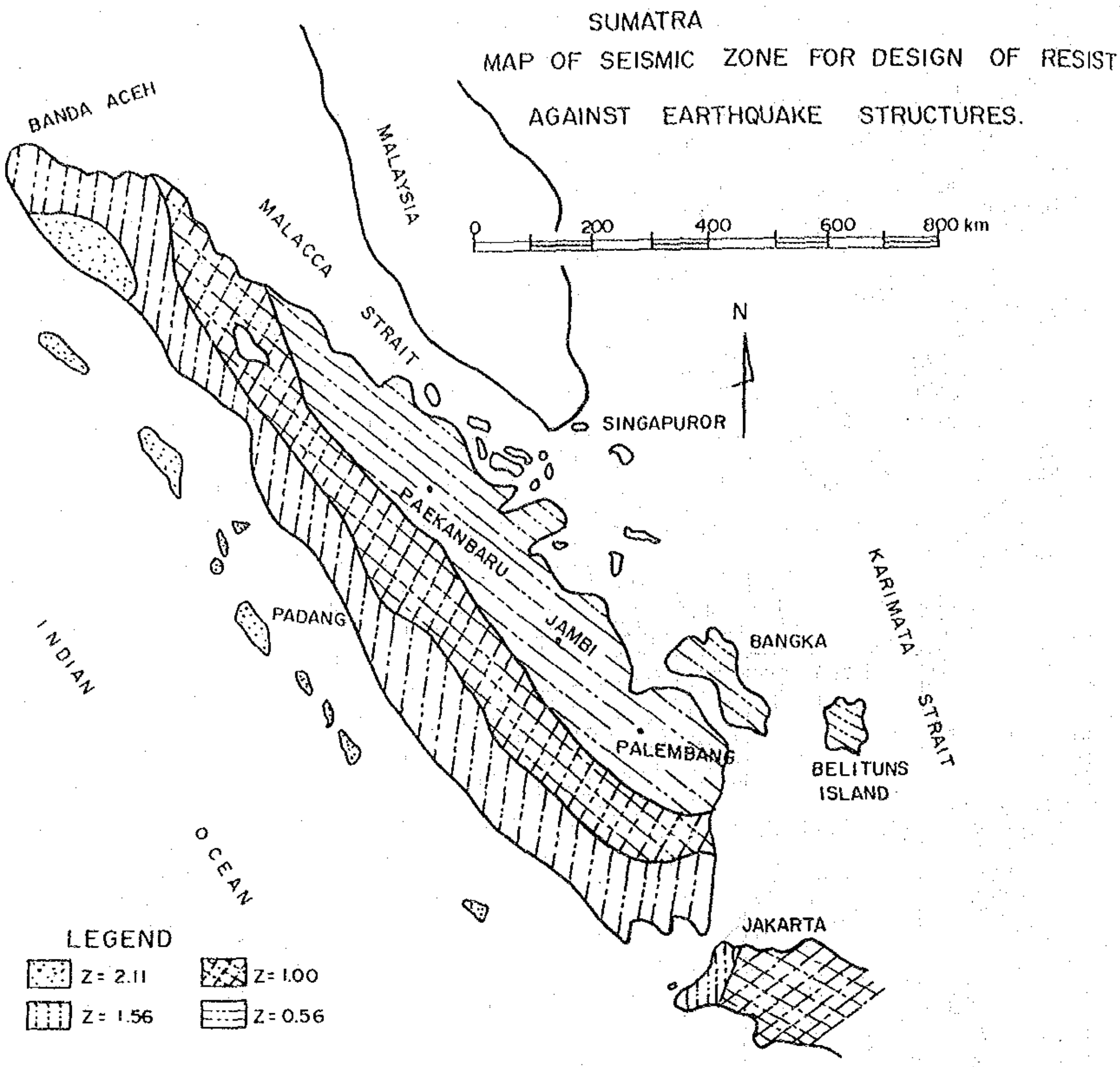


Fig.14 Epicenter Map of Significant Earthquakes



$$a d = b_1 (a c \times Z)^{b_2}$$

$$K = \frac{a d}{g}$$

a d = Acceleration of desion earthquake.
a₁ b2 = Couticiem of soil rock.
a c = Acceleration of base earthquake
K = Coelicient of earthquake.
g = Gravitation = 980 (cm sec^2)
T = Turnperiod average.
1gal = 1 cm/del2
Z = Cocficent of Zone.

CORRECTION FACTOR OF SOIL ROCKCLASS

SOIL CLASS	b1	b2
ROCK	2.76	0.71
Dilluvium	0.97	1.05
Alluvium	1.56	0.89
Soil Alluvium	0.29	1.32

TURN PERIOD (T) ACCELERATION OR DASE EARTHQUAKE

T(year)	ac(gal)	T(year)	ac(gal)
20	86	50	113
100	160		

Fig.15 Map of Seismic Zone for Design of Resist against arthquake Structures

ANNEX C

SOIL AND LAND USE

ANNEX C : SOIL AND LAND USE

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List of Tables

1. Objectives

Within the framework of Rokan River Basin Overall Irrigation Project Plan Study, the Lower Rokan Kiri Area was selected as a priority area for the feasibility study of irrigation project during Phase-I study. Aerial photographs of the target area were then taken on November 1991 with an approximate photo-scale of 1:20,000. The topographic maps used for the current survey are of 1:5,000 scaled which were prepared based on the said aerial photographs. The survey area for the feasibility study was therefore the area covered by those topographic maps including the area proposed for the weir site.

The soil and land use study was carried out in order to set up the rationalized land use plan of the proposed development area. This annex deals with all the study results obtained through the current soil and land use study.

The present study was carried out stepwise by three (3) phases, namely (i) soil and land suitability classification, (ii) present land use analysis and (iii) land use planning.

The soil survey was carried out to collect detail soil information of the survey area aiming at (i) identification and classification of major soil units of the survey area, (ii) clarification of distribution pattern of major soil units and their physiographic positions, and (iii) verification of physical and chemical properties of major soil units by laboratory test. The land suitability classification was then carried out for paddy, upland crops and perennial crops mainly based on the FAO system and the criteria by the Soil Research Institute, Bogor (TOR No. 59b/1982).

The present land use analysis aims at clarification of the prevailing land use patterns and verification of constraints against maximum utilization of land resources for agricultural development.

Land use plan was formulated as an ultimate products of the present study taking all the results of agronomy, land suitability classification, hydrology, socio- and agro-economy into consideration.

2. Survey Area

The survey area is situated on both sides of Rokan Kiri River with a total extent of 41,336 ha which is broadly divided into two areas; the Rokan Kiri left bank (24,382 ha) and the Rokan Kiri right bank (16,954 ha).

The physiography of the survey area is characterized by the flat alluvial plain on both sides of Rokan Kiri River, flat or almost flat terraces and undulating hills at the southern fringes.

The alluvial plain runs from southwest to northeast in the survey area and the soils in this area have been derived from recent alluvial deposits. The considerable part of this area is covered by grass, bush and/or secondary forest. This implies that the area has been extensively utilized for human activities such as crop production.

The terraces cover the major part of the survey area and are found on both banks of the Rokan Kiri River. These terraces are almost flat with less than 2% slope but are slightly declining from about 40 meter above mean sea level in the southeast to about 20 meter in the northeast. In the right bank of the Rokan Kiri River, the border of the terrace and alluvial plain is gradual. On the other hand, there are escarpments between terrace and alluvial plain in the left bank.

The undulating hills in the southern fringes of the survey area are mainly utilized for the large scale plantation of oil palms.

3. Soil Study

3.1 Survey Methods

The detailed soil survey for about 10,000 ha in the survey area has already been carried out by P.T. ISUDA during November 1991 and January 1992. The soil map was prepared and the land suitability of each soil type was studied for paddy, upland crops and perennial crops, respectively. This information was fully taken into consideration for the current field survey.

Prior to the field survey, pre-study on the physiographic condition of the survey area was made using the topographic maps scaled on 1:5,000 and the aerial photographs scaled on 1:20,000. The profile pit and/or auger boring were then made at the selected points in the survey area. The total observation amounts to 53 of which 12 were of profile observation by digging test pit and described according to the FAO Guideline for Soil Profile Description. The soil profile descriptions are presented in Table 3.1.

At those profile pits, 36 soil samples from respective soil layer were collected for the laboratory test. The items of physico-chemical analysis are as follows:

- Mechanical Analysis (Soil Texture)
- pH (H2O, KCl)
- Electric Conductivity
- Cation Exchange Capacity (CEC)
- Exchangeable Base(Ca, Mg, Na, K and Al)
- Total Carbon
- Total Nitrogen
- Organic Matter
- Available Phosphate
- Soluble Cations and Anions

The results of physico-chemical analysis of sample soils are presented in Table 3.2.

3.2 Major Soils

Based on the physiographic conditions and the results of laboratory analysis, the major soils in the survey area are classified into Tropodults, Dystropepts, Tropaquepts and Tropofluvents according to the U.S. Soil Taxonomy. Table 3.3 shows the correlation of three soil classification systems, they are INDONESIAN (TOR No. 59a/1983, PUSAT PENELITIAN TANAH), FAO/UNESCO and USDA systems.

Soils on undulating hills in the southern fringes of the survey area are mainly classified into Tropodults (Acrisols). These soils have been derived from quaternary deposits through weathering and leaching. They are more or less well drained and have been utilized for shifting cultivation. In these days, however, considerable area have been brought under large scale plantation of oil palm.

Soils on the terraces can be classified either Dystropepts/Humitropepts (Cambisols) or Tropaquepts (Gleisols). Dystropepts/Humitropepts are found on the terrace of both banks and the escarpment slopes. Texture of this soil varies from sandy loam to clay and the drainage conditions are moderately well to somewhat poor. Aquic Dystropepts are distributed at low relief with rather high groundwater table of about 50-100 cm. Tropaquepts, on the other hand, extend their area only on the terrace of left bank of the river. These soils are strongly affected by high groundwater table which is generally at or near the surface. The soil is characterized by a deep black humic layer at the surface. In most cases, white sandy sediments underlie below 50-90 cm from the ground surface.

The presence of Tropohemists (Histosols) in the survey area was suggested by the careful interpretation of landsat image. This was practically confirmed by the soil survey done by P.T. ISUDA. Furthermore, according to the information obtained through inhabitants of transmigration area, the presence of Tropohemists in some depressions was also confirmed. It was, however, difficult to demarcate the exact distribution area of these soils. These soils are scatteredly distributed within the area of Tropaquepts.

Dominant soil types of alluvial plain in both sides of the river are Tropofluvents (Fluvisols). These soils have been derived from recent alluvial deposits. The effective soil depth is deep to very deep. In some cases, the soils have been influenced by high water table and periodic stagnant water by seasonal flood. The frequency of flood reported by the villagers was approximately once per 5 years.

3.3 Soil Mapping Unit

It is quite difficult to illustrate the distribution and extent of each soil type on map, because they are fractionally dispersed and intricated each other. An appropriate soil mapping unit was therefore prepared in order to illustrate the general distribution of various major soil groups. Five mapping units were distinguished by applying the soil association system based on the physiographic soil features in the survey area.

The soil distribution map is shown in Fig. 2.2.4.1 of the main report of Volume III. The acreage and the proportional extent of each soil mapping unit are shown in Table 3.4.

(1) Soil Mapping Unit 1: Association of Typic Tropodults and Typic Dystropepts

This mapping unit is observed on the undulating hills in the southern fringes of the survey area. The lands of this unit are gently sloping or undulating with the drainage condition of moderately well to well. Many oil palm plantations have been established in the land of this unit.

(2) Soil Mapping Unit 2: Association of Typic Tropodults, Typic Dystropepts and Humitropepts

This mapping unit exists on or near the edge of the terraces and on the escarpment slopes between terrace and alluvial plain mainly in the left bank of the Rokan Kiri river. The lands of this unit are gently sloping to sloping with the drainage condition of somewhat poorly to moderately well. Erodibility is rather high in this unit due to the topographic feature of the land. The white sandy layer was exposed due mainly to the vegetation clearance at some points in this unit.

(3) Soil Mapping Unit 3: Association of Typic Dystropepts, Aquic Dystropepts and Humitropepts

This mapping unit widely extends over the flat terraces in both banks of the Rokan Kiri river. The land of this unit is flat to almost flat with slopes less than 2%. The soils are moderately deep to deep and the texture is mainly fine. The drainage condition is generally somewhat poorly and strongly affected by the micro-relief of the land. Aquic Dystropepts can be found at lower relief showing hydromorphic properties below 50cm but within 100cm of the surface.

(4) Soil Mapping Unit 4: Association of Histic Tropaquepts, Humitropepts and Tropohemists

This mapping unit exists on the terraces mainly in the left bank of the Rokan Kiri river. The land of this unit is flat or slightly depressed and the drainage condition is poorly to very poorly. The soils are influenced by permanent high water table showing hydromorphic properties within 50cm of the surface. The topsoils are very dark colored, thick and are rich in organic matter. The white sandy sediments can typically be found below 50 to 90cm from the ground surface in the land of this unit.

(5) Soil Mapping Unit 5: Association of Tropofluvents, Aquic Tropofluvents and Typic Tropaquepts

This mapping unit covers the alluvial plains of the Rokan Kiri river. The land of this unit is flat to almost flat with slopes less than 2%. The soils of this unit have been derived from recent alluvial deposits. They are deep, generally silty clay loam to clay in texture and are somewhat poorly drained. These soils have more favorable conditions in soil fertility than the other soils.

4. Land Suitability

4.1 General

To assess land development potentials of the survey area, the land suitability classification was carried out. The lands were assessed mainly based on the principles of the FAO system and the criteria proposed by the Soil Research Institute, Bogor (TOR No. 59b/1982) with some modification.

According to the FAO system, the land suitability for each specific utilization is classified into 5 classes depending on the degree of suitability and the definitions of such land classes are given as follows:

S1 : Highly Suitable

Land having no significant limitations to sustained application of a given use, or only minor limitations that will not significantly reduce productivity or benefits and will not raise inputs above an acceptable level.

S2 : Moderately Suitable

Land having limitations which, in aggregate, are moderately severe for sustained application of a given use; the limitations will reduce productivity or benefits, and increase required inputs to the extent that the overall advantage to be gained from the use, although still attractive, will be appreciably inferior to that expected on Class S1 land.

S3 : Marginally Suitable

Land having limitations which, in aggregate, are severe for sustained application of a given use and will so reduce productivity or benefits, or increase required inputs, that this expenditure will be only marginally justified.

N1 : Currently not Suitable

Land having limitations which may be surmountable in time, but which cannot be corrected with existing knowledge at currently acceptable cost; the limitations are so severe as to preclude successful sustained use of the land in the given manner.

N2 : Permanently not Suitable

Land having limitations which appear so severe as to preclude any possibilities of successful sustained use of the land in the given manner.

4.2 Rating Specifications

The following land qualities were selected to assess the suitability of each soil unit for different purposes such as paddy, upland crops and perennial crops. The specification of land suitability classification based on the Soil Research Institute, Bogor is shown in Table 4.1.

(1) Effective Soil Depth
(2) Topsoil Texture
(3) Permeability of Subsoil
(4) Gravel Contents in Topsoil
(5) Soil Fertility
(6) Soil Reaction (pH)
(7) Aluminum Saturation
(8) Slope and Land Form
(9) Micro-relief
(10) Erodibility
(11) Drainability
(12) Frequency of Flood Hazard
(13) Salinity

4.3 Land Suitability Classification

Each land unit was evaluated in terms of its suitability for paddy, upland crops and perennial crops (Fig. 2.2.5.1 to 2.2.5.3 of the main report of Volume III). The evaluation was made by taking the following improvement to be carried out through the project implementation into consideration. Suitability evaluation of each soil mapping unit is shown below and the detailed analysis is shown in Table 4.2.

- Accumulation of silt by irrigation water will improve the permeability condition of subsoil specially for paddy field.

- Application of fertilizer and manure will improve the soil fertility of paddy and upland crops to a certain extent.

- Soil reaction in the paddy field will be improved by the saturation of irrigation water and/or lime application.

- Drainage condition will be improved by preparing artificial drainage network.

Soil Mapping Unit	Paddy	Upland Crops	Perennial Crops
Unit 1	N1td	S3nte	S3ne
Unit 2	N1td	S3nte	S3ne
Unit 3	S3t	S3n	S3n
Unit 4	S3t	S3nd	S3nd
Unit 5	S2tdf	S2nedf	S2ned

(1) Land Suitability for Paddy

Undulating hills and escarpment slopes are currently not suitable for paddy due mainly to rather steep topography and the moderately well to well drainage condition.

Terrace soils are marginally suitable for paddy due to a high degree of the micro-relief.

Alluvial soils are moderately suitable for paddy cultivation. The degree of micro-relief, the somewhat poor drainage condition and the frequency of flood hazard are moderate limitations.

(2) Land Suitability for Upland Crops

Undulating hills and escarpment slopes are marginally suitable for the cultivation of upland crops. The low fertility status of the soils is one of the limitations. The lands are susceptible to erosion due to their gently sloping to undulating topography.

Terrace soils are also marginally suitable for upland crops. The low fertility status of the soils is the main limitation. The poor to very poor drainage conditions are the other limitation for the soils under the soil mapping unit 4.

Alluvial soils are moderately suitable for the cultivation of the upland crops. The low soil fertility, the erodibility, the somewhat poor drainage condition and the frequency of flood hazard are moderate limitations.

(3) Land Suitability for Perennial Crops

Undulating hills and escarpment slopes are marginally suitable for the cultivation of perennial crops due mainly to the low soil fertility and erodibility.

Terrace soils are also marginally suitable for perennial crops. The low fertility status of the soils is the main limitation. The poor to very poor drainage conditions are the other limitation for the soils under the soil mapping unit 4.

Alluvial soils are moderately suitable for the cultivation of the perennial crops. The low soil fertility, the erodibility and the somewhat poor drainage condition are moderate limitations.

5. Present Land Use

5.1 Survey Methods

The land use survey was made by using aerial photographs and topographic maps recently prepared for this study. Confirmation survey was also carried out by ground truth.

Firstly, the tentative land use/vegetation map was prepared based on the aerial photographs scaled on 1:20,000. Special attention was paid for the demarcation of primary and secondary forests, since the border of those categories was clearly distinguished on the aerial photographs. The detailed classification for farm land, grassland and others was carried as a second step based on the topographic map scaled on 1:5,000 and the results of the ground truth.

5.2 Present Land Use

The present land use/vegetation map of the survey area is shown in Fig. 2.4.1.1 of the main report of Volume III. Table 5.1 shows the acreage and the proportional extent of each category in the survey area.

Primary forests are the thick tropical rain forests with fully developed stratification. The first layer is composed of large trees about 30-35 m in height with discontinued canopy surface. While, thickly populated trees about 20 m in height with continued canopy surface constitute the second and/or third layer. Under these tree layers, usually, bush and floor layers are existing. These forests occupy more than 40% of the survey area.

Secondary forests, on the other hand, have been established after certain human activities and the average tree height is about 10-20 m. These forests are composed of pioneer species and are densely populated with very flat canopy layer. They are clearly distinguished from primary forests and are mainly distributed around the river course of Rokan Kiri. A part of these forests is being utilized for the small scale plantation of rubber plants. These areas are mainly distributed around original villages such as Kota Lama and Kota Intan.

Bush/grass lands are distributed near the river course, around the road systems and the periphery of transmigration areas. A part of this area is also categorized as the small scale plantation area of young rubber trees. These areas are mainly distributed around the original villages and also around the new villages such as Kota Baru, Kota Raya and Muara Jaya.

Alang-alang lands can intensively be found at the periphery of the developed area for transmigration activities. These lands can be considered to have been formed through abandonment of the field once cleared for transmigration activities and also for shifting cultivation.

Farm lands are mainly utilized for the cultivation of upland crops. These fields are found in both the river course and transmigration areas. The main upland crop is dry land rice and the other crops such as maize, peanut and soybean are also cultivated. Wet land rice have been cultivated within a very limited area mainly at Kota Intan, SKP-A and Kota Raya.

Plantation areas are distributed in the southern fringes of the survey area mostly on the undulating hills. Oil palms are mainly cultivated under large scale commercial plantation.

Residential areas are the transmigration areas and the original villages such as Kota Lama, Kota Intan and Muara Dilam. Within the residential area, about 800 ha are utilized for gardens around the houses. Of those, the area about 275 ha is utilized for the cultivation of vegetable crops such as sweet potato, cassava, green beans and others. The remaining areas are mainly utilized for the cultivation of tree crops such as coconut, coffee and clove.

6. Land Use Plan

6.1 Land Development Potentials

According to the information on soil condition, present land use condition and other physical and social factors, the following points have been taken into consideration for the formulation of a rationalized land use plan.

- The land near the edge of the terraces and on the escarpment slopes (Soil Mapping Unit 2) should be protected from soil erosion by conserving the existing vegetation cover.

- Priority should be given to the alluvial plains (Soil Mapping Unit 5) as a potential area for the agricultural development due to its rater high suitability to the crop production. An appropriate flood protection measures should, however, be taken for the effective development. A part of alluvial plains with very high probability of flood hazard should be avoided from the potential area.

- According to the result of the present land use, the primary forests occupy more than 40% of the survey area. Although these primary forests belong to the conversion forest which could be utilized for agriculture, they play very important roles in the environment. The forests on the undulating hills and the escarpment slopes are not only protecting the erosion of surface soils but also helping the recharge of rain water. Furthermore, these forests provide the inhabitants with a considerable amount of fuel wood for their cooking and other purposes. The effective conservation of these forest resources should therefore be considered very carefully.

- The area of bush/grass Lands and alang-alang Lands should selectively be converted to a potential area for agricultural development due to their easy accessibility.

The gross area to be developed as a first stage was thus designated as shown in Fig.3.2.1.1 of the main report of Volume III. Soil distribution and the present land use in the gross area is characterized as follows (Table 6.1/Table 6.2);

- The total acreage of the gross area is 12,200 ha. Of which 8,062 ha is in the left bank of the river. Nearly 60 % of the area is occupied by Gleisols and more than 25 % is Fluvisols. Those area will mainly be utilized for paddy cultivation. About 10 % of the area is escarpment slopes which should be protected from soil erosion by conserving the existing vegetation cover. About 65 % of the total area is occupied by the primary and secondary forest and about 25 % is covered by bush, grass and alang-alang. Consequently, the remaining 10 % is being utilized for crop cultivation and residential area.

- As for the right bank, the land of 4,138 ha was picked up along the existing road system. The main soil type in this area is Cambisols which occupies more than 80 % of the total area. The rest of the area is covered by Fluvisols. The primary and secondary forest occupies more than 75 % of the area and more than 20 % of the area is covered by bush, grass and alang-alang. The existing crop fields and residential area thus occupies only a few percent of the area.

6.2 Future Land Use

The future land use plan of the gross area has been proposed by taking the existing settlements and new transmigration program into account. The land allocation is designed according to the following basis;

- Net irrigation area per 1 H/H : 1.75 ha
- Residential area including home yard per 1 H/H : 0.25 ha
- Public area per 1 H/H : 0.25 ha
- Right of Way : 5 % of the total of above 3 items

Table 6.3 shows the proposed land allocation in the gross area. The land of 2,643 ha was allocated for the total of 1,120 H/H in the existing transmigration area. The land was also allocated for the people in Teluk Sono and Muara Dilam based on the same principle. For the people form Kota Lama and Kota Intan, however, the village areas (residential area and public area) was excluded. The new transmigration programme should consequently be planned for the total of 2,254 H/H to be allocated in the area of 5,320 ha which is about 44 % of the gross area.

Table 6.4 shows the comparison between the present land use and the proposed land use in the gross area. The net irrigable area under the proposed land use is 8,300 ha (68 % of the gross area) in total which will mainly be availed for paddy and upland crop cultivation. The area which is currently not suitable for the crop cultivation (10 % of the gross area) will be protected against soil erosion by maintaining the present vegetation cover. The village areas for the new immigrants will be developed according to the new transmigration programme. The existing village areas will also be developed by expanding the home yard and public spaces as per above mentioned principle.

Table 3.1 (1) : Soil Profile Description (1)

GENERAL

Date	: 16th February, 1992
Profile No.	: No. 1
Soil Mapping Unit	: Unit 3
Soil Classification	:
Indonesian system	: Kambisol Distrik
FAO system	: Distric Cambisols
USDA system	: Typic Dystropepts
Description Kind	: Profile Pit

SITE DESCRIPTION

Location	: 9.0 Km southwest of SKP-A
Elevation	: El. 33m amsl
Physiography	: Terrace
Slope	: Flat
Vegetation/Land Use	: Bush/Secondary forest
Drainage Condition	: Somewhat poorly
Groundwater Table	: 80cm from soil surface

SOIL PROFILE DESCRIPTION

A	0 - 2 cm	Brown (10YR4/4) moist; light clay; structureless crumb; friable moist; few fine pores; few small roots; clear irregular boundary;
B1	2 - 40 cm	Yellowish brown (10YR5/6) moist; heavy clay; weak very coarse sabangular blocky; slightly sticky wet; few small pores; smooth diffuse boundary;
B2	40 - 60 cm	Yellowish brown (10YR5/8) moist; heavy clay; moderate medium sabangular blocky; slightly sticky wet; common small pores;

Table 3.1 (2) : Soil Profile Description (2)

GENERAL

Date	: 16th February, 1992
Profile No.	: No. 2
Soil Mapping Unit	: Unit 3
Soil Classification	:
Indonesian system	: Kambisol Gleiik
FAO system	: Gleyic Cambisols
USDA system	: Aquic Dystropepts
Description Kind	: Profile Pit

SITE DESCRIPTION

Location	: 2.0 Km southwest of SKP-A
Elevation	: El. 30m amsl
Physiography	: Terrace
Slope	: Flat
Vegetation/Land Use	: Alang-alang
Drainage Condition	: Somewhat poorly
Groundwater Table	: 70cm from soil surface

SOIL PROFILE DESCRIPTION

A	0 - 10 cm	Dark grayish yellow (2.5Y5/2) moist; light clay; weak fine subangular blocky; slightly sticky wet; common medium pores; common small roots; gradual wavy boundary;
B1	10 - 36 cm	Light gray (2.5Y7/1) moist; heavy clay; moderate medium sabangular blocky; sticky wet; few small pores; few fine roots; diffuse smooth boundary;
B2	36 - 80 cm	Grayish yellow (2.5Y6/2) moist; heavy clay; moderate medium sabangular blocky; sticky wet; few medium pores; few fine roots;

Table 3.1 (3) : Soil Profile Description (3)

GENERAL	
Date	: 17th February, 1992
Profile No.	: No. 3
Soil Mapping Unit	: Unit 3
Soil Classification	:
Indonesian system	: Kambisol Gleiik
FAO system	: Gleyic Cambisols
USDA system	: Aquic Dystropepts
Description Kind	: Profile Pit
SITE DESCRIPTION	
Location	: 3.5 Km north of SP-3
Elevation	: El. 41m amsl
Physiography	: Terrace
Slope	: Flat (summit of micro-relief)
Vegetation/Land Use	: Alang-alang with burnt trees
Drainage Condition	: Somewhat poorly
Groundwater Table	: 40 cm from soil surface

SOIL PROFILE DESCRIPTION

A	0 - 10 cm	Dark brown (10YR3/3) moist; weak fine crumb; slightly sticky wet; common fine pores; common big roots; gradual wavy boundary;
B1	10 - 30 cm	Bright yellowish brown (10YR6/6) moist; silty clay; weak fine subangular blocky; sticky wet; few small pores; few big roots; diffuse smooth boundary;
B2	30 - 80 cm	Bright yellowish brown (10YR7/6) moist; light clay; weak medium subangular blocky; sticky wet; few small pores; few big roots;

Table 3.1 (4) : Soil Profile Description (4)

GENERAL

Date	: 17th February, 1992
Profile No.	: No. 4
Soil Mapping Unit	: Unit 4
Soil Classification	:
Indonesian system	: Gleisol Histik
FAO system	: Humic Gleysols
USDA system	: Histic Tropaquepts
Description Kind	: Profile Pit

SITE DESCRIPTION

Location	: 7.0 Km north of SP-2
Elevation	: El. 30m amsl
Physiography	: Terrace
Slope	: Flat
Vegetation/Land Use	: Primary forest
Drainage Condition	: Poorly (artificially drained)
Groundwater Table	:

SOIL PROFILE DESCRIPTION

Ao(F)	0 - 5 cm	Organic matter
A1	5 - 15 cm	Brownish black (10YR3/2) moist; loam; very fine crumb; loose moist; few small pores; common fine roots; gradual wavy boundary;
B1	15 - 30 cm	Grayish olive (5Y4/2) moist; clay loam; weak fine crumb; friable moist; few fine roots; diffuse irregular boundary;
B2	30 - 40 cm	Grayish olive (5Y5/2) moist; loam; weak fine crumb; friable moist; few fine roots; gradual wavy boundary;
C	40 - 80 cm	Light yellow (2.5Y7/3) moist; clay loam; structureless crumb; firm moist;

Table 3.1 (5) : Soil Profile Description (5)

GENERAL

Date	: 17th February, 1992
Profile No.	: No. 5
Soil Mapping Unit	: Unit 4
Soil Classification	:
Indonesian system	: Gleisol Histik
FAO system	: Humic Gleysols
USDA system	: Histic Tropaquepts
Description Kind	: Profile Pit

SITE DESCRIPTION

Location	: 4.0 Km north of SP-1
Elevation	: El. 36m amsl
Physiography	: Terrace
Slope	: Flat
Vegetation/Land Use	: Edge of primary forest
Drainage Condition	: Poorly
Groundwater Table	: 40 cm from soil surface

SOIL PROFILE DESCRIPTION

Ao(F)	0 - 5 cm	Organic Matter
A1	5 - 25 cm	Brownish black (2.5Y3/2) moist; clay loam; moderate fine subangular blocky; slightly sticky wet; few small roots; gradual wavy boundary;
B	25 - 60 cm	Grayish yellow (2.5Y6/2) moist; clay loam; weak medium subangular blocky; slightly sticky wet; few big roots;

Table 3.1 (6) : Soil Profile Description (6)

GENERAL

Date	: 18th February, 1992
Profile No.	: No. 6
Soil Mapping Unit	: Unit 4
Soil Classification	:
Indonesian system	: Gleisol Histik
FAO system	: Humic Gleysols
USDA system	: Histic Tropaquepts
Description Kind	: Profile Pit

SITE DESCRIPTION

Location	: 2.5 Km northwest of SKP-B
Elevation	: El. 22m amsl
Physiography	: Terrace
Slope	: Flat
Vegetation/Land Use	: Edge of primary forest
Drainage Condition	: Poorly
Groundwater Table	: 25 cm from soil surface

SOIL PROFILE DESCRIPTION

Ao(H)	0 - 4 cm	Organic Matter
A1	4 - 25 cm	Black (7.5YR2/1) moist; weak fine subangular blocky; slightly sticky wet; few medium pores; few small roots; gradual wavy boundary;
B	25 - 50 cm	Dull yellowish brown (10YR5/4) moist; clay loam; sticky wet;

Table 3.1 (7) : Soil Profile Description (7)

GENERAL

Date	: 18th February, 1992
Profile No.	: No. 7
Soil Mapping Unit	: Unit 4
Soil Classification	:
Indonesian system	: Gleisol Histik
FAO system	: Humic Gleysols
USDA system	: Histic Tropaquepts
Description Kind	: Profile Pit

SITE DESCRIPTION

Location	: 0.2 Km south of SKP-B
Elevation	: El. 23m amsl
Physiography	: Terrace
Slope	: Flat
Vegetation/Land Use	: Edge of primary forest
Drainage Condition	: Poorly
Groundwater Table	: 25 cm from soil surface

SOIL PROFILE DESCRIPTION

Ao(H)	0 - 10 cm	Organic Matter
A1	10 - 25 cm	Black (7.5YR2/1) moist; moderate fine subangular blocky; sticky wet; few small pores; common big roots; gradual wavy boundary;
B	25 - 60 cm	Bright yellowish brown (10YR7/6) moist; sticky wet; few small roots;

Table 3.1 (8) : Soil Profile Description (8)

GENERAL

Date	: 18th February, 1992
Profile No.	: No. 8
Soil mapping Unit	: Unit 4
Soil Classification	:
Indonesian system	: Gleisol Histik
FAO system	: Humic Gleysols
USDA system	: Histic Tropaquepts
Description Kind	: Profile Pit

SITE DESCRIPTION

Location	: 1.0 Km northeast of SKP-B
Elevation	: El. 21m amsl
Physiography	: Terrace
Slope	: Flat
Vegetation/Land Use	: Bush
Drainage Condition	: Poorly (artificially drained)
Groundwater Table	: 105 cm from soil surface

SOIL PROFILE DESCRIPTION

A1	0 - 15 cm	Black (7.5YR2/1) moist; moderate medium granular; very friable moist; common fine pores; many small roots; gradual smooth boundary;
A2	15 - 40 cm	Brownish black (7.5YR3/1) moist; clay loam; moderate fine subangular blocky; friable moist; few small pores; common big roots; gradual wavy boundary;
B1	40 - 60 cm	Grayish brown (7.5YR4/2) moist; sandy loam; weak fine subangular blocky; slightly sticky wet; few small pores; few big roots; diffuse irregular boundary;
B2	60 - 85 cm	Dull yellow orange (10YR6/4) moist; clay loam; weak fine subangular blocky; slightly sticky wet; few small pores; clear irregular boundary;
C	85 - 105 cm	Light gray (5Y8/1) moist; light clay; structureless crumb; firm moist;

Table 3.1 (9) : Soil Profile Description (9)

GENERAL	
Date	: 19th February, 1992
Profile No.	: No. 9
Soil Mapping Unit	: Unit 5
Soil Classification	:
Indonesian system	: Aluvial Distrik
FAO system	: Distric Fluvisols
USDA system	: Typic Tropofluvents
Description Kind	: Profile Pit
SITE DESCRIPTION	
Location	: 1.2 Km northeast of Kota Lama
Elevation	: El. 38m amsl
Physiography	: Alluvial plain
Slope	: Flat
Vegetation/Land Use	: Secondary forest
Drainage Condition	: Somewhat poorly
Groundwater Table	:

SOIL PROFILE DESCRIPTION

A	0 - 10 cm	Brown (7.5YR4/3) moist; silty clay; weak medium subangular blocky; very friable moist; few small pores; few small roots; gradual wavy boundary;
B1	10 - 80 cm	Brown (7.5YR4/4) moist; few fine faint mottlings (7.5YR5/8); silty clay loam; moderate medium subangular blocky; friable moist; common small pores; few small roots; diffuse broken boundary;
B2	80 - 100 cm	Dull yellowish brown (10YR5/3) moist; silty clay loam; moderate coarse subangular blocky; slightly sticky wet; common small pores; few small roots;

Table 3.1 (10) : Soil Profile Description (10)

GENERAL

Date	: 19th February, 1992
Profile No.	: No. 10
Soil Mapping Unit	: Unit 5
Soil Classification	:
Indonesian system	: Aluvial Eutrik
FAO system	: Eutric Fluvisols
USDA system	: Aquic Tropofluvents
Description Kind	: Profile Pit

SITE DESCRIPTION

Location	: 1.5 Km east of Muara Dilam
Elevation	: El. 24m amsl
Physiography	: Alluvial plain
Slope	: Flat
Vegetation/Land Use	: Secondary forest
Drainage Condition	: Somewhat poorly
Groundwater Table	: 65 cm from soil surface

SOIL PROFILE DESCRIPTION

A	0 - 5 cm	Brownish black (10YR3/2) moist; moderate medium crumb; very friable moist; common small pores; medium small roots; clear smooth boundary;
B1	5 - 20 cm	Grayish olive (5Y5/2) moist; heavy clay; weak very coarse subangular blocky; slightly sticky wet; common medium pores; common big roots; diffuse broken boundary;
B2	20 - 70 cm	Bright yellowish brown (2.5Y6/6) moist; silty clay; moderate coarse subangular blocky; slightly sticky wet; few medium pores; few small roots;

Table 3.1 (11) : Soil Profile Description (11)

GENERAL

Date	: 20th February, 1992
Profile No.	: No. 11
Soil Mapping Unit	: Unit 4
Soil Classification	:
Indonesian system	: Kambisol Umbrik
FAO system	: Humic Cambisols
USDA system	: Humitropepts
Description Kind	: Profile Pit

SITE DESCRIPTION

Location	: 1.0 Km southeast of SKP-F
Elevation	: El. 31m amsl
Physiography	: Terrace
Slope	: Flat
Vegetation/Land Use	: Bush/Secondary forest
Drainage Condition	: Somewhat poorly
Groundwater Table	:

SOIL PROFILE DESCRIPTION

A11	0 - 8 cm	Black (7.5YR2/1) moist; loam; moderate fine crumb; loose moist; common fine pores; common fine roots; clear irregular boundary;
A12	8 - 35 cm	Dull yellowish brown (10YR4/3) moist; loam; moderate fine subangular blocky; very friable moist; few fine pores; few small roots; gradual irregular boundary;
B	35 - 80 cm	Light gray (2.5Y7/1) moist; common medium distinct mottlings (7.5YR6/8); clay loam; moderate medium subangular blocky; friable moist;

Table 3.1 (12) : Soil Profile Description (12)

GENERAL

Date	:	20th February, 1992
Profile No.	:	No. 12
Soil Mapping Unit	:	Unit 2
Soil Classification	:	
Indonesian system	:	Kambisol Umbrik
FAO system	:	Humic Cambisols
USDA system	:	Humitropepts
Description Kind	:	Profile Pit

SITE DESCRIPTION

Location	:	8.0 Km southwest of SKP-F
Elevation	:	El. 36m amsl
Physiography	:	Edge of Terrace
Slope	:	Flat
Vegetation/Land Use	:	Secondary forest
Drainage Condition	:	Moderately well
Groundwater Table	:	

SOIL PROFILE DESCRIPTION

A11	0 - 8 cm	Brownish black (7.5YR3/1) moist; clay loam; weak fine subangular blocky; very friable moist; few small pores; common small roots; gradual irregular boundary;
A12	8 - 20 cm	Brownish gray (7.5YR4/1) moist; clay loam; weak fine subangular blocky; very friable moist; few small pores; common small roots; clear wavy boundary;
B	20 - 80 cm	Dull yellow orange (10YR7/2) moist; light clay; weak medium subangular blocky; friable moist; few fine pores; few medium roots;

Table 3.2 Chemical and Physical Properties of Sample Soils

Profile Number	Layer	Depth (cm)	Soil Texture: Sand (%)	Silt (%)	Clay (%)	Classification	EC(1:5) mmho/cm	pH (1:5) H2O	pH (1:5) KCl	Total C (%)	Total N (%)	C/N Ratio	Org-Matter	P2O5 Bray I (ppm)	P2O5 HCl (25%) (mg/100g)	K2O	Exchangeable Cations (me/100g) Ca	Mg	Na	K	Al	H	CEC (me/100g)	Saturation ratio (%) Base	Al	Soluble Cation and Anion (me/100g) Ca	Mg	Na	K	Cl	SO4
1-1	A	0-2	40.7	26.4	32.9	Light Clay	0.0230	5.35	4.20	1.14	0.10	11.4	2.13	1.63	6.25	23.69	0.92	0.69	0.62	0.27	1.75	0.04	14.67	17.04	11.93	0.250	0.210	0.060	0.200	0.015	0.026
1-2	B1	2-40	35.3	18.7	46.0	Heavy Clay	0.0086	4.61	3.99	0.51	0.06	8.5	0.95	1.26	3.79	14.86	0.27	0.37	0.66	0.13	4.60	0.06	18.17	7.87	25.32	0.020	0.070	0.090	0.050	0.066	0.227
1-3	B2	40-60	30.8	19.4	49.8	Heavy Clay	0.0066	4.82	4.00	0.38	0.06	6.3	0.71	0.63	5.76	14.45	0.24	0.36	0.63	0.15	4.28	0.29	18.69	7.38	22.90	0.005	0.060	0.080	0.070	0.015	0.191
2-1	A	0-10	13.5	44.0	42.5	Light Clay	0.0399	5.52	4.32	4.86	0.27	18.0	9.09	15.15	16.20	19.37	2.00	1.41	0.67	0.29	0.79	0.38	22.36	19.54	3.53	0.160	0.350	0.050	0.220	0.038	0.029
2-2	B1	10-36	18.4	27.4	54.2	Heavy Clay	0.0166	4.79	4.02	0.93	0.10	9.3	1.74	4.42	3.79	23.42	0.42	0.44	0.64	0.36	4.68	0.52	24.80	7.50	18.87	0.090	0.120	0.070	0.120	0.023	0.012
2-3	B2	36-80	11.7	24.5	63.8	Heavy Clay	0.0138	4.61	3.98	0.47	0.08	5.9	0.88	0.49	2.35	9.64	0.28	0.38	0.61	0.20	5.24	0.59	22.36	6.57	23.43	0.060	0.110	0.170	0.130	0.045	0.105
3-1	A	0-10	-	-	-	-	0.1270	5.21	3.91	10.42	0.46	22.7	19.49	26.11	28.00	21.71	1.95	1.82	0.71	0.69	2.62	0.52	26.20	19.73	10.00	0.930	0.350	0.260	0.080	0.085	0.071
3-2	B1	10-30	18.7	46.4	34.9	Silty Clay	0.3850	3.98	3.62	2.51	0.17	14.8	4.69	7.93	12.95	19.36	0.29	0.73	0.78	0.37	8.25	4.84	25.15	8.63	32.80	0.390	0.360	0.120	0.090	0.149	0.528
3-3	B2	30-80	28.1	36.9	35.0	Light Clay	0.0256	4.59	3.83	0.86	0.10	8.6	1.61	2.25	3.32	19.72	0.03	0.58	0.70	0.29	10.63	1.56	26.72	5.99	39.78	0.030	0.350	0.120	0.060	0.077	0.160
4-1	Ao	0-5	-	-	-	-																									
4-2	A1	5-15	54.6	34.0	11.4	Loam	0.0496	5.33	4.26	4.85	0.25	19.4	9.07	13.76	13.48	16.03	0.40	0.42	0.75	0.18	1.75	0.31	15.72	11.13	11.13	0.010	0.100	0.090	0.100	0.069	0.053
4-3	B1	15-30	49.4	26.1	24.5	Clay Loam	0.0214	5.23	4.80	1.65	0.10	16.5	3.09	5.05	5.76	5.78	0.26	0.31	0.68	0.10	0.30	0.06	8.38	16.11	3.58	0.000	0.030	0.070	0.030	0.030	0.031
4-4	B2	30-40	51.3	36.3	12.4	Loam	0.0183	5.22	4.80	0.93	0.07	13.3	1.74	2.51	3.32	9.55	0.29	0.31	0.69	0.10	0.32	0.04	7.16	19.41	4.47	0.000	0.020	0.030	0.020	0.015	0.016
4-5	C	40-80	50.6	33.2	16.2	Clay Loam	0.0147	4.99	4.61	0.44	0.05	8.8	0.82	1.37	7.75	2.88	0.25	0.31	0.68	0.10	0.40	0.05	7.51	17.84	5.33	0.000	0.030	0.050	0.020	0.015	0.013
5-1	Ao	0-5	-	-	-	-																									
5-2	A1	5-25	54.5	30.5	15.0	Clay Loam	0.2000	5.30	4.40	2.18	0.16	13.6	4.08	6.62	23.54	11.80	0.26	0.32	0.67	0.11	1.03	0.23	11.53	11.80	8.93	0.010	0.060	0.140	0.050	0.045	0.035
5-3	B	25-60	54.0	22.6	23.4	Clay loam	0.1090	4.75	4.32	0.51	0.06	8.5	0.95	3.77	2.83	5.94	0.35	0.34	0.75	0.10	1.07	0.45	9.26	16.41	11.56	0.010	0.040	0.040	0.020	0.023	0.004
6-1	Ao	0-4	-	-	-	-																									
6-2	A1	4-25	-	-	-	-	0.0348	5.01	4.25	11.24	0.39	28.8	21.02	3.77	37.93	18.92	0.03	0.39	0.70	0.17	2.06	1.21	49.95	2.58	4.12	0.004	0.070	0.110	0.090	0.085	0.086
6-3	B	25-50	38.6	43.1	18.3	Clay Loam	0.0160	5.12	4.45	5.92	0.19	31.2	11.07	1.88	10.32	18.20	0.00	0.39	0.76	0.20	1.02	0.10	41.92	3.22	2.43	0.000	0.040	0.160	0.090	0.108	0.090
7-1	Ao	0-10	-	-	-	-																									
7-2	A1	10-25	-	-	-	-	0.0511	5.39	4.49	13.27	0.45	29.5	24.81	2.51	60.79	15.49	0.00	0.39	0.76	0.23	1.19	0.24	55.37	2.49	2.15	0.000	0.040	0.160	0.090	0.061	0.050
7-3	B	25-60	-	-	-	-	0.0212	5.24	4.50	7.85	0.25	31.4	14.68	2.51	24.29	29.63	0.22	0.36	0.74	0.20	1.11	0.06	29.34	5.18	3.78	0.000	0.040	0.100	0.100	0.045	0.039
8-1	A1	0-15	-	-	-	-	0.1710	6.29	5.71	14.81	0.79	18.7	27.69	54.01	75.68	13.73	4.88	3.08	0.99	0.27	ND	0.05	48.98	18.82	ND	0.800	0.340	0.320	0.230	0.660	0.460
8-2	A2	15-40	56.6	27.5	15.9	Clay Loam	0.0231	5.48	5.00	5.29	0.22	24.0	9.89	9.55	44.25	13.60	0.56	0.62	1.01	0.09	0.24	0.30	30.21	7.55	0.79	0.010	0.080	0.310	0.050	0.460	0.440
8-3	B1	40-60	68.4	17.0	14.6	Sandy Loam	0.0178	5.23	4.98	3.40	0.15	22.7	6.36	2.51	18.45	22.61	0.22	0.36	0.74	0.13	0.30	0.01	32.31	4.49	0.93	0.000	0.040	0.050	0.070	0.015	0.129
8-4	B2	60-85	44.7	33.7	21.6	Clay Loam	0.0165	5.47	5.16	3.22	0.10	32.2	6.62	3.77	22.68	10.32	0.35	0.39	0.70	0.06	ND	0.18	22.88	6.56	ND	0.000	0.050	0.280	0.050	0.300	0.540
8-5	C	85-105	39.4	28.4	32.2	Light Clay	0.0091	4.93	4.19	0.51	0.05	10.2	0.95	2.51	1.41	5.22	0.31	0.34	0.75	0.45	1.98	0.92	11.35	16.30	17.44	0.010	0.050	0.050	0.050	0.150	0.130
9-1	A	0-10	15.4	53.0	31.6	Silty Clay	0.0964	6.14	5.51	2.03	0.21	9.7	3.80	11.70	48.27	54.19	4.68	2.46	0.73	0.16	ND	0.05	24.98	32.15	ND	5.300	0.550	0.100	0.030	0.170	0.013
9-2	B1	10-80	20.2	55.8	24.0	Silty Clay Loam	0.0202	5.79	4.35	0.51	0.09	5.7	0.95	5.05	37.93	30.81	3.20	1.94	0.74	0.16	0.32	0.17	14.15	42.69	2.26	5.090	0.360	0.120	0.070	0.038	0.015
9-3	B2	80-100	27.8	48.2	24.0	Silty Clay Loam	0.0143	5.69	4.18	0.38	0.07	5.4	0.71	13.83	40.75	59.72	2.97	1.82	0.81	0.22	0.63	0.49	17.64	32.99	3.57	4.460	0.350	0.180	0.140	0.038	0.139
10-1	A	0-5	-	-	-	-	0.1910	5.78	4.59	16.74	0.66	25.4	31.30	32.39	66.31	47.20	5.53	2.67	0.79	0.45	0.08	0.23	20.44	46.18	0.39	4.400	0.350	0.180	0.140	0.023	0.058
10-2	B1	5-20	10.8	35.6	53.6	Heavy Clay	0.0342	5.74	4.38	0.72	0.09	8.0	1.35	7.02	14.55	51.79	4.17	2.64	0.78	0.23	0.32	0.13	23.41	33.40	1.37	5.100	0.360	0.150	0.130	0.038	0.019
10-3	B2	20-70	11.2	46.6	42.2	Silty Clay	0.0300	5.90	4.51	0.51	0.08	6.4	0.95	5.71	27.35	47.65	3.51	2.67	0.82	0.23	0.08	0.28	13.97	51.75	0.57	1.460	0.360	0.160	0.150	0.038	0.011
11-1	A11	0-8	41.5	44.0	14.5	Loam	0.0675	6.65	3.38	4.80	0.20	24.0	8.98	15.70	15.11	15.31	0.91	1.43	0.72	0.20	1.75	0.49	23.75	13.73	7.37	0.030	0.360	0.070	0.110	0.015	0.009
11-2	A12	8-35	44.7	43.7	11.6	Loam	0.0231	4.71	3.87	1.58	0.07	22.6	2.95	8.33	3.79	7.30	0.29	0.38	0.66	0.10	1.11	0.24	7.86	18.19	14.12	0.020	0.150	0.090	0.030	0.450	ND
11-3	B	35-80	44.0	31.2	24.8	Clay Loam	0.0141	4.60	4.10	0.31	0.03	10.3	0.58	3.77	9.80	5.13	0.21	0.30	0.70	0.09	1.98	0.22	9.61	13.53	20.60	0.005	0.050	0.050	0.020	0.023	ND
12-1	A11	0-8	46.3	33.7	20.0	Clay Loam	0.0529	4.41	3.55	2.74	0.15	18.3	5.12	8.99	10.32	7.84	0.45	0.45	0.73	0.20	2.46	1.04	12.58	14.55	19.55	0.010	0.150	0.050	0.110	0.024	0.026
12-2	A12	8-35	43.3	38.3	18.5	Clay Loam	0.0296	4.86	4.01	1.88	0.12	15.7	3.52	7.02	8.78	7.30	0.31	0.33	0.67	0.13	2.06	0.36	12.40	11.61	16.61	0.010	0.080	0.060	0.060	0.038	0.026
12-3	B	35-80	39.6	27.8	32.6	Light Clay	0.0082	4.87	4.31	0.72	0.07	10.3	1.35	2.51	2.83	3.78	0.27	0.33	0.77	0.09	1.51	0.46	11.53	12.66	13.10	0.000	0.030	0.070	0.030	0.015	0.022

Table 3.3 : Correlation of three Soil Classification Systems

PPT	FAO/UNESCO	USDA
1. Podsolik Ortoksik	Orthic Acrisol	Typic Tropodults
2. Kambisol Distrik	Distric Cambisols	Typic Dystropepts
3. Kambisol Gleiik	Gleyic Cambisols	Aquic Dystropepts
4. Kambisol Umbrik	Humic Cambisols	Humitropepts
5. Gleisol Histik	Humic Gleisols	Histic Tropaquepts
6. Aluvial Distrik	Distric Fluvisols	Typic Tropofluvents
7. Aluvial Eutrik	Eutric Fluvisols	Aquic Tropofluvents
8. Organosol Hemik	Distric Histosols	Tropohemists

Table 3.4 : Soil Mapping Unit and their Association

Soil Mapping Unit	Soil Association	Physiography	Topography	Drainage	Left Bank		Right Bank		Total	
					Area(ha)	(%)	Area(ha)	(%)	Area(ha)	(%)
1	Typic Tropodults Typic Dystropepts	Undulating/ Rolling	Slope (3 - 10%)	Moderately well to well	1,744	(7.2)	4,939	(29.1)	6,683	(16.2)
2	Typic Tropodults Typic Dystropepts Humitropepts	Escarpment	Slope (2 - 8%)	Somewhat poorly to Moderately well	1,008	(4.1)	0	(0.0)	1,008	(2.4)
3	Typic Dystropepts Aquic Dystropepts Humitropepts	Terrace	Slope (0 - 2%)	Somewhat poorly	5,484	(22.5)	7,837	(46.2)	13,321	(32.2)
4	Histic Tropaquepts Humitropepts (Tropohemists)	Terrace	Slope (0 - 2%)	Poorly to very poorly	11,390	(46.7)	0	(0.0)	11,390	(27.6)
5	Typic Tropofluvents Aquic Tropofluvents	Alluvial Plain	Slope (0 - 2%)	Somewhat poorly	4,756	(19.5)	4,178	(24.6)	8,934	(21.6)
	TOTAL				24,382	(100.0)	16,954	(100.0)	41,336	(100.0)

Table 4.1 Specification for Land Suitability Classification

Factor	Symbol	S1			S2			S3			N1		
		Paddy	Upland Crops	Perenial Crops	Paddy	Upland Crops	Perenial Crops	Paddy	Upland Crops	Perenial Crops	Paddy	Upland Crops	Perenial Crops
1. Effective Soil depth	(s)	> 75cm	> 75cm	>100cm	> 50cm	> 50cm	> 75cm	> 25cm	> 25cm	> 50cm	> 10cm	> 10cm	> 25cm
2. Top Soil Texture (0-30cm)	(s)	CL-C	Medium-Fine	Medium-Fine	SCL-C	Medium-Fine	Medium-Fine	SL-C	M.Coarse-Fine	M.Coarse-Fine	LS-C	V.Coarse-Fine	V.Coarse-Fine
3. Permeability of Subsoil	(s)	Slow	-	-	M.Slow-Slow	-	-	Moderate-Slow	-	-	Rapid-V.Slow	-	-
4. Gravel Content in Top Soil	(s)	< 5%	< 5%	< 5%	< 25%	< 25%	< 25%	< 50%	< 50%	< 50%	< 75%	< 75%	< 75%
5. Soil Fertility	(n)	High	High	High	M.High-High	Moderate-high	Moderate-high	Low-High	Low-High	Low-High	V.Low-High	V.Low-High	V.Low-High
6. Soil Reaction (pH)	(a)												
- Mineral Soils		5.5-7.5	5.5-7.0	5.5-7.0	4.5-7.5	4.5-7.5	4.5-7.5	4.0-8.0	4.0-8.0	4.0-8.0	3.5-8.5	3.5-8.5	3.5-8.5
- Peat Soils		4.5-7.5	-	-	4.0-8.0			3.5-8.5			3.0-8.5		
7. Aluminium Saturation	(c)	< 60%	< 20%	< 40%	< 70%	< 40%	< 60%	< 80%	< 60%	< 80%	< 90%	< 80%	< 90%
8. Slope and Land Form	(t)	More than 80% of lands are below 3%	< 3%	< 8%	More than 80% of lands are below 3%	< 3%	< 8%	More than 50% of lands are below 5%	< 8%	< 15%	More than 40% of lands are below 8%	< 15%	< 45%
9. Micro-relief	(t)	< 15cm			< 30cm			< 60cm			> 60cm		
10. Erodibility	(e)	-	Very Low	Very Low	-	Low-V.Low	Low-V.Low	-	Moderate-V.Low	Moderate-V.Low	-	High-V.Low	High-V.Low
11. Drainability	(d)	Poorly	M.Well-Well	M.Well-Well	S.Poorly-Poorly	M.Well-Well	S.Excessive-Well	S.Poorly-V.Poorly	S.Excessive-S.Poorly	S.Excessive-S.Poorly	Well-V.Poorly	Excessive-Poorly	Excessive-Poorly
12. Frequency of Flood Hazard	(f)	< 1 time in 10 years	< 1 time in 10 years	-	< 3 times in 10 years	< 3 times in 10 years	-	< 4 times in 10 years	< 4 times in 10 years	-	< 6 times in 10 years	Very Frequent	-
13. Salinity (micro-mho/cm)	(x)	< 1,500	< 1,500	< 1,500	< 2,500	< 2,500	< 2,500	< 3,500	< 3,500	< 3,500	< 4,500	< 4,500	< 4,500

Table 4.2 (1) : Land Suitability Evaluation

Soil Mapping Unit 1 : Association of Typic Tropudults and Typic Dystropepts

Factor	Symbol	Paddy	Upland Crops	Perennial Crops
1. Effective Soil Depth	(s)	S2	S2	S2
2. Top Soil Texture	(s)	S2	S2	S2
3. Permeability of Subsoil	(s)	S2	-	-
4. Gravel Contents in Top Soil	(s)	S1	S1	S1
5. Soil Fertility	(n)	S2	S3	S3
6. Soil Reaction (pH)	(a)	S1	S2	S2
7. Alminium Saturation	(c)	S1	S2	S1
8. Slope and Land Form	(t)	N1	S3	S2
9. Micro-relief	(t)	S3	-	-
10. Erodibility	(e)	-	S3	S3
11. Drainability	(d)	N1	S1	S1
12. Frequency of Flood Hazard	(f)	S1	S1	-
13. Salinity	(x)	S1	S1	S1
Land Suitability Class		N1td	S3nte	S3ne

Table 4.2 (2) : Land Suitability Evaluation

Soil Mapping Unit 2 : Association of Typic Tropudults, Typic Dystropepts and Humitropepts

Factor	Symbol	Paddy	Upland Crops	Perennial Crops
1. Effective Soil Depth	(s)	S2	S2	S2
2. Top Soil Texture	(s)	S2	S2	S2
3. Permeability of Subsoil	(s)	S2	-	-
4. Gravel Contents in Top Soil	(s)	S1	S1	S1
5. Soil Fertility	(n)	S2	S3	S3
6. Soil Reaction (pH)	(a)	S1	S2	S2
7. Alminium Saturation	(c)	S1	S1	S1
8. Slope and Land Form	(t)	N1	S3	S2
9. Micro-relief	(t)	S3	-	-
10. Erodibility	(e)	-	S3	S3
11. Drainability	(d)	N1	S1	S1
12. Frequency of Flood Hazard	(f)	S1	S1	-
13. Salinity	(x)	S1	S1	S1
Land Suitability Class		N1td	S3nte	S3ne

Table 4.2 (3) : Land Suitability Evaluation

Soil Mapping Unit 3 : Association of Typic Dystropepts,
Aquic Dystropepts and Humitropepts

Factor	Symbol	Paddy	Upland Crops	Perennial Crops
1. Effective Soil Depth	(s)	S2	S2	S2
2. Top Soil Texture	(s)	S2	S2	S2
3. Permeability of Subsoil	(s)	S2	-	-
4. Gravel Contents in Top Soil	(s)	S1	S1	S1
5. Soil Fertility	(n)	S2	S3	S3
6. Soil Reaction (pH)	(a)	S1	S2	S2
7. Alminium Saturation	(c)	S1	S2	S1
8. Slope and Land Form	(t)	S1	S1	S1
9. Micro-relief	(t)	S3	-	-
10. Erodibility	(e)	-	S2	S2
11. Drainability	(d)	S2	S2	S2
12. Frequency of Flood Hazard	(f)	S1	S1	-
13. Salinity	(x)	S1	S1	S1
Land Suitability Class		S3t	S3n	S3n

Table 4.2 (4) : Land Suitability Evaluation

Soil Mapping Unit 4 : Association of Histic Tropaquepts, Humitropepts and Tropohemists

Factor	Symbol	Paddy	Upland Crops	Perennial Crops
1. Effective Soil Depth	(s)	S2	S2	S2
2. Top Soil Texture	(s)	S2	S2	S2
3. Permeability of Subsoil	(s)	S2	-	-
4. Gravel Contents in Top Soil	(s)	S1	S1	S1
5. Soil Fertility	(n)	S2	S3	S3
6. Soil Reaction (pH)	(a)	S1	S2	S2
7. Alminium Saturation	(c)	S1	S1	S1
8. Slope and Land Form	(t)	S1	S1	S1
9. Micro-relief	(t)	S3	-	-
10. Erodibility	(e)	-	S2	S2
11. Drainability	(d)	S2	S3	S3
12. Frequency of Flood Hazard	(f)	S1	S1	-
13. Salinity	(x)	S1	S1	S1
Land Suitability Class		S3t	S3nd	S3nd

Table 4.2 (5) : Land Suitability Evaluation

Soil Mapping Unit 5 : Association of Typic Tropofluvents and Aquic Tropofluvents

Factor	Symbol	Paddy	Upland Crops	Perennial Crops
1. Effective Soil Depth	(s)	S1	S1	S1
2. Top Soil Texture	(s)	S1	S1	S1
3. Permeability of Subsoil	(s)	S1	-	-
4. Gravel Contents in Top Soil	(s)	S1	S1	S1
5. Soil Fertility	(n)	S1	S2	S2
6. Soil Reaction (pH)	(a)	S1	S1	S1
7. Alminium Saturation	(c)	S1	S1	S1
8. Slope and Land Form	(t)	S1	S1	S1
9. Micro-relief	(t)	S2	-	-
10. Erodibility	(e)	-	S2	S2
11. Drainability	(d)	S2	S2	S2
12. Frequency of Flood Hazard	(f)	S2	S2	-
13. Salinity	(x)	S1	S1	S1
Land Suitability Class		S2tdf	S2nedf	S2ned

Table 5.1 : Present Land Use in the Survey Area

Present Land Use	Left Bank		Right Bank		Total	
	Area(ha)	(%)	Area(ha)	(%)	Area(ha)	(%)
Primary Forest	11,406	46.8	6,089	35.9	17,495	42.3
Secondary Forest	4,995	20.5	5,306	31.3	10,301	24.9
Bush/Grass Lands	4,225	17.3	1,713	10.1	5,938	14.4
Alang Alang Lands	908	3.7	1,131	6.7	2,039	4.9
Paddy	25	0.1	2	0.0	27	0.1
Upland Crops	1,125	4.6	318	1.9	1,443	3.5
Plantation Area	891	3.7	2,202	13.0	3,093	7.5
Residential Area	807	3.3	193	1.1	1,000	2.4
	24,382	100.0	16,954	100.0	41,336	100.0

Table 6.1 : Soil Distribution in the Gross Area

Soil Mapping Unit	Soil Association	Left Bank Area(ha)	Left Bank (%)	Right Bank Area(ha)	Right Bank (%)	Total Area(ha)	Total (%)
1	Typic Tropodults Typic Dystropepts	16	(0.2)	0	(0.0)	16	(0.1)
2	Typic Tropodults Typic Dystropepts Humitropepts	766	(9.5)	0	(0.0)	766	(6.3)
3	Typic Dystropepts Aquic Dystropepts Humitropepts	355	(4.4)	3,401	(82.2)	3,756	(30.8)
4	Histic Tropaquepts Humitropepts (Tropohemists)	4,781	(59.3)	0	(0.0)	4,781	(39.2)
5	Typic Tropofluvents Aquic Tropofluvents	2,144	(26.6)	737	(17.8)	2,881	(23.6)
TOTAL		8,062	(100.0)	4,138	(100.0)	12,200	(100.0)

Table 6.2 : Present Land Use in the Gross Area

Present Land Use	Left Bank		Right Bank		Total	
	Area(ha)	(%)	Area(ha)	(%)	Area(ha)	(%)
Primary Forest	2,876	35.7	2,392	57.8	5,268	43.2
Secondary Forest	2,332	28.9	762	18.4	3,094	25.4
Bush/Grass Lands	1,787	22.2	538	13.0	2,325	19.1
Alang Alang Lands	193	2.4	339	8.2	532	4.4
Paddy	0	0.0	2	0.0	2	0.0
Upland Crops	552	6.8	85	2.1	637	5.2
Plantation Area	0	0.0	0	0.0	0	0.0
Residential Area	322	4.0	20	0.5	342	2.8
	8,062	100.0	4,138	100.0	12,200	100.0

Table 6.3 : Proposed Land Allocation in the Gross Area

Proposed Land Allocation	Left Bank		Right Bank		Total	
	Area(ha)	(%)	Area(ha)	(%)	Area(ha)	(%)
Existing Transmigration Area (1,120H/H)						
SKP-A(190H/H)			448		448	
SKP-B(345H/H)	814				814	
SKP-G(400H/H)	944				944	
SKP-F(185H/H)	437				437	
Sub-Total	2,195	27.2	448	10.8	2,643	21.7
Area for Old Village People (1,216H/H)						
Teluk Sono (133H/H)	314				314	
Muara Dilam (617H/H)	1,456				1,456	
Kota Lama - 1 (133H/H)	248				248	
Kota Lama - 2 (333H/H)			620		620	
Sub-Total	2,018	25.0	620	15.0	2,638	21.6
New Transmigration Area (2,254H/H)						
New Village - 1 (400H/H)			944		944	
New Village - 2 (380H/H)			898		898	
New Village - 3 (450H/H)			1,062		1,062	
New Village - 4 (345H/H)	814				814	
New Village - 5 (235H/H)	554				554	
New Village - 6 (360H/H)	850				850	
New Village - 7 (84H/H)	198				198	
Sub-Total	2,416	30.0	2,904	70.2	5,320	43.6
Area for the People from Kota Intan	300	3.7	0	0.0	300	2.5
Other Lands	1,133	14.1	166	4.0	1,299	10.6
Total	8,062	100.0	4,138	100.0	12,200	100.0

Table 6.4 : Proposed Land Use in the Gross Area

	Present Land Use		Proposed Land Use		
	Survey Area	Gross Area	Area to be Developed	Non Development Area	Total Proposed Land Use
Paddy Fields	27	2	5,926	-	5,926
Upland Crops	1,443	637	2,374	-	2,374
Primary Forest	17,495	5,268	-	304	304
Secondary Forest	10,301	3,094	-	751	751
Bush/Grass Lands	5,938	2,325	-	244	244
Alang Alang Lands	2,039	532	-	-	-
Plantation Area	3,093	-	-	-	-
Village Areas	1,000	342	1,720	342	2,062
Right of Way	-	-	539	-	539
Total	41,336	12,200	10,559	1,641	12,200

ANNEX D

FARM PRACTICES

ANNEX D FARM PRACTICES

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ANNEX D FARM PRACTICES

1. INTRODUCTION

1.1 Study Objective

The objective of study of farm practices in the Phase II Field Study from 26th January to 26th March 1992 is to understand the present agricultural situation in the priority Project Area and agricultural development policy. For this objective the field survey was conducted at first covering the sub-districts of Kepunuhan and Kunt Darussalam in Kampar district, Riau Province. During this period interviews with some farmers and government personnel were conducted and data from local government offices were collected.

On the other hand, the objective of study of farm practices in the Phase II Home Office Work in Japan from 2nd June to 31st July 1992 is to analyze the present agricultural conditions and formulate appropriate farming practices under the proposed irrigation conditions.

1.2 Data Collection and Farm Economy Survey

Data have been collected from the following offices:

a. BPP offices of the Kunto Darussalam sub-districts and Kampar district,
b. PUs of Kampar district, Pekanbaru of Riau and Padang of West Sumatra,
c. Provincial Agricultural Offices of Riau and West Sumatra,
d. Provincial Livestock Office, Riau,
e. PUSKUD (cooperative at province level) and KUD (cooperative at village level) of Karya Maju, Kampar District,
f. Kanwil of Transmigration of Riau Province,
g. Fishery offices of Kampar District and Riau Province, and
h. Village chiefs and sub-district chiefs concerned.

In addition farm economy survey has been conducted by the Research Institute of the Riau Islamic University. On the basis of this survey detailed analyses have been conducted in order to study the feasibility of the Lower Rokan Kiri Irrigation Development Project.

2. PRESENT AGRICULTURAL CONDITIONS

2.1 Climate

The climate of the Project Area is tropical monsoon with dry season from June to October and wet season from November to May. Annual rainfall is approximately 2,300 mm. The mean monthly temperature is 24.5°C to 26.1°C. The relative humidity of Kota Lama is as high as 91.4% and the average monthly relative humidity is from 82.3 to 92.6%. The solar radiation energy, which is generally correlated with rice yield, is 265 cal/cm^2/day in average and this value is relatively low probably because of occurrence of many cloudy days.

The climatic condition of the Project Area is generally suitable for tropical agriculture, especially for rice, legumes, vegetables, tree crops and plantation crops.

2.2 Geography, Soil and Land Use

The Project Area is located along Rokan Kiri River in Kampar District and extends from the weir site which is 10 km northwest of Ujungbatu to the estimated lowest available land in elevation for irrigation which is 27 km North of Kota Lama. This area extends over two sub-districts, namely Kunt Darussalam and Kepunuhan.

The Project Area is generally flat and mostly covered by either heavy forest or transmigration projects.

The soil is roughly classified into four types. The soils of both sides of the meandering Rokan Kiri River are Fuluvisols. In the southern part of the Project Area Acrisols are generally found. The center of the Project Area is largely covered by Cambisols and the Northern part is Gleisols. Gleisols and Fulvisols are fertile, while others are generally non-fertile. (refer to the Annex of soil study for detailed information)

Approximately 87 % of the Survey Area is covered by forest, bush, and grass land, while the remainder is large-scale plantation, residential area, and farm land. The marginal area of forest is currently used for fire wood collection.

2.3 People and Activities

The number of households in the Project Area is estimated at approximately 3,800. The villages are classified into three types, namely (1) original village where local people live, (2) new village which has become administratively village after some years of transmigration, and (3) transmigration village where transmigrants live under the administration of transmigration office. The major activities of original villages are trading, shifting cultivation, rubber plantation and fishing. On the other hand the major activities of new villages and transmigration villages are farming of food crops and casual labour employment on large scale plantation. Since the population density in the Project Area is low and labour force is limited, new transmigration programmes are essential to efficiently develop the area currently covered by forest.

2.4 Crop Production

2.4.1 Agricultural Statistics

The major crops in the Project Area are both wet and upland rice, maize, cassava, sweet potato, peanut, green beans, soybean, vegetables, and chili. Production statistics according to the Agricultural Extension Office of Kunto Darussalam and Kepenuhan Sub-districts are shown in Table 2.1 for April to September 1990, rainy season cropping, and Table 2.2 for October 1990 to March 1991, dry season cropping. A summary is shown below;

Summary of Agricultural Production in the Project Area

	Area(Ha)	Yield(t/Ha)	Prod'tn(t)
1990 Apr.-Sep., Wet Season Cropping			
Wet land rice	27.0	2.3	62.8
Upland rice	1,238.8	1.1	1,408.9
Maize	47.8	1.9	91.1
Cassava	45.4	16.7	711.4
Sweet potato	155.4	1.7	258.2
Peanut	40.5	0.8	30.8
Mung bean	27.2	0.6	17.1
Soybean	115.4	0.7	77.7
Vegetables	47.4	0.7	35.3
Chili	32.9	1.1	36.5
Total	1,777.8		

	Area(Ha)	Yield(t/Ha)	Prod'tn(t)
1990/1991 Oct.-Mar., Dry Season Cropping			
Wet land rice	44.0	2.3	102.1
Upland rice	67.5	0.8	55.6
Maize	78.0	2.0	154.5
Cassava	77.0	15.4	1,182.0
Sweet potato	10.0	7.9	79.0
Peanut	27.0	0.8	20.6
Mung bean	19.0	0.7	13.2
Soybean	246.5	0.9	218.2
Vegetables	72.0	0.8	56.6
Chili	20.5	1.5	30.3
Total	661.5		

Source : Programa Penyuluhan Pertanian 1991/1992, BPP, Kota Lama and Agricultural Statistics of Kec. Kepunuhan 1991

The yield of all crops in the Project Area is lower than that of the Objective Area, namely wet land rice yield is 2.3 t/ha in the Project Area and 3.6 t/ha in the Objective Area and soybean's yield is 0.7-0.9 t/ha in the Project Area and 1.25 t/ha in the Objective Area. These low yields are probably caused by low technology level, unstable natural factors and low availability of farm inputs.

2.4.2 Farm Economy Survey

Farm Economy Survey was conducted in order to grasp the accurate figures of agricultural production in the Project Area. The detailed figures of crop productivity in 1991 are shown in Table 2.3. Since this survey has been conducted through detailed interview survey of 150 samples, it seems reasonable to conclude that these figures represent the present agricultural condition in the Project Area. The weighted averages of all villages are, therefore, regarded as the present crop yields, namely 3.1 t/ha for irrigated rice, 0.8 t/ha for wet land rice, 0.9 t/ha for upland rice, 0.7 t/ha for soybean, 0.6 t/ha for peanut, 0.9 t/ha for maize, 9.0 t/ha for cassava, 0.4 t/ha for chili, and 0.4 t/ha for mung bean.

On the basis of the crop yields above, the present agricultural production in the Project Area is estimated as shown in Table 2.4. In this table rubber which is widely planted and for which the planted area is rapidly increasing has been included. In addition some crops which are assumed to be cultivated mainly in home yards are excluded from the table.

The cropping intensity under these conditions is estimated at 125 %, provided that the present farming land is 1,905 ha in total including rubber planted area. The present cropping pattern is shown in Figure 2.1.

2.4.3 Farming Practices and Cropping Patterns

Wet land rice

Cultivation of wet land rice area is very limited due to the low level of land reclamation and the productivity of the same is as low as 0.8 t/ha. In Kota Intan rice cultivation shows high productivity, namely 3.1 t/ha in the rainy season because of semi-technical irrigation system, but there is no irrigation water available in the dry season.

Intensification programme for the rice production is also conducted in the forms of INSUS and INMUM.

Cropping seasons are twice during the year. One is wet season cropping, namely starting land preparation in July, transplanting in August/September and harvesting in December/January. The other is dry season cropping, namely starting land preparation in January/February, transplanting in February/March and harvesting in June/July. High Yielding Variety(HYV) is commonly utilized and local varieties rarely cultivated. Land preparation is mostly done by hand and farm mechanization has not yet began. However, draft animal ploughing is being extended by the effort of the livestock office and IFAD. Farm inputs are still at a minimal level. Labour source is usually family labour. At the peak time of labour demand, labour is supplied by communal work, called Gotong Royong.

Dry land rice

Upland paddy is widely planted. Planted area is 1,239 ha in the wet season (July to December/January) and 68 ha in the dry season (February/March to June/July) 1990/1991. Draft animal ploughing is often used for land preparation in the three new villages of Kota Baru, Kota Raya and Muara Jaya, and manual ploughing in other areas. Direct seeding method is used with HYV. Cultivation of local varieties is rarely seen.

Palawija crops (secondary crops)

The most important palawija crop is soybean, especially in SKP F and SKP G under UPSUS Programme (the government's technical support programme of fertilizer and leguminous bacteria). The planted area of soybean is more than that of both wet land and upland rice in dry season cropping. Yield is 0.7 t/ha which is relatively low. Fertilizer is usually used and inoculation with Rhizobium is practiced for nitrogen fixation.
Other crops are sweet potato, maize, vegetables, cassava, peanut, chili and mung bean in descending order of size of planted area as of the cropping season of October/March, 1990. The yields of these crops are generally low.

Plantation crops

Cultivation of small scale plantation crops, of which the major ones are rubber, coconut, coffee and clove, is gradually increasing. The most important plantation crop is rubber and the harvested area and yield are 275 ha and 0.8 ton of unsmoked latex respectively (refer to Table 2.5). In the new villages the planted area of rubber is increasing, namely by 160 ha in 1991.

Coconut is classified into a plantation crop here but this product is obviously consumed locally and rather horticultural crop. The coconut production in the three new villages is practiced mainly in home yards.

Coffee is also produced in the new villages and the yield is 303 kg/ha. Clove production here is very new and at a minimal production level.

Rubber is an important cash crop and planted in pure stands. On the other hand, the other three tree crops are planted mainly in home yards in mixed stands for home consumption.

2.4.4 Farm Inputs and Labour Requirement

Farm inputs, labour inputs and farm tool possession have been surveyed by Farm Economy Survey, as shown in Table 2.6 and 2.7. Although farm inputs widely vary due to crop variety and farm intensification level, fertilizer usage is generally low, namely up to 65 kg/ha of urea, while the government recommendation is 200 kg/ha for the types of soil in the Project Area. Agrochemical use is also minimal. On the other hand labour inputs are relatively high for all crops. This is because of low mechanization level, low availability of draft animal power, farmer's labour intensive attitude, etc. When farm mechanization proceeds, especially in land preparation to ox plough or hand tractor plough, currently labour-intensive work will become less labour-intensive but this will be offset by harvesting and post-harvesting process requiring more labour due to productivity increase.

As for farm tool possession it is clear that expensive farm tools have not been extended except for ploughs in new villages which were distributed along with cow as draft animal under the IFAD livestock programme. The introduction of on-farm machinery is now being promoted by both private and public sectors. PT. Pertani is keenly promoting a tractor land preparation service at Rp 110,000 per ha of low land paddy field and also sales of hand tractor. One KUD in Kab. Kampar is also conducting a land preparation service by tractor donated by the Japanese Government. In West Sumatra and Java tractor is already a major method for land preparation.

The capital stock in the Project Area is, however, still minimal and thus animal power seems to be the best way for mechanization in the short term. In the long term, mechanization will be gradually extended as capital stock increases.

2.5 Livestock and Fowls

The important livestock and fowl in the Project Area are cow and chicken. Cow is very important as a draft animal for land preparation and also as capital stock. Approximately 70 % of farm households in Kota Baru, 60 % in Kota Raya and 100 % in Muara Jaya own cows. This is the achievement of the IFAD programme. In the transmigration areas, namely SKP-A, B, F and G, the selection of farmers to distribute cows to is under processing and the IFAD programme will start as soon as the stock breeds arrive. In three original villages there are some cows and water buffalos mainly as capital stock. However, when it is found that these animals are useful as draft animals, they will be propagated and utilized. Therefore, holding of draft animals will be popular through the Project Area.

Domestic fowls, namely chicken and duck, are commonly raised in the new villages and the transmigration areas for home consumption and local sale.

2.6 Farmer Attitudes Regarding to Irrigation Development

The farmer attitude towards the proposed irrigation development is positive and encouraging. 88 % of the farmers expressed their willingness to join the irrigation scheme. They are well aware that irrigation systems provide better and stabler productivity when proper farming methods are adopted simultaneously, and that is a result their living standard will be raised. The remaining 12 % of farm households do not think that irrigation is urgently needed, or otherwise, they do not understand the benefit generated by irrigation.

On condition that tertiary canals are constructed by the Indonesian Government, 94 % of farmers are willing to pay the irrigation fee of Rp 1,000 to 50,000 per hectare per year. The mean and median of this amount which farmers are willing to pay is Rp 8,685 and Rp 6,500, respectively.

The farmers are ready to provide land for the irrigation facilities, unless such land is very productive with tree crops, such as rubber or coffee, or such land that needs to be provided is very large in size. In these cases appropriate compensation is essential by "land for land" or "cash for land" basis.

When the irrigation system is ready, farmers are willing to intensify their farming together with introduction of modern farming technology and more farm inputs. For the transmigrants this intensified farming system itself well accords with their original aspirations and purpose for transmigration to this area.

3 AGRICULTURAL DEVELOPMENT PLAN

3.1 Current Agricultural Programmes

3.1.1 In the Project Area

Agricultural Extension Office (BPP) is responsible for extension service and in general one BPP staff, called PPL, lives in each village and conducts extension work in collaboration with the residential or visiting staff of the transmigration office, livestock development office, village cooperatives (KUD), etc.

In the Project Area, SKP B is covered by BPP of Kota Tengah in Kepunuhan Sub-district, but actually PPL in SKP B has been absent for the last one year. Other villages and areas in the Project Area are served by BPP of Kota Lama in Kunto Darussalam Sub-district.

The first and most important step of extension work is to organize farmers into groups for efficient extension work. The main topic is food crop production technology. Others topics are plantation crops, fishery, livestock and socio-economy. The major activities for food crops are INSUS and INMUM of wet land rice, upland rice, maize and soybean. The target yield of these crops as of April-September 1991 are as follows:

	INSUS	INMUM
rice	5 t/Ha	4 t/Ha
upland rice	2	2
maize	1.8	1.4
soybean	1.2	1.2

In the transmigration areas "Lahan Usaha II", which has been given to each transmigrant with holdings the size of 0.75 ha, has not been well developed. This area is supposed to be developed through the self-effort of the transmigrant, while each transmigrant receives 1.0 ha of cleared Lahan Usaha I, a prepared house unit and various other subsidies. The development of Lahan Usaha II can not be realistically conducted using only one chainsaw from the transmigration office for 250 to 400 households, because the area is covered by heavy forest. The government well recognizes that the development of Lahan Usaha II is very difficult without government assistance or subsidy.

The transmigration office, therefore, has made a plan to provide one chainsaw per 15 households. When this plan is materialized, the further development of Lahan Usaha II can be expected.

3.1.2 SUPRA INSUS in West Sumatra

Since SUPRA INSUS is the national intensification programme for cultivation of irrigated rice, and SUPRA INSUS in Riau Province has just started from 1991 at an experimental level, it is supposed to implement SUPRA INSUS programme for food crop production in the Project Area.

In the period of the Phase II Field Work, the observation of SUPRA INSUS in West Sumatra Province as an experimental area has been conducted. The findings are shown as follows:

(1) It is most difficult but important and essential to coordinate interministry cooperation, since the programme implementation requires cooperation from more than 10 ministries.

(2) The main recommendations are (i) paddy & fish (fish farming in rice field) in rainy season, (ii) palawija (maize and soybean) in dry season and (iii) paddy in dry season. The cropping intensity is 200 % in total.

(3) Average farm size is 0.5 ha per farmer.

(4) Yields are 10 t/ha of dry paddy, 2 t/ha of soybean and 5 t/ha of hybrid maize.

(5) There is no serious pest damage without fallow period for pest management.

(6) Seeds are renewed every year.

(7) There is no problem of drying paddy grains after harvesting.

(8) Farm mechanization is advanced, namely land preparation of 75 % of paddy field is done by hand tractor and 25 % by cow or water buffalo.

3.2 Agricultural Development and Proposed Land Use

Agricultural development in the Project Area, on condition that irrigation and social infrastructure will be constructed, should be conducted taking into account the following factors:

- both national and regional development strategy,
- regional specific factors for farming, such as agricultural climate, soil, geography, water availability, pest, farming technology level and manpower,
- profitability,
- marketability and
- farmers' will

In the Project Area, since there is abundant water and land resources, the irrigation potential is quite high. Nevertheless, there is no irrigation facility or good social infrastructure and thus the land productivity is very low and the local people and transmigrants remain isolated and poor.

Outside the Project Area in Riau Province rice is in acute shortage and thus the local government is very keen to promote rice production increase.

In and around the Project Area the national and local government are eager to promote the transmigration programme in order to efficiently utilize the land, water and human resources.

Considering the facts above and the resources of the land, water and human power in the Project Area, it is reasonable to conclude that the introduction of food crop production, which can support the local food demand and raise farmer's income, is appropriate under the irrigation facility development.

Following the agricultural development policy and strategy above, the Project Area will be irrigated as much as possible together with the construction of reasonable social infrastructure. However, the capability of the farmers is limited in technology, mechanization, capital, etc. The standard farm size per farm household is estimated at 1.75 ha besides house area and gardening area which is equivalent to 2.0 ha of the standard holding size for transmigrants.

In the Project Area there are three types of villages as explained in section 2.3. Farmers of original village mainly practice extensive rubber plantation and its size is generally small. On the other hand the farm size of new and transmigration village farmers is fixed, namely:

House and garden area	0.25 ha
Lahan Usaha I	1.00 ha
(cleared by the government before transmigration)	
Lahan Usaha II	0.75 ha
(developed by transmigrant with self-effort)	

In addition o.25 ha per household is allocated for public facilities, such as road, school, cemetery, etc.
The land which is currently not utilized is assumed to be allocated to new comers and utilized in the same manner as under the transmigration programme. In addition it is assumed that the farmers of original villages will receive the irrigable area of the same size of the transmigrant farm. In reality, the district office of Kampar is responsible for the land acquisition and reallocation of the irrigable area from and to land owners.

On the basis of this assumption the future land use in the Project Area may be proposed as shown in Table 3.1 and is summarized as follows:

Proposed Land Use in the Gross Area (unit: ha)

	Present	Proposed	
	Gross Area	Area to be developed	Total proposed land use
Farming area	639	8,300	8,300
Paddy	(548)	(5,926)	(5,926)
Palawija	(91)	(2,374)	(2,374)
Primary forest	5,268	4,964	304
Secon. forest	3,094	2,343	751
Bush/grass	2,325	2,081	244
Alang	532	532	0
Village area	342	1,720	2,062
Right-of-way		539	539
Total	12,200	10,559	12,200

3.3 Crop Selection

Following the policy and strategy of agricultural development in the Project Area, It seems reasonable and appropriate to select rice as a main crop and soybean and peanut as palawija crops in both the wet and dry season under irrigation condition. This crop selection well accords with the SUPRA INSUS which is the national super intensification programme in irrigated area. Soybean and peanut are also advantageous from the viewpoint of soil fertility, profitability, marketability, and nutrition. Soybean and peanut, however, may be affected by injury through continuous cropping. In order to avoid this injury, the rotation of irrigated paddy and upland crops is essential and useful.

From the viewpoint of profitability, vegetables of solanaceae and cucurbitaceae families are promising but it may not be possible to produce these in large scale due to available labour force and market limitation. The detailed analyses of labour requirement and crop budget are explained in section 3.7.

3.4 Cropping Pattern

In SUPRA INSUS a cropping intensity of more than 200 % is proposed as the technical package. In respect of cropping period, 300 % cropping intensity is theoretically possible by using an early maturing variety and modern mechanization. However, the present mechanization level is still initial and population pressure is low, thus the practical cropping intensity seems to be 200 %. In Java, however, mechanization has advanced and population pressure is high and thus a cropping intensity of more than 200 % is being practiced. It is, therefore, assumed that when the required conditions are satisfied, a cropping intensity of more than 200 % can be practiced.

As discussed in Agricultural Development in the former section, selected crops for the irrigation development in the Project Area are rice, soybean, and peanut. The cropping pattern shown in Fig. 3.1 has been proposed as the most appropriate pattern on the basis of the study of the present cropping pattern, the recommendation by the Dinas Pertanian Riau, the cropping pattern of similar projects, various aspects of agronomic factors and profitability. Wet season rice cropping starts with sowing in October/November and is harvested in February/March. Rice cultivation in the dry season is from March/April to July/September. As for palawija, wet season cropping starts with land preparation in November/December and is harvested in February/March. Cultivation of dry season palawija is from April/March to July/August.

It is expected that cropping intensity will be raised through farmers effort's to maximize their profitability under the proposed irrigation condition. However, manpower is limited and on-farm mechanization level is still initial. It is, therefore, estimated that each farmer will cultivate rice in 70 % of the area of his farm, namely 1.25 ha out of 1.75 ha, and palawija crops on the rest of his farm in both dry and wet seasons. This represents diversification in crops, income source and manpower demand. The cropping intensity of this proposed cropping pattern is 200 %.

3.5 Proposed Farming Practices and Farm Inputs

Agricultural production infrastructure is not enough to maximize productivity. In addition to the construction of reasonable facilities, appropriate farming practices are essential in order to fully exploit the potential productivity of crops and natural resources.

Proposed farming practices should be suitable to each area's specific condition, following the recommendation by SUPRA INSUS.

The summary of SUPRA INSUS is as follows:

a. Items determined at the extension worker level

-suitable cropping pattern for each area,
-rotation of rice variety (For pest management, different rice varieties should be used by season and area. However, recommended rice varieties are determined by BPP Kabpaten office.), and
-For pest management, harvesting period is limited to one week and non-cultivation period should be more than one month.

b. Items to be determined by each BPP office

-integrated pest management system,
-water control, and
-seed supply system.

c. Ten technical packages recommended

-use of certified HYV seeds,
-appropriate fertilizer application, rotation of variety and use of the same variety within a farmers' group,
-cropping intensity of more than 200 %, high density

planting (more than 200,000 hills per ha) and unification of cropping season,
-integrated pest management,
-appropriate land preparation (plowing twice with more than 15-20 cm depth, and puddling once),
-effective water control,
-appropriate field management, i.e. transplanting, weeding, water control, etc,
-use of growth hormone at appropriate time and with appropriate amount, and
-post-harvest improvement (possession of 20 sickles and a drying facility within a farmers' group).

The proposed farming practices by item and activity are explained in the following sections.

3.5.1 Paddy

(i) Variety

High yielding varieties (HYVs) should be essentially adopted and appropriate resistant varieties should be chosen taking pest occurrence into consideration. Present recommended varieties are PB46, PB56, Kelera, Bahbutong etc. On the other hand, commonly planted rice varieties are PB42 and Sentani. These varieties are compared as follows:

Variety	Yield(t/ha)	Growth Period(Days)	Taste
PB46	4.0--5.0	125--130	poor
PB56	4.0--4.5	110--115	poor
Kelara	4.0--5.0	90--110	poor
Bahbutong	4.0--5.0	115--125	good
PB42	4.5--5.5	135--145	poor
Sentani	3.0	107--114	good

As a tendency of farmer's preference, varieties are divided into two extremes, namely high yield but poor taste, or low yield but good taste. It is, therefore, important to consider pest resistance, farmers' preference, productivity, etc, in order to determine the recommendation of rice varieties.

(ii) Seed

Recommended seed amount is 30 kg/ha. Selection by specific gravity of 1.13 should be practiced.
Seed disinfection before pregermination should be done and sowing to nursery should be done at the appropriate time.
It is recommended to use certified seed every time. However, if this is very costly, seed should be renewed at least once every four plantings.

Fertilizer at the nursery stage is 5 kg of urea for one hectare of main field and the nursery period is 20 days. The size of nursery is approximately one twentieth to thirtieth of planted area in the field.

(iii) Land Preparation

Plowing at least twice with 15 - 20 cm depth and puddling one time ten days before transplanting should be practiced. It is recommended to do these works by oxen.

(iv) Transplanting

Transplanting is done by hand. High density planting of more than 200,000 hills per ha can be materialized with the spacing of 30 cm x 15 cm. Number of plants per hill should be two to three with depth of two to three centimeter.

(v) Fertilizer

Fertilizer application should be planned on the basis of soil type. The standard plan is summarized as follows:

Type	Total amount(kg/ha)	Basal (ratio)	1st top* (ratio)	2nd top** (ratio)
Urea	200	1/3	1/3	1/3
TSP	100	1/1		
Kcl	50	1/3	1/3	1/3

* : 20 days after transplanting
**: Panicle formation stage

Manure use is recommended as much as possible.

(vi) **Weeding**

Weeding should be manually done at least three times in one cropping. It is recommended to introduce the rotary weeder.

(vii) **Pest Control**

As well as herbicide, agrochemical use should be minimized as little as possible with respect to financial and environmental impact. This can be made possible by the introduction of an integrated pest control system. Rat and wild boar should be controlled by regional coordinated work.

(viii) **Harvesting and Post-Harvest**

It is recommendable to use sickle for harvesting but not Ani-ani. There is no serious problem for post-harvest of dry season rice, since the harvesting time is relatively dry. On the other hand the post-harvest of rainy season rice is troublesome and thus the threshing and drying should be completed within a short period. It is, therefore, desired to introduce at least the pedal thresher. As for drying, it is essential to construct communal paved drying yards.

(ix) **Water Control and Others**

Appropriate water control and management through irrigation facilities is essential to achieve effective results. There are several critical periods when appropriate water control is required, namely transplanting time, non-productive tillering stage, panicle formation stage, and flowering stage. Thus, water control and management should be carefully done at these stages.

Land preparation, transplanting and harvesting, which require a large amount of manpower in a short period, are commonly practices by self-help communal work, called "Gotong Royong". All these communal activities require effective coordination, and cooperation with the assistance of BPP. The reasonable base of those communal works seems to be an irrigation block.

3.5.2 Palawija Crops

It is important to cultivate palawija crops from various aspects, namely pedology, integrated pest management, profitability, marketability, diversification of labour requirement and so on.

Recommended palawija crops are soybean and peanut. The detailed farming practice should follow the recommendation of the BPP Kota Lama and the major farm inputs and labour requirement are shown in Table 3.2. Two important points for soybean and peanut cultivation are as follows:

(1) Inoculation of leguminous bacteris:
This inoculation is important to exploit the productivity of crops and to improve the soil fertility. Appropriate type of leguminous bacteris should be selected, following the consultation with BPP.

(2) Lime application:
Peanut requires lime when it formulates peas in the soil and thus lime application is essential.

The standard farming descriptions recommended by the Agricultural Department of Riau Province are as follows:

	Soybean	Peanut
Variety	Wilis, Dempo, Kerinci	Gajah, Macan Banteng
Planting period	100 days	90 days
Yield	1.8 t/Ha	1.6 t/Ha
Plant density	500,000 plants 20cm x 20cm 2 plants/hill	160,000 plants 25cm x 25cm 1 plant/hill
Inoculation	necessary	necessary

3.6 Anticipated Crop Yields and Production

According to the Provincial Statistics, the yields of major crops are summarized below:

Crop	Project Area(t/ha)	Riau Province (t/ha)	National Average(t/ha)*
Wetland Paddy		2.99	4.57
irrigated	3.1		
rainfed	0.8		
Upland Paddy	0.9	1.83	2.09
Soybean	0.7	0.81	1.13
Peanut	0.6	0.95	1.02

*: Source: "REELITA VI, Subsektor Tanaman Pangan" by Direktorat Bina Program & Direktorat Jenderal Pertanian Tanaman Pangan, 1992

Note: The data of National Average are for 1990.

It is important to remember that the productivity widely varies due to soil condition, climate, crop's potential, different production infrastructure, technical level, etc, by area. Therefore, the anticipated crop yields with and without Project should be estimated on the basis of the study of the present yields in the Project Area, the yields of similar projects, potentials of crop variety and so on, under the condition that agricultural production infrastructure will be largely improved, and that the upgrading of farming technology and the strengthening of the agricultural supporting system will be materialized.

Furthermore, according to the report by Direktorat Bina Program and Direktorat Jenderal Pertanian Tanaman Pangan, namely REELITA VI, Subsektor Tanaman Pangan, the annual yield increase ratios out of Java Island 1988-91, are 1.5 % for rainfed rice, 3.0 % for upland rice, 0.3 % for soybean, and -1.1 % for peanut.

On the other hand, "A Model to Analyse Autonomous Development of Rice Production and Demand in Indonesia" by Poul S. Grashoff estimates the rice yield growth rates at 1.73 % up to 1995, 1.39 % up to 2000 and 1.11 % up to 2015 in sumatra.

As a result it seems reasonable to estimate the yield growth ratios under the condition of without Project as follows:

Irrigated paddy	1.5 %
Rainfed paddy	1.5 %
Upland paddy	1.5 %
Soybean	0.3 %
Peanut	0.0 %

It is also presumed for simplicity that this yield growth is mainly caused by introduction of better varieties and better farming management which does not require much increase of labour inputs, except for harvesting and post-harvesting activities. In other words, the yield growth is accompanied only by the labour input increase for harvesting by the same ratio of the yield growth.

In conclusion, the crop yields are anticipated as follows:

crop	anticipated yield(t/ha)	
	with Project	without Project
Wet season paddy		
irrigated	5.0	3.5
rainfed		0.9
upland		1.0
Dry season paddy		
irrigated	5.5	
rainfed		0.9
upland		1.0
Soybean	1.6	0.7
Peanut	1.8	0.6

The crop yields will reach the anticipated level five years after the completion of project construction accompanied by upgrading of farming technology. The crop production increase is assumed to be linear over five years.

The anticipated crop production under present, without Project, and with Project conditions are shown in Table 3.3 in detail and summarized as below:

Anticipated Crop Production (unit: metric ton)

	Present	without Project	with Project
Paddy	522	581	62,223
Palawija	301	301	7,596

3.7 Requirement of Labour and Draft Animal

On the basis of Farm Economy Survey the present labour inputs have been estimated by crop as shown in Table 2.6. On the basis of this analysis the labour requirements with Project and without

Project in the future have been estimated as shown in Table 3.2 and 3.4 and also are summarized as follows:

Anticipated labour requirement (man-day)

Crop	with Project	without Project	present
Irrigated	137	131	127
Rainfed		150	147
Upland		139	135
Soybean	120	91	91
Peanut	124	129	129

This labour requirement and presently available labour force per farm household have been utilized to finalize the proposed cropping season together with water availability, since labour force is an essential factor and also a major potential constraint for agricultural production. Upon conclusion of labour requirement analysis as shown in Table 3.5, it has become clear that necessary labour force for the proposed cropping pattern and farming practices can be supplied within the present labour availability.

As for draft animal power, cows are used for land preparation in the New Villages and the average quantity of cow per household is 0.7 in Kota Baru, 0.6 in Kota Raya, 1.4 in Muara Jaya and 0.9 in three villages. This extension of cows has been promoted by the IFAD programme which started in 1983. In the transmigration villages this programme is under processing and will soon start. Thus, in the year 2000, most farm household will own cows for land preparation and it is expected that there will be no shortage for draft animal power supply.

3.8 Farm Mechanization

One of the most important objectives of the Project is to increase farmers' income. The possible strategies to achieve this objective are to raise and stabilize crop productivity through good farm management and good production infrastructure, and to enlarge farm size by enlargement of planting area, efficient labour use, and farm mechanization.

As discussed in section 2.4, the farm mechanization in the Project Area so far is non-existent, except for ox ploughing. In the Project Area there are some positive and negative factors