25 m.eq./100gr. of air-dried soils, corresponding to about 35 to 50 % of the C.E.C. values. Essential plant nutrients are quite deficient.

As to their hydrodynamic characteristics, these soils have rather high moisture holding capacity, while, they have low permeability coefficients and poor or imperfect drainabilities. Compactnesses or bearing capacities are rather high ranging 4 to 5 Kg/cm^2 in N-value at the moisture condition of field capacity of sub-surface soils.

In the light of the above features and characteristics, it is considered that the soils in this soil group would be highly suitable for the culture of paddy rice as well as various dry field crops, though some proper measures such as modification of soil reaction should be taken up.

V.4.3 Ultisols

The soils of this group are derived from the diluvial materials with loamy to sandy skeletal in texture and/or partially from sandstones of the tertiary formation. These soils widely extend over the undulating or rolling hills lying in the eastmost of the survey area. The extent of Ultisols is about 5,780 ha, corresponding to about 6 % of the total survey area. In the survey area, Ultisols is composed of one sub-order Ustults, one great group Haplustults, one sub-group Typic Haplustults, and one family Sandy skeletal, Acid, Typic Haplustults.

Sandy skeletal, Acid, Typic Haplustults

Soil unit (15): Ultisols in order, Ustults in sub-order, Haplustults in great group, Typic Haplustults in sub-group.

The soils of Typic Haplustults are correlated with Red-Yellow Podzolic soils in the U.S.D.A. classification system modified in the 1949. In the previous soil study in this survey area made by the Bogor Soil Research Institute, 1976, these soils are classified into Podzolic soils.

Generally, the soils of this soil group are the gravelly or stony soils (skeletal regime) with textural matrix of coarse loamy to loamy sand. The soils have relatively shallow effective soil depth which is limited by the paralithic contact or compacted gravel layer. On these soils, the laterization as the specific soil formation is proceeded in relatively deep profile, while the podzolization is weak or unremarkable in the sub-surface profile.

The typical horizon sequence is A1/ A12/ B/ C. A1 horizon is an ochric epipedon having less than 10 cm in thickness but somewhat out-eroded from the profile. The soils have an exposed small gravel and stones particularly on the soil surface. The matrix colour ranges between dark reddish brown to dull brown

(10YR 5/2 to 5/3). The accumulation or deposition of organic matters on the soils is very weak in common, owing to meager vegetation, so the soils are rather hardly and firmly consolidated. A12 horizon to a depth of about 25 cm is forming subsurface soils which are brown to reddish brown (10YR 5/3 to 5/5); coarse loamy to sandy loam in texture with many small gravels; compact and rather firmly consolidated, while very friable when moistened. B horizon to a depth of about 50 cm is a cambic horizon in which the soil is strong brown (7.5YR 5/5) to reddish brown (10YR 5/3) in colour; coarse loamy in texture; compact and firmly consolidated, while very friable when wet; coarse blocky structure. The soils also have gravels but rather few in quantity and sometimes very rare. C horizon is a basal lithological layer which might be the diluvium or saprolites of the sandstones of the tertiary formation. In this horizon or layer, the soils partly have a paralithic contact regime. Many gravels are included.

These soils are strong acid ranging from 4.0 to 5.0 in pH throughout the profile. Total organic carbon is estimated at about 1 to 2% in surface soils, while 0.5 % or less in sub-soils. C.E.C. ranges between 10 to 20 m.eq. in loamy soils and less than 10 m.eq. in sandy soils. Base saturation degree of these soils is estimated at less than 10 % of each C.E.C. value. Available plant nutrients are quite deficient. In regard to their hydrodynamic characteristics, the soils have very low moisture holding capacity, while the sub-soil layers have rather high perpeability coefficients ranged from 8.5×10^{-3} to 5.0×10^{-3} cm/sec.

In the light of their profile features, natures and properties, the soils of Typic Haplustults are unsuitable for irrigated farming. To realize the agricultural production in the area of these, it is recommended to proceed special programmes aiming at the animal grazing, orchard plantation, aforestation etc.

V.4.4 Histosols

The soils of Histosols develop on the alluvial depression lying rather widely on the foot of undulating hills. These soils extend over about 9,160 ha., corresponding to about 10 % of the total survey area. All the land of these soils is covered with the secondary or tertiary forests with growth of ferns, osmandas and other swampy grasses. The Histosols herein defined are classified into Fibrists (undecomposed organic matters), Hemists (moderately decomposed peat) and Saprists (well decomposed peat) in sub-order at the higher category in the survey area. Histosols are correlated with Bog soils (peat and/or peaty soils) in the U.S.D.A. classification system defined in 1938. In the previous soil study in 1976, these soils are classified into the Organic soils.

Dysic, Terric Tropofibrists

Soil unit (16): Histosols in order, Fibrists in sub-order, Tropofibrists in great group, Terric Tropofibrists in sub-group.

The soils of this soil group are Histosols having such specific characteristics as (1) deep organic profile under submerged condition, (2) low degree of decomposition of organic materials (fibrous), (3) no mineral stratification within the organic profile, (4) extremely strong acid throughout the profile even under the present field conditions. These soils lie in the central part of the deep depression and occupy about 2,700 ha or 33 % of the total extent of Histosols. The land of these soils are covered with the dense swampy forest and more or less submerged throughout the year.

Generally, these soils have deep organic profile more than 100 cm and fibric regime throughout the profile. The typical profile sequence of these soils is O2/ O31/ O32/ Cg. O2 horizon is hemic epipedon very thinly developed on the surface. The epipedon has 5 to 10 cm in thickness, brownish black to dark brown (7.5YR 3/0 to 3/2); relatively well decomposed but still low in mineralization; very loose consistence when wet, while extremely firm consistence when dry. O31 horizon to a depth of about 50 cm is fibric pedon having dark brown (7.5YR 4/2 to 4/3) in colour; loose; no mineral components. O32 horizon is also the fibric pedon having brown to dull brown (5YR to 7.5YR 5/4 to 5/6) in colour; loose consistence. Thickness of this horizon varies from 50 to 110 cm, and thereunder, mud-clay soils underlie deeply. The mud-clay are generally gray (5Y 4/3 to 5/2) in colour; rather compact and massive structure.

Regarding their chemical properties, these soils are extremely strong acid ranged between 4.0 to 4.5 in pH under the present field condition, while the reaction change to more strong at 3.5 to 4.9 in pH when dried. A potential acidity, which determaind on pH at the maximum oxidation condition ranges from 2.0 to 2.5 in pH. The total organic carbon is estimated at about 50 to 60 % in the surface and 25 to 30 % in the sub-surface soils. Mineral component and essential plant nutrients are quite deficient throughout the profile.

Taking into consideration the features and characteristics mentioned above, the land of this soil group is not so suitable for profitable irrigation farming of paddy rice and common tropical dry field crops.

Dysic, Terric Tropohemists

Soil unit (17): Histosols in order, Hemists in sub-order, Tropohemists in great group, Terric Tropohemists in sub-group.

The soils of this soil group are also Histosols which have hemic regime in rather well decomposition degree of organic

matters in certain depth of the profile. The soils develop in deep depression neighbouring to the Fibrists (16). The extent of Hemists is estimated at about 2.340 ha, corresponding to about 25 % of total extent of Histosols. The land of this soil area is being covered with the secondary to tertiary swampy forests and submerged most of a year. Natural drainage subjects to drying the soil surface for about 60 days during the dry season. In such a case, the soils on the surface profile are put under the oxidization and the decomposition of organic matters is highly proceeded.

General horizon sequence of these soils is O1/ O2/O22/ O3/ Cg with diffuse and irregular boundaries, except upper boundary of Cg horizon which is specified into smooth and abrupt form. O1 horizon is sapric epipedon having a thickness of less than 10 cm, in common. The soils in this horizon are very dark, brown (10YR 3/0 to 3/1) in colour; loose and very soft when wet but very firmly consolidated when dry. O2 horizon to a depth of about 25 cm on the surface profile is hemic pedon having dark brown (7.5YR 4/3) in colour; loose compactness. The organic matters are relatively well decomposed but still have many fibrous residues. O22 horizon, commonly to a depth of about 50 cm, is also hemic pedon. The matrix is brown (5YR 5/3) to dull brown (7.5YR 4/3) in colour and includes many fibrous residues. The soils in both O2 and O22 horizons are loose consistence when wet but very firm consistence when dry. O3 horizon is fibric pedon which consists of fibrous matterials. They are very rough in compactness and brown (5YR 5/5) in colour. This horizon is limited to a depth of about 120 cm below the ground surface, and thereunder, mud-clay underlies deeply. The mud-clay are generally gray (5Y 3/3 to 4/3) in colour, fine loam to clay loam in texture and rather compact.

The total organic carbon is about 50 % throughout histic layer, while less than 2 % in mud-clay. Mineral component and essential plant nutrients are very small in contents in these soils. The soil reaction ranges as extremely strong acid as 3.5 to 4.5 in pH under the present field condition, while 3.0 to 4.0 when air-dried. A potential acidity is estimated at 2.0 to 2.5 in pH.

According to the soil and topographic conditions stated in the above, it is difficult to realize a sustainable agricultural production in the area of these soils. Poor drainage due to deep depression and unfavourable soil conditions such as extremely strong acid, very low fertility, very soft but very firm consistence when dry, etc. are unpreventable constraint for agricultural development. In order to modify these conditions satisfactorily, considerably high capital investment and recurrent cost will be required not only for the initial development but also for continuous upkeeping of favorable conditions. Under the current circumstances of agricultural economy, these cost and investment will be scarcely justifiable.

Dysic, Terric Troposaprists

Soil unit (18): Histosols in order, Saprists in sub-order, Troposaprists in great group, Terric Troposaprists in sub-group.

The soils of this soil group are Histosols which are specified by the sapric regime (highly decomposed degree of organic materials). The soils mainly lie over the depression around the other Histosols. The extent of this soil group is estimated at about 4,120 ha, corresponding to 45 % of total Histosols. Recently, some small area of this soil has been developed as paddy field. Practically, however, the yield of paddy rice is far lower than that in the area of other soils. It is considered that the growing of paddy rice is restricted seriously under the conditions of extremely acid soil reaction, poor fertility and relatively deep flooding in the crop season. The remaining land is mostly grown by natural vegetation such as gelam shrub, swampy grasses, etc.

Owing to relatively good effect of natural drainage in the dry season, organic matters are well decomposed throughout the deep profile. Generally, the soils have the horizon sequence of O1/ O12/ O2/ C1/ C2 with diffuse and irregular boundaries. O1 horizon is the sapric epipedon having a thickness of about 20 cm. The soils in this horizon are dark reddish brown (5YR 3/2) to dull reddish brown (10YR 5/3) in colour; soft and rather loose consistence when wet, while firmly consolidated when dry. Mineralization or decomposition of organic matters is almost completed in this horizon. O12 horizon to a depth of about 45 cm is sapric pedon. The soils are very dark gray (5YR 3/1 to 4/0) to dark reddish gray (5YR 4/2) in colour; soft and loose consistence when wet, firm consistence when dry. Many fibrous residues are still included in this horizon. O2 horizon to a depth of about 60 cm to 100 cm is hemic pedon that have dark gray to very dark gray (2.5YR 3/0 to 4/1) in colour; considerable amount of fibrous materials on the profile; very loose in compactness. C1 horizon is the mineral soils irregularly mixed with the hemic soils. They are dark gray (2.5YR 4/0 to 4/1) in matrix colour and sandy clay in texture and massive structure. C2 horizon is also the mineral soils which are considered as mud-clay. The soils are sandy clay loam to loam in texture; gray (5Y 5/2 to 4/3) in colour; rather compact and massive structure.

Regarding their chemical properties, the soils are extremely strong acid with pH value ranged between 3.5 and 4.5 under the present field conditions, while these soils become more strong acid of 3.0 to 3.5 in pH when air-dried. A potential acidity of these soils are estimated at 2.0 to 2.5 in pH. Total organic carbon is about 60 % in histic soils, while a few percent in the mineral soils. Exchangeable bases and essential plant nutrients are quite poor in these soils except mud-clay which are rather rich in bases.

In order to expect the profitable farming in the area of these soils, proper drainage and soil improvement particularly for modification of soil acidity and fertilization are indispensable.

V.5 LAND CLASSIFICATION

V.5.1 Basic Consideration for Land Classification

The land classification for delineation of the potential arable area is made in accordance with the land classification system defined by the Bureau of Reclamation, the U.S. Department of Interior, 1953 as modified in 1967, especially for the land evaluation on lowlying paddy field and its production. In this classification, the lands are graded with emphasis on their capability for irrigated paddy rice cultivation under the Project.

Among the specification of the land evaluation defined in the above reference, the following soil and physical environments are taken into consideration as the essential for evaluation.

(1) Soil textural qualities (s): limitation due to coarse texture with gravel to economic development of paddy field with irrigation facilities and/or very fine texture for diversified crops (palawija) with irrigation.

(2) Effective soil depth (k): limitation due to sand, gravel, cobble, plinthite, mud- clay, histic soils and/or impermeable layer within shallow depth below ground surface.

(3) Soil acidity (a): limitation due to strong acid reaction of soils. Especially, the soils having potential acidity limit to economic farm operations

(4) Topography (t): limitation mainly due to unsuitable land elevation to economical gravity irrigation, and relief conditions unsuitable for economical drainage improvement and field arrangement.

(5) Drainage (d): limitation mainly due to the seasonal flooding for paddy cultivation or very poor internal drainability caused by high groundwater table and heavy clayey texture for economic farming with palawija.

Among the limiting factors in the above, the seasonal flooding is the biggest constraint to the proper agricultural development, although the present paddy rice cultivation is directly sustained by the use of flood water. Very poor internal drainability caused by heavy clayey texture and high groundwater table is also the limitation particularly to the economic farming of palawija.

In order to develop the Project area successfully, rather high capital investment would be required for the flood and drainage control.

The main topographic constraint is the elevation of land. The lands with elevation more than 13 m could not be irrigated by gravity flow through the proposed irrigation canal. Deep depressions lying along the river Barito and/or lying widely on the foot of the hills have a severe limitation to the economical drainage improvement. Undulating or rolling relief conditions in the hilly area are another topographic constraint. Mainly due to steep slopes, it is difficult to make economical field arrangement for proper irrigation farming.

The fine textural features consist of 35 to 70 % of clay, 30 to 60 % of silt and very rare sandy particles is generally accepted for the paddy rice cultivation. While, the cultivation of diversified crops will be restricted to a certain degree due to such unfavourable characteristics as very low intake rate, very high moisture holding capacity, and very low permeability coefficient of soils.

The fine textured soils having very hard consistence when dry, while very soft and friable consistence when wet, will also restric the farm mechanization to some extent. According to the field data so far obtained from dry field, a bearing capacity expressed in N-value is rather small as compared with the value of 4 Kg/cm^2 which is generally accepted as the minimum allowable value for the introduction of farm machinery. In order to realize the proper farm mechanization, it will be required to increase the bearing capacity sufficiently by the improvement of soil moisture regime by providing the proper drainage facilities.

Coarse textured soils having very rapid percolation rate and low moisture holding capacity, are also not suitable for economical irrigation development due to large water requirements for upkeeping the favourable range of soil moisture in a certain depth of the soils. Gravelly and stony soils in the hilly area will largely limit the farm operations and limit the rooting activities of the crops.

Organic soils also have the constraint to the agricultural development. In order to meliorate these soils, it is required to apply proper quantity of lime or other alkaline materials for correcting soil acidity and/or sufficient water for leaching active acidities. According to the annual report on the Barambai Transmigration project (1978), it is noteworthy that the ground surface in Histosols area is being gradually subsided, year by year, at the rate of about 5 cm deep/year on an average caused by a decomposition of the organic matters. As a result, a large labour force is required for maintenance of the farm facilities and land levelling. Those recurrent cost for operation and maintenance of the farm facilities could not be justified, under the current situation of the farm economics.

As for the constraints upon low fertility, it is considered that the deficiency of the essential plant nutrients could be supplemented by application of manures and chemical fertilizers. However, it is noted that fertilization efficiency particularly of phosphate will be reduced due to chemical absorption to be proceeded with active alumina under the strong acid conditions. As far as the crop production especially of diversified crops are concerned, profitable production will not be expected in this survey area without the correction of strong acid soil conditions.

Shallow soil depth especially due to mud-clay will restrict not only the crop production but also the economical field arrangement. Once aggravation occurs in the brackish and sulphuric regimes by a strong oxidation of soils attributed to deep excavation, it is very difficult to recover the good soil conditions. In order to reclaim these soils successfully, it is necessary to study the specific land use and irrigation cum drainage engineerings, from the viewpoint of soil improvement and land reformation.

Some other constraints are also found in the survey area, such as prevailing various pests and diseases, low familiarity of the farmers with the modernized farming practices and improved varieties of crops, low intensity of agricultural supporting services and so on. So far as the purpose of this land classification is concerned, however, these conditions could be excluded from this land classification study, conceptionally.

V.5.2 Specification of Land Classification

Taking into account the soil and land conditions presented in the preceding Sections and also the plant-physiological characteristics of paddy rice and palawija, the terms of land classification and their specific degree corresponding to the land suitability classes are established in accordance with the land classification standard defined by the U.S. Bureau of Reclamation. In this context, the following conditions are additionally taken into consideration for the soil and land appraisals.

(1) Condition for seedling establishment particularly for diversified crops, and soil tillability.

(2) Workability

(3) Possibility of farm mechanization

(4) Capability for maintaining surface water particularly for paddy rice cultivation.

The criteria for rating of soil and land factors is tabulated in Table V-5. The terms of land classification and their specific degree are summarized in Table V-6.

V.5.3 Land Classification

Upon the basis of the terms of land classification and their specific degree corresponding to the land suitability classes for irrigation development, the land defined in each soil group is evaluated as shown in the Tables V- 7 to V- 24.

In rating the irrigation suitability of land, limiting factors of soil and land are assessed whether it is corrigible or difficult to involve in the land development. Hence, the potential land suitability herein defined as the most permissible land class are graded by applying the lowest rate of limiting factor: In this context, such physical natures as soil depth, soil texture, and topographic conditions are the essential limitation in the survey area.

In the light of the profile features soil chemical and physical characteristics, all of the low-lying lands, except for swamp where the soils are classified into the soil families (6), (16), (17) and (18), are involved in the highly suitable land class (I) for irrigated paddy rice cultivation. From the drainage engineering point of view, however, this land grade might be down to the suitable (II) to moderately suitable (III) land classes because of rather high capital investment required for flood protection and also rather expensive management cost of surface drainage during the cropping season particularly in the rainy season. The area defined as the soil family (6) where the area is being influenced by the deep seasonal flooding and the soils are shallowly bottomed by the mud-clay (potential acid sulphate soils) is also classified into arable land. Taking into account the low degree of such limiting factors, the land of soil family (6) is graded into marginally suitable land class (IV).

In order to reclaim the land in Histosols, high investment would be required for proper drainage improvement because of the existence of depression where the flood water is deeply stagnated throughout the year. In addition, high maintenance cost of the facilities and high investment for land levelling would also be required for proper drainage operation because of Histosols which would gradually be decomposed irregularly, depending on the degree of decomposition of the organic materials. So far as crop production on Histosols is concerned, no profitable production are expected due to the soils having extremely high acidities and very high contents of organic carbon which largely limit the fertilizer response to crops. With these limiting factors, the area of Histosols is classified into unsuitable land class (V).

The other areas occupied by the soils of families (1), (2), (3), (8), (12) and (15) are free from the flood and have no large constraints upon drainage. Because of the undulating topography in most of the area, however, it will be rather difficult to make field arrangement suitable for proper management of irrigation

water. Besides, the soils having coarse textures with many gravels throughout the profile will make the field arrangement for irrigation and farm operation difficult. It is considered that most of the land of these soils is unsuitable (V) for economic irrigation development. However, the land in the valley of these areas will be graded into the land classes (III) or (IV) owing to the soil and topography which are specified sufficiently with the requirements of irrigation suitability.

From the above land evaluation, the land in the survey area is classified into four suitable land classes for paddy and diversified crops with irrigation as shown in Table V-25, and the extent of each class is illustrated on the land classification map attached to this report.

The first class includes the suitable land (II) in which high productivity and profitability can be sufficiently expected from the soil and land. However, there are moderate limitations caused by strong acid soil reaction, poor essential plant nutrients, and seasonal floodings. These factors are likely to reduce crop yield and/or to increase recurrent costs for the crop production and improvement of soil and land.

The second class is the moderately suitable land (III). The land of this class is also expected to have fairy productivity for the paddy and diversified crops, though there are some limitations which may reduce crop yield and call for higher recurrent costs for the production and soil melioration. Rather deep flooding will be the constraint of this land class.

The third is the marginally suitable land (IV). The land of this class is also expected to obtain higher crop yield through proper land use, when the deep water stagnation is reduced by the tidal drainage system, successfully. However, improvement of the drainage system would require a large investment. The potential acid soil shallowly underlain is another constraint. When the soils are dried by heavy drainage works, the present soil reaction would change to extremely strong acid caused by the oxidation process of soils.

The last class is the economically unsuitable land (V) for the irrigation development programme. Because of the land having very serious limitations such as deep water stagnation and potential acid organic soils in the low-lying area and corse textured soil with gravels, shallow soil depth, rolling or undulating topography, etc. in the hilly area, the economic development could not be expected with the land in this class, though some possibilities for agricultural development with other specific crops and tree crops are recognized.

To repeat in general, all of the lands in the project area have more or less some constraints which would reduce crop yields and require higher cost for crop production and soil improvement particularly for introduction of the diversified dry field crops.

V.6 DEMARCATION OF POTENTIAL ARABLE LAND

According to the systematic appraisal of soils and land made in the preceding section V.5, the land in the survey area is classified into four land classes in which the first two classes are the suitable land for irrigated farming, the third class is the marginally suitable land and the fourth is economically unsuitable land for the irrigation development.

In this land classification, about 49,100 or about 53 % of total survey area are selected as the potential arable land (classes II and III). Generally, these lands have sufficiently deep soil, moderate tillability, high irrigability and sustainable surface drainability. The physical constraints prevailing in the area could be improved and/or modified satisfactorily within the reasonable capital investment.

About 22,040 ha of the land are graded into marginally arable land (class IV). These lands are also considered as the potential arable land. However, special measures will be required for agricultural utilization, particularly for melioration of aggravated soil features caused by their drainage improvement. It is rather difficult, at present, to expect economical use of these soils for profitable irrigation farming of paddy rice and other common up land crops by implementing comprehensive irrigation and drainage system. Accordingly, the land in this class is not recommended for the project.

The remaining area, 21,640 ha, is classified into class V (economically unsuitable for irrigation farming), and then, these lands are precluded from the project study.

Based on the above land classification, demarcation of irrigable land to be taken for the project study is made as shown in Table-V- 26.

V.7 SUMMARY AND RECOMMENDATIONS

In this soil investigation and studies, the soils in the Riam Kanan Irrigation Project area are broadly classified into 4 orders, 10 sub-orders, 12 great groups, 17 sub-groups and 18 families based on the morphological features and specific characteristics.

In view of the land productivity, tillability or arability, and irrigability cum drainability, it is noteworthy that such various characteristics, as strong acid reaction as well as potential acidity, poor content of essential plant nutrients, undesirable textural features, and inadequate permeability coefficient, and excessively hard and firm consistence when dry, are the common defects of all soil groups in the survey area.

To speak in general, the soils classified into the families (4), (5) and (7) of Entisols and (9), (10), (13) and (14) of Inceptisols have no significant differences among their soil features in case of their agricultural use for irrigation farming with this project. In common, these soils are wet and massive throughout the profile. They are extremely hard and firmly consolidated when dry, while very soft and friable when wet. They have very high moisture holding capacity, while the permeability coefficient is very low ranging between 5.0×10^{-5} cm/sec and 5.0×10^{-6} cm/sec in percolation rate. They are strong to very strong acid with pH values ranged from 4.5 to 5.5 throughout the profile. EC values are mostly less than 1.0 m.mho/cm/25°C (free from the salinity problem). Cation exchange capacity ranges between 25 and 60 m.eq./100 gr. of air-dried soils and the capacity is saturated by the bases at less than 50 % in which calcium and magnecium are dominant. In some exceptional cases, saturation degree higher than 50 % is found only in the soils of family (5) and (10).

The soils of the families (6) and (11) are resemble closely to the above soils in general features except in the regime of soil acidity. Under natural conditions when the soils are moistened, they show pH values ranging from 4.5 to 5.5, but the soils particularly the sub-soils change to extremely strong acid conditions (pH 3.0 to 3.5) when dry. Their potential acidities shown by pH value are ranging from 2.5 to 3.0.

The soils of the families (1), (2) and (12) are the sandy soils which consist of moderately coarse to fine quartz sands with small gravels throughout the profile. Due to very lack of weatherable minerals and clayey fractions, these soils have very poor plant nutrients and small cation exchange capacity. Regarding the hydrodynamic characteristics, the soils have very small moisture holding capacity, while very rapid percolation speed throughout the profile, even though the groundwater is shallowly lying below ground surface.

The soils of the families (3), (8) and (15) generally consist of loamy to sandy skeletals throughout the profile. Due to their poor vegetations and undulating topographies, almost all of the surface soils are more or less eroded out, and then, organic matters in the soils are only very few. Cation exchange capacity ranges between 5 and 10 m.eq., while its base saturagion is only 10 % or so. The essential plant nutrients such as nitrogen, phosphorus, potash, etc. are very poor. Owing to very coarse texture throughout the profile, the soils have low moisture holding capacity and very rapid percolation rate. The tillability or arability of these soils is low in general.

The soils of the families (16), (17) and (18) are primarily the organic materials deeply deposited in the depression. Generally, these soils are strong to very strong acid with pH values ranging between 4.5 and 5.0 throughout the profile under submarged conditions, and they show an extremely strong acid reaction with

pH values less than 3.5 when dry. The potential acidity are estimated at around 2.5 in pH. No mineral stratification and/or fractions are observed in the profile, and then, available plant nutrients and effective bases are very rare in these soils.

In view of their response for crops, the soils in the project area are quite deficient in the essential plant nutrient, such as nitrogen phosphorus, effective bases inclusive of potash, and are strong to very strong acid throughout the profile. The deficiency of these chemical elements could be corrected by future application of chemical fertilizers of proper amounts. However, it is noted that the fertilizing effeciency especially of phosphate would be very low due to high contents of active aluminum ions in strong acid soils. It is, therefore, recommended to select the most suitable fertilizers and the best method of fertilization in due consideration of the relationship among soils- water- crops.

Deficiency of effective bases will be the cause strong acidity and extremely hard and firm consistence of soils when dry. At the initial stage of the development, it would be required to make basic improvement of such unfavourable soil conditions by means of proper liming practice.

The soils are one of the most important and basic element for development of profitable agriculture. It is, therefore, recommended to make the best effort to improve the soil conditions properly in a long run of the years. Once aggravated by some causes, it is very difficult to recover the good conditions. Hence, it is also recommended to make continuous studies and field monitoring on the probable change of soil characteristics in a long range either in the project area or in an experimental farm.

In the light of the features and characteristics of soils described above, the land suitability is classified into four classes in accordance with the U.S. Bureau of Reclamation standard modified in 1967.

Out of total survey area, about 49,100 ha or about 35 % are selected as the potential arable land (classes II and III). Generally, these lands have sufficiently effective soil depth. moderate tillability, high irrigability and sustainable surface drainability.

About 22,040 ha of land are graded into marginally arable land (class IV). It is rather difficult, at present, to study economical use of these soils for profitable agricultural development with irrigation. Accordingly, the land in this class IV is not recommended for the project.

The remaining area, 21,640 ha, is classified into class V (economically unsuitable for irrigation farming) and is excluded from the project study.

Table V-1 Soil Classification in Higher Categories

Order	Sub-order	Great Soil Group	Soil Sub-group
1. Entisols	1. Psamments	1. Quartzipsamments	1. Aeric Quartzi-psamments
			2. Haplaquodic Quartzipsamments
	2. Orthents	2. Troporthents	3. Typic Troporthents
	3. Aquents	3. Fluvaquents	4. Typic Fluvaquents
			5. Thapto-Histic Fluvaquents
		4. Hydraquents	6. Sulfic Hydraquents
	4. Fluvents	5. Tropofluvents	7. Typic Tropofluvents
2. Inceptisols	5. Tropepts	6. Dystropepts	8. Typic Dystropepts
	6. Aquepts	7. Tropaquepts	9. Aeric Tropaquepts
			10. Typic Tropaquepts
			11. Histic Tropaquepts
		8. Haplaquepts	12. Aeric Haplaquepts
			13. Typic Haplaquepts
3. Ultisols	7. Ustults	9. Haplustults	14. Typic Haplustults
4. Histosols	8. Fibrists	10. Tropofibrists	15. Terric Tropofibrists
	9. Hemists	11. Tropohemists	16. Terric Tropohemists
	10. Saprists	12. Troposaprists	17. Terric Troposaprists

Note: The soil classification is made in accordance with the U.S. Soil Taxonomy system, 1973.

Table V-2 Soil Classification in Lower Categories

Soil Sub-group	Soil Family	Extent Area (ha)
1. Aquic Quartzi-psamments	1. Acid, Aquic Quartzipsamments	4,690
2. Haplaquodic Quartzipsamments	2. Sandy skeletal, Acid, Haplaquodic Quartzipsamments	2,250
3. Typic Troporthents	3. Sandy skeletal, Acid, Typic Troporthents	3,270
4. Typic Fluvaquents	4. Fine, Acid, Typic Fluvaquents	2,350
5. Thapto-Histic Fluvaquents	5. Fine, Dysic, Thapto-Histic Fluvaquents	1,890
6. Sulfic Hydraquents	6. Loamy, Dysic, Sulfic Hydraquents	12,720
7. Typic Tropofluvents	7. Clayey, Acid, Typic Tropofluvents	3,720
8. Typic Dystropepts	8. Loamy skeletal, Acid, Typic Dystropepts	3,170
9. Aeric Tropaquepts	9. Loamy, Acid, Aeric Tropaquepts	25,830
10. Typic Tropaquepts	10. Loamy, Acid, Typic Tropaquepts	6,680
11. Histic Tropaquepts	11. Loamy, Acid, Histic Tropaquepts	4,010
	12. Sandy, Dysic, Histic Tropaquepts	1,100
12. Aeric Haplaquepts	13. Clayey, Acid, Aeric Haplaquepts	4,960
13. Typic Haplaquepts	14. Loamy, Acid, Typic Haplaquepts	1,200
14. Typic Haplustults	15. Sandy skeletal, Acid, Typic Haplustults	5,780
15. Terric Tropofibrists	16. Dysic, Terric Tropofibrists	2,700
16. Terric Tropohemists	17. Dysic, Terric Tropohemists	2,340
17. Terric Troposaprists	18. Dysic, Terric Troposaprists	4,120
	Total	92,780

Table V-3 Present Soil Classification Correlated with Previous Soil Classification

Present Classification		Previous Classification	
Great Group	Sub-group	Great Group	Sub-group
1. Quartzipsamments	1. Aquic Quartzipsamments	1. Regosols	1. Oxic Regosols
	2. Haplaquodic Quartzipsamments	2. Spodzols	2. Humic Spodzols
2. Troporthents	3. Typic Troporthents	3. Regosols	3. Oxic Regosols
3. Fluvaquents	4. Typic Fluvaquents		
	5. Thapto-Histic Fluvaquents		
4. Hydraquents	6. Sulfic Hydraquents	4. Alluvial soils	4. Thionic Alluvial soils
5. Tropofluvents	7. Typic Tropofluvents		5. Dystric Alluvial soils
6. Dystropepts	8. Typic Dystropepts	5. Latosols or Lateric soils	
7. Tropaquepts	9. Aeric Tropaquepts	6. Alluvial soils	6. Dystric Alluvial soils
	10. Typic Tripaquepts		7. Eutric Alluvial soils
	11. Histic Tropaquepts		8. Dystric Alluvial soils
8. Hapraquepts	12. Aeric Haplaquepts		
	13. Typic Haplaquepts		9. Eutric Alluvial soils
9. Haplustults	14. Typic Haplustults	7. Podzolic soils	
10. Tropofibrists	15. Terric Tropofibrists	8. Organic soils	10. Fibric Histosols
11. Tropohemists	16. Terric Tropohemists		11. Hemic Histosols
12. Troposaprists	17. Terric Troposaprists		12. Sapric Histosols

Table V-4 Major Characteristics of Soils and Environmental Conditions

Sub-group	Mapping Unit (family No.)	Landform and Topography	Land Use or Vegetation	Seasonal Flood	
				Duration (month)	Depth (cm)
1. Aquic Quartzi-psamments	1	old sand dune & low-terrace; nearly flat	bushes	-	-
2. Haplaquodic Quartzipsamments	2	low-terrace; nearly flat	bushes	-	-
3. Typic Troporthents	3	undulating; very gentle sloping	alang-alang	-	-
4. Typic Fluvaquents	4	recent levee; nearly flat	village-yard	Dec.-Mar.	30
5. Tapto-Histic Fluvaquents	5	recent levee; nearly flat	paddy field	full-season	50
6. Sulfic Hydraquents	6	depression; flat	paddy field or gelam tree	full season	100 or more
7. Typic Tropofluvents	7	flood plain; flat	gelam shrub	Nov.-May	50
8. Typic Dystropepts	8	undulating; gentle slope	alang-alang	-	-
9. Aeric Tropaquepts	9	flood plain; flat	paddy field	Dec.-Mar.	30
10. Typic Tropaquepts	10	flood plain; flat	paddy field	Dec.-Apr.	50

Note: 1) Mapping unit (family No.) is the soils which classified into the soil family at lower category in the soil classification. The figures are directly referred to the serial No. of the soils illustrated in the soil map.

2) Duration of the seasonal flooding is preliminarily defined as the period with water standing.

3) Depth of the seasonal flooding shows the maximum depth of peak flooding water.

- to be continued -

Sub-group	Mapping Unit (family No.)	Landform and Topography	Land Use or Vegetation	Seasonal Flood Duration (month)	Seasonal Flood Depth (cm)
11. Histic Tropaquepts	11	flood plain; flat	gelam and swampy forest	Dec.-May	50
		low-terrace; nearly flat	gelam and swampy forest	-	-
12. Aeric Haplaquepts	12	levee; nearly flat	village-yard and plantation	Dec.-Feb.	30
13. Typic Haplaquepts	13	old levee; nearly flat	plantation and village-yard	-	-
14. Typic Haplustults	14	rolling; steep slope	alang-alang	-	-
15. Terric Tropofibrists	15	depression;	swampy-forest	full-season	100 or more
16. Terric Tropohemists	16	depression;	swampy-forest	full-season	100 or more
17. Terric Troposaprists	17	flood plain; flat	gelam shrub or swampy forest	full-season	50 or more

Note: 1) Mapping unit (family No.) is the soils which classified into the soil family at lower category in the soil classification. The figures are directly referred to the serial No. of the soils illustrated in the soil map.

2) Duration of the seasonal flooding is preliminarily defined as the period with water standing.

3) Depth of the seasonal flooding shows the maximum depth of peak flooding water.

Mapping Unit	Ground Water Fluctuation (cm)	Soil Depth (cm)	Soil Texture	Specific Horizon	Salinity
1.	0 to 50	0 to 5	LS/SG	-	free
2.	10 to 50	0 to 10	LS/SG	spodic	free
3.	-	30 to 50	L/LG	-	free
4.	10 to 50	100 to 150	SiC/C	cambic	free
5.	0	30 to 50	SiC/peat	histic	free
6.	0	30 to 50	C/C	sulfic or dysic	free
7.	0 to 20	100 to 150	C/C	gleyic	free
8.	-	10 to 20	fL/LG	cambic	free
9.	20 to 50	150 or more	SiC/C	gleyic	free
10.	0 to 30	100 to 150	SiC/C	gleyic	free
11.	10 to 50	100 to 150	humic C/ SiC	histic	free
12.	5 to 30	30 to 50	humic S/S	histic	free
13.	10 to 60	150 or more	SiC/C	gleyic	free
14.	30 to 70	150 or more	C/SiC	cambic	free
15.	-	5 to 25	LG/LG	cambic	free
16.	-	100 to 150	peat	fibric	free
17.	-	100 to 150	peat	hemic	free
18.	-	50 to 100	peat	sapric	free

Mapping Unit	Acidity (pH: H_2O) (field)	(air-dry)	(potential)	C.E.C. (m.e)	Base Saturation Degree (%)	Soil Evaluation
1.	4.5 to 5.5	4.5 to 5.0	-	2 to 7	5 to 20	non-arable
2.	4.0 to 5.0	3.5 to 4.0	-	1 to 6	5 to 15	non-arable
3.	4.5 to 5.5	4.5 to 5.0	-	3 to 10	10 to 20	conditionally arable
4.	4.5 to 5.5	4.0 to 4.5	-	30 to 50	40 to 60	arable
5.	4.5 to 5.0	3.5 to 4.5	3.0 to 3.5	25 to 45	30 to 45	conditionally arable
6.	4.0 to 4.5	3.0 to 4.0	2.5 to 3.5	50 to 60	10 to 20	conditionally arable
7.	4.0 to 5.0	3.5 to 4.0	3.0 to 3.5	30 to 50	30 to 50	arable
8.	4.5 to 6.0	4.5 to 5.0	-	10 to 25	5 to 10	conditionally arable
9.	4.5 to 5.5	4.5 to 5.0	-	30 to 60	35 to 60	arable
10.	4.0 to 4.5	4.0 to 4.5	-	30 to 60	40 to 60	arable
11.	4.0 to 4.5	3.5 to 4.0	3.0 to 3.5	5 to 10	5 to 10	arable
12.	4.0 to 4.5	3.5 to 4.0	3.0 to 3.5	5 to 15	5 to 10	arable
13.	4.5 to 6.0	4.5 to 5.0	-	25 to 35	30 to 50	arable
14.	4.5 to 5.5	4.0 to 5.0	-	30 to 50	35 to 50	arable
15.	4.0 to 5.0	4.0 to 4.5	-	10 to 20	5 to 10	conditionally arable
16.	4.0 to 4.5	3.5 to 4.0	2.0 to 2.5	100 to 150	few	currently non-arable
17.	3.5 to 4.5	3.0 to 4.0	2.0 to 2.5	150 to 170	few	currently non-arable
18.	3.5 to 4.5	3.0 to 3.5	2.0 to 2.5	50 to 65	few	conditionally arable

Table V-5(1) Soil Profile Features and Chemical Properties

Pit No.	Sample No.	Horizon Sequence		Depth (cm)	Soil Colour (when wet)	Mottling	Texture (on-field)	Groundwater Table (cm)	Soil Acidity (PH 1:2.5) Field	Air-dried	Oven-dried	Oxid. (H_2O_2)	Salinity (EC m.mho/cm) Field	Air-dried
1	1	I	A1	0-15	Grayish brown	few	clay	20	4.9	5.3	4.3	3.5	0.08	0.12
	2	II	C1	15-80	Light brownishgray	many	clay		4.6	5.0	4.6	3.8	0.12	0.09
2	3	I	Ao	0-5	Brownish black	-	Humic sand	10	4.1	4.2	3.8	2.5	0.12	0.13
	4	II	A1	5-50	Dark brown	-	Humic sand		4.1	4.7	4.7	3.3	0.12	0.07
4	5	I	A1	0-15	Very dark brown	few	Humic clay	20	4.7	5.2	4.4	3.5	0.07	0.07
	6	II	C1	15-100	Light grayish brown	Many	clay		4.7	5.1	4.3	4.1	0.13	0.06
5	7	I	A1	0-15	Dark grayish brown	few	clay	45	4.9	5.0	5.1	3.4	0.29	0.21
	8	II	C1	15-50	Light gray	common	clay		6.0	6.1	5.5	5.0	0.19	0.26
	9	III	C2	50-90	Light grayish brown	many	clay		6.5	6.5	5.5	4.0	0.24	0.68
6	10	I	A1	0-10	Dark grayish brown	few	clay loam	30	4.8	4.7	4.4	3.4	0.40	0.40
	11	II	C1	10-90	Light gray	common	clay		5.0	5.2	4.0	3.6	0.69	1.10
	12	III	C2g	90-150	Light brownish gray	many	clay		6.5	6.0	5.9	4.1	1.14	1.69
7	13	I	A1	0-13	Dark brown	-	clay	30	4.3	4.4	3.9	3.1	0.38	0.47
	14	II	C1	13-100	Light brownish gray	common	clay		4.5	4.7	3.9	3.1	0.19	0.17
	15	III	C2g	100+	Light greenish gray	-	clay		5.5	4.5	3.9	3.4	0.23	1.38
8	16	I	A1	0-50	Brownish gray	-	Humic clay	flooded(+30)	5.4	5.0	4.2	3.0	2.55	7.94
	17	II	A12	50-100	Brownish gray	-	clay		6.1	5.8	5.2	2.7	1.53	0.07
	18	III	C1	100+	Dull gray	-	clay		6.1	6.2	5.2	4.0	0.55	0.99
9	19	I	A1	0-20	Very dark brown	few	clay	35	5.5	5.5	5.0	3.8	0.43	0.33
	20	II	C1	20-75	Dark gray	few	clay		6.1	6.0	5.4	4.5	0.45	0.20
	21	III	C2	75-120	Light gray	common	clay		6.1	6.3	5.6	4.2	0.33	0.54
	22	IV	C3g	120+	Light greenish gray	-	clay		6.4	6.5	5.5	4.9	0.51	1.19
	23	I	A1	0-10	Dark brown	-	fine sandy loam	flooded(+10)	4.7	4.2	3.7	3.4	0.12	0.54
	24	II	C1	10-85	Light brown	-	fine sandy loam		4.3	4.8	3.9	3.0	0.15	0.14
	25	III	C2g	85-130	Dark gray	-	fine sandy loam		4.0	3.7	2.9	2.3	0.45	2.27
	26	IV	C3g	130+	Gray	-	clay		4.2	3.9	3.2	2.5	0.85	1.89
10	27	I	A1	0-10	Dark brownishgray	-	clay	25	4.9	5.1	4.4	3.5	0.05	0.05
	28	II	C1	10-100	Gray	common	clay		4.7	5.0	4.1	4.0	0.06	0.05
11	29	II	C1	5-45	Dark gray	common	clay	flooded(+5)	4.4	4.5	3.9	3.4	0.06	0.19
	30	III	C2	45-60	Light gray	many	clay		4.3	4.3	3.8	3.6	0.05	0.20
	31	IV	C3	60-75	Light gray	many	loamy sandy		4.4	4.7	3.9	3.7	0.17	0.15
	32	V	C4	75-100	Light gray	common	loamy		4.5	4.7	4.2	3.7	0.12	0.16
	33	VI	C5g	100-150+	Light brownish gray	-	clay loam		4.6	4.7	4.2	3.6	0.01	0.13
12	34	I	A1	0-10	Very dark brown	-	Humic clay	40	4.5	3.5	4.0	3.1	0.19	0.41
	35	II	A1	10-75	Light brownish gray	many	clay		4.5	4.7	3.8	3.7	0.11	0.14
	36	III	C2	75-150+	Gray	-	silty clay		4.8	4.7	3.9	3.3	0.13	0.11
13	37	I	A1	0-25	Dark brown	-	clay	30	5.0	5.6	4.4	3.4	0.25	0.33
	38	II	C1	25-100	Light brownish gray	common	clay		5.0	5.3	4.6	3.9	0.22	0.02
	39	III	C2g	100-240+	Greenish gray	-	clay		6.1	6.0	4.8	3.8	0.75	0.68
14	40	I	A1	0-10	Dark gray	-	clay	35	4.9	5.2	4.3	3.7	0.16	0.23
	41	II	A12	10-30	Dark gray	-	clay		5.2	5.3	4.2	4.0	0.15	0.13
	42	III	C1	30-150	Gray	many	clay		5.9	5.9	5.1	4.8	0.25	0.04

Table V-3(2) Soil Profile Features and Chemical Properties

Pit No.	Sample No.	Horizon Sequence		Depth (cm)	Soil Colour (when wet)	Mottling	Texture (on-field)	Groundwater Table (cm)	Soil Acidity (PH 1:2.5) Field	Air-dried	Oven-dried	Oxid. (H_2O_2)	Salinity (EC mmho/cm) Field	Air-dried
15	43	I	A1	0-15	Dark gray	common	clay	60	5.2	4.9	4.4	3.9	0.21	0.32
	44	II	C1	15-55	Light brownish gray	common	clay		5.5	5.3	5.0	4.6	0.36	0.64
	45	III	C2	55-100	Brownish gray	many	clay		5.9	5.8	5.4	5.1	0.16	0.38
	46	IV	C3g	100-200+	Greenish gray	-	clay		6.3	5.9	5.4	4.0	0.42	0.87
17	47	I	A1	0-20	Dark gray	-	clay	55	5.2	5.1	4.5	3.4	0.14	0.40
	48	II	C1	20-55	Gray	common	clay		5.3	4.8	4.8	4.3	0.07	0.61
	49	III	C2	55-70	Light brownish gray	many	clay		6.2	5.7	5.6	5.2	0.06	0.29
	50	IV	C3g	70-110+	Gray	-	clay		6.7	6.0	5.9	3.3	0.31	0.39
19	51	I	A1	0-20	Dark gray	-	clay	20	5.4	4.8	4.5	3.7	0.16	0.17
	52	II	C1	20-40	Gray	common	clay		5.9	5.0	4.9	4.0	0.30	0.35
	53	III	C2	40-120+	Brownish gray	many	clay		6.5	5.6	5.5	5.1	0.15	0.19
20	54	I	A1	0-40	Very dark gray	-	Humic clay	20	5.2	4.6	5.1	4.1	0.20	0.18
	55	II	C1	40-60	Gray	few	clay		5.1	4.5	4.6	4.0	0.14	0.20
	56	III	C2	60-120	Light brownish gray	many	clay		5.3	4.3	4.5	3.7	0.10	0.13
	57	IV	C3g	120-240+	Gray	few	clay		5.1	4.8	5.0	4.1	0.13	0.10
21	58	I	A1	0-25	Dark gray	-	clay	40	5.9	4.7	5.0	2.2	0.14	0.19
	59	II	C1	25-120	Gray	many	clay		6.4	5.1	5.4	5.1	0.17	0.10
	60	III	C2g	120-200+	Brownish gray	common	clay		5.0	5.1	5.5	5.1	0.15	0.15
22	61	I	A1	0-15	Very dark gray	-	clay	40	5.0	4.6	4.5	3.7	0.15	0.25
	62	II	C1	15-30	Light gray	few	clay		5.5	4.1	4.6	4.6	0.17	0.19
	63	III	C2	30-80	Light brownish gray	many	clay		6.2	5.7	5.4	5.4	0.36	0.30
	64	IV	C3g	80-150+	Gray	common	clay		6.3	5.6	5.1	3.3	0.44	0.89
23	65	I	Ao	0-10	Very dark gray	-	Humic clay	50	4.2	4.3	3.8	2.6	0.07	0.41
	66	II	A1	10-35	Dark brown	-	Humic clay		4.5	4.0	3.8	3.6	0.07	0.49
	67	III	A12	35-50	Dark brown	-	Humic clay loam		4.0	3.9	4.0	2.7	0.09	0.52
	68	IV	C1	50-150+	Gray	-	Medium sand		4.5	4.2	4.1	2.8	0.07	0.46
24	69	I	O1	0-12	Dark brown	-	Peat	0	4.0	3.7	3.3	2.6	0.04	0.29
	70	II	O12	10-100+	Brown	-	peat		3.9	3.6	3.4	2.4	0.08	0.24
25	71	I	A1	0-5	Very dark brown		Humic clay loam	-	4.8	5.2	4.0	3.4	0.06	0.01
	72	II	C1	5-50	Light gray	common	Sandy clay		4.9	4.9	4.6	3.9	0.06	0.01
	73	III	C2	50-100	Light brownish gray	common	loam		4.9	4.9	4.2	3.9	0.12	0.00
	74	IV	C3g	100-150+	Dark gray	-	clay loam		5.6	5.1	4.3	3.9	0.04	0.01
26	75	I	A1	0-20	Very dark brown	-	Humic clay loam	-	4.7	4.7	4.8	3.1	0.06	0.01
	76	II	A2	20-50	Dark brown	-	Humic loam		5.6	4.9	5.2	3.8	0.06	0.00
	77	III	C1	50-100+	Brownish gray	-	Sandy clay		4.8	5.0	5.1	4.2	0.10	0.01
27	78	I	A1	0-20	Dark gray	few	clay	40	5.5	5.1	4.3	4.3	0.05	0.03
	79	II	C1	20-110	Light brownish gray	many	clay		5.9	5.7	4.7	4.2	0.37	0.03
28	80	I	A1	0-20	Dark brwon	-	clay	70	5.6	5.2	5.2	4.3	0.70	0.10
	81	II	C12	20-50	Light gray	few	clay		6.6	6.2	5.9	4.9	0.33	0.03
	82	III	C2	50-120	Light brownish gray	many	clay		7.0	6.2	5.6	5.6	0.72	0.11
	83	IV	C3g	120-150	Gray	few	clay		7.1	6.2	5.9	4.8	0.86	0.14
	84	V	C4g	100-150+	Light blueish gray	few	loamy sand		7.5	6.8	5.9	5.0	0.87	0.15

Table V-3(3) Soil Profile Features and Chemical Properties

Pit No.	Sample No.	Horizon Sequence		Depth (cm)	Soil Colour (when wet)	Mottling	Texture (on-field)	Groundwater Table (cm)	Soil Acidity (PH 1:2.5) Field	Air-dried	Oven-dried	Oxid. (H_2O_2)	Salinity (EC m.mho/cm) Field	Air-dried
30	85	I	A1	0-15	Dark gray	few	clay	45	5.8	5.0	5.2	3.0	0.25	0.06
	86	II	C1	15-50	Light gray	many	clay		5.7	5.6	5.3	4.2	0.40	0.09
	87	III	C2	50-100	Gray	common	clay		6.7	6.3	4.8	4.5	0.99	0.13
	88	IV	C3g	100-150+	Gray	common	clay		7.3	5.9	4.8	4.3	0.71	0.28
31	89	I	A1	0-20	Dark Brown	few	clay	65	5.3	5.0	4.8	3.8	0.52	0.03
	90	II	C1	20-50	Light brownish gray	common	clay		5.1	5.1	5.0	3.6	0.76	0.11
	91	III	C2	50-120	Brownish gray	common	clay		5.0	4.9	4.9	3.9	0.54	0.13
	92	IV	C3g	120-250+	Light greenish gray	-	clay		7.3	6.2	5.6	3.2	0.67	0.29
32	93	I	A1	0-15	Dark brown	few	clay	55	5.5	4.9	5.2	3.8	0.34	0.02
	94	II	C1	15-100	Light brownish gray	many	clay		5.1	4.3	4.3	4.3	0.14	0.07
	95	III	C2	100-130	Gray	common	clay		5.4	4.0	5.2	3.1	0.39	0.12
	96	IV	C3g	130-200+	Light greenish gray	-	clay		6.3	4.8	4.4	3.8	1.00	0.36
33	97	I	A1	0-20	Dark brown	-	Humic clay	35	5.0	4.9	5.1	3.9	0.81	0.32
	98	II	C1	20-45	Light brown	few	clay		5.4	5.2	4.8	4.0	0.65	0.09
	99	III	C2	45-100	Gray	many	clay		5.5	5.4	5.2	3.4	0.89	0.16
	100	III	C3g	100-200+	Light greenish gray	-	clay		6.8	6.1	5.8	3.9	0.70	0.23
34	101	I	A1	0-30	Very dark brwon	-	Humic clay	30	5.0	4.4	4.3	3.8	1.89	0.03
	102	II	C1	30-50	Light brownish gray	-	clay		5.5	5.3	5.2	3.6	1.03	0.17
	103	III	C2	50-150	Gray	common	clay		5.2	4.3	4.5	2.2	1.27	0.67
35	104	I	A1	0-15	Dark gray	-	clay	45	5.4	5.0	5.2	3.4	0.92	0.27
	105	II	C1	15-50	Light brownish gray	common	clay		5.9	5.2	5.2	3.3	1.01	0.33
	106	III	C2g	50-130+	Light blueish gray	few	clay		6.6	5.8	5.6	4.2	0.28	0.32
36	107	I	A1	0-5	Grayish brown	few	Humic clay		5.6	5.2	5.2	3.6	1.07	0.18
	108	II	C1	5-45	Gray	common	clay		6.0	5.3	5.4	3.4	0.96	0.21
	109	III	C2	45-150	Dark brown	-	Peaty clay		6.9	5.3	4.2	3.1	1.51	0.68
	110	IV	C3	150-200	Dull brown	-	Peaty clay	6	6.8	4.8	4.9	3.0	1.68	0.85
	111	V	C4g	200-250+	Gray	-	clay		6.9	5.3	5.3	3.8	2.18	0.67
37	112	I	A1	0-25	Dark bwon	-	Gravelly sandy loam		6.5	5.5	4.8	4.2	0.44	0.03
	113	II	B1	25-110	Yellowish brown	-	Gravelly sandy loam		6.0	5.6	5.1	4.8	0.44	0.01
	114	III	B12	110-220+	Reddish brown	-	Gravelly sandy loam		5.9	4.9	5.2	4.5	0.15	0.01
38	115	I	A1	0-25	Dark brown	-	Sandy loam		5.8	5.8	5.4	4.2	0.36	0.01
	116	II	B12	25-55	Yellowish brown	-	Sandy loam		5.7	5.6	5.5	4.3	0.35	0.01
41	117	I	A1	0-15	Dark yellowish	-	Silty clay loam		5.3	5.2	5.3	4.1	0.38	0.01
42	118	I	A1	0-40	Dull brown	-	loam		5.1	5.6	5.0	4.6	0.41	0.01
	119	II	C1	40-150+	Yellowish brown	-	fine loam		5.5	5.6	5.4	5.3	0.39	0.00
43	120	I	A1	0-20	Dark brown	-	clay loam		5.4	5.2	5.1	4.0	0.38	0.01
	121	II	C1	20-100+	Reddish brown	-	Lammy clay		5.6	5.0	5.0	3.8	0.35	0.01
44	122	I	A1	0-15	Dark grayish brown	-	Humic clay	30	4.7	5.3	5.4	4.2	0.04	0.03
	123	II	C12	15-30	Dark gray	few	clay		5.2	4.9	4.8	4.1	0.05	0.03
	124	III	C2	30-100	Light brownish gray	common	clay		4.7	4.5	4.0	4.0	0.07	0.06
	125	IV	C3g	100-130	Light reddish gray	many	clay		4.4	4.0	3.1	3.1	0.11	0.19
	126	V	C4g	130-250+	Dark gray	-	clay		4.4	3.6	3.6	3.2	0.27	0.11

Table V-3(4) Soil Profile Features and Chemical Properties

Pit No.	Sample No.	Horizon Sequence		Depth (cm)	Soil Colour (when wet)	Mottling	Texture (on-field)	Groundwater Table (cm)	Soil Acidity (PH 1:2.5)				Salinity (EC m.mho/cm)	
									Field	Airdried	Ovendried	Oxid. (H_2O_2)	Field	Airdried
45	127	I	A1	0-30	Very dark brown	-	Humic clay	45	4.8	4.6	4.2	3.8	0.09	0.15
	128	II	C1	30-45	Grayish brown	few	clay		4.9	5.0	4.9	4.2	0.05	0.04
	129	III	C2	45-70	Light brownish gray	common	clay		4.6	4.6	3.8	4.0	0.10	0.06
	130	IV	C3	70-130	Light reddish gray	few	clay		4.2	4.2	4.5	3.5	0.12	0.17
46	131	I	A1	0-5	Very dark brown	-	clay	55	4.8	4.6	4.2	4.0	0.12	0.14
	132	II	C1	5-30	Gray	few	clay		4.8	4.6	4.8	4.0	0.04	0.05
	133	III	C2	30-70	Light gray	common	clay		4.6	3.9	3.5	3.2	0.05	0.05
	134	IV	C3g	70-120	Light brownish gray	-	clay		4.5	3.9	3.4	3.0	0.12	0.46
	135	V	C4g	120-250+	Very dark gray	-	clay		4.2	3.8	4.3	3.1	0.18	0.03
47	136	I	A1	0-20	Very dark brown	-	Humic clay	50	4.7	4.8	4.5	4.0	0.04	0.04
	137	II	C1	20-50	Light brownish gray	many	clay		4.5	3.9	3.7	3.6	0.06	0.03
	138	III	C2	50-90	Brownish gray	few	clay		4.3	4.4	4.6	3.5	0.05	0.04
	139	IV	C3g	90-150+	Very dark gray	-	clay		4.3	3.8	4.3	3.2	0.16	0.35
48	140	I	A1	0-15	Dark brown	-	Humic clay	60	5.0	5.0	4.1	3.4	0.07	0.05
	141	II	C1	15-35	Light gray	few	clay		5.8	5.8	4.2	4.2	0.00	0.03
	142	III	C2	35-100	Light brownish gray	many	clay		5.9	6.0	5.9	5.2	0.05	0.10
	143	IV	C3g	100-140	Light bluish gray	few	clay		7.0	6.7	5.8	5.3	0.16	0.13
	144	V	C4g	140-250	Light brownish gray	-	silty clay		6.7	5.3	5.3	5.1	0.22	0.22

Table V-6(1) Results of Soil Chemical Analyses

Pit No.	Sample No.	Horizon Sequence		Total Carbon (%)	Total Nitrogen (%)	C/N	Total P_2O_5 (mg)	Total K_2O (mg)	Water Soluble Cation & Anion: Na (m.e)	K (m.e)	C_a+M_g (m.e)	SO_4 (ppm)	Cl (ppm)	P_2O_5 (ppm)	Exchangeable Bases: Na (m.e)	K (m.e)	C_a+M_g (m.e)	C.E.C. (m.e)	Base Satulation Degree (%)
1	1	I	A1	3.68	0.33	11.15	22.5	0.6	0.025	0.125	0.302	10	340	9	0.9	0.42	0.56	39	4.8
	2	II	C1	1.10	-		35.0	1.4	0.050	0.175	0.279	60	360	-					
2	3	I	Ao	10.87	0.11	98.82	7.5	2.3	0.050	0.038	0.321	60	340	5	1.28	0.48	0.47	50	4.5
	4	II	A1	0.98	0.02	49.00	7.5	0.1	0.225	0.338	0.100	21	225	19	0.78	0.42	0.42	38	4.2
4	5	I	A1	1.24	0.29	4.28	35.0	0.5	0.125	0.025	1.092	21	240	9	0.54	0.48	0.44	24	6.1
	6	II	C1						0.125	0.013	1.185	4	240						
5	7	I	A1	2.25	0.43	5.23	7.0	0.5	0.275	0.018	0.720	33	230	14	0.54	0.48	0.44	37	3.9
	8	II	C1						0.225	0.025	0.521	19	270						
	9	III	C2						0.055	0.350	2.115	90	360						
6	10	1	A1	3.18	0.66	4.82	90.0	0.4	0.225	0.018	1.370	42	290	11	0.54	0.53	0.46	44	3.5
	11	II	C1						0.775	0.025	1.557	72	330						
	12	III	C2g						1.250	0.105	3.278	133	720						
7	13	I	A1	5.57	0.49	11.37	60.0	0.5	0.300	0.010	1.511	23	25	11	0.90	0.53	0.54	40	4.9
	14	II	C1						0.200	0.030	0.953	16	310						
	15	III	C2g						1.000	0.018	0.732	133	350						
8	16	I	A1	40.28	0.64	62.94	37.5	4.8	3.765	0.580	2.141	205	360	14	2.56	1.28	1.67	68	8.3
	17	II	A12						3.137	0.350	7.742	14	450						
	18	III	C1						3.350	0.275	3.375	123	640						
9	19	I	A1	2.78	0.10	27.80	47.5	0.6	0.380	0.030	0.732	26	330	14	0.90	0.64	0.79	39	6.0
	20	II	C1						0.625	0.030	0.534	24	290						
	21	III	C2						0.925	0.025	4.620	74	400						
	22	IV	C3g						1.300	0.388	5.411	154	275						
10	23	1	A1	2.70	0.27	10.00	22.5	0.1	0.200	0.063	0.999	38	240	11	0.74	0.48	0.36	26	6.08
	24	II	C1						0.125	0.025	0.441	10	270						
	25	III	C3g						0.125	0.025	0.451	154	20						
	26	IV	C3g						0.275	0.063	0.561	205	210						
11	27	I	A1	1.32	0.01	132.00	47.5	0.1	0.125	0.018	0.162	44	190	9	1.28	0.52	0.56	32	7.06
	28	II	C1						0.225	0.030	0.116	2	170						
12	29	II	C1	0.34	0.08	6.75	17.5	0.2	0.125	0.018	0.488	19	270	9	1.60	0.35	0.26	19	11.63
	30	III	C2						0.125	0.075	0.534	16	50						
	31	IV	C3						0.225	0.030	0.300	10	250						
	32	V	C4						0.125	0.038	0.162	6	220						
	33	VI	C5g						0.083	0.100	0.255	10	280						
13	34	I	A1	2.56	0.36	7.11	70.0	0.2	0.400	0.300	0.160	12	400	11	1.10	0.53	0.45	34	6.12
	35	II	C1						0.250	0.150	0.534	12	270						
	36	III	C2						0.125	0.018	0.162	2	270						
14	37	I	A1	7.44	0.64	11.63	75.0	0.8	0.200	0.025	0.860	33	280	11	1.45	0.68	0.38	36	6.97
	38	II	C1						0.275	0.025	0.730	37	420						
	39	III	C2g						0.700	0.050	2.301	42	390						
15	40	I	A1		0.25		22.5	0.5	0.225	0.025	0.348	10	35	7	0.90	0.48	0.70	24	8.67
	41	II	A12						0.400	0.013	0.395	21	30						
	42	III	C1						0.475	0.013	0.255	14	25						

Table V-6(2) Results of Soil Chemical Analyses

Pit No.	Sample No.	Horizon Sequence		Total Carbon (%)	Total Nitrogen (%)	C/N	Total P_2O_5 (mg)	Total K_2O (mg)	Water Soluble Cation & Anion: Na (m.e)	K (m.e)	$Ca+Mg$ (m.e)	SO_4 (ppm)	Cl (ppm)	P_2O_5 (ppm)	Exchangeable Bases: Na (m.e)	K (m.e)	$Ca+Mg$ (m.e)	C.E.C. (m.e)	Base Satulation Degree (%)
16	43	I	A1	0.67	0.16	4.19	22.5	0.4	0.400	0.013	0.488	21	10	7	1.83	0.53	0.86	27	11.93
	44	II	C1						1.575	0.013	0.346	31	62						
	45	III	C2						1.750	0.025	0.423	35	85						
	46	IV	C3g						1.650	0.025	0.627	42	540						
17	47	I	A1		0.31		15.0	0.4	1.300	0.013	0.325	10	128	11	1.45	0.48	1.04	28	10.61
	48	II	C1						1.150	0.018	0.209	21	290						
	49	III	C2						1.650	0.018	0.186	23	290						
	50	IV	C3g						1.600	0.025	0.274	26	890						
19	51	I	A1	1.80	0.27	6.67	35.0	0.4	0.275	0.018	0.441	4	25	14	1.10	0.58	0.63	30	7.70
	52	II	C1						0.400	0.018	0.302	14	35						
	53	III	C2						0.400	0.075	0.311	166	40						
20	54	I	A1	1.61	0.19	5.32	107.5	0.4	0.125	0.013	0.425	12	27	44	0.90	0.42	0.52	37	4.97
	55	II	C1						0.275	0.018	0.215	21	50						
	56	III	C2						0.225	0.018	0.348	36	30						
	57	IV	C3g						0.275	0.018	0.415	31	25						
21	58	I	A1	0.85	0.04	21.25	4.5	0.4	0.275	0.013	0.162	17	10	14	1.28	0.64	0.63	30	8.50
	59	II	C1						0.225	0.013	1.278	19	45						
	60	III	C2g						0.275	0.075	0.860	4	220						
22	61	I	A1	1.65	0.07	23.57	47.5	0.4	0.350	0.025	0.395	14	240	16	1.60	0.80	0.72	37	8.42
	62	II	C1						0.125	0.013	0.395	69	25						
	63	III	C2						0.125	0.018	0.432	38	566						
	64	IV	C3g						1.150	0.030	0.906	65	50						
23	65	I	Ao	30.0	0.63	47.62	55.0	0.2	0.625	0.050	0.152	6	114	11	1.45	0.43	0.80	36	7.44
	66	III	A1						1.475	0.018	0.273	23	129						
	67	III	A12						1.150	0.025	0.441	13	310						
	68	IV	C1						1.075	0.030	0.231	33	119						
24	69	I	O1	6.0	1.58	3.80	375.0	2.3	0.151	0.010	0.302	45	118	34	1.45	0.74	0.24	150	1.62
	70	II	O12						0.234	0.070	0.163	58	940						
25	71	I	A1	11.64	0.30	38.80	22.5	0.3	0.116	0.030	0.721	6	32	9	1.45	0.48	0.20	21	10.14
	72	II	C1	0.08	0.02	4.00	7.5	0.2	0.231	0.017	0.162	12	80	11	1.45	0.48	0.42	7	33.57
	73	III	C2						0.150	0.025	0.162	58	60						
	74	IV	C3g						0.430	0.131	0.302	58	310						
26	75	I	A1	3.64	0.03	121.33	17.5	0.1	0.310	0.025	0.255	4	270	14	2.01	0.53	0.44	29	10.28
	76	II	A2						0.175	0.008	0.156	4	290						
	77	III	C1						0.175	0.015	0.116	13	320						
27	78	I	A1	0.85	0.19	4.47	15.0	0.1	0.170	0.015	0.674	4	25	18	1.60	0.58	0.68	32	8.94
	79	II	C1						0.130	0.025	0.418	16	20						
28	80	I	A1	10.51	0.55	19.11	47.5	0.7	0.125	0.025	0.236	69	280	18	1.45	0.74	0.84	43	7.05
	81	II	C1						0.550	0.015	0.185	74	125						
	82	III	C2						0.450	0.020	1.557	84							
	83	IV	C3g						0.310	0.030	1.697	74	320						
	84	V	C4g						0.230	0.140	2.162	77	119						

Table V-6(1) Results of Soil Chemical Analyses

Pit No.	Sample No.	Horizon	Sequence	Total Carbon (%)	Total Nitrogen (%)	C/N	Total P_2O_5 (mg)	Total K_2O (mg)	Water Soluble Cation & Anion Na (m.e)	K (m.e)	Ca+Mg (m.e)	SO_4 (ppm)	CL (ppm)	P_2O_5 (ppm)	Exchangeable Bases Na (m.e)	K (m.e)	Ca+Mg (m.e)	C.E.C. (m.e)	Base Satulation Degree (%)
30	85	I	A1	11.89	0.59	20.15	42.5	0.6	0.300	0.008	1.120	36	270	14	1.60	0.48	0.76	38	7.47
	86	II	C1						0.015	0.800	1.321	63	420						
	87	III	C2						0.120	0.150	1.557	74	119						
	88	IV	C3g						1.250	0.100	1.232	128	510						
31	89	I	A1						0.580	0.025	1.488	85	230						
	90	II	C1						1.325	0.063	0.321	105	470						
	91	III	C2						0.473	0.052	0.425	133	485						
	92	IV	C3g																
32	93	I	A1	14.88	0.57	26.11	16.00	2.5	0.488	0.008	0.331	10	310	16	2.01	0.68	0.30	25	11.96
	94	II	C1						0.217	0.025	1.278	36	340						
	95	III	C2						2.175	0.050	0.977	63	450						
	96	IV	C3g						1.250	0.250	0.732	128	460						
	97	I	A1	6.99	0.31	22.55	75.0	0.8	1.155	0.265	0.231	22	365	27	1.45	0.74	0.60	48	5.69
	98	III	C1						1.025	0.010	0.472	33	380						
	99	III	C2						1.325	0.015	0.465	82	600						
	100	IV	C3g						2.425	0.113	0.395	110	630						
34	101	I	A1	7.10	0.47	15.11	17.5	0.8	4.250	0.175	0.385	2	350	7	1.45	1.10	0.66	34	9.44
	102	II	C1						2.900	0.050	0.234	35	470						
	103	III	C2						2.982	0.245	0.372	141	920						
35	104	I	A1	12.75	0.50	25.50	47.5	1.0	2.300	0.138	0.432	133	670	16	2.01	1.10	1.10	38	11.08
	105	II	C1						2.300	0.200	3.650	141	685						
	106	III	C2g						2.575	0.143	0.837	65	720						
36	107	I	A1	3.45	0.20	17.25	80.0	1.0	1.225	0.125	0.750	84	540	7	1.10	1.01	0.30	38	7.66
	108	II	C1	3.49	0.46	7.59	60.0	1.8	2.575	0.150	1.697	90	560	7	1.83	1.28	1.06	43	9.70
	109	III	C2						3.127	0.288	0.523	179	810						
	110	IV	C3						3.608	0.300	0.231	159	770						
	111	V	C4g						2.138	0.254	0.324	120	980						
37	112	I	A1	0.85	0.15	5.67	17.5	0.2	1.145	0.145	0.465	16	120	7	0.90	0.35	0.42	8	20.88
	113	II	B1						0.175	0.013	0.432	4	240						
	114	III	B12						0.175	0.010	0.348	6	20						
38	115	I	A1	8.48	0.11	77.09	12.5	0.1	0.250	0.030	0.237	6	270	17	1.10	0.89	0.43	6	40.33
	116	II	B1						0.325	0.010	0.162	13	100						
41	117	I	A1		0.10		25.0	0.4	0.300	0.020	0.165	6	210	31	0.74	0.54	0.39	18	9.28
42	118	I	A1	1.38	0.10	13.20	12.5	0.1	0.260	0.017	0.162	16	50	7	0.90	0.75	0.26	9	21.22
	119	II	C1						0.008	0.050	0.209	60	126						
43	120	I	A1	0.39	0.08	4.88	17.5	0.2	0.250	0.000	0.214	14	114	25	0.54	0.43	0.14	14	7.93
	121	II	C1						0.015	0.250	0.217	4	250						
44	122	I	A1	4.68	1.00	4.68	255.0	0.6	0.125	0.010	0.395	16	275	10	1.10	0.97	0.50	45	5.71
	123	II	C1						0.175	0.000	0.437	19	330						
	124	III	C2						0.550	0.020	0.790	33	15						
	125	IV	C3g						0.560	0.017	0.825	118	20						
	126	V	C4g						0.510	0.048	0.250	307	510						

Table V-6(4) Results of Soil Chemical Analyses

Pit No.	Sample No.	Horizon Sequence		Total Carbon (%)	Total Nitrogen (%)	C/N	Total P_2O_5 (mg)	Total K_2O (mg)	Water Soluble Cation & Anion						Exchangeable Bases			C.E.C. (m.e)	Base Satulation Degree (%)
									Na (m.e)	K (m.e)	$Ca^{++}Mg$ (m.e)	SO_4 (ppm)	CL (ppm)	P_2O_5 (ppm)	Na (m.e)	K (m.e)	$Ca^{++}Mg$ (m.e)		
45	127	I	A1	0.54	0.36	1.50	25.0	2.5	0.175	0.010	0.572	87	305	9	0.74	0.38	0.52	45	3.64
	128	II	C1						0.350	0.000	0.124	35	340						
	129	III	C2						0.300	0.008	0.175	31	320						
	130	IV	C3						0.58	0.038	0.234	74	220						
46	131	I	A1	6.23	1.89	3.30	90.0	0.4	0.600	0.038	0.432	87	350	7	1.28	1.11	0.68	24	12.79
	132	II	C1	3.90	0.36	10.83	22.5	0.2	0.350	0.025	1.139	29	450	9	1.28	1.12	0.40	26	10.77
	133	III	C2						0.350	0.027	0.581	24	620						
	134	IV	C3g						0.410	0.032	0.572	25	450						
	135	V	C4g						0.600	0.075	0.475	192	440						
47	136	I	A1	4.80	0.29	16.55	207.5	0.6	0.560	0.040	0.263	14	55	11	1.28	1.20	0.48	46	6.43
	137	II	C1						0.510	0.020	0.168	17	15						
	138	III	C2						0.250	0.038	0.431	23	25						
	139	IV	C3g						0.488	0.075	0.674	29	380						
48	140	I	A1	4.96	1.08	4.59	35.0	0.5	0.440	0.070	0.627	26	50	7	0.90	0.65	0.72	19	11.95
	141	II	C1						0.440	0.050	0.534	19	32						
	142	III	C2						1.250	0.036	0.425	60	213						
	143	IV	C3g						0.550	0.050	2.000	84	290						
	144	V	C4g						0.550	0.020	0.162	92	350						

Table V-7 Phosphate Absorbed by Soil at Different PH levels and Gross Active Acidity of Soil

Pit No.	Horizon Sequence		Texture (field)	PH level 3	4	5	6	7	8	9	Gross Active Acidity (m.e/100gr)
2	I	Ao	Humic sand	1,020	895	695	545	770	795	858	2.48
	II	A1	Humic sand	820	772	410	295	395	745	795	0.85
8	I	A1	Humic clay	1,170	1,145	895	845	270	945	1,070	1.25
	II	A12	clay	845	770	420	645	670	695	720	2.45
	III	C1	clay	695	670	645	595	895	1,170	1,245	1.13
9	I	A1	Sandy laom	1,345	1,095	245	545	945	1,020		1.67
	II	C1	Sandy laom	970	920	895	620	770	970	1,045	1.60
	III	C2	Loamy sand	1,195	1,145	920	895	520	1,135	1,145	12.23
	IV	C3g	clay	1,370	1,325	1,250	1,295	1,095	1,220	1,345	18.68
19	I	A1	clay	820	795	770	570	325	420	970	0.98
	II	C1	clay	1,025	920	645	245	470	795	995	1.05
	III	C2	clay	995	845	745	450	645	870	1,370	0.95
23	I	Ao	Humic clay	770	645	595	520	295	795	1,295	4.98
	II	A1	Humic clay	1,045	940	770	620	645	870	1,020	7.35
	III	A12	Clay laom	1,320	1,270	520	380	420	1,270	1,345	9.10
	IV	C1	sand	1,245	670	345	170	370	595	620	2.25
28	I	A1	clay	1,295	795	670	420	770	920	930	1.38
	II	C1	clay	715	695	570	370	95	425	435	1.20
	III	C2	clay	1,195	945	845	820	1,045	1,145	1,170	1.25
	IV	C3g	clay	1,295	1,195	1,170	1,070	1,145	1,195	1,270	0
	V	C4g	Loamy sand	1,145	970	920	850	895	945	970	0
47	I	A1	Humic clay	1,245	1,195	1,170	1,045	1,145	1,220	1,270	1.83
	II	C1	clay	845	830	795	670	545	595	670	1.55
	III	C2	clay	1,170	920	675	640	445	545	595	4.00
	IV	C3g	clay	1,395	1,370	1,345	1,305	1,385	1,320	1,370	17.55

Note: Figures are shown by mili-gramme of P_2O_5 to be absorbed in soils.

Table V-8 Criteria for Rating of Land Factors

1. Soil Conditions

1.1 Soil Texture Qualities

	Surface Soils	Sub-surface Soils
so:	Coarse loamy to fine loam	Fine loamy to fine clay
s1:	Fine loamy to fine clay	Coarse loamy to fine clay
s2:	Coarse loamy and/or very fine clayey	Coarse loamy and/or very fine clayey
s3:	Sandy and/or histic soils	Sandy and/or histic soils

1.2 Effective Soil Depth

Depth to sand, gravel, cobble, plinthite, mud-clay or histics

ko:	Very deep	- more than 90 cm
k1:	Deep	- 50 to 90 cm
k2:	Moderate	- 20 to 50 cm
k3:	Shallow	- less than 20 cm

Depth to impermeable layer for Diversified Crops			Depth to impermeable layer for Paddy Rice		
io:	Very deep	- more than 150 cm	ko:	Very deep	- more than 90 cm
i1:	Deep	- 120 to 150 cm	k1:	Deep	- 50 to 90 cm
i2:	Moderate	- 100 to 120 cm	k2:	Moderate	- 20 to 50 cm
i3:	Shallow	- less than 100 cm	k3:	Shallow	- less than 20 cm

1.3 Soil Acidity (pH: H_2O 1:1 soil-water suspension)

ao:	Slightly acid to neutral	- 6.1 to 7.5
a1:	Moderately strong acid	- 5.6 to 6.0
a2:	Strong acid	- 5.1 to 5.5
a3:	Very strong acid	- 4.6 to 5.0
a4:	Extremely strong acid	- less than 4.5

2. Topography

2.1 Relief Conditions

ro:	Flat to nearly flat
r1:	Gently sloped land
r2:	Undulating
r3:	Rolling

2.2 Sloping Conditions

to:	0 to 2%
t1:	2 to 5% in single slope
t2:	5 to 8% in single slope
t3:	8 to 15%
t4:	more than 15%

3. Drainage Conditions

3.1 Soil Drainability

do:	Well drainable
d1:	Moderately drainable
d2:	Somewhat poorly drainable
d3:	Poorly drainable
d4:	Very poorly drainable

3.2 Seasonal Flooding

fo:	Non seasonal flooding (non inundation)
f1:	Seasonal flooding shallowly (sometime inundated)
f2:	Seasonal flooding deeply (frequently inundated)
f3:	Flooding throughout the year (inundated all the times)

Source: Irrigation suitability classification, US. Bureau of Reclamation, 1967

Table V-9 Terms of Land Classification and Their Specific Degree

Suitability	Suitable				Unsuitable
Specific Degree	Very High (1)	High (2)	Moderately High (3)	Low (4)	Very Low (5)
Soil and Land Qualities					
1. Soil fertilities					
- organic carbon (%)	more than 0.75	more than 0.75	0.15 to 0.75	less than 0.15	less than 0.15
- total nitrogen (%)	more than 0.05	more than 0.05	0.01 to 0.05	less than 0.01	less than 0.01
- available P_2O_5 (ppm)	high	moderate	low	very low	very low
- C.E.C (m.eq.)	more than 10	more than 10	3 to 10	less than 3	less than 3
- potassium (m.eq.)	more than 0.2	more than 0.2	0.1 to 0.2	less than 0.1	less than 0.1
- base saturation (%)	more than 40	more than 40	10 to 40	less than 10	less than 10
2. Soil Acidity (pH: 1:1 soil-water suspension)	more than 5.6	more than 5.6	4.6 to 5.5	less than 4.5	less than 4.5
3. Soil Depth (cm)					
- depth to sand, etc.	more than 90	more than 90	50 to 90	20 to 50	less than 20
- depth to impermeable layer	more than 150	120 to 150	120 to 150	100 to 120	less than 100
4. Topography					
- relief	flat to nearly flat	flat to nearly flat	gently sloped	undulating	rolling
- slope (%)	0 to 2	2 to 5	5 to 8	8 to 15	more than 15
5. Drainage Conditions					
- drainability	well	moderate	somewhat poor	poor	very poor
- seasonal flooding	non flooding	non flooding	short and shallowly flooded	long and deeply flooded	permanently and deeply flooded
Land Capability					
6. Conditions for seeding establishment and tillability					
- soil structure	structureless & granular	sub-angular blocky	sub-angular blocky	blocky to massive	massive
- consistence	friable	friable	firm	very firm	extremely firm
- susceptibility to surface sealing	slight	slight	moderate	strong	strong
7. Workability					
- consistence when wet	non to slightly sticky & plastic	slightly sticky & plastic	sticky & plastic	very sticky & very plastic	very sticky & very plastic
- consistence when dry	loose to moderate	moderately hard	moderately hard to hard	very hard	very hard to extremely hard
8. Possibility for farm mechanization					
- land form & slope	flat to gently sloped	gently undulating	undulating	rolling	rolling and steeply sloped
- bearing capacity in N-value	more than 4 Kg/cm^2	3 to 4 Kg/cm^2	3 to 4 Kg/cm^2	less than 3 Kg/cm^2	less than 3 Kg/cm^2
9. Capability for maintaining surface water					
- perceability	less than 1.4×10^{-4} cm/sec.	1.3 to 5.5×10^{-3} cm/sec.	1.6×10^{-3} to 5.5×10^{-4} cm/sec.	less than 1.6×10^{-3} cm/sec.	less than 1.6×10^{-3} cm/sec.

Note: Source; Land suitability classification for irrigated paddy and diversified crops defined by U.S. Bureau of Reclamation, 1967.

Criteria for land capability appraisal is preliminarily estimated based on the specific degree generally accepted.

Table V-10 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	2	2	3	3	(3)	(3)
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	a(2-a3)	a(2-a3)	a4	a4	a4	a4
3. Soil depth										
- depth to sand, etc.	ko	ko	ko	ko	k1	k1	k2	k2	(k3)	(k3)
- depth to impermeable layer	ko	io	(ko)	(io)	k1	i1	k2	i2	k3	i3
4. Soil texture	so-s1	so	so-s1	s1	s2	s2	s2	s3	(s3)	(s3)
5. Topography										
- relief	ro-r1	ro-r1	ro-r1	ro-r1	r2	r2	r3	r3	r3	r3
- slope	to	(to)	(to)	t1	t1	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	d3-d4	(do)	d3-d4	d1	d2	d2	d1	d3	(do)	d4
- flooding	(fo)	fo	fo-f1	(fo)	f2	fo	f3	f1	f3	f2-f3
7. Condition for seedling establishment	1-2	(1)	(1-2)	2	3-4	3	4-5	4	4-5	5
8. Workability	(1-2)	(1-2)	3	3	3	3	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	(1)	(1)	2-3	2-3	2-3	2-3	4	4	5	5
10. Capability for maintaining surface water	1	(4)	2	3	3	2	4	1	(4)	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (1)

Entisols in order. Psamments in sub-order. Quartzipsamments in great group, Aquic Quartzipsamments in sub-group and Acid, Aquic Quartzipsamment in family.

TOPOGRAPHY

Old sand dune, slightly elevated

VEGETATION

Bushes and ferns

LAND SUITABILITY

For paddy rice : class V
For upland crops: class V

Table V-11 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Marginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	2	2	3	3	(3)	(3)
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	a2-a3	a2-a3	a4	a4	a4	a4
3. Soil depth										
- depth to sand, etc.	ko	ko	ko	ko	k1	k1	k2	k2	(k3)	(k3)
- depth to impermeable layer	ko	io	(ko)	(io)	k1	i1	k2	i2	k3	i3
4. Soil texture	so-s1	so	so-s1	s1	s2	s2	s2	s3	s3	s3
5. Topography										
- relief	ro-r1	ro-r1	ro-r1	ro-r1	r2	r2	r3	r3	r3	r3
- slope	to	(to)	to	t1	t1	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	d3-d4	(do)	d3-d4	d1	d2	d2	d1	d3	(do)	d4
- flooding	(fo)	(fo)	fo-f1	fo	f2	fo	f3	f1	f3	f2-f3
7. Condition for seedling establishment	1-2	(1)	(1-2)	2	3-4	3	4-5	4	4-5	5
8. Workability	(1-2)	(1-2)	3	3	3	3	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	(1)	(1)	2-3	2-3	2-3	2-3	4	4	5	5
10. Capability for maintaining surface water	1	(4)	2	3	3	2	4	1	(4)	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (2)

Entisols in order, Psamment in sub-order, Quartzipsamment in great group, Haplaquodic Quartzipsamment in sub-group and Sandy skeletal, Acid, Haplaquodic Quartzipsamment in family.

TOPOGRAPHY

Terrace, slightly elevated

VEGETATION

Bushes and ferns, somewhat gelam shrub

LAND SUITABILITY

For paddy rice : class V
For upland crops: class V

Table V-12 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	2	2	3	3	(3)	(3)
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	(a2-a3)	(a2-a3)	a4	a4	a4	a4
3. Soil depth										
- depth to sand, etc.	ko	ko	ko	ko	k1	k1	(k2)	(k2)	k3	k3
- depth to impermeable layer	ko	io	ko	io	(k1)	(i1)	k2	i2	k3	i3
4. Soil texture	so-s1	so	so-s1	s1	s2	s2	s2	s3	(s3)	(s3)
5. Topography										
- relief	ro-r1	ro-r1	ro-r1	ro-r1	(r2)	(r2)	r3	r3	r3	r3
- slope	to	to	to	(t1)	(t1)	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	d3-d4	(do)	d3-d4	d1	d2	d2	d1	d3	(do)	d4
- flooding	(fo)	(fo)	fo-f1	fo	f2	fo	f3	f1	f3	f2-f3
7. Condition for seedling establishment	1-2	(1)	(1-2)	2	3-4	3	4-5	4	4-5	5
8. Workability	(1-2)	(1-2)	3	3	3	3	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	(1)	(1)	2-3	2-3	2-3	2-3	4	4	5	5
10. Capability for maintaining surface water	1	(4)	2	3	3	2	4	1	(4)	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (3)

Entisols in order, Orthents in sub-order, Troporthents in great group, Typic Troporthents in sub-group and Sandy skeletal, Acid, Typic Troporthents in family.

TOPOGRAPHY

Bottom land in undulation, gently sloped land

VEGETATION

Alang-alang grasses and short bushes, somewhat reclaimed for the upland field

LAND SUITABILITY

For paddy rice : class V
For upland crops: class IV

Table V-13 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	(2)	(2)	3	3	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	(a2-a3)	(a2-a3)	a4	a4	a4	a4
3. Soil depth - depth to sand, etc. - depth to impermeable layer	(ko) (ko)	(ko) io	ko ko	ko io	k1 k1	k1 i1	k2 k2	k2 i2	k3 k3	k3 (i3)
4. Soil texture	(so-sl)	so	so-sl	(sl)	s2	s2	s2	s3	s3	s3
5. Topography - relief - slope	ro-r1 (to)	ro-r1 (to)	(ro-r1) to	(ro-r1) t1	r2 t1	r2 t2	r3 t2	r3 t3	r3 t3-t4	r3 t4
6. Drainage - drainability - flooding	(d3-d4) fo	do fo	d3-d4 (fo-f1)	d1 fo	d2 f2	d2 fo	d1 f3	(d3) (f1)	do f3	d4 f2-f3
7. Condition for seedling establishment	1-2	1	1-2	2	3-4	3	(4-5)	(4)	4-5	5
8. Workability	1-2	1-2	3	3	(3)	(3)	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	2-3	2-3	2-3	2-3	(4)	(4)	5	5
10. Capability for maintaining surface water	(1)	4	2	3	3	2	4	(1)	4	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (4)

Entizols in order, Aquents in sub-order, Fluvaquents in great group, Typic Fluvaquents in sub-group and Fine, Acid, Typic Fluvaquents in family

TOPOGRAPHY

Recent river levee extending narrowly along the river Barito.

VEGETATION

House-yard and coconut plantation, somewhat paddy rice cultivation for the rainy season cropping

LAND SUITABILITY

For paddy rice : class II
For upland crops: class IV

Table V-14 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	(2)	(2)	3	3	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	(a2-a3)	(a2-a3)	a4	a4	a4	a4
3. Soil depth - depth to sand, etc. - depth to impermeable layer	ko ko	ko io	ko (ko)	ko io	k1 k1	k1 i1	(k2) k2	(k2) i2	k3 k3	k3 (i3)
4. Soil texture	so-s1	so	(so-s1)	(s1)	s2	s2	s2	s3	s3	s3
5. Topography - relief - slope	ro-r1 to	ro-r1 (to)	(ro-r1) (to)	(ro-r1) t1	r2 t1	r2 t2	r3 t2	r3 t3	r3 t3-t4	r3 t4
6. Drainage - drainability - flooding	d3-d4 fo	do fo	(d3-d4) fo-f1	d1 fo	d2 (f2)	d2 fo	d1 f3	d3 f1	do f3	(d4) (f2-f3)
7. Condition for seedling establishment	1-2	1	1-2	2	3-4	3	(4-5)	(4)	4-5	5
8. Workability	1-2	1-2	3	3	(3)	(3)	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	2-3	2-3	2-3	2-3	4	4	(5)	(5)
10. Capability for maintaining surface water	(1)	4	2	3	3	2	4	1	4	(1)

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (5)

Entisols in order. Aquents in sub-order. Fluvaquents in great group. Thapto-Histic Fluvaquents in sub-group and Fine, Dysic, Thapto-Histic Fluvaquents in family.

TOPOGRAPHY

Recent river levee extending narrowly over along the river Barito.

VEGETATION

Paddy rice in the rainy season cropping

LAND SUITABILITY

For paddy rice : class IV
For upland crops: class V

Table V-15 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	(2)	(2)	3	3	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	a2-a3	a2-a3	(a4)	a4	a4	(a4)
3. Soil depth										
- depth to sand, etc.	ko	ko	ko	ko	k1	k1	(k2)	(k2)	k3	k3
- depth to impermeable layer	ko	io	ko	io	k1	i1	(k2)	(i2)	k3	i3
4. Soil texture	so-s1	so	(so-s1)	(s1)	s2	s2	s2	s3	s3	s3
5. Topography										
- relief	ro-r1	ro-r1	(ro-r1)	(ro-r1)	r2	r2	r3	r3	r3	r3
- slope	(to)	to	to	(t2)	t1	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	(d3-d4)	do	d3-d4	d1	d2	d2	d1	d3	do	(d4)
- flooding	fo	fo	fo-f1	fo	f2	fo	f3	f1	(f3)	(f2-f3)
7. Condition for seedling establishment	1-2	1	1-2	2	3-4	3	(4-5)	(4)	4-5	5
8. Workability	1-2	1-2	3	3	(3)	(3)	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	2-3	2-3	2-3	2-3	4	4	(5)	(5)
10. Capability for maintaining surface water	(1)	4	2	3	3	2	4	1	4	(1)

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (6)

Entisoils in order, Aquents in sub-order, Hydraquents in great group, Sulfic Hydraquents in sub-group and Loamy. Acid, Sulfic Hydraquents in family.

TOPOGRAPHY

Depression, so-called tidal swamp.

VEGETATION

Paddy rice in the rainy season cropping, somewhat nippa, mangrove, etc. and somewhat gelam shrub.

LAND SUITABILITY

For paddy rice : class IV
For upland crops: class V

Table V-16 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	(2)	(2)	3	3	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	a2-a3	a2-a3	(a4)	a4	a4	(a4)
3. Soil depth										
- depth to sand. etc.	(ko)	(ko)	ko	ko	k1	k1	k2	k2	k3	k3
- depth to impermeable layer	(ko)	io	ko	io	k1	i1	k2	i2	k3	(i3)
4. Soil texture	(so-s1)	so	so-s1	(s1)	s2	s2	s2	s3	s3	s3
5. Topography										
- relief	ro-r1	ro-r1	ro-r1	ro-r1	r2	r2	r3	r3	r3	r3
- slope	(to)	to	to	t1	t1	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	(d3-d4)	do	d3-d4	d1	d2	d2	d1	(d3)	do	d4
- flooding	fo	fo	(fo-f1)	fo	f2	fo	f3	(f1)	f3	f2-f3
7. Condition for seedling establishment	1-2	1	1-2	2	3-4	3	(4-5)	(4)	4-5	5
8. Workability	1-2	1-2	3	3	(3)	(3)	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	2-3	(2-3)	(2-3)	2-3	4	4	5	5
10. Capability for maintaining surface water	(1)	4	2	3	3	2	4	1	4	(1)

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (7)

Entisols in order, Fluvents in sub-order, Tropofluvents in great group, Typic Tropofluvents in sub-group and Fine, Acid, Typic Tropofluvents in family.

TOPOGRAPHY

Lowlying alluvial plain, flat to nearly flat topography.

VEGETATION

Gelam shrub, somewhat fallow in paddy rice cultivation.

LAND SUITABILITY

For paddy rice : class II
For upland crops: class IV

Table V-17 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	2	2	3	3	(3)	(3)
2. Soil acidity	ao-a1	ao-a1	(ao-a1)	ao-a1	a2-a3	(a2-a3)	a4	a4	a4	a4
3. Soil depth										
- depth to sand, etc.	ko	ko	ko	ko	k1	k1	k2	k2	(k3)	(k3)
- depth to impermeable layer	ko	io	(ko)	(io)	k1	i1	k2	i2	k3	k3
4. Soil texture	so-s1	so	so-s1	s1	s2	s2	s2	(s3)	(s3)	s3
5. Topography										
- relief	ro-r1	ro-r1	ro-r1	ro-r1	r2	r2	r3	(r3)	(r3)	r3
- slope	to	to	to	t1	t1	(t2)	(t2)	t3	t3-t4	t4
6. Drainage										
- drainability	d3-d4	(do)	d3-d4	d1	d2	d2	d1	d3	(do)	d4
- flooding	(fo)	(fo)	fo-f1	fo	f2	fo	f3	f1	f3	f2-f3
7. Condition for seedling establishment	1-2	1	1-2	2	(3-4)	(3)	4-5	4	4-5	5
8. Workability	1-2	1-2	3	3	(3)	(3)	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	2-3	2-3	2-3	2-3	(4)	(4)	5	5
10. Capability for maintaining surface water	1	(4)	2	3	3	2	4	1	(4)	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (8)

Inceptisols in order, Tropepts in sub-order, Dystropepts in great group, Typic Dystropepts in sub-group and Loamy skeletal, Acid, Typic Dystropepts in family.

TOPOGRAPHY

Undulating hills.

VEGETATION

Alang-alang grasses, somewhat use for village accommodation.

LAND SUITABILITY

For paddy rice : class V
For upland crops: class V

Table V-18 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Marginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	(1)	(1)	2	2	3	3	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	a2-a3	a2-a3	a4	a4	a4	a4
3. Soil depth										
- depth to sand, etc.	(ko)	(ko)	ko	ko	k1	k1	k2	k2	k3	k3
- depth to impermeable layer	ko	io	(ko)	io	k1	(i1)	k2	i2	k3	i3
4. Soil texture	(so-s1)	so	so-s1	(s1)	s2	s2	s2	s3	s3	s3
5. Topography										
- relief	(ro-r1)	ro-r1	ro-r1	(ro-r1)	r2	r2	r3	r3	r3	r3
- slope	(to)	(to)	to	t1	t1	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	(d3-d4)	do	d3-d4	d1	d2	d2	d1	(d3)	do	d4
- flooding	fo	fo	(fo-f1)	fo	f2	fo	f3	(f1)	f3	f2-f3
7. Condition for seedling establishment	1-2	1	1-2	2	(3-4)	(3)	4-5	4	4-5	5
8. Workability	1-2	1-2	(3)	(3)	3	3	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	2-3	(2-3)	(2-3)	2-3	4	4	5	5
10. Capability for maintaining surface water	(1)	4	2	3	3	2	4	(1)	4	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (9)

Inceptisols in order, Aquepts in sub-order, Tropaquepts in great group, Aeric Tropaquepts in sub-group and Fine Loamy, Acid, Aeric Tropoquepts in family.

TOPOGRAPHY

Alluvial plain, flat topography

VEGETATION

Paddy rice cultivation in the rainy season cropping

LAND SUITABILITY

For paddy rice : class II
For upland crops: class IV

Table V-19 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	(1)	(1)	2	2	3	3	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	(a2-a3)	a2-a3	a4	(a4)	a4	a4
3. Soil depth - depth to sand. etc. - depth to impermeable layer	(ko) ko	(ko) io	ko (ko)	ko io	k1 k1	k1 i1	k2 k2	k3 (i2)	k3 k3	k3 i3
4. Soil texture	(so-sl)	so	so-sl	(sl)	s2	s2	s2	s3	s3	s3
5. Topography - relief - slope	(ro-r1) (to)	(ro-r1) (to)	ro-r1 to	ro-r1 t1	r2 t1	r2 t2	r3 t2	r3 t3	r3 t3-t4	r3 t4
6. Drainage - drainability - flooding	d3-d4 fo	do fo	(d3-d4) fo-f1	d1 fo	d2 (f2)	d2 fo	d1 f3	(d3) f1	do f3	d4 (f2-f3)
7. Condition for seedling establishment	1-2	1	1-2	2	(3-4)	(3)	4-5	4	4-5	5
8. Workability	1-2	1-2	(3)	(3)	3	3	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	2-3	2-3	(2-3)	(2-3)	4	4	5	5
10. Capability for maintaining surface water	(1)	4	2	3	3	2	4	1	4	(1)

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (10)

Inceptisols in order. Aquepts in sub-order. Tropaquepts in great group. Typic Tropaquepts in sub-group and Loamy, Acid. Typic Tropaquepts in family.

TOPOGRAPHY

Alluvial plain, slightly depressed land, flat topography.

VEGETATION

Paddy rice in the rainy season cropping.

LAND SUITABILITY

For paddy rice : class III
For upland crops: class V

Table V-20 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Marginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	(1)	(1)	2	2	3	3	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	a2-a3	a2-a3	(a4)	a4	a4	(a4)
3. Soil depth										
- depth to sand, etc.	(ko)	(ko)	ko	ko	k1	(k1)	k2	k2	k3	k3
- depth to impermeable layer	(ko)	io	ko	io	k1	(i1)	k2	i2	k3	i3
4. Soil texture	so-s1	so	(so-s1)	(s1)	s2	s2	s2	s3	s3	s3
5. Topography										
- relief	ro-r1	ro-r1	(ro-r1)	(ro-r1)	r2	r2	r3	r3	r3	r3
- slope	to	(to)	(to)	t1	t1	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	d3-d4	do	(d3-d4)	d1	d2	d2	d1	(d3)	do	d4
- flooding	fo	fo	(fo-f1)	fo	f2	fo	f3	(f1)	f3	f2-f3
7. Condition for seedling establishment	1-2	1	(1-2)	(2)	3-4	3	4-5	4	4-5	5
8. Workability	1-2	1-2	(3)	(3)	3	3	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	2-3	2-3	2-3	(2-3)	(4)	4	5	5
10. Capability for maintaining surface water	1	4	(2)	3	3	(2)	4	1	4	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (11)

Inceptisols in order, Aquepts in sub-order, Tropaquepts in great group, Histic Tropaquepts in sub-group and Loamy, Acid, Histic Tropaquepts in family.

TOPOGRAPHY

Lowlying land, flat to nearly flat topography

VEGETATION

Gelam shrub, somewhat paddy rice cultivation in the rainy season cropping.

LAND SUITABILITY

For paddy rice : class II
For upland crops: class IV

Table V-21 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS		Suitable								Unsuitable	
		Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/	LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility		1	1	1	1	2	2	(3)	(3)	3	3
2. Soil acidity		ao-a1	ao-a1	ao-a1	ao-a1	a2-a3	a2-a3	(a4)	a4	a4	(a4)
3. Soil depth											
- depth to sand, etc.		ko	ko	ko	ko	(k1)	(k1)	k2	k2	k3	k3
- depth to impermeable layer		(ko)	(io)	ko	io	i1	i1	k2	i2	k3	i3
4. Soil texture		so-s1	so	so-s1	s1	s2	s2	s2	(s3)	(s3)	s3
5. Topography											
- relief		ro-r1	ro-r1	ro-r1	ro-r1	r2	r2	r3	r3	r3	r3
- slope		to	(to)	(to)	t1	t1	t2	t2	t3	t3-t4	t4
6. Drainage											
- drainability		d3-d4	do	d3-d4	(d1)	d2	d2	(d1)	d3	do	d4
- flooding		fo	fo	(fo-f1)	fo	f2	fo	f3	(f1)	f3	f2-f3
7. Condition for seedling establishment		1-2	1	(1-2)	(2)	3-4	3	4-5	4	4-5	5
8. Workability		1-2	1-2	(3)	(3)	3	3	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization		1	1	2-3	(2-3)	(2-3)	2-3	4	4	5	5
10. Capability for maintaining surface water		(1)	4	2	3	3	2	(4)	1	4	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (12)

Inceptisols in order. Aquepts in sub-order. Tropaquepts in great group. Histic Tropaquepts in sub-group and Sandy. Dysic, Histic Tropaquepts in family.

TOPOGRAPHY

Lowlying land. flat to nearly flat topography

VEGETATION

Gelam shrub, somewhat cassava, beans, etc. in the dry season.

LAND SUITABILITY

For paddy rice : class IV
For upland crops: class IV

Table V-22 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Marginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	(1)	(1)	2	2	3	3	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	a2-a3	a2-a3	a4	a4	a4	a4
3. Soil depth										
- depth to sand, etc.	(ko)	(ko)	ko	ko	k1	k1	k2	k2	k3	k3
- depth to impermeable layer	io	io	(io)	io	i1	(i1)	i2	i2	i3	i3
4. Soil texture	so-s1	so	so-s1	(s1)	s2	s2	s2	s3	s3	s3
5. Topography										
- relief	ro-r1	ro-r1	ro-r1	ro-r1	r2	r2	r3	r3	r3	r3
- slope	to	(to)	to	t1	t1	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	d3-d4	do	d3-d4	d1	d2	d2	d1	(d3)	do	d4
- flooding	fo	fo	fo-f1	(fo)	f2	fo	f3	f1	f3	f2-f3
7. Condition for seedling establishment	1-2	1	(1-2)	(2)	3-4	3	4-5	4	4-5	5
8. Workability	1-2	1-2	(3)	(3)	3	3	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	(2-3)	(2-3)	2-3	2-3	4	4	5	5
10. Capability for maintaining surface water	(1)	4	2	3	3	2	4	1	4	(1)

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (13)

Inceptisols in order, Aquepts in sub-order, Haplaquepts in great group, Aeric Haplaquepts in sub-group and Clayey, Acid, Aeric Haplaquepts in family.

TOPOGRAPHY

River levee extending narrowly over along the river Martapura, nearly flat topography.

VEGETATION

Village accommodation, coconut and rubber plantation, somewhat paddy rice in the rainy season.

LAND SUITABILITY

For paddy rice : class II
For upland crops: class IV

Table V-23 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	(1)	(1)	2	2	3	3	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	a2-a3	a2-a3	a4	a4	a4	a4
3. Soil depth										
- depth to sand, etc.	(ko)	(ko)	ko	ko	k1	(k1)	k2	k2	k3	k3
- depth to impermeable layer	ko	io	(ko)	io	k1	(i1)	k2	i2	k3	i3
4. Soil texture	so-s1	so	(so-s1)	(s1)	s2	s2	s2	s3	s3	s3
5. Topography										
- relief	ro-r1	ro-r1	ro-r1	ro-r1	r2	r2	r3	r3	r3	r3
- slope	to	(to)	(to)	t1	t1	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	d3-d4	do	d3-d4	d1	d2	d2	d1	(d3)	do	d4
- flooding	fo	fo	fo-f1	(fo)	f2	fo	f3	f1	f3	f2-f3
7. Condition for seedling establishment	1-2	1	(1-2)	(2)	3-4	3	4-5	4	4-5	5
8. Workability	1-2	1-2	(3)	(3)	3	3	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	(2-3)	(2-3)	2-3	2-3	4	4	5	5
10. Capability for maintaining surface water	(1)	4	2	3	3	2	4	1	4	(1)

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (14)

Inceptisols in order, Aquepts in sub-order, Haplaquepts in great group, Typic Haplaquepts in sub-group and Loamy, Acid, Typic Haplaquepts in family.

TOPOGRAPHY

Old river levee, flat to nearly flat topography.

VEGETATION

Village accommodation, rubber plantation and somewhat paddy rice in the rainy season.

LAND SUITABILITY

For paddy rice : class II
For upland crops: class II

Table V-24 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	2	2	3	(3)	(3)	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	(a2-a3)	a2-a3	a4	(a4)	a4	a4
3. Soil depth										
- depth to sand. etc.	(ko)	ko	ko	(ko)	k1	k1	k2	k2	(k3)	(k3)
- depth to impermeable layer	(ko)	io	ko	(io)	k1	i1	k2	i2	k3	i3
4. Soil texture	so-s1	so	so-s1	s1	s2	s2	s2	(s3)	(s3)	s3
5. Topography										
- relief	ro-r1	ro-r1	ro-r1	ro-r1	(r2)	(r2)	r3	r3	r3	r3
- slope	to	to	to	(t1)	(t1)	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	d3-d4	(do)	d3-d4	d1	d2	d2	d1	d3	(do)	d4
- flooding	(fo)	(fo)	fo-f1	fo	f2	fo	f3	f1	f3	f2-f3
7. Condition for seedling establishment	1-2	1	(1-2)	(2)	3-4	3	4-5	4	4-5	5
8. Workability	1-2	1-2	3	(3)	(3)	3	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	(2-3)	(2-3)	2-3	2-3	4	4	5	5
10. Capability for maintaining surface water	1	(4)	2	3	3	2	4	1	(4)	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (15)

Ultisols in order, Ustults in sub-order. Haplustults in great group. Typic Haplustults in sub-group and Sandy skeletal, Acid, Typic Haplustalts in family.

TOPOGRAPHY

Undulating and/or rolling hills, relative short and steep sloping topography.

VEGETATION

Alang-alang grasses, somewhat accommodation of villages and somewhat use for clove plantation which are being underplanting.

LAND SUITABILITY

For paddy rice : class V
For upland crops: class V

Table V-25 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	2	2	(3)	(3)	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	a2-a3	a2-a3	(a4)	a4	a4	(a4)
3. Soil depth										
- depth to sand, etc.	(ko)	(ko)	ko	ko	k1	k1	k2	k2	k3	k3
- depth to impermeable layer	(ko)	(io)	ko	io	k1	i1	k2	i2	k3	i3
4. Soil texture	so-s1	so	so-s1	s1	s2	s2	s2	(s3)	(s3)	s3
5. Topography										
- relief	ro-r1	ro-r1	(ro-r1)	(ro-r1)	r2	r2	r3	r3	r3	r3
- slope	to	(to)	(to)	t1	t1	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	d3-d4	do	(d3-d4)	d1	d2	d2	d1	d3	do	(d4)
- flooding	fo	fo	fo-f1	fo	f2	fo	(f3)	f1	f3	(f2-f3)
7. Condition for seedling establishment	1-2	1	1-2	2	(3-4)	(3)	4-5	4	4-5	5
8. Workability	1-2	1-2	3	3	(3)	(3)	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	2-3	2-3	2-3	2-3	4	4	(5)	(5)
10. Capability for maintaining surface water	1	(4)	2	3	3	2	(4)	1	4	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (16)

Histosols in order, Fibrists in sub-order, Tropofibrists in great group, Terric Tropofibrists in sub-group and Dysic, Terric Tropofibrists in family.

TOPOGRAPHY

Deep depression (to be old oxbow), permanent swamp.

VEGETATION

The secondary to tertiary swampy forest.

LAND SUITABILITY

For paddy rice : class V
For upland crops: class V

Table V-26 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	2	2	(3)	(3)	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	a2-a3	a2-a3	(a4)	a4	a4	(a4)
3. Soil depth										
- depth to sand, etc.	(ko)	(ko)	ko	ko	k1	k1	k2	k2	k3	k3
- depth to impermeable layer	(ko)	(io)	ko	io	k1	i1	k2	i2	k3	i3
4. Soil texture	so-s1	so	so-s1	s1	s2	s2	s2	(s3)	(s3)	s3
5. Topography										
- relief	ro-r1	ro-r1	(ro-r1)	(ro-r1)	r2	r2	r3	r3	r3	r3
- slope	to	(to)	(to)	t1	t1	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	d3-d4	do	(d3-d4)	d1	d2	d2	d1	d3	do	(d4)
- flooding	fo	fo	fo-f1	fo	f2	fo	(f3)	f1	f3	(f2-f3)
7. Condition for seedling establishment	1-2	1	1-2	2	(3-4)	(3)	4-5	4	4-5	5
8. Workability	1-2	1-2	3	3	(3)	(3)	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	2-3	2-3	2-3	2-3	4	4	(5)	(5)
10. Capability for maintaining surface water	1	(4)	2	3	3	2	(4)	1	4	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (17)

Histosols in order. Hemists in sub-order. Tropohemists in great group, Terric Tropohemists in sub-group and Dysic. Terric Tropohemists in family.

TOPOGRAPHY

Deep depression (to be old oxbow), permanent

VEGETATION

Secondary swamp forest, somewhat gelam shrub.

LAND SUITABILITY

For paddy rice : class V
For upland crops: class V

Table V-27 Suitability Evaluation of Soil and Land for Irrigated Agriculture

ORDER / LAND SUITABILITY CLASS	Suitable								Unsuitable	
	Highly Suitable (I)		Suitable (II)		Moderately Suitable (III)		Maginally Suitable (IV)		Unsuitable (V)	
SOIL-LAND/ QUALITIES/ LAND USE TYPE	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field	Paddy field	Upland field
1. Soil fertility	1	1	1	1	2	2	(3)	(3)	3	3
2. Soil acidity	ao-a1	ao-a1	ao-a1	ao-a1	a2-a3	a2-a3	(a4)	a4	a4	(a4)
3. Soil depth										
- depth to sand, etc.	ko	ko	(ko)	(ko)	k1	k1	k2	k2	k3	k3
- depth to impermeable layer	ko	io	(ko)	fo	k1	(i1)	k2	i2	k3	i3
4. Soil texture	so-s1	so	so-s1	s1	s2	s2	s2	(s3)	(s3)	s3
5. Topography										
- relief	ro-r1	ro-r1	ro-r1	ro-r1	r2	r2	r3	r3	r3	r3
- slope	to	(to)	(to)	t1	t1	t2	t2	t3	t3-t4	t4
6. Drainage										
- drainability	d3-d4	do	d3-d4	d1	d2	d2	d1	d3	do	(d4)
- flooding	fo	fo	fo-f1	fo	f2	fo	(f3)	f1	f3	f2-f3
7. Condition for seedling establishment	1-2	1	1-2	2	(3-4)	(3)	4-5	4	4-5	5
8. Workability	1-2	1-2	3	3	(3)	(3)	4-3	4-5	4-5	4-5
9. Possiblity for farm mechanization	1	1	2-3	2-3	2-3	2-3	4	4	(5)	(5)
10. Capability for maintaining surface water	1	(4)	2	3	3	2	(4)	1	4	1

Note: Figures show the degree of soil and land quality specified in Table V-5 and V-6.

SOIL UNIT (18)

Histosols in order, Saprists in sub-order, Troposaprists in great group, Terric Troposaprists in sub-group and Dysic, Terric Troposaprists in family.

TOPOGRAPHY

Alluvial depression, permanent swamp, some area dried in short period in the dry season.

VEGETATION

Gelam shrub, somewhat paddy rice in the rainy season (very low growing conditions and low yield in this area).

LAND SUITABILITY

For paddy rice : class IV
For upland crops: class V

Table V-28 Land Classification

Land Suitability for Irrigated Paddy Rice Cultivation

Land Class	Definition	Area (ha)	%
Class 1	Very Suitable for objectives (No land satisfied in the project area)	-	-
Class 2	Suitable for the objectives	38,700	41.7
Class 3	Moderately suitable for objectives	10,400	11.2
Class 4	Marginally suitable for objectives	22,040	23.7
Class 5	Unsuitable for objectives	21,640	23.4
	Total	92,780	100.0

Land Suitability for Diversified Crops (Poloxijo) with Irrigation

Land Class	Definition	Area (ha)	%
Class 1	Very suitable for objectives (No land satisfied in the project area)	-	-
Class 2	Suitable for the objectives	1,200	1.3
Class 3	Moderately suitable for the objectives	1,150	1.2
Class 4	Marginally suitable for the objectives	42,040	45.3
Class 5	Unsuitable for the objectives	48,390	52.2
	Total	92,780	100.0

Note: The specification of land classification is referred to the land classification system defined by the Bureau of Reclamation U.S. Department of Interior, 1953, modified in 1967, especially for the land evaluation on lowland paddy field and its production (Lam Nam Oon Project, Thailand).

Table V-29 Land Classification and Potential Irrigable Area (ha) by Sub-area

Land Suitability Classes	Sub-area A	Sub-area B	Sub-area C	Sub-area D	Sub-total	Sub-area E	Sub-area F	Total
1. Physical Area Surveyed:								
Class I	0	0	0	0	0	0	0	0
Class II	2,930	8,300	6,300	13,720	31,250	7,050	400	38,700
Class III	0	1,380	400	2,330	4,110	5,290	0	10,400
Class IV	400	3,650	0	4,550	8,600	11,590	1,850	22,040
Class V	2,430	8,370	0	0	10,800	1,170	9,670	21,610
Total	5,760	21,700	6,700	20,600	54,760	26,100	11,920	92,780
2. Physical Area Delineated for Project:								
Class II	2,600	8,100	4,000	11,450	26,150	6,650	400	33,200
Class III	0	1,380	400	2,100	3,880	3,550	0	7,430
Class IV	400	2,900	0	4,500	7,800	4,550	1,850	14,200
Class V	660	6,000	0	0	6,660	0	9,670	16,330
Total	3,660	18,380	4,400	18,050	44,490	14,750	11,920	71,160
2.1 Gross Area to be Taken for Project:								
Class II	2,600	7,800	4,000	11,450	25,850	6,650	0	32,500
Class III	0	1,380	400	2,100	3,880	3,550	0	7,430
Class IV	400	0	0	0	400	0	0	400
Total	3,000	9,180	4,400	13,550	30,130	10,200	0	40,330
2.2 Gross Area to be Excluded from Project: (due to unfavourable soil and topography)								
Class II	0	300	0	0	300	0	400	700
Class III	0	0	0	0	0	0	0	0
Class IV	0	2,900	0	4,500	7,400	4,550	1,850	13,800
Class V	660	6,000	0	0	6,660	0	9,670	16,330
Total	660	9,200	0	4,500	14,360	4,550	11,920	30,830

Note: The land in Class IV is basically excluded from the development plan. However, an area of 400 ha of Class IV in the sub-area A is taken up for the Project. Why such an area is taken up for the project is that it is not practical to exclude the area in a form of patch with a view to systematic alignment of the drainage network and to proper operations of the network in the sub-area.

Table V-30 Typical Soil Profile of Aquic Quartzipsamments

(Soil Unit: 1)

1. Soil Group: Entisols in order, Psamments in sub-order, Quartzipsamments in great group, Aquic Quartzipsamments in sub-group and Acid, Aquic Quartzipsamments in family.

2. Topography: Old sand dune, slightly elevated and undulated.

3. Vegetation: Bushes and ferns

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Features
A1	0 to 10	Grayish brown (10YR 5/2) in colour; medium to fine quartz sand in texture, partly including many small gravels; very loose consistence; gradually and smoothly change to the following horizon.
C1	10 to 50	Light gray (10YR 7/1) in colour; sandy in texture with partial gravelly sand; rather compact but very loose consistence when wet; diffuse and smooth boundary with the following soils.
C12 or C2g	50 cm below	White to pinkish white (10YR 8/1 to 7.5 YR 8/2) in colour; sand in texture having many small gravels partially; compact but very friable consistence when wet. The soils generally underlie in the ground water layer.

Note: The soils are generally strong acid throughout the profile under natural condition when wet.

Almost all of the land of this soil area is free from the seasonal flooding, while shallow groundwater table throughout the year.

Table V-31 Typical Soil Profile of Haplaquodic Quartzipsamments

(Soil Unit: 2)

1. Soil Group: Entisols in order, Psamments in sub-order, Quartzipsamments in great group, Haphaquodic Quartzipsamments in sub-group and Sandy, skeletal Acid, Haplaquodic Quartzipsamments in family.

2. Topography: Lowlying terrace, slightly elevated and nearly flat topography.

3. Vegetation: Bushes and ferns, somewhat gelam shrub.

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Peatures
A1	0 to 10	Dark brown (7.5YR 3/2) to very dark gray (5YR 3/1) in colour; sandy texture; loose and soft consistence when wet; gradual and smooth boundary with the underlying soils.
B1	10 to 15	This horizon is considered an albic horizon and the soils are white (10YR to 7.5YR 8/1 to 8/2) in colour; rather coarse sandy texture; structureless and very friable consistence ; loose; abrupt and smooth boundary with the underlying soils.
B2	15 to 30	This horizon is considered spodic soils. The soils are dark brown to brown (7.5YR 4/2 to 10YR 5/3) in colour; sandy texture; rather compact but friable consistence when wet; structureless; diffuse and irregular boundary with the underlying soils.
C1	30 to 100	Medium sandy texture; white in colour; rather compact but structureless and friable consistence; gradually and smooth boundary with the next horizon.
C2g	below 100	Sandy clay to loamy clay in texture; light brownish gray to light gray in colour; compact; massive structure; rather hard and firm consistence when dry. The soils in this layer are considered the diluvium deeply deposited in this area.

Note: The soils are strong acid throughout the profile under natural conditions when wet.

The land is free from the seasonal flooding but high groundwater table throughout the year.

Table V-32 Typical Soil Profile of Typic Troporthents

(Soil Unit: 3)

1. Soil Group: Entisols in order, Orthents in sub-order, Troporthents in great group, Typic Troporthents in sub-group and Sandy skeletal, Acid, Typic Troporthents in family.

2. Topography: Bottom in undulating hills, gently sloped land.

3. Vegetation: Alang-alang grasses and short bushes, somewhat used for upland field and grown by cassava, beans, corn, etc. mainly for self-consumption.

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Features
A1	0 to 15	Dark brown (7.5YR 3/2) to brown (7.5YR 4/2) in matrix colour; coarse loamy to sandy texture; including more than 35 % of gravels and fragments of laterites; weak sub-angular blocky structure; rather firmly consolidated; non to very slightly plastic and sticky when wet; gradually and smoothly change to the lowlying soils.
C1	15 to 50	The soils are considered colluvial soils. They are sandy to coarse loamy skeletals in texture; rather compact but friable consistence when wet; abruptly bounded by the diluvium and/or saprolite of sandstones in tertiary formation.
C2	below 50	These soils are considered the basic lithological foundation derived from dilumium and/or sandstones. They have weak or slight paralithic contact regime. The soils contain effusive gravels and stones.

Note: The soils are very strong acid throughout the profile under the natural condition when wet.

The soils have very high permeabilily coefficient throughout the profile.

Table V-33 Typical Soil Profile of Typic Fluvaquents

(Soil Unit: 4)

1. Soil Group: Entisols in order, Aquents in sub-order, Fluvaquents in great group, Typic Fluvaquents in sub-group and Fine, Acid, Typic Fluvaquents in family.

2. Topography: Recent river levee extending narrowly along the river Barito.

3. Vegetation: House yard and coconut plantation.

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Features
A11	0 to 10	Dark brown to brown (10YR 4/3); silty clay to clay; massive; hard and firm when dry, soft and friable consistence when wet; few, fine yellowish brown mottles; abrupt and smooth boundary.
A12	10 to 30	Mottled dark gray (N1/) to dark grayish brown (10YR 4/2); fine clay; massive; soft and friable when wet, but vary hard and firm consistence when dry; fine and strong brown stains around the old roots; clear and smooth boundary.
C1g	30 to 95	Gray (5Y 5/1); silty clay to clay; massive structure; common, strong brown (7.5YR 5/6) stains around the old roots; intercarating very thin silt strata; clear and smooth boundary.
C2g	95 to 150	Gray (N5/); silty loam; massive structure; no mottles in the profile. Below the soils, mud- clay underlies deeply.

Note: Strong to very strong acid throughout the profile.
No salinity is observed in this soil.

Table V-34 Typical Soil Profile of Thapto-Histic Fluvaquents

(Soil Unit: 5)

1. Soil Group: Entisols in order, Aquents in sub-order, Fluvaquents in great group, Thapto- Histic Fluvaquents in soil sub-group and Fine, Dysic, Thapto- Ristic Fluvaquents in family.

2. Topography: Recent river levee extending narrowly along the river Barito.

3. Vegetation: Paddy rice in the wet season cropping.

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Features
A11	0 to 15	Brownish black to gray (10YR 3/2 to 5Y 4/2); fine clay; massive structure; friable and very soft when wet, but hard and firm consistence when dry; very few brown mottling along the old roots; gradually change to the next horizon.
A12	15 to 50	Gray (5YR 4/1 to 4/2); light clay to silty clay; very few stains around the old roots; soft and friable when wet, while very hard and firm consistence when dry; massive structure; abrupt and smooth boundary.
Ob	50 to 150	Brownish gray (10YR 5/1) to dark grayish brown (2.5YR 4/2); fibric regime (not so well decomposed); very loose, smooth boundary.
Cg	below 150	Grayish colour of mud-clay (marine sediments) silty sand to fine sand in texture and the layer includes many buried cells.

Note: Very strong acid throughout the profile under the natural condition when moistened, but when they dried by drainage control, the soil reaction change to extremely strong acid.

No salinity affected to this soil.

Table V-35 Typical Soil Profile of Sulfic Hydraquents

(Soil Unit: 6)

1. Soil Group: Entisols in order, Aquents in sub-order, Hydraquents in great group, Sulfic Hydraquents in sub-group and Loamy, Dysic, Sulfic Hydraquents in family.

2. Topography: Depression, so called tidal swamp or back swamp.

3. Vegetation: Paddy rice in the wet season cropping, somewhat nippa, mangrove forest or gelam shrub.

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Features
A11g	0 to 15	Dark gray (5Y 4/2) to grayish olive (7.5Y 5/2); fine clay to silty clay; very soft and very friable when wet, while very hard and firm consistence when dry; gradual and smooth boundary.
A12g	15 to 50	Gray (2.5Y 5/1 to 5Y 5/1); clay to silty clay; massive structure; plastic and sticky; non mottlings; rather compact, but soft and friable consistence when wet and very hard consistence when dry; abrupt and smooth boundary.
Cg	50 to 150	Grayish yellow (2.5YR 4/2) to grayish olive (7.5Y 5/2); silty clay to fine loam; massive; bearing capacity expressed in the N-value at less than 0.7 kg/cm^2. This soil might be the mud-clay.

Note: The land of this soil area is inundated throughout the year.

The soils are very strong acid under the natural condition when moistened and very strong to extremely strong acid when dry.

No salinity problems are found in this area.

Table V-36 Typical Soil Profile of Typic Tropogluvents

(Soil Unit: 7)

1. Soil Group: Entisols in order, Fluvents in sub-order, Tropofluvents in great group, Typic Tropofluvents in sub-group and Clayey, Acid, Typic Tropofluvents in family.

2. Topography: Lowlying alluvial plain, flat to nearly flat topography.

3. Vegetation: Gelam shrub, somewhat reclaimed for paddy field but mostly lies waste at present.

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Peatures
A1	0 to 15	Dark brown to grayish brown (10YR 5/1 to 5/2); clay to silty clay; weak sub-angular blocky structure; soft and friable consistence when wet and rather hard, while not so firm consistence when dry; gradually change to the next horizon.
C1	15 to 50	Brown (10YR 6/3 to 6/5); clay to silty clay; massive structure; plastic and sticky when wet; rather compact; hard and firmly consolidated when dry; diffuse and smooth boundary.
C2g	50 to 130	Greenish gray (5GY 5/1) and light olive gray (5Y 6/2); many cloudy type of ferruginous mottling in the upper part of the layer and these mottles gradually decrease with the depth; silty clay; rather compact; massive structure; very plastic and very sticky; very hard and firmly consolidated when dry.

Note: The soils are very strong to strong acid throughout the profile.

Permeability of sub-soil layer ranges from 2.5×10^{-1}cm/sec to 6.3×10^{-1}cm/sec.

No salinity constraints are found on these soils.

Table V-37 Typical Soil Profile of Typic Dystropepts

(Soil Unit: 8)

1. Soil Group: Inceptisols in order, Tropepts in sub-order, Dystropepts in great group, Typic Dystropepts in sub-group and Loamy skeletal, Acid, Typic Dystropepts in family.

2. Topography: Undulating hills.

3. Vegetation: Alang-alang grasses, somewhat use for village accommodation.

4. Dexcription of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Peatures
A1	0 to 15	Dark brown (10YR 5/2) to reddish brown (10YR 5/3); loamy to sandy clay loam; sub-angular blocky structure; friable when wet but rather firmly consolidated when dry; many small gravels and stones in the profile, particularly effusive quantity on the soil surface; gradually and smooth boundary.
B1	15 to 45	Yellowish red (5YR 5/6) to reddish brown (10YR 4/4); coarse loamy to sandy loam with many small gravels and fragments of laterites and ferruginous concretions; sub-angular to blocky structures; rather friable consistence when wet and firm consistence when dry; gradually and smooth boundary.
B2	45 to 100	Yellowish red (5YR 4/8); gravelly sandy clay loam to gravelly fine loam, somewhat non or very few gravels in this layer; massive to very coarse blocky structure; compact and rather firmly consolidated; gradually somewhat clear and smooth boundary.
C	100 to 150 or more	Yellowish brown (2.5YR 5/4 to 5YR 5/6); loamy to loam sand; having effusive small gravels; massive structure; rather compacted. Somewhat soils have paralithic contact or saprolite of the sandstones and somewhat unweathered diluvial layer consisting of white sand clayey to clay loam in texture; rather compacted; friable consistence when wet.

Note: The soils are strong to very strong acid throughout the profile.

Table V-38 Typical Soil Profile of Aeric Tropaquepts

(Soil Unit: 9)

1. Soil Group: Inceptisols in order, Aquepts in sub-order, Tropaquepts in great group, Aeric Tropaquepts in subgroup and Loamy, Acid, Aeric Tropaquepts in family.

2. Topography: Alluvial plain, very flat topography.

3. Vegetation: Paddy rice in the wet season cropping.

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Features
A1(g)	0 to 15	Dark gray to very dark gray (10YR 3/2 to 4/2); fine clay; few strong brown stains around the old roots; slightly sticky and plastic; massive structure; very soft and friable when wet, while hard and firm consistence when dry; gradual and smooth boundary.
C1g	15 to 50	Light gray to light brownish gray (10YR 6/1 to 7/1); silty clay to fine clay; many to effusive and distinct mottles with strong brown (7.5YR 5/6) in colour; massive structure; plastic and sticky; rather friable when wet; very hard and firm consistence when dry; diffuse and smooth boundary.
C2g	50 to 90	Gray to grayish brown (7.5Y 5/1 to 6/1); silty clay; coarse but cloudy mottles with brown in colour; massive structure; moistened throughout the year; diffuse boundary.
C3g or IIC3g	90 to more than 150	This is the permanent gley soils. The soils are dark gray to gray (2.5Y 4/0 to 5/0 mixed with greenish gray in matrix colour; silty clay to fine clay, somewhat fine sandy loam to loam in texture; very plastic and sticky; massive structure; very hard and firm consistence when dry, while soft and friable when wet. Following the C3g horizon, the mud-clay layer underlie deeply. The mud-clay are very dark gray in clour, fine loam to silty clay in texture and massive.

Note: The soils are strong to very strong acid throughout the profile.

Table V-39 Typical Soil Profile of Typic Tropaquepts

(Soil Unit: 10)

1. Soil Group: Inceptisols in order, Aquepts in sub-order, Tropaquepts in great group, Typic Tropaquepts in subgroup and Loamy, Acid, Typic Tropaquepts in family.

2. Topography: Alluvial plain, slightly depressed land but nearly flat.

3. Vegetation: Paddy rice in the wet season cropping

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Features
Ag	0 to 20	Grayish black to very dark gray (2.5Y 2/C to 3/0); humic clay to humic silty clay; very soft and friable when wet, while very hard and firm consistence when dry; massive structure; strong brown stains around the old roots, clear to gradual boundary.
C1g	20 to 45	Light brownish gray to light gray (10YR 6/2 to 7.5Y 6/2); clay to silty clay; many, rather coarse and distinct mottles with brown colour; very plastic and sticky when wet; massive structure; soft and friable consistence when wet, while hard and firm consistence when dry; diffuse boundary.
C2g	45 to 75	Gray (7.5Y 4/2 to 5/1); fine clay; few, coarse and cloudy type of ferruginous mottlings with yellowish brown in colour; very plastic and very sticky when wet; massive structure; soft when wet, but hard and firm consistence when dry; diffuse boundary.
C3g	75 to 130	Dark gray (5Y 3/1 to 4/0); silty clay; no mottlings; massive structure; very plastic and sticky; soft consistence when wet but hard when dry.
		Following the C3g horizon, the mud-clay underlie deeply. The mud-clay are generally fine loam to fine sand in texture and somewhat including many buried small cells.

Note: The soils are very strong acid throughout the profile.

Table V-40 Typical Soil Profile of Histic Tropaquepts

(Soil Unit: 11)

1. Soil Group: Inceptisols in order, Aquepts in sub-order, Tropaquepts in great group, Histic Tropaquepts in sub-group and Loamy, Acid, histic Tropaquepts in family.

2. Topography: Lowlying land, flat to nearly flat.

3. Vegetation: Galam shrub, somewhat paddy rice in the wet season cropping.

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable/Features
Ao or A1	0 to 35	This horizon is primarily the sapric epipedon having dark reddish brown to very dark grayish brown (5YR 3/2 to 7.5YR 3/0); soft and very friable consistence when wet, while rather firmly consolidated when dry; clear and smooth boundary.
C1g	35 to 50	Dark grayish brown to gray (5Y 3/1 to 4/2); fine clay to silty clay; many, distinct ferruginous mottlings (10YR 5/4 to 5/6); massive structure; plastic and very sticky; soft and friable when wet, but very hard and firm consistence when dry; diffuse and smooth boundary.
C2g	50 to 75	Light brownish gray to light gray (5Y to 7.5Y 4/3 to 5/2); few to common cloudy type of ferruginous mottling with yellowish brown (7.5YR 5/3); massive structure; soft and friable when wet and hard consistence when dry; diffuse boundary.
C3g	75 to 150	This horizon is the permanent gley soils. The soils are dark gray (5Y 4/1 to 4/2) mixed with grayish olive (2.5Y 5/4); fine clay; massive structure; diffuse boundary. Following the C3g horizon, the mud-clay underlie deeply. The mud-clay is generally very dark gray (5Y 3/0 to 4/1) in colour, fine loam in texture and massive in structure.

Table V-41 Typical Soil Profile of Histic Tropaquepts

(Soil Unit: 12)

1. Soil Group: Inceptisols in order, Aquepts in sub-order, Tropaquepts in great group, Histic Tropaquepts in subgroup and Sandy, Dysic Histic Tropaquepts in family.

2. Topography: Lowlying land, flat to nearly flat.

3. Vegetation: Gelam shrub, somewhat cassava, bean etc. are grown in the dry season cropping.

4. Soil Description:

Specific Horizon	Soil Depth (cm)	Remarkable Features
A1	0 to 30	Very dark brown (10YR 3/2 to 4/1); humic fine sandy loam; soft and rather loose consistence when wet; non structure; gradually and smooth boundary.
C1g	30 to 45	Brownish gray in matrix colour; sandy loam in texture; rather compact but friable when wet; many, fine and distinct ferruginous mottling; diffuse boundary.
C2g	45 to 100	Dark gray to brownish gray (7.5Y 5/1 to 5/2) in colour; sandy loam in texture; very friable consistence when wet; permanently saturated with the groundwater.
C3	100 to 150 more over	This is the basic soil layer to be derived from the diluvials. The soils are white to grayish white in colour; sandy clay to sandy clay loam in texture; very compact but very friable consistence when moistened. The soils include some percent of the plinthites and quartz gravels.

Note: The soils are very strong acid throughout the profile under the natural conditions when wet. Once dried by drinage, the soils would become extremely strong acid.

Table V-42 Typical Soil Profile of Aeric Haplaquepts

(Soil Unit: 13)

1. Soil Group: Inceptisols in order, Aquepts in sub-order, Haplaquepts in great group, Aeric Haplaquepts in subgroup and Clayey, Acid Aeric Haplaquepts, in family

2. Topography: River levee extending narrowly along the river Martapura, nearly flat.

3. Vegetation: Village accommodation, coconut plantation and somewhat paddy rice in the wet season cropping.

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Features
A1	0 to 10	Grayish brown (5Y 4/2) to brownish gray (7.5YR 5/2); fine clay; strong brown (10YR 5/6) stains around the old roots; rather compact; soft and friable when wet, while hard and firm consistence when dry; massive structure; gradually and smooth boundary.
A12	10 to 25	Light brownish gray (7.5YR 5/4 to 5/6); fine clay; many and fine size of distinct ferruginous mottling (10YR 5/5); reddish brown stains around the old roots; massive; plastic and sticky; soft and friable when wet but hard and firm consistence when dry; diffuse and smooth boundary.
C1g	25 to 55	Light grayish brown (7.5YR 5/4 to 5/6); fine clay; massive structure; effusive and coarse size of distinct mottles (10YR 6/3 to 7/2); fine tublar stains along the old roots; compact; diffuse and smooth boundary.
C12g	55 to 70	This horizon is also the mottled soils but their matrix colour are slightly darker than that in C1g horizon. The mottles are common in density and coarse but cloudy in form. These mottles decrease with the depth. Other specific characters are very similar to that in C1g horizon.
C2g	70 to 150 or more	The soils are permanent gley soil over-saturated with the groundwater. The soils are gray (2.5Y to 5Y 5/2) in colour mixed with grayish olive (2.5Y 6/4 to 6/5); fine clay; massive structure; plastic and sticky; rather compact.

Table V-43 Typical Soil Profile of Typic Haplaquepts

(Soil Unit: 14)

1. Soil Group: Inceptisols in order, Aquepts in sub-order, Haplaquepts in great group, Typic Haplaquepts in sub-group and Loamy, Acid, Typic Haplaquepts, in family.

2. Topography: River levee, flat to nearly flat.

3. Vegetation: Village accommodation, rubber plantation.

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Features
A1	0 to 15	Dark brown (10YR 4/2 to 5/1) to dark grayish brown (7.5Y 3/1 to 4/2); silty clay; weak subangular blocky structure; slightly sticky and plastic; friable consistence when wet; gradually and smooth boundary.
A12 or B	15 to 35	This horizon is the cambic horizon. The soils are dark reddish brown (5YR 3/2) to dark brown (7.5YR 4/2); fine clay; blocky structure; friable consistence when wet, while firm consistence when dry; plastic and sticky; rather compact; diffuse and smooth boundary.
C1g	35 to 75	This horizon is the mottled soils which have light grayish brown (5Y 6/5 to 6/4); clay; strong brown ferruginous mottles (10YR 5/6); massive structure; plastic and sticky; rather friable consistence when wet but firm consistence when dry; diffuse boundary.
C2g	75 to 150 or more	This horizon is the gleyic soils having gray in colour; silty clay in texture; rather compact; massive structure; firmly consolidated when dry; common to few cloudy type of ferruginous mottling; very plastic and sticky when wet. The mottlings gradually decrease with the depth.

Note: The soils are strong acid throughout the profile.

Table V-44 Typical Soil Profile of Typic Haplustults

(Soil Unit: 15)

1. Soil Group: Ultisols in order, Ustults in sub-order, Haplustults in great group, Typic Haplustults in subgroup and Sandy skeletal, Acid, Typic Haplustults, in family.

2. Topography: Undulating and/or rolling hills, relatively short and steep sloping.

3. Vegetation: Alang-alang grasses, somewhat accommodation of village and somewhat used for clove plantation (still seedling stage).

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Features
A1	0 to 10	Dark reddish brown to dull brown (10YR 5/2 to 5/3) in matrix colour; loamy sand in texture; effusive small gravels and fragments of laterites particularly on the soil surface; rather hardly consolidated; mostly non-plastic and sticky; very friable when wet; gradually change to the underlying horizon.
A12	10 to 25	Brown to reddish brown (10YR 5/3 to 5/5); loamy sand in texture; effusive gravels; compact and rather firmly consolidated; very friable when wet; non-plastic and sticky when wet; gradually change to the underlying horizon.
B	25 to 50	Strong brown to reddish brown (7.5YR 5/5 to 10YR 5/3); coarse loamy in texture; compact and firmly consolidated, while very friable when wet; coarse blocky structure; including some small gravels and stones but somewhat very few or non gravel in the profile; slight sticky and plastic when wet; diffuse and smooth boundary.
C	50 to 150 and more	This soil is primarily the basic lithological layer which might be the diluvium or saprolites of the sandstones in the tertiary formation.

Note: The soils are strong acid throughout the profile.

The soils partly have a paralithic contact regime. Many gravels exist throughout the profile.

Table V-45 Typical Soil Profile of Terric Tropofibrists

(Soil Unit: 16)

1. Soil Group: Histsols in order, Fibrists in sub-order, Tropofibrists in great group, Terric Tropofibrists in sub-group and Dysic, Terric Tropofibrists in family.

2. Topography: Deep depression (to be old oxbow), permanent swamp.

3. Vegetation: Primary or secondary swamp forest.

4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Features
01	0 to 10	Brownish black to dark brown (7.5YR 3/0 to 3/2) in colour; hemic; still low mineralization; very loose when wet, while very firm consistence when dry; diffuse boundary.
021	10 to 50	Dark brown (7.5YR 4/2 to 4/3) in colour; fibric; loose; no mineral compounds or stratification in the profile; diffuse boundary.
022	50 to 110	Brown to dull brown (5 YR to 7.5YR 5/4 to 5/6) in colour; fibric; abruptly and smoothly change to the following soil layer.
Cg	110 to 150 more over	This soil layer might be the mud-clay soils which have gray (5Y 4/3 to 5/2) in colour; silty clay to fine loam in texture; rather compact and massive in structure.

Note: The soils are very strong to extremely strong acid throughout the profile under the natural condition when moistened and become more strong acid when dry.

The land of this soil area is submarged throughout the year.

Table V-46 Typical Soil Profile of Terric Tropohemists

(Soil Unit: 17)

1. Soil Group: Histosols in order, Hemists in sub-order, Tropohemists in great group, Terric Tropohemists in sub-group and Hemic, Dysic, Terric in soil family of Terric Tropohemists.

2. Topography: Deep depression (alluvial depression), permanent swamp.

3. Vegetation: Secondary swamp forest, somewhat gelam shrub.

4. Soil Description:

Specific Horizon	Soil Depth (cm)	Remarkable Features
O1	0 to 10	Very dark brown (10YR 3/0 to 3/1) in colour; sapric; loose and very soft consistence when wet, while very firmly consolidated when dry; gradually but irregularly change to the underlying horizon.
O2	10 to 25	Dark brown (7.5YR 4/3) in colour; hemic; very loose; no mineral fraction and/or stratification; diffuse boundary.
O22	25 to 50	Brown (5YR 5/3) to dull brown (7.5YR 4/3) in colour; hemic but still low degree of decomposition; loose and soft consistence when wet, while very firmly consolidated when dry; diffuse boundary with the underlying horizon.
O3	50 to 120	Brown (5YR 5/5) in colour; fibric; very rough in compactness; very clearly bounded by the mineral soils underarth.
Cg	below 120	Gray (5Y 3/3 to 4/3) in colour; fine loam to clay loam in texture and rather compact. This soils might be the mud-clay.

Note: The soils are very strong to extremely strong acid throughout the profile under the natural condition when wet and when dry caused by drainage, they become more strong acid soils.

Table V-47 Typical Soil Profile of Terric Troposaprists

(Soil Unit: 18)

1. Soil Group: Histosols in order, Saprists in sub-order, Troposaprists in great group, Terric Troposaprists in sub-group and Dysic, Terric, Troposaprists, in family.

2. Topography: Depression (alluvial depression), permanent swamp, somewhat dried in short period in the dry season.

3. Vegetation: Galam shrub, somewhat used for paddy rice cultivation in the wet season but the yield is very poor.

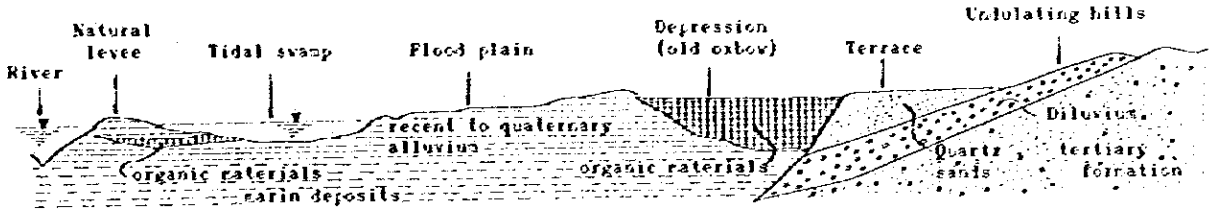
4. Description of Soils:

Specific Horizon	Soil Depth (cm)	Remarkable Peatures
O1	0 to 20	Dark reddish brown (5YR 3/2) to dull reddish brown (10YR 5/3) in colour; sapric; soft and rather loose consistence when wet, while firmly consolidated when dry; mineralization and/or decomposition is almost completed in this soils; gradually but irregular boundary with the underlying soils.
O12	20 to 45	Very dark gray (5YR 3/1) to dark reddish gray (5YR 4/2) in colour; sapric; soft and loose consistence when wet, very firmly consolidated when dry; many fibrous residues in the profile; diffuse and irregular boundary.
O2	45 to 60	Dark gray to very dark gray (2.5YR 3/0 to 4/1) in colour; hemic; considerable amount of fibrous materials or residues in the profile; very loose consistence; diffuse and irregular boundary.
C1	60 to 100	Dark gray (2.5YR 4/0 to 4/1) in matrix colour and sandy clay in texture mixed with hemic materials; compact and massive structure; plastic and sticky; friable consistence when wet, while firm consistence when dry; gradually and smooth boundary.
C2	below 100	This soil is the mineral soils having sandy clay loam to loam in texture; gray (5Y 5/2 to 4/3) in colour; massive structure; rather compact.

The soils might be the mud-clay.

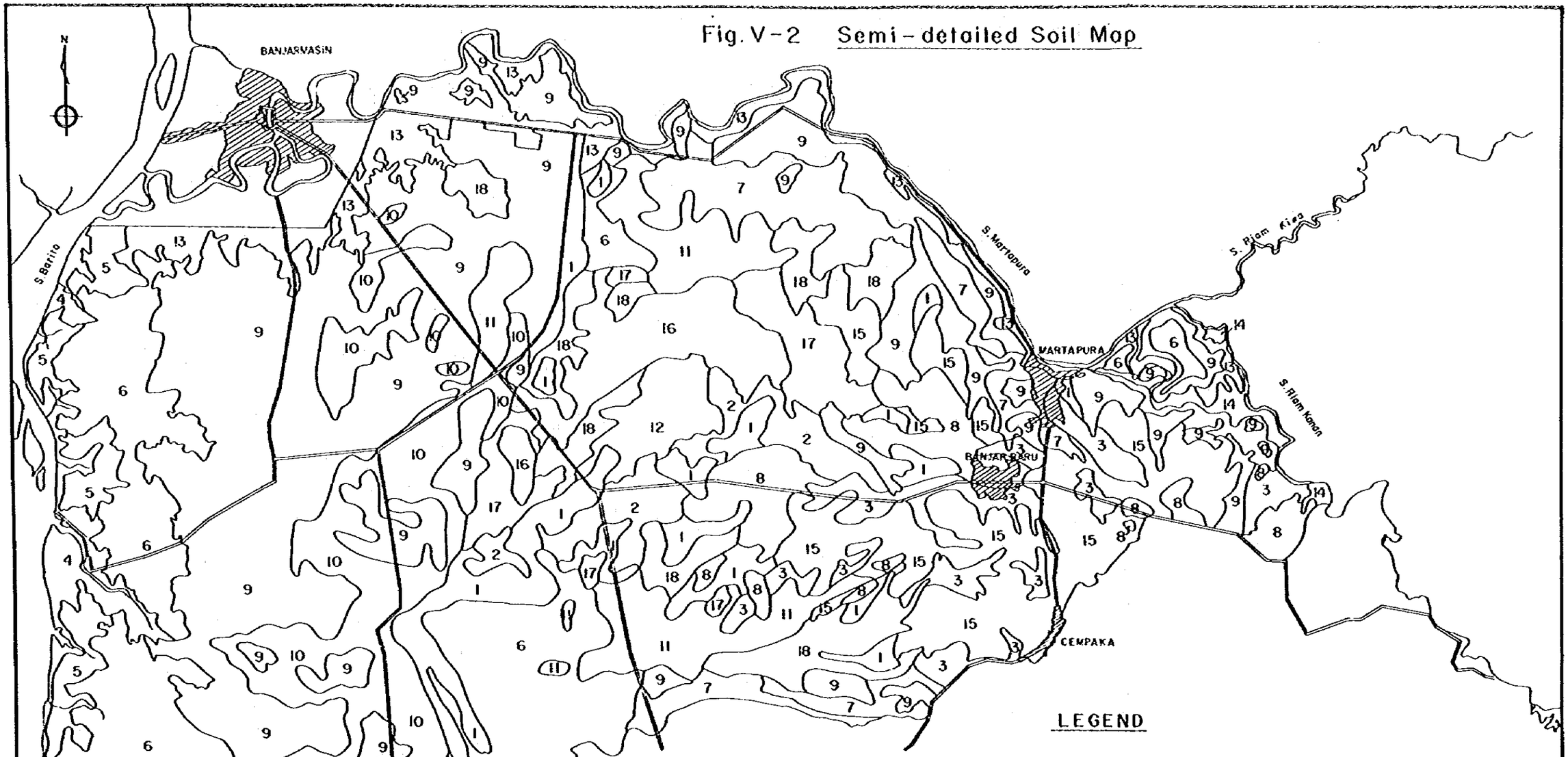
Note: The soils are very strong to extremely strong acid throughout the profile under the natural conditions when wet and they become more strong acid conditions when dry.

Fig. V-1 Schematic Topography and Lithological Features
(Sketch profile in Rian Kanan Irrigation Projec Area)



Geomorphological Unit					
Alluvial plain			Depression		
Natural levee	Tidal swamp	Flood plain	(old oxbow)	Terrace	Undulating hills
Lithological Materials					
Alluvium	Alluvium	Alluvium	Organic matters	Quartz sands	Diluvium
Basic Soil Formations					
Hydromorphic weathering	Hydromorphic weathering	Hydromorphic weathering	Hydromorphic weathering	Hydromorphic weathering	Oxidation weathering
Lithological Profile Sequence					
Recent alluvium deeply overlie mud-clay, and somewhat organic layer interca-lated in shallow profile	Recent to quater-nary alluvium shallowly overlie mud-clay layer	Recent to quater-nary alluvium deeply overlie mud-clay layer	Organic materials deeply deposited	Quartz sands overlie gravel diluvium layer	Gravelly diluvium overlie tertiary formation of sandstones from ground surface
Soil Texture Quality					
Clay to silty clay	Clay to silty clay	Clay to silty clay	Peat/peaty materials	Medium to fine sand, somewhat sandy skeletals	Loamy to sandy skeletals
Seasonal Flooding					
Flooding more than 160 con-secutive days and 30 cm deep at maximum	Flooding through-out the year and 100 cm deep at maximum	Flooding 100 to 120 consecutive days and 30 cm deep at maximum	Flooding through-out the year and more than 100 cm deep in peak season	Somewhat flooding shallowly in rainy season	Free from flood-ing, all the times
Groundwater and Its Seasonal Fluctuation					
0 to 15 cm in surface profile	Submerged deeply	10 to 30 cm, somewhat 50 cm in dry season	Mostly submerged	10 to 100 cm	200 to 500 cm or more
Present Land Use					
Village accomo-dation, coconut plantation	Paddy field, somewhat galam shrub or swampy forest	Paddy field, somewhat galam shrub	Swampy forest	Bushes, galam shrub and some-what upland field	Alang-alang grass and bushes and somewhat upland field
Corresponding Sub-areas					
Sub-area D and E	Sub-area D and E	Sub-area A, B, C, D and E	Sub-area B and E	Sub-area B and E	Sub-area A, B, E and F

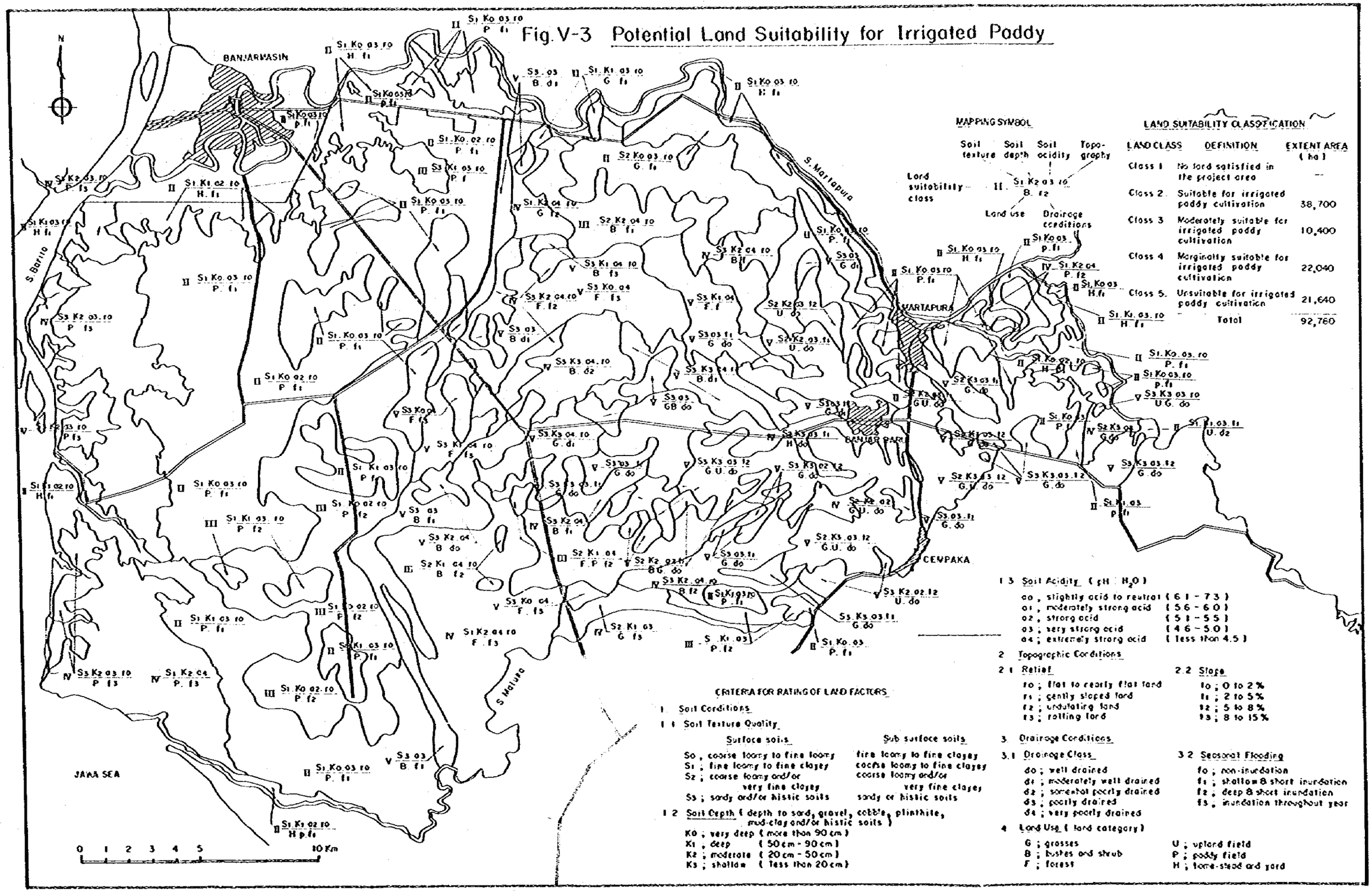
Fig. V-2 Semi-detailed Soil Map



LEGEND

SERIAL No OF SOIL UNIT	SOIL FAMILY	EXTENT AREA (ha)	SERIAL No OF SOIL UNIT	SOIL FAMILY	EXTENT AREA (ha)	SERIAL No OF SOIL UNIT	SOIL FAMILY	EXTENT AREA (ha)
1.	Acid, Aquic Quartzipsamments	4,690	7.	Clayey, Acid, Typic Tropofluvents	3,720	13.	Clayey, Acid, Aeric Haplaquepts	4,960
2.	Skeletal, Acid, Haplaquodic Quartzipsamments	2,250	8.	Loamy skeletal, Acid, Typic Dystropepts	3,170	14	Loamy, Acid, Typic Haplaquepts	1,200
3.	Sandy skeletal, Acid, Typic Troporthents	3,270	9.	Loamy, Acid, Aeric Tropaquepts	25,830	15	Sandy skeletal, Acid, Typic Haplustults	5,780
4.	Fine, Acid, Typic Fluvaquents	2,350	10	Loamy, Acid, Typic Tropaquepts	6,680	16	Dysic, Terric Tropofibrists	2,700
5.	Fine, Dysic, Thapto-Histic Fluvaquents	1,890	11	Loamy, Acid, Histic Tropaquepts	4,010	17.	Dysic, Terric Tropohemists	2,340
6.	Loamy, Dysic, Sulfic Hydraquents	12,720	12	Sandy, Dysic, Histic Tropaquepts	1,100	18.	Dysic, Terric Tropaquepts	4,120

Fig. V-3 Potential Land Suitability for Irrigated Paddy



MAPPING SYMBOL

Soil texture | Soil depth | Soil acidity | Topography

Land suitability class — Land use — Drainage conditions

Example: II S1 K2 o3 ro / B f2

LAND SUITABILITY CLASSIFICATION

LAND CLASS	DEFINITION	EXTENT AREA (ha)
Class 1	No land satisfied in the project area	--
Class 2	Suitable for irrigated paddy cultivation	38,700
Class 3	Moderately suitable for irrigated paddy cultivation	10,400
Class 4	Marginally suitable for irrigated paddy cultivation	22,040
Class 5	Unsuitable for irrigated paddy cultivation	21,640
	Total	92,760

CRITERIA FOR RATING OF LAND FACTORS

1 Soil Conditions

1.1 Soil Texture Quality

Surface soils	Sub surface soils
So ; coarse loamy to fine loamy	fine loamy to fine clayey
Si ; fine loamy to fine clayey	coarse loamy to fine clayey
Sz ; coarse loamy and/or very fine clayey	coarse loamy and/or very fine clayey
Ss ; sandy and/or histic soils	sandy or histic soils

1.2 Soil Depth (depth to sand, gravel, cobble, plinthite, mud-clay and/or histic soils)

Ko ; very deep (more than 90 cm)
K1 ; deep (50 cm - 90 cm)
K2 ; moderate (20 cm - 50 cm)
K3 ; shallow (less than 20 cm)

1.3 Soil Acidity (pH H_2O)

oo ; slightly acid to neutral (6.1 - 7.3)
o1 ; moderately strong acid (5.6 - 6.0)
o2 ; strong acid (5.1 - 5.5)
o3 ; very strong acid (4.6 - 5.0)
o4 ; extremely strong acid (less than 4.5)

2 Topographic Conditions

2.1 Relief	2.2 Slope
ro ; flat to nearly flat land	fo ; 0 to 2 %
r1 ; gently sloped land	f1 ; 2 to 5 %
r2 ; undulating land	f2 ; 5 to 8 %
r3 ; rolling land	f3 ; 8 to 15 %

3. Drainage Conditions

3.1 Drainage Class	3.2 Seasonal Flooding
do ; well drained	fo ; non-inundation
d1 ; moderately well drained	f1 ; shallow & short inundation
d2 ; somewhat poorly drained	f2 ; deep & short inundation
d3 ; poorly drained	f3 ; inundation throughout year
d4 ; very poorly drained	

4 Land Use (land category)

G ; grasses — U ; upland field
B ; bushes and shrub — P ; paddy field
F ; forest — H ; home-stead and yard

ANNEX VI

AGRICULTURE

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ANNEX VI AGRICULTURE

VI.1 GENERAL

The agricultural investigation and studies are carried out in and around the project area. The field investigation is to clarify the present agricultural conditions and to assess the potential land productivity in the project area. For these purposes, the data and information on land holding, land tenure system, land use, cropping patterns, crop yield and production, farming practices, farm inputs, etc. are collected in and around the project area.

The data and information are obtained mainly from the government agricultural offices concerned, such as the Department of Agricultural Extension Services South Kalimantan, Agricultural Extension Services of Kabupaten Banjar, Kabupaten Tanah Laut and Banjarmasin city, Central Research Institute for Agriculture at Banjarmasin and Agrarian office in South Kalimantan. Besides, the field interview with farmers was made so as to obtain more practical information particularly for farming practices and labour requirement. Yield of paddy rice was also confirmed by sampling yield check survey carried out at 6 locations sporadically selected in the project area.

Taking into account the physical nature of land and the present agricultural conditions and further the socio-economic background of agriculture, the government policy for further agricultural development and the farmers' wishes, the most applicable and profitable agricultural setting is formulated making reference to the land suitability classification and the engineering study on the irrigation and drainage improvement. In this context, the following studies are made.

(1) Selection of suitable crops and their varieties based on their marketability, profitability, familiarity to farmers and agronomic characteristics suitable for the soil and climatic conditions in the project area.

(2) Formulation of the most suitable cropping pattern and proposed land use on the basis of the climatic conditions, irrigation and drainage works to be constructed under the Project, labour force available in a farm household as well as in the whole project area and plant physiological characteristics of crops.

(3) Estimation of the prospective unit yield and production, and farm inputs based on the present crop production in and around the project area, crop research and soil conditions.

(4) Introduction of the most applicable farming practices, taking into account the present farming practices, availability of labour force, prospective field conditions to be improved in the future, the characteristics of crop varieties to be introduced, the prevailing pests and diseases in and around the project area and development plan of agricultural extension services in South Kalimantan Province. In this connection, preliminary discussion is also made to study the possibility of introducing farm mechanization and cattle farming.

(5) Marketing of farm inputs and outputs.

(6) Analysis of the present farm economy for the project evaluation.

(7) Present agricultural supporting services.

VI.2 REGIONAL AGRICULTURAL CONDITIONS

The Kalimantan island has various natural resources for the development. Mainly because of small population, however, the socio-economic development in this island is still at very beginning stage.

The island is divided into four provinces, East, West, South and Central Provinces. The Riam Kanan Irrigation Project is located in South Kalimantan Province. Among four provinces, South Kalimantan is comparatively well developed. The mainstay of economic activities in this province is also agriculture, supporting about 50% of GDP in the province, and about 70% of working population are engaged in agriculture.

Agriculture in South Kalimantan is broadly divided into two types, namely small-holder farming and plantation agriculture. According to the statistics in 1973, the small-holder farming covers about 270,000 ha of farmland cultivated by 260,000 farm families, while the plantation farming occupies approximately 36,000 ha of land. It can be said from these figures that the mainstay of agriculture in this province is the small-holder farming.

The main crop of the small-holder farming is paddy rice, a stable food of the people. It is reported that total cultivated area of paddy in 1976 in South Kalimantan was about 260,000 ha, which correspond to about 34% of total cultivated area of paddy in Kalimantan. Table VI-1 shows production of main crops in the whole Kalimantan and South Kalimantan in recent five years. As seen in this table, rice production in 1976 in South Kalimantan occupied about 40% of total rice production in the whole Kalimantan. The South Kalimantan is therefore the largest rice producing area in Kalimantan.

Table VI-2 shows gross value of agricultural products in South Kalimantan and Kabupaten Banjar in which most of the project area (about 80% in area) is included. This table indicates that about 80% of total gross value are supported by food crop productions, of which about 66% by dry paddy, in the whole South Kalimantan.

Most of paddy are cultivated under rainfed condition. Therefore, yield and production of paddy rice are still not stable, depending on the precipitation during the cropping season.

VI.3 LAND HOLDING AND LAND TENURE SYSTEM

The investigation and study on the present land holding and land tenure system are made for five sub-areas A, B, C, D and E which are taken up for the Project (see Annex VIII). Most of the project area is included in Kabupaten Banjar, and a part of it in Kabupaten Tanah Laut. Kabupaten Banjar has 8 Kecamatan and 36 Desa, and there are 1 Kecamatan and 6 Desa in Kabupaten Tanah Laut, which are concerned the Project.

According to the population census in 1976 provided by the statistic office, Banjarmasin, total population in the project area is estimated about 214,000, of which about 210,000 persons are engaged in agriculture. The total house-hold being engaged in the paddy rice cultivation is about 34,850.

VI.3.1 Land Holding

Table VI-3 shows the number and area of farms by size of holding in three representative Kecamatan in the project area, since the data on the present land holding in the whole project area are not available. As seen in this table, small farmers who own 0.5 to 1.0 ha of land occupy about 35% of total farm family and followed by further small farmers whose land holding ranges between 0.1 and 0.5 ha of land. The average land holding in the project area is assumed to be 1.0 ha. Most of the land owners who own more than 3 ha of land live in the cities.

VI.3.2 Land Tenure System

Table VI-4 shows the present land tenure system in four representative Kecamatan in the project area. This table indicates that about 73% of total farms are occupied by the land owner farmer, about 21% by tenant and 6% by land owner cum tenant. In the vicinity of Banjarmasin, the number of the land owner farmer decreases, on the contrary, the tenant increases, as compared with those in other rural areas.

The farm land owned by a farm family is divided into 2 to 3 farm plots in general. This means that average size of a farm plot ranges between 0.3 ha and 0.4 ha.

The crop sharing system is predominant in this area. The harvested paddy is shared with the land owner and the tenant at the sharing rate ranging between 1 : 1 and 1 : 2.

VI.4 PRESENT CONDITIONS OF AGRICULTURE IN THE SURVEY AREA

VI.4.1 Present Land Use

The present land use survey was carried out in the area which includes the project area and its surrounding areas to obtain as much data and information as possible for the various studies. The survey area is 92,780 ha.

In spite of the present agricultural constraints, approximately 45,300 ha or about 50% of the total survey area are used as agricultural land long since. Most of the agricultural land is in low-lying flood plain. The agriculture in the survey area is characterized by a large share of paddy rice cultivation. Paddy field is about 40,500 ha or about 90% of the total agricultural land, and most of the remaining agricultural land is used for small-scale plantations of rubber and coconut.

The paddy field has been developed with the canal network constructed by the people without any technical advice from the government offices. The canal network is used not only for both irrigation and drainage purposes but also for navigation for transporting farm products and other consumable commodities using small boats. The existing canals have no structures for water control, except for few check structures. Seasonal flooding is generally seen in the whole paddy field in the rainy season. On the contrary, no sufficient irrigation water is available in the dry season. The prevailing paddy cultivation is therefore practiced only in the rainy season using the stagnant water in the paddy field.

Out of 4,800 ha of plantation area, rubber plantations occupy about 2,500 ha and coconut plantations, 2,300 ha. Rubber plantations exist mainly in the old river levees or hilly land where the land is free from the seasonal flooding, while coconut plantations are in the low-lying flood plain or the recent levees along the rivers Barito, Martapura and Maluka. The peak time of the latex productivity of these plantations is nearly over, and their productivity tends towards decreasing.

The land primarily defined as the infrastructural land including the village compounds, airport, roads, canals, rivers, etc. is estimated at about 7,400 ha or about 8% of the total survey area.

The remaining area of about 40,080 ha are wild land at present. According to the present vegetation and topographical environment, the wild land is broadly classified into five land types; (1)

Alang-alang grass land in the hilly area, (2) Gelam shrub in the low-lying flood plain, (3) Bushes in the old sand dune or sand terrace on the foot of the hills, (4) Swampy forest in the low-lying areas and (5) Swampy grass area in the low-lying flood plain. The area of each land type is (1) 9,800 ha, (2) 4,980 ha, (3) 6,400 ha, (4) 18,200 ha and (5) 700 ha, respectively.

The Alang-alang grass land (sub-area F) is being developed gradually with transmigration settlement, and small-scale clove plantations and farmland for cultivation of upland crops mainly for home consumption by transmigrants are settled in a small area. However, most of the land is not suitable for profitable agricultural development with irrigation because of very shallow and gravelly or stony soils.

The land covered with Gelam shrub extends over the low-lying flood plain along the river Martapura (sub-areas A and B). The land is very densely covered with young Gelam trees which might be at the tertiary or the fourth vegetation stage. Because of light flooding with a shallow water depth even in the dry season and fine clayey alluvium deeply deposited in this area, it would be possible to reclaim this shrub land for the increase of agricultural productivity in the project area.

The land being covered by bushes under vegetation of fern extends mainly on the foot of the hills (sub-areas B and E). Due to medium to fine size of quartz sand skeletal deeply deposited, all the lands in this category are not suitable for agricultural use.

The swampy forest extends in the sub-areas B and E. The northern half of the sub-area B is covered by the secondary or tertiary forest developed on the deep peat soils. Because of such physical environments as deep water stagnation and the soils having an extremely strong acidity, the land covered with the swampy forest is not suitable for agricultural use as mentioned in Annex V. The southern half of the sub-area E is densely covered mainly by wild vegetation such as mangroves, gelam trees and swampy grasses, etc.. Although the land is at present deeply inundated throughout the year, it could be developed for agricultural use particularly for paddy rice cultivation with proper drainage improvement, but such development would be limited to small area from the soil and agronomic viewpoints.

The swampy grass land is developed in a narrow area along the river Maluka and small streams in the project area. Among the grasses being grown, rushes are harvested in a small area for handicraft of mat. The main constraint to the agricultural development is a deep water stagnation throughout the year. If such a water stagnation could be improved economically, it would be possible to utilize this land for paddy cultivation.

The present land use in the survey area is summarized in Table VI-5 and shown in detail in Table VI-6 and Fig. VI-1.

VI.4.2 Present Cropping Pattern and Farming Practices

Present Cropping Pattern

The field survey of the present cropping patterns and farming practices is also made in the area, 92,780 ha in total, including the project area and its surrounding areas for the same reason as mentioned before.

Paddy rice is the main crop in the area, and monoculture of paddy rice using the flood water in the rainy season is predominant throughout the survey area.

Generally, the water depth of flooding in the paddy field increases from November and reaches the maximum of about 50 to 70 cm between the end of January and mid-February. Afterwards, the stagnant water gradually decreases its depth and reaches the minimum water depth of about 15 to 20 cm during the period from March to April. Under these flooding conditions, the following paddy rice cultivation is practiced as a whole in the survey area.

It is noted in the present paddy cultivation that two-time transplanting or three-time transplanting of seedlings is traditionally practiced at the nursery stage, and so-called "Ani-ani" (harvest of matured panicles only) is the common practice for the harvesting. It is considered that these farming practices would be suited to the paddy cultivation in this area under the present field conditions and from the plant physiological characteristics of the prevailing varieties such as high shattering, uneven maturing and high plant height.

Paddy seeds at a rate of 5 to 10 kg per hectare are sown in the nursery bed during the months from October for early planting to January for late planting, according to the availability of water necessary for plant growth. Young seedling is grown for 30 to 40 days in the nursery bed and transplanted to the field where sufficient water is available, with a plant space of 50 x 50 cm approximately. These seedlings are re-transplanted to more wide area after making tiller-separation, so as to expand the planted area over the total holding. When the time at which the depth of stagnant water reaches the maximum is over and the water depth decreases to the favourable level for plant growth (approximately 20 cm), the final transplanting to the main field is carried out around the end of February which is the earliest one and in May that is the latest one. After growing for 7 to 10 months, the paddy is harvested during the period from May to October.

Early transplanting of paddy is generally common in most part of the sub-areas C, D and E. It seems that the seasonal flooding is controlled to a certain extent by the existing canal network, though the land is deeply submerged at the peak flood time. While, late transplanting is practiced mostly in the sub-area B and a part of the D. It may be caused by the deep water stagnation for rather long time. Recently, the varieties with a short growing period such as Pelita I/1, I/2 and C4-63 have been introduced in these areas, but they are still at the trial stage.

In the tidal swamp extending along the river Barito, the paddy rice is also cultivated with early transplanting because of sufficient water available throughout the season and high plant height which would have a tolerance to deep water stagnation.

In the depressions of the polders in the sub-areas A and B, the paddy rice is cultivated only in the dry season from April to October because of deep flooding during the rainy season.

The present cropping pattern of paddy cultivation in the survey area is illustrated in Fig. VI-2. Under this cropping pattern, local varieties such as Lemo, Bayar and the varieties of Siam series are cultivated in most of the area. These varieties have high photo-sensitivity, as shown in Table VI-7 and Fig. VI-3.

Present Farming Practices

All the works for farming are operated manually, not using any animal and mechanical powers. No soil preparation, i.e. ploughing, harrowing, puddling, etc., is usually practiced in this area. The field preparation being practiced by the farmers is only to return straw of paddy rice and grasses to their farm as primitive manuring. During the growing stage from the final transplanting to harvest of panicles, attention is paid by the farmers only to weed control and cleaning of the field ridges. The use of chemical fertilizers and agricultural chemicals is still insignificant in this area. Water ponded by the field ridges is drained out to the canals by cutting the field ridge when almost all of the panicles are headed successfully. Generally, harvesting is practiced two or three times even for one variety because of uneven maturing of panicles. Threshing and processing of products are also made by hand with small farming instruments such as winnower, etc.

The food crops other than paddy rice such as maize, cassava, sweet potato, beans, etc. are also grown in small area of house yard, canal embankment, field ridges, etc. They are mostly for home consumption. In the paddy field, no diversified crops (so-called palawija) are introduced at present, even though there is time enough for their cultivation during the dry season due to high groundwater table.

As for industrial crops, rubber and coconut are dominant in this area. However, their share in the rural economy is not so significant. Recently, clove plantations have been developed in the hilly area (sub-area F), but most of them are limited to small area. Coffee and pepper are also grown in house yard mainly for home consumption.

There are few milk cows and draft oxen in the survey area. They are mainly grazed in the hilly area by use of alang-alang grasses. Due to meager vegetation for feeding, production of milk is still far from the requirements for the sufficient income.

VI.4.3 Farm Inputs and Labour Requirements

As stated before, the farm inputs such as fertilizers, chemicals, etc. are generally not applied to all of the crops. The use of these farm inputs is still under demonstration and research in the rural agricultural extension programs. The paddy seeds (5 to 10 kg/ha) are an essential farm input in this area. These are commonly provided by the farmers themselves from the previous production.

The labour requirements for cultivation of paddy rice are summarized in Table VI-8. All the works for farming are generally operated by the family labours, sufficiently. In case of the farm operations in the farms with more than 1.5 ha-holding, seasonal labours are employed to supplement a shortage of family labour at the peak time such as field preparation, transplanting, harvesting and processing, etc. They are mainly small holder in the project area and partly come from the outside. The labour wages are usually paid in kind, one-tenth of the harvested stalk paddy in common. It is estimated at about 5 to 6 kg/day, which correspond to Rp 400 to 500 of wage/day. Payment in cash is very rare in the project area at present.

VI.4.4 Crop Yield and Production

Administratively, most of paddy field in the survey area, about 80% of total paddy field, belongs to Kabupaten Banjar. The average yield and production of paddy rice in the survey area are estimated based on the statistical data obtained from Kabupaten Banjar. Table VI-9 shows the cultivated area and production of paddy rice in Kabupaten Banjar for recent five years from 1973 to 1977. From this table, the average yield of dry paddy is estimated at 1.75 tons/ha.

According to the statistical data (1971) prepared by the Badan Urusan Logistic office (BULOG), it is noted that the field losses of grains are approximately 25% of the total production in common

as shown in Table VI-10. Considering the above, the actual crop yield would be approximately 2.3 tons/ha. This is also confirmed through the yield check survey as shown in Table VI-11.

Even in either case, the present yield of paddy in the survey area is still lower than the average yield of 3 tons/ha in the whole Indonesia /1. It is considered that the low yield is caused by carious agricultural constraints such as low fertility of soils, no technical irrigation and drainage, primitive farming practices with no soil preparation, very rare fertilization and control of pests and diseases, insufficient agricultural support services, etc. in most of the area. High field losses of paddy during harvesting and processing are also one of the causes.

Total annual production of paddy in the survey area is estimated at 70,900 tons in dry paddy. The annual paddy production in the project area is estimated at about 52,400 tons. The estimated paddy production in each sub-area is shown in Table VI-12.

VI.5 MARKETING AND PROCESSING FACILITIES

VI.5.1 Marketing of Farm Inputs and Outputs

Farm Inputs

Fig. VI-4 shows the present marketing flow of farm inputs. The capacity of the existing storages for marketing of farm inputs in the project area is as follows:

Location	Capacity (ton)	
(1) Banjarmasin	2,000	
(2) Banjarbaru	5,500	(under planning)

The farmers under the BIMAS Program can purchase necessary farm inputs such as fertilizers, chemicals, etc. through BUUD/KUD.

/1: Statistical Yearbook of Indonesia. The figure is shown by dry paddy converted from 3.9 tons/ha of dry stalk paddy at a conversion rate of 76%.

The farmers other than the BIMAS Program have to buy such farm inputs from private companies. The prices of farm inputs for the BIMAS farmer are subsidized by the Government. The farm inputs used for one crop of paddy cultivation under the BIMAS Program in the project area is estimated at about 15 tons of Urea, 30 tons of T.S.P. and 300 liters of insecticides. Current prices of farm inputs at the farm gate are shown in Table VI-13 prepared based on the results of "an economic survey and statistical data provided by the Agricultural Extension Services and Kabupaten Banjar, 1978.

Marketing of Rice

The share of rice production occupies more than 90% of total agricultural production in the project area. Fig. VI-5 shows the present market flow of rice. The farmer can sell his paddy to BUUD/KUD or middlemen or both as he likes. The share of marketing of paddy by BUUD/KUD is very limited mainly due to the shortage of BUUD/KUD offices in the project area.

DOLOG (Depot Logistik) purchases paddy from BUUD/KUD for stabilizing the price of rice at a floor price and sell it when the market price goes up above the ceiling price. However, the operations of DOLOG are still limited to the supply to the military and government employees due to inadequate organization, insufficient staffing and storing capacity. Most of paddy and rice are handled by middlemen and private companies. This means that the farmers often sell their farm products at unreasonable prices. It is estimated from the present production and rice consumption in Kabupaten Banjar that about 18,000 tons of rice are marketed through DOLOG, private companies and middlemen in Banjarmasin and other major cities in the project area. With the completion of the Project, it is assumed that about 120,000 tons of rice would be marketed. In order to increase the share of marketing of paddy by BUUD/KUD, further improvement of the activities and increase in number of BUUD/KUD are strongly recommended. Current price of rice and other agricultural products are shown in Table VI-14.

VI.5.2 Processing Facilities

The main processing facility for farm products in the project area is rice mills. The number and the capacity of existing rice mills in the project area are shown in Table VI-15. Small-scale rice mills with a milling capacity of 1 to 2 tons/hr occupy about 65% of total mills in number. It is estimated that there are two rice mills with a total capacity of 4 tons/hr in a Desa on an average. It is assumed from these figures that the present rice mills would be sufficient in both the capacity and number in the sub-areas A, B, C and D, even after the completion of the Project. As seen in Table VI-15, however, Kecamatan Banjarbaru and Aluh Aluh have a shortage of rice mills in number. The increase in both number and capacity of rice mills in these areas will be required in connection with the project implementation.

VI.6 PRESENT FARM ECONOMY

The study on the present farm economy is made based on the data and information obtained mainly from the field farm economy survey. The analysis of the present farm economy is made by taking a typical farm with a land holding of 1 ha which is the average land holding in the project area.

VI.6.1 Gross Farm Income

Table VI-16 shows that the present annual budget of a typical owner farmer with 1 ha-land holding. This table indicates that farmers in the project area get their income mainly from farming activities particularly paddy rice production. The cultivation of palawija is very limited, because paddy rice occupies the land for long time ranging from 6 months to 10 months. Income from the sale of livestock is also insignificant, because the farmers raise very small number of fowl and duck in their house yards.

Total annual farm income is estimated at RP. 163,750 per average farm holding 1.0 ha. In addition, the farmers get income from non-farm activities such as seasonal labour for big land owners and plantations, labour for public works and others which account for about 28% of the gross income. Total gross income is estimated at Rp. 227,970 (or US$365).

VI.6.2 Gross Outgo

Total annual outgo is estimated at Rp. 226,420, of which Rp. 220,300 corresponding to about 97% of total outgo are spent for family expenditure.

The balance of the budget or capacity to pay is therefore estimated at only Rp. 1,550 (or US$2.5).

VI.7 AGRICULTURAL SUPPORT SERVICES

VI.7.1 Agricultural Extension Services

In connection with the re-organization of the Central Government carried out in August, 1974, the organization for agricultural extension services in Indonesia has been much improved through establishment of an Agency for agricultural education, training and extension in the Ministry of Agriculture. At the same time, the Agricultural Development Center (ADC) has been established at the provincial level. The main functions of the ADC are as follows:

(1) Extension of new and improved farming technics derived from the research works,

(2) Preparation and determination of the main activities necessary for extension services,

(3) Training of the representative farmers (contact farmers), and

(4) Preparation of programs including necessary texts for the training.

In 1975, the Rural Extension Center (REC) was opened, and the main activities of this center are summarized below.

(1) Preparation of programs for extension services for the farmers,

(2) Public relations necessary for extension services,

(3) Services for improvement of farm management,

(4) Guidance for optimum use of farm inputs, and

(5) Guidance for optimum farm mechanization.

The present staffing and equipment of the Rural Extension Centers related to the Project are shown in Table VI-17, and the organization of the Center is illustrated in Fig. VI-6 (see also Fig. VI-7).

As seen in Table VI-17, the project area is served by three Rural Extension Centers. The area and farm family served by each P.P.L. (field extension worker) range widely from area to area : as for the area between 1,000 ha and 14,000 ha, and as to the farm family between 500 and 9,000 families.

A P.P.L. is giving necessary guidance directly to 16 contact farmers (key farmer) in his service area and a contact farmer transfers new and improved farming technics which he has leanred to a group of consisting of 16 to 20 farmers. This is a common practice in extension services.

In addition, some of the contact farmers operate demonstration farms, each covering 0.1 to 0.2 ha, in their villages for effective transfer of technical knowledge to their member farmers.

In addition to the guidance to 16 contact farmers as his main work, P.P.L. is serving for proper management of demonstration farms, guidance to the farmers under the BIMAS/INMAS Programs, meeting and discussions with the agencies and personnel concerned, and so on. Under these conditions, it would be difficult to expect

higher efficiency in his extension services unless further improvement of the present staffing and equipment would be made. Particularly, such an improvement in the project area is essential for successful implementation of the Project.

VI.7.2 Research Works

The agricultural research works in South Kalimantan Province are conducted by the Central Research Institute for Agriculture, Kalimantan and seven sub-stations of the Institute located in seven Kabupaten, as illustrated in Fig. VI-8.

The Institute consists of six departments including general affairs, and the main activities are as follows:

(1) Plant breeding tests,

(2) Fertilizers tests for both local and high-yielding varieties,

(3) Tests for control of pests and diseases,

(4) Experiments on plant physiology, and

(5) Socio-economic survey.

These main activities are mostly concentrated on paddy rice.

The main research works being carried out at the seven sub-stations are the application tests of local varieties suitable for each Kabupaten area, and some field tests for introduction of palawija such as variety test, fertilizer tests, etc. are also conducted.

In the project area, there is an experimental farm having 20 ha of paddy field at Handil Manarap in the sub-area C. In this farm, fertilizer tests and test for plant protection are made using the local varieties of paddy and some high-yielding varieties such as IR-26, IR-28, IR-34 and IR-36.

This experimental farm has an office, a storage and paddy drying yard (concrete pavement) and also a simple meteorological station. This farm has a plan to expand its research activities in the test fields of seed breeding, fertilizer response, weed control, etc. However, the progress of these testing works is still very low, because the staffing, buildings, testing equipment and apparatus are still not sufficient.

VI.7.3 Seed Multiplication and Supply

The present organization for seed multiplication and distribution in South Kalimantan Province is illustrated in Fig. VI-9.

Foundation seeds are supplied from CRIA (Central Research Institute for Agriculture) to the Balai Benih seed center through the agricultural extension service sections in the Province and Kabupaten Banjar.

The Balai Benih seed center is located in the sub-area C and covers about 10 ha of paddy field, of which about 2 ha are used as seed farm. The seeds of IR-26, IR-28, IR-36 and B4-62C are multiplied. After multiplication at this seed center, the seeds are distributed firstly two seed growers and then, distributed to the BIMAS farmers through BUUD/KUD and/or directly to common farmers. However, the services in this field are still limited. Further efforts are required for satisfying the seed qualities and for distributing the improved seeds smoothly to as wide area as possible, because the activities of BUUD/KUD in this field are not managed properly.

VI.7.4 BIMAS and INMAS Credits

The agricultural credit is provided under the agricultural supporting programs, namely BIMAS/INMAS Biasa and BIMAS/INMAS Baru.

The unit amount of the credit for the Program in the 1976/77 fiscal year was about Rp. 26,000/ha for paddy and Rp. 38,000/ha for palawija (mostly for beans). According to the farm economic survey, the BIMAS/INMAS Programs being carried out in the project area are the Biasa Program. Thus the paddy cultivation under the Programs is practiced by using only local varieties mostly without fertilization and application of agro-chemicals.

The past records on the area served by the BIMAS and INMAS Programs in the project area are given in Table VI-18. The annual average of the area under the Programs is estimated at 1,700 ha for rainy season paddy and 800 ha for dry season paddy, respectively, of which the area under the BIMAS Package Program is 700 ha for rainy season paddy and 200 ha for dry season paddy. The present BIMAS/INMAS Programs cover only 7% for rainy season paddy and 3% for the dry season paddy of total irrigable area proposed for the Project. The main reason for these small coverages is due to the fact that there is no technical irrigation system in the project area.

Table VI-19 shows the records on total amount of credit provided for the farmers and its repayment in the project area. The unit amount averages about Rp. 20,000/ha. It is noted in this table that the repayment of the credit was very low, ranging between 10% and 30%.

VI.7.5 Agricultural Cooperatives

The Indonesian Peoples Bank (BRI) provides rural credit all over the country. Since 1964, BIMAS Program has been introduced to attain self-sufficiency in foodstuff. Under the Program, the activities of the Bank have been considerably strengthened to offer special short term loan for paddy production. In the project area, however, the number of BRI is still insufficient. Additional establishment will be required for improvement of the present situation, particularly for the successful implementation of the Project.

The existing agricultural cooperatives related to the Project are shown in Table VI-20. They are BUUD (Badan Usaha Unit Desa)/ KUD (Koperasi Unit Desa), KIOS and Rice Mill Unit.

Among them, BUUD/KUD play an important role in providing various services for the farmers to achieve the final purpose of levelling up their living standard mainly through the increase of their farm income. The main activities are the supply of necessary farm inputs such as improved seeds, fertilizers, agricultural chemicals, some farming instruments, etc. and marketing of farm products. As seen in Table VI-18, however, only 8 BUUD/KUD are now in operation, which are insufficient to provide necessary services for 42 villages in the project area.

VI.8 AGRICULTURAL DEVELOPMENT PLAN

VI.8.1 Basic Concept for Development

The agricultural development in the proposed project area is studied, taking into account the following:

(1) Improvement of the present agricultural constraints.

(2) Increase in production of staple food crops by means of crop intensification so as to contribute to the government policy for self-sufficiency in food.

(3) Level up of the living standard of the farmers through the increase of their farm products.

The present main physical constraints to the development of profitable farming are summarized as follows:

(1) Poor drainage conditions especially in low-lying areas which result in low crop yield due to crop damage at flood times and restriction to introduction of double cropping.

(2) High shortage of irrigation water due to no technical irrigation facilities.

(3) Low land productivity mainly due to poor soil conditions in some part of the project area.

The poor drainage conditions and the shortage of irrigation water in the project area could be improved by providing the systematic irrigation and drainage facilities. The improvement of the present low land productivity could also be made through introduction of improved irrigation farming with proper manuring.

The specific objective of the agricultural sector in the Pelita II is the attainment of self-sufficiency in food grains. Under the Pelita II, the Government of Indonesia is making much effort to increase the production of main food crops, especially rice, through further development of the improved irrigation farming as one of the important government's strategies.

Under these circumstances, the main concept of agricultural development in the project area would be to:

- increase and stabilize crop yield and production of rainy season paddy through proper drainage improvement, supply of clean irrigation water, and introduction of improved farming practices,

- increase paddy production by introducing double cropping of paddy with year-round irrigation and drainage facilities, high-yielding varieties and improved farming technics, and

- increase paddy production by providing new farm land in the areas which have favourable physical conditions for agricultural development.

With the above main concept, the proposed agricultural development in the project area is studied as presented hereunder.

VI.8.2 Proposed Land Use

As will be discussed in Annex VIII, total net irrigable land proposed for the Project would be 32,610 ha, and they are divided into five sub-areas from A to E. Out of 32,610 ha, 24,020 ha of land would be used for double cropping of paddy rice with high-yielding varieties under the year-round irrigation (technical irrigation), and the remaining 8,590 ha of land would be covered with a single cropping of paddy rice with high-yielding varieties

mainly because of poor drainage conditions even with the Project and the limited water source of irrigation supply. Table VI-21 shows the present and proposed land use in each sub-area.

As seen in this table, 910 ha in net of the existing rubber plantations in the sub-areas A, B and C are proposed to be shifted into new paddy field, based on the results of the study on this shifting program shown in Table VI-22. This table indicates that the shifting of the existing rubber plantations into paddy field would be more profitable than continuation of managing the present plantations both without and with the renewal of their productivity.

In addition, 3,470 ha in net of shrub land which are left undeveloped at present could be used for increase of crop production with proper irrigation and drainage improvement because of its favourable drainability and soil conditions for paddy rice cultivation. The new paddy field thus opened would be allocated for some new settlement and to the present small farmers whose land holding is less than 1 ha in the project area.

VI.8.3 Proposed Cropping Patterns

Paddy rice is remained as the main crop in the project area. Cropping patterns of paddy cultivation under the Project are studied taking into account the climate, drainage, irrigation, agronomic characteristics of paddy varieties and available labour forces in both unit farm family and the total project area.

The climate in the project area characterized by warm and humid conditions as well as sufficient sunshine hours is favourable for paddy cultivation. Double cropping of paddy could be practiced in the perfect and favourably drainable lands with proper irrigation and drainage improvement. In this case, attention should be paid to the fact that high rainfall intensity and relatively long rain days in the wet season will largely restrict smooth operations of harvest and processing of paddy. Favourable harvest time would be limited to the period from the end of the rainy season to the end of the dry season. With this view, double cropping of paddy a year with the first harvest at the end of the rainy season and the second harvest at the end of the dry season would be practically the most applicable pattern to the project area. This pattern would also be acceptable from the other agronomic points of view.

In order to maximize the potential productivity and profitability of the proposed cropping pattern, high-yielding varieties are introduced as much as possible instead of local varieties. The high-yielding varieties with growing period of 110 to 120 days and the varieties specified for 130 to 140 day-growing would be adopted for the dry season cropping and the wet season cropping, respectively. These varieties would be selected among the improved varieties such as B-series, IR-series, etc.

For the poorly drainable land, 510 ha in net in the sub-areas A and B, single cropping in the dry season would be adopted with high-yielding varieties which would be the same as those selected for the perfect and favourably drainable lands.

Single cropping of paddy rice with improved high-yielding varieties in the rainy season would be applied to 8,080 ha of paddy field which could not be served by the year-round irrigation because of the limited amount of water from the Riam Kanan. Out of 8,080 ha, however, 3,460 ha of land would be irrigated throughout the year using the water to be lifted from the Maluka in the future. Double cropping of paddy rice with high-yielding varieties would be introduced into this irrigated area.

Fig. VI-10 shows the proposed cropping patterns discussed in the above, and the proposed cropping area in each sub-area is shown in Table VI-23.

In the proposed cropping patterns, it is estimated that the duration of transplanting including sowing would be about two months mainly because of limited labour force of the unit farm family and full manual operations. The sowing of the rainy season paddy would be practiced during the period from mid-November to mid-January, and harvest between early April and late May. The dry season paddy would be sown from mid-May to mid-July and harvested between mid-September and mid-November.

In order to introduce these new cropping patterns into the project area successfully, it is inevitable to provide strong agricultural supporting services, including training of both the field extension workers and the farmers, by all government agencies concerned. In this connection, it is recommended to establish a pilot demonstration farm in the project area for which the study is made in the subsequent section.

VI.8.4 Proposed Farming Practices and Farm Inputs

In order to expect possible higher return per hectare with irrigation and drainage improvement, improved farming technics should be introduced into the project area. The proposed farming practices and farm inputs to be applied are studied to find the most practical way which would be acceptable for the farmers, taking into account the following: (1) the soils and lands to be improved by the Project, (2) land holding size including tenant and cultivation right, (3) availability of labour force in and around the project area, (4) familiarity of the farmer with modern farming and (5) the farmers' intension.

The land productivity in the project area would be much improved especially by the control of seasonal floodings and the construction of technical irrigation facilities. Mainly from the economical point of view, however, the proposed drainage improvement would be made, concentrating on the lowering of inundation depth in the rainy season, and the perfect drainage improvement including the lowering of the ground water tables in the paddy field is not recommended, because it would not be justifiable from both technical and economical points of view at the present stage. Under these conditions, the soils in most of the project area are still moistened throughout the year, and the bearing capacity of most land is too weak to receive the large-scale agricultural machinery.

As mentioned before, average land holding per farm household is 1 ha including tenant and cultivation right. A farm family consists of 6 persons on an average, of which 3 persons are workable.

The familiarity of the farmers with the modern irrigation farming is low at present. However, the result of interviews with the farmers in the project area shows that most of the farmers have a high intension of introducing improved farming with proper irrigation and drainage.

In connection with the introduction of double cropping of paddy rice into the project area, the possibility of introducing animal and/or mechanical powers for farming under the above conditions is studied. As for the animal power, practically, it would take very long time to increase the number of the draft animals sufficiently to cover the whole project area mainly due to the lack of breeders and low familiarity of the farmers with the livestock farming, though there would be a possibility of increasing the number of such draft animals using by-products from the increased paddy production in the project area in the future.

In addition, there still exist some constraints to the profitable farm mechanization particularly for land preparation mainly due to the weak bearing capacity of the land, except for such other farming practices as weeding, plant protection, threshing, etc. for which small-scale farm machines and equipment could be used.

Based on the results of the above discussions, it is planned that the proposed farming would be practiced basically by manual operations with small farming equipment and instruments such as rotary weeder, knap-sack type mist cum duster, treadle thresher, winnover, etc. According to the analysis of seasonal labour requirements in the unit farm (1 ha), the labour force in the unit farm would be sufficient for growing the high-yielding varieties of paddy rice by full manual operations, except for a small

shortage of labour at the peak time such as land preparation, transplanting and harvest time as shown in Table VI-24 and Fig. VI-11.

Seasonal labours could be employed from the surrounding areas to supplement the shortage of family labour force. As shown in Table VI-25, potential labour forces being registered in Banjarmasin and Kabupaten Banjar are estimated at about 1,550 and 900 persons, respectively. However, the Provincial Labour office estimates that there would be about 16,500 persons of latent labour force in the above areas which are not registered. If these latent labour forces could be employed for farming, there would be no problem in providing the necessary labour force for farming in the project area.

In order to expect possible high crop yield, it is recommended to grow the suitable varieties such as IR-28, IR-30, GATA, GATI, etc. for the dry season cropping and IR-26, IR-34, Pelita I/1, etc. for the wet season cropping, taking into account the improved field conditions and plant-physiological characteristics particularly for low shattering, high tolerance to pests and diseases, non-photo-sensitivity and short growing period and high productivity.

It is essential for profitable farming that soil preparation, fertilization, plant protection, weeding and water management should be practiced properly. Among the above practices, plant protection by chemical application is of importance, because the entire project area is now infected by pests and diseases mainly of plant hoppers, stem borers, leaf-blight, etc.

Some modifications would also be required for transplanting and harvesting. They are one-time transplanting with young seedling and harvest by cutting all the straws using sickles. Particularly, the proposed harvesting method is one of the most practical countermeasure for saving the labour requirements and also for protecting the plant from the infection of pests and diseases.

Soil Preparation

For the wet season paddy, soil preparation would be started from the middle of November by using hoe or spade. Since the soils are still soft and friable at this time, ploughing could be practiced smoothly under favourable soil moisture conditions. Harrowing cum puddling would be required, after the ploughing, for land levelling for even distribution of irrigation water throughout the land and for protecting the young seedlings from deep submergence. Prior to the harrowing cum puddling, application of basic fertilizers would be practiced to prepare the fertile soil conditions for the seedlings.

As for the dry season cropping of paddy, the soil preparation would be carried out from the middle of May immediately after harvesting of the wet season paddy. All the practices would be the quite same as those for the wet season paddy stated above.

Seeding

At present, there are two types of paddy planting method. One is the ordinary transplanting method extensively propagated in the whole Indonesia, and the other is the direct seeding to the main field.

The transplanting method is generally accepted by the farmers, because higher crop yields are obtained from this method as compared with those from the direct seeding method. However, a large labour force is required for this transplanting method.

Generally, the direct seeding method would require only 20% of labour force necessary for the transplanting method. However, the direct seeding method calls for prudent soil preparation, particularly for very smooth land levelling. The difficulty in weeding and lower crop yields due to plant lodging would also be the disadvantage of this method.

Considering the merit and demerit of the above two planting methods discussed in Table VI-26, the transplanting method would be adopted in the project area, also because the farmers are already familiar with this method. In order to expect higher crop yields with the Project, the following improvement of the present transplanting method is recommended.

Seedlings would be prepared in small plot covering about 4% in area of the main field and would be grown for 20 to 25 days. The seed requirement would be 25 kg/ha. Prior to the seeding, seeds would be treated by using chemicals to control the diseases. Transplanting would be made with a plant spacing of 30 cm x 15 cm and a few seedlings for each hill.

Fertilization

As recommended in Annex V, proper application of fertilizers is essential for realization of the anticipated crop production in the project area. The soils are quite deficient in plant nutrients especially nitrogen, phosphorus, effective bases inclusive of some potassium. Therefore, these chemical elements are necessary to be supplemented by fertilization.

Based on the test results of soil chemical properties, chemical elements required are estimated at about 90 to 120 kg of nitrogen, 60 kg of phosphate and 35 to 60 kg of potash for both wet and dry season paddy. Considering the present soil conditions, suitable kinds of fertilizers would be urea, triple-super phosphate (T.S.P.)

and potassium chloride (KCl) for the elements of nitrogen, phosphorus and potassium, respectively. The chemical fertilizer requirements would, then, be 250 kg/ha of urea, 100 kg/ha of T.S.P and 60 kg/ha of KCl, respectively.

As for the fertilization of urea, split-application method is recommended to control the growing conditions favourably at each growing stage. T.S.P. and KCl would be applied at one time as the basic fertilization when soil preparation is practiced. Suitable dosage and application time at each growing stage are given in Fig. VI-12.

Plant Protection

As for the plant protection, intensive application of insecticides would be required for control of plant hoppers, stem borers, etc. Considering the life-cycle of these insects, 3 to 4 lit/ha of insecticides would be required for 3 to 4 times application during one cropping (see Fig. VI-12).

The damage of the plant caused by diseases is not serious as compared with that due to the insects, since most of the farmers are using the local varieties which have a tolerance to the diseases. When the high-yielding varieties are introduced, however, it would be necessary to apply about 2 lit/ha of fungicides to control the diseases for each crop season (see Fig. VI-12).

In selecting suitable insecticides and fungicides, chemical toxicity which directly or indirectly affects the human being should be taken into consideration. In this context, carbamate and organophosphate, i.e. Diazinon, Sumithion, Sevine, Dimecron, etc. are recommended as the insecticides and antibiotic chemicals, i.e. Kasumin, Kasurabcide, etc. and Hinosan as the fungicides.

In order to operate the proposed plant protection works, it is strongly recommended to organize the systematic plant protection program through the farmers' cooperative or association. Individual protection is not recommended, which some time results in serious damage to the crop caused by strong reaction attributable to unsystematic plant protection.

Weeding

The weed control is one of essential farming practices in paddy rice cultivation. At present, many chemicals so-called harbicides have been developed for this purpose, and their efficiency are highly accepted particularly for saving the labour requirements. However, these chemicals are still harmful for not only human beings but also natural environments.

The proposed practice for weeding, therefore, would be to introduce the rotary weeder, being widely used in Java, which also saves the labour requirements. Taking into account the plant-physiological characteristics of weeds seen in the project area, three-time weeding especially at the vegetative stage of paddy is recommended. The rotary weeding would also contribute to a good growth of paddy rice through effective soil conservation by rotor ploughing.

Harvest

It is recommended that the present Ani-ani system be changed to the new harvesting system by cutting all straws using sickles.

Ani-ani method is traditionally accepted as the most suitable method for harvesting local varieties of paddy rice with specific characteristics such as high lodging and shattering, long growing period and uneven maturation of panicles, tall plant height, etc. However, this traditional method will not be suitable for the high-yielding varieties from the following two main points:

(1) High labour requirement will be needed for the ani-ani method, because the harvest should be carried out within a short period, since most of panicles of high-yielding varieties are matured within such a short period.

(2) Large labour force will also be required mainly for threshing of stalk paddy harvested by the ani-ani method because of low shattering of the improved high-yielding varieties.

In order to save the labour force as much as possible for harvest and threshing of paddy, the improved harvesting method using the sickles is proposed in the project area. According to the data available from the BIMAS Program in Kalimantan, the labour requirements are estimated at about 68 man-day/ha for the ani-ani method, while 30 man-day/ha for the proposed method.

Threshing

Mechanical threshing is preferable for the improved varieties of paddy rice instead of traditional hand threshing. In this view, it is proposed to use the treadle thresher being propagated in Java, which is obtainable in the markets in Indonesia, at the initial stage of the development.

Engine-driven thresher would be introduced in the future, when the reserves per household are increased sufficiently for keeping modern farm machines and equipment.

The farm inputs, labour requirements and farm equipment required for a typical farmer with 1 ha-land holding are summarized in Table VI-27.

VI.8.5 Anticipated Crop Yield

The researches and trials on crop cultivation in the Barito river basin are being carried out by the Branch of the Central Research Institute for Agricultural in Banjarmasin from 1961 up to the present. However, the results are still not enough to confirm the feasibility of the Project.

According to the crop experiments in East Java, the alluvial soils, which are similar to those in the project area except for soil acidities, show a good response to the crop production with an advance of sufficient irrigation and drainage control and proper fertilization as shown in Table VI-28. The highest yield recorded was about 6 tons/ha of dry paddy (equivalent to 7.5 tons/ha of dry stalk paddy) with economically reasonable amount of fertilizers of 200 to 250 kg/ha of urea combined with 50 kg/ha of T.S.P. It will be a paddy productivity of these alluvial soils.

In the Brantas river basin where the paddy field is served by sufficient irrigation water throughout the crop season, approximately 4.7 tons/ha of dry paddy on an average are harvested under the BIMAS Program.

In the project area, technical demonstration of paddy cultivation using high-yielding varirties of IR-26, IR-32 and IR-36 was made at nine locations (40 ha in total) by the leading farmers under the direct guidance of the rural extension offices in 1977, as shown in Table VI-29. In this demonstration program, paddy was grown under the rain-fed condition with four times plant protection but without any fertilization. According to the production records of this program, average unit yield of each variety is estimated at about 4 tons/ha in dry paddy.

In the area served by the Intangan and Kahakan Irrigation Projects in Kabupaten Hulu Sungai Tengah, average unit yield of high-yielding varieties was 4.7 tons/ha in technical irrigation area under the BIMAS Program (see Table VI-29).

From the above figures, it is conservatively estimated that target yields would be 4.0 tons/ha and 4.5 tons/ha for the rainy and the dry season paddy, respectively, using high-yielding varieties. These target yields will be used for estimating the anticipated project benefits.

VI.8.6 Build-up Period of Target Yield of Crop

In order to attain the proposed target yields at a possible earlier stage, it is essential to improve and strengthen the present agricultural supporting services including further expansion of the BIMAS/INMAS Programs. These efforts would have to be made within the Pelita III (The Third National Development Plan) which will last from 1979 to 1984, in keeping pace with the project implementation.

Under the Plan, particularly, the increase in number of the field extension workers (PPL) would be indispensable. It is desirable that one PPL will serve 500 ha of net paddy field. This means that 66 persons of PPL will be required for covering 33,000 ha of net paddy field in the project area. On the other hand, 16 PPL are actually working in the project area at present. Therefore, 50 persons of PPL are required to be additionally stationed in the project area with an annual increase of 10 persons during the period of the Pelita III.

With the above background, in estimating the build-up period of target yields of paddy, the following three conditions are taken into consideration.

(1) Level-up of farmers' cultivation technics

Most of the farmers in the project area are not yet familiar with new farming practices such as proper soil-crop fertilization, plant protection, water management, etc. Under these conditions, it would take long time to train them in this fields sufficiently for managing the profitable irrigation farming. Considering further effort for the training of the farmers in these fields to be made under the Plan, it is anticipated that the purpose of such training would be attained in the 7th year after commencement of the extension program.

(2) Level-up of operation technics of on-farm facilities

Proper operation of the irrigation and drainage facilities would be one of the most important matter in the project operation. Particularly, proper distribution of the irrigation water at on-farm level would largely contribute to the attaining the project target in success. Operation of on-farm irrigation and drainage facilities would be first experiences for most of farmers in the project area. The technical guidance services would be carried out by the project office, but it is anticipated that five years would be required to acquire the full knowledge of operation technics by farmers themselves after commencement of technical guidance.

(3) Stabilization of soil and land conditions

According to the information through the interviews with farmers, the stabilization of newly reclaimed soils and lands would take approximately three years. It is estimated that the land conditions for crop production of new paddy field to be reclaimed from the present rubber plantations and shrub land would be stabilized in the 3rd year after commencement of the paddy cultivation.

The results of the discussion on the above three conditions are shown in Table VI-30 and illustrated in Fig. VI-13. As seen in this figure, the build-up period to attain the target of crop production would be 7 years after commencement of project operation.

Table VI-31 shows the estimated progress of increase to the target yield within the build-up period based on the results of the above discussion. Based on this estimated progress and increase of irrigated land, anticipated crop production in each year during the built-up period is estimated as presented in the following section.

VI.8.7 Anticipated Crop Production

The yield and production of paddy rice in the project area would increase year by year with the proper irrigation and drainage improvement as well as further development of the agricultural supporting services under both the Project and the Pelita III.

Based on the projected progress of increase of crop yield studied in the above, the anticipated annual crop production and increment in each sub-area are estimated in Table VI-32. The annual production at the full development stage would be about 238,700 tons of dry paddy, and the increment would be about 179,000 tons.

VI.9 MARKETING AND PRICE PROSPECTS

VI.9.1 Marketing Prospect of Paddy

As seen in Fig. VI-14, the demand and supply of rice in Indonesia are still not balanced mainly due to the increase in population together with the increase in rice consumption per capita induced by level-up of the living standard, and it is reported that annual import of rice reached about 1.3 million tons in 1976.

The production and consumption of rice in the whole Kalimantan in recent six years are shown in Table VI-33, and the table shows that production and consumption of rice are balanced with surplus only in South Kalimantan. Table VI-34 also shows the production and consumption of rice in South Kalimantan. Most of surplus rice is exported to other provinces in Kalimantan.

The study on future prospect of demand-supply condition of paddy in Kalimantan is made and illustrated in Fig. VI-15. Assuming that the annual growth rate of population is 2.65% (data from the statistic office) and that the rice consumption is 150 kg per capita, and that the annual growth rate of paddy production is 5%, the estimated paddy production would not catch up with the forecasted demand.

With the completion of the Project, about 120,000 tons of rice would be marketed in the project area, most of which would be exported to other provinces in Kalimantan which have a shortage of rice.

VI.10 PROPOSED AGRICULTURAL SUPPORTING SERVICES

VI.10.1 General

In order to attain the expected crop production through the introduction of double cropping a year with irrigation and drainage improvement, it is essential to provide more intensive agricultural supporting services, in addition to proper operation and maintenance of the project facilities.

For this purpose, further improvement of the present supporting services would be required, particularly for extension services, agricultural cooperatives, credit and research works. In addition, it is recommended to establish the farmer's association for proper farm management under the guidance of the government agencies concerned.

VI.10.2 Extension Services

As mentioned in the proceding Chapter VI.7.1, the service area of one PPL (field extension worker) at present ranges widely from 1,000 ha to 14,000 ha. Under these conditions, it would be difficult to expect higher efficiency in his service, especially after the completion of the Project. In this view, it is recommended to increase the number of PPL in order that one PPL would serve about 500 ha of land in which about 500 farmers would be included. PPL would guide and transfer the improved irrigation farming technics to 20 contact farmers selected among 500 farmers, and a contact farmer would transfer new farming technics to his 25 member farmers. If this density of one PPL/500 ha is applied to the initial stage development area, total number of PPL required is estimated at 66 persons. On the other hand, 16 PPL are now working in the project area. Therefore, actual increase in number is 50 persons. It is proposed that additional 50 PPL would be stationed during the next Pelita III. In addition, training of PPL should be strengthened by providing further training facilities and programs.

Further improvement would also be required for equipment and instruments necessary for PPL's activities such as vehicles, soil testing apparatus, visual aids, etc.

Moreover, it is proposed to organize a special section in the rural extension centers for systematic observation of pests and diseases, possible early inspection of outbreak of crop damage due to pests and diseases and for preparation of its protection program.

VI.10.3 Research and Pilot Demonstration Scheme

The present agricultural research works being conducted by the Central Research Institute for Agriculture, Kalimantan are mainly concentrated on the tests of local varieties of paddy rice. The present farming and crop-soil-water management by the farmers are not improved yet for further increase of agricultural production. In order to realize the proposed agricultural development, improvement of the present agricultural conditions should be started as early as possible. Under these conditions, it is recommended to organize a Pilot Demonstration Scheme in the project area.

The main activities of the Scheme would be: (1) tertiary and quarternary development with the construction of the irrigation and drainage facilities as well as road network, as one of the typical model for the future development, (2) organization of the systematic water and farm management as well as the farmer's association, (3) crop demonstration including training and guidance, (4) seed multiplication for smooth distribution of improved seeds, and (5) agronomic and irrigation engineering field experiments.

VI.10.4 Agricultural Cooperatives and Credit

In connection with the project implementation, further effort will have to be made for improvement of the present activities of the agricultural cooperatives.

As stated before, the number of BUUD/KUD now in operation in the project area is still not sufficient. The increase in number of this cooperative is recommended especially for Desa which have no BUUD/KUD unit at present. It is proposed at the same time to train the staff for more smooth management of this cooperative.

The present activities of BRI are also limited mainly because of insufficient number of this cooperative in the project area. With the completion of the Project, all lands in the project area would be turned into technical irrigation area which would be the basis for introducing the BIMAS Package Program. The expansion of the area under the BIMAS Program will play an important role in increasing crop production with the Project. In this view, further effort would be required for the increase in number of BRI and

the expansion of the BIMAS Program. In addition, it is expected that the present low repayment of the credit by the BIMAS farmers would be improved by the increase of crop production under the Project.

VI.10.5 Farmer's Association

Practically no farmer's associations exist in the project area at present. With the completion of the Project, however, the association organized by farmers themselves should be established for proper water management at farm level as well as cooperative works by farmers for such systematic plant protection, etc. The main activities of the association would be (1) operation and maintenance of the irrigation and drainage network below the tertiary turnouts, (2) cooperative works for early inspection and protection of pests and diseases, (3) extension of improved irrigation farming technics to each farmer, including exchange of improved irrigation farming technics to each farmer, including exchange of improved seeds, through the management of small-scale demonstration farms and (4) collection of water charge in the future.

Fig. VI-16 shows the proposed organization of the farmer's association. Generally, an association would be established in one Desa in which about 500 farmers would be involved. The association would have a committee which would consist of a chairman, a secretary, a treasury, a water distributer and about 20 contact farmers. They would be all elected from the member farmers of the association.

For the smooth and efficient operations of the project-wise program, all government agencies concerned and the farmer's associations would have to be well integrated into one workable network, particularly for proper irrigation water control.

Functions of Each Organization Structure

The farmer's association would be managed under the direct supervision and guidance of the Project office as well as the regional Agricultural office through the advisory committies to be organized at each administrative level, i.e. Kabupaten, Kecamatan and Desa (village). The functions to be envisaged in each structure unit would be as follows:

(1) Kabupaten Committee

The Kabupaten Committee is the advisory and/or supervisors group for operation and management of the farmer's association. Bupati would be the chairman of this committee and who would be responsible to manage the following:

- to solve the problems encountered and make the policy for irrigation and plant protection scheduling, collaborating with the project office and Kabupaten agricultural office, and

- to take care of cooperation between the Kecamatans and/or villages within the project area.

(2) Kecamatan Committee

Kecamatan Committee to be headed by Camat would be also the supervisor group. Camat will assist Bupati in supervision and would be responsible for the following:

- to coordinate with Bupati for supervision and to secure Bupati's policy to prevent it from any deviation,

- to activate the farmers for supporting agricultural development in any case of regular repair and maintenance of the tertiary and terminal project facilities and proper operation of the plant protection, and extension of modern rice farming, etc., and

- to support the relationship between the villages within the commanding area.

(3) Village Committee

Kepala Desa (village chief) would manage this committee and would have a duty to supervise and execute Bupati's policy on the implementation of proper water management at village level as well as the arrangement of systematic operation of plant protection, seed multiplication and seed distribution, etc.

With respect to the above activities, such organization as village cooperative (BUUD/KUD), Bank Rakyat Indonesia (BRI) and agricultural extension workers (PPL) would closely coordinate with the Village Committee so as to efficiently operate and manage the farmer's association. The village cooperative body which would have a function of assisting the management of farmer's association in economical aspects, together with the project office as technical advisor. The BRI act as a depository bank for credit to the farmers, and PPL would advice the crop rotation schedule for profitable farming under the irrigation schedule prepared by the project office. Systematic plant protection as well as extension of modern farming practices would be also provided by PPL through this operation and management programme on the organization.

(4) Farmer's Association

The Board of farmer's organization herein envisaged would consist of (i) Water Distributer and Gate-keepers, (ii) Secretary and Treasury and contact farmers in section.

The water distributer and gate-keepers section would have the following functions:

- to discuss and consult with the contact farmers for deciding annual water supply schedule,

- to assist the PPL in introducing the new irrigation farming technic and practices,

- to plan and execute the repair and maintenance schedule on the facilities within the commanding area in cooperation with the contact farmers and farmers,

- to cooperate with the O & M outpost of the project office for emergency repair of the facilities belonging to the O & M outpost,

- to inspect the use of irrigation water by the farmers, and

- to contact and record actual irrigated land to be reported by the contact farmers.

The Secretary and Treasury section would be responsible for the followings:

- to make financial administration, and

- to arrange O & M contribution from farmers through the contact farmers.

The Contact Farmers group would have the following functions:

- to register the farmers who will require water supply and to inform these aspect to the Distributers and Gate-keepers section,

- to make sure that all farmers in the area have been informed the days of water supply and/or plant protection schedule,

- to organize and supervise the members on irrigation practices making some corrections, if necessary,

- to closely cooperate with other section as well as PPL in organizing proper operation of plant protection, seed distribution, etc., and

- to arrange the operation and maintenance contribution from farmers to be delivered to the Treasure.