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UPENJA SUGAR PROJECT

ZANZIBAR

DETAILED SOIL SURVEY

By E.R. Jordens

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In opdracht van de H.V.A., Amsterdam, heeft de Stichting voor Bodemkartering een bodemkundig onderzoek uitgevoerd op Zanzibar. Het veldwerk is uitgevoerd in de periode mei-juli 1984. Daaraan werkten mee A.J. Krabbenborg en Ing. G. van der Veen van de Stiboka en Ir. E.R. Jordens van de vakgroep Bodemkunde en Geologie van de Landbouwhogeschool. Ir. E.R. Jordens, die teamleider was, stelde ook het rapport samen.

Het rapport van dit bodemkundig onderzoek is gepubliceerd als rapport nr. 1811 van de Stichting voor Bodemkartering. Het is ook als afzonderlijk deelrapport (volume IV) opgenomen in het eindrapport van de H.V.A. aan haar opdrachtgever, i.c. de regering van Zanzibar.

Dit eindrapport is getiteld Feasibility Study Upenja Sugar Project.

Soil Survey Institute
Wageningen
The Netherlands

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Wageningen
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SUMMARY

The Upenja-area belongs to the Bambi-Upenja corridor. This was originally a deep faulted zone and later on an ancestral shoestring sand deposited as channel or sandstone within the Rufiji River's Miocene delta. During a more recent submersion, tidal action has eroded the original sands and sandstones. The channel or valley has been refilled with marine sand, shells and shark's teeth and coral reefs. After the sealevel fell, the channel has been subsequently filled with colluvial erosion products, constituted of mainly clay and sand-size material from the Miocene, surrounding ridges.

Physiographically the survey area has been subdivided into a plain and a sloping upland area fringing into the plain. The whole area slopes to the east, where the majority of streams and drainage ways, entering the area in the west, disappear. A few scattered sinkholes are found in the southern part of the area, serving also as natural drainage outlets. In the south-eastern part, rock outcrops of coral limestone are found, while the thickness of the recent colluvial layer diminishes towards the east and south. At a few locations coral reef limestone was encountered within auger depth.

The textural composition of the colluvial material, clay with a relative high sand fraction, results in impermeable soils causing considerable flooding of the area during the rainy seasons, especially in the eastern part.

The land use of the area has been fairly well adapted to these conditions. The flat plain is mainly used for rainfed rice production. In the north an irrigated ricescheme is being implemented. In the middle of the plain sugarcane is grown in a artificially drained area. In the poorly drained areas, mainly the valley bottoms of the upland, rice is the major crop while the somewhat better drained ridges are used for foodcrops like cassave. Fruit trees and palmtrees are scattered around the upland area, mango and coconutpalm-trees are concentrated on the better drained ridge and summit areas.

The soils in the area are differentiated according to their drainage conditions and textural characteristics of topsoil and subsoil. According to the FAO/Unesco legend of the "Soil Map of the World" the soils are mainly Dystric Gleysols i.e. in general, soils with little profile development which show hydromorphic properties within 50 cm of the surface and have a low base saturation. The soils have little pedogenetic profile development as a result of the virtual absence of vertical water movement and

biological activity within the subsoil. This is expressed by weakly developed structures in the B-horizon.

In the flat plain, the majority of the soils are heavy, poorly drained clay soils with grey matrix colours and with distinct red and yellow mottling under the shallow, somewhat lighter topsoils. The lighter textures of the topsoils are attributed to cultivation practices and subsequent erosion of the finer clay particles through surface runoff induced by the impermeability of the subsoil. This phenomenon was observed all over the Upenja area and more outspoken on the ridges and summit areas of the upland. As a result of decreasing stream velocity, an accumulation of finer particles and organic matter has taken place in the lower areas in the east and south of the plain. It has resulted in soils with a uniform, heavy clay texture throughout.

The somewhat better drained areas in the plain consist of soils with a medium or sometimes coarse textured topsoil/subsoil underlain by the strongly mottled, heavy grey clay. The medium and coarse textures are a result of higher stream velocities at the time of deposition.

The area called upland is probably from Miocene origin with an irregular relief covered by coral limestone on which colluvium of varying thickness is deposited and which is in later stages more or less eroded, resulting in a gently undulating relief.

The upland soils are also subdivided according to their drainage properties, texture of topsoil and subsoil and topographical position. The valley bottoms consist of the poorly drained soils while the slopes are in general somewhat better drained. On the summit and shoulder areas, the better drained soils have a medium textured topsoil, while the poorly drained soils have a fine textured topsoil.

All the soils of the survey area are underlain by strongly mottled, heavy clay causing a perched watertable at shallow depth, irrespective of the topographical position of the soils. The soils show weak to moderate vertic properties (distinct cracking when drying) especially when the clay percentage of the topsoil is sufficiently high.

The results of the chemical analyses show that the soils in the Upenja area are chemically rather uniform. They have a low nutrient status. The organic matter content is moderate in most topsoils and low to very low in the subsoils while the same applies to the nitrogen percentage, resulting in satisfactory C/N ratios. The phosphate figures show very low levels except for a few profiles under sugarcane where the phosphate content is slightly higher in the topsoils. A marked potassium deficiency was determined in all analysed soils. No sodium hazard is

expected. Calcium shows a low level, but in some places moderate levels were encountered. Magnesium has moderate to high levels, due to the marine influence on the parent material. The relatively high magnesium levels will increase the calcium and particularly the potassium deficiency. According to electrical conductivity measurements in the field, there is no salinity hazard. The pH values are in the range of slightly to strongly acid and correspond with an average base saturation of around 50%. Although there are no clay mineralogical data available, it is expected that the clay minerals present are of the smectite and kaolinite type with a 1:1 ratio (CEC/100g clay of about 50 me).

The physical properties of the soils are mainly determined by the textural characteristics, a high content of clay-size particles with a relative high sand fraction while the fraction of silt-size particles is almost absent. The physical analyses executed show for the majority of soils a very low infiltration rate and a very low saturated hydraulic conductivity of only a few mm/day. The bulk density is moderate to high, while the moisture storage capacity between field capacity and wilting point is low. This results in a lack of oxygen during the rainy seasons, seriously hampering root development (except rice) and a shortage of available moisture for moderately deep and shallow rooting crops during the dry periods.

Artificial drainage and, possibly, irrigation will make the physical constraints less severe while proper fertilization might improve the low nutrient status of the soils.

The present suitability of the soils for moderate, rainfed cane production is based on their capacity to supply sufficient oxygen and moisture. The nutrient availability of the soils is not taken into consideration because of lack of differentiation. The effects of slope on the suitability of the soils for mechanized cultivation is not taken into consideration because the majority of slope percentages encountered are less than 6% and are not a severe constraint for mechanization.

The very poorly drained soils e.g. valley bottoms, drainage ways and low lying swampy areas are presently considered not suitable.

The poorly and imperfectly drained soils in either the plain or the upland area are considered marginally suitable in case they have a fine textured (clay) subsoil within about 20 cm of the surface, independently of the texture of the topsoil.

The imperfectly and poorly drained soils with a coarse to medium texture to a depth of about 60-70 cm are at present classified as moderately suitable.

The following is a breakdown of the areas (in ha and % of the total area) covered by the three soil suitability classes distinguished in the survey area:

Moderately Suitable	380 ha, or	16.6 % of the survey area
Marginally Suitable	2018 ha, or	67.0 % of the survey area
Not Suitable	546 ha, or	18.1 % of the survey area

Not surveyed, water, ponds and rocks	66 ha, or	2,3 % of the survey area
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Total	<hr/>	3010 ha
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1. ENVIRONMENT

1.1 GEOLOGY AND PHYSIOGRAPHY

The island of Zanzibar consist mainly of fluvial and (shallow) marine fine sand, silt and clay deposits of the Miocene Rufiji river delta. These sediments are believed to be upto 5000 m thick. They show the typical deltaic meandering river patterns with the coarser and finer deposits corresponding with different flow velocities of the original streams. In the context of the present physiography the original channels of coarser, sandy material are now considered as valleys or corridors. These corridors, separated by ridges, are described as the Bumbwi and the Bambi-Upenja corridors. The survey area is located in the latter.

Until the Pleistocene Zanzibar was an integral part of the deltaic system but due to uplifting and rift-faulting, Zanzibar was raised and cut off the mainland coast by subsequent stepwise raising of the sealevel which shaped the wavecut cliffs of which remnants are recognizable in the eastern part of the survey area. Tidal action eroded the looser, sandy material of the channels until the resistant clayey channel beds and banks were re-exposed. In Quaternary times, reef and coralline limestone growth in the channel areas and the wide coastal coral-rag platform east of the survey area commenced in a falling sea. In more recent times, after the channels were cut off from the sea, the channels or corridors were partially filled with colluvial material from the surrounding ridges, covering the reef systems, coral rubble and Miocene channel sediments.

The following is a characteristic geological section of the channels (after J. Johnson, Final Report-volume 6, FAO Project No. URT/73/024):

0-15 m	Red,brown soils and grey clays
15-30 m	Coralline and reef limestone
over	Sand and soft sandstone or uneroded remnants of the original deltaic sands
then	Bedrock (so-called) of blue,grey, green Miocene clay, shale or marls

The geological sequence for Zanzibar can be split up as follows:

- Q1 Quaternary soils, alluvials and colluvials
- Q2 Quaternary coralline limestone and "coral rag"
- Q3 Quaternary but reworked sands from the Miocene "shoestring sands" (sometimes indistinguishable from M2 sands)
- M1 Miocene limestone, including crystalline, sandy reef and detrital facies
- M2 Miocene sands and sandstone, both as uneroded and undisturbed channel deposits and interstratified sands and sandstones
- M3 Miocene clays, shales, marls, generally silty and sometimes sandy

The Miocene limestones are karstic but if the Quaternary limestones are karstic as well is not yet clear. However, especially in the eastern side of the survey area several sinkholes were encountered, serving as natural drainage outlets for streams entering the area in the west. These sinkholes are mainly located along a line running NNW-SSE, corresponding with a major fault zone on which the northern extension of the channel or Bambi-Upenja corridor is superimposed.

The valley profile is strongly asymmetric, accentuated by the sloping surface from west to east, with the deeper colluvial layers (Q1 material) in the north-west of the survey area. At a few locations coral limestone (presumably Q2 material) was encountered within 1-2 metres which might also be a result of the strongly irregular surface of the Quaternary coralline reef growth.

Physiographically the area is subdivided into the plains, a relative flat area, with dominant slopes between 0-2 % and an upland area with slopes up to 6 %, fringing into the valley, or corridor. This subdivision is the first level of the legend used to describe the soils of the area (see Soil map). The relief of the upland area is more pronounced, possibly due to the relief of the Q2 and M2 sediments underlaying the colluvial layer (Q1). The survey area as a whole is sloping to the east with a watershed at the narrowest part of the Upenja valley. The streams and drainage ways, that enter the area in the west, are diverted by the watershed in a NNE and SSE direction after which they disappear into karstic sinkholes.

1.2 PRESENT LAND-USE

The present land-use in the survey area is generally well adapted to the natural conditions, especially soil drainage. This results in differences in present land-use between the flat or almost flat part of the area and the undulating part, the latter being slightly better drained.

The flat or almost flat part of the survey area is mainly used for the cultivation of rainfed rice. In the northern part an irrigated rice scheme is being implemented and sugarcane is grown in an artificially drained area near Upenja village. Mango trees are found planted along roads and scarcely scattered over the area. In the eastern part of the valley, near the edge of the Miocene ridge, Borassus palms are also present. Small trees and shrubs are bordering the major streams.

In the undulating part of the survey area the land-use is somewhat different. The valley bottoms are used for rainfed rice, while on the higher and better drained areas with somewhat lighter topsoils, foodcrops like cassave are grown. The density of mango-trees and Borassus palms is substantially higher than in the flat part of the area. Concentrations of Coconut trees are confined to the somewhat better drained and lighter profiles. Bananas are found near the homesteads, especially in the western part, where the density of trees and palms also increases.

2. METHODS

2.1 FIELD METHODS

Basic material available for the survey were among others panchromatic aerial photographs on a 1:20.000 scale, taken in 1978, and a 1:10:000 base map, showing the essential topographical information such as roads, streams, villages and contours with 5 m vertical interval. The aerial photographs were enlarged to 1:10.000 scale on which a systematic photointerpretation of the area was executed. The survey area was subdivided physiographically into "plains" and "upland" (see chapter 3) for which different survey methods were used.

In the plains, field checks by augering were executed according a regular grid pattern mainly because of the flat relief. In the upland, the field checks by augering were located on the basis of the aerial photo interpretation. About 90% of the augerings were done to a depth of 120 cm and 10% to a depth of 300 cm. The total of about 750 augerings were described according to FAO guidelines (FAO, 1977, Guidelines for soil profile description, second edition). The average density of augerings is 1 per 4 ha.

Soil pits to a depth of 150 cm were dug at well chosen locations based on the information gathered from the augerings and the aerial photo interpretation. 45 soil pits were described according to FAO guidelines. A selection of 25 detailed profile descriptions is included in annex 1 of this report. Samples for chemical and physical analyses were taken from the individual soil horizons of 10 soil pits. For a substantial number of horizons measurements of the pH and the electrical conductivity were executed during fieldwork. The results of these measurements are included in the relevant profile descriptions (annex 1). pH and electrical conductivity were measured in 1:2.5 soil:demineralised water mixtures.

From a few profile horizons large core samples were taken in order to estimate the saturated hydraulic conductivity. The results of these experiments indicated that the permeability of the soils was virtually zero; due to the compactness of the soils no measurements could be done.

2.2 LABORATORY METHODS

Chemical and physical analyses were executed by the Soils Laboratory of the Tanzania Ministry of Agriculture, National Soil Service, Mlingano, Tanga. The following methods were used:

Mechanical analyses:	Sieving and pipette method
pH:	1:2.5 soil:water and 1:2.5 soil:CaCl ₂
Carbon:	Walkley-Black wet oxidation method
Nitrogen:	Kjeldahl method
Phosphorus:	Bray and Kurtz II
Cation exchange cap.+ exchangeable cations:	Extraction with ammonium acetate

Physical analyses were executed by the laboratory of the Netherlands Soil Survey Institute, Wageningen, The Netherlands. The following physical soil characteristics were determined on undisturbed core samples:

Saturated hydraulic conductivity
Moisture content at pF values 1.0, 1.5, 1.8, 2.0, 2.3,
2.7, 3.4 and 4.2

The results of the various chemical and physical analyses are presented in annex 2 of this report.

3. SOILS

3.1 GENERAL DESCRIPTION

The soils of the survey area belong geologically to the Quaternary (Q1) sediments, e.g. colluvial material consisting of weathered products from the Miocene ridges surrounding the valley or corridor. The colluvial material consists of clay with a relatively high sand and low silt content. The rather homogeneous composition of the material is the result of the uniformity of the geological formation the material is derived from and the short distances the material was transported by colluvial processes. The basin-like structure of the valley, with its sinkholes serving as natural drainage outlets, might also have been of influence. The minor differences in sand fraction and sand content of the parent material as observed in the field, do not have enough significant agronomic implications to justify a differentiation of the soils at this level.

The textural composition of the colluvial material, clay with a relative high sand and a low silt content, together with the topographical position of the area, results in soils with a distinct perched watertable. During rainy seasons they are waterlogged. Especially in the lower eastern side, the area is flooded some time for several metres after periods of heavy rainfall. In the upland area the drainage condition is to a great extent determined by the topographical position in the landscape and slope of the soils. Because of the important implications for agricultural practices, the drainage condition of the soils is used as second entry in the legend applied for this survey (see Soil map). For this purpose the soils are subdivided into the following drainage classes: very poorly (class 0), poorly (class 1) and imperfectly (class 2) drained soils.

The third entry of the legend covers the textural differences in the soil profiles. For each mapping unit the texture of topsoil and subsoil is described according to FAO guidelines (see Soil map). Topsoil descriptions usually refer to the top 20-30 cm of the soil while the subsoil descriptions cover the deeper soil horizons. Changes in subsoil texture often occur at a depth of 60-70 cm, at which depth practically always a heavy, impermeable clay of colluvial origin is encountered.

Table 1 shows a schematic breakdown of the soil map legend using the three levels of entry. For this purpose the usual textural classes are grouped into coarse (C), medium (M) and fine (F) textured (see FAO/Unesco legend of the "Soil Map of the World"). In the last column the classification of the soils according to the FAO/Unesco legend of the "Soil Map of the World" is indicated.

Table 1. Schematic breakdown of the soil map legend.

I. PLAINS, slopes 0-2%

Dominant slope class 1 (0-2%)

Mapping unit	Drainage class	Topsoil textural class	Subsoil textural class	FAO/Unesco classification
Pvp1	0	M	M	Dystric Gleysol
Pvp2	0	M	F	Dystric Gleysol
Pvp3	0	F	F	Dystric Gleysol Gleyic Cambisol
Pp1	1	C	F	Dystric Gleysol
Pp2	1	C	M	Dystric Gleysol
Pp3	1	M	M	Dystric Gleysol Gleyic Cambisol
Pp4	1	M	F	Dystric Gleysol Humic Gleysol
Pp5	1	F	F	Dystric Gleysol Humic Gleysol Gleyic Cambisol
Pi1	2	C	M	Dystric Gleysol Gleyic Cambisol
Pi2	2	M	M	Dystric Gleysol Gleyic Cambisol Dystric Fluvisol
Pi3	1-2	M	F	Dystric Gleysol Gleyic Cambisol

II. UPLAND, slopes 0-6%

Valley bottoms, dominant slope class 1 (0-2%)

Uvp1	0	C	M	Dystric Gleysol
Uvp2	0	M	M	Dystric Gleysol
Uvp3	0	M	F	Dystric Gleysol
Uvp4	0	F	F	Dystric Gleysol

Sloping land, dominant slope class 2 (2-6%)

Up1	1	C	F	Dystric Gleysol
Up2	1-2	C	M	Dystric Gleysol
Up3	1	M	F	Dystric Gleysol Humic Gleysol Gleyic Cambisol
Up4	1	F	F	Dystric Gleysol Gleyic Cambisol

Flat interfluvies and hilltops, dominant slope class 1 (0-2%)

Ui1	2	C	F	Dystric Gleysol Humic Gleysol
Ui2	2	C	M	Dystric Gleysol Gleyic Cambisol
Ui3	2	M	M	Dystric Gleysol Humic Gleysol
Ui4	1-2	M	F	Dystric Gleysol Humic Gleysol

Remark: The following soil phases are recognized and referred to by the additional symbols to the mapping units:

- l Levelled
- q Massive subsoil structure
- r Coral limestone encountered within augerdepth

The lighter topsoils on the topographically higher areas and slopes are the result of a sorting process in which the finer clay particles are dispersed and laterally transported. This erosional process is induced by the impermeability of the subsoil. In the topographically lower areas and in the plains, sorting of material takes place due to different flow velocities of the water streams. This sorting is encountered along the drainage ways and results in stratified sandy profiles which may have thick topsoils of accumulated clay and humic material (thick black A-horizon). This accumulation is also found in the lower areas and near the sinkholes. However, the areas covered are often too small to be distinguished separately on the soil map.

The specific textural composition of the soils of the Upenja area results in a very low saturated hydraulic conductivity. This leads to a negligible vertical water movement and a low biological activity in the profile resulting in a very limited pedogenetic profile development. The structure development of the B-horizon is in general weak (cambic B-horizon). However, if the sand content of the clay soils is relatively low, the soils show weak to moderate vertic properties, e.g. pressure faces or slickensides and distinct cracking when drying (see also chapter 3.3).

According to the FAO/Unesco legend of the "Soil Map of the world" the majority of the soils are classified as Dystric Gleysols, i.e. soils with little profile development which show distinct hydromorphic properties within 50 cm of the surface and have a low base saturation. In the case of a substantial accumulation of organic material in the topsoil (Umbric A horizon) the soils are classified as Humic Gleysols. In the case of somewhat better drainage conditions the hydromorphic properties start between 50 and 100 cm of the surface. In this case the soils are classified either as Gleyic Cambisols or Humic Cambisols. A small number of Fluvisols, soils lacking a Cambic B horizon and stratified as a result of alluvial processes, were encountered.

3.2 DESCRIPTION OF THE SOIL MAPPING UNITS

3.2.1 SOILS OF THE PLAINS

Pvp Very poorly drained soils

Soil mapping unit	Area in ha	Profile description (annex 1)
-----	-----	-----
Pvp1	39	1
Pvp2	71	2
lPvp2	2	-
Pvp3	160	4
lPvp3	8	3

These soils are found in the low laying areas of the plains and include the drainage ways and the areas bordering the drainage ways. The range in general profile characteristics is:

Topsoil

Colour: black to dark yellowish brown
Texture: sandy clay loam to clay
Structure: fine crumb to fine angular blocky
Consistence: (slightly) plastic ; sticky; (very) friable
Biological activity: moderate to abundant

Subsoil

Colour: dark grey to grey
Texture: sandy clay loam to clay
Structure: weak fine angular blocky
Consistence: plastic; sticky; friable to firm
Mottles: common to many prominent red mottles
Biological activity: moderate
Special features: weakly developed pressure skins

Over

Colour: grey to light grey
Texture: clay
Structure: weak to moderate angular blocky
Consistence: very plastic; very sticky; firm to very firm
Mottling: many to common red and yellow mottles
Biological activity: weak
Special features: moderate slickensides

Remark: The transition between the topsoil and subsoil is usually clear as a result of cultivation practices while the other boundaries are gradual unless it concerns outspoken stratified profiles near a gully or drainageway. In the latter case the texture and other characteristics of the subsoil horizons differ from the general description.

Pp Poorly drained soils.

Soil mapping unit	Area in ha	Profile description (annex 1)
-----	-----	-----
Pp1	4	-
Pp2	36	-
Pp3	43	-
Pp4	285	5,6
lPp4	4	-
rPp4	1	-
qPp4	6	-
lqPp4	3	-
Pp5	870	7,8,9
lPp5	277	10,11
rPp5	104	-

These soils are located at a relative higher topographical position than the very poorly drained soils (Pvp). Their drainage condition is usually slightly better, especially in the levelled area where artificial drainage is used. The coarser topsoils, if immediately underlain by heavy clay, are the result of recent alluvial sedimentation processes. The medium and fine textured top and subsoils are thought to be the result of textural differences of the colluvial parent material. The range in general profile characteristics is:

Topsoil

Colour: very dark grey to black

Texture: loamy sand to clay

Structure: granular (sandy textures); fine crumb to fine angular blocky

Consistence: (slightly) plastic; (slightly) sticky; loose to (very) friable

Biological activity: moderate to abundant

Subsoil

Colour: dark yellowish brown to dark grey

Texture: sandy clay loam to clay

Structure: weak to moderate angular blocky

Consistence: plastic; sticky; friable to firm

Mottling: common to many prominent red or yellow and red mottles

Biological activity: abundant to moderate

Special features: in clay subsoils moderate slickensides

Over

Colour: dark yellowish brown to grey

Texture: clay

Structure: moderate to weak angular blocky

Consistence: plastic; very sticky; firm to very firm

Mottling: many prominent red mottles

Biological activity: weak

Special features: as above

Remark: The transition between the topsoil and subsoil is abrupt in case the soils are located in levelled areas.

Pi Imperfectly to poorly drained soils

Soil mapping unit	Area in ha	Profile description (annex 1)
-----	----	-----
Pi1	25	-
lPi1	3	-
Pi2	58	12,13,14
lPi2	32	-
Pi3	25	-
lPi3	1	-

These soils of the plains that belong to unit Pi are better drained, either due to their topographical position or to the slightly better permeability as a result of the lighter texture. The range of general profile characteristics is:

Topsoil

Colour: very dark grey
Texture: loamy sand to sandy clay loam
Structure: granular to fine crumb
Consistence: non plastic to slightly plastic; slightly sticky to sticky; loose to very friable
Biological activity: abundant

Subsoil

Colour: dark yellowish brown to brown
Texture: sandy loam to sandy clay
Structure: weak fine angular blocky
Consistence: (slightly)plastic; slightly sticky to sticky; friable
Mottling: few to common strong brown to red mottles
Biological activity: abundant to moderate

Over

Colour: dark yellowish brown to grey
Texture: sandy clay to clay
Structure: weak to moderate angular blocky
Consistence: slightly plastic to plastic; sticky; friable to firm
Mottling: common to many prominent red and yellow mottles
Biological activity: moderate to weak
Special features: profiles with clay textures show weak to moderate slickensides

Remark: Outspoken stratified profiles differ from this general description. The transition between top and subsoil is abrupt in case of levelling.

3.2.2 SOILS OF THE UPLAND

Uvp Very poorly drained valley bottoms, dominant slopes
ranqing from 0 - 2 %

Soil mapping unit	Area in ha	Profile description (annex 1)
-----	----	-----
Uvp1	25	-
Uvp2	25	-
Uvp3	134	15,16
Uvp4	84	-

These soils are located in the valleys and drainage ways of the upland. The lighter top and subsoil textures of this mapping unit are to a great extent the result of the more recent erosional and subsequent alluvial processes in which sedimentation of material of different particle size takes place according to the flow velocity of the water running off higher located areas. They are always underlain by the typical heavy, grey, from origin colluvial clay. The drainage class of the soils of these mapping units is class 0, very poorly drained, due to their topographical position and rather impermeable deeper subsoil. The range of general profile characteristics:

Topsoil

Colour: very dark grey

Texture: sandy clay loam to clay

Structure: weak, fine crumb

Consistence: sligthly plastic; sticky; very friable to friable

Biological activity: common to abundant

Subsoil

Colour: dark grey

Texture: sandy clay loam to clay

Structure: weak fine subangular and angular blocky

Consistence: plastic; sticky; friable

Mottling: many prominent red mottles

Biological activity: common

Over

Colour: grey

Texture: sandy clay to clay

Structure: weak angular blocky

Consistence: plastic; sticky to very sticky; friable to firm

Mottling: many prominent red mottles

Biological activity: weak

Remark: In case of stratified profiles the transition between horizons is abrupt.

Up Poorly to imperfectly drained sloping land, dominant slopes ranging from 2 - 6 %

Soil mapping unit	Area in ha	Profile description (annex 1)
Up1	50	-
Up2	75	-
Up3	287	17,18,19
1Up3	2	-
Up4	20	-

These soils are mainly located on the sloping areas of the upland and due to their topographic position somewhat are better drained than the soils of the Uvp mapping units. The textural differentiation of in particular the topsoils is a result of the sorting of the material, in first instances by lateral movement of the finer particles. The range of general profile characteristics:

Topsoil

Colour: black to dark grey
Texture: sandy loam to clay
Structure: weak fine crumb
Consistence: slightly plastic; slightly sticky; very friable to friable
Biological activity: common

Subsoil

Colour: dark yellowish brown to dark grey
Texture: sandy clay loam to clay
Structure: weak fine angular blocky
Consistence: slightly plastic to plastic; sticky; friable
Mottles: common to many prominent red mottles
Biological activity: common

Over

Colour: dark grey to grey
Texture: clay
Structure: weak to moderate angular blocky
Consistence: plastic; very sticky; friable to firm
Mottles: many prominent red mottles
Special features: moderate developed slickensides

Ui Imperfectly to poorly drained flat interfluves and hilltops,
dominant slopes ranging from 0 - 2 %

Soil mapping unit	Area in ha	Profile description (annex 1)
-----	----	-----
Ui1	15	20,21
Ui2	93	22,23
Ui3	15	24
Ui4	64	25

These soils are located at the topographical higher areas and are generally the better, however imperfectly, drained soils of the upland. The flat interfluves are often, due to their waterlogged character poorly drained. The textural differentiation of in particular the topsoil is a result of the sorting processes described for the sloping areas. The range of general profile characteristics is:

Topsoil

Colour: very dark greyish brown to black
Texture: loamy sand to sandy clay
Structure: weak fine crumb
Consistence: non plastic to slightly plastic; slightly sticky to sticky; loose to very friable
Biological activity: abundant to common

Subsoil

Colour: yellowish brown to dark grey
Texture: sandy clay loam to clay
Structure: weak fine angular blocky
Consistence: plastic; sticky; friable to firm
Mottling: common to many strong brown to red mottles
Biological activity: common

Over

Colour: dark grey to grey
Texture: sandy clay to clay
Structure: weak to moderate fine angular blocky
Consistence: plastic; sticky to very sticky; firm
Mottling: many prominent red mottles
Biological activity: weak
Special features: weak to moderate developed slickensides

3.3 SOIL CHEMICAL AND PHYSICAL CHARACTERISTICS

The results of the chemical and physical analyses are presented in annex 2. These data show that the soils of the Upenja area are chemically rather uniform which corresponds with the parent material they are derived from, but have a low nutrient status.

The organic matter content of the topsoils is low to very low. The highest organic matter levels are found in the levelled and artificially drained areas, presently under sugarcane, as a result of the application of filter mud from the sugarcane factory and in the lower areas where an accumulation of organic matter has taken place. The nitrogen percentages are of the same magnitude resulting in satisfactory C/N ratios. The phosphate figures show very low levels except for a few profiles under sugarcane where the phosphate content, due to fertilization, is slightly higher.

The exchangeable potassium figures do show a marked potassium deficiency in all analyzed soils while no sodium hazard is expected. The higher sodium figure of the Bwg2 horizon of profile description 15 (field no. 4) is possibly due to analytical errors.

Calcium shows a low level, but in the places under sugar cane moderate levels were encountered together with slightly higher pH values as a result of fertilization practices. Magnesium has moderate to high levels, due to the marine influence on the parent material. However, the relatively high magnesium levels will increase the calcium and particularly the potassium deficiency.

The electrical conductivity measurements of which the results are mentioned in the profile description, see annex 1, indicate that there is no salinity hazard.

The pH values are in the range of slightly to strongly acid and correspond with a base saturation % of 50 and less, except for the Ap horizon of profile description 7 (field no. 6) of which either the pH value or the CEC value is too low, possibly as a result of analytical errors. The strongly acid soils, especially the subsoils, are of a level that toxic concentrations of aluminium might be expected for Al sensitive crops.

The cation exchange capacity (CEC) figures are moderate to high and in concurrence with the clay and organic matter content. An exception has to be made for the CEC figure of the Bw horizon of profile description 23 (field no. 14) which CEC figure is far too low, in view of the uniformity of this profile. Although there are no clay mineralogical data available, it is expected that the clay minerals present are of the smectite and kaolinite type with about a 1:1 ratio (CEC/100 g clay of about 50 me).

The physical properties of the soils are mainly determined by the textural characteristics, in general a high content of clay-size particles with a relative high sand fraction while the fraction of silt-size particles is almost absent. The physical analyses (see annex 2) executed show a low to very low saturated hydraulic conductivity and infiltration in concurrence with the texture classes of the samples.

The results of a substantial number of the physical analyses executed on the 100 ml core samples are only indicative and do not represent the actual situation in the field. The samples with a high clay content (c, sc and scl textures) did swell in the range of 5-10 % of the volume out of the core during the permeability measurements and pretreatment for the pF measurements despite the fact that the samples were taken during the rainy season. This is to be expected with a smectite type of clay. Therefore the total pore space values are overestimated while the bulk density figures of those particular samples are too low and the actual permeability will be lower than the results are indicating. As a consequence of the above, the moisture retaining capacity between pF 2.3 and 4.2 of the majority of soils is low to very low, about 10 % measured of which 3-5 % is attributed to swelling of the sample. The organic matter containing topsoils with a relatively low clay content do have a moderate to good moisture retaining capacity. However, the total amount of moisture available to the plant is not only determined by topsoil alone but also by subsoil characteristics, while the rooting depth has to be taken into account as well.

The capacity of the majority of the soils analysed to supply sufficient oxygen to the roots, as indicated by the difference between total pore space and moisture content at field capacity, is extremely low which hampers normal root development seriously, except for rice.

4. SOIL SUITABILITY FOR RAINFED SUGARCANE

This chapter deals with an estimation of the present suitability of the soils of the survey area for rainfed cane production. It is emphasized that due to the typical soil characteristics discussed in earlier chapters, the constraints are such that an optimal production (about 80 tons/ha) is not to be expected without major and costly improvements. Therefore, the soils are classified according to their present suitability for moderate rainfed cane production without major improvements such as artificial drainage and irrigation. It is assumed that cane cultivation is mechanized. As far as the relevant soil characteristics are concerned, in particular the slope, there are no severe limitations to be expected in the plains and the upland with maximum slopes of about 6%. However, the upland, with its undulating relief and consequently more risks of soil erosion, will be less suitable for mechanized agriculture than the flat or almost flat plains.

The nutrient availability of the soils is not taken into account as a differentiating criteria for the soil suitability for sugarcane because of the rather uniform, but generally low nutrient status of the soils concerned.

The criteria used to classify the suitability of the soils for sugarcane are limited to their capacity to supply sufficient oxygen and moisture during the growing season of the cane with reference to the related climatological criteria. The general suitability of the climate for rainfed cane production will be dealt with in the main report.

The availability of moisture during the dry periods is among others determined by the moisture storage capacity of the soil between field capacity (pF 2.3) and wilting (pF 4.2) and the rooting depth, while the oxygen supply is mainly determined by the pore space and the moisture percentage below saturation of the soil. The criteria used are closely related, in particular for a crop like sugarcane with a year round growing period. During the rainy periods, when the poorly drained soils are waterlogged, oxygen will not be sufficiently available for a proper root development resulting in a shallow root system. This reduces the availability of moisture during periods when evapotranspiration exceeds rainfall. As a result the crop will suffer from water stress.

The following relation of the criteria used to differentiate the mapping units and those to differentiate the present suitability of the mapping units can be established. The moisture holding capacities of the textural classes is decreasing in the following order: Medium, Fine, Coarse. Differences in textural class of topsoil and subsoil are taken into consideration in the

estimation of the moisture availability of the profiles. It will be clear that a profile with a medium texture in topsoil and subsoil is the most suitable in this respect.

Oxygen availability in relation to drainage condition increases from the very poorly drained to the imperfectly drained soils, while the drainage class itself is for a part determined by the textural differentiation of the profile.

The following soil suitability classification of the mapping units for moderately productive, rainfed sugarcane, is based on the above complex of factors. For the spatial distribution of the different suitability classes one is referred to the Soil Suitability Map accompanying this report.

Soil suitability class	Total area in ha	Soil mapping unit	Major limiting factors
Moderately suitable (S2)	380	Pp2,Pp3,Pi1,lPi1, Pi2,lPi2,Up2,Ui2, Ui3	
Marginally suitable (S3)	2018	Pp1,Pp4,rPp4,lPp4, lqPp4,qPp4,Pp5,rPp5, lPp5,Pi3,lPi3,Up1, Up3,lUp3,Up4,Uil,Ui4	drainage cond. (topsoil texture) subsoil texture
Not suitable (NS)	546	Pvp1,Pvp2,lPvp2,Pvp3, lPvp3,Uvp1,Uvp2,Uvp3, Uvp4	topographical position drainage cond.

PROFILE DESCRIPTION Nr. 1I. Information on the Site Sampled

- a) Field number :20
- b) Soil name : Pvp1
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 28-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 36.240 Y= 36.260
- g) Elevation : 46,50 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : gently sloping (2-6%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 2 (2-6%)
- j) Vegetation or land-use : shifting cultivation

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 0, very poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 0.6 m (perched)
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|------|------------|--|
| Ap | 0 - 20 cm | Black (10YR 2/1), moist sandy clay loam;
very weak, fine subangular blocky structure;
slightly plastic, sticky, friable; many,
fine pores; common, fine and medium roots;
clear, wavy boundary |
| Bwg1 | 20 - 56 cm | Grey (10YR 5/1), moist clay loam to clay;
weak to moderate, fine angular blocky
structure; plastic, sticky, friable; common,
medium, prominent red (2.5YR 4/8) mottles; |

pressure skins; common, fine pores; common,
fine roots; gradual, smooth boundary

Bwg2 56 - 150 cm Light grey (10YR 6/1), moist clay; moderate,
coarse, angular blocky structure; very
plastic, very sticky, firm; common, coarse,
prominent, strong brown (7.5YR 5/8) mottles;
common, moderate slickensides; few, fine
pores, few, very fine roots

Horizons: Ochric epipedon
Cambic B horizon

PROFILE DESCRIPTION Nr. 2

I. Information on the Site Sampled

- a) Field number :28
- b) Soil name : Pvp2
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 28-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 38.420 Y= 36.720
- g) Elevation : 35.50 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : rice

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 0, very poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 0.6 m (perched)
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|------|------------|---|
| Ap | 0 - 14 cm | Black (N2), moist sandy clay loam; weak, fine crumb structure; slightly plastic, sticky, very friable; many, fine pores; common, fine roots; clear, smooth boundary |
| Bwg1 | 14 - 48 cm | Grey (5Y 5/1), moist clay; weak to moderate, fine angular blocky structure; very plastic, sticky, firm; many, medium, distinct strong brown (7.5YR 4/6) mottles; common, fine pores; common, fine roots; diffuse, smooth boundary |

Bwg2 48 - 150 cm Grey (N5), moist clay; moderate, medium
columnar structure breaking into moderate,
medium angular blocks; very plastic, very
sticky, very firm; many, coarse, prominent
strong brown (7.5YR 5/8) mottles; abundant,
moderate slickensides; few, very fine pores;
very few, very fine roots

Horizons: Ochric epipedon
Cambic B horizon

PROFILE DESCRIPTION Nr. 3

I. Information on the Site Sampled

- a) Field number : 3
- b) Soil name : 1Pvp3
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 25-5-'84
- e) Authors of description : E.R. Jordens - G. v.d. Veen
- f) Location : x= 35.830 Y= 38.440
- g) Elevation : 39.50 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat (levelled)
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : sugarcane

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 0, very poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table : 1.0 m (perched)
- e) Evidence of erosion : none
- f) Human influence : levelled

III. Description of Individual Soil Horizons

- | | | |
|-----|------------|---|
| Ap | 0 - 16 cm | Dark yellowish brown (10YR 3/4), moist clay; weak, fine crumb structure; plastic, sticky, friable; many, medium pores; common, fine roots; pH 5.0; clear, wavy boundary |
| ABg | 16 - 30 cm | Dark grey (10YR 4/1), moist clay; weak, fine angular blocky structure; plastic, sticky, friable; many, coarse prominent red (10R 4/8) mottles; common, fine pores; common, fine roots; pH 5.0; gradual, wavy boundary |

- Bwg1 30 - 42 cm Grey (10YR 5/1), moist clay; weak, fine angular blocky structure; plastic, sticky, friable; many, coarse prominent red (10R 4/8) mottles; pressure faces; common to few, very fine pores; few, fine roots; pH 5.1; gradual, smooth boundary
- Bwg2 42 - 150 cm Grey (5Y 6/1), moist clay; weak, fine to medium angular blocky structure; very plastic, very sticky, firm; common, coarse prominent red (10R 4/8) mottles; pressure faces; pH 4.9
- *(Bwg3) 150 - 170 cm Grey (5Y 6/1), moist clay; very plastic, very sticky, firm; common, coarse, prominent red (10R 4/8) mottles
- * (Cg) 170 - 320 cm Grey (5Y 6/1), moist clay; very plastic, very sticky, firm; olive yellow (2,5Y 6/6) mottling

Horizons: Ochric A epipedon
 Cambic B horizon

* described through augering

PROFILE DESCRIPTION Nr. 4

I. Information on the Site Sampled

- a) Field number : 12
- b) Soil name : Pvp3
- c) Higher category classification : Humic Cambisol
- d) Date of examination : 19-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 38.120 Y= 37.050
- g) Elevation : 36.50 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 2 (2-6%)
- j) Vegetation or land-use : grasses

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 0, very poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 2.5m (perched)
- e) Evidence of erosion : none
- f) Human influence : none

III Description of Individual Soil Horizons

- | | | |
|----|-----------|---|
| Ap | 0 - 8 cm | Black (10YR 2/1), moist clay; weak, fine, crumb structure; slightly plastic, sticky, friable; common, fine pores; common, fine roots; pH 7.0; EC 0.3 mS; clear, smooth boundary |
| A1 | 8 - 28 cm | Black (N2), moist clay; columnar structure breaking into moderate, fine angular blocks; plastic, sticky, friable; common, fine pores; common, fine roots; pH 7.0; EC 0.3 mS; clear, smooth boundary |

- | | | |
|--------|-------------|--|
| B2 | 28 - 35 cm | Black (N2), moist clay loam; moderate, fine angular blocky structure; plastic, sticky, friable; common, fine pores; common, fine roots; pH 7.0; **EC 0.3 mS; clear, smooth boundary |
| B3 | 35 - 56 cm | Black (N2), moist clay; columnar structure breaking into moderate, fine angular blocks; consistency as above; few, fine pores; few, fine roots; pH 6.2; EC 0.04 mS; clear, smooth boundary |
| 2B4 | 56 - 66 cm | Very dark grey (10YR 3/1), moist sandy clay loam; structureless, fine granulars; slightly plastic, sticky, friable; few, fine pores; very few, very fine roots; pH 6.2; EC 0.04 mS; clear, smooth boundary |
| 2B5 | 66 -150 cm | Very dark greyish brown (10YR 3/2), sandy loam; structureless, fine granulars; non plastic, sticky, very friable; pH 6.2; EC 0.04 mS |
| *(3Cg) | 150 -320 cm | Dark grey (10YR 4/1), moist clay; slightly plastic, sticky, friable; common, medium, distinct dark yellowish brown (10Yl 3/4) mottles; few (1-2 mm) manganese concretions |

Horizons: Umbric epipedon
Cambic B horizon

Remarks: - Limestone gravels to a depth of 56 cm
- Stratified profile, near gully

* described through augering

** Field determinations in 1 : 2.5 (soil : water) v/v solutions

PROFILE DESCRIPTION Nr. 5

I. Information on the Site Sampled

- a) Field number : 21
- b) Soil name : Pp4
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 28-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 36.770 Y= 36.320
- g) Elevation : 45.50 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : rice

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 1, poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 0.4 m (perched)
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|------|------------|---|
| Ap | 0 - 16 cm | Black (10YR 2/1), moist sandy clay loam to clay loam; weak, fine crumb structure; slightly plastic, sticky, friable; many, fine and medium pores; frequent, fine roots; abrupt, wavy boundary |
| Bwg1 | 16 - 30 cm | Dark grey (10YR 4/1), moist clay loam; weak, fine, subangular to angular blocky structure; plastic, sticky, friable; many, medium, prominent dark brown (7.5YR 4/4) mottles; common, medium pores; common, fine |

roots; gradual, smooth boundary

Bwg2 30 - 52 cm Light grey (10YR 6/1), moist clay; weak,
fine angular blocky structure; plastic,
sticky, friable; many, medium, prominent red
(10R 5/8) mottles; common, medium pores;
common, fine roots; gradual, smooth boundary

Bwg3 52 - 150 cm Light grey (10YR 6/1), moist clay; weak to
moderate, fine to medium angular blocky
structure; plastic, sticky, friable; common,
medium, prominent red (10R 5/8) mottles;
few, fine pores; very few, very fine roots

Horizons: Ochric epipedon
Cambic B horizon

PROFILE DESCRIPTION Nr. 6

I. Information on the Site Sampled

- a) Field number :22
- b) Soil name : Pp4
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 28-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 36.950 Y= 36.360
- g) Elevation : 44.50 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : rice

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 1, poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 0.4 m (perched)
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|------|------------|---|
| Ap | 0 - 18 cm | Very dark grey (10YR 3/1), moist clay loam.
weak, fine crumb structure; slightly
plastic, sticky, very friable; many, fine to
medium pores; common, fine and medium roots;
clear, smooth boundary |
| Bwg1 | 18 - 62 cm | Grey (10YR 5/1), moist clay; weak, fine
angular blocky structure; plastic, sticky,
friable; common, medium, prominent red
(10R 5/8) and strong brown (7.5YR 5/8)
mottles; common, fine to medium pores; |

common, fine and medium roots; gradual,
smooth boundary

Bwg2 62 - 150 cm Light grey (10YR 6/1), moist clay; weak to
moderate, fine angular blocky structure;
plastic, sticky, friable; many, coarse,
prominent red (10R 5/8) mottles; few, fine
pores; very few, very fine roots

Horizons: Ochric epipedon
Cambic B horizon

PROFILE DESCRIPTION NR. 7

I. Information on the Site Sampled

- a) Field number : 6
- b) Soil name : Pp5
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 16-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 36.180 y= 42.880
- g) Elevation : 32.00 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : rice and grasses

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 1, poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table : 1.2 m (perched)
- e) Evidence of erosion : none
- f) Human influence : none

III. Description of Individual Soil Horizons

- | | | |
|----|------------|--|
| Ap | 0 - 18 cm | Very dark grey (10YR 3/1), moist clay;
moderate, fine crumb structure; plastic,
sticky, very friable; medium, fine pores;
frequent, medium roots; common, fine (1-2mm)
manganese and iron concretions; pH 6.3;
EC < 0.01 mS; clear, wavy boundary |
| AB | 18 - 32 cm | Dark yellowish brown (10YR 4/4), moist clay,
weak, fine angular blocky structure;
plastic, sticky, very friable; medium, |

fine pores; common to few, fine roots; pH
6.3; EC <0.01 mS; distinct, smooth boundary

Bwg 32 - 150 cm Dark yellowish brown (10YR 4/4), moist clay;
weak, medium breaking into fine angular
blocky structure; plastic, very sticky, very
firm; common, medium, faint strong brown
(7.5YR 4/6) mottles; pressure faces; common,
fine pores; few, fine roots; pH 6.2;
EC <0.01 mS

* (Bwg) 150 - 160 cm As above

* (Cg) 160 - 320 cm Yellowish brown (10YR 5/6), moist clay;
plastic, very sticky, very firm; few fine,
faint strong brown (7.5YR 5/6) mottles

Horizons: Ochric epipedon
Cambic B horizon

Remarks: A1-material also occurs in Cg-horizon

* described through augering

PROFILE DESCRIPTION NR. 8

I. Information on the Site Sampled

- a) Field number : 7
- b) Soil name : Pp5
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 16-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x = 35.380 y = 42.400
- g) Elevation : 36.00 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : rice

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 1, poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table : -
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|------|------------|--|
| Ap | 0 - 20 cm | Very dark grey (10YR 3/1), moist sandy clay loam; weak, fine crumb structure; plastic, sticky, friable; common, medium pores; frequent, medium roots; pH 5.4; EC < 0.01mS; abrupt, smooth boundary |
| Bwg1 | 20 - 85 cm | Grey (5Y 5/1), moist clay; weak, medium breaking into fine angular blocky structure; plastic, very sticky, firm; many, medium, prominent, red (10R 4/8) mottles; common, |

PROFILE DESCRIPTION NR. 9

I. Information on the Site Sampled

- a) Field number :25
- b) Soil name : Pp5
- c) Higher category classification : Humic Gleysol
- d) Date of examination : 28-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 37.790 y= 36.530
- g) Elevation : 41.50 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : rice

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 1, poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 0.4 m (perched)
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|------|------------|--|
| Ap | 0 - 30 cm | Black (10YR 2/1), moist clay loam to clay; weak, fine crumb structure; slightly plastic, sticky, friable; many, medium and fine pores; many, fine roots; abrupt, wavy boundary |
| Bwg1 | 30 - 46 cm | Dark grey (10YR 4/1), moist clay; weak, fine angular blocky structure; plastic, sticky, friable; many, coarse, prominent strong brown (7.5YR 5/8) and red (10R 4/8) |

mottles; many, medium to fine pores; common,
fine roots; gradual, smooth boundary

Bwg2 46 - 120 cm Grey (10YR 5/1), moist clay; weak to
moderate, medium angular blocky structure;
very plastic, sticky, firm; many, coarse,
prominent red (10R 4/8) mottles; common,
fine pores; very few, very fine roots;
gradual, smooth boundary

Bwg3 120 - 150 cm Light grey (10YR 6/1), moist clay; weak,
coarse angular blocky structure; very
plastic, very sticky, firm; many, coarse,
prominent red (10R 4/8) mottles

Horizons: Umbric epipedon
Cambic B horizon

PROFILE DESCRIPTION NR. 10

I. Information on the Site Sampled

- a) Field number :38
- b) Soil name : 1Pp5
- c) Higher category classification : Humic Gleysol (Gh)
- d) Date of examination : 3-7-'84
- e) Authors of description : E.R. Jordens - G. v.d. Veen
- f) Location : x= 34.930 y= 39.360
- g) Elevation : 46.50 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat (levelled)
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : sugarcane

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 1, poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 0.4 m (perched)
- e) Evidence of erosion : none
- f) Human influence : levelled

III Description of Individual Soil Horizons

- | | | |
|------|------------|---|
| Ap | 0 - 30 cm | Very dark greyish brown (10YR 3/2), moist clay loam; weak, fine crumb structure; slightly plastic, sticky, friable; few, fine, distinct strong brown (7.5YR 5/8) mottles; many, medium to fine pores; frequent, fine roots; abrupt, smooth boundary |
| Bwg1 | 30 - 55 cm | Dark grey (10YR 4/1), moist clay; moderate, fine angular blocky structure; plastic, |

sticky, firm; many, medium, prominent red
(2.5YR 4/8) mottles; common, medium to fine
pores; common, fine roots; distinct, smooth
boundary

Bwg2 55 - 150 cm Grey (10YR 5/1), moist clay; weak, medium
columnar structure breaking into weak, fine
angular blocks; very plastic, very sticky,
very firm; many, coarse, prominent strong
brown (7.5YR 4/6) mottles; common, moderate
slickensides; few, fine pores; very few,
very fine roots

Horizons: Umbric epipedon
Cambic B horizon

PROFILE DESCRIPTION NR. 11

I. Information on the Site Sampled

- a) Field number : 2
- b) Soil Name : 1Pp5
- c) Higher category classification : Gleyic Cambisol
- d) Date of examination : 25-5-'84
- e) Authors of description : E.R. Jordens - G. v.d. Veen
- f) Location : x= 35.950 y= 40.400
- g) Elevation : 41.00 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat (levelled)
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : sugarcane

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 1, poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table : 1.5 m (perched)
- e) Evidence of erosion : none
- f) Human influence : levelled

III. Description of Individual Soil Horizons

- | | | |
|----|------------|---|
| Ap | 0 - 40 cm | Very dark grey (10YR 3/1), moist clay;
moderate, coarse, angular blocky structure
when dry and crumb structure when moist;
plastic, sticky, friable; few, fine, faint red
mottles; many, fine pores; many, fine roots;
pH 5.6; abrupt, smooth boundary |
| AB | 40 - 60 cm | Dark yellowish brown (10YR 4/4), moist clay;
moderate medium angular blocky structure;
plastic, very sticky, firm; many, coarse,
prominent strong brown mottles; common, fine |

pores; few, small (2-3 mm) iron and
manganese concretions; common, fine roots;
pH 6.0; distinct, smooth boundary

Bw 60 - 150 cm Dark yellowish brown (10YR 4/6), moist clay;
moderate to weak, medium angular blocky
structure; plastic, very sticky, firm; many,
coarse, prominent strong brown mottles; few,
fine pores; few, small (2-3 mm) iron and
manganese concretions; few, fine roots;
pH 5.9

*(Bw) 150 - 320 cm Dark yellowish brown (10YR 4/6), moist clay;
plastic, very sticky, firm

Horizons : Umbric epipedon
Cambic B horizon

* described through augering

PROFILE DESCRIPTION NR. 12

I. Information on the Site Sampled

- a) Field number : 10
- b) Soil name : Pi2
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 16-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 34.900 y= 42.820
- g) Elevation : 38.00 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : rice

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q1
- b) Drainage : class 2, imperfectly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table : -
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|----|------------|---|
| Ap | 0 - 17 cm | Very dark grey (10YR 3/1), loamy sand; structureless; non plastic. slightly sticky, loose; pH 5.9; EC 0.01 mS; clear, wavy boundary |
| AB | 17 - 44 cm | Dark brown to brown (7.5YR 4/4), sandy clay loam; weak, fine angular blocky to subangular blocky structure; slightly plastic, slightly sticky, friable; few, fine, faint yellowish red (5YR 4/6) mottles; |

many, medium pores; frequent, medium roots;
pH 5.9; EC 0.02 mS; gradual, smooth boundary

Bwg1 44 - 80 cm Grey (10YR 5/1), moist sandy clay loam;
weak, fine angular blocky structure;
plastic, sticky, friable; many, coarse,
prominent red (10R 4/8) mottles; common,
medium pores; common, medium roots; pH 5.1;
EC < 0.01 mS; distinct, smooth boundary

Bwg2 80 -150 cm Grey (5Y 5/1), moist clay; weak, medium
angular blocky structure; plastic, sticky,
firm; common, coarse, prominent red
(10R 4/8) mottles; common, fine pores; few,
fine roots; pH 5.4; EC 0.03 mS

*(Bwg2) 150 -320 cm As above

Horizons: Ochric epipedon
Cambic B horizon

*described through augering

PROFILE DESCRIPTION NR. 13

I. Information on the Site Sampled

- a) Field number : 1
- b) Soil name : 1Pi2
- c) Higher category classification : Gleyic Cambisol
- d) Date of examination : 25-5-'84
- e) Authors of description : E.R. Jordens - G. v.d. Veen
- f) Location : x= 35.650 y=39.850
- g) Elevation : 43.50 m
- h) Landform :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat (levelled)
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : sugarcane
- k) Climate :

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q1
- b) Drainage : class 1, poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table : 1.1 m (perched)
- e) Evidence of erosion : none
- f) Human influence : levelled

III. Description of Individual Soil Horizons

- | | | |
|----|------------|--|
| Ap | 0 - 30 cm | Very dark grey (10YR 3/1), moist sandy clay loam; weak, fine crumb structure; plastic, slightly sticky, friable; common, fine pores; common, fine roots; pH 5.7; abrupt, smooth boundary |
| Bw | 30 - 80 cm | Dark yellowish brown (10YR 4/4), moist sandy clay; weak, fine angular blocky structure; plastic, sticky, friable; many, coarse, prominent red (10R 4/8) mottles; many, |

medium pores; frequent, medium roots; pH
5.4; gradual, smooth boundary

Bwg1 80 - 120 cm Grey (5Y 5/1), moist sandy clay; weak, fine
angular blocky structure; plastic, sticky,
firm; many, coarse, prominent red (10R 4/8)
mottles; many, medium pores; common, medium
roots; pH 5.3

*(Bwg2) 120 - 200 cm Grey (5Y 5/1), moist sandy clay; plastic,
sticky, firm; many, coarse, prominent red
(10R 4/8) mottles

*(Cg1) 200 - 290 cm Grey (5Y 6/1), moist clay; plastic, sticky,
firm; many, coarse, prominent strong brown
(7.5YR 5/8) and few, fine, distinct red
(10R 4/8) mottles

*(Cg2) 290 - 320 cm Grey (5Y 6/1), moist clay; plastic, sticky,
firm; many, coarse, prominent yellowish
brown (10YR 5/8) mottles

Horizons: Umbric epipedon

Cambic B horizon

* described through augering

PROFILE DESCRIPTION NR. 14

I. Information on the Site Sampled

- a) Field number :16
- b) Soil name : 1Pi2
- c) Higher category classification : Dystric Fluvisol
- d) Date of examination : 26-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 35.420 y= 40.250
- g) Elevation : 45.50 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat (levelled)
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : sugarcane

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 2, imperfectly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 1.0 m (perched)
- e) Evidence of erosion : none
- f) Human influence : levelled

III Description of Individual Soil Horizons

- | | | |
|----|------------|---|
| Ap | 0 - 18 cm | Very dark grey (10YR 3/1), moist sandy loam; weak, fine crumb structure; slightly plastic, sticky, friable; many, medium to fine pores; many, fine to coarse roots; pH 5.8; EC 0.02 mS; abrupt, smooth boundary |
| C1 | 18 - 52 cm | Dark yellowish brown (10YR 4/6), moist sandy loam; weak, fine crumb structure; slightly plastic, sticky, friable; few, fine, faint strong brown (7.5YR 5/6) mottles; many, |

medium to fine pores; many, fine to coarse roots; pH 6.3; EC 0.01 mS; clear, smooth boundary

C2 52 - 95 cm Dark yellowish brown (10YR 4/6), moist loamy sand; structureless; non plastic, non sticky, loose; common, medium, distinct strong brown (7.5YR 5/6) mottles; common to few, fine pores; few, fine roots; pH 6.1; EC < 0.01 mS; gradual, smooth boundary

Cg 95 - 150 cm Grey (10YR 5/1), moist sandy clay loam; weak, fine angular blocky structure; plastic, sticky, friable; many, medium, prominent strong brown (7.5YR 5/6) mottles; common, weak slickensides; few, fine to very fine pores; very few, fine roots; pH 6.5; EC 0.02 mS

Horizons: Ochric epipedon

Remarks : Pockets of B-horizon in the Ap horizon.

PROFILE DESCRIPTION NR. 15

I. Information on the Site Sampled

- a) Field number : 4
- b) Soil name : Uvp3
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 25-5-'84
- e) Authors of description : E.R. Jordens - G. v.d. Veen
- f) Location : x= 35.550 y= 35.770
- g) Elevation : 46.00 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography: flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : cassave

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q
- b) Drainage : class 0, very poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table : 1.5 m (perched)
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III. Description of Individual Soil Horizons

- | | | |
|------|------------|--|
| Ap | 0 - 12 cm | Very dark grey (10YR 3/1), moist sandy clay loam; weak, fine crumb structure; plastic, sticky, friable; common, medium pores; common, fine roots; pH 5.6; gradual, wavy boundary |
| Bwg1 | 12 - 38 cm | Dark grey (10YR 4/1), moist clay; weak, fine angular blocky to subangular blocky structure; plastic, sticky, friable; many, coarse prominent red (10R 4/8) mottles; |

pressure faces; common, medium pores;
common, fine roots; pH 5.3; distinct, smooth
boundary

- Bwg2 38 - 66 cm Grey (10YR 5/1), moist clay; moderate, fine
angular blocky structure; plastic, very
sticky, firm; many, coarse, prominent red
(10R 4/8) and strong brown (7.5YR 5/8)
mottles; pressure faces; common, medium
pores; common, fine roots; pH 4.7; distinct,
smooth boundary
- Bwg3 66 - 150 cm Grey (5Y 5/1), moist clay; moderate, medium
angular blocky structure; plastic, sticky,
firm; common, coarse, prominent red (10R
4/8) and strong brown (7.5YR 5/8) mottles;
pressure faces; common, fine to very fine
pores; few, fine roots; pH 4.5
- *(Bwg3) 150 - 170 cm Grey (5Y 5/1), moist clay; plastic, sticky,
firm, common, coarse, prominent red (10R
4/8) and strong brown (7.5YR 5/8) mottles
- *(Cg1)) 170 - 200 cm Grey (5Y 5/1), moist sandy clay loam;
slightly plastic, sticky, friable; common,
coarse, prominent strong brown (7.5YR 5/8)
mottles
- *(Cg2) 200 - 240 cm Grey (5Y 5/1), moist sandy clay; plastic,
sticky, friable; common, coarse, prominent
strong brown (7.5YR 5/8) mottles
- *(R) 240 - 360 cm Grey (5Y 5/1), very coarse loamy sand;
common, coarse, prominent strong brown
(7.5YR 5/8) mottles; pH 6.1

Horizons : Ochric epipedon
 Cambric B horizon

* described through augering

I. Information on the Site Sampled

- a) Field number :30
- b) Soil name : Uvp4
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 2-7-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 37.470 y= 34.440
- g) Elevation : 38.50 m
- h) Land-form :
 - (i) Physiographic position of the site : upland
 - (ii) Topography of surrounding country : gently sloping
(2-6%
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : cassave

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 0, very poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: —
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|------|------------|---|
| Ap | 0 - 12 cm | Very dark grey (10YR 3/1), moist clay loam;
very weak, fine crumb structure; non
plastic, slightly sticky, very friable;
many, fine pores; common, fine roots;
pH 5.7; EC 0.03 mS; clear, wavy boundary |
| Bwg1 | 12 - 42 cm | Dark grey (10YR 4/1), moist clay; very weak,
fine angular blocky structure; plastic,
sticky, friable; many, coarse, prominent red
(10R 4/8) mottles; many, fine pores; common, |

fine roots; gradual, smooth boundary

Bwg2 42 - 80 cm Grey (10YR 5/1), moist clay; very weak, fine angular blocky structure; very plastic, very sticky, firm; many, coarse, prominent red (10R 4/8) mottles; common, fine pores; few to very few, very fine roots; gradual, smooth boundary

Bwg3 80 - 150 cm Light grey (10YR 6/1), moist clay; very weak, fine angular blocky structure; very plastic, very sticky, very firm; many coarse, prominent red (10R 4/8) and common, medium, distinct strong brown (7.5YR 5/8) mottles; few, very fine pores up to 100 cm

*(Cg1) 150 - 170 cm Light grey (10YR 6/1), moist clay; consistency as above; mottling as above

*(Cg2) 170 - 320 cm Red (2.5YR 4/8), moist clay; plastic, sticky, firm; few, medium, distinct strong brown (7.5YR 5/8) mottles

Horizons: Ochric epipedon
 Cambic B horizon

* described through augering

PROFILE DESCRIPTION NR. 17

I. Information on the Site Sampled

- a) Field number :29
- b) Soil name : Up3
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 2-7-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 36.420 y= 34.170
- g) Elevation : 45.50 m
- h) Land-form :
 - (i) Physiographic position of the site : upland
 - (ii) Topography of surrounding country : gently sloping
(2-6%
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 2 (2-6%)
- j) Vegetation or land-use : cassave

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 1, poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: —
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|----|------------|--|
| Ap | 0 - 18 cm | Black (10YR 2/1), moist sandy clay loam;
weak, fine crumb structure; plastic, sticky,
friable; many, fine pores; common, fine
roots; pH 4.8; EC 0.2 mS; clear, wavy
boundary |
| Bw | 18 - 44 cm | Dark yellowish brown (10YR 4/4), moist clay;
weak, fine angular blocky structure;
plastic, sticky, friable; many, coarse,
prominent red (2.5YR 4/6) mottles; common, |

fine pores; few, fine roots; pH 5.5;
EC 0.02 mS; diffuse, smooth boundary

Bwg1 44 - 63 cm Dark grey (10YR 4/1), moist clay; weak, fine
angular blocky structure; very plastic, very
sticky, firm; many, coarse, prominent red
(10R 4/6) mottles; common, fine pores; few,
fine roots; pH 5.6; EC 0.02 mS; diffuse,
smooth boundary

Bwg2 63 - 150 cm Grey (10YR 5/1), moist clay; weak, very fine
angular blocks; very plastic, very sticky,
firm; many, coarse, prominent red (10R 4/6)
mottles; few, fine pores; very few, very
fine roots; pH 5.6; EC 0.01 mS

*(Cg) 150 - 180 cm Light grey (10YR 6/1), moist clay; very
plastic, very sticky, very firm; many,
coarse, prominent yellowish brown (10YR 5/8)
mottles; pH 7.4; EC 0.2 mS

Horizons: Ochric epipedon
Cambic B horizon

Remarks: At 180 cm end of augering because of coral limestone

* described through augering

PROFILE DESCRIPTION NR. 18

I. Information on the Site Sampled

- a) Field number : 36
- b) Soil name : Up3
- c) Higher category classification : Humic Gleysol
- d) Date of examination : 2-7-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 37.330 y= 33.390
- g) Elevation : 36.00 m
- h) Land-form :
 - (i) Physiographic position of the site : upland
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 2 (2-6%)
- j) Vegetation or land-use : shifting cultivation

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 1, poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 0.2 m (perched)
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|------|------------|--|
| Ap | 0 - 26 cm | Black (10YR 2/1), moist sandy clay loam; weak, fine crumb structure; slightly plastic, slightly sticky, very friable; common, medium, faint strong brown (7.5YR 4/6) mottles; many, fine pores; frequent, fine roots; clear, wavy boundary |
| Bwg1 | 26 - 40 cm | Dark grey (10YR 4/1), moist clay; weak, fine angular blocky structure; plastic, sticky, friable; common, medium, distinct strong |

brown (7.5YR 4/6) and common, fine, distinct red (2.5YR 4/8) mottles; many, fine pores; common, fine roots; gradual, smooth boundary

Bwg2 40 - 150 cm Dark grey (N4), moist clay; weak, fine angular blocky structure; plastic, very sticky, firm; many, coarse, prominent red (10R 5/8) mottles; common, very fine pores; very few, very fine roots up to 100 cm

*(Bwg2) 150 - 180 cm Dark grey (N4), moist clay; very plastic, very sticky, firm; many, coarse, prominent red (10R 5/8) mottles

*(Cg) 180 - 320 cm Dark grey (N4), moist clay; very plastic, very sticky, firm; many coarse, prominent strong brown (7.5YR 4/8) mottles

Horizons: Umbric epipedon
Cambic B horizon

* described through augering

PROFILE DESCRIPTION NR. 19

I. Information on the Site Sampled

- a) Field number :31
- b) Soil name : Up3
- c) Higher category classification : Gleyic Cambisol
- d) Date of examination : 2-7-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : x= 38.000 y= 34.430
- g) Elevation : 34.50 m
- h) Land-form :
 - (i) Physiographic position of the site : upland
 - (ii) Topography of surrounding country : gently sloping
(2-6%
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 2 (2-6%)
- j) Vegetation or land-use : cassave

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 2, imperfectly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: —
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|----|------------|---|
| Ap | 0 - 20 cm | Black (10YR 2/1), moist sandy clay loam;
weak, fine crumb structure; slightly
plastic, sticky, friable; many, fine and
medium pores; frequent, fine and medium
roots; pH 5.7; EC 0.04 mS; clear, wavy
boundary |
| AB | 20 - 52 cm | Dark yellowish brown (10YR 4/4), moist clay;
weak, fine to very fine angular blocky
structure; plastic, sticky, friable; few, |

fine, faint red (2.5YR 4/6) mottles; common,
fine pores; few, fine to very fine roots; pH
5.6; EC 0.01 mS; diffuse, smooth boundary

Bw 52 - 74 cm Dark yellowish brown (10YR 4/6), moist clay;
weak, fine to very fine angular blocky
structure; plastic, sticky, friable; few,
fine, faint red (2.5YR 4/6) mottles; common,
weak slickensides; common, fine pores; very
few, very fine roots; pH 6.5; EC 0.01 mS;
diffuse, smooth boundary

*(Bwg) 74 - 100 cm Grey (10YR 5/1), moist clay; moderate, fine
angular blocky structure; very plastic,
sticky, friable; many, coarse, prominent
dark yellowish brown (10YR 4/6) and strong
brown (7.5YR 5/8) mottles; common, moderate
slickensides; pH 6.8; EC 0,02 mS

Horizons: Ochric epipedon
 Cambic B horizon

Remarks: End of description because of coral limestone at 100 cm
depth

* described through augering

PROFILE DESCRIPTION NR. 20

I. Information on the Site Sampled

- a) Field number : 34
- b) Soil name : Ui1
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 2-7-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : X= 37.170 y= 34.240
- g) Elevation : 43.50 m
- h) Land-form :
 - (i) Physiographic position of the site : upland
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : shifting cultivation

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 2, imperfectly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 0.4 m (perched)
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|------|------------|--|
| Ap | 0 - 11 cm | Black (10YR 2/1), moist sandy clay loam; weak, fine crumb structure; slightly plastic, slightly sticky, very friable; many, fine pores; frequent, fine roots; clear, wavy boundary |
| Bwg1 | 11 - 41 cm | Dark grey (10YR 4/1), moist clay; weak, fine angular blocky structure; plastic, sticky, friable; many, medium, distinct strong brown (7.5YR 5/6) mottles; many, fine pores; |

common, fine roots; gradual, smooth boundary

Bwg2 41 - 150 cm Dark grey (N4), moist clay; weak, fine
angular blocky structure; plastic, very
sticky, firm; many, coarse, prominent red
(10R 5/8) mottles; common, very fine pores;
very few, very fine roots up to 100 cm

*(Bwg2) 150 - 170 cm Dark grey (N4), moist clay; plastic, very
sticky, firm; many, coarse, prominent red
(10R 5/8) mottles

*(Cg) 170 - 320 cm Dark grey (N4), moist clay; very plastic,
very sticky, firm; many, coarse, prominent
strong brown (7.5YR 4/8) mottles

Horizons: Ochric epipedon

Cambic B horizon

* described through augering

PROFILE DESCRIPTION NR. 21

I. Information on the Site Sampled

- a) Field number : 35
- b) Soil name : U1
- c) Higher category classification : Humic Gleysol
- d) Date of examination : 2-7-'84
- e) Author (s) of description : E.R. Jordens - G.v.d. Veen
- f) Location : X= 37.150 y= 33.800
- g) Elevation : 43.50 m
- h) Land-form :
 - (i) Physiographic position of the site : upland
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : shifting cultivation

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 2, imperfectly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 0.2 m (perched)
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|------|------------|--|
| Ap | 0 - 26 cm | Black (10YR 2/1), moist sandy clay loam; weak, fine crumb structure; slightly plastic, slightly sticky, very friable; common, medium, faint strong brown (7.5YR 4/6) mottles; many, fine pores; frequent, fine roots; clear, wavy boundary |
| Bwg1 | 26 - 45 cm | Dark grey (10YR 4/1), moist clay; weak, fine angular blocky structure; plastic, sticky, friable; many, medium, distinct strong brown |

(7.5YR 5/6) mottles; many, fine pores;
common, fine roots; gradual, smooth boundary

Bwg2 45 - 150 cm Dark grey (N4), moist clay; weak, fine
angular blocky structure; plastic, very
sticky, firm; many, coarse, prominent red
(10R 5/8) mottles; common, very fine pores;
very few, very fine roots up to 100 cm

*(Bwg2) 150 - 170 cm Dark grey (N4), moist clay; plastic, very
sticky, firm; many, coarse, prominent red
(10R 5/8) mottles

*(Cg) 170 - 320 cm Dark grey (N4), moist clay; very plastic,
very sticky, firm; many, coarse, prominent
strong brown (7.5YR 4/8) mottles

Horizons: Umbric epipedon
Cambic B horizon

* described through augering

PROFILE DESCRIPTION NR. 22

I. Information on the Site Sampled

- a) Field number :17
- b) Soil name : Ui2
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 26-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : X= 37.060 y= 34.760
- g) Elevation : 42.00 m
- h) Land-form :
 - (i) Physiographic position of the site : plain to upland
 - (ii) Topography of surrounding country : gently sloping (2-6%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : shifting cultivation

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 2, imperfectly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 0.4 m (perched)
- e) Evidence of erosion : none
- f) Human influence : none

III Description of Individual Soil Horizons

- | | | |
|------|------------|---|
| A1 | 0 - 18 cm | Very dark grey (10YR 3/1), moist loamy sand; very weak, fine crumb structure; non plastic, slightly sticky, loose; many, medium to fine pores; common, fine roots. pH 5.7; EC < 0.01 mS; gradual, smooth boundary |
| Bwg1 | 18 - 55 cm | Dark grey (10YR 4/1), moist loamy sand; very weak, fine crumb structure; non plastic, |

slightly sticky, loose; common, medium
distinct strong brown (7.5YR 4/6) mottles;
few to common, fine to medium pores;
frequent to common, fine to medium roots;
pH 5.6; EC 0.01 mS; gradual, smooth boundary

Bwg2 55 - 150 cm Grey (5Y 5/1), moist sandy clay; weak, fine
angular blocky structure; plastic, sticky,
firm; many, coarse, prominent red (10R 5/8)
mottles; few, fine pores; very few, very
fine roots; pH 5.5; EC 0.01 mS

Horizons: Ochric epipedon

Cambic B horizon

Remarks : Gritty material throughout the profile

PROFILE DESCRIPTION NR. 23

I. Information on the Site Sampled

- a) Field number :14
- b) Soil name : Ui2
- c) Higher category classification : Gleyic Cambisol
- d) Date of examination : 19-6-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : X= 35.540 y= 35.110
- g) Elevation : 51.50 m
- h) Land-form :
 - (i) Physiographic position of the site : plain
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : cassave

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 2, imperfectly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 1.0 m (perched)
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|----|------------|--|
| Ap | 0 - 34 cm | Very dark greyish brown (10YR 3/2), moist sandy loam; weak, fine crumb structure; non plastic, slightly sticky, loose; many, medium pores; coarse, medium and fine roots; clear, wavy boundary |
| Bw | 34 - 70 cm | Yellowish brown (10YR 5/6), moist sandy clay loam; weak, fine crumb structure; slightly plastic, sticky, friable; common, medium, distinct red (2.5YR 4/8) mottles; common, |

medium pores; medium, fine roots; distinct,
smooth boundary

Bwg 70 - 150 cm Grey (10YR 5/1), moist clay; weak, medium,
subangular blocky structure; plastic,
sticky, friable; many, coarse, prominent red
(10R 4/8) mottles; common, fine pores;
medium, fine roots

*(Cg) 150 - 320 cm Grey to light gray (N6), moist sandy clay;
very plastic, very sticky, firm; few,
medium, distinct reddish yellow (7.5YR 7/8)
and many, coarse, prominent red (10R 4/8)
mottles; coarse gritty (quartz) fragments.

Horizons: Umbric epipedon
Cambic B horizon

* described through augering

PROFILE DESCRIPTION NR. 24

I. Information on the Site Sampled

- a) Field number :43
- b) Soil name : Ui3
- c) Higher category classification : Dystric Gleysol
- d) Date of examination : 3-7-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : X = 35.900 y = 37.070
- g) Elevation : 45.000m
- h) Land-form :
 - (i) Physiographic position of the site : upland
 - (ii) Topography of surrounding country : gently sloping (2-6%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : cassave

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 1, poorly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 0.7 m (perched)
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

- | | | |
|-----------------|------------|---|
| Ap | 0 - 20 cm | Black (N2), moist sandy clay loam; weak, fine crumb structure; plastic, sticky, friable; many, fine and medium pores; common, fine and medium roots; clear, smooth boundary |
| AB ₉ | 20 - 32 cm | Dark grey (10YR 4/1), moist sandy clay loam; weak, fine angular blocky structure; very plastic, very sticky, firm; many, medium, prominent red (2.5YR 4/6) mottles; many, fine and medium pores; common, fine |

and few, coarse roots; gradual, smooth
boundary

Bwg1 32 - 72 cm Grey (10YR 5/1), moist sandy clay loam;
moderate, fine angular blocky structure;
very plastic, very sticky, firm; many,
medium, prominent red (10R 5/8) and common,
medium, prominent strong brown (7.5YR 5/8)
mottles; few to common, fine pores; very
few, few fine roots; gradual, smooth
boundary

Bwg2 72 - 150 cm Light grey (10YR 6/1), moist clay; moderate,
fine angular blocky structure; very plastic,
very sticky, firm; many, coarse, prominent
strong brown (7.5YR 5/8) mottles; few, very
fine pores; very few, very fine roots up to
100 cm

Horizons: Ochric epipedon
Cambic B horizon

Remarks: Ap-material through cracks in AB-horizon

PROFILE DESCRIPTION NR. 25

I. Information on the Site Sampled.

- a) Field number :37
- b) Soil name : Ui4
- c) Higher category classification : Humic Gleysol
- d) Date of examination : 2-7-'84
- e) Authors of description : E.R. Jordens - G.v.d. Veen
- f) Location : X = 37.230 Y = 32.890
- g) Elevation : 36.00 m
- h) Land-form :
 - (i) Physiographic position of the site : upland
 - (ii) Topography of surrounding country : flat or almost flat (0-2%)
 - (iii) Microtopography : flat
- i) Slope on which profile is sited : class 1 (0-2%)
- j) Vegetation or land-use : transition arable land (rice) and palmtree bush

II. General Information on the Soil

- a) Parent material : colluvial material derived from Q 1
- b) Drainage : class 2, imperfectly drained
- c) Moisture conditions in the soil : moist throughout
- d) Depth of groundwater table: 15.0 m and perched groundwater level at 0.7 m
- e) Evidence of erosion : none
- f) Human influence : reworked topsoil

III Description of Individual Soil Horizons

Ap	0 - 28 cm	Very dark grayish brown (10YR 3/2), moist sandy loam; very weak, fine crumb to granular structure; non plastic, slightly sticky, loose; many, fine to medium pores; frequent, fine and few, medium roots; pH 5.9; EC 0.02 mS; diffuse, smooth boundary
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- Bw 28 - 42 cm Dark brown (10YR 3/3), moist loam; very, weak, fine crumb structure; slightly plastic, slightly sticky, very friable; few, fine, faint strong brown (7.5YR 4/6) mottles; many, fine to medium pores; frequent, fine and few, medium roots; pH 5.4; EC 0.01 mS; gradual, smooth boundary
- Bwg1 42 - 68 cm Dark grey (10YR 4/1), moist clay; weak, fine angular blocky structure; plastic, sticky, friable; common, medium, prominent red (2.5YR 5/8) mottles; common, fine pores; very few, very fine roots; pH 5.2; EC 0.02 mS; clear, smooth boundary
- Bwg2 68 - 150 cm Light grey (10YR 6/1), moist clay; moderate, coarse angular blocky structure; very plastic, very sticky, firm; many, coarse, prominent red (10R 5/8) mottles; common, moderate slickensides; few, fine pores; very few, very fine roots; pH 5.2; EC 0.02 mS
- *Cg 150 - 320 cm Light grey (10YR 6/1), moist clay; very plastic, very sticky, firm; many, coarse, prominent red (10R 5/8) mottles

Horizons: Umbric epipedon

Cambic B horizon

* described through augering

ANNEX 2

ANALYTICAL DATA

SOIL CHEMICAL AND MECHANICAL DATA

Mapping Unit: 1Pvp3 FAO/UNESCO classification: Dystric Gleysol

Profile description number: 3 Field number: 3

Laboratory no.	47	48	49
Horizon	Ap	ABg	Bwg2
Depth in cm	0-16	16-40	70
pH - H2O	5.5	5.1	5.0
pH - CaCl2	4.4	4.0	4.0
Organic matter %	1.5	0.5	0.3
Nitrogen %	0.17	0.07	0.05
P205 - ppm	1.4	1.4	-
Cation Exch. Cap. me/100g	34.0	26.4	37.6
Exchangeable Cations me/100g:			
Sodium	0.42	0.65	0.90
Potassium	0.05	0.02	0.02
Calcium	8.60	3.20	3.20
Magnesium	4.80	2.40	1.80
Base saturation %	40.8	21.5	15.7
Sand (2.0 - 0.05 mm) %	33	32	31
Silt (0.05 - 0.002 mm) %	12	10	9
Clay (< 0.002 mm) %	55	58	60

Mapping Unit: Pp5 FAO/UNESCO classification: Dystric Gleysol

Profile description number: 7 Field number: 6

Laboratory no.	53	54	55
Horizon	Ap	AB	Bwg
Depth in cm	0-18	18-32	60-80
pH - H2O	5.7	6.6	6.5
pH - CaCl2	5.3	5.7	5.6
Organic matter %	2.4	1.3	0.7
Nitrogen %	0.20	0.13	0.07
P205 - ppm	2.8	1.4	2.1
Cation Exch. Cap. me/100g	28.6	38.4	27.4
Exchangeable Cations me/100g:			
Sodium	0.24	0.22	0.25
Potassium	0.03	0.02	0.01
Calcium	15.60	13.60	10.60
Magnesium	0.40	5.60	2.00
Base saturation %	56.9	50.6	46.9
Sand (2.0 - 0.05 mm) %	29	30	31
Silt (0.05 - 0.002 mm) %	10	8	5
Clay (< 0.002 mm) %	61	62	64

Mapping Unit: Pp5 FAO/UNESCO classification: Dystric Gleysol

Profile description number: 8 Field number: 7

Laboratory no.	56	57	58
Horizon	Ap	Bwg	Cg1
Depth in cm	0-20	40-60	100-120
pH - H2O	5.6	5.6	6.8
pH - CaCl2	4.7	4.4	6.0
Organic matter %	1.4	0.5	0.2
Nitrogen %	0.14	0.07	0.03
P2O5 - ppm	-	2.1	1.4
Cation Exch. Cap. me/100g	33.6	-	36.8
Exchangeable Cations me/100g:			
Sodium	0.25	0.40	1.20
Potassium	0.02	0.01	0.01
Calcium	8.40	9.00	13.60
Magnesium	3.70	5.60	4.00
Base saturation %	36.8	-	51.1
Sand (2.0 - 0.05 mm) %	50	44	46
Silt (0.05 - 0.002 mm) %	12	12	12
Clay (< 0.002 mm) %	32	44	42

Mapping Unit: 1Pp5 FAO/UNESCO classification: Gleyic Cambisol

Profile description number: 11 Field number: 2

Laboratory no.	44	45	46
Horizon	Ap	AB	Bw
Depth in cm	0-40	40-60	60-150
pH - H2O	6.1	6.2	6.2
pH - CaCl2	5.4	5.5	5.7
Organic matter %	2.4	1.2	0.5
Nitrogen %	0.23	0.17	0.15
P2O5 - ppm	9.1	-	1.4
Cation Exch. Cap. me/100g	-	-	-
Exchangeable Cations me/100g:			
Sodium	0.21	0.19	0.21
Potassium	0.05	0.04	0.03
Calcium	16.00	12.20	11.20
Magnesium	4.60	6.20	4.80
Base saturation %	-	-	-
Sand (2.0 - 0.05 mm) %	42	35	40
Silt (0.05 - 0.002 mm) %	8	5	4
Clay (< 0.002 mm) %	50	65	56

Mapping Unit: Pi2 FAO/UNESCO classification: Dystric Gleysol

Profile description number: 12 Field number: 10

Laboratory no.	63
Horizon	Bwg1
Depth in cm	40-50
pH - H2O	5.5
pH - CaCl2	4.2
Organic matter %	0.2
Nitrogen %	0.08
P205 - ppm	1.4
Cation Exch. Cap. me/100g	-
Exchangeable Cations me/100g:	
Sodium	0.18
Potassium	0.01
Calcium	2.80
Magnesium	2.80
Base saturation %	-
Sand (2.0 - 0.05 mm) %	60
Silt (0.05 - 0.002 mm) %	12
Clay (< 0.002 mm) %	28

Mapping Unit: Pi2 FAO/UNESCO classification: Gleyic Cambisol

Profile description number: 13 Field number: 1

	41	42	43
Laboratory no.	41	42	43
Horizon	Ap	Bw	Bwg1
Depth in cm	0-30	50-80	80-120
pH - H2O	5.4	5.1	4.6
pH - CaCl2	4.6	4.2	3.9
Organic matter %	1.3	0.8	0.6
Nitrogen %	0.16	0.06	0.06
P205 - ppm	5.6	1.4	-
Cation Exch. Cap. me/100g	-	-	-
Exchangeable Cations me/100g:			
Sodium	0.18	0.20	0.25
Potassium	0.02	0.02	0.02
Calcium	6.00	4.00	2.20
Magnesium	2.60	2.00	2.20
Base saturation %	-	-	-
Sand (2.0 - 0.05 mm) %	59	54	55
Silt (0.05 - 0.002 mm) %	21	10	9
Clay (< 0.002 mm) %	20	36	36

Mapping Unit: Pi2

FAO/UNESCO classification: Dystric Fluvisol

Profile description number: 14

Field number: 16

Laboratory no.	64	65	66	67
Horizon	Ap	C1	C2	Cg
Depth in cm	0-18	40	70	110
pH - H2O	5.7	6.2	6.2	6.9
pH - CaCl2	4.8	5.1	5.2	6.0
Organic matter %	1.1	0.5	0.1	0.2
Nitrogen %	0.11	0.07	0.04	0.04
P205 - ppm	2.8	1.4	2.1	1.4
Cation Exch. Cap. me/100g	-	-	-	-
Exchangeable Cations me/100g:				
Sodium	0.14	0.15	0.12	0.18
Potassium	0.04	0.02	0.01	0.02
Calcium	7.20	3.20	4.40	13.00
Magnesium	1.60	0.60	2.60	0.80
Base saturation %	-	-	-	-
Sand (2.0 - 0.05 mm) %	68	67	88	62
Silt (0.05 - 0.002 mm) %	14	13	4	10
Clay (< 0.002 mm) %	18	15	8	28

Mapping Unit: Uvp3

FAO/UNESCO classification: Dystric Gleysol

Profile description number: 15

Field number: 4

Laboratory no.	50	51	52
Horizon	Ap	Bwg2	Bwg3
Depth in cm	0-12	50	80
pH - H2O	5.7	5.5	5.2
pH - CaCl2	4.7	3.9	3.9
Organic matter %	1.0	0.3	0.3
Nitrogen %	0.09	0.04	0.04
P205 - ppm	2.8	1.4	1.4
Cation Exch. Cap. me/100g	-	-	-
Exchangeable Cations me/100g:			
Sodium	0.30	1.38	0.18
Potassium	0.10	0.03	0.03
Calcium	4.60	5.20	4.80
Magnesium	5.40	4.00	3.20
Base saturation %	-	-	-
Sand (2.0 - 0.05 mm) %	58	43	47
Silt (0.05 - 0.002 mm) %	22	17	14
Clay (< 0.002 mm) %	20	40	39

Mapping Unit: Ui2

FAO/UNESCO classification: Dystric Gleysol

Profile description number: 22

Field number: 17

Laboratory no.	68	69	70
Horizon	A1	Bwg1	Bwg2
Depth in cm	0-15	40	110
pH - H2O	5.3	5.6	5.5
pH - CaCl2	4.4	4.2	4.2
Organic matter %	1.0	0.5	0.4
Nitrogen %	0.10	0.06	0.09
P205 - ppm	1.4	1.4	1.4
Cation Exch. Cap. me/100g	-	17.6	24.0
Exchangeable Cations me/100g:			
Sodium	0.16	0.18	0.31
Potassium	0.03	0.01	0.02
Calcium	2.40	2.20	3.20
Magnesium	2.60	2.80	3.40
Base saturation %	-	29.5	28.9
Sand (2.0 - 0.05 mm) %	77	82	57
Silt (0.05 - 0.002 mm) %	18	7	11
Clay (< 0.002 mm) %	5	11	32

Mapping Unit: Ui2

FAO/UNESCO classification: Gleyic Cambisol

Profile description number: 23

Field number: 14

Laboratory no.	60	61	62
Horizon	Ap	Bw	Bwg
Depth in cm	0-34	34-70	70-100
pH - H2O	5.6	5.4	5.5
pH - CaCl2	4.6	4.2	4.1
Organic matter %	0.7	-	-
Nitrogen %	0.08	0.08	0.07
P205 - ppm	1.4	-	1.4
Cation Exch. Cap. me/100g	19.6	8.2	15.2
Exchangeable Cations me/100g:			
Sodium	0.15	0.16	0.25
Potassium	0.01	0.01	0.01
Calcium	2.20	1.60	2.00
Magnesium	3.00	3.60	3.20
Base saturation %	27.3	-	35.9
Sand (2.0 - 0.05 mm) %	74	71	64
Silt (0.05 - 0.002 mm) %	13	11	10
Clay (< 0.002 mm) %	13	18	26

SOIL PHYSICAL DATA

Mapping Unit: 1Pvp3 FAO/Unesco classification: Dystric Gleysol

Profile description number: 3 Field number: 3

Horizon	Ap	ABg	Bwg2
Depth in cm	0-16	16-40	70
Sand (2.0 - 0.05 mm) %	33	32	31
Silt (0.05 - 0.002 mm) %	12	10	9
Clay (< 0.002 mm) %	55	58	60
Texture class	c	c	c
Permeability in cm/hour	0.05	0.08	<0.01
Bulk density in g/cc	1.27	1.29	1.30
Total pore space in vol %	51	52	52
Moisture content in vol % at:			
pF = 1.0	50	50	51
pF = 1.5	49	49	50
pF = 1.8	47	47	49
pF = 2.0	46	46	48
pF = 2.3	43	45	47
pF = 2.7	40	42	44
pF = 3.4	36	37	40
pF = 4.2	33	34	35
Volume % moisture between FC and WP	10	11	12

Mapping Unit: Pp5 FAO/Unesco classification: Dystric Gleysol

Profile description number: 8 Field number: 7

Horizon	Ap
Depth in cm	0-20
Sand (2.0 - 0.05 mm) %	50
Silt (0.05 - 0.002 mm) %	12
Clay (< 0.002 mm) %	32
Texture class	scl
Permeability in cm/hour	0.08
Bulk density in g/cc	1.49
Total pore space in vol %	42
Moisture content in vol % at:	
pF = 1.0	41
pF = 1.5	40
pF = 1.8	37
pF = 2.0	35
pF = 2.3	33
pF = 2.7	30
pF = 3.4	28
pF = 4.2	23
Volume % moisture between FC and WP	10

Mapping Unit: Pi2

FAO/Unesco classification: Dystric Gleysol

Profile description number: 12

Field number: 10

Horizon	Bwg1
Depth in cm	40-50
Sand (2.0 - 0.05 mm) %	60
Silt (0.05 - 0.002 mm) %	12
Clay (< 0.002 mm) %	28
Texture class	scl
Permeability in cm/hour	0.12
Bulk density in g/cc	1.61
Total pore space in vol %	37
Moisture content in vol % at:	
pF = 1.0	37
pF = 1.5	34
pF = 1.8	30
pF = 2.0	29
pF = 2.3	27
pF = 2.7	24
pF = 3.4	22
pF = 4.2	17
Volume % moisture between FC and WP	10

Mapping Unit: Pi2

FAO/Unesco classification: Gleyic Cambisol

Profile description number: 13

Field number: 1

Horizon	Ap	Bw	Bwg1
Depth in cm	0-30	50-80	80-120
Sand (2.0 - 0.05 mm) %	59	54	55
Silt (0.05 - 0.002 mm) %	21	10	9
Clay (< 0.002 mm) %	20	36	36
Texture class	scl	sc	sc
Permeability in cm/hour	0.54	0.82	0.22
Bulk density in g/cc	1.56	1.31	1.48
Total pore space in vol %	40	48	44
Moisture content in vol % at:			
pF = 1.0	38	47	43
pF = 1.5	36	42	41
pF = 1.8	33	38	39
pF = 2.0	30	37	38
pF = 2.3	26	35	37
pF = 2.7	21	31	33
pF = 3.4	15	25	23
pF = 4.2	10	18	15
Volume % moisture between FC and WP	16	17	22

Mapping Unit: Pi2

FAO/Unesco classification: Dystric Fluvisol

Profile description number: 14

Field number: 16

Horizon	Ap	C1	C2	Cg
Depth in cm	0-18	40	70	110
Sand (2.0 - 0.05 mm) %	68	67	88	62
Silt (0.05 - 0.002 mm) %	14	13	4	10
Clay (< 0.002 mm) %	18	15	8	28
Texture class	sl	sl	ls	scl
Permeability in cm/hour	1.01	1.86	2.17	1.66
Bulk density in g/cc	1.55	1.52	1.72	1.78
Total pore space in vol %	44	40	33	35
Moisture content in vol % at:				
pF = 1.0	42	38	31	34
pF = 1.5	40	34	27	33
pF = 1.8	38	28	20	31
pF = 2.0	36	25	17	30
pF = 2.3	33	22	15	29
pF = 2.7	27	18	12	27
pF = 3.4	18	14	8	19
pF = 4.2	12	10	5	13
Volume % moisture between FC and WP	21	12	10	16

Mapping Unit: Ui2

FAO/Unesco classification: Dystric Gleysol

Profile description number: 22

Field number: 17

Horizon	Bwg1	Bwg2
Depth in cm	40	110
Sand (2.0 - 0.05 mm) %	82	57
Silt (0.05 - 0.002 mm) %	7	11
Clay (< 0.002 mm) %	11	32
Texture class	ls	scl
Permeability in cm/hour	6.28	0.36
Bulk density in g/cc	1.68	1.54
Total pore space in vol %	32	44
Moisture content in vol % at:		
pF = 1.0	31	43
pF = 1.5	25	41
pF = 1.8	16	40
pF = 2.0	12	39
pF = 2.3	8	38
pF = 2.7	5	35
pF = 3.4	3	22
pF = 4.2	2	18
Volume % moisture between FC and WP	6	20

Mapping Unit: Ui2

FAO/Unesco.classification: Gleyic Cambisol

Profile description number: 23

Field number: 14

Horizon	Bw	Bw
Depth in cm	34-70	34-70
Sand (2.0 - 0.05 mm) %	71	71
Silt (0.05 - 0.002 mm) %	11	11
Clay (< 0.002 mm) %	18	18
Texture class	sl	sl
Permeability in cm/hour	0.21	0.21
Bulk density in g/cc	1.73	1.73
Total pore space in vol %	36	36
Moisture content in vol % at:		
pF = 1.0	36	36
pF = 1.5	33	33
pF = 1.8	30	30
pF = 2.0	29	29
pF = 2.3	27	27
pF = 2.7	25	25
pF = 3.4	21	21
pF = 4.2	18	18
Volume % moisture between FC and WP	9	9