

**SEMI-DETAILED SURVEY OF THE
SOILS OF THE CHUKA-MATERI AND
OF THE RUKURIRI-ISHIARA AREA**

by

N. Bongers, J. Pulles and D. Legger (eds.)

May, 1988



**DEPARTMENT OF SOIL SCIENCE AND GEOLOGY
AGRICULTURAL UNIVERSITY WAGENINGEN
THE NETHERLANDS**

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FOREWORD

In 1985 the Trainings Project In Pedology (TPIP) of the Agricultural University of Wageningen started a project in the Chuka area in Kenya with the objective to produce a reconnaissance soil map of the Chuka and Ishiara mapsheets (Survey of Kenya), and to train post graduate students.

All activities of the T.P.I.P. were carried out in cooperation with the Kenya Soil Survey (KSS) and the National Agricultural Laboratories (NAL), Ministry of Agriculture, Nairobi.

After completion of an exploratory survey, two semi-detailed sample strips were selected, to cover the full range of agro-ecological zones and soils from the slopes of the Mt. Kenya to the Tana river.

Both sample strips, the so-called Rukuriri-Ishiara and the Chuka-Materi strips, are described in this report. Because the Chuka-Materi area was the second strip to be surveyed, some profile descriptions of the Rukuriri-Ishiara strip were used as representative ones for this area as well.

N. Bongers, J. Pulles, D. Legger (eds.)

1 ENVIRONMENT

1.1 LOCATION AND ACCESSIBILITY

The survey areas are located in Eastern Province, Kenya, and are part of the Chuka-South area (mapsheet no. 122/3 and 122/4), between latitudes 0° 15' and 0° 30' South, and longitudes 37° 30' and 38° 00' East.

The major part of the Chuka-Materi area is located in Meru district, and most of the Rukuriri-Ishiara area is located in Embu district, with both strips having relatively small parts in Kitui district. The width of the areas varies from 2 to 4 km, their length is almost 60 km.

The northern boundary of the Chuka-Materi area from Mt. Kenya Forest down to Kathwana is formed by the Tungu river, followed by the Mara river, with an extension North of Chuka up to Nithi river. The southern boundary is the Ruguti river followed by the Naka river, and from Kaanwa on by a tributary of the Naka river. At Kathwana the area moves straight eastwards being 3 km wide.

The area in Mt. Kenya Forest is accessible by mud road, and from Chuka to Kathwana by a mud-gravel road. East of Kathwana the accessibility is poor (see Fig. 1.1).

West of Ishiara the northern boundary of the Rukuriri-Ishiara area is formed by the Thuchi river, the southern boundary by the Irangi-Kyeni road, followed by the Gitwa river and the Kegonge-Kanyuambora road.

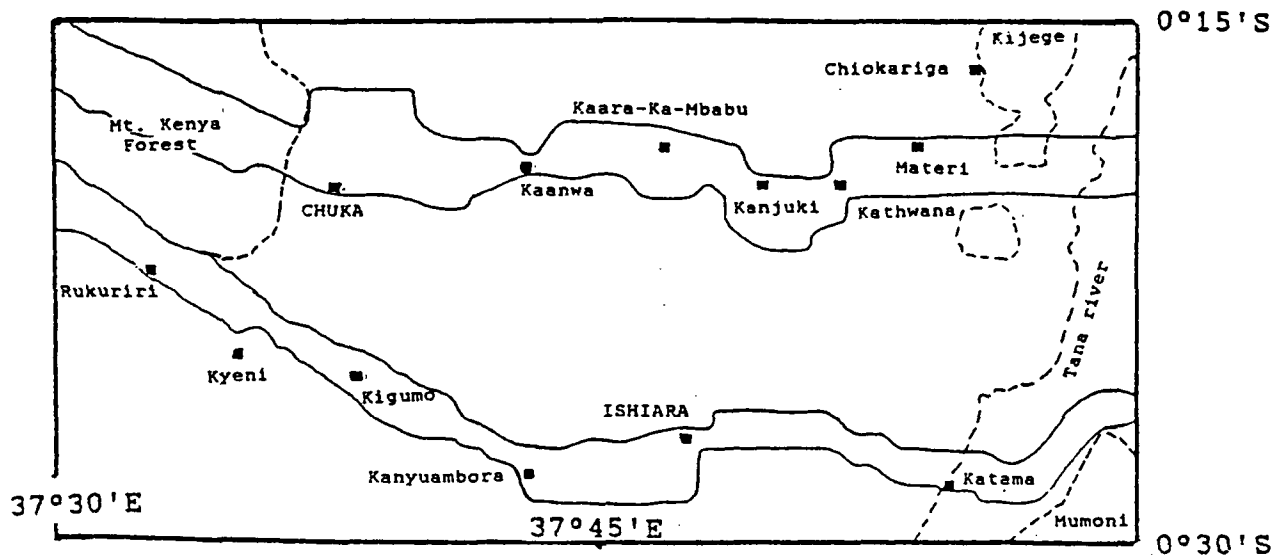


Figure 1.1 Location of the survey areas. The upper strip is the Chuka-Materi area, the lower one the Rukuriri-Ishiara area.

Eastwards, the boundaries are formed by straight lines, parallel to the road towards the Tana river bridge (see Fig. 1.1).

Down to Kanyuambora the accessibility is by dry weather murram roads, and further eastward by all weather murram roads. East of Tana river the accessibility is very limited.

1.2 CLIMATE

1.2.1 Introduction

The agricultural potential of an area is mainly determined by the prevailing climatic conditions. Especially the climatic characteristics rainfall, evaporation and temperature are of major importance for crop performance. The survey area is located near the equator which accounts for the minor variations in monthly temperature and the occurrence of two rainy seasons which coincide with the passing of the Inter Tropical Convergence Zone.

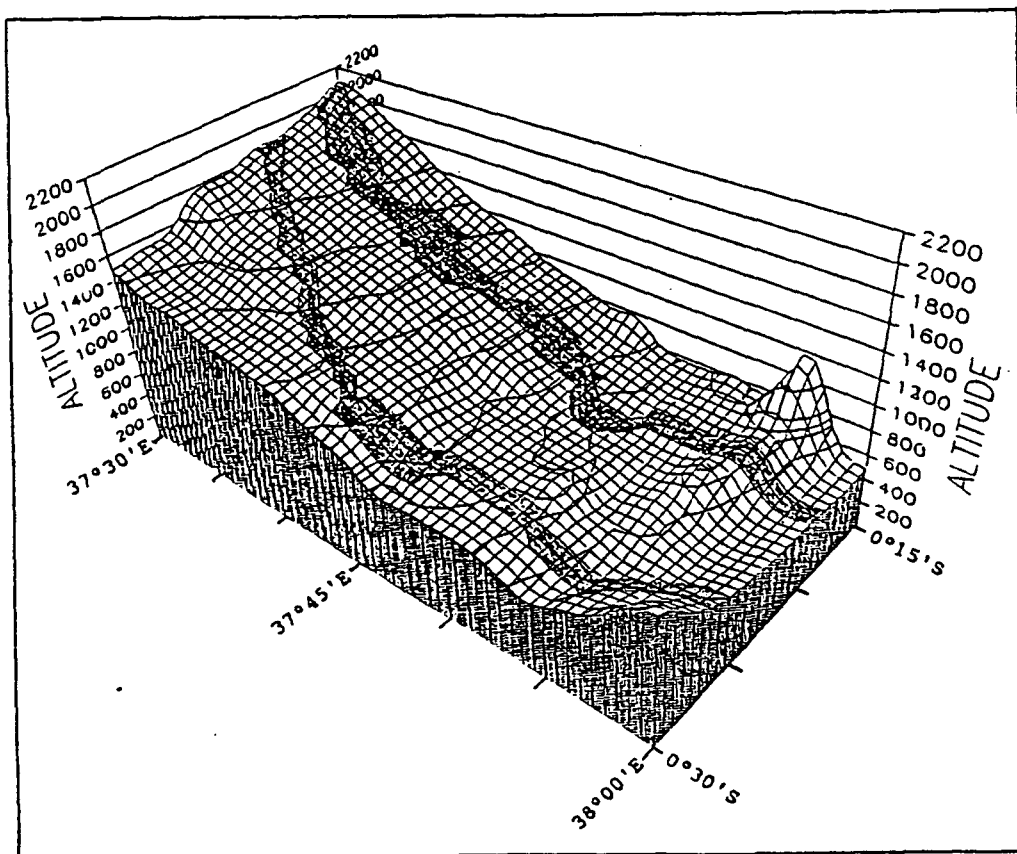


Figure 1.2 Approximate altitude map of the Chuka South area, and location of the two survey areas.

Situated on the slopes of Mt. Kenya (see Fig. 1.2), there is a difference in altitude between East and West of about 1500 metres. The altitude has a pronounced effect on the climate. With increasing altitude, the amount of rainfall increases, and both temperature and evaporation decrease.

During a year four different seasons can be distinguished, notably a short dry season in January and February, a long rainy season from March to May, a long dry season from June to September and a short rainy season from October to December.

At higher altitudes the rainy periods start 20 to 30 days earlier than in the lower parts of the area.

During the long dry season, especially in July, the area knows a persistent cloud cover which results in a relatively low temperature and evaporation.

1.2.2 Average annual rainfall

The contrast between the high and low areas is shown by the rainfall figures (Fig. 1.3). The rainfall varies from an annual average of almost 2200 mm in the very western part of the area to less than 750 mm near Tana river in the eastern part of the area.

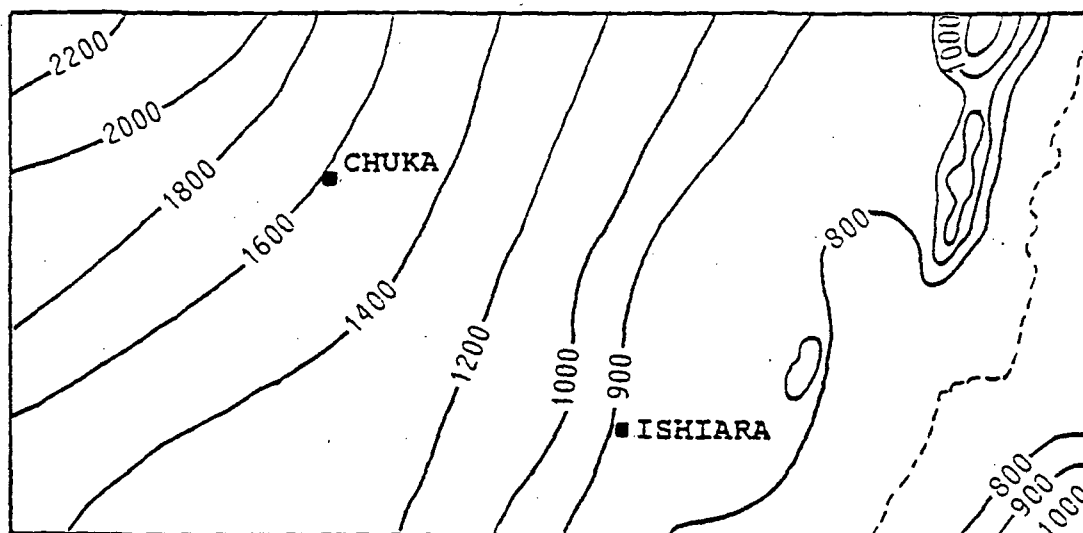


Figure 1.3 The average annual rainfall (mm/year) in the Chuka-South area (Pulles, 1987).

Using data of 13 rainfall recording stations with more than 15 years of recordings, in and near the survey area, it was found that 86% of the variation in rainfall can be explained by altitude (Pulles, 1987). Figure 1.3 was drawn after including data of stations with recordings of a shorter period.

Where the local relief is high, the rainfall increases, e.g. near Kijege and Mumoni mountains (see Fig. 1.1 and 1.2). The reliability of annual rainfall can be demonstrated by the coefficient of variation (standard deviation divided by mean) which is about 0.25 in the western part and 0.50 in the eastern part of the area.

1.2.3 Seasonal rainfall

Most of the rainfall is concentrated in two rainy seasons. During the long rains, from March to May, most rain falls in April. The short rains, from October to December, have November as its wettest month. Most of the precipitation, during all seasons, falls in showers of short duration with high intensities.

A rainy season can be defined as the period in which precipitation exceeds half of the potential evapotranspiration ($r \geq ETo/2$). Using this definition the long rains have a duration of 40-50 days in the East to 80-90 days in the West, and the short rains of 50-60 days to 70-80 days respectively. The highest northwestern part of the area has a trimodal rainfall pattern with a third rainy period in July and August (evaporation in these months is relatively low).

In Fig. 1.4 the average monthly rainfall data of three stations are presented. All these stations have two pronounced rainy periods. Chogoria Forest Station and Chuka County Council Farm show a small third peak in July. The rainfall distribution of Chogoria Forest qualifies for one with a trimodal rainfall pattern because the third peak exceeds half of the potential evapotranspiration.

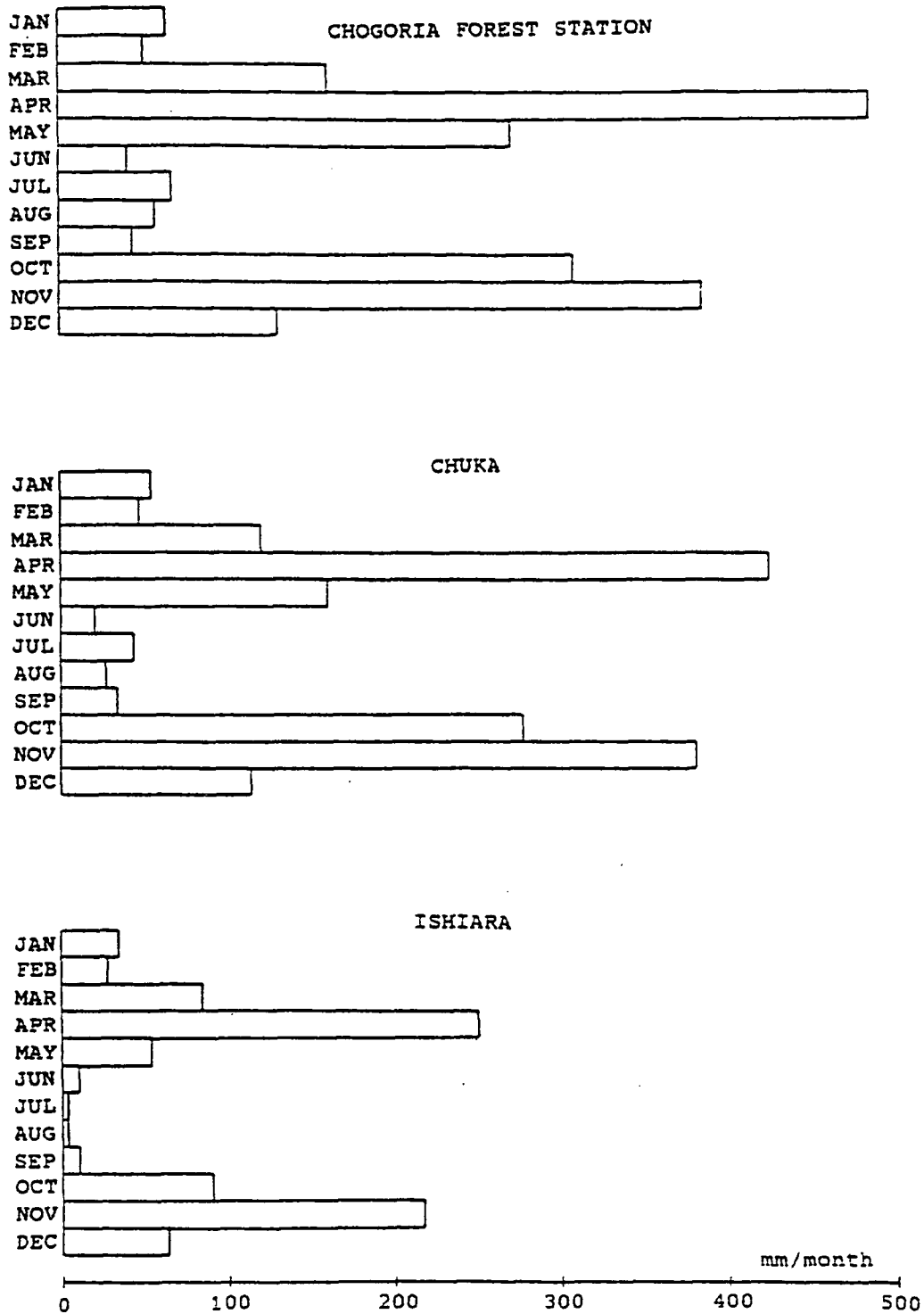


Figure 1.4 Average monthly rainfall for Chogoria Forest Station (2050 mm/year), Chuka County Council Farm (1700 mm/year) and Ishiara (890 mm/year).

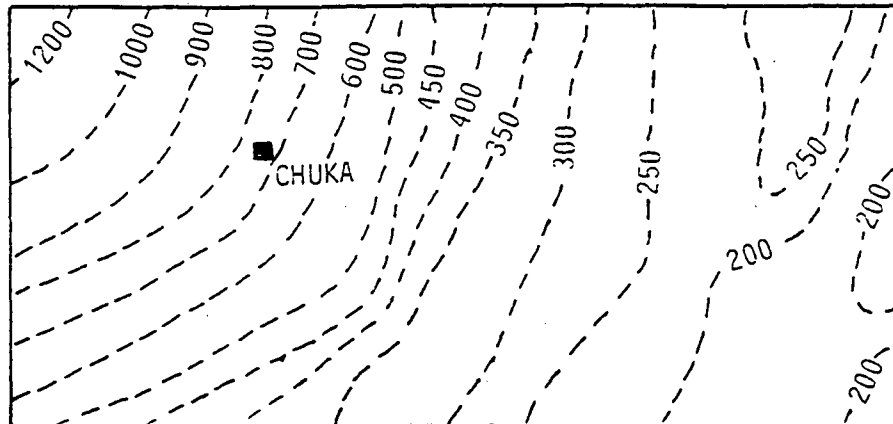


Figure 1.5 60% reliability of rainfall of the first and middle rains (March- September) in the Chuka-South area (Jaetzold and Schmidt, 1983). The dashed area approximately covers the survey areas.

The reliability or probability of the rainfall is important for agriculture. An impression of the 60% reliability, the amount of rainfall in mm that has been exceeded in 6 out of 10 years, is presented in figures 1.5 and 1.6.

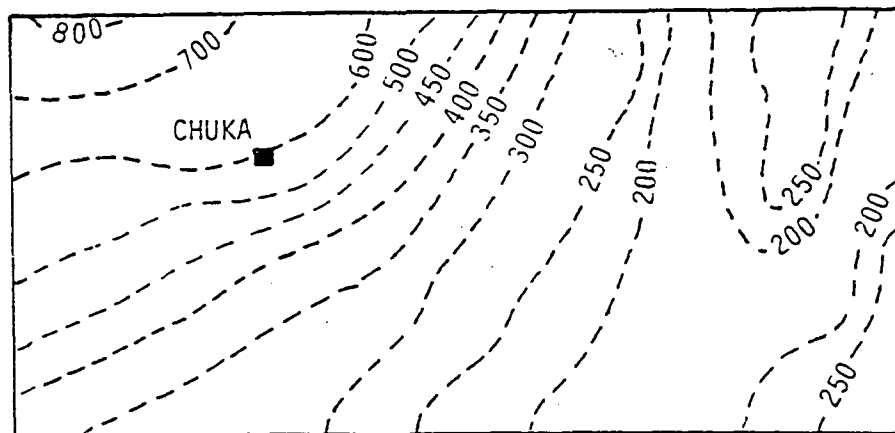


Figure 1.6 60% reliability of rainfall of the second rains (October - February) in the Chuka-South area (Jaetzold and Schmidt, 1983). The dashed area is the approximate location of the survey areas.

1.2.4 Average annual potential evaporation

Due to lack of evaporation data within the survey area, the evaporation was related to altitude as has been done by Woodhead for the whole of Kenya. The average potential evaporation (E_o) varies from 1700 mm/year in the

northwestern part of the area, to 2250 mm/year in the eastern part (Woodhead, 1968).

The area can be divided in different moisture availability zones (Sombroek et al., 1982) determined by the ratio r/E_o of the average precipitation and evaporation. This ratio $r/E_o * 100\%$ varies from 130% in the northwestern part to 25-40% in the eastern part of the area.

The ranges of the different moisture availability zones are presented in Table 1.1 and Fig. 1.7. These zones reflect the potential availability of moisture because the ratio does not account for possible run-off or run-on.

Table 1.1 Moisture availability zones (Sombroek et al., 1982)

Zone	$r/E_o * 100\%$	description
I	> 80	humid
II	65 - 80	sub-humid
III	50 - 65	semi-humid
IV	40 - 50	semi-humid to semi-arid
V	25 - 40	semi-arid
VI	15 - 25	arid
VII	0 - 15	very arid

Especially in the East this causes an overestimation due to the common occurrence of surface sealing and a resulting surface run-off of up to 80%. Therefore, the real availability in the East will correspond with semi-arid to arid, and in extreme cases even very arid.

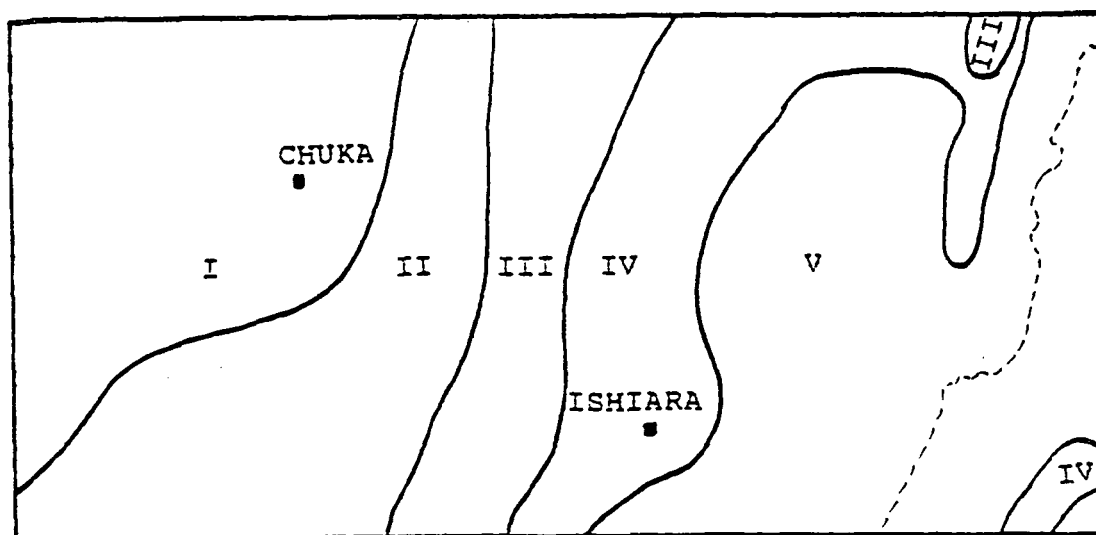


Figure 1.7 Moisture availability zones in the Chuka South area.

1.2.5 Temperature

The mean annual temperature in the area varies from about 15° C in the very northwestern part of the area to 26° C in the eastern half of the area (see Fig. 1.8).

For East Kenya the relation between altitude and mean annual temperature is (Braun, 1986)

$$T = 29.3 - 0.0066 * \text{altitude (metres)}$$

The mean minimum temperature varies from 10 - 12° C in the western part of the area to more than 14° C towards the East.

Table 1.2 The mean annual temperature zones (Sombroek et al., 1982) with the mean annual temperature, the mean maximum temperature, the mean minimum temperature and the corresponding altitudes for eastern Kenya.

Zone	m e a n t e m p e r a t u r e (°C)			Altitude (m)
	annual	maximum	minimum	
VI	14 - 16	20 - 22	8 - 10	2300 - 2000
V	16 - 18	22 - 24	10 - 12	2000 - 1700
IV	18 - 20	24 - 26	12 - 14	1700 - 1400
III	20 - 22	26 - 28	14 - 16	1400 - 1100
II	22 - 24	28 - 30	16 - 18	1100 - 800
I	24 - 26	30 - 32	18 - 20	800 - 500

The coldest month is July with a mean temperature of about 3° C less than that of the warmest month, March.

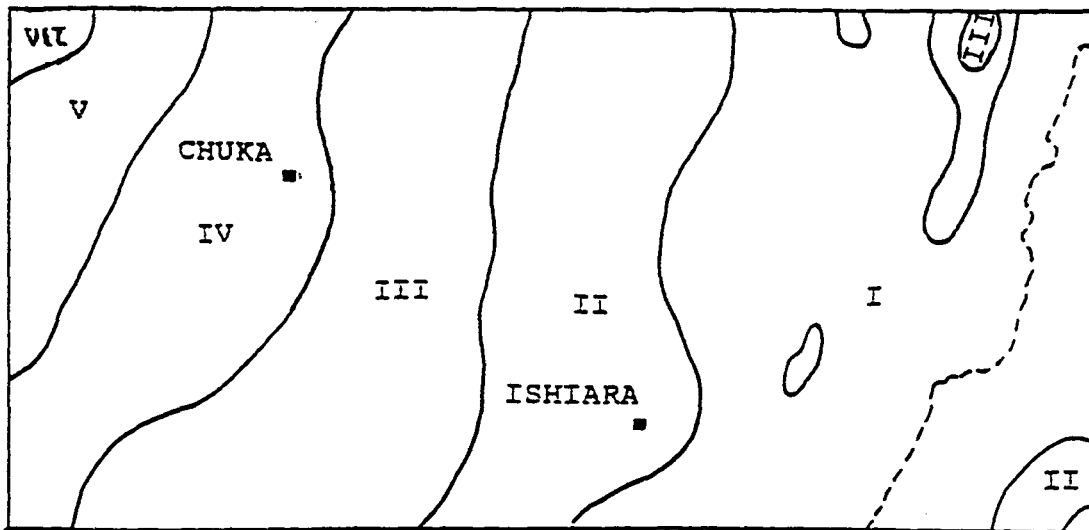


Figure 1.8 Mean annual temperature zones in the Chuka South area.

1.3 PHYSIOGRAPHY

In general the area can be divided into two distinct physiographic units; the eastern slopes of Mt. Kenya in the West, and the Basement System terrain in the East.

Mt. Kenya, which is the remnant of a Tertiary volcano, has a relatively flat profile. The Chuka area comprises a part of its eastern slopes, up to about 2000 m. These dissected slopes are classified as Mountain footridges. The mountain footridges are strongly dissected by perennial streams and

rivers (such as Nithi, Thuchi, Tungu, and Naka) descending from the mountain.

In the mountain footridges a distinction has been made between those with major incisions (Ra), and those with minor incisions (Ri).

The volcanic deposits become thinner towards the East. These flows closely reflect the flat sub-Miocene peneplain landscape over which they spread widely. In the Chuka-Materi area the lowest flows are strongly eroded and dissected. They form so-called Uplands (symbol U) as a transition from the mountain footridges to the Basement System area.

In the Rukuriri-Ishiara strip the lowest flows have resisted erosion resulting in the landform of a volcanic Plateau (P). The Thuchi valley is the northern boundary of this plateau. Both the slopes to this valley and the transition of volcanics into the Basement area are classified as major scarps (M) because of their steep relief (>30%) and high relief intensity.

Unique for the Rukuriri-Ishiara area are the sinkholes in the volcanic area. These are concave depressions, with no water outlet, classified as Bottomlands (B).

The Basement System terrain forms a dissected, rolling landscape, classified as Uplands (symbol U). These uplands are the remnants of the Basement System rocks which have been lowered well below the level of the sub-Miocene peneplain. The higher isolated parts of these uplands with slopes of 30% or more but with a relief intensity of less than 300 m are called Hills (symbol H).

When the relief intensity is higher than 300 m the landform is Mountain, as in the Kibiro Hills (located South of Kijege in Fig. 1.1) and Mumoni Forest. Some hills and mountains are bordered by footslopes (F), formed by colluvial materials from these hills and mountains.

Another landform is formed by the remnants of river terraces which are called an Alluvial plain if they are recognizable as terraces because of their flat topography and their alluvial deposits. Most terrace remnants are too strongly dissected to be called an Alluvial plain.

The village of Materi (see Fig. 1.1) is situated on a Plateau (symbol L). It is a flat area made up of basalts and in the West bordered by a minor scarp.

1.4 GEOLOGY

The Basement System rocks (belonging to the Mozambique Belt) form the floor of all the other rocks of the area. These rocks are composed of heterogenous migmatic gneisses, granulites, and schists of varied and complex origin.

During the Miocene these Basement System rocks formed a peneplain which was covered by volcanics from Mt. Kenya during the late Tertiary. Most of these volcanics are so-called lahars. Lahars are consolidated mudflows from the slopes of a volcano and embed all kinds of volcanic rocks in a matrix of pyroclastics.

The parts of the Basement System area which are not covered by the volcanics have undergone various erosion cycles and now form the uplands, hills, and mountains. Most of the hills and the mountains are intrusive rocks, mostly granitoid or (ultra) mafic rocks, which are more resistant against erosion. The intrusions of ultra basics (hornblendes), such as those of Twanguku hill, caused a very high grade of metamorphism in the surrounding gneisses and migmatites, resulting in zones rich in granulites, such as the Kanjuki

area.

Some hills are built up from the same rocks as their surroundings but have been protected against erosion by a cover of relatively resistant volcanic rock (lahar).

The gneisses which form the main part of the Basement System rocks are in general rich in minerals like hornblende and biotite. On weathering these minerals release much iron from their crystal lattices. This iron gives the soils developed on these gneisses a deep red colour. Soils developed on granitoid gneisses, which contain more quartz, have a lighter, orange colour because of the lower amounts in ferromagnesian minerals and higher amounts of quartz.

During the Pleistocene the Nyambeni volcanoes were active. One of the elongated olivine basalt flows produced by these volcanoes, filled the former bed of the Mutonga river. Since then this ancient riverbed is protected against erosion by these volcanics. This caused an inversion of the landscape and at present the basalts form the higher parts in the landscape. An example of these Pleistocene basalts is the plateau on which Materi is situated.

Sedimentary rocks cover only a small part of the area. Some remnants of Quarternary terraces are found together with the recent alluvial deposits. These deposits are rich in secondary lime because of the (former?) enrichment of calcium carbonates in these deposits by lateral groundwater movement.

2. METHODS

2.1 OFFICE-METHODS

The topographical maps of the survey area at scale 1 : 50 000 (Chuka, mapsheet no. 122/3 (1976) and Ishiara, mapsheet no. 122/4 (1976)) were enlarged to a scale of 1 : 25 000 to form the base map.

The major parts of the survey areas are covered by aerial photographs of scale 1 : 12 500 (1982), except for the area west of Kaanwa and Kigumo, of which only 1 : 50 000 (1968) photographs were available. These were enlarged to a scale of about 1 : 25 000. In the survey area east of Ishiara photo interpretation had to be carried out when fieldwork was near completion, due to lack of aerial photographs at an earlier stage. After fieldwork the basic photo-interpretation was adjusted according to field observations and a vertical sketchmaster was used to transfer the preliminary soil boundaries to the base map.

2.2 FIELD-METHODS

The Rukuriri-Ishiara survey area was subdivided into five parts, being from west to east: Rukiriri, Kigumo, Kavengero, Ishiara and Katama. In May 1985 the Kigumo area was surveyed (Aalders and Nobbe), followed by, successively, Kavengero (Simons, June 1985), Ishiara (Visser and Veldkamp, June 1985), Rukiriri (Bongers & Simons, August 1985) and Katama (Kraayvanger and Pulles, October 1985). For the Rukuriri-Ishiara survey previous fieldwork carried out by the KSS was consulted (See Chapt. 3.1).

The Chuka-Materi survey area was subdivided in four parts. These are from West to East, with between brackets the surveyors and time of survey:

Mt. Kenya Forest to Kaanwa (Oren, November 1985), Kaanwa to Kathwana (Veldkamp and Visser, October 1985), Kathwana to Kibiro Hills (Kraayvanger, February 1986) and Kibiro Hills to Tana River (Pulles, February 1986).

Soil augerings to a depth of 1.20 m (if soil permitted) were made with an Edelman-auger (normal type). In the drier areas (Ishiara, Katama, and West of Kathwana), where soils are very hard and stony, a riverside or sand auger was used occasionally. Except for the Ishiara area soil augerings were made on lines at a distance ranging from 100 to 300 m. Distance between the lines ranged from 300 to 1000 m. In the Ishiara area sites for augerings were selected from the aerial photographs. Augerhole observations helped to define the soil units.

On representative sites, in each soil unit, profile pits were dug. Registration of soil and site characteristics was done according to the "Guidelines for soil profile descriptions" (FAO, 1977). The soil colour was determined using "Munsell Soil Color Charts" (Munsell Color, 1975). To determine the pH a Hellige pH-set was used.

About 1200 augerings and 97 profile pits in the Rukuriri-Ishiara area, and 750 augerings and 31 profile pits in the Chuka-Materi area were described.

From each soil horizon of the profile pits, a sample was taken and send to National Agricultural Laboratories (NAL, Nairobi) for chemical analysis (See Chapt. 2.3). Next 49 profile pits were selected as representative ones.

From a selected number of pits composite samples (0-20 cm and 40-60 cm) were collected in a radius of 5 m from the pit and send to NAL for fertility analysis.

At selected spots in the tea, coffee, cotton and livestock-millet zone in the Rukuriri-Ishiara strip (for explanation of terms see: Jaetzold and Schmidt, 1983) catenas were studied on chemical and physical properties (e.g. fertility, moisture, infiltration, erodibility). Ring samples were collected for bulk density and pF-measurements, and tin samples were taken to study the micro morphology. Furthermore, samples were sieved wet and send to Wageningen for mineral analysis. Results of these studies have been presented in separate reports.

2.3 LABORATORY-METHODS

All samples were analysed at NAL, Nairobi (Hinga et al., 1980). The samples taken from each horizon were subjected to the so-called survey analysis. The following analyses were carried out:

Survey analysis:

1. texture analysis, limited pretreatment
2. pH-H₂O, pH-KCl, and EC in 1 : 2.5 suspension,
3. %C (Walkley-Black),
4. CEC (NaOAc) at pH7.0
5. exchangeable Ca, Mg, K and Na at pH 7.0,

Fertility analysis:

1. pH-H₂O,
2. Na, K, Ca, Mg and Mn (cmol(+)/kg) *
3. P (mg/Kg)
4. %N (Kjeldahl), %C (Walkley-Black)
5. Exchangeable acidity in cmol(+)/kg *

* 1 cmol(+)/kg = 1 me/100g

3. SOILS

3.1 PREVIOUS SOIL-INVESTIGATIONS

On the exploratory soil map of Kenya (Sombroek et al., 1980), the soils of the volcanic footridges are classified as NITISOLS, the soils of the plateaus and uplands as (nito-rhodic) FERRALSOLS. The soils of the Basement System were predominantly FERRALSOLS, with some ACRISOLS and LUVISOLS in the Uplands and REGOSOLS, CAMBISOLS with a lithic phase and LITHOSOLS in the hills and mountains.

A semi-detailed soil survey was carried out near Ishiara (Gachene, 1983). The soils were classified as LITHOSOLS, CAMBISOLS and FERRALSOLS.

3.2 GENERAL PROPERTIES OF THE SOILS

The soils of the survey area can be divided into two broad groups, viz. soils developed on volcanic materials (lahar/ phonolite) and soils developed on Basement System rocks.

Soils developed on lahar/ phonolite consist mainly of well drained, very deep, red, friable, clay (NITISOLS and ACRISOLS). In the Bottomlands moderately well to imperfectly drained soils occur (VERTISOLS and GLEYSOLS). East of the escarpment the soils abruptly change. Here the soils are somewhat excessively drained, shallow to deep, red, friable to firm loamy sand to clay (LUVISOLS). There are many truncated profiles with the argillic B-horizon at the surface.

The soil fertility is the highest in the areas of volcanic origin. In the volcanic footridges, yields are limited by lack of potassium (as a result of excessive leaching) and/or phosphorus (because of too low P contents and strong sorbtion). In general the soils in the footridges have 2-3 %C, a pH-H₂O of 6 to 7 and a P-Mehlich of 10-20 mg/kg. In the Basement these values have an order of magnitude of approximately 0-1 %C, pH-H₂O of 4-5 and >40 P respectively (Simons, 1987).

3.3 SOIL GENESIS AND CLASSIFICATION

3.3.1 Introduction

The soils in the survey area were classified according to the FAO/UNESCO legend for the soil map of the world FAO/Unesco (1974). The FAO legend has been adjusted to the "Kenyan Concept", which makes it better applicable to Kenyan soils.

The classification is based on measurable and observable characteristics, which are the result of soil forming processes. Soil classification is in the first place a tool for correlation of soil information between the different areas. The names indicate major chemical and physical soil characteristics, which are instantly understood by any soil scientist who is familiar with the particular classification system.

In section 3.3.2 the soil forming factors will be discussed, the major classification units will follow in section 3.3.3

3.3.2 Soil genesis aspects

Soil characteristics are the result of the parent material and of soil forming factors. For a better understanding of the pattern of the soils in

the survey area some obvious trends in soil genesis in relation to soil forming factors are summarized.

- Influence of parent material

Parent material is less important than climate. Although many minor differences in soils can be explained by their difference in parent material, they often cannot be expressed in the name of the soil.

- Influence of climate

Climate is one of the most important factors of soil formation in the survey area. In the western part a sequence, based on climate, can be found in the volcanic materials of the footslopes of Mt. Kenya. In this catena the rainfall decreases and the temperature increases in an eastern direction. This has a strong influence on the organic matter content and results in a sequence from West to East of humic Acrisol, dystic Acrisol, chromic Acrisol.

In the eastern part the rainfall is much less what is associated with a lower leaching rate. However the common soils here are chromic Luvisols, which presence indicates leaching rates which cannot be explained by the present relative low rainfall. Probably in the past the climate has been much wetter.

- Influence of landform and age

The landform is important for soil formation on the volcanic plateau. Its horizontal position results in imperfect drainage conditions by which soils with murram (= hardened plinthite) develop.

The scarp of the plateau as well as some small ridges in the Basement System suffer from severe erosion due to their shape. This gives a strong rejuvenation of the soils.

- Influence of drainage

In the western part most soils are well drained. In the eastern part a lot of run-off occurs, which causes somewhat excessive drainage conditions. As stated above, the imperfect drainage on the plateau caused the formation of murram. Partly this is no longer an active process, because signs of poor drainage conditions are limited.

In some valley bottoms in the western part and in the bottomlands poor drainage conditions cause hydromorphic properties, resulting in gleyic subgroups. A satisfactory explanation for the genesis of bottomlands can not yet be given.

- Influence of man

In the eastern part people nowadays apply shifting cultivation with too short a rest period because of the high population pressure. Combined with overgrazing this causes a lot of erosion. The erosion results in truncation of many profiles and a constant rejuvenation of the landscape.

In the volcanic part the cultivation of steep slopes gives rise to erosion too. Here it results mostly in the off-flow of the humic topsoil. But in general the influence is not as strong as in the Basement System.

3.3.3 Major classification units

Nitisols

These are strongly weathered and strongly leached soils with an AB-horizon sequence. An ochric or umbric epipedon overlies an argillic B-horizon of which at least a part has a base saturation below 50%. The argillic B has a clay distribution such that the percentage of clay does not decrease from its maximum by as much as 20% within 150 cm of the surface. This argillic is characterized by shiny pedfaces on at least some of the pedsurfaces (Kenyan Concept).

In the survey area there are humic Nitisols, having a dark (umbric) topsoil relatively rich in acid humic material. Also a large area is covered by dystric Nitisols, having a more red topsoil with less organic matter.

The humic Nitisols are found mostly in the area covered by the Mt. Kenya forest where they have a high organic matter content in the B-horizon. The dystric Nitisols cover the mountain footridges between about 1800 and 1400m.

Acrisols

The Acrisols are strongly weathered and strongly leached soils with an AB-horizon sequence. An ochric or umbric epipedon overlies an argillic B-horizon of which at least a part has a base saturation of less than 50%.

Several subunits are found in the survey area. The humic Acrisols have an umbric epipedon, which is rich in acid humic material. On the plateau the humic Nitisols transform into Humic Acrisols, in eastern direction. In the ferric Acrisols the argillic horizon overlies petroplinthite (murrum), which indicates at least imperfectly drained conditions, now or in the past. Some Acrisols with an umbric epipedon have ferric properties too. As they key out as humic first, they are called humic (ferric) Acrisols (Kenyan Concept). The chromic ones have a reddish colour, with hues being redder than 5YR (Kenyan Concept). Chromic Acrisols can transform to Ferralsols, containing more low activity clay. These soils are called ferral-chromic Acrisols (Kenyan Concept). They follow in the sequence of humic Acrisol, chromic Acrisol to ferral-chromic Acrisol. The gleyic Acrisols are found in the bottomlands. They develop under moderately well drained conditions and show hydromorphic properties within 50 cm of the surface.

Luvisols

In principle the Luvisols are moderately weathered soils with an AB-horizon sequence. An ochric or umbric epipedon overlies an argillic B-horizon that has consistently a base saturation higher than 50%.

Chromic, calcic and orthic Luvisols are encountered in the survey area. The chromic ones have a reddish colour with a hue redder than 5YR (Kenyan Concept). They are very common in the area of soils developed on Basement System rocks. Calcic Luvisols have concretions of soft powdery lime or a calcic horizon. Their appearance is mostly associated with (recent or ancient) streams. Orthic Luvisols are those without any of the specific characteristics for the other subunits.

Fluvisols

The Fluvisols are young soils developed on recent alluvial deposits. They do not have differentiating horizons due to soil forming processes. They may

have an irregular decreasing organic matter content or they may receive fresh sedimentary material at regular intervals or have a fine stratification.

The Fluvisols in the survey area are mostly dystric, having a base saturation of less than 50% in at least part of the soil between 20 and 50 cm to the surface. They appear in the dry riverbeds of intermittent streams. Along the Tana river some eutric Fluvisols occur.

Cambisols

Cambisols are young and limited weathered soils. They have an AB-horizon sequence, in which the B-horizon is not pronounced enough to qualify as an argillic. There are many weatherable primary minerals in these soils.

The subunits dystric, eutric and gleyic are encountered in the survey area. The dystric Cambisols have no umbric epipedon, and the base saturation of the B-horizon is less than 50% at least in some part of the B-horizon. The eutric ones have no umbric epipedon, but the base saturation of the B-horizon is consistently above 50%. Dystric and eutric Cambisols appear on the eroded edges of the plateau. Gleyic Cambisols show hydromorphic properties because of moderately well drained conditions. They are found mostly in the valley bottoms in the western part of the survey area.

Lithosols

Lithosols are shallow soils with an AR-horizon sequence. An ochric epipedon overlies a layer of continuous coherent hard rock within 25 cm (Kenyan Concept) of the surface. There is no B-horizon.

The lithosols developed on ferro-magnesian rocks are eutric, having a high base saturation. The Lithosols appear especially at places with severe erosion such as those at very small ridges of hard rock and at the scarp of the volcanic plateau.

3.3.4 Statistics

Some correlation research has been done regarding the colours of the soils in the Mountain Footridges of the Chuka strip, in the altitude range from about 2150 m to 1250 m. The corresponding mapping units are RiVn1/AC + RiVn1/DF, RiVhn/AC, RiVn2/DF and RiVCs/DF, see Table 3.1.

Although a sharp difference between the colours of the topsoils of the units with slopes classes AC and DF is absent, more soils of unit RiVhn/AC have an umbric horizon, than the adjacent RiVn2/DF which has only 20 % umbric, probably due to the fact that the steeper slopes have thinner A-horizons.

Table 3.1 Percentage of certain colours in topsoils and subsoils at different altitudes of the volcanic footridges.

Altitude upper border Topsoil	1900	1800	1500	1250	1250	1100
		RiVn1		RiVhn	RiVn2	RiVCs
reddish brown	14	?		-	-	9
yellowish red	7	7		2	1	-
dark reddish brown	67	89		88	88	74
dark red	-	?		2	8	3
red	-	?		-	-	-
dusky red	-	?		4	3	-
dark brown	12	?		-	-	14
very dusky red	-	?		4	-	-
% umbric	25	25		50	21	40

Subsoil		RiVn1		RiVhn	RiVn2	RiVCs
reddish brown	22	-	-	-	1	
yellowish red	41	40	14	2	7	
dark reddish brown	31	7	16	72	36	
dark red	6	40	64	14	45	
red	-	13	7	-	4	
dusky red	-	-	-	12	7	
nr. of observations	54	40	58	50	73	35

In general there appears to be a shift in colour of the B-horizon from yellowish red and (dark) reddish brown at higher altitudes, to dark red at the lower altitudes in unit (RiVn1). This reflects also a decrease in the percentage of humic NITISOLS with decreasing altitude.

3.4 DESCRIPTION OF THE SOIL MAPPING UNITS

3.4.1 Systematics and Nomenclature

Each soil mapping unit is identified by a code. The first entry in the legend is based on physiography: volcanic footridges, plateaus, uplands, etc. The second entry is based on parent material or geology: lahar, granitoid gneisses, undifferentiated Basement System rocks, etc. The third entry is for the soils. One or two symbols are used to indicate certain soil characteristics and/or depth class. A further symbol is used to indicate the overall slope class.

The following characters were used in the soil mapping units:

First entry = Physiography

- M mountains and major scarps
- H hills and minor scarps
- L plateaus
- Ri mountain footridges with minor incissions

Ra mountain footridges with major incissions
 F footslopes
 U uplands
 P plains
 A floodplains
 B bottomlands

Second entry = Geology

A alluvial sediments from various sources
 B basic and ultrabasic igneous rocks (basalts etc.)
 F gneisses rich in ferromagnesian minerals, hornblende gneisses
 G granites, granodiorites
 P pyroclastic rocks
 Q granitoid gneisses/quartzites
 U undifferentiated Basement System gneisses/rocks
 V undifferentiated or various igneous (volcanic) rocks

Third entry = Soil characteristics and depth class

Soil characteristics	Depth class
a luvisol	P shallow
d vertisol	p moderately deep
h humic	M shallow over
n nitic	petroplinthite (murrum)
g gleyic	m moderately deep murrum
r red	
b brown	
s gravelly/stony	
e moderately strong erosion	
E strong erosion	C complex
t moderately rocky	CV valley complex
T rocky	CS slope complex

1, 2 general subdivisions

Fourth entry = Slope class

A flat to almost flat	0 - 2 %
B gently sloping	3 - 5 %
C sloping	6 - 8 %
D moderately steep	9 - 16 %
E steep	17 - 30 %
F very steep	> 30 %

3.4.2 Legend

M Soils of the mountains and major scarps

MF Soils developed on gneisses rich in ferro-magnesian minerals

MFps/F well-drained, moderately deep, dark reddish brown, firm, sandy clay
 (chromic LUVISOLS)

- MG** Soils developed on granites and granitoid gneisses
- MGPs somewhat excessively drained, shallow, brown to reddish brown,
 HGPs sand to sandy clay loam, very gravelly, loose to friable
 (orthic LUVISOLS, eutric REGOSOLS and LITHOSOLS)
- MU** Soils developed on undifferentiated Basement System rocks
- MUPs somewhat excessively drained shallow, dark brown to reddish brown,
 very gravelly and very stony, friable, sandy clay to silty clay. Most
 soils have a Bt horizon
 (chromic LUVISOL and LITHOSOLS)
- H** Soils of the hills and minor scarps
- HB** Soils developed on basic and ultrabasic igneous rocks
- HBst somewhat excessively drained, shallow to moderately deep, dark brown
 to dark reddish brown, friable, sandy clay loam to sandy loam
 (eutric REGOSOLS and LITHOSOLS (10%))
- HBPs somewhat excessively drained, shallow, dark reddish brown, clay, very
 gravelly, friable (eutric LITHOSOLS and chromic LUVISOLS)
- HBPT somewhat excessively drained, shallow, dark brown, sandy clay loam to
 clay, firm. In places A-horizon has eroded away.
 (LITHOSOLS, chromic LUVISOLS)
- HF** Soils developed on gneisses rich in ferromagnesian minerals
- HFpr somewhat excessively drained, moderately deep, dark reddish brown
 UFpr friable, sandy clay loam (eutric REGOSOLS)
- HFps somewhat excessively drained, shallow, dark reddish brown, stony,
 friable, sandy loam A over rock (eutric LITHOSOLS)
- HG** Soils developed on granites and granitoid gneisses
- HGPs see MGPs
- HQ** Soils developed on granitoid gneisses
- HQps somewhat excessively drained, shallow to moderately deep, dark
 yellowish brown to strong brown, gravelly and very stony, loose, sand
 to loamy sand (eutric CAMBISOLS and LITHOSOLS)
- HQph somewhat excessively drained, shallow over rotten rock to moderately
 deep, dark brown, calcareous, gravelly, friable, sandy clay loam to
 clay (calcaric PHAEZEMS)
- HV** Soils developed on consolidated lahars
- HVCS complex of well drained, very shallow to very deep, dark brown to
 dark red, friable to firm, clayey soils with an ABCR horizon
 sequence, clayskins are present in the B horizon. The deeper soils
 occur on the upper slopes and in the valley bottom
 (ACRISOLS and LITHOSOLS)

L Soils of the plateaus

LB Soils developed on basic and ultrabasic igneous rocks

LBar well drained, deep, red, clay, gravelly, friable (ferric ACRISOLS)
LBas

LV Soils developed on consolidated lahars

LVr well drained, very deep, dark red, friable, clay having an AB horizon sequence and 10 to 40 cm humic topsoil. In the B horizon clayskins are found (ferral-chromic and humic ACRISOLS)

LVm moderately well to well drained, shallow to deep, dark brown to dark reddish brown, mottled, very friable, gravelly clay over petroplinthite with a humic topsoil of less than 40 cm (humic ferric ACRISOLS)

LVm+r complex of LVr and LVm

LVMp well drained, very shallow to deep, brown to dark reddish brown, very gravelly, very friable, sandy clay over petroplinthite. (dystric CAMBISOLS, pisolitic phase, and LITHOSOLS)

Ri Soils of the mountain footridges with minor incisions

RiV Soils developed on consolidated lahars

RiVn1 well drained, very deep, yellowish red to dark red, very friable, clay, with AB horizon sequence, in places with humic topsoil (humic and dystric NITISOLS)

RiVn2 well drained, extremely deep, dark reddish brown to dark red, friable, clay, having an AB horizon- sequence with 20-40 cm humic topsoil and shiny pedfaces in the B (dystric and humic NITISOLS)

RiVhn as RiVn2, sometimes lacking an A and acid topsoil < 40cm (humic NITISOLS)

RiVCs complex of well drained, shallow to moderately deep (in places deep to very deep), dark reddish brown to yellowish red, friable to firm, gravelly to very gravelly, clay. With AB, AC or AR horizon sequence, in places with humic topsoil. (dystric REGOSOLS, orthic, humic and chromic ACRISOLS humic NITISOLS)

Ra Soils of the mountain footridges with major incisions

RaV Soils developed on consolidated lahars

RaVhn well drained, very deep, dark reddish brown, friable, clay. With AB horizon sequence, with humic topsoil (humic NITISOLS)

RaVn as unit RiVn2, but less deep and with a redder topsoil. At places rotten rock within 1.20m

RaVCV as in unit RaVCV/EF, but moderately deep to very deep (ACRISOLS, dystric NITISOLS)

F Soils of the footslopes

FQ Soils developed on granitoid gneisses

FQbs well drained, deep, dark brown to dark reddish brown, calcareous (in places calcaric horizon), slightly gravelly, friable, sandy loam to clay (calcaric CAMBISOL and calcaric PHAEOZEM)

FQps somewhat excessively drained, shallow to deep, dark yellowish brown to dark reddish brown, gravelly, friable, loamy sand to sandy loam with usually an AB-horizon sequence (orthic LUVISOLS and LITHOSOLS)

FQst well drained moderately to very deep, strong brown to reddish brown, gravelly and fairly rocky, firm to friable, sandy clay with an AB horizon sequence (eutric CAMBISOLS and luvic PHAEOZEMS)

A Soils of the floodplains

Soils developed on alluvial sediments

AAar well drained, very deep, red to dark reddish brown, friable, clay (chromic LUVISOLS)

Soils of the bottomlands

BV Soils developed on consolidated lahar

BVg poorly to imperfectly drained, shallow to moderately deep, very dark gray to dark brown, mottled, slightly gravelly, firm, cracking, clay with ACG horizon sequence, with a humic topsoil of less than 30cm overlying petroplinthite/ rotten rock (plinthic GLEYSOLS)

BVr moderately well to well drained, deep to very deep, dark reddish brown to dark red, mottled, very friable, clay, having an AB horizon sequence, overlying petroplinthite with a 30 - 60cm humic topsoil (gleyic, ferric and humic ACRISOLS)

U Soils of the uplands

UA Soils developed on alluvial sediments from various sources

UAa well drained, very deep, dark brown to reddish brown, sand, loose (orthic LUVISOLS)

UAae somewhat excessively drained, very deep, dark reddish brown, sandy clay loam, friable (orthic LUVISOLS)

UAap well drained, moderately deep, dark brown to dark reddish brown, friable, clay (vertic and chromic LUVISOLS)

UB Soils developed on basic and ultrabasic igneous rocks

UBps somewhat excessively to well drained, moderately deep, dark reddish brown to reddish brown, friable, clayloam to clay
(chromic LUVISOLS)

UF Soils developed on gneisses rich in ferromagnesian minerals

UFar well to somewhat excessively drained, moderately deep to very deep, dark red to dark reddish brown, friable, sandy clay to clay
(orthic LUVISOLS and chromic LUVISOLS)

UFb well drained, deep, dark brown, sandy clay, friable, calcareous.
deep homogenous profile (calciic LUVISOLS)

UFea somewhat excessively drained, deep over rotten rock, dark red, friable, sandy clay loam (chromic LUVISOLS)

UFer1 well drained, shallow to moderately deep, red, firm to friable, sandy clay to clay. The soils have an AB horizon sequence, except for places where the A-horizon is missing (chromic LUVISOLS)

UFer2 somewhat excessively drained, deep to very deep, dark reddish brown to dark red, fairly gravelly, friable clay with an AB horizon sequence (ferric and plinthic ACRISOLS)

UFes somewhat excessively drained, shallow to moderately deep, dark reddish brown, clay, firm (chromic and ferric LUVISOLS)

UFpe somewhat excessively to well drained, moderately deep, dark red to dark brown, friable, clay to sandy clay loam
(orthic and chromic LUVISOLS)

UFps well drained, shallow to moderately deep, dark brown, friable, sandy clay loam to clay (orthic LUVISOLS and chromic ACRISOLS)

UFpT somewhat excessively drained, shallow to moderately deep, dark reddish brown, firm, sandy clay loam to clay (chromic LUVISOLS)

UFrt well to somewhat excessively drained, moderately deep to deep, yellowish red to dark reddish brown, friable, silty clay to sandy clay (chromic LUVISOLS and orthic LUVISOLS)

UFst somewhat excessively drained, shallow to deep, dark reddish brown, clay, friable (chromic LUVISOLS and eutric REGOSOLS)

UFCEp somewhat excessively drained, moderately deep to deep, dark brown to dark reddish brown, friable to firm, loamy sand to clay
(LITHOSOLS, eutric CAMBISOLS and chromic LUVISOLS)

UFCh well drained, moderately deep to deep, dark reddish brown, calcareous, gravelly, friable, sandy clay loam to clay
(calciic CAMBISOLS, calcaric PHAEZEMS and calciic CHERNOZEMS)

UP Soils developed on pyroclastic rocks

UPPT somewhat excessively drained, very shallow, very dark greyish brown, sand to sandy clay loam. Thin A-horizon over hard rock
(LITHOSOLS)

UQ Soils developed on granitoid gneisses

- UQes somewhat excessively drained, shallow to moderately deep, dark reddish brown, loamy sand to sandy clayloam, very friable to friable.
(orthic and chromic LUVISOLS)
- UQet somewhat excessively drained, shallow to moderately deep, reddish brown, slightly gravelly to stony, loamy sand to sandy clay loam, very friable, in places the A is missing
(orthic LUVISOLS)
- UQpE well drained, shallow to deep, dark red to dark reddish brown, friable, sandy clayloam to sandy clay
(chromic LUVISOLS and LITHOSOLS)
- UQPe somewhat excessively drained, very shallow to shallow, dark red to dark reddish brown, friable to firm, sandy loam to clay
(chromic LUVISOLS and LITHOSOLS)
- UQps well drained, shallow to moderately deep, dark brown to dark reddish brown, fairly gravelly and fairly stony, friable, loamy sand to clay loam
(eutric CAMBISOLS and LITHOSOLS)
- UQPT somewhat excessively drained, very shallow, dark red to dark reddish brown, friable, sandy clay loam to sandy loam, 75% consists of bare rock
(LITHOSOLS)
- UQPt somewhat excessively drained, shallow, red, sandy clay, gravelly, friable.
(LITHOSOLS, chromic LUVISOLS)

UU Soils developed on undifferentiated Basement System rocks

- UUap somewhat excessively drained, moderately deep, dark reddish brown, friable, clay loam to clay.
(orthic LUVISOLS)
- UUES somewhat excessively drained, shallow to moderately deep, red, sandy clay loam to sandy clay, friable
(chromic and orthic LUVISOLS)
- UUs somewhat excessively drained, moderately deep, dark reddish brown, friable to firm, slightly gravelly clayloam to clay
(luvic PHAEZEM)
- UUCE somewhat excessively drained, deep, dark reddish brown, firm, sandy clay
(chromic LUVISOLS)

UV Soils developed on consolidated lahars

- UVat as in unit PVat
- UVh well drained, moderately deep to very deep, dark brown to dark reddish brown, friable, clay
(humic NITISOLS and humic ACRISOLS)
- UVhp well drained, moderately deep, dark reddish brown to dark brown, friable, clay.
(humic ACRISOLS)

- UVhr well drained, deep to very deep, dark reddish brown, friable, clay.
(humic NITISOLS)
- UVmpr well drained, shallow to moderately deep, dark reddish brown,
friable, clay to silty clay (ferric ACRISOLS and LITHOSOLS)
- UVn well drained, very deep, dark reddish brown, friable, clay with an AB
horizon sequence and a 20-50cm humic topsoil (dystric NITISOLS)
- UVnr as UVn but with a 30-60cm humic topsoil
- UVpr Well drained, shallow to moderately deep, dark red to dark reddish
brown, friable, silty clay to sandy clay
(ferric ACRISOLS and LITHOSOLS)
- UVr well drained, moderately deep to deep, dark red to dark reddish
brown, friable, clay (ferrals-chromic and chromic ACRISOLS)
- UVst Somewhat excessively drained, very shallow to moderately deep, dark
brown to dark reddish brown, friable, sandy clay
(dystric CAMBISOLS and LITHOSOLS)
- UVCs complex of well drained, deep, dark reddish brown, firm, clay to
gravelly clay; with AB, and in places AC or AR horizon sequences
(humic NITISOLS, humic and chromic ACRISOLS)
- UC Soils developed on various parent materials**
- U(F+Q)CV
- P Soils of the plains**
- PA Soils developed on alluvial sediments from various sources**
- PA1 well drained, very deep, dark brown, loamy sand to clay loam, very
friable. (eutric FLUVISOLS)
- PA2 well drained, very deep, dark reddish brown, sandy clay loam, very
friable to friable. (chromic LUVISOLS)
- PAd moderately well drained, moderately deep to deep, black, firm, clay.
(chromic and pellic VERTISOLS)
- PAP well drained, shallow to moderately deep, dark reddish brown to dark
brown, friable, sandy clay loam to sandy clay
(vertic and chromic LUVISOLS)
- PV Soils developed on consolidated lahars**
- PVat excessively to well drained, shallow to moderately deep, dark reddish
brown to dark brown, friable, sandy clay to clay
(orthic LUVISOLS and LITHOSOLS)

4 FARMING AND LAND USE

4.1 Introduction

As a result of rapid changes within short distances in climate and soils in the Chuka area, there is a clear zonation in different kinds of land use. In general a clear shift in importance of different crops and sources of income can be observed when going from West to East. The importance of maize decreases while that of millet increases. Both the possibility of growing cash crops and the percentage of off-farm jobs decreases towards the East. Agriculture is practised mostly on farms of up to about 6 acres. The most easterly regions in which the land is registered are Kaanwa and Ishiara. Officially the more easterly regions are still free for settling. The population density is decreasing towards the East.

Throughout that area small-scale subsistence agriculture is found. The ecological differences cause a variation in complexity of the farming system. This complexity is determined by the number of different crops and farm activities. In the middle section the farming systems are relatively more complex.

All crops grown in both survey strips are rainfed, except for a small irrigation scheme near Ishiara. Two growing seasons occur in the area. Foodcrops are found throughout the area and until recently cash crops occurred only West of Kathwana. Nowadays cotton has been introduced in the more eastern parts.

Intercropping is a common practice, especially with food crops, and only to limited extent for cash crops such as tea, coffee and cotton, which are commonly grown in monocultures, especially tea and cotton. Perennial crops are only found West of Kanjuki.

The cash crops tea, coffee, cotton and tobacco are marketed by boards. These boards also provide most of the inputs such as seeds, fertilizers and chemicals. They also advise on the cultivation of the crops, by means of extension workers.

Other sources of income are off-farm jobs, forestry, livestock keeping, charcoal exploitation, beehives and basket-work. In the East, where cash crops are absent, livestock keeping and charcoal exploitation are very important in providing cash.

For field operations such as soil preparation, planting and weeding, common tools are panga, (forked) jembe and morro. In the Kathwana - Kanjuki area the use of an ox-plough is common, and in the more eastern areas a morro is preferred because of the stoniness of the soils.

Soil erosion is a very severe problem, especially East of Kaara-Ka-Mbabu. In the whole area various measures are taken to protect the soil from erosion. Coffee is planted on terraces, in the middle and eastern parts of the sample strip contour ploughing and - ridging is common as well as trashlining. Grasslining is found East of Kaanwa, where the ecological conditions are suitable and where there is a need of grass for live-stock. Stonelining is common East of Kaara-Ka-Mbabu where stones are easily available.

East of Kaanwa fallow practices are barely present due to the high land pressure. When the amount of available land increases, the fallow practice becomes more common, but the fallow period is still short in the East because of the scarcity of time and labour for clearing the land.

Considering the low importance of fallow and clearing, the cropping system of two crops a year, the absence of fertilizing and the low level of manuring, a decrease in soil fertility seems inevitable.

4.2 Present land use

The present land use is discussed by taking major villages to represent areas or zones, going from West to East. Kathageri is a village located Northeast of Kyeni (see fig. 1.1) in the Ishiara strip. Some characteristics of these locations are given in the next table.

Table 4.1 Characteristics of some locations in the Chuka and Ishiara strips.

Location	Altitude (m)	Temp. zone	Rainfall (mm)	Soils (FAO)	Landform
Mt.Kenya For	1600	4-5	1800	Nitisols	Mt. Footridges
Chuka	1400	3-4	1600	Nitisols	Mt. Footridges
Kaanwa	1150	2-3	1350	humic Niti/Acri's	Uplands(lahar)
Kaara-K-M.	900	2	1100	Acri/Cambi/Luvi's	Uplands
Kanjuki	750	1	900	Luvisols	Uplands
E.o.Kathwana	700	1	750	Luvisols/Regosols	Uplands/Hills
Rukuriri	1700	4-5	1800	dystric Nitisols	Mt. Footridges
Kathageri	1500	4	1600	dystric Nitisols	Mt. Footridges
Kigumo	1350	3	1400	humic Nitisols	Mt. Footridges
Kanyuambora	1100	2-3	1100	Cambi/Acrisols	Plateau
Ishiara	850	2	900	Luvisols	Uplands
Katama	700	1	750	Luvisols/Regosols	Uplands/Hills

Rukuriri / Mt.Kenya Forest to Chuka

Tea is the main cash crop, and also some coffee is present. Maize is also present although the conditions are not very favourable. Besides this, bananas are grown and cattle is being kept. The importance of cattle increases going up the slopes of Mt. Kenya. The cattle is kept at zero or minimal grazing units, fed on napier grass (*Pennisetum purpureum*). Forestry is playing an important role, and off-farm jobs are common.

Kathageri / Chuka

Coffee is the main cash crop. Maize is the only cereal foodcrop, often intercropped with all kinds of beans. Besides these crops, bananas, pawpaw, and some cassava are found. The limited land area has forced the farmers to adopt zero or minimal grazing practices for their cattle. Again the main source of cattle fodder is napier grass, which is grown in pure stands or on the edge of coffee terraces to limit erosion. Apart from the provision of milk, the production of manure is an important reason for keeping the cattle.

Near Chuka, the off-farm jobs are quite common.

Kigumo / Kaanwa

This is the coffee zone (Jaetzold and Schmidt, 1983). In this zone coffee, tobacco and to a minor extent cotton are grown as cash crops. The major foodcrops are maize and pigeon pea, and to a minor extent sorghum. Intercropping occurs frequently. Other crops are cassava and sweet potato. Fruit trees are common.

Cattle is kept in a kraal at the homesteads for manure and traction. There

is already quite a lot of charcoal burning, and beekeeping for earning cash. Many people are having an off-farm job. The land is registered and because of population pressure the farms are small. Cultivation is on a permanent basis.

Kanyuambora / Kaara-Ka-Mbabu

The main food crops are Bulrush millet, maize and sorghum, in order of importance. These cereals are often intercropped with pulses like pigeon peas and greengrams. Cotton is the main cash crop, followed by tobacco, and is cropped in pure stands with input of fertilizers.

A large area is dense bushland which accounts for the importance of charcoal exploitation and herding of cattle and goats. Sunflower is grown for chicken food. Mango, banana and pawpaw trees are present.

Ishiara / Kanjuki

The importance of cotton as a cash crop has increased. This is the most eastern region where the performance of maize is still sufficient. When intercropped with beans, the latter crop is harvested when the maize is still developing.

Grazing of cattle is of increasing importance, especially Ishiara is famous for its goats. The farm size is larger here. Because the physiognomy is more open, shifting cultivation is being practised.

Katama / East of Kathwana

The main food crop, Bulrush millet, is commonly grown in monocultures. Sometimes it is intercropped with greengrams, pigeon peas or cotton, of which the latter has been introduced recently.

Shifting cultivation is very common. Fields are occupied for about two to four seasons, followed by a fallow period of another two to four seasons. The pressure on the communal land is still increasing. Besides the cultivation of crops, a lot of grazing and browsing occurs, as well as charcoal exploitation. These are important sources of income in this area.

Near Tana river the extensive agriculture is limited to the alluvial deposits along the Tana or dry rivers. These areas have a relatively high moisture availability because of seepage water. Crops grown here are millet, cotton and pulses.

5 LAND EVALUATION

5.1 Introduction

In assessing the productive capacity of the soils in an area, one needs to know the soils and their distribution, their input requirements and the expected responses to input application. A soil survey provides the fundamental information about soil and land characteristics.

In the Kenyan approach of land evaluation it is basic that the evaluation is applied for a well defined land use. The relevant land utilisation types (LUT) are therefore identified at an early stage of the land evaluation procedure. In our survey strips these LUT's consist of single crops, and not of complex land uses.

The land utilisation types with their crop requirements will be discussed in paragraph 5.3. The physical land suitability, according to its land qualities, is described in paragraph 5.2. The final matching of crop requirements and land qualities will be exercised according to the method of the most limiting factor. The results of the rating for physical land suitability and of the matching for the various mapping units are listed in Appendix D.

5.2 Physical land suitability

The physical suitability of land is determined by many different land qualities, which are often closely related. The rating of land qualities has been done according to the "proposal for 3rd Approximation for Rating of Land qualities" (Weeda, 1985, see Appendix C).

The land qualities (LQ) considered are:

1. availability of water
2. temperature
3. availability of nutrients
4. hindrance by salinity and /or alkalinity
5. resistance to erosion
6. availability of oxygen for root growth
7. possibilities for land preparation
8. hindrance of natural vegetation
9. hindrance of overgrazing

The Agroclimatic Zone Map of Kenya (Sombroek et al., 1982) distinguishes 7 zones for moisture availability (see table 1.1). The need for a continuous moist period is not regarded here. Thus in a bimodal rain distribution pattern, which is the case in this area, the requirements may be hard to meet.

It should be noted that the altitude relation used in the approximation has only limited value in this area, because it is known that in eastern Kenya the temperature is approximately 2° C lower than in western Kenya at the same altitude (Braun, 1980).

The rating for nutrient availability is slightly different from Weeda's proposal. The nutrient availability and the pH are treated separately because often the pH requirements of crops are well known, while the nutrient requirements are only vaguely known.

With the most limiting factor method most Basement System soils receive the rating low to very low for nutrients because of the low carbon content of these soils.

5.3 Land utilisation types and crop requirements

5.3.1 Introduction

The basic needs for growth are the same for all plants. Radiation, moisture and nutrients are very important for any plant to grow. Furthermore, there are more specific needs such as oxygen for root growth and the absence of salinity or alkalinity. The quantitative level of these needs vary with the desired yield. There is a difference between the minimum (or maximum) input for a plant to survive and the requirements for optimal production. This difference is expressed by an optimum and a tolerance for a certain crop requirement.

Besides the physical needs, mentioned above, depending on soil and climate, some crop requirements are more related to cultivation practices, like hindrance by natural vegetation and overgrazing, the possibility of land preparation and erosion hazard.

A higher yield level requires use of fertilizers and a higher level of management, together with well developed services like extension workers and cooperatives.

In this case the land evaluation is executed for the present level of input and management, as described in chapter 4. This means that the cash crops tea and coffee have a present medium management level marked by application of fertilizers. A high management level with application of lime does not occur in this area.

The possibility of irrigation has not been considered. With irrigation the dependence of yield on rainfall diminishes.

Because of difficulties in defining LUT's, with all the possible combinations of mixed cropping and intercropping, it was decided to do the land evaluation for single-crop LUT's only. For each crop the requirements are given, without considering the influence of growing them together with other crops.

5.3.2 Crop requirements

In table 5.1 crop requirements for 9 crops, common in the Chuka area, are listed. For the foodcrops we chose: maize (*Zea mays*), bulrush millet (*Pennisetum typhoides*), sorghum (*Sorghum bicolor*), cowpeas (*Vigna unguiculata*) beans (*Phaseolus vulgaris*) and cassava (*Manihot esculenta*), for the cashcrops: cotton (*Gossypium hirsutum*), coffee (*Coffea arabica*) and tea (*Camelia sinensis*).

Table 5.1. Crop requirements of the selected single LUT's.

	available moisture zone	moisture storage capacity	temperature zone	availability of nutrients	salinity & alkalinity	availability of oxygen	erosion hazard
maize	I-II (I-V)	1-3 (1-7)	24-30 (15-35)	high pH 5.5-7.0 (5.0-8.0)	medium tolerance	well drained imperfect tol.	high
millet	II-III (II-VI)	3-4	22-30	medium pH 5.0-8.0		well drained	high
sorghum	I-II (I-V)	1-3	24-30 (15-35)	medium pH 5.5-6.5 (5.0-8.5)	medium tolerance	moderately well drained logging tol.	high
cowpeas	II (II-V)	2-3	(20-30)	pH 5.5-6.5			high
beans	II (I-IV)	1-2 (3)	15-20 (10-24)	medium pH 6.0-7.0	low tolerance	well drained	medium
cassava	I-II (I-V)	3-4	20-30	medium, low tol any pH tolerated		well drained	medium
cotton	II-III (I-V)	1-3	20-30 (16-35)	medium pH 7.0-8.0 (5.5-8.0)	tolerant		high
coffee	II-III (I-V)	1-2 (3)	18-20	medium pH 5.0-6.0 (4.5-7.0)		well drained	medium
tea	I (I-II)	1-2	16-20	high pH 4.0-5.5 (4.0-6.0)	low tolerance	well drained mod. well tol.	low

Because of the little information available on the subject of differences in needs between crop varieties it is only possible to give an estimate of the crop requirement for each crop. The differences between cultivars can be greater than the differences between crop species. The various cultivars of maize in the Chuka area are an example of that.

Most of the requirements are derived from Jaetzold and Schmidt (1983), Sombroek et al. (1982), Doorenbos and Kassam (1979) and Young (1976).

For each crop the figures for every crop requirement can be fitted into a conversion table, to match them with the land qualities, given in paragraph 5.2.

For grazing, a common feature in the eastern part of the Chuka area, no requirements are given. Most grazing, with either high or low rates of stocking is done on natural vegetation like grasses, herbs and shrubs. It can be practised when crop agriculture is not possible anymore.

5.4 Matching results

The results of the matching are presented in Appendix D. Four suitability classes are distinguished:

- S1 very suitable
- S2 suitable
- S3 marginally suitable
- N not suitable.

A large area in the highlands of the survey area receives a S1 rating for tea. The area with an altitude ranging between 2000 and 1100 m is very suitable, except for the area around Kyeni, a zone of about 4 km wide extending to the left lower corner of the area, which is only moderately suitable for tea. Above 2000 m (in Mt. Kenya forest) the rating is S3 because of the low temperature. Lower than 1400 m the area is not suitable for tea because of the high temperature. Near Rukuriri the suitability for tea is higher than near Chuka and the Mt. Kenya Forest, due to the fact that the rainfall at Rukuriri is more equally distributed over the year (KMD data of Irangi forest station).

The only area that receives a S1 rating for coffee is the area around Kyeni which was S3 for tea. The rest of the area between 2000 and 1100 m is marginally suitable with temperature and moisture limiting above 1700 m, moisture between 1700 and 1400 m, and temperature lower than 1400. Below 1100 the rating is N, the border lying approximately at Kaanwa and somewhat West of Kanyuambora.

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APPENDIX A

SOIL MAPPING UNITS

M Soils of the mountains and the major scarps

MF Soils developed on gneisses rich in ferro-magnesian minerals

Soil mapping unit MFps/F

Number of augerings	: 4
Parent material	: hornblend-biotite gneiss
Macrorelief	: mountainess slopes
Erosion	: moderate rill erosion
Rockiness/ stoniness	: gravelly, very stoney and bouldery
Land use	: very extensive grazing, shifting cultivation on the lower slopes
Soils general	: Well-drained, moderately deep, dark reddish brown, firm, sandy clay
Range of characteristics	
, colour	: A+B: dark reddish brown
, texture	: A: gravelly sand B: very gravelly sandy clay loam loam to sandy clay
, structure	: A: single grain structure B: medium subangular blocky structure
, consistence	: A: non sticky, nonplastic, loose B: slightly sticky, slightly plastic; firm
Diagnostic properties	: argillic B
Classification	: chromic LUVISOLS
Representative profiles	: 39, 40 and 41

MG Soils developed on granites and granitoid gneisses

Soil mapping unit MGPs/EF

HGPs/EF

Number of augerings in unit	: 2
Parent material	: granitoid gneisses and granites
Macro relief	: hilly to mountaineous, slopes >16%
Erosion	: moderate to severe sheet, slight rill and gully erosion
Rockiness/stoniness	: very gravelly, stony to very stony, bouldery; in places rocky
Land use	: partly protected forest; dense bushland to wooded bushland; extensive grazing; charcoal exploitation
Soils, general	: somewhat excessively drained, shallow, brown to reddish brown, sand to sandy clay loam, very gravelly, loose to friable
Range of characteristics	
, colour	: A: dark brown to dark yellowish brown B: brown to reddish brown

,texture : A+B: sand to sandy clay loam, very gravelly
,structure : A+B: weak fine to medium subangular blocky
,consistence : A+B: bloose to friable when moist; non to slightly sticky and non to slightly plastic when wet
Diagnostic properties : argillic B-horizon or (para)lithic phase
Classification : orthic LUVISOLS, eutric REGOSOLS and LITHOSOLS
Representative profile : 47

MU Soils developed on undifferentiated Basement System rocks

Soil mapping unit **MUPs/EF**

Number of augerings in unit : 12
Parent material : lahar and undifferentiated gneisses
Macro relief : hilly to mountainous, slopes > 8 %
Erosion : moderate rill and slight gully erosion
Rockiness/stoniness : very gravelly, stony and rocky
Land use : grazing; cropping of maize and millet
Soils general : somewhat excessively drained, shallow, dark brown to dark reddish brown, very gravelly and very stony, friable, sandy clay to silty clay. Usually the soils only have a B-horizon.

Range of characteristics
,colour : B: dark brown to dark reddish brown
,texture : B: sandy clay to silty clay
,consistence : slightly sticky and slightly plastic when wet.

Chemical properties : for the Luvisols: %C is about 0.25 throughout the profile; pH-H2O is 5.5, pH-KCL is 5.0; CEC is about 13 cmol(+)/Kg soil; BS ranges from 62% to 74%

Diagnostic properties : argillic B and at places continuous hard rock within 25 cm depth
Classification : chromic LUVISOLS and LITHOSOLS
Representative profiles : 18 and 28
Remarks : sometimes translocated iron and manganese concretions. 50% of this unit consists of LITHOSOLS

H Soils of the hills and the minor scarps

HB Soils developed on basic and ultrabasic igneous rocks

Soil mapping unit **HBst/E**

HBst/EF

Number of augerings in unit : 8
Parent material : mafic intrusives mixed with migmatites and gneisses
Macro relief : hilly to steeply dissected, slopes > 16%
Erosion : slight to moderate sheet and rill

erosion

Rockiness/stoniness : very gravelly and stony, bouldery and rocky

Land use : grazing only

Soils, general : somewhat excessively drained, shallow to moderately deep, dark brown to dark reddish brown, friable, sandy clay loam to sandy loam

Range of characteristics

 ,colour : A: dark brown
 : B: dark reddish brown to dark brown

 ,texture : A+B: sandy clay loam to sandy loam

 ,structure : A+B: subangular blocky

 ,consistence : A+B: friable when moist;slightly sticky and slightly plastic when wet

Diagnostic properties : non continuous hard rock within 25 cm depth

Classification : eutric REGOSOLS and LITHOSOLS (10%)

Representative profile : 3

Soil mapping unit **HBPs/EF**

Number of augerings in unit : 2

Parent material : mafic intrusives (diorite)

Macro relief : hilly to mountaineous, slopes >16%

Erosion : slight rill erosion; in places gullies

Rockiness/stoniness : very gravelly and very stony

Land use : Munguni Forest is a protected forest and spitting cobra reserve; extensive grazing on the smaller hills

Soils, general : somewhat excessively drained, shallow, dark reddish brown, clay, very gravelly, friable

Range of characteristics

 ,colour : A+B: dark reddish brown

 ,texture : A+B: clay to sandy clay loam; very gravelly

 ,structure : A+B: mediumgranular to medium subangular blocky

 ,consistence : A+B: friable when moist;slightly sticky and slightly plastic when wet

Diagnostic properties : continuous hard rock within 25 cm or in places argillic B horizon when deeper

Classification : eutric LITHOSOLS and chromic LUVISOLS

Representative profiles : 17 and 47

Soil mapping unit **HBPT/E**

Number of augerings in unit : 2

Parent material : gneisses rich in ferromagnesian minerals and basalts (on the scarpslope)

Macro relief : undulating to rolling, slopes 16-30%

Erosion : moderate to severe rill erosion

Rockiness/stoniness : gravelly, stony, bouldery and rocky

Land use : extensive grazing

Soils, general : somewhat excessively drained, shallow, dark brown, sandy clay loam to clay, firm. In places A-horizon has eroded

away.

Range of characteristics

,colour	: A+B: dark brown to dark reddish brown
,texture	: A+B: clay to slightly gravelly sandy clayloam
,structure	: A+B: medium granular
,consistence	: A+B: firm when moist; slightly sticky and slightly plastic when wet

Diagnostic properties : continuous rock layer within 25cm, argillic B

Classification : LITHOSOLS, chromic LUVISOLS

Representative profiles : 17 and 47

HF Soils developed on gneisses rich in ferromagnesian minerals

Soil mapping unit	UFpr/CD	HFpr/DE	HFpr/E
Number of augerings in unit	:	11	
Parent material	:	gneisses rich in ferromagnesian minerals	
Macro relief	:	undulating to rolling, slopes 8-30%	
Erosion	:	slight to moderate sheet and rill erosion	
Rockiness/stoniness	:	gravelly; fairly stony, bouldery and rocky	
Land use	:	grazing	
Soils, general	:	somewhat excessively drained, moderately deep, dark reddish brown friable, sandy clay loam	
Range of characteristics			
,colour	:	A+B: dark reddish brown	
,texture	:	A+B: sandy clay loam	
,structure	:	A+B: fine subangular blocky	
,consistence	:	A+B: very friable when moist; slightly sticky and non plastic when wet	
Diagnostic properties	:	no diagnostic horizons; ochric epipedon	
Classification	:	eutric REGOSOLS	
Representative profile	:	3	

Soil mapping unit **HFps/E**

Number of augerings	:	2
Parent material	:	gneisses rich in ferro-magnesian minerals and mafic rocks.
Macro relief	:	hilly, slopes 16-30%
Erosion	:	moderate rill erosion
Rockiness/stoniness	:	stony
Land use	:	grazing
Soils, general	:	somewhat excessively drained, shallow, dark reddish brown, stony, friable, sandy loam. Have only an A horizon over rock.
Range of characteristics		
,colour	:	A: dark reddish brown
,texture	:	A: sandy loam
,consistence	:	slightly plastic and slightly sticky when wet

ACRISOLS, continuous hard rock within
25cm of the surface for LITHOSOLS
Classification : ACRISOLS and LITHOSOLS
Representative profiles : 1 and 22

HQ Soils developed on granitoid gneisses

Soil mapping unit HQps/EF

Number of augerings : 12
Parent material : granitoid gneisses
Macro relief : hilly, slopes > 16 %
Erosion : slight to moderate rill and gully erosion
Rockiness, stoniness : gravelly and very stony
Landuse : grazing.
Soils, general : somewhat excessively drained, shallow to moderately deep, dark yellowish brown to strong brown, gravelly and very stony, loose, sand to loamy sand

Range of characteristics
 , colour : dark yellowish brown to strong brown
 , texture : sand to sandy clay loam
 , consistence : non sticky and slightly plastic
Diagnostic properties : cambic B horizon and at places continuous hard rock within 25cm depth.
Classification : eutric CAMBISOLS and LITHOSOLS.
Representative profile : 27
Remarks : 10%-40% of the area consists of bare rock

Soil mapping unit HQph/EF

Number of augerings : 12
Parent material : granitoid gneisses
Macro relief : hilly to mountainous, slopes > 16 %
Erosion : moderate sheet, severe rill, in places also severe gully erosion
Rockiness/stoniness : very gravelly, very stony (boulders)
Land use : dense bushland, extensive browsing by goats, charcoal exploitation
Soils, general : somewhat excessively drained, shallow over rotten rock to moderately deep, dark brown, calcareous, gravelly, friable, sandy clay loam to clay

Range of characteristics
 , colour : A+B: dark brown
 , texture : A: clay, in places clay loam
 B: clay to clay loam
 , consistence : friable when moist, slightly sticky and slightly plastic when wet
Diagnostic properties : mollic epipedon, in places paralithic or

Classification : lithic phase
: calcaric PHAEZOZEMS
Representative profile : 30

L Soils of the plateaus

LB Soils developed on basic and ultrabasic igneous rocks

Soil mapping unit LBar/A

Number of augerings in unit : 2
Parent material : basalts
Macro relief : flat, slopes < 2%
Erosion : slight sheet
Rockiness/stoniness : in places slightly gravelly (murrum)
Land use : wooded bushland; extensive grazing
Soils, general : well drained, deep, red, clay, gravelly,
friable

Range of characteristics

 , colour : A: dark reddish brown
 : B: red

 , texture : A: silty clay to clay
 : B: silty clay to clay, gravelly (Fe/Mn
 concretions)

 , structure : A: fine subangular blocky
 : B: medium granular

 , consistence : A+B: friable when moist; slightly sticky
 to sticky and slightly plastic to
 plastic when wet

Diagnostic properties : argillic B-horizon; ferric properties
Classification : ferric ACRISOLS
Representative profile : 42

Soil mapping unit LBas/AB

Number of augerings : 2
Parent material : basalts
Macro relief : flat to undulating, slopes < 5%
Erosion : moderate sheet and slight rill erosion
Rockiness/stoniness : gravelly; in places stony and bouldery
Land use : extensive grazing; wooded bushland
Soils, general : see LBar/A
Range of characteristics : see LBar/A
Diagnostic properties : argillic B-horizon; ferric properties
Classification : ferric ACRISOLS
Representative profile : 42

LV Soils developed on consolidated lahars

Soil mapping unit LVr/AB

Number of augerings in unit : 52
Parent material : lahar / phonolite
Macro relief : flat to gently undulating, slopes 0-5 %
Erosion : slight sealing occurs as a result of

splash erosion
 Rockiness / stoniness : nil
 Land use : bushland used for extensive grazing and rotation of annual and perennial crops are combined in a system of shifting cultivation, food crops grown are maize, beans, bananas, cowpea, pigeon pea and sweet potato, the main cash crops are cotton and tobacco, many trees especially mango trees occur in the area.
 Soils, general : well drained, very deep, dark red, friable, clay, having an AB horizon sequence and 10 to 40 cm humic topsoil. Clayskins occur in the B-horizon.
 Range of characteristics
 ,colour : A: dark reddish brown
 B: dark red
 ,texture :A+B: clay
 ,structure : A: weak to moderate, granular to subangular blocky.
 B: weak to moderate subangular blocky
 ,consistence : friable when moist, slightly sticky and slightly plastic when wet
 Chemical properties : %C ranges from 1.6% in the A-horizon to 0.5% in the B-horizon; pH-H₂O is 5.4 and pH-KCl is 4.7; CEC ranges from 23 to 11 cmol(+)/Kg soil; BS ranges from 46% to 22%
 Diagnostic properties : ochric or umbric A, argillic B
 Classification : ferral-chromic and humic ACRISOLS
 Representative profile : 9

Soil mapping unit **LVr/BC**

Number of augerings in unit : 10
 Parent material : lahar / phonolite
 Macro relief : gently undulating to undulating, slopes 3-8 %
 Erosion : as in unit LVr/AB
 Rockiness/stoniness : nil
 Land use : as in unit LVr/AB
 Soils, general : as in unit LVr/AB, but with a redder topsoil

Soil mapping unit **LVm/BC**

Number of augerings in unit : 10
 Parent material : lahar / phonolite
 Macro relief : gently undulating to undulating, slope 3-8 %
 Erosion : nil
 Rockiness / stoniness : at places slightly gravelly, few stones
 Land use : as in unit LVr/AB with less trees
 Soils, general : moderately well to well drained, shallow to deep, dark brown to dark reddish

brown, mottled, very friable, gravelly clay, over petroplinthite (murram)/rock with a humic topsoil less than 40 cm.

Range of characteristics
 , colour : A: dark brown
 B: dark reddish brown
 , texture : A: slightly gravelly clay
 B: gravelly to very gravelly clay
 , structure : A+B: moderate, medium to coarse,
 subangular blocky falling apart to
 granular
 , consistence : very friable when moist, slightly sticky
 and slightly plastic when wet
Diagnostic properties : ochric or umbric A, argillic B,
 pisoferic phase
Classification : humic ACRISOLS with a pisolitic phase
 (humic ferric ACRISOLS)
Representative profile : 20

Soil mapping unit **L_{Vm+r}/AB**

Number of augerings in unit : 45
Macro relief : flat to gently undulating, slopes 0-5 %
Land use : as in unit L_{Vr}/AB, but with grassland in
 pond-like depressions used for grazing
Soils, general : the member units of this association are
 L_{Vr}/AB and L_{Vm}/BC, unit L_{Vm} occupies the
 pond-like depressions and the areas
 where rock is approaching the surface.
Chemical properties : for Cambisols: %C ranges from 1.4 in the
 A-horizon to 0.5 in the B-horizon;
 pH-H₂O is 5.8, pH-KCL is 5.0; CEC
 ranges from 23 to 14 cmol(+)/Kg soil; BS
 ranges from 23% to 7% for Acrisols: %C
 ranges from 1.3 in the A-horizon to 0.7
 in the B-horizon; pH-H₂O is 5.9, pH-KCL
 = 5.4; CEC ranges from 17 to 12
 cmol(+)/Kg soil; BS ranges from 37% to
 48%
Classification : Dystric CAMBISOLS and ferral-chromic and
 ferral-humic ACRISOLS
Representative profiles : 2 and 16

Soil mapping unit **L_{Vm}p/AB**

Number of augerings : 25
Parent material : lahar / phonolite
Macro - relief : flat to gently undulating, slopes 0-5 %
Erosion : nil
Rockiness/stoniness : very gravelly, rocky
Land use : extensive cropping of cotton, maize,
 pigeon peas and sorghum
Soils, general : well drained, very shallow to deep,
 brown to dark reddish brown, very
 gravelly, very friable, sandy clay over

petroplinthite (murram)/ rock. The soils have an AB-horizon sequence

Range of characteristics

,colour : A: dark brown
B: dark brown to dark reddish brown

,texture : A+B: very gravelly sandy clay

,consistence : very friable when moist, slightly sticky and slightly plastic when wet

Chemical properties : for Cambisols: %C ranges from 1.4 in the A-horizon to 0.5 in the B-horizon; pH-H₂O is 5.8, pH-KCL is 5.0; CEC ranges from 23 to 14 cmol(+)/Kg soil; BS ranges from 23% to 7% for Lithosols: %C is 1.0 in the A-horizon; pH-H₂O is 5.6, pH-KCL is 4.9; CEC is 7 cmol(+)/Kg soil; BS is 77%

Diagonostic properties : cambic B, more than 40% murram within 100 cm of the surface, at places continuous hard rock within 25 cm of the surface

Classification : dystric CAMBISOLS pisolitic phase and LITHOSOLS

Representative profiles : 2 and 17

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Ri Soils of the mountain footridges with minor incissions

RiV Soils developed on consolidated lahars

Soil mapping units **RiVnl/AB RiVnl/AC RiVnl/BD RiVnl/DF**

Number of augerings in units : 170

Parent material : lahar

Macro relief : rolling to mountaineous, slopes < 8% or slopes > 16%

Erosion : nil

Rockiness/ stoniness : nil

Land use : Mt. Kenya Forest; timber exploitation

Soils, general : well drained, very deep, yellowish red to dark red, very friable, clay. With AB horizon sequence, in places with humic top soil.

Range of characteristics

,colour : A: dark reddish brown
B: yellowish red to dark red

,texture : A+B: clay

,structure : A: fine subangular blocky
B: coarse to very coarse angular blocky

,consistence : A: very friable when moist; slightly sticky and slightly plastic when wet
B: very friable to friable when moist; slightly sticky and slightly plastic when wet

Diagnostic properties : ochric A-horizon and nitic B-horizon; 25% of the soils has an umbric horizon

Classification : complex of humic and dystric NITISOLS

Representative profiles : 8 and 23

In general : the B-horizon displays a shift in colour

Soil mapping unit **RiVn2/BD**

Number of augerings in unit : 26
Parent material : lahar / phonolite
Macro relief : as in unit RiVn2/AB, but slopes 3-16 %
Erosion : slight splash and sheet erosion
Rockiness/stoniness : nil
Land use : as in unit RiVn2/AB
Soils, general : as in unit RiVn2/AB

Soil mapping unit **RiVn2/DF**

Number of augerings in unit : 171
Parent material : lahar / phonolite
Macro relief : hilly to mountaineous, slopes > 8%; flat to undulating in valley bottoms
Erosion : slight sheet and rill erosion. Severe erosion is prevented adequately by building and good maintainance of terraces for coffee with strip cropping of napier grass. Tea has a coverage of nearly 100%, which prevents soil erosion.
Rockiness/stoniness : in some places rocky
Land use : as in unit RiVn2/AB; on the steeper slopes permanent crops like coffee and tea are dominant, near the streams cocoyam, bananas, sugarcane and sweet potatoes are grown.
Range of characteristics, consistence : A+B: friable to firm when moist; slightly sticky to sticky and slightly plastic to plastic when wet
Soils, general : as in unit RiVn2/AB, but very deep and the colour of the topsoil is redder
Chemical properties : %C ranges from 1.3 in the A-horizon to 0.4 in the B-horizon; pH-H2O is 5.3, pH-KCL is 4.2; CEC ranges from 13 to 4cmol(+)/Kg soil; BS ranges from 14% to 10%
Diagnostic properties : ochric epipedon and nitic B-horizon; 20% of the area has an umbric horizon, nitic B- horizon
Classification : dystric and humic NITISOLS; the vallley bottoms, about 10% of this unit, include some humic and gleyic ACRISOLS.
Representative profile : 22

Soil mapping unit **RiVhn/AC**

Number of augerings : 51
Macro relief : hilly to mountaineous, slopes < 8 %
Landuse, soils, general : as in unit RiVhn/AB

Range of characteristics
 ,colour : A+B: dark reddish brown
 ,structure : A: weakcoarse granular to fine
 subangular blocky
 In general : 50 % of the soils has an umbric horizon.
 Some dystric NITISOLS occur.

Soil mapping unit **RiVhm/AB**

Acreage :
 Number of augerings in unit : 11
 Parent material : lahar / phonolite
 Macro relief : hilly to mountainous, slopes 0-5 %
 Erosion : nil
 Rockiness/stoniness : nil
 Land use : Mt. Kenya forest is used for timber and
 firewood production, the outer 100m of
 the forest is under clearance now and
 will be used for growing of tea, other
 parts of this unit are used for
 cultivation of tea and some foodcrops
 like maize, beans and potatos
 Soils, general : well drained, extremely deep, reddish
 brown to dark red, friable, clay, having
 an AB horizon sequence, sometimes
 lacking an A horizon, with an acid humic
 topsoil less than 40 cm thick. Few to
 common shiny pedfaces are present in the
 B horizon.

Range of characteristics
 ,colour : A: dark reddish brown to dark red
 B: reddish brown to dark red.
 ,texture :A+B: clay
 ,structure : A: weak coarse granular to fine
 subangular blocky
 B: moderate medium (sub)-angular
 blocky.
 ,consistence : A: very friable when moist, slightly
 plastic and slightly sticky when
 wet.
 B: friable when moist, slightly sticky
 to sticky and slightly plastic to
 plastic when wet.
 Chemical properties : %C ranges from 3.3% in the A-horizon to
 1.0% in the B-horizon; pH-H₂O is 4.8 and
 pH-KCl is 4.2;CEC ranges from 21 to 15
 cmol(+)/Kg soil; BS ranges from 8% to
 6%
 Diagnostic properties : ochric A, nitic B, high organic matter
 content in the B-horizon
 Classification : humic NITISOLS
 Representative profile : 23

Soil mapping unit **RiVhm/BD**

Number of augerings in unit : 7

Parent material : lahar / phonolite
 Macro relief : hilly to mountainous, slopes 3-16 %
 Erosion : nil
 Rockiness / stoniness : nil
 Landuse : as in unit RiVhn/AB
 Soils, general : as in unit RiVhn/AB, but with a
 different colour
 Range of characteristics
 , colour : A: reddish brown to dark red
 B: red

Soil mapping unit **RiVhn/DF**

Number of augerings in unit : 34
 Parent material : lahar / phonolite
 Macro relief : hilly to mountainous, slopes > 8 %
 Erosion : nil
 Rockiness/stoniness : nil
 Land use : as in unit RiVhn/AB
 Soils, general : as in unit RiVhn/AB, but less deep and
 with a different colour
 Range of characteristics
 , colour : A: dark reddish brown to yellowish red.
 B: yellowish red to dark red
 Chemical properties : %C ranges from 3.6 in the A-horizon to
 0.7 in the B-horizon; pH-H2O is 4.3,
 pH-KCL is 3.8; CEC ranges from 16 to
 6cmol(+)/Kg soil;BS ranges from 26% to
 6%
 Representative profile : 21

Soil mapping unit **RiVCs/DF**

Number of augerings in unit : 39
 Parent material : lahar
 Macro relief : hilly to mountaineous, slopes > 8%
 Erosion : moderate water erosion; in places more
 severe
 Rockiness/ stoniness : fairly gravelly and fairly stony;
 towards the East and on steeper slopes
 more stony and in places rocky
 Land use : half the area is in use for permanent
 cultivation of maize, beans, sorghum and
 cassava; 10% is in use for coffee; the
 rest is bushland to woodland, in places
 with napier grass. In the valley
 bottoms, 10% of this unit, bananas,
 sugarcane and maize are grown
 Soils, general : well drained, shallow to moderately deep
 (in places deep to very deep), dark
 reddish brown to yellowish red, friable
 to firm, gravelly to very gravelly,
 clay. With AB, AC or AR horizon
 sequence, in places with humic topsoil.
 Range of characteristics

,colour : A: dark reddish brown
: B: dark reddish brown to yellowish red
,texture : A+B: gravelly to very gravelly clay
,structure : A+B: medium angular blocky
,consistence : A+B: friable to firm when moist; slightly
sticky to sticky and slightly
plastic to plastic when wet
Diagnostic properties : in about 30% of area umbric A-horizon;
argillic B-horizon; in valley bottoms
also nitic B-horizon
Classification : complex of dystric REGOSOLS (30%),
orthic ACRISOLS (20%), and humic and
chromic ACRISOLS (each 10%). In valley
bottoms, 10% of area, complex of humic
NITISOLS (+50%) and ACRISOLS.
Representative profiles : 5, 20, 24 and 25
In general : also some LITHOSOLS, humic CAMBISOLS and
dystric NITISOLS occur. Transition area
from mountain footridges to upland. The
lahar is relatively shallow and murram
is appearing.

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Ra Soils of the mountain footridges with major incissions

RaV Soils developed on consolidated lahars

Soil mapping unit RaVhm/AC

Number of augerings in unit : 6
Parent material : lahar
Macro relief : hilly to mountaineous, slopes < 8%
Erosion : nil
Rockiness/ stoniness : nil
Land use : permanent cultivation of crops like
bananas sugarcane, maize and arrow
roots.
Soils, general : well drained, very deep, dark reddish
brown, friable, clay. With AB horizon
sequence, with humic topsoil
Range of characteristics
,colour :A+B: dark reddish brown
,texture :A+B: clay
,structure : A: fine subangular blocky
: B: very coarse angular blocky, falling
apart into coarse and medium
subangular blocky peds
,consistence :A+B: friable when moist; slightly sticky
and slightly plastic when wet
Diagnostic properties : umbric A-horizon; nitic B-horizon and
high organic matter content throughout
the profile
Classification : humic NITISOLS

Representative profile : 24
In general : the soils of this unit resemble the soils of the other valley bottoms, yet are more homogenous, because of the deeper drainage of the rivers in this unit.

Soil mapping unit **RaVhn/EF**

Number of augerings in unit : 9
Parent material : lahar / phonolite
Macro relief : mountainous, slopes > 16 %
Erosion : nil
Rockiness/stoniness : nil
Land use : forest reserve
Soils, general : as in unit RiVhn/AB, but less deep, with a different colour and with an acid humic topsoil less than 50 cm
Range of characteristics , colour : A+B: dark brown to dark reddish brown

Soil mapping unit **RaVn/EF**

Number of augerings in unit : 21
Parent material : lahar / phonolite
Macro relief : hilly to mountainous, slopes > 16 %
Erosion : slight sheet and rill erosion
Rockiness/stoniness : nil
Land use : rotation of annual crops like maize and beans, permanent cultivation of coffee and tea. In the valleybottom bananas are grown.
Soils, general : as in unit RiVn2/AB, but less deep and with a redder colour of the topsoil. At places rotten rock occurs within a depth of 1.20m

Soil mapping unit **RaVCV/EF**

Number of augerings in unit : 64
Parent material : lahar / phonolite
Macro relief : hilly to mountainous, slope > 16 %
Erosion : slight to moderate sheet and rill erosion, slight gully erosion, common measurement against soil erosion is making thrashlines
Rockiness / stoniness : rocky and stony on slopes, few rocks and stones on valley bottom
Land use : annual crop cultivation, maize and beans at parts where soil depth is shallow or deeper; unproductive land, occasionally used for grazing, occurs at parts where soils are very shallow or very rocky
Soils, general : a complex of well drained, very shallow to very deep, dark brown to dark red,

friable to firm, clayey soils with an ABCR-horizon sequence, the B- and CR-horizon are often mixed, clayskins are present in the B- horizon. The deeper soils occur on the upper slope and in the valley bottom. In the western part of this unit soils are deeper and the rockiness/stoniness is less. NITISOLS occur in the western part only and ACRISOLS mainly in the eastern part, the amount of LITHOSOLS increases from west to east

- Range of characteristics
- ,colour : A: dark brown to dark reddish brown
B: dark brown to dark red
 - ,texture : A: silt loam to silty clay
B: clay at places slightly gravelly to gravelly
A+B: moderate to strong, fine to coarse, (sub)angular blocky
 - ,consistence : hard to very hard when dry, friable to firm when moist, slightly sticky and slightly plastic to plastic when wet
- Chemical properties : Acrisols: %C ranges from 1.3 in the A-horizon to 0.3 in the B-horizon; pH-H₂O is 5.3, pH- KCL is 4.7; CEC ranges from 22 to 12 cmol(+)/Kg soil; BS ranges from 9% to 5% Nitisols: %C ranges from 1.3 in the A-horizon to 0.4 in the B-horizon; pH-H₂O is 5.3, pH-KCL is 4.2; CEC ranges from 13 to 4 cmol(+)/Kg soil; BS ranges from 14% to 10%
- Diagnostic properties : ochric or umbric A, argillic B for ACRISOLS, nitic B for NITISOLS, continuous hard rock within 25 cm of the surface for LITHOSOLS
- Classification : complex of dystric NITISOLS (30%), humic ACRISOLS (30%) and chromic Acrisols with some LITHOSOLS and Rankers.
- Representative profiles : 1 and 22
- =====

F Soils of the footslopes

FQ Soils developed on granitoid gneisses

Soil mapping unit **FQps/D**

- Number of augerings : 4
 - Parent material : granitoid gneisses
 - Macro relief : rolling, slopes 8-16 %
 - Erosion : slight rill erosion
 - Stoniness/rockiness : gravelly
 - Land use : grazing, cropping of millet, cotton, beans and maize.
- Soils, general : somewhat excessively drained, shallow to deep, dark yellowish brown to dark reddish brown, gravelly, friable, loamy

sand to sandy loam. The soils usually have an AB-horizon sequence.

Range of characteristics

,colour : A: dark brown
B: dark yellowish brown to dark reddish brown

,texture :A+B: loamy sand to sandy loam

,consistence : friable when moist, slightly sticky and non plastic when wet.

Chemical properties : %C ranges from 0.6 in the A-horizon to 0.3 in the B-horizon; pH-H₂O is 6.0, pH-KCL is 5.7; CEC ranges from 11 to 17 cmol(+)/Kg soil, BS ranges from 79% to 37%.

Diagnostic properties : argillic B, at places continuous rock within 25cm depth.

Classification : orthic LUVISOLS and LITHOSOLS

Representative profile : 12

Remarks : 5% of this unit is bare rock.

Soil mapping unit **FQst/BC**

Number of augerings : 5

Parent material : granitoid gneisses and colluvium

Macro relief : gently undulating to undulating, slopes 2-8 %

Erosion : slight rill erosion

Rockiness/stoniness : gravelly and fairly rocky

Land use : grazing, cropping of maize, cotton and pigeon peas.

Soils, general : well drained, moderately deep to very deep, strong brown to reddish brown, gravelly and fairly rocky, firm to friable, sandy clay. The soils have an AB-horizon sequence.

Range of characteristics

,colour : A: dark brown
B: strong brown to reddish brown

,texture :A+B: sandy clay

,consistence : firm to friable when moist, sticky and slightly plastic when wet

Chemical properties : for the Phaeozems: %C ranges from 1.0 in the A-horizon to 0.3 in the B-horizon; pH-H₂O is 5.6, pH-KCL is 4.9; CEC ranges from 12 to 14 cmol(+)/Kg soil; BS ranges from 64% to 94%

Diagnostic properties : cambic B and at places mollic A and argillic B-horizon

Classification : eutric CMBISOLS and luvic PHAEZEMS

Representative profiles : 15 and 27

Remarks : 10% of this unit is bare rock, 20% is humic ACRISOLS

Soil mapping unit **FQbs/CD**

Number of augerings in unit : 7
 Parent material : colluvium of granitoid gneisses
 Macro relief : undulating to rolling, slopes 5-16 %
 Erosion : moderate sheet and rill, slight gully erosion
 Rockiness/stoniness : very gravelly and stony
 Land use : dense bushland, extensive browsing, shifting cultivation with cropping of millet and sorghum
 Soils, general : well drained, deep, dark brown to dark reddish brown, calcareous (in places calcic horizon), slightly gravelly, friable, sandy clay loam to clay
 Range of characteristics
 ,colour : A: dark brown
 B: strong brown to dark reddish brown
 ,texture : A: sandy clay loam
 B: clay loam
 ,consistence : friable when moist, slightly sticky and slightly plastic when wet
 Diagnostic properties : in places mollic A, in places calcic horizon
 Classification : calcic CAMBISOLS and calcaric PHAEOZEMS
 Representative profiles : 29 and 35

A Soils of the floodplains

AA Soils developed on alluvial sediments

Soil mapping unit AAar/A

Number of augerings : 2
 Parent material : phonolite rich river deposits
 Macro relief : flat, slopes 0-2 %
 Erosion : nil
 Rockiness/stoniness : nil
 Land use : cropping of maize, sorghum, sugarcane, cassava, bananas beans, grass, cotton (in the irrigation scheme)
 Soils, general : well drained, very deep, red to dark reddish brown, friable, clay.
 Range of characteristics
 ,colour : A: dark reddish brown
 B: dark red
 ,texture : A+B: clay
 ,consistence : friable when moist, sticky and slightly plastic when wet
 Chemical properties : %C ranges from 0.3 in the A-horizon to 0.2 in the B-horizon; pH-H₂O is 5.5, pH-KCL is 5.0; CEC is about 13 cmol(+)/Kg soil; BS ranges from 62% to 74%
 Diagnostice properties : argillic B horizon
 Classification : chromic LUVISOLS
 Representative profile : 18
 Remarks : in some parts of this unit, (in the irrigation scheme) salts were observed

at the soil surface.

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B Soils of the bottomlands

BV Soils developed on consolidated lahars

Soil mapping unit **BVr/AB**

Number of augerings in unit : 5
Parent material : lahar / phonolite
Macro relief : gently undulating to undulating, slope 0-5 %
Erosion : nil
Rockiness / stoniness : none to very few rocks
Land use : occasionally ponded, grazing, rotation of annual crops like maize, beans, cocoyam, sweet potato
Soils, general : moderately well to well drained, deep to very deep, dark reddish brown to dark red, mottled, very friable, clay, having an AB horizon sequence, overlying petroplinthite (murrum) with a 30 to 60 cm humic topsoil.
Range of characteristics
 , colour : A: dark reddish brown
 B: dark reddish brown to dark red
 , texture : A: clay
 B: clay, at places gravelly
 , structure : A: moderate, fine, granular
 B: fine to medium, subangular to angular blocky
 , consistence : very friable when moist, slightly sticky and slightly plastic when wet
Chemical properties : %C ranges from 1.6% in the A-horizon to 1.0% in the B-horizon; pH-H₂O is 5.0 and pH-KCl is 4.4; CEC ranges from 25 to 17 cmol(+)/Kg soil; BS ranges from 25% to 12%
Diagnostic properties : umbric A, argillic B, at places having a pisolitic phase and/or hydromorphic properties within 50 cm of the surface
Classification : gleyic, ferric and humic ACRISOLS
Representative profile : 6

Soil mapping unit **BVg/AB**

Parent material : lahar/ phonolite with admixture of colluvium
Macro relief : gently undulating to undulating, slopes 0-5 %
Erosion : nil
Rockiness / stoniness : none to very few rocks
Land use : grassland used for grazing
Soils, general : poorly to imperfectly drained, shallow to moderately deep, very dark gray to dark brown, mottled, slightly gravelly, firm, cracking, clay, with an ACG

horizon sequence with a humic topsoil less than 30 cm overlying petroplinthite (murram) / rotten rock.

Range of characteristics
 ,colour :A+B: very dark gray to dark brown
 ,texture : A: clay
 B: slightly gravelly clay
 ,structure :A+B: strong angular blocky
 ,consistence : firm when moist, slightly sticky and plastic when wet

Chemical properties : %C ranges from 2.2 in the A-horizon to 0.6 in the B-horizon; pH-H2O is 5.1, pH-KCL is 3.3; CEC ranges from 25 to 10 cmol(+)/Kg soil; BS ranges from 14% to 62%

Diagnostic properties : ochric or umbric A, hydromorphic properties within 50cm of the surface

Classification : plinthic GLEYSOLS

Representative profile : 11

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U Soils of the uplands

UA Soils developed on alluvial sediments from various sources

Soil mapping unit UAae/BC

Number of augerings in unit : 3
Parent material : Non recent alluvial deposits
Macro relief : undulating, slopes 3-8%
Erosion : Severe sheet; in places severe rill erosion
Rockiness/stoniness : In places gravelly
Land use : Extensive grazing; dense wooded bushland
Soils, general : Somewhat excessively drained, very deep, dark reddish brown, sandy clay loam, friable

Range of characteristics
 ,colour :A+B: Dark brown to dark reddish brown
 ,texture : A: Sand
 B: Sandy clay loam
 ,structure : A: Fine granular to fine subangular blocky
 B: Porous massive, strongly coherent
 ,consistence : A: Loose when moist; non sticky and non plastic when wet
 B: Friable when moist; slightly sticky and slightly plastic when wet

Diagnostic properties : Argillic B-horizon

Classification : orthic LUVISOLS

Representative profile : 46

Soil mapping unit UAa/AB

Number of augerings in unit : 7
Parent material : Recent to subrecent alluvial deposits of intermittent rivers

Macro relief : gently undulating to undulating, slopes <5%
 Erosion : In places slight sheet and rill erosion
 Rockiness/stoniness : Nil
 Land use : Shifting cultivation of millet and cotton; extensive grazing during short fallow period with grassland
 Soils, general : Well drained, very deep, dark brown to reddish brown, sand, loose
 Range of characteristics
 ,colour : A: Brown to dark brown
 : B: Reddish brown to dark brown
 ,texture :A+B: Sand
 ,structure : A: Weak medium subangular blocky
 : B: Porous massive, strongly coherent
 ,consistence :A+B: Loose when moist; non sticky and non plastic when wet
 Diagnostic properties : -
 Classification : orthic LUVISOLS
 Representative profile : 46
 In general : In places slightly gravelly

Soil mapping unit **UAa/D**

Number of augerings in unit : 1
 Parent material : Recent to subrecent alluvial deposits
 Macro relief : Rolling, slopes 8-16%
 Erosion : Moderate sheet and gully, slight rill erosion
 Rockiness/stoniness : Slightly gravelly, fairly stony
 Land use & soils : As in UAa/AB

Soil mapping unit **UAap/B**

Number of augerings in unit : 2
 Parent material : Mainly terrace remains (non recent alluvial deposits)
 Macro relief : undulating, slopes 3-5%
 Erosion : Slight sheet and rill erosion
 Rockiness/stoniness : Fairly stony and gravelly
 Land use : Cropping of maize, sorghum, millet and pigeon peas
 Soils, general : Well drained, moderately deep, dark brown to dark reddish brown, friable, clay
 Range of characteristics
 ,colour : A: Dark brown
 : B: Dark brown to dark reddish brown
 ,texture :A+B: Clay
 ,structure :
 ,consistence :A+B: Friable when moist; slightly sticky and slightly plastic when wet
 Diagnostic properties : Argillic B-horizon
 Classification : vertic and chromic LUVISOLS
 Representative profiles : 14 and 15

UB Soils developed on basic and ultrabasic igneous rocks

Soil mapping unit **UBps/B** **UBps/BC** **UBps/CD.**

Number of augerings in unit : 2
Parent material : mainly mafic intrusives mixed with migmatites and gneisses
Macro relief : Gently undulating to rolling
Erosion : Slight rill and sheet erosion
Rockiness/stoniness : Gravelly and fairly stony
Land use : Grazing; cropping of millet, maize and pigeon peas
Soils, general : Somewhat excessively to well drained, moderately deep, dark reddish brown to reddish brown, friable, clayloam to clay

Range of characteristics
 ,colour :A+B: Dark reddish brown to reddish brown
 ,texture :A+B: Clay loam to clay
 ,structure :A+B: Subangular blocky
 ,consistence :A+B: Friable when moist;slightly sticky and slightly plastic when wet

Diagnostic properties : Argillic B-horizon
Classification : chromic LUVISOLS
Representative profile : 14

UF Soils developed on gneisses rich in ferromagnesian minerals

Soil mapping unit **UFps/BC**

Number of augerings in unit : 5
Parent material : Gneisses rich in ferromagnesian minerals
Macro relief : Gently undulating to undulating
Erosion : Slight sheet and rill erosion
Rockiness/stoniness : Gravelly, stony and fairly rocky
Land use : Grazing; cropping of cotton, millet, sorghum, and cow pea
Soils, general : Well drained, shallow to moderately deep, dark brown, friable, sandy clay loam to clay

Range of characteristics
 ,colour :A+B: Dark brown
 ,texture :A+B: Sandy clay loam to clay
 ,structure : A: Fine subangular blocky
 : B: Medium subangular blocky
 ,consistence :A+B: Friable when moist; slightly sticky and slightly plastic when wet

Diagnostic roperties : Argillic B-horizon
Classification : orthic LUVISOLS and chromic ACRISOLS
Representative profiles : 4 and 9

Soil mapping unit **UFar/AB**

Number of augerings in unit : 44
Parent material : Gneisses rich in ferromagnesian minerals
Macro relief : flat to gently undulating to rolling, slopes 0-5 %

Erosion : moderate sheet and rill erosion, in places moderate gully erosion

Rockiness/stoniness : slightly gravelly to gravelly, in places stony

Land use : dense bushland to bushlandthicket, charcoal exploitation, cropping of millet, in places intercropping with sorgum, also some greengrams, maize and pigeon peas.

Soils, general : Well to somewhat excessively drained, moderately deep to very deep, dark red to dark reddish brown, friable, sandy clay to clay

Range of characteristics

,colour : A: Dark reddish brown, in places dark brown

: B: Dark red to dark reddish brown

,texture :A+B: Sandy clay to clay

,structure : A: Fine subangular blocky

: B: Medium subangular blocky

,consistence :A+B: Friable when moist; slightly sticky to sticky and slightly plastic to plastic when wet

Diagnostic properties : Argillic B-horizon

Classification : orthic LUVISOLS and chromic LUVISOLS

Representative profiles : 12, 36 and 44

Soil mapping unit	UFar/B	UFar/BC	UFar/CD
Number of augerings in unit	: 40		
Parent material	: Gneisses rich in ferromagnesian minerals, and non recent alluvial deposits		
Macro relief	: Gently undulating to undulating		
Erosion	: Slight to moderate sheet, rill and gully erosion		
Rockiness/stoniness	: In places slightly gravelly, stony, bouldery and rocky		
Land use	: Grazing; cropping of sorgum, millet, maize, pigeon peas, cotton, sunflowers and greengrams		
Soils and properties	: As in unit UFar/A+B		

Soil mapping unit	UFpe/A	UFpe/B	UFpe/AB	UFpe/BC
Number of augerings in unit	: 16			
Parent material	: Gneisses rich in ferromagnesian minerals (migmatites)			
Macro relief	: undulating, slopes <5% or 3-8%			
Erosion	: Moderate rill and sheet, and slight gully erosion			
Rockiness/stoniness	: In places fairly stony and gravelly			
Land use	: Grazing; cropping of cotton, cowpeas, sorgum and millet			
Soils, general	: Somewhat excessively to well drained, moderately deep, dark red to dark brown,			

friable, clay to sandy clay loam

Range of characteristics

 ,colour : A: Dark brown
 : B: Dark red to dark brown

 ,texture :A+B: Clay to sandy clay loam

 ,structure : A: Fine subangular blocky
 : B: Medium subangular blocky

 ,consistence : A: Friable when moist; slightly sticky
 and non plastic when wet
 : B: Friable when moist;slightly sticky
 and slightly plastic when wet

Diagnostic properties : Argillic B-horizon

Classification : orthic and chromic LUVISOLS

Representative profiles : 4 and 14

Soil mapping unit **UFpe/C** **UFpe/CD**

Number of augerings in unit : 5

Parent material : Gneisses rich in ferromagnesian minerals

Macro relief : Undulating to rolling, slopes 6-16%

Erosion : Moderate rill and slight sheet and gully
 erosion

Rockiness/stoniness : Gravelly, stony and fairly rocky

Land use : Grazing; cropping of cotton,cowpeas,
 sorghum and millet

Soil qualities : see unit UFpe3/A

Diagnostic properties : Argillic B-horizon

Classification : chromic LUVISOLS

Representative profiles : 4 and 14

Soil mapping unit **UFrt/AB** **UFrt/B.**

Number of augerings in unit : 8

Parent material : Gneisses rich in ferromagnesian minerals
 and granitoids (20%)

Macro relief : Flat to gently undulating

Erosion : Slight rill and sheet erosion

Rockiness/stoniness : Slightly gravelly, stony and in places
 fairly rocky

Landuse : Grazing; cropping of millet and sorghum

Soils, general : Well to somewhat excessively drained,
 moderately deep to deep, yellowish red
 to dark reddish brown, friable, silty
 clay to sandy clay

Range of characteristics

 ,colour : A: Dark reddish brown
 : B: Yellowish red to dark reddish brown

 ,texture :A+B: Silty clay to sandy clay

 ,structure : A: Fine subangular blocky
 : B: Medium subangular blocky

 ,consistence :A+B: Friablewhen moist; slightly sticky
 and slightly plastic when wet

Diagnostic properties : Argillic B-horizon

Classification : chromic LUVISOLS and orthic LUVISOLS

Representative profiles : 4 and 12

Soil mapping unit	UFrt/BC	UFrt/CD
Number of augerings in unit	:	8
Parent material	:	Gneisses rich in ferromagnesian minerals and granitoides (30%)
Macro relief	:	Gently undulating to rolling
Erosion	:	Moderate sheet and rill erosion
Rockiness/stoniness	:	Gravelly, stony and bouldery; in places fairly rocky
Land use	:	Grazing
Soil qualities	:	As in unit UFrt/AB.
Diagnostic properties	:	Argillic B-horizon or continuous hard rock within 25 cm depth
Classification	:	chromic LUVISOLS and LITHOSOLS
Representative profile	:	4

Soil mapping unit **UFea/AB**

Number of augerings in unit	:	3
Parent material	:	gneisses rich in ferro-magnesian minerals
Macro relief	:	flat to gently undulating, slopes 0-5 %
Erosion	:	severe sheet and rill, moderate gully erosion
Rockiness/stoniness	:	slightly gravelly
Land use	:	shifting cultivation, extensive grazing
Soils, general	:	somewhat excessively drained, deep over rotten rock, dark red, friable, sandy clay loam
Range of characteristics		
,colour	:	A: dark reddish brown B: dark red
,texture	:	A: sandy loam B: sandy clay loam
,consistence	:	A: very friable when moist B: friable when moist
Diagnostic properties	:	argillic B
Classification	:	chromic LUVISOLS
Representative profile	:	34

Soil mapping unit **UFCh/AB**

Number of augerings in unit	:	53
Parent material	:	gneisses rich in ferro-magnesian minerals
Macro relief	:	gently undulating, slopes 0-5 %
Erosion	:	slight sheet, slight rill, in places moderate rill and gully erosion
Rockiness/stoniness	:	slightly gravelly to gravelly, in places fairly stony
Land use	:	shifting cultivation with cropping millet and sorghum, sometimes with maize and greengrams
Soils, general	:	well drained, moderately deep to deep, dark reddish brown, calcareous,

gravelly, friable, sandy clay loam to clay

Range of characteristics
 ,colour :A+B: dark reddish brown
 ,texture : A: sandy clay loam to clay, in places slightly gravelly
 B: gravelly sandy clay loam to clay
 ,consistence : firm when moist

Diagnostic properties : mollic A, in places calcic horizon, argillic B, ochric A

Classification : calcic CAMBISOLS, calcaric PHAEOZEMS and calcic CHERNOZEMS

Representative profiles : 30, 31 and 37

Soil mapping unit **UFes/BC**

Number of augerings in unit : 31

Parent material : gneisses rich in ferro-magnesian minerals

Macro relief : undulating, slopes 2-8 %

Erosion : slight to moderate rill, moderate gully erosion

Rockiness/stoniness : gravelly and fairly stony to stony

Land use : bushland and extensive browsing

Soils, general : somewhat excessively drained, moderately deep to deep, dark reddish brown, gravelly, firm, clay

Range of characteristics
 ,colour :A+B: dark reddish brown
 ,texture :A+B: sandy clay loam to clay
 ,consistence : firm when moist

Diagnostic properties : ochric A, in places mollic A, argillic B

Classification : chromic LUVISOLS and luvic PHAEOZEMS

Representative profiles : 32 and 49

Soil mapping unit **UFes/C** **UFes/CD**

Number of augerings in unit : 4

Parent material : gneisses rich in ferromagnesian minerals

Macro relief : undulating to rolling, slopes 6-16%

Erosion : moderate rill and gully erosion

Rockiness/stoniness : gravelly and stony; in places very gravelly and stony

Land use : extensive grazing; shifting cultivation

Soils, general : somewhat excessively drained, shallow to moderately deep, dark reddish brown, clay, firm

Range of characteristics
 ,colour :A+B: dark reddish brown
 ,texture :A+B: sandy clayloam to clay, often gravelly
 ,structure : A: medium granular
 : B: medium subangular blocky
 ,consistence :A+B: firm when moist; slightly sticky and slightly plastic when wet

Diagnostic properties : argillic B-horizon; in places pisoferric

Classification : chromic and ferric LUVISOLS
Representative profile : 44

Soil mapping unit **UFpT/DE**

Number of augerings : 1
Parentmaterial : biotite gneiss
Macrorelief : rolling to hilly
Erosion : moderate rill erosion
Rock/stoniness : gravelly, very stoney, bouldery and at spots rockoutcrops
Landuse : grazing and shifting cultivation
Soils general : Somewhat excessively drained, shallow to moderately deep, dark reddish brown, firm, sandy clay loam to clay

Range of characteristics

,colour :A+B: dark reddish brown
,texture : A: gravelly loamy sand
 B: very gravelly sandy clay loam to clay
,structure : A: single grain to medium granular structure
 B: medium subangular blocky structure
,consistence : A: non sticky, non plastic; friable
 B: slightly sticky, slightly plastic, firm

Diagnostic properties : argillic B
Classification : chromic LUVISOLS
Representative profiles : 39, 40 and 41

Soil mapping unit **UFCEp/D**

Number of augerings : 8
Parent material : diorite and hornblende-quartz gneisses
Macrorelief : undulating to rolling
Erosion : moderate to severe rill and gully erosion
Rock/stoniness : gravelly and at spots very stoney and bouldery
Landuse : grazing and shifting cultivation
Soils general : somewhat excessively drained, moderately deep to deep, dark brown to dark reddish brown, friable to firm, loamy sand to clay

Range of characteristics
 , colour : A: dark brown to dark reddish brown
 B: dark reddish brown
 , texture : A: non to gravelly loamy sand
 B: non to very gravelly sandy clay to clay
 , structure : A: medium granular structure
 B: medium subangular blocky structure
 , consistence : A+B: non to slightly sticky, non to slightly plastic, friable to firm

Diagnostic properties : argillic B, coherent rocklayer within 25 cm depth and cambic B

Classification : LITHOSOLS, eutric CAMBISOLS and chromic LUVISOLS

Representative profiles : 17, 33, 39, 40 and 41

Soil mapping unit **UFst/CD**

Number of augerings in unit : 4
Parent material : Gneisses rich in ferromagnesian minerals
Macro relief : Undulating to rolling, slopes 6-16%
Erosion : Severe sheet and slight rill; in places moderate to severe rill and gully erosion
Rockiness/stoniness : Gravelly and fairly stony, fairly rocky; in places very gravelly and/or stony
Land use : Extensive grazing and shifting cultivation
Soils, general : Somewhat excessively drained, shallow to deep, dark reddish brown, clay, friable

Range of characteristics
 , colour : A+B: Dark reddish brown to dark red
 , texture : A: Loamy sand to clay
 B: Clay
 , structure : A: Granular to fine subangular blocky
 B: Medium to coarse subangular blocky
 , consistence : A+B: Very friable to firm when moist; slightly sticky to sticky and slightly plastic to plastic when wet

Diagnostic properties : argillic B-horizon or ochric A over rotten rock

Classification : chromic LUVISOLS and eutric REGOSOLS

Representative profiles : 3 and 38

Soil mapping unit **UFb/C**

Number of augerings in unit : 1
Parent material : Gneisses rich in ferromagnesian minerals
Macro relief : Undulating, slopes 6-8%
Erosion : Moderate sheet erosion
Rockiness/stoniness : Nil
Land use : Extensive grazing; wooded bushland
Soils, general : Well drained, deep, dark brown, sandy
clay, friable, calcareous. Deep
homogenous profile

Range of characteristics
 ,colour :A+B: Dark brown
 ,texture : A: Sandy loam
 : B: Sandy clay
 ,structure :A+B: Fine subangular blocky
 ,consistence :A+B: Friable when moist;slightly sticky
 and slightly plastic when wet

Diagnostic properties : Argillic B-horizon; soft powdery lime
Classification : calcic LUVISOLS

Soil mapping unit **UFer1/AB**

Number of augerings in unit : 1
Parent material : granitoid gneisses and gneisses rich in
ferro-magnesian minerals
Macro relief : flat to gently undulating, slopes 0-5 %
Erosion : nil
Rockiness/stoniness : nil
Land use : cropping of maize, sorghum and pigeon
peas
Soils, general : as in unit UFer1/BC, but less stony and
gravelly.

Soil mapping unit **UFer1/B**

Number of augerings in unit : 1
Macro relief : undulating, slopes 3-5%
Rockiness/stoniness : Gravelly
Land use : Wooded bushland; extensive grazing
Soils : see unit UFer1/AB but shallow to
moderately deep and red. A-horizon is
missing.

Soil mapping unit **UFer1/BC**

Number of augerings in unit : 11
Parent material : gneisses rich in ferro-magnesian
minerals
Macro relief : gently undulating to undulating, slopes
2-8 %
Erosion : moderate rill and gully erosion
Rockiness/stoniness : at some places fairly stony and gravelly

Landuse : grazing, cropping of millet, sorghum and cotton; dense bushland, some charcoal exploitation

Soils, general : well drained, very deep, dark red, firm to friable, sandy clay to clay. The soils have an AB-horizon sequence.

Range of characteristics

 ,structure : A: moderate fine to medium subangular to angular blocky
 : B: moderate coarse angular blocky

 ,colour : A: dark reddish brown
 B: dark red

 ,texture :A+B: sandy clay to clay

 ,consistence : firm to friable when moist, slightly sticky and plastic when wet

Chemical properties : % C ranges from 0.3 in the A-horizon to 0.2 in the B-horizon; pH-H₂O is 5.5, pH-KCL is 5.0; CEC is about 13 cmol(+)/Kg soil; BS ranges from 62% to 74%

Diagnostic properties : argillic B-horizon

Classification : chromic LUVISOLS.

Representative profiles : 18 and 44

Remarks : in this unit there is probably lateral groundwater movement from the plateau and therefore there is more water available for plant growth than in surrounding areas.

Soil mapping unit **UFer2/B**

Number of augerings : 2

Parent material : gneisses rich in ferro-magnesian minerals

Macro-relief : gently undulating, slopes 2-5 %

Erosion : moderate rill and severe gully erosion

Rockiness/stoniness : fairly gravelly

Land use : grazing, cropping of millet and cotton

Soils, general : somewhat excessively drained, deep to very deep, dark reddish brown to dark red, fairly gravelly, friable clay. The soils have an AB- horizon sequence.

Range of characteristics

 ,colour : A: dark reddish brown
 : B: dark red to dark reddish brown

 ,texture :A+B: clay

 ,structure : moderate medium subangular blocky structure

 ,consistence : friable when moist, slightly sticky and slightly plastic when wet

Chemical properties : % C is 0.3 throughout the profile; pH-H₂O is 5.1, pH-KCL is 4.9; CEC ranges from 16 to 11 cmol(+)/Kg soil; BS ranges from 41% to 63%

Diagnostic properties : argillic B

Classification : ferric and plinthic ACRISOLS

Representative profile : 13

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UP Soils developed on pyroclastic rocks

Soil mapping unit UPPT/AB

Number of augerings in unit	: 2
Parent material	: Consolidated undifferentiated pyroclastic alluvial deposits
Macro relief	: gently undulating, slopes < 5%
Erosion	: Moderate sheet and rill erosion
Rockiness/stoniness	: Slightly gravelly to gravelly, fairly stony, very rocky
Land use	: Extensive grazing; grassland to bushland
Soils, general	: Somewhat excessively drained, very shallow, very dark greyish brown, sand to sandy clay loam. Thin A-horizon over hard rock.
Range of characteristics	
,colour	: A: Very dark greyish brown
,texture	: A: Sand to sandy clay loam
,structure	: A: Fine granular
,consistence	: A: Very friable when moist; non to slightly sticky and non to slightly plastic when wet
Diagnostic properties	: continuous hard rock within 25 cm
Classification	: LITHOSOLS
In general	: at borders of unit eutric REGOSOLS.

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UQ Soils developed on granitoid gneisses

Soil mapping unit UQet/DE

Number of augerings in unit	: 4
Parent material	: granitoid gneisses
Macro relief	: hilly, slopes 8-30%
Erosion	: moderate sheet, rill and gully erosion
Rockiness/stoniness	: Gravelly, stony and bouldery, fairly rocky to rocky
Land use	: Shifting cultivation of millet; wooded bushland; charcoal exploitation
Soils, general	: Somewhat excessively drained, shallow to moderately deep, reddish brown, slightly gravelly to stony, loamy sand to sandy clay loam, very friable. In places missing A-hor.
Range of characteristics	
,colour	: A: Dark brown to dark yellowish brown
	: B: Reddish brown
,texture	: A: Sand to sandy clay loam
	: B: Loamy sand to sandy clay loam, slightly gravelly to stony
,structure	:A+B: Weak fine to medium subangular blocky
,consistence	:A+B: Loose to friable when moist; non to slightly sticky and non to slightly plastic when wet
Diagnostic properties	: Argillic B-horizon

Classification : orthic LUVISOLS
Representative profile : 47
In general : near Kibiro Hills many large boulders occur

Soil mapping unit **UQPT/DE**

Number of augerings : 7
Parent material : granitoid gneisses
Macro relief : rolling to hilly, slopes 8-30 %
Erosion : moderate rill and gully erosion
Rockiness/stoniness : stony, gravelly and very rocky
Land use : grazing, cropping of millet, sorghum, maize and beans.
Soils, general : somewhat excessively drained, very shallow, dark red to dark reddish brown, friable, sandy clay loam to sandy loam. In this unit 75% of the area consists of bare rock.
Diagnostic properties : Coherent hard rock within 25 cm depth
Classification : LITHOSOLS

Soil mapping unit **UQPt/DE**

Number of augerings in unit : 2
Parent material : Granitoid gneisses
Macro relief : rolling, slopes 8-30%
Erosion : Moderate sheet and rill, slight gully erosion
Rockiness/stoniness : Gravelly to very gravelly, stony and bouldery, fairly rocky to rocky
Land use : Dense bushland; extensive grazing
Soils, general : Somewhat excessively drained, shallow, red, sandy clay, gravelly, friable
Range of characteristics
 , colour : A: Dark brown
 : B: Red
 , texture : A: Slightly gravelly sandy clay loam
 : B: Gravelly sandy clay
 , structure : B: Moderate fine to medium subangular blocky
 , consistence : A+B: Friable when moist; slightly sticky and slightly plastic
Diagnostic properties : argillic B-horizon or (para)lithic phase
Classification : LITHOSOLS, chromic LUVISOLS
Representative profile : 45

Soil mapping unit **UQpE/BC**

Number of augerings : 31
Parent material : granitoid gneisses
Macro relief : gently undulating to undulating, slopes 2-8 %
Erosion : moderate to severe rill and gully erosion
Rockiness/stoniness : fairly gravelly, stony and rocky

Landuse : grazing and cropping of millet, maize, beans, sorghum and cotton
 Soils, general : well drained, shallow to deep, dark red to dark reddish brown, friable, sandy clay loam to sandy clay
 Classification : chromic LUVISOLS and LITHOSOLS

Soil mapping unit **UQPe/AC**

Number of augerings : 12
 Parent material : granitoid gneisses
 Macro relief : undulating, slopes 0-8 %
 Erosion : slight rill and at spots severe sheet, rill and gully erosion
 Rockiness/stoniness : fairly gravelly and stony
 Land use : grazing, cropping of millet, sorghum and beans
 Soils, general : somewhat excessively drained, very shallow to shallow, dark red to dark reddish brown friable to firm, sandy loam to clay. The soils only have a B-horizon.
 Range of characteristics
 , colour : B: dark red
 , texture : B: sandy loam to sandy clay loam
 , consistence : friable to firm when moist, slightly sticky and non-plastic when wet
 Diagnostic properties : argillic B or continuous hard rock within 25 cm depth
 Classification : chromic LUVISOLS and LITHOSOLS
 Representative profiles : 14 and 29
 Remarks : in 10% of this unit bare rock is exposed as tors and 10% of this unit consists out of other types of Lithosols

Soil mapping unit **UQPe/CD**

Number of augerings : 2
 Parent material : granitoid gneisses
 Macro relief : undulating to rolling, slopes 5-16 %
 Erosion : moderate rill and gully erosion
 Rockiness/stoniness : fairly gravelly and stony
 Land use : grazing, cropping of maize, sorghum, millet and cotton.
 Soils, general : as in unit UQPe/AC

Soil mapping unit **UQPe/EF**

Number of augerings : 1
 Parent material : granitoid gneisses and migmatites
 Macro relief : hilly to mountainous, slopes >16 %
 Erosion : slight rill erosion
 Rockiness/stoniness : fairly stony and rocky
 Land use : grazing, cropping of millet, sorghum, beans and cotton

bushland
 Soils, general : Somewhat excessively drained, shallow to moderately deep, dark reddish brown, loamy sand to sandy clayloam, very friable to friable
 Range of characteristics
 , colour : A+B: dark red to dark reddish brown
 , texture : B: Sand to sandy clay; in places gravelly
 , structure : B: fine to medium subangular blocky
 , consistence : B: Loose to firm when moist; non to slightly sticky and non to slightly plastic when wet
 Diagnostic properties : Argillic B-horizon
 Classification : complex of orthic and chromic LUVISOLS
 Representative profile : 45 and 47
 In general : near Materi scarp LITHOSOLS are present

UU Soils developed on undifferentiated Basement System rocks

Soil mapping unit	UUes/BC	UUes/CD	UUes/DE
Number of augerings in unit	: 63		
Parent material	: Undifferentiated Basement System gneisses; a varied succession of granitoid gneisses and gneisses rich in ferromagnesian minerals, with many aplite and pegmatite vein intrusives		
Macro relief	: Gently undulating to undulating, undulating to rolling, rolling to hilly		
Erosion	: Severe sheet, moderate rill and slight gully erosion; in places more severe water erosion		
Rockiness/stoniness	: Gravelly to very gravelly fairly stony; in places fairly bouldery and fairly rocky		
Land use	: Dense bushland; few shifting cultivation of millet; charcoal exploitation; extensive grazing		
Soils, general	: Somewhat excessively drained, shallow to moderately deep, red, sandy clay loam to sandy clay, friable		
Range of characteristics			
, colour	: A: Dark brown to reddish brown B: Dark reddish brown to red B+CR: Dark reddish brown to red		
, texture	: A: Sand to loamy sand; in places gravelly B: Loamy sand to clay; in places slightly gravelly to gravelly B+CR: Sandyclay loam to sandy clay, very gravelly		
, structure	: A+B: Weak to moderate fine to medium subangular blocky B+CR: Predominantly rock structure		
, consistence	: A: Loose to very friable when moist; non to slightly sticky, non to		

slightly plastic when wet
 B: Very friable to friable when moist;
 slightly sticky to sticky, slightly
 plastic to plastic when wet
 B+CR: Friable when moist; slightly sticky
 to sticky, slightly plastic to
 plastic when wet

Diagnostic properties : Argillic B-horizon; in places paralithic
 phase

Classification : chromic and orthic LUVISOLS

Representative profiles : 45 and 47

In general : Unit UUs/B+C consists for 50% out of 47
 and 20% of 49; UUs/C+Dis40% 47 and 40%
 49. The other soils are mainly
 moderately deep, dark red to red soils
 of light texture, possibly FERRALSOLS.

Soil mapping unit **UUap/C**

Number of augerings in unit : 2

Parent material : Undifferentiated Basement System
 gneisses

Macro relief : Undulating

Erosion : In places slight rill erosion

Rockiness/stoniness : In places slightly gravelly and fairly
 stony

Land use : Extensive grazing; shifting cultivation
 of millet, sorghum and legumes

Soils, general : Somewhat excessively drained, moderately
 deep, dark reddish brown, friable, clay
 loam to clay

Range of characteristics

, colour : A: Dark brown to dark reddish brown
 : B: Dark reddish brown

, texture : A: Sandy loam to sandy clay loam
 : B: Sandy clay loam to clay

, structure : A: Medium granular
 : B: Medium granular to subangular blocky

, consistence : A+B: Friable when moist; slightly sticky
 and slightly plastic when wet

Diagnostic properties : Argillic B-horizon

Classification : orthic LUVISOLS

Soil mapping unit **UUs/B**

Number of augerings in unit : 3

Parent material : undifferentiated banded gneisses

Macro relief : gently undulating, slopes 2-5 %

Erosion : moderate sheet, slight rill erosion

Rockiness/stoniness : gravelly, fairly stony

Land use : shifting cultivation, cropping millet,
 sorghum and cotton, bushland (in places
 dense) for charcoal exploitation

Soils, general : somewhat excessively drained, moderately
 deep, dark reddish brown, friable to
 firm, slightly gravelly clayloam to clay

Range of characteristics
 ,colour :A+B: dark reddish brown
 ,texture :A+B: slightly gravelly clay loam to clay
 ,consistence : friable to firm when moist
 Diagnostic properties : mollic A, argillic B
 Classification : luvic PHAEOZEMS
 Representative profile : 49

Soil mapping unit **UUCE/B**

Number of augerings : 5
 Parentmaterial : Basement system gneisses
 Macrorelief : gently undulating
 Erosion : severe sheet, rill and at spots severe gully erosion
 Rock/stoniness : at spots gravelly and stoney
 Landuse : grazing and shifting cultivation
 Soils general : Somewhat excessively drained, deep, dark reddish brown, firm, sandy clay

Range of characteristics
 ,colour :A+B: dark reddish brown
 ,texture : A: sandy clay
 B: slightly to very gravelly sandy clay
 ,structure :A+B: medium subangular blocky structure
 ,consistence :A+B: slightly sticky, slightly plastic, firm

Diagnostic prperties : argillic B
 Classification : chromic LUVISOLS
 Representative profiles : 39, 40 and 41

UV Soils developed on consolidated lahars

Soil mapping unit **UVh/B**

Number of augerings in unit : 10
 Parent material : Consolidated lahars
 Macro relief : Gently undulating
 Erosion : Nil
 Rockiness/stoniness : Fairly bouldery and gravelly
 Land use : Cropping of coffee, maize, mangoes and pigeon peas
 Soils, general : Well drained, moderately deep to very deep, dark brown to dark reddish brown, friable, clay.

Range of characteristics
 ,colour : A: Dark brown
 B: Dark reddish brown to dark brown
 ,texture :A+B: Clay
 ,structure : A: Medium granular
 B: Medium subangular blocky
 ,consistence :A+B: Friable when moist; sticky and slightly plastic when wet

Diagnostic horizons : Argillic or nitic B-horizon
 Classification : humic NITISOLS and humic ACRISOLS
 Representative profiles : 1 and 10

Soil mapping unit **UVh/CD**

Number of augerings in unit : 8
Parent material : Consolidated lahars
Macro relief : Undulating to rolling.
Erosion : Slight rill and sheet erosion
Rockiness/stoniness : Stony and bouldery
Land use : Cropping of coffee, maize, mangoes and
pigeon peas.
Soils and properties : As in unit UVh/B

Soil mapping unit **UVhp/BC**

Number of augerings in unit : 5
Parent material : Consolidated lahars
Macro relief : Gently undulating to undulating
Erosion : Slight rill and sheet erosion
Rockiness/stoniness : Slightly gravelly, stony and bouldery
Land use : Forestry and grazing
Soils general : Well drained, moderately deep, dark
reddish brown to dark brown, friable,
clay
Range of characteristics
 , colour : A: Dark brown
 : B: Dark reddish brown to dark brown
 , texture : A+B: Clay
 , structure : A+B: Coarse subangular blocky
 , consistence : A+B: Friable when moist; slightly sticky
 and slightly plastic when wet
Diagnostic properties : Argillic B-horizon, humic epipedon
Classification : humic ACRISOLS
Representative profiles : 20 and 24

Soil mapping unit **UVnr/AB**

Number of augerings in unit : 26
Parent material : lahar / phonolite
Macrorelief : undulating to rolling, slopes < 5 %
Erosion : slight splash and sheet erosion
Rockiness / stoniness : nil
Land use : rotation of annual crops like maize and
beans, permanent cultivation of coffee
and bananas
Soils, general : well drained, very deep, dark reddish
brown, friable, clay, having an AB
horizon sequence with 30 - 60 cm humic
topsoil
Range of characteristics
 , colour : A: dark reddish brown
 : B: dark reddish brown to dark red
 , texture : A+B: clay
 , structure : A: moderate fine granular to fine
 subangular blocky
 : B: moderate to strong, medium to

,consistence : coarse, subangular to angular blocky
:A+B: friable when moist, slightly sticky to sticky and slightly plastic to plastic when wet

Chemical properties : %C ranges from 1.5 in the A-horizon to 0.4 in the B-horizon; pH-H₂O is 5.2, pH-KCl is 4.7; CEC ranges from 21 to 15 cmol(+)/Kg soil; BS ranges from 32% to 26%

Diagnostic properties : ochric A-horizon, nitic B-horizon

Classification : dystric NITISOLS, chromic ACRISOLS

Representative profiles : 7 and 26

Soil mapping unit **UVn/AB** **UVn/BD**

Number of augerings in unit : 25

Parent material : lahar / phonolite

Macro relief : undulating to rolling, slopes 3-16 %

Erosion : slight splash and sheet erosion (on the steeper slopes gully erosion may occur, but building and good maintenance of terraces combined with strip cropping of napier grass prevents soil erosion adequately)

Rockiness/stoniness : nil

Land use : on the upper slopes, near the homesteads, foodcrops like maize and beans are grown, on the steeper slopes coffee is grown on terraces, near the streams bananas, sugarcane and cocoyams are grown

Soils, general : as in unit UVnr/AB, but with a 20 to 50 cm humic topsoil.

Soil mapping unit **UVat/AB**

Soils, other characteristics : see unit PVat/AB

Soil mapping unit **UVr/C**

Number of augerings in unit : 7

Parent material : Consolidated lahars

Macro relief : Undulating, slopes 5-8%

Erosion : Moderate sheet, slight rill erosion

Rockiness/stoniness : None

Land use : Cropping of pigeon peas, maize, millet, and sorghum

Soils, general : Well drained, moderately deep to deep, dark red to dark reddish brown, friable, clay

Range of characteristics

 ,colour : A: dark reddish brown
 : B: dark red to dark reddish brown

 ,texture : A+B: clay

 ,structure : A: fineto medium granular to medium subangular blocky

B: medium subangular blocky to coarse angular blocky
 ,consistence : friable when moist; slightly sticky and slightly plastic when wet
 Diagnostic properties : Argillic B-horizon
 Classification : chromic ACRISOLS
 Representative profiles : 9 and 16
 In general :

Soil mapping units **UVr/AB** **UVr/BC**

Number of augerings in units : 17
 Parent material : Consolidated lahars
 Macro relief : undulating, slopes 0-5% and 3-8%
 Erosion : slight rill erosion
 Rockiness/stoniness : none
 Land use : Pigeon peas, maize, millet and sorghum
 Soil qualities : see unit UVr/C
 Diagnostic properties : Argillic B-horizon
 Classification : ferrallo-chromic and chromic ACRISOLS
 Representative profiles : 9 and 16
 In general : in places ferric ACRISOLS (profile 13)

Soil mapping unit **UVhr/B**

Number of augerings in unit : 3
 Parent material : Lahars and non recent alluvial deposits
 Macro relief : Gently undulating
 Erosion : Slight sheet and rill erosion
 Rockiness/stoniness : Nil
 Landuse : Cropping of bananas, cassava, maize, napier grass, and pigeon peas.
 Soils, general : Well drained, deep to very deep, dark reddish brown, friable, clay
 Range of characteristics
 ,colour :A+B: dark reddish brown
 ,texture :A+B: clay
 ,structure : A: granular structure
 : B: subangular blocky structure
 ,consistence : friable when moist; slightly sticky and slightly plastic when wet
 Diagnostic properties : Nitic B-horizon
 Classification : humic NITISOLS
 Representative profile : 24

Soil mapping unit **UVCs/CD**

Number of augerings in unit : 20
 Parent material : Lahar
 Macro relief : Undulating to rolling
 Erosion : Slight to moderate sheet; in places moderate rill and gully erosion
 Rockiness/ stoniness : Slightly gravelly, stony to very stony (boulders), fairly rocky
 Land use : The major part of the slopes are used

for permanent cultivation of annual crops like maize, beans, sorghum and cassava. The remaining 30% are natural bush and trees and serve as pasture and fallow. The use of valley bottoms (10-15% of this unit) is as in unit RiVCs/DF.

Soils, general : Well drained, deep, dark reddish brown, firm, clay to gravelly clay. With AB, and in places AC or AR horizon sequences.

Range of characteristics

 ,colour :A+B: Dark reddish brown

 ,texture :A+B: Clay to gravelly clay

 ,structure : A: Fine to medium subangular blocky

 : B: Very coarse angular blocky

 ,consistence : A: Very friable to friable when moist; sticky and plastic when wet

 B: Friable to firm when moist; sticky and plastic when wet

Diagnostic properties : Umbric or ochric A-horizon, argillic or nitic B-horizon

Classification : Complex of humic NITISOLS (25%), humic ACRISOLS (25%) and chromic ACRISOLS (20%).

Representative profiles : 9, 20 and 24

In general : In the valley bottoms humic NITISOLS are dominating. On slopes also humic CAMBISOLS and RANKERS (differing thickness of umbric A- horizon) occur.

Soil mapping unit **UVst/AB**

Number of augerings in unit : 10

Parent material : consolidated lahars

Macrorelief : undulating, slopes 0-5%

Erosion : slight sheet, rill and gully erosion; in places moderate erosion.

Rockiness / stoniness : very gravelly and stony; bouldery and rocky

Land use : extensive grazing; annual cropping of cotton, maize, sorghum, millet and tobacco

Soils, general : somewhat excessively drained, very shallow to moderately deep, dark brown to dark reddish brown, friable, sandy clay

Range of characteristics

 ,colour :A+B: dark brown to dark reddish brown

 ,texture :A+B: clay to sandy clay loam

 ,structure : A: medium granular

 B: fine subangular blocky

 ,consistence : friable when moist; slightly sticky and slightly plastic when wet

Diagnostic properties : cambic B-horizon or continuous hard rock within 25 cm depth

Classification : dystic CAMBISOLS and LITHOSOLS

Representative profiles : 5 and 17

Land use : Cropping of maize and pigeon peas
 Soils, general : Well drained, shallow to moderately deep, dark reddish brown, friable, clay to silty clay

Range of characteristics
 ,colour :A+B: Dark reddish brown
 ,texture :A+B: Clay to silty clay
 ,structure : A: Moderate granular structure
 : B: Fine subangular blocky
 ,consistence :A+B: Friable when moist; slightly sticky and slightly plastic when wet

Diagnostic properties : Argillic B-horizon, murrum in profile or continuous hard rock within 25 cm depth

Classification : ferric ACRISOLS and LITHOSOLS(20%)

Representative profiles : 17 and 42

Soil mapping unit **UVnr/AB**

Number of augerings in unit : 6
 Soils, other characteristics : see unit UVnr/AB<ISHIARA>
 Remarks : almost 30% of unit consists of chromic ACRISOLS (profile 27)

UC Soils developed on various parent materials

Soil mapping unit **U(F+Q)CV/BD**

Number of augerings : 74
 Parent material : alluvium, colluvium and non recent alluvium. granitoid and ferro-magnesian rich gneisses

Macro - relief : undulating to rolling
 Erosion : slight rill erosion, at spots severe rill and gully erosion

Rockiness/stoniness : stony and gravelly in river-beds, fairly stony and rocky on slopes towards river

Land use : grazing, water-supply
 Soils, general : somewhat excessively drained, shallow to moderately deep, dark brown to dark reddish brown, gravelly, sometimes stony, friable, sand to clay. The soils have only a B or C horizon
 ,colour : B: dark brown to dark reddish brown
 ,texture : B: sand to clay
 B: non to slightly sticky, non to slightly plastic when wet

Diagnostic properties : argillic B or continuous hard rock within 25 cm depth, and at places calcium carbonate concretions and petrocalcic

Classification : FLUVISOLS, LITHOSOLS, calcic and chromic ACRISOLS, LUVISOLS, CAMBISOLS, eutric REGOSOLS and calcaric PHEAOZEMS

Representative profiles : 18 and 19

=====

P Soils of the plains

PA Soils developed on alluvial sediments from various sources

Soil mapping unit **PA1/A**

Number of augerings in unit : 4
Parentmaterial : recent alluvial deposits
Macro relief : flat to gently undulating, slopes < 2%
Erosion : nil
Rockiness/stoniness : nil
Land use : cropping of millet, maize, sugarcane, bananas and papaya; wooded grassland with extensive grazing.
Soils, general : well drained, very deep, dark brown, loamy sand to clay loam, very friable
Range of characteristics
 ,colour : A: dark brown
 ,texture : A: sand to clay loam
 ,structure : A: weak fine to medium subangular blocky
 ,consistence : A: loose to friable when moist; non to slightly sticky and non to slightly plastic when wet
Classification : eutric FLUVISOLS
Representative profile : 48

Soil mapping unit **PA2/A**

Number of augerings in unit : 6
Parentmaterial : pleistocene alluvial deposits
Macro relief : gently undulating to undulating, slopes <2%
Erosion : nil
Rockiness/stoniness : nil
Land use : grassland to wooded bushland; extensive grazing
Soils, general : well drained, very deep, dark reddish brown, sandy clay loam, very friable to friable
Range of characteristics
 ,colour : A: dark brown to reddish brown
 : B: dark reddish brown to dark red
 ,texture : A: sand to loamy sand
 : B: sand to sandy clay loam
 ,structure : A: weak medium subangular blocky
 : B: porous massive, strongly coherent
 ,consistence : A+B: loose to friable when moist; non to slightly sticky and non to slightly plastic when wet
Diagnostic properties : argillic B-horizon
Classification : chromic LUVISOLS
Representative profile : 43

Soil mapping unit **PAd/AB**

Number of augerings in unit : 1
Parent material : non recent alluvial deposits
Macro relief : gently undulating, slopes < 5%
Erosion : none
Rockiness/stoniness : none
Land use : grazing; cropping of cotton
Soils in general : moderately well drained, moderately deep
to deep, black ,firm, clay

Range of characteristics
 ,colour :A+B: black
 ,texture :A+B: clay
 ,structure :A+B: angular blocky
 ,consistence :A+B: firm when moist; sticky and slightly
plastic when wet

Diagnostic properties : vertic properties
Classification : chromic and pellic VERTISOLS
Representative profile : 29

Soil mapping unit **PAP/AB**

Number of augerings in unit : 2
Parent material : non recent alluvial deposits
Macro relief : gently undulating, slopes < 5%
Erosion : slight rill and sheet erosion
Rockiness/stoniness : nil
Land use : cropping of millet, sorghum, beans and
cotton
Soils, general : well drained, shallow to moderately
deep, dark reddish brown to dark brown,
friable, sandy clay loam to sandy clay

Range of characteristics
 ,colour :A+B: dark reddish brown to dark brown
 ,texture :A+B: sandy clay loam to sandy clay
 ,structure :A+B: angular and subangular blocky
 ,consistence :A+B: friable when moist; sticky and
slightly plastic when wet

Diagnostic properties : argillic B-horizon
Classification : vertic and chromic LUVISOLS
Representative profile : 15

PV Soils developed on consolidated lahars

Soil mapping unit **PVat/AB**

Number of augerings in unit : 8
Parent material : consolidated lahars
Macro relief : undulating, slopes < 5%
Erosion : slight sheet, rill and gully erosion
Rockiness/stoniness : rocky; in places gravelly and stony
Land use : grazing; lahar exploitation for stone
production at boundary of this unit
Soils, general : excessively to well drained, shallow to
moderately deep, dark reddish brown to
dark brown, friable, sandy clay to clay

Range of characteristics	
,colour	: A: dark brown
	: B: dark brown to dark reddish brown
,texture	:A+B: sandy clay to clay
,structure	: A: medium granular
	: B: medium subangular blocky
,consistence	:A+B: friablewhen moist; non sticky and non plastic when wet
Diagnostic properties	: argillic B-horizon or continuous hard rock within 25 cm depth
Classification	: orthic LUVISOLS and LITHOSOLS(50%)
Representative profile	: 17
In general	: at low places also vertic LUVISOLS occur (less than 10%).

APPENDIX B

PROFILE DESCRIPTION 1

Date/ season : 25/7/85; end of the long rains
Sheet-observation no : 122/3-1
Coordinates : 3468 E, 99543 N
Elevation : 1380 m
Authors : Willy Simons
Soil mapping unit : RaVCV, HVCS
Soil classification : ferric ACRISOL
(FAO, soil taxonomy) plinthic Paleudult
Geology : Mt. Kenya series
Local petrography/ parent material : lahar / phonolite
Physiography : Mountain Footridges
Macro-relief : undulating
Slope (length, shape and pattern) : 200 m, convex, irregular
Slope gradient : 10 %
Position on slope : middle slope
Meso- and micro-relief : nil
Vegetation/ Landuse : pasture/ grazing
Erosion : nil
Rock outcrops : fairly rocky
Surface stoniness : nil
Overwash : nil
Surface runoff : medium
Surface sealing/crusting/cracking : nil
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep, > 2 m
Presence of salts/ alkali : nil
Soilfauna influences : moderate
Expected rooting depth : very deep

Horizons:

Ah 0-30 cm Dark reddish brown (5YR 3/2) when moist; clay; moderate fine subangular blocky structure; very friable when moist, sticky and slightly plastic when wet; few thin clayskins; many medium and many fine pores; frequent fine roots; gradual and smooth transition to:

Bt1 30-80 cm Dark reddish brown (2.5YR 3/4) when moist; clay; moderate medium subangular blocky structure; friable when moist, sticky and slightly plastic when wet; continuous thin clayskins; common medium and few fine pores; common fine roots; diffuse and smooth transition to:

Bt2 80-140 cm Dark reddish brown (2.5YR 3/4) when moist; clay; moderate medium and coarse subangular blocky structure; friable when moist, slightly sticky and slightly plastic when wet; broken thin clayskins; common medium pores; no roots; abrupt and smooth transition to:

Bcs 140-160 cm Dark red (2.5YR 3/6) when moist; very gravelly clay; moderate fine subangular blocky structure; friable when moist, slightly sticky and slightly plastic when wet; few medium pores; dominant iron concretions, Ø 5-10 mm; no roots.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 1

Field observation no.: 122/3-01 Soil Classification: ferric ACRISOL

Laboratory number /85	4922	4923	4924	4925
Horizon designation	Ah	Bt1	Bt2	Bcs
Depth, cm	0-30	30-80	80-140	140-160
pH-H2O (1:2.5)	5.3	5.1	4.7	4.7
pH-M KCl (1:2.5)	4.7	4.3	4.3	4.3
EC mS/cm (1:2.5)	0.07	0.05	0.02	0.02
C%	1.3	0.4	0.4	0.3
CEC cmol(+)/Kg, pH 8.2	21.6	16.5	16.0	12.0
Exch. Ca cmol(+)/Kg	2.4	0.5	0.1	0.1
,, Mg ,,	2.8	0.9	0.6	0.2
,, K ,,	0.8	0.5	0.2	0.2
,, Na ,,	0.2	0.1	0.1	0.1
Sum cations	6.2	3.7	1.0	0.6
Base saturation, pH 8.2	29	22	6	5
ESP, pH 8.2	1	1	1	1
Gravel %, > 2mm				
Sand % 2 - 0.05 mm	10	6	6	22
Silt % 0.05 - 0.002 mm	14	10	8	12
Clay % < 0.002 mm	76	84	86	66
Texture class	C	C	C	C

FERTILITY (Composite sample of at least 5 locations)

Depth, cm	0-20	40-60
Laboratory number /85	4966	8413
pH-H2O (1:2.5)	5.4	5.3
Na cmol(+)/Kg	tr	0.1
K ,,	0.8	0.6
Ca ,,	2.4	0.4
Mg ,,	2.8	1.6
Mn ,,	0.7	0.9
P mg/kg	51	8
N%	0.2	?
C%	1.7	?
Hp	0.2	0.4

CEC = 16 cmol(+)/Kg clay
 CEC = 720 ,, /Kg carbon

PROFILE DESCRIPTION 2

Date/ season : 18/5/85; end rainy season
Sheet-observation no : 122/3-4
Coordinates : 3604 E, 99501 N
Elevation : 1060 m
Authors : Willy Simons
Soil mapping unit : LVm+r, LVMp
Soil classification (FAO) : dystric CAMBISOL
(soil taxonomy) ustic Dystropept
Geology : Mt. Kenya series
Local petrography/ Parent material : lahar / phonolite
Physiography : Plateaus
Macro-relief : gently undulating
Slope gradient : 2 %
Meso- and micro-relief : nil
Vegetation/ Landuse : thickets used for extensive grazing
Erosion : nil
Rock outcrops : nil
Surface stoniness : fairly stony (boulders)
Overwash : nil
Surface runoff : slow
Surface sealing/crusting/cracking : nil
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep, > 2 m
Presence of salts/ alkali : nil
Soilfauna influences : moderate
Expected rooting depth : very deep

Horizons:

Ah 0-25 cm Very dark grey (5YR 3/1) when moist; clay; moderate medium angular blocky structure; friable, slightly sticky and non-plastic; many medium and fine pores; gradual and smooth transition to:

Bcs 25-50 cm Dark reddish brown (5YR 3/3) when moist; very gravelly sandy clay loam; moderate medium angular blocky structure; friable, slightly sticky and non plastic; very frequent hard iron concretions, \emptyset 5 mm; many medium and fine pores; common medium roots; gradual and smooth transition to:

BCcs 50-60 cm Reddish brown (5YR 4/3) when moist; common prominent very dark grey and few prominent red mottles; very gravelly sandy loam; structureless; firm, non sticky and non plastic; few medium pores; very frequent hard iron and manganese concretions, \emptyset 5-10 mm; few fine roots; clear and smooth transition to:

Ccsl 60-100 cm Dark reddish brown (2.5YR 3/4) when moist; many prominent red and common prominent yellow mottles; very gravelly sandy clay; strong

coarse granular structure; firm, non sticky and non plastic; few medium pores; very frequent hard iron and manganese concretions, \emptyset 5-10 mm; few fine roots; gradual and smooth transition to:

Ccs2 100-160+ cm

Reddish brown (5YR 4/3) when moist; many prominent yellow mottles; very gravelly clay; strong very coarse granular structure; friable, non sticky and non plastic; many medium and fine pores; very frequent soft iron and manganese concretions, \emptyset 10- 20 mm; few fine roots.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 2

Field Obs. No.: 122/3-4

Soil Classification: dystric CAMBISOL

Lab. no. /85	4934	4935	4936	4937	4938
Horizon designation	Ah	Bcs	BCcs	Ccsl	Ccs2
Depth (cm)	0-25	25-50	50-60	60-100	100-160
pH-H2O (1:2.5)	5.8	5.4	5.3	5.5	5.9
pH-M KCl (1:2.5)	5.0	4.8	5.1	4.8	4.6
EC mS/cm (1:2.5)	0.07	0.02	0.02	0.02	0.03
C%	1.4	0.7	0.5	0.5	0.5
CEC cmol(+)/Kg, pH 8.2	23.2	13.2	7.9	13.7	14.0
Exch. Ca cmol(+)/Kg	9.5	3.8	2.2	2.3	2.4
,, Mg ,,	4.0	2.5	1.2	2.2	2.8
,, K ,,	1.1	0.3	0.2	0.2	0.2
,, Na ,,	0.1	0.1	0.1	0.1	0.1
Sum cations	14.7	6.7	3.7	4.8	5.5
Base saturation, pH 8.2	63	51	47	35	39
ESP at pH 8.2	<1	1	1	1	1
Gravel % > 2mm	-	-	-	-	-
Sand % 2-0.05 mm	28	60	76	46	36
Silt % 50-2 um	18	8	6	10	12
Clay % < 2 um	54	32	18	44	52
Texture class	C	SCL	SL	SC	C

FERTILITY (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. ... / 85	4969
pH-H2O (1:2.5)	5.8
Na cmol(+)/Kg	0.1
K ,,	1.1
Ca ,,	9.6
Mg ,,	4.2
Mn ,,	0.8
Exch. acid. ,,	tr
P ug/g	34
N%	0.18
C%	1.8

CEC = 20 cmol(+)/Kg clay

CEC = 900 ,,

PROFILE DESCRIPTION 3

Date/ season : 18/5/85; end rainy season
Sheet-observation no : 122/4-7
Coordinates : 3733 E, 99622 N
Elevation :
Authors : Willy Simons
Soil classification : eutric REGOSOL
(FAO, soil taxonomy) : typic Ustropept
Geology : basement system
Local petrography/ Parent material : hornblende gneisses
Physiography : Hill
Macro-relief : hilly
Slope (length, shape and pattern) : 40 m, concave, regular
Slope gradient : 20%
Position on slope : lower slope
Meso- and micro-relief : nil
Vegetation/ Landuse : grassland, probably used for
grazing
Erosion : nil
Rock outcrops : nil
Surface stoniness : rubble land
Overwash : nil
Surface runoff : very rapid
Surface sealing/crusting/cracking : nil
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep, > 2m
Presence of salts/ alkali : nil
Soilfauna influences : extreme
Expected rooting depth : shallow

Horizons:

Ah 0-10/20 cm Dark reddish brown (5YR 3/2) when moist; common medium distinct yellowish brown mottles (10YR 5/6) when moist; slightly gravelly sandy loam; strong fine subangular blocky structure; friable, non sticky and non plastic; many medium and fine pores; frequent fine and few medium roots; clear and broken transition to:

CR/B 10/20-80 cm Dark reddish brown (2.5YR 3/4) when moist; no roots; clear and smooth transition to:

CR 80-150+ cm Rotten rock; frequent hard carbonate concretions, \emptyset 0-10 mm, in joints.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 3

Field Observation No.: 122/4-7

Soil Classification: eutric REGOSOLS

Lab. no. .../85	4945
Horizon designation	Ah
Depth (cm)	0-10
pH-H ₂ O (1:2.5)	7.4
pH-M KCl (1:2.5)	6.9
EC (mS/cm; 1:2.5)	0.07
C (%)	0.7
CEC cmol(+)/Kg, pH 7.0	8.0
Exch. Ca (cmol(+)/Kg)	3.8
,, Mg ,,	3.0
,, K ,,	0.1
,, Na ,,	0.6
Sum cations	12.5
Base sat. at pH 7.0	100+
ESP at pH 7.0	8
Gravel % >2mm	-
Sand % 2-0.05mm	77
Silt % 50-2 um	11
Clay % <2 um	12
Texture class	SL

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../85	4972
pH-H ₂ O (1:2.5)	6.9
Ca cmol(+)/Kg	8.8
Mg ,,	3.4
K ,,	0.1
Mn ,,	0.3
Exch. acid. ,,	-
P ug/g	134
C %	0.3
N %	0.07

CEC = 37 cmol(+)/Kg clay at:
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 4

Date/ season : 18/5/85; end rainy season
Sheet-observation no : 122/4-8
Coordinates : 3681 E, 99636 N
Elevation :
Authors : Willy Simons
Soil mapping unit : U3M1
Soil classification (FAO) : orthic ACRISOL
Geology : basement system
Local petrography/ Parent material : hoornblende gneisses
Physiography : Upland
Macro-relief : gently undulating
Slope (length, shape and pattern) : -
Slope gradient : 0%
Position on slope : -
Meso- and micro-relief : nil
Vegetation/ Landuse : bushland used for extensive grazing

Erosion : moderate; pipe and sheet erosion
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : medium
Surface sealing/crusting/cracking : strong sealing, 7 mm thick
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep, > 2m
Presence of salts/ alkali : nil
Soilfauna influences : limited
Expected rooting depth : very deep

Horizons:

Ah 0-20 cm Dark red (2.5YR 3/6) when moist; clay; strong fine subangular blocky structure; very hard, non sticky and non plastic; common fine pores; common fine roots; gradual and smooth transition to:

Bt1 20-90 cm Dark reddish brown (2.5YR 3/4) when moist; clay; strong medium subangular blocky structure; patchy thin clayskins; very hard, sticky and slightly plastic; common medium pores and few fine pores; few fine roots; gradual and smooth transition to:

Bt2 90-120 cm Dark red (2.5YR 3/6) when moist; clay; strong coarse angular blocky structure; broken thin clayskins; very hard, sticky and slightly plastic; common medium pores and few fine pores; few fine roots; gradual and smooth transition to:

BC 120-150 cm Dark red (2.5YR 3/6) when moist; clay; strong coarse angular blocky structure; patchy thin clayskins; very hard, sticky and slightly

plastic; few fine pores; few fine roots;
abrupt and smooth transition to:

CR 150-170+ cm Rotten rock

Remark: rock fragments throughout the solum.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 4

Field Observation No.: 122/4-8 Soil Classification: orthic ARCRISOL

Lab. no. .../85	4946	4947	4948	4949
Horizon designation	Ah	Bt1	Bt2	BC
Depth (cm)	0-20	20-90	90-120	120-150
pH-H2O (1:2.5)	6.5	6.5	6.7	7.0
pH-M KCl (1:2.5)	5.4	5.4	5.6	5.6
EC (mS/cm; 1:2.5)	0.07	0.06	0.06	0.17
C (%)	0.5	0.4	0.4	0.3
CEC cmol(+)/Kg, pH 7.0	16.4	17.0	16.1	15.0
Exch. Ca cmol(+)/Kg)	4.3	4.3	3.3	5.3
,, Mg ,,	3.4	4.1	5.4	4.9
,, K ,,	0.6	0.1	0.1	0.1
,, Na ,,	0.1	0.1	0.1	0.1
Sum cations	8.4	8.6	8.9	10.4
Base saturation at pH 7.0	51	51	55	69
ESP at pH 7.0	1	1	1	1
Gravel % >2mm				
Sand % 2-0.05mm	35	31	31	31
Silt % 50-2 um	9	9	0	15
Clay % <2 um	56	60	60	54
Texture class	C	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../85	4973
pH-H2O (1:2.5)	6.0
Ca cmol(+)/Kg	5.0
Mg ,,	3.8
K ,,	0.5
Mn ,,	0.2
Exch. acid. ,,	-
P ug/g	34
C %	0.8
N %	0.10

CEC = 25 cmol(+)/Kg clay
CEC = 500 ,, carbon

PROFILE DESCRIPTION 5

Date/ season : 16/5/85; end rainy season
Sheet-observation no : 122/4-10
Coordinates : 3624 E, 99652 N
Elevation :
Authors : Willy Simons
Soil mapping unit : U2M1
Soil classification (FAO) : dystic CAMBISOL
Geology : Mt. Kenya series
Local petrography/ Parent material : pyroclastic agglomerates
Physiography : Upland
Macro-relief : undulating
Slope (length, shape and pattern) : 250m, straight, regular
Slope gradient : 8%
Position on slope : middle slope
Meso- and micro-relief : nil
Vegetation/ Landuse : bushland used for extensive grazing
Erosion : slight; splash erosion
Rock outcrops : nil
Surface stoniness : stony
Overwash : very slight
Surface runoff : medium
Surface sealing/crusting/cracking : weak sealing
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : none to limited
Expected rooting depth : moderately deep

Horizons:

Ah 0-15 cm Very dark gray (5YR 3/1) when moist; few fine distinct yellowish red mottles; slightly stony clay; moderate medium granular structure; very friable, non sticky and slightly plastic; few iron concretions, \emptyset 4-10 mm; many medium pores; frequent fine and few coarse roots; clear and smooth transition to:

AB 15-30 cm Dark reddish gray (5YR 4/2) when moist; common medium prominent yellowish red mottles; gravelly and stony clay; moderate fine subangular blocky structure; friable, non sticky and slightly plastic; frequent iron concretions, \emptyset 4-10 mm; many medium pores; common fine and very few medium roots; clear and smooth transition to:

Bw 30-50/80 cm Dark reddish brown (5YR 3/4) when moist; many coarse prominent red mottles; gravelly and slightly stony clay; moderate fine subangular blocky structure; very friable, non sticky and slightly plastic; frequent iron concretions, \emptyset 4-10 mm; many medium pores; common fine and

very few medium roots; clear and irregular transition to:

BC 50/80-110 cm Dark reddish gray (5YR 4/2) when moist; many coarse prominent yellowish red mottles; very stony clay; moderate fine subangular blocky structure; very friable, non sticky and slightly plastic; common medium pores; clear and smooth transition to:

CR 110-130+ cm Rotten rock.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 5

Field Observation No.: 122/4-10 Soil Classification: dystric CAMBISOL

Lab. no. .../85	4954	4955	4956	4957
Horizon designation	Ah	AB	Bw	BC
Depth (cm)	0-15	15-30	30-50/80	50/80-110
pH-H2O (1:2.5)	6.1	5.6	5.3	5.6
pH-M KCl (1:2.5)	5.2	4.6	4.0	4.1
EC (mS/cm; 1:2.5)	0.08	0.04	0.03	0.03
C (%)	2.1	0.9	0.7	0.4
CEC cmol(+)/Kg, pH 7.0	28.3	23.5	25.5	24.0
Exch. Ca cmol(+)/Kg	5.9	2.5	1.9	4.5
,, Mg ,,	6.2	3.2	2.2	4.6
,, K ,,	1.6	1.8	1.6	1.7
,, Na ,,	0.2	0.2	0.3	0.8
Sum cations	13.9	7.7	6.0	11.6
Base saturation at pH 7.0	49	33	24	48
ESP at pH 7.0	1	1	1	3
Gravel % >2mm	-	-	-	-
Sand % 2-0.05mm	33	39	27	25
Silt % 50-2 um	23	19	21	19
Clay % <2 um	44	42	52	46
Texture class	C	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../85	4975
pH-H2O (1:2.5)	5.8
Ca cmol(+)/Kg	6.8
Mg ,,	3.4
K ,,	0.9
Mn ,,	0.5
Exch. acid. ,,	-
P ug/g	28
C %	1.8
N %	0.13

CEC = 45 cmol(+)/Kg clay
 CEC = 450 ,, carbon

PROFILE DESCRIPTION 6

Date/ season : 1/6/85; end rainy season
Sheet-observation no : 122/3-17
Coordinates : 3490 E, 99537 N
Elevation : 1360 m
Authors : Inge Aalders and Hans Nobbe
Soil mapping unit : BVr
Soil classification : gleyic Acrisol
(FAO, soil taxonomy) : epiaquic Palehumult
Geology : Mt. Kenya series
Local petrography/ Parent material : lahar / phonolite
Physiography : Bottomlands
Macro-relief : flat
Slope (length, shape and pattern) : -
Slope gradient : 2 %
Position on slope : -
Meso- and micro-relief : nil
Vegetation/ Landuse : grazing
Erosion : very slight sheet and splash
erosion
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : very slow
Surface sealing/crusting/cracking : nil
Drainage class : moderately well drained
Flooding : nil
Groundwater level (actual) : temporarily moderately deep
Presence of salts/ alkali : nil
Soilfauna influences : limited
Expected rooting depth : deep

Horizons:

Ah1 0-35/40 cm Dark reddish brown (5YR 3/2) when moist; clay; moderate fine granular structure; very friable, slightly sticky and slightly plastic; many fine pores; gradual and wavy transition to:

Ah2 35/40-65/70 cm Dark brown (7.5YR 3/2) when moist; very few fine faint black mottles; clay; moderate fine subangular and granular structure; very friable, sticky and slightly plastic; many fine pores; abundant medium roots; gradual and wavy transition to:

BA 65/70-105/110 cm Dark brown (7.5YR 3/2) when moist; clay; few fine faint black, red and yellow mottles; moderate fine subangular blocky structure; friable, slightly sticky and slightly plastic; patchy thin manganese cutans; many fine pores; very few coarse and common fine roots; gradual and wavy transition to:

Btg 105/110-130+ cm Dark reddish brown (5YR 3/3) when moist; clay; abundant little black concretions; strong

medium angular blocky structure; broken thin manganese cutans; very friable, sticky and slightly plastic; very few coarse and common fine roots.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 6

Field Observation No.: 122/3-17 Soil Classification: gleyic ACRISOL

Lab. no. .../85	5772	5773	5774	5775
Horizon designation	Ah1	Ah2	BA	Btg
Depth (cm)	0-35	40-65	65-105	110-130
pH-H ₂ O (1:2.5)	5.0	5.0	4.9	5.0
pH-M KCl (1:2.5)	4.4	4.5	4.3	4.1
EC (mS/cm; 1:2.5)	0.04	0.04	0.04	0.03
C (%)	1.6	1.2	1.1	1.0
CEC cmol(+)/Kg, pH 7.0	24.7	23.5	18.7	16.5
Exch. Ca (cmol+)/Kg)	5.0	3.2	2.0	1.3
,, Mg ,,	1.0	1.0	0.5	0.3
,, K ,,	0.2	0.1	0.1	0.1
,, Na ,,	0.1	0.2	0.1	0.1
Sum cations	6.3	4.5	2.7	1.8
Base saturation at pH 7.0	26	19	14	11
ESP at pH 7.0	<1	1	<1	<1
Gravel % >2mm	-	-	-	-
Sand % 2-0.05mm	6	12	8	12
Silt % 50-2 um	36	24	20	14
Clay % <2 um	58	64	72	74
Texture class	C	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../85	5792	8418
pH-H ₂ O (1:2.5)	5.2	5.4
Ca cmol(+)/Kg	5.2	2.0
Mg ,,	1.4	1.0
K ,,	0.3	0.3
Mn ,,	0.8	1.6
Exch. acid. ,,	0.5	0.9
P ug/g	38	17
C %	1.4	n.d.
N %	0.10	n.d.

CEC = 28 (0-65 cm) and 17 (65-130 cm) cmol(+)/Kg clay
 CEC = 500 cmol(+)/Kg carbon

PROFILE DESCRIPTION 7

Date/ season	: 1/6/85; end rainy season
Sheet-observation no	: 122/3-18
Coordinates	: 3485 E, 99543 N
Elevation	: 1390 m
Authors	: Hans Nobbe and Inge Aalders
Soil mapping unit	: UVn
Soil classification (FAO, soil taxonomy)	: dystric NITISOL rhodic Paleudult
Geology	: Mt. Kenya series
Local petrography/ Parent material	: lahar / phonolite
Physiography	: Mountain Footridges
Macro-relief	: flat to very gently undulating
Slope (length, shape and pattern)	: > 200 m, straight, regular
Slope gradient	: 1 %
Position on slope	: middle slope
Meso- and micro-relief	: nil
Vegetation/ Landuse	: annual crop cultivation
Erosion	: very slight sheet and splash erosion
Rock outcrops	: nil
Surface stoniness	: nil
Overwash	: nil
Surface runoff	: very slow
Surface sealing/crusting/cracking	: nil
Drainage class	: well drained
Flooding	: nil
Groundwater level (actual)	: always deep
Presence of salts/ alkali	: nil
Soilfauna influences	: moderate
Expected rooting depth	: very deep

Horizons:

Ah 0-35 cm	Dark reddish brown (5YR 3/2) when moist; clay; moderate very fine granular structure; friable, sticky and slightly plastic; many fine pores; very frequent very fine and common fine roots; gradual and wavy transition to:
Bt1 35-100 cm	Dark reddish brown (5YR 3/3) when moist; clay; moderate very fine to fine subangular blocky structure; friable, slightly sticky and slightly plastic; patchy thin clayskins and shiny pedfaces; many fine pores; few fine and common very fine roots; diffuse and smooth transition to:
Bt2100-160+ cm	Dark reddish brown (2.5YR 3/4) when moist; clay; moderate very fine subangular blocky structure; friable, slightly sticky and slightly plastic; patchy thin clayskins and shiny pedfaces; many fine pores; few fine and common very fine roots.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 7

Field Observation No.: 122/3-18 Soil Classification: dystric NITISOL

Lab. no. .../85	5776	5777	5778
Horizon designation	Ah	Bt1	Bt2
Depth (cm)	0-35	35-100	100-160

pH-H ₂ O (1:2.5)	5.2	5.3	5.5
pH-M KCl (1:2.5)	4.7	4.8	5.2
EC (mS/cm; 1:2.5)	0.04	0.04	0.04
C (%)	1.5	0.7	0.4
CEC cmol(+)/Kg, pH 7.0	20.5	17.7	15.1
Exch. Ca (cmol(+)/Kg)	4.0	3.4	3.2
,, Mg ,,	2.4	1.9	0.6
,, K ,,	0.1	0.1	0.1
,, Na ,,	0.1	0.1	<0.1
Sum cations	6.6	5.5	3.9
Base saturation at pH 7.0	32	31	26
ESP at pH 7.0	<1	1	<1
Gravel % >2mm			
Sand % 2-0.05mm	12	8	6
Silt % 50-2 um	24	18	16
Clay % <2 um	64	74	78
Texture class	C	C	C

FERTILITY ASPECTS (Composite sample from at least five locations)

Depth (cm)	0-20	40-60
Lab. no. .../85	5793	8419
pH-H ₂ O (1:2.5)	5.7	5.3
Ca cmol(+)/Kg	5.2	2.4
Mg ,,	2.8	2.8
K ,,	0.2	0.1
Mn ,,	1.0	1.4
Exch. acid. ,,	-	0.5
P ug/g	32	6
C %	1.9	n.d.
N %	0.24	n.d.

CEC = 17 cmol(+)/Kg clay
 CEC = 650 ,, carbon

PROFILE DESCRIPTION 8

Date/ season : 1/6/85; end rainy season
Sheet-observation no : 122/3-22
Coordinates : 3443 E, 99567 N
Elevation : 1480 m
Authors : Hans Nobbe and Inge Aalders
Soil mapping unit : RiVn
Soil classification : dystric NITISOL
(FAO, soil taxonomy) : orthoxic Palehumult
Geology : Mt. Kenya series
Localpetrography/ Parent material : lahar / phonolite
Physiography : Mountain Footridges
Macro-relief : undulating
Slope (length, shape and pattern) : 100 m, concave, regular
Slope gradient : 4 %
Position on slope : summit
Meso- and micro-relief : nil
Vegetation/ Landuse : perennial crop cultivation; coffee
Erosion : very slight splash and sheet erosion
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : slow
Surface sealing/crusting/cracking : nil
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : limited
Expected rooting depth : very deep

Horizons:

Ap 0-16 cm Dark reddish brown (5YR 3/3) when moist; clay; moderate very fine granular structure; friable, slightly sticky and slightly plastic; many fine pores; few very fine, common fine and few medium roots; gradual and smooth transition to:

BA 16-25 cm Dark reddish brown (5YR 3/3) when moist; clay; moderate very fine subangular blocky and fine granular structure; friable, slightly sticky and slightly plastic; broken thin clayskins; many fine pores; few very fine, common fine and few medium roots; gradual and smooth transition to:

Bt1 25-60 cm Dark reddish brown (2.5YR 3/4) when moist; clay; strong to moderate fine subangular blocky structure; broken thin clayskins; friable, slightly sticky and slightly plastic; many fine pores; very few very fine, very few medium and very few coarse roots; gradual and smooth transition to:

Bt2 60-160+ cm

Dark red (2.5YR 3/6) when moist; clay; moderate to weak fine subangular blocky structure; friable, slightly sticky and slightly plastic; patchy thin clayskins and shiny pedfaces; very few very fine, very few medium and very few coarse roots.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 8

Field Observation No.: 122/3-22 Soil Classification: dystric NITISOL

Lab. no. .../85	5783	5784	5785	5786
Horizon designation	Ap	BA	Bt1	Bt2
Depth (cm)	0-16	16-25	25-60	60-160
pH-H2O (1:2.5)	4.9	5.0	5.0	4.0
pH-M KCl (1:2.5)	4.4	4.7	4.6	4.6
EC (mS/cm; 1:2.5)	0.07	0.05	0.05	0.06
C (%)	2.1	1.4	0.8	0.5
CEC cmol(+)/Kg, pH 7.0	18.2	16.0	11.0	9.5
Exch. Ca cmol(+)/Kg	1.3	2.0	1.1	1.1
,, Mg ,,	2.3	1.4	1.2	1.7
,, K ,,	0.4	0.3	0.1	0.1
,, Na ,,	<0.1	<0.1	<0.1	<0.1
Sum cations	4.0	3.7	2.4	2.9
Base sat. at pH 7.0	22	23	22	31
ESP at pH 7.0	<1	<1	<1	<1
Gravel % >2mm	-	-	-	-
Sand % 2-0.05mm	10	10	8	4
Silt % 50-2 um	18	14	14	12
Clay % <2 um	72	76	78	84
Texture class	C	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../85	8424	8425
Ca cmol(+)/Kg	1.2	0.4
Mg ,,	3.8	2.8
K ,,	0.3	0.2
Mn ,,	1.3	1.3
Exch. acid. ,,	0.6	0.4
P ug/g	14	14
C %	2.2	n.d.
N %	0.07	n.d.
pH-H2O (1:2.5)	5.0	5.1

CEC = 8 cmol(+)/ Kg clay
 CEC = 600 ,, carbon

PROFILE DESCRIPTION 9

Date/ season : 21/6/85; end rainy season
Sheet-observation no : 122/3-26
Coordinates : 3554 E, 99504 N
Elevation : 1140 m
Authors : Willy Simons
Soil mapping unit : LVR
Soil classification : ferral-humic ACRISOL
(FAO, soil taxonomy) orthoxic Palehumult
Geology : Mt. Kenya series
Local petrography/ Parent material : lahar / phonolite
Physiography : Plateaus
Macro-relief : gently undulating
Slope (length, shape and pattern) : -
Slope gradient : 0 %
Position on slope : summit
Meso- and micro-relief : nil
Vegetation/ Landuse : annual crop cultivation; sweet
potato
Erosion : nil
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : very slow
Surface sealing/crusting/cracking : weak sealing
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : moderate
Expected rooting depth : very deep

Horizons:

Ap 0-15 cm Dark reddish brown (5YR 3/3) when moist; clay; moderate medium granular structure; very friable, slightly sticky and slightly plastic; many medium and few fine pores; common fine roots; clear and smooth transition to:

Ah 15-35 cm Dark reddish brown (2.5YR 3/4) when moist; clay; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; many medium and few fine pores; few fine roots; gradual and smooth transition to:

Bt1 35-85 cm Dark red (2.5YR 3/6) when moist; clay; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; many medium and few fine pores; few fine roots; diffuse and smooth transition to:

Bt2 85-130+ cm Dark red (2.5YR 3/6) when moist; clay; moderate coarse subangular blocky structure;

friable, slightly sticky and slightly plastic; patchy thin clayskins; many medium and few fine pores; few fine roots.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 9

Field Obs. No.: 122/3-26 Soil Classification : ferral-humic ACRISOL

Lab. no. .../85	6738	6739	6740	6741	
Horizon designation	Ap	Ah	Bt1	Bt2	
Depth (cm)	0-15	15-35	35-85	85-130	
pH-H ₂ O (1:2.5)	5.4	5.1	5.2	5.2	
pH-M KCl (1:2.5)	4.7	4.5	4.9	4.9	
EC (mS/cm; 1:2.5)	0.04	0.04	0.04	0.04	
C (%)	1.6	1.2	1.0	0.5	
CEC cmol(+)/kg, pH 7.0	22.5	19.5	13.9	10.9	
Exch. Ca cmol(+)/kg	5.1	3.8	2.5	2.1	
„ Mg „	3.4	2.9	2.5	1.9	
„ K „	1.6	0.6	0.1	0.1	
„ Na „	0.2	0.2	0.1	0.1	
Sum cations	10.3	7.5	5.2	4.2	
Base sat. at pH 7.0	46	38	37	39	
ESP at pH 7.0	1	1	1	1	
Gravel % >2mm	-	-	-	-	
Sand % 2-0.05mm	15	13	11	9	
Silt % 50-2 um	19	15	15	9	
Clay % <2 um	66	72	74	82	
Texture class	C	C	C	C	
Depth (cm)	0-5	25-30	55-60	95-100	130-135
pF 0	68.2	65.9	65.2	62.6	63.2
pF 2.0	38.1	38.8	40.0	41.5	42.6
pF 2.3	33.8	35.7	35.9	35.0	35.7
pF 3.7	26.4	25.1	26.7	24.4	25.0
pF 4.2	23.8	24.6	24.5	23.4	25.0

FERTILITY ASPECTS (Composite samples from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../85	6499	8430
-----	-----	-----
Ca cmol(+)/kg	1.2	1.1
Mg „	3.0	3.1
K „	0.9	0.5
Mn „	1.0	1.7
Exch. acid. „	0.2	0.4
P ug/g	6	11
C %	1.2	n.d.
N %	0.12	n.d.
pH-H ₂ O (1:2.5)	5.2	5.3

CEC = 16 (0-35 cm) and 9 (35-130 cm) cmol(+)/ kg clay
 CEC = 700 cmol(+)/kg carbon

PROFILE DESCRIPTION 10

Date/ season : 21/6/85; end rainy season
Sheet-observation no : 122/3-29
Coordinates : 3546 E, 99506 N
Authors : Willy Simons
Soil classification : humic ACRISOL
(FAO, soil taxonomy) palehumult
Geology : Mt. Kenya series
Local petrography/ Parent material : pyroclastic agglomerates
Physiography : Plateau
Macro-relief : undulating
Slope (length, shape and pattern) : concave, regular
Slope gradient : 1%
Position on slope : middle slope
Meso- and micro-relief : termite mound nearby
Vegetation/ Landuse : annual crop cultivation; maize and
beans
Erosion : nil
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : very slow
Surface sealing/crusting/cracking : slight sealing
Drainage class : moderately well drained
Flooding : nil
Groundwater level (actual) : always deep, >120 cm
Presence of salts/ alkali : nil
Soilfauna influences : moderate
Expected rooting depth : deep

Horizons:

Ah 0-25/35 cm Dark reddish brown (5YR 2.5/2) when moist; clay; moderate coarse subangular blocky structure; many macro and fine pores; friable, slightly sticky and slightly plastic; common fine and medium roots; clear and wavy transition to:

Bt 25/35-90 cm Dark reddish brown (5YR 3/3) when moist; clay; moderate coarse subangular blocky structure; few thin clayskins; many macro and fine pores; friable, slightly sticky and slightly plastic; common fine and medium roots; gradual and smooth transition to:

2Ah 90-105 cm Black (5YR 2.5/1) when moist; clay; moderate medium subangular blocky structure; many macro and fine pores; friable, slightly sticky and slightly plastic; common fine and medium roots; clear and smooth transition to:

2ACg 105-125 cm Dark reddish gray (5YR 4/2) when moist; slightly gravelly clay; common fine distinct reddish brown mottles; moderate medium

subangular blocky structure; many macro and fine pores; firm, slightly sticky and slightly plastic; few soft iron concretions, \emptyset 1 cm; few medium and coarse roots; gradual and smooth transition to:

2Cg 125-140+ cm Brown (7.5YR 5/4) when moist; gravelly clay; common fine distinct yellowish red mottles; moderate medium subangular blocky structure; common macro and fine pores; firm, slightly sticky and slightly plastic; very frequent soft iron concretions, \emptyset 1 cm; few medium and coarse roots.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 10

Field Observation No.: 122/3-29 Soil Classification: humic ACRISOLS

Depth (cm)	0-25	35-90	90-105	105-125	125-140
Horizon designation	Ah	Bt	2Ah	2ACg	2Cg
Lab. no. .../85	6752	6753	6754	6755	6756

pH-H ₂ O (1:2.5)	5.8	5.5	5.1	5.0	5.1
pH-M KCl (1:2.5)	5.0	4.6	4.3	4.2	4.3
EC (mS/cm; 1:2.5)	0.07	0.04	0.05	0.05	0.05
C (%)	2.7	2.0	1.5	0.6	0.5
CEC cmol(+)/kg, pH 7.0	31.5	26.4	23.4	18.1	16.1
Exch. Ca cmol(+)/kg	7.7	6.9	5.7	4.7	3.8
,, Mg ,,	3.6	3.7	3.2	2.6	2.5
,, K ,,	2.0	0.9	0.5	0.7	0.6
,, Na ,,	0.2	0.1	0.2	0.2	0.2
Sum cations	11.5	11.6	9.6	8.2	7.1
Base sat. at pH 7.0	37	44	41	45	44
ESP at pH 7.0	1	<1	1	1	1
Gravel % >2mm	0	0	0	0	0
Sand % 2-0.05mm	19	19	19	19	13
Silt % 50-2 um	27	21	25	21	9
Clay % <2 um	54	60	56	60	78
Texture class	C	C	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../85	6503

Ca cmol(+)/kg	11.2
Mg ,,	3.6
K ,,	1.2
Mn ,,	1.2
Exch. acid. ,,	-
P ug/g	52
C %	2.6
N %	0.17
pH-H ₂ O (1:2.5)	5.7

CEC = 23 cmol(+)/ kg clay
CEC = 700 ,, carbon

PROFILE DESCRIPTION 11

Date/ season : 21/6/85; end rainy season
Sheet-observation no : 122/3-30
Coordinates : 3543 E, 99505 N
Elevation : 1150 m
Authors : Willy Simons
Soil mapping unit : BVg
Soil classification : plinthic GLEYSOL
(FAO, soil taxonomy) : plintaquept
Geology : Mt. Kenya series
Local petrography/ Parent material : lahar / phonolite
Physiography : Bottomlands
Macro-relief : undulating
Slope (length, shape and pattern) : complex
Slope gradient : 1 %
Meso- and micro-relief : nil
Vegetation/ Landuse : pasture used for grazing
Erosion : nil
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : ponded
Surface sealing/crusting/cracking : strong crusting; 5 mm thick
Drainage class : poorly drained
Flooding : occasionally
Groundwater level (actual) : temporarily shallow
Presence of salts/ alkali : nil
Soilfauna influences : limited
Expected rooting depth : moderately deep

Horizons:

Ah 0-8 cm Black (7.5YR 2/0) when moist; clay; strong fine subangular blocky structure; firm, slightly sticky and plastic; common fine pores; common fine roots; clear and wavy transition to:

Bg 8-25/45 cm Dark greyish brown (10YR 4/2) when moist; many fine prominent yellowish red mottles; clay; strong coarse subangular blocky structure; firm, slightly sticky and plastic; common fine pores; common medium and fine roots; clear and smooth transition to:

Cgc 25/45-65cm Dark greyish brown (10YR 4/2) when moist; many fine prominent red mottles; very gravelly clay; strong coarse subangular blocky structure; firm, slightly sticky and plastic; few fine pores; very frequent hard spherical iron concretions, \emptyset 4-20 mm; common fine roots; clear and smooth transition to:

Cr 65-90+ cm Dark greyish brown (10YR 4/2) when moist; clay; strongly coherent porous massive structure; firm, slightly sticky and plastic;

structure; firm, slightly sticky and plastic;
very few fine pores; no roots.

Remark: ironstone layer at 30-35 cm.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 11

Field Obs. No.: 122/3-30 Soil Classification: plinthic GLEYSOL

Lab. no. .../85	6757	6758	6759	6760
Horizon designation	Ah	Bg	Cgc	Cr
Depth (cm)	0-8	8-25	45-65	65-90
pH-H ₂ O (1:2.5)	5.1	5.0	5.2	6.1
pH-M KCl (1:2.5)	3.3	3.6	4.1	4.9
EC (mS/cm; 1:2.5)	0.05	0.07	0.05	0.18
C (%)	2.2	0.9	0.6	0.6
CEC cmol(+)/kg, pH 7.0	24.6	18.5	14.2	10.2
Exch. Ca cmol(+)/kg	2.1	1.9	1.7	3.5
,, Mg ,,	0.7	0.6	0.7	2.4
,, K ,,	0.4	0.2	0.2	0.2
,, Na ,,	0.2	0.2	0.2	0.2
Sum cations	3.4	2.9	2.8	6.4
Base sat. at pH 7.0	14	16	18	63
ESP at pH 7.0	1	1	1	2
Gravel % >2mm	0	0	0	0
Sand % 2-0.05mm	23	15	33	13
Silt % 50-2 um	25	15	9	7
Clay % <2 um	52	70	58	80
Texture class	C	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../85	6504	8438
pH-H ₂ O (1:2.5)	5.1	5.0
Ca cmol(+)/kg	2.4	2.0
Mg ,,	0.7	1.3
K ,,	0.3	0.2
Mn ,,	1.4	1.2
Exch. acid. ,,	-	-
P ug/g	6	8
C %	1.9	n.d.
N %	0.18	n.d.

CEC = 17 cmol(+)/ kg clay (0-65 cm)

CEC = 700 ,, / ,, carbon

PROFILE DESCRIPTION 12

Date/ season : 1/7/85; dry season
Sheet-observation no : 122/4-31
Coordinates : 3632 E, 99487 N
Elevation : 840 m
Authors : Tom Veldkamp and Philip Visser
Soil mapping unit : FQps
Soil classification : luvic ARENOSOL to orthic LUVISOLS
(FAO, soil taxonomy) Arent
Geology : Basement System
Local petrography/ Parent material : biotite gneisses
Physiography : Footslopes
Macro-relief : hilly
Slope (length, shape and pattern) : 80m, concave, regular
Slope gradient : 1 %
Position on slope : lower slope
Meso- and micro-relief : minor gullies
Vegetation/ Landuse : dense woodland bushland with
Acacia
Erosion : moderate
Rock outcrops : rocky
Surface stoniness : stony
Overwash : nil
Surface runoff : slow
Surface sealing/crusting/cracking : sealing, 2cm thick
Drainage class : somewhat excessively drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : moderate
Expected rooting depth : moderately deep

Horizons:

AB 0-20 cm Dark reddish brown (5YR 3/4) when moist; sandy clay loam; weak, coarse subangular blocky structure; friable, non-plastic and non-sticky; common fine pores; gradual and irregular transition to:

BCt 20-70+cm Dark yellowish brown (10YR 4/6) when moist; sandy loam; moderate to strong medium platy structure in cracks in rotten rock; friable, non-sticky and non-plastic; patchy thin clayskins; common medium pores

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 12

Field Observation No.: 122/3-31 Soil Classification: luvic ARENOSOL

Lab. no. .../85	7355	7356
Horizon designation	BA	BC
Depth (cm)	0-20	20-70

pH-H ₂ O (1:2.5)	6.2	6.7
pH-M KCl (1:2.5)	5.7	6.2
EC (mS/cm; 1:2.5)	0.07	0.13
C (%)	0.6	0.3
CEC cmol(+)/kg, pH 7.0	10.9	10.3
Exch. Ca cmol(+)/kg	5.0	3.9
,, Mg ,,	3.0	2.0
,, K ,,	0.4	0.1
,, Na ,,	0.3	0.4
Sum cations	8.7	6.4
Base sat. at pH 7.0	79	62
ESP at pH 7.0	3	2
Gravel % >2mm	0	0
Sand % 2-0.05mm	66	68
Silt % 50-2 um	15	19
Clay % <2 um	19	13
Texture class	SL	SL

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../85	7344

Ca cmol(+)/kg	3.9
Mg ,,	1.7
K ,,	0.2
Mn ,,	0.1
Exch. acid. ,,	-
P ug/g	2
C %	0.6
N %	0.07
pH-H ₂ O (1:2.5)	6.2

CEC = >50 cmol(+)/kg clay
 CEC = ca 500 ,, carbon

PROFILE DESCRIPTION 13

Date/ season : 1/7/85; dry season
 Sheet-observation no : 122/4-32
 Coordinates : 3642 E, 99494 N
 Elevation : 835 m
 Authors : Tom Veldkamp and Philip Visser
 Soil mapping unit : UFer2
 Soil classification : plinthic ACRISOL
 (FAO, soil taxonomy) : oxic Haplustalf
 Geology : Basement System
 Local petrography/ Parent material : phonolite rich river deposits
 Physiography : Uplands
 Macro-relief : very gently undulating
 Slope (length, shape and pattern) : 100 m, straight, regular
 Slope gradient : 0 %
 Position on slope : lower slope
 Meso- and micro-relief : nil
 Vegetation/ Landuse : dense bushland with acacia
 Erosion : very slight sheet erosion
 Rock outcrops : nil
 Surface stoniness : nil
 Overwash : nil
 Surface runoff : very slow
 Surface sealing/crusting/cracking : nil
 Drainage class : well drained
 Flooding : nil
 Groundwater level (actual) : always deep
 Presence of salts/ alkali : nil
 Soilfauna influences : moderate
 Expected rooting depth : very deep

Horizons:

Bt1 0-70 cm Red (2.5YR 4/6) when moist; clay; moderate medium subangular blocky structure; very friable, slightly sticky and slightly plastic; patchy thin clayskins; few fine pores; gradual and smooth transition to:

Bt2 70-110 cm Yellowish red (5YR 5/8) when moist; clay; coarse subangular blocky structure; friable, slightly sticky and slightly plastic; broken thin clayskins; common medium pores; gradual and smooth transition to:

BC 110-140+ cm Yellowish red (5YR 4/6) when moist; slightly gravelly clay; moderate fine subangular blocky structure; friable, non sticky and non plastic; broken thin clayskins; common medium pores; few hard iron and manganese concretions, ϕ 10-50 mm.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 13

Field Obs. No.: 122/4-32 Soil Classification: plinthic ACRISOLS

Lab. no. .../85	7357	7358	7359
Horizon designation	Bt1	Bt2	BC
Depth (cm)	0-70	70-110	110-140
pH-H ₂ O (1:2.5)	5.1	5.1	5.1
pH-M KCl (1:2.5)	4.9	4.5	4.7
EC (mS/cm; 1:2.5)	0.06	0.07	0.06
C (%)	0.3	0.3	0.3
CEC cmol(+)/kg, pH 7.0	16.1	13.6	11.0
Exch. Ca cmol(+)/kg	2.3	2.5	2.6
,, Mg ,,	3.0	2.6	2.2
,, K ,,	1.2	0.7	0.9
,, Na ,,	0.1	0.2	0.2
Sum cations	6.6	6.0	5.9
Base sat. at pH 8.2	41	44	54
ESP at pH 8.2	1	1	2
Gravel % >2mm	0	0	51
Sand % 2-0.05mm	20	20	34
Silt % 50-2 um	11	15	23
Clay % <2 um	69	65	43
Texture class	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../85	7345
Ca cmol(+)/kg	2.6
Mg ,,	2.1
K ,,	0.8
Mn ,,	0.2
Exch. acid. ,,	0.5
P ug/g	11
C %	0.4
N %	0.04
pH-H ₂ O (1:2.5)	4.7

CEC = 21 cmol(+)/kg clay
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 14

Date/ season : 1/7/85; dry season
 Sheet-observation no : 122/4-34
 Coordinates : 3645 E, 99498 N
 Elevation : 855 m
 Authors : Tom Veldkamp and Philip Visser
 Soil mapping unit : UFCp, UQPe
 Soil classification : chromic LUVISOL
 (FAO, soil taxonomy) : udic Rhodustalf
 Geology : Basement System
 Local petrography/ Parent material : hornblende biotite gneiss
 Physiography : Uplands
 Macro-relief : undulating
 Slope (length, shape and pattern) : 100 m, convex, complex
 Slope gradient : 5 %
 Position on slope : upper slope
 Meso- and micro-relief : gullies, tors
 Vegetation/ Landuse : bush with A. conifera
 Erosion : severe gully erosion
 Rock outcrops : fairly rocky
 Surface stoniness : rubble land
 Overwash : very slight
 Surface runoff : rapid
 Surface sealing/crusting/cracking : strong capping, 10 mm thick
 Drainage class : somewhat excessively drained
 Flooding : nil
 Groundwater level (actual) : always deep
 Presence of salts/ alkali : nil
 Soilfauna influences : moderate
 Expected rooting depth : deep

Horizons:

Bt1 0-22 cm Dark red (2.5YR 3/6) when moist; slightly gravelly clay; strong coarse subangular blocky structure; friable, slightly sticky and slightly plastic; broken thin clayskins; common medium and fine pores; abrupt and wavy transition to:

Bt2 22-30 cm Dark red (2.5YR 3/6) when moist; very gravelly clay; strong fine angular blocky structure; friable, slightly sticky and slightly plastic; broken thin clayskins; many medium and fine pores; abrupt and wavy transition to:

Bt3 30-40 cm Dark red (2.5YR 3/6) when moist; slightly gravelly clay; strong coarse angular blocky structure; friable, slightly sticky and slightly plastic; broken thin clayskins; common medium and fine pores; gradual and wavy transition to:

BC 40-90 cm Dark red (2.5YR 3/6) when moist; slightly gravelly sandy clay loam; strong coarse angular blocky structure; friable, non-sticky

and non-plastic; patchy thin clayskins; many medium and fine pores; clear and irregular transition to:

R 90-110+ cm Hornblende biotite gneiss.

LABORATORY DATA OF PROFILE DESCRIPTION no.: 14

Field observation no: 122/4-34 Classification: chromic LUVISOL

Laboratory number /85	7362	7363	7364	7365
Horizon designation	Bt1	Bt2	Bt3	BC
Depth, cm	0-22	22-30	30-40	40-90
pH-H ₂ O (1:2.5)	5.6	5.4	5.5	5.8
pH-M KCl (1:2.5)	5.4	5.3	5.3	5.6
EC mS/cm (1:2.5)	0.04	0.04	0.04	0.04
C %	0.4	0.3	0.3	0.1
CEC cmol(+)/kg, pH 8.2	17.3	14.1	14.1	9.0
Exch. Ca cmol(+)/kg	5.3	4.2	4.7	3.2
,, Mg ,,	4.6	3.8	3.3	2.0
,, K ,,	0.2	0.1	0.1	0.1
,, Na ,,	0.1	0.1	0.1	0.2
Sum cations	10.2	8.2	8.2	5.5
Base saturation, pH 8.2	59	58	58	61
ESP, pH 8.2	<1	<1	<1	2
Gravel % < 2mm				
Sand % 0.05- 2mm	38	40	42	56
Silt % 2 - 50 um	9	13	15	13
Clay % <2 um	53	47	43	31
Texture class	C	C	C	SCL

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Laboratory number .../85	7347
-----	-----
Ca cmol(+)/kg	4.6
Mg ,,	3.6
K ,,	0.2
Mn ,,	tr
Exch. acid. ,,	-
P mg/kg	19
N%	0.07
C%	0.7
pH-H ₂ O (1:2.5)	5.7

CEC = 27 cmol(+)/kg clay
 CEC = 700 ,, carbon

PROFILE DESCRIPTION 15

Date/ season : 6/7/85; dry season
 Sheet-observation no : 122/3-35
 Coordinates : 3569 E, 99469 N
 Elevation : 1050 m
 Authors : Tom Veldkamp and Philip Visser
 Soil mapping unit : FQst
 Soil classification : luvic PHAEOZEM, vertic LUVISOL
 (FAO, soil taxonomy) typic Argiustoll
 Geology : Basement System
 Local petrography/ Parent material : colluvium/alluvium
 Physiography : Uplands
 Macro-relief : undulating
 Slope (length, shape and pattern) : convex, complex
 Slope gradient : 6 %
 Position on slope : lower slope
 Meso- and micro-relief : nil
 Vegetation/ Landuse : dense woodland bushland with
 Acacia nilotica and caparis sp.
 Erosion : moderate
 Rock outcrops : no rocks to very few rocks
 Surface stoniness : no stones to very few stones
 Overwash : slight
 Surface runoff : medium
 Surface sealing/crusting/cracking : crusting, 5 mm thick
 Drainage class : moderately well drained
 Flooding : nil
 Groundwater level (actual) : always moderately deep
 Presence of salts/ alkali : nil
 Soilfauna influences : moderate
 Expected rooting depth : moderately deep

Horizons:

Ah 0-30 cm Very dark greyish brown (10YR 3/2) when moist; sandy clay; strong medium and coarse subangular blocky structure; friable, slightly plastic and slightly sticky; no cutans; common fine pores; gradual and wavy transition to:

Bt 30-60 cm Dark brown (7.5YR 4/4) when moist; clay; strong very coarse prismatic structure; firm, sticky and slightly plastic; continuous thin cutans; few fine pores; gradual and wavy transition to:

BC 60-70+ cm Olive grey (5Y 4/2) when moist; clay; weak very coarse prismatic structure; very firm, non-sticky and slightly plastic; continuous thin cutans; few fine pores; few soft calcium carbonate concretions, \emptyset 0.5 mm.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 15

Field Observation No.: 122/3-35 Soil Classification: luvic PHAEOZEM

Lab. no. .../85	7366	7367	7368
Horizon designation	Ah	Bt	BC
Depth (cm)	0-30	30-60	60-70
pH-H ₂ O (1:2.5)	5.6	5.3	7.5
pH-M KCl (1:2.5)	4.9	4.7	6.6
EC (mS/cm; 1:2.5)	0.03	0.03	0.24
C (%)	1.0	0.6	0.3
CEC cmol(+)/kg, pH 8.2	12.1	16.1	14.1
Exch. Ca cmol(+)/kg	4.5	5.6	9.9
,, Mg ,,	2.9	3.2	3.5
,, K ,,	0.3	0.3	0.1
,, Na ,,	0.2	0.2	0.7
Sum cations	7.9	9.2	14.2
Base sat. at pH 8.2	65	57	100+
ESP at pH 8.2	2	1	5
Gravel % >2mm	0	0	0
Sand % 2-0.05mm	48	38	38
Silt % 50-2 um	15	13	15
Clay % <2 um	37	49	47
Texture class	SC	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../85	7348
Ca cmol(+)/kg	5.8
Mg ,,	1.6
K ,,	0.1
Mn ,,	0.1
Exch. acid. ,,	-
P ug/g	13
C %	1.0
N %	0.17
pH-H ₂ O (1:2.5)	5.6

CEC = 29 cmol(+)/kg clay
 CEC = 200 ,, carbon

PROFILE DESCRIPTION 16

Date/ season : 6/7/85; dry season
Sheet-observation no : 122/3-36
Coordinates : 3593 E, 99496 N
Elevation : 1100 m
Authors : Tom Veldkamp and Philip Visser
Soil mapping unit : LVM+r
Soil classification : ferral-humic ACRISOL
(FAO, soil taxonomy) : oxic Haplustalf
Geology : Mt. Kenya series
Local petrography/ Parent material : lahar / phonolite
Physiography : Plateaus
Macro-relief : very gently undulating
Slope (length, shape and pattern) : > 100 m, straight.
Slope gradient : 1 %
Position on slope : -
Meso- and micro-relief : nil
Vegetation/ Landuse : bushland with Combretum and mango
Erosion : nil
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : very slow
Surface sealing/crusting/cracking : crusting, 1 cm thick
Drainage class : somewhat excessively drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : moderate
Expected rooting depth : extremely deep

Horizons:

Ah 0-60 cm Dark brown (7.5YR 3/2) when moist; clay; strong medium subangular blocky and strong very fine granular structure; friable, slightly sticky and slightly plastic; patchy thin cutans; many medium and fine pores; diffuse and wavy transition to:

Bt1 60-110 cm Yellowish red (5YR 4/6) when moist; sandy clay; moderate coarse angular blocky structure; friable, sticky and non plastic; thin broken cutans; many medium and fine pores; gradual and wavy transition to:

Bt2 110-140+ cm Yellowish red (5YR 4/6) when moist; sandy clay; moderate coarse angular blocky structure; friable, slightly sticky and slightly plastic; no cutans; many medium and fine pores.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 16

Field Obs. No.: 122/3-36 Soil Classification: ferral-humic ACRISOL

Lab. no. .../85	7369	7370	7371
Horizon designation	Ah	Bt1	Bt2
Depth (cm)	0-60	60-110	110-140
pH-H ₂ O (1:2.5)	5.9	5.7	5.7
pH-M KCl (1:2.5)	5.4	5.3	5.5
EC (mS/cm; 1:2.5)	0.02	0.02	0.02
C (%)	1.3	0.9	0.7
CEC cmol(+)/kg, pH 8.2	16.7	15.0	11.5
Exch. Ca cmol(+)/kg	4.2	3.3	3.3
,, Mg ,,	2.3	2.8	2.0
,, K ,,	0.7	0.2	0.1
,, Na ,,	0.1	0.2	0.2
Sum cations	7.3	6.5	5.6
Base sat. at pH 8.2	44	43	49
ESP at pH 8.2	1	1	2
Gravel % >2mm	0	0	0
Sand % 2-0.05mm	18	14	12
Silt % 50-2 um	13	9	7
Clay % <2 um	69	77	81
Texture class	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../85	7349
Ca cmol(+)/kg	3.1
Mg ,,	2.0
K ,,	1.0
Mn ,,	0.2
Exch. acid. ,,	-
P ug/g	21
C %	2.3
N %	0.15
pH-H ₂ O (1:2.5)	6.1

CEC = 10 cmol(+)/kg clay
 CEC = 700 ,, carbon

PROFILE DESCRIPTION 17

Date/ season	: 6/7/85; dry season
Sheet-observation no	: 12/3-37
Coordinates	: 3612 E, 99502 N
Elevation	: 1010 m
Authors	: Tom Veldkamp and Philip Visser
Soil mapping unit	: LVMP, LVMP
Soil classification (FAO, soil taxonomy)	: LITHOSOL (eutric) lithic Ustorthent
Geology	: Mt. Kenya series
Local petrography/ Parent material	: lahar / phonolite
Physiography	: Plateaus
Macro-relief	: flat
Slope (length, shape and pattern)	: > 100 m, straight, regular
Slope gradient	: 1 %
Position on slope	: -
Meso- and micro-relief	: nil
Vegetation/ Landuse	: bushland with Acacia, Combretum and Euphorbia candelabrum
Erosion	: slight sheet erosion
Rock outcrops	: rocky
Surface stoniness	: rubble land
Overwash	: nil
Surface runoff	: slow
Surface sealing/crusting/cracking	: nil
Drainage class	: excessively drained
Flooding	: nil
Groundwater level (actual)	: always deep
Presence of salts/ alkali	: nil
Soilfauna influences	: limited
Expected rooting depth	: very shallow

Horizons:

ABcs	0-20 cm	Dark reddish brown (5YR 3/4) when moist; slightly stony and very gravelly sandy loam; moderate fine granular and subangular blocky structure; friable, slightly sticky and non plastic; no cutans; many medium and fine pores; very frequent hard iron and manganese concretions, \emptyset 5-15 mm; clear and wavy transition to:
R	20+ cm	Rotten rock.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 17

Field Obs. No.: 122/4-37 Soil Classification: (eutric) LITHOSOL

Lab. no. .../ 85	7372
Horizon designation	ABcs
Depth (cm)	0-20

pH-H ₂ O (1:2.5)	5.6
pH-M KCl (1:2.5)	4.9
EC (mS/cm; 1:2.5)	0.03
C (%)	1.0
CEC cmol(+)/kg, pH 8.2	7.2
Exch. Ca cmol(+)/kg	1.5
,, Mg ,,	1.1
,, K ,,	0.7
,, Na ,,	0.2
Sum cations	3.5
Base sat., pH 7.0	49
ESP at pH 7.0	3
Gravel % >2mm	45
Sand % 2-0.05mm	68
Silt % 50-2 um	7
Clay % <2 um	25
Texture class	SCL

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../85	7350

Ca cmol(+)/kg	<0.1
Mg ,,	1.1
K ,,	1.4
Mn ,,	0.1
Exch. acid. ,,	-
P ug/g	15
C %	1.4
N %	0.10
pH-H ₂ O (1:2.5)	5.6

CEC = 9 cmol(+)/kg clay at:
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 18

Date/ season : 6/7/85; dry season
Sheet-observation no : 122/4-38
Coordinates : 3634 E, 99499 N
Elevation : 885 m
Authors : Tom Veldkamp and Philip Visser
Soil mapping unit : UFer1, UFpe
Soil classification : chromic LUVISOL
(FAO, soil taxonomy) : udic Rhodustalf
Geology : Basement System
Local petrography/ Parent material : gabbro-nitite, gneisses, talcum
Physiography : Uplands
Macro-relief : gently undulating
Slope (length, shape and pattern) : > 100 m, complex
Slope gradient : 4 %
Position on slope : -
Meso- and micro-relief : clay pit
Vegetation/ Landuse : dense bushland woodland with
Acacia tortulis and Euphorbia sp.
Erosion : slight rill erosion
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : very slow
Surface sealing/crusting/cracking : sealing, 5mm thick
Drainage class : somewhat excessively drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : moderate
Expected rooting depth : very deep

Horizons:

Bw1 0-40 cm Dark red (2.5YR 3/6) when moist; sandy clay;
strong coarse angular blocky structure;
friable, sticky and plastic; thin broken
clayskins; common medium and fine pores; clear
and wavy transition to:

Bw240-150+cm Dark red (2.5YR 3/6) when moist; sandy clay;
strong coarse angular blocky structure;
friable, sticky and plastic; thin broken
clayskins; common fine pores.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 18

Field Observation No.: 122/4-38 Soil Classification: chromic LUVISOL

Lab. no. .../85	7373	7374
Horizon designation	Bw1	Bw2
Depth (cm)	0-40	40-150

pH-H ₂ O (1:2.5)	5.5	6.2
pH-M KCl (1:2.5)	5.0	5.5
EC (mS/cm; 1:2.5)	0.04	0.05
C (%)	0.3	0.2
CEC cmol(+)/kg, pH 7.0	13.0	12.6
Exch. Ca cmol(+)/kg	4.7	4.7
,, Mg ,,	2.8	4.3
,, K ,,	0.3	0.2
,, Na ,,	0.3	0.2
Sum cations	8.1	9.4
Base sat. at pH 7.0	62	75
ESP at pH 7.0	3	2
Gravel % >2mm	0	0
Sand % 2-0.05mm	50	50
Silt % 50-2 um	7	11
Clay % <2 um	43	39
Texture class	SC	SC

Depth (cm)	5-10	40-45	80-85	125-130

pF 0	35.8	27.1	28.0	29.5
pF 2.0	21.7	21.2	21.8	22.3
pF 2.3	19.4	19.4	19.8	20.4
pF 3.7	12.7	13.1	13.4	14.3
pF 4.2	12.2	12.6	12.9	13.4

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../85	7351

Ca cmol(+)/kg	3.6
Mg ,,	0.9
K ,,	0.3
Mn ,,	0.1
Exch. acid. ,,	-
P ug/g	13
C %	0.5
N %	0.09
pH-H ₂ O (1:2.5)	6.0

CEC = 28 cmol(+)/kg clay
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 19

Date/ season : 6/7/85; dry season
Sheet-observation no : 122/4-39
Coordinates : 3673 E, 99505 N
Elevation : 845 m
Authors : Tom Veldkamp and Philip Visser
Soil mapping unit : UFpe
Soil classification : calcic LUVISOL ?
(FAO, soil taxonomy) : typic Haplustalf ?
Geology : Basement System
Local petrography/ Parent material : gneisses
Physiography : Uplands
Macro-relief : gently undulating
Slope (length, shape and pattern) : 20 m, convex
Slope gradient : 4 %
Position on slope : upper slope
Meso- and micro-relief : nil
Vegetation/ Landuse : dense bushland woodland with
Boscia and Acacia tortillis
Erosion : moderate sheet, rill and gully
erosion
Rock outcrops : nil
Surface stoniness : exceedingly stony
Overwash : nil
Surface runoff : medium
Surface sealing/crusting/cracking : weak crusting, 3 cm thick
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : moderate
Expected rooting depth : very deep

Horizons:

Ah 0-35 cm Strong brown (7.5YR 4/6) when moist; gravelly sandy clay loam; strong medium subangular blocky structure; friable, sticky and non plastic; patchy thin cutans; few medium and fine pores; very frequent hard calcium carbonate concretions, \emptyset 20-30 mm; clear and wavy transition to:

Bt 35-130+ cm Dark yellowish brown (10YR 4/6) when moist; gravelly clay; strong coarse angular blocky structure; friable, sticky and non plastic; broken thin cutans; common medium and few fine pores; very frequent hard calcium carbonate concretions, \emptyset 20-30 mm;

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 19

Field Observation No.: 122/4-39 Soil Classification: calcic LUVISOL

Lab. no. .../85	7375	7376
Horizon designation	Ah	Bt
Depth (cm)	0-35	35-130

pH-H ₂ O (1:2.5)	7.3	7.4
pH-M KCl (1:2.5)	6.7	6.7
EC (mS/cm; 1:2.5)	0.14	0.15
C (%)	0.2	0.2
CEC cmol(+)/kg, pH 7.0	13.5	21.6
Exch. Ca cmol(+)/kg	16.4	31.7
,, Mg ,,	5.3	3.4
,, K ,,	0.3	0.2
,, Na ,,	0.8	0.8
Sum cations	22.8	36.1
Base sat. at pH 8.2	100+	100+
ESP at pH 8.2	5	4
Gravel % >2mm	0	35
Sand % 2-0.05mm	56	42
Silt % 50-2 um	19	13
Clay % <2 um	25	45
Texture class	SCL	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../85	7352

Ca cmol(+)/kg	8.7
Mg ,,	3.0
K ,,	0.4
Mn ,,	0.2
Exch. acid. ,,	-
P ug/g	5
C %	0.5
N %	0.08
pH-H ₂ O (1:2.5)	7.5

CEC = 48 cmol(+)/ kg clay at:
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 20

Date/ season : 26/7/85; cold season
 Sheet-observation no : 122/3-42
 Coordinates : 3354 E, 99508 N
 Elevation : 1140 m
 Authors : Jan Kuyper
 Soil mapping unit : LVm
 Soil classification : humic ACRISOL
 (FAO, soil taxonomy) Paleustalf
 Geology : Mt. Kenya series
 Local petrography/ Parent material : lahar / phonolite
 Physiography : Plateaus
 Macro-relief : flat to gently undulating
 Slope (length, shape and pattern) : 200 m, straight, regular
 Slope gradient : 2 %
 Position on slope : middle slope
 Meso- and micro-relief : nil
 Vegetation/ Landuse : annual crop cultivation; maize
 Erosion : nil
 Rock outcrops : nil
 Surface stoniness : slightly gravelly
 Overwash : nil
 Surface runoff : slow
 Surface sealing/crusting/cracking : nil
 Drainage class : well drained
 Flooding : nil
 Groundwater level (actual) : always deep, > 2 m
 Presence of salts/ alkali : nil
 Soilfauna influences : limited
 Expected rooting depth : deep

Horizons:

Ap 0-5 cm Dark brown (7.5YR 3/2) when moist; clay; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few thin clayskins; common medium and fine pores; frequent very fine and common fine roots; gradual and smooth transition to:

AB 5-50 cm Dark brown (7.5YR 3/2 when moist); clay; moderate coarse subangular blocky structure; very friable, slightly sticky and slightly plastic; few thin clayskins; many medium and common fine pores; frequent very fine and common fine roots; abrupt and smooth transition to:

B + CR 50-100 cm Dark reddish brown (5YR 3/4 when moist); very gravelly clay; weak medium subangular blocky falling apart to moderate fine granular structure; very friable, slightly plastic; few thin slickensides; many medium and common fine pores; frequent very fine and common fine roots; abrupt and wavy transition to:

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 20

Field observation no.: 122/3-42

Classification: humic ACRISOL

Laboratory number /86	4097	4098	3696
Horizon designation	Ap	AB	B+CR
Depth, cm	0-5	5-50	50-100

pH-H ₂ O (1:2.5)	6.2	6.4	5.7
pH-M KCl (1:2.5)	5.2	5.2	5.1
EC mS/cm (1:2.5)	0.14	0.06	0.04
C %	1.6	1.1	0.3
CEC cmol(+)/kg, pH 8.2	22.2	19.1	12.7
Exch. Ca cmol(+)/kg	4.4	4.4	2.6
,, Mg ,,	3.3	2.4	1.3
,, K ,,	2.7	1.0	1.2
,, Na ,,	0.4	0.2	0.2
Sum cations	11.8	8.0	5.3
Base saturation, pH 8.2	49	42	42
ESP at pH 8.2	2	1	1
Gravel % > 2mm	0	0	?
Sand % 0.05 - 2mm	20	20	34
Silt % 2 - 50 um	14	12	10
Clay % < 2 um	66	68	56
Texture class	C	C	C

CEC = 20 cmol(+)/ kg clay
 CEC = 500 ,, carbon

No reliable fertility data available.

PROFILE DESCRIPTION 21

Date/ season : 7/9/85; cold season
Sheet-observation no : 122/3-47
Coordinates : 3376 E, 99607 N
Elevation : 1735 m
Authors : Willy Simons and Richard Kraayvanger

Soil mapping unit :
Soil classification : humic NITISOL
(FAO, soil taxonomy) orthoxic Palehumult
Geology : Mt. Kenya series
Local petrography /Parent material : lahar / phonolite
Physiography : Mountain Footridges
Macro-relief : mountainous
Slope (length, shape and pattern) : 200 m, straight, regular
Slope gradient : 34 %
Position on slope : middle slope
Meso- and micro-relief : nil
Vegetation/ Landuse : forest, land preparation for tea
Erosion : nil
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : medium
Surface sealing/crusting/cracking : nil
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : moderate
Expected rooting depth : very deep

Horizons:

O 5-0 cm Organic horizon; abrupt and smooth transition to:

Ah 0-30/40 cm Reddish brown (5YR 4/4) when moist; clay; moderate medium subangular blocky structure; very friable, slightly sticky and slightly plastic; common thin clayskins; many medium and fine pores; frequent very fine and fine, common medium and few coarse roots; clear and wavy transition to:

Bt 30/40-160+ cm Yellowish red (5YR 4/6) when moist; clay; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; common thin clayskins and shiny pedfaces; many medium and fine pores; few very fine and fine and very few medium roots.

LABORATORY DATA OF PROFILE NO.: 21

Field observations no.: 122/3-47 Classification: humic NITISOL

Laboratory number ../85	8301	8302	8303
Horizon designation	O	Bt	Bt
Depth, cm	0-30	40-100	100-160

pH-H ₂ O (1:2.5)	4.3	4.0	4.4
pH-M KCL (1:2.5)	3.8	3.8	4.1
EC (mS/cm)(1:2.5)	0.15	0.09	0.04
C %	3.6	1.2	0.7
CEC cmol(+)/kg, pH 8.2	15.5	8.8	6.5
Exch. Ca cmol(+)/kg	2.5	1.1	0.1
,, Mg ,,	0.8	0.5	0.1
,, K ,,	0.6	0.1	0.1
,, Na ,,	0.1	0.1	0.1
Sum cations	4.0	1.8	0.4
Base Saturation, pH 8.2	26	20	6
Gravel % > 2mm			
Sand % 0.05 - 2 mm	10	10	10
Silt % 2 - 50 um	15	7	7
Clay % < 2um	75	83	83
Texture class	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth, cm	0-20	40-60
Laboratory number .../85	8451	8452

Ca cmol(+)/kg	<0.1	<0.1
Mg ,,	0.9	0.7
K ,,	0.5	0.3
Mn ,,	0.8	0.3
Exch. acid. ,,	2.9	2.7
P mg/kg	26	18
N %	0.82	
C %	4.6	
pH-H ₂ O, 1: 2.5	3.9	4.1

CEC = 6 cmol(+)/kg clay
 CEC = 300 ,, carbon

PROFILE DESCRIPTION 22

Date/ season : 4/9/85; dry season
Sheet-observation no : 122/3-50
Coordinates : 3417 E, 99578 N
Elevation : 1570 m
Authors : Nicole Bongers
Soil mapping unit : RiVn
Soil classification : humic NITISOL
(FAO, soil taxonomy) orthoxic Palehumult
Geology : Mt. Kenya series
Local petrography/ parent material : lahar / phonolite
Physiography : Mountain Footridges
Macro-relief : mountainous
Slope (length, shape and pattern) : 100 m, convex, regular
Slope gradient : 32 %
Position on slope : middle slope
Meso- and micro-relief : nil
Vegetation/ Landuse : perennial crop cultivation;
coffee
Erosion : nil
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : rapid
Surface sealing/crusting/cracking : nil
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep, > 2 m
Presence of salts/ alkali : nil
Soilfauna influences : none to limited
Expected rooting depth : extremely deep

Horizons:

Ah 0-30 cm Dark reddish brown (2.5YR3/4), when moist; clay; weak medium subangular blocky falling apart to fine subangular blocky structure; very friable, slightly sticky and non plastic; common thin clayskins; many medium and fine pores; frequent very fine, few fine and medium roots; clear and wavy transition to:

Bt 30-145+ cm Dark red (2.5YR3/6), when moist; clay; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; continuous thin clayskins and shiny pedfaces; common macropores and many biopores; very few fine medium and coarse roots.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 22

Field Observation No.: 122/3-50 Soil Classification: humic NITISOL

Lab. no. .../85	8037	8038	8039	8040
Horizon designation	Ah	Bt	Bt	Bt
Depth (cm)	0-30	30-70	70-110	110-150
pH-H ₂ O (1:2.5)	5.3	4.8	4.8	5.0
pH-M KCl (1:2.5)	4.2	4.1	4.2	4.2
EC (mS/cm; 1:2.5)	0.04	0.06	0.06	0.03
C (%)	1.3	1.2	0.5	0.4
CEC cmol(+)/kg, pH 7.0	12.5	11.3	6.0	5.3
Exch. Ca cmol(+)/kg	0.8	0.5	0.3	0.1
,, Mg ,,	0.3	0.2	0.1	0.1
,, K ,,	0.5	0.1	0.1	0.1
,, Na ,,	0.1	0.1	0.1	0.1
Sum cations	1.7	0.9	0.6	0.4
Base sat. at pH 7.0	14	8	10	8
ESP at pH 7.0	1	1	2	2
Gravel % >2mm	0	0	0	0
Sand % 2-0.05mm	9	7	7	7
Silt % 50-2 um	9	7	7	7
Clay % <2 um	82	86	86	86
Texture class	C	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../85	8463	8464
Ca cmol(+)/kg	0.3	0.2
Mg ,,	0.3	0.2
K ,,	0.1	0.2
Mn ,,	0.1	0.1
Exch. acid. ,,	3.7	2.8
P ug/g	34	21
C %	n.d.	n.d.
N %	1.0	n.d.
pH-H ₂ O (1:2.5)	4.3	4.5

CEC = 5 cmol(+)/ kg clay
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 23

Date/ season : 27/8/85
Sheet-observation no : 122/3-52
Coordinates : 3338 E, 99617 N
Elevation : 1870 m
Authors : Nicole Bongers & Willy Simons
Soil mapping unit : RiVhn
Soil classification : humic NITISOL
(FAO, soil taxonomy) : orthoxic Palehumult
Geology : Mt. Kenya series
Local petrography/ Parent material : lahar / phonolite
Physiography : Mountain Footridges
Macro-relief : hilly
Slope (length, shape and pattern) : straight, regular
Slope gradient : 5 %
Position on slope : middle slope
Meso- and micro-relief : nil
Vegetation/ Landuse : forest
Erosion : nil
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : slow
Surface sealing/crusting/cracking : nil
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep, > 2 m
Presence of salts/ alkali : nil
Soilfauna influences : moderate
Expected rooting depth : extremely deep

Horizons:

O 9-0 cm Organic horizon; abrupt and smooth transition to:

Ah 0-25 cm Dark reddish brown (5YR 3/2) when moist; clay; moderate coarse subangular blocky structure; very friable, slightly sticky and slightly plastic; common thin clayskins; many medium and fine pores; common very fine, fine and medium, very few coarse roots; gradual and wavy transition to:

Bt1 25-105 cm Yellowish red (5YR 4/6) when moist; clay; moderate coarse subangular blocky structure; friable, slightly plastic; common thin clayskins and shiny pedfaces; many medium and fine pores; few fine medium, very few coarse roots; clear and wavy transition to:

Bt2 105-150 cm Yellowish red (5YR 4/6) when moist; clay; moderate coarse subangular blocky structure; friable, slightly sticky and slightly plastic; common moderately thick clayskins and shiny pedfaces; many medium and fine pores; few medium roots:

Remark: augered to 230 cm, colour becomes more yellowish, more clayskins

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 23

Field Observation No.: 122/3-52 Classification: humic NITISOL

Laboratory number /85	8023	8024	8025	8026
Horizon designation	0	Ah	Bt1	Bt2
Depth, cm	0-25	25-70	70-105	105-150
pH-H2O (1:2.5)	4.8	4.6	4.6	4.4
pH-M KCl (1:2.5)	4.2	4.3	4.4	4.2
EC mS/cm (1:2.5)	0.03	0.02	0.02	0.02
C %	3.2	1.8	1.3	1.0
CEC cmol(+)/kg, pH 8.2	21.0	18.0	14.0	14.8
Exch. Ca cmol(+)/kg	1.5	0.8	0.7	0.7
,, Mg ,,	<0.1	<0.1	<0.1	<0.1
,, K ,,	0.1	0.1	<0.1	0.1
,, Na ,,	<0.1	<0.1	<0.1	<0.1
Sum cations	1.7	0.9	0.7	0.8
Base saturation, pH 8.2	8	5	5	5
ESP, pH 8.2	<1	<1	<1	<1
Gravel % > 2mm				
Sand % 0.05-2mm	31	15	15	15
Silt % 2-50 um	25	9	7	7
Clay % < 2um	44	76	78	78
Texture class	C	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth, cm	0-20	40-60
Laboratory no.:	8467	8468
Ca cmol(+)/kg	0.8	0.2
Mg ,,	0.1	0.2
K ,,	0.1	0.1
Mn ,,	2.2	2.0
Exch. acid. ,,	0.8	1.9
P mg/kg	16	11
N%	0.20	?
C%	2.5	?
pH-H2O (1:2.5)	4.3	4.4

CEC= 11.5 cmol(+)/kg clay
 CEC= 500 ,, carbon

PROFILE DESCRIPTION 24

Date/ season : 29/8/85; end of cold season
Sheet-observation no : 122/3-62
Coordinates : 3547 E, 99630 N
Elevation : 1260 m
Author : E. Oren
Soil mapping unit : UVCps/CE
Soil classification : humic NITISOL
(FAO, soil taxonomy)
Geology : Mt. Kenya series
Local petrography/ Parent material : lahar
Physiography : upland
Macro-relief : rolling
Slope (length, shape and pattern) : 200 m
Slope gradient : 5%
Position on slope : valley bottom
Meso- and micro-relief : -
Vegetation/ Landuse : annual cropping like bananas,
sorghum, maize, cassava. - good
performance
Erosion : nil
Rock outcrops : nil
Surface stoniness : nil
Overwash : slight
Surface runoff : slow
Surface sealing/crusting/cracking : slightly crusting
Drainage class : well drained
Flooding : nil (mostly not present)
Groundwater level (actual) : always deep, >150 cm
Presence of salts/ alkali : nil
Soilfauna influences : moderate termites activity
Expected rooting depth : very deep, >150 cm

HORIZONS:

Ap 0 - 10 cm Dark reddish brown (5YR3/3) moist; many fine distinct coal mottles; clay; strong fine subangular blocky structure; very friable, sticky and plastic; many medium and fine pores; many fine and few medium roots; abrupt smooth transition to:

Ah 10 - 50 cm Dark reddish brown (5YR3/3) moist; many fine distinct black (coal) mottles; clay; moderate medium subangular blocky structure; friable, sticky and slightly plastic; many medium and fine pores; few fine and very few medium roots; gradual irregular transition to:

Bt 50 - 150 cm Dark reddish brown (5YR3/3) moist; many fine distinct black (coal) mottles; clay; strong coarse and medium subangular blocky structure; friable, sticky and plastic; broken moderately thick clayskins; many medium and common fine pores; very few fine and very few medium roots.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 24

Field Observation No.: 122/3-62 Soil Classification: humic NITISOL

Lab. no. .../85	7999	8000	8001
Horizon designation	Ap	Ah	Bt
Depth (cm)	0-10	10-50	50-150
pH-H ₂ O (1:2.5)	6.0	5.8	5.7
pH-M KCl (1:2.5)	5.2	4.8	4.6
EC (mS/cm; 1:2.5)	0.05	0.05	0.03
C (%)	1.6	1.8	1.3
CEC cmol(+)/kg, pH 7.0	23.7	20.5	22.8
Exch. Ca cmol(+)/kg	7.1	6.9	6.1
,, Mg ,,	2.4	2.0	2.3
,, K ,,	1.3	1.0	0.8
,, Na ,,	0.3	0.3	0.3
Sum cations	11.1	10.2	9.5
Base sat. at pH 7.0	46	50	42
ESP at pH 7.0	1	1	1
Gravel % >2mm	0	0	0
Sand % 2-0.05mm	16	16	16
Silt % 50-2 um	18	28	18
Clay % <2 um	66	56	66
Texture class	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../85	8013	8014
Ca cmol(+)/kg	5.4	5.0
Mg ,,	3.2	3.4
K ,,	1.0	0.6
Mn ,,	1.5	1.6
Exch. acid. ,,	0.4	0.4
P ug/g	6	6
C %	1.3	1.1.
N %	0.18	n.d.
pH-H ₂ O (1:2.5)	5.2	5.1

CEC = 23 cmol(+)/kg clay
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 25

Date/ season : 30/8/85; end of cold season
Sheet-observation no : 122/3-64
Coordinates : 3532 E, 99652 N
Elevation : 1300 m
Authors : Enav Oren
Soil mapping unit : RiVPs/DF
Soil classification : orthic ACRISOL
(FAO, soil taxonomy)
Geology : Mt. Kenya series
Local petrography /Parent material : lahar
Physiography : mountain footridges
Macro-relief : mountainous
Slope (length, shape and pattern) : 160 m, convex, regular
Slope gradient : 35%
Position on slope : middle slope
Meso- and micro-relief : coffee terrasses
Vegetation/ Landuse : perennial crops: coffee
Erosion : severe water erosion
Rock outcrops : few rock outcrops
Surface stoniness : exceedingly stony
Overwash : nil
Surface runoff : rapid
Surface sealing/crusting/cracking : slightly crusting
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep, >120 cm
Presence of salts/ alkali : nil
Soilfauna influences : moderate termite activity
Expected rooting depth : 90 cm

HORIZONS:

Ah 0-15 cm Dark reddish brown (5YR3/4) when moist; slightly stony and slightly gravelly clay; strong fine subangular blocky structure; soft, very friable, sticky and plastic; common medium and fine pores; many fine and common medium roots; clear irregular transition to:

B/CR 15-30 cm Dark reddish brown (5YR3/4) when moist; gravelly, stony and bouldery clay; strong medium angular blocky structure; firm, sticky and plastic; broken moderately thick clayskins; common medium and fine pores; many fine and common medium roots; clear irregular transition to:

CR/B 30-90 cm Dark reddish brown (5YR3/4) when moist; very stony and bouldery clay; strong medium angular blocky structure; firm, sticky and plastic; patchy moderately thick clayskins; few, medium soft to hard, irregular, red iron and black manganese concretion of concentric structure; common medium and fine pores; few fine and few medium roots; diffuse irregular transition to:

CR 90-120 cm Rotten rock.

R >120 cm Rock.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 25

Field Observation No.: 122/3-64 Soil Classification: orthic ACRISOL

Lab. no. .../85	8006	8007	8008
Horizon designation	Ah	B/CR	CR/B
Depth (cm)	0-15	15-30	30-90
pH-H2O (1:2.5)	5.4	5.2	5.4
pH-M KCl (1:2.5)	4.6	4.3	4.1
EC (mS/cm; 1:2.5)	0.04	0.03	0.05
C (%)	0.4	0.4	0.4
CEC cmol(+)/kg, pH 8.2	17.5	16.1	18.9
Exch. Ca cmol(+)/kg	5.1	4.1	5.1
,, Mg ,,	4.3	3.8	4.7
,, K ,,	2.0	1.6	1.5
,, Na ,,	0.3	0.2	0.3
Sum cations	11.7	9.7	11.6
Base sat. at pH 8.2	67	60	61
ESP at pH 8.2	2	1	2
Gravel % >2mm	?	?	?
Sand % 2-0.05mm	23	15	33
Silt % 50-2 um	25	15	9
Clay % <2 um	52	70	58
Texture class	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../85	8017	8018
Ca cmol(+)/kg	3.0	1.9
Mg ,,	4.2	4.6
K ,,	1.1	0.8
Mn ,,	1.1	1.2
Exch. acid. ,,	0.5	0.8
P ug/g	6	tr
C %	0.8	1.1
N %	0.10	n.d.
pH-H2O (1:2.5)	5.0	5.0

CEC = 27 cmol(+)/kg clay at:
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 26

Date/ season : 28/8/85; end of cold season
 Sheet-observation no : 122/3-65
 Coordinates : 3560 E, 99635 N
 Elevation : 1190 m
 Authors : Enav Oren
 Soil mapping unit : UVnr/AB
 Soil classification : dystric NITISOL
 (FAO, soil taxonomy)
 Geology : Mt. Kenya series
 Local petrography/ parent material : lahar
 Physiography : plateau
 Macro-relief : gently undulating
 Slope (length, shape and pattern) :
 Slope gradient : 5%
 Position on slope : summit
 Meso- and micro-relief : nil
 Vegetation/ Landuse : permanent cultivation of annual
 crops like sorghum, beans, maize
 Erosion : nil
 Rock outcrops : nil
 Surface stoniness : nil
 Overwash : nil
 Surface runoff : slow
 Surface sealing/crusting/cracking : slightly crusting
 Drainage class : well drained
 Flooding : nil
 Groundwater level (actual) : always deep, >150 cm
 Presence of salts/ alkali : nil
 Soilfauna influences : moderate termites activity
 Expected rooting depth : very deep, >150 cm

HORIZONS:

Ap	0-15 cm	Dark reddish brown (5YR3/3) when moist; clay; strong fine subangular blocky structure; common medium and and few fine pores; very friable, sticky and plastic; common fine and few medium roots; abrupt smooth transition to:
Ah	15-30 cm	Dark reddish brown (5YR3/4) when moist; clay; strong fine subangular blocky structure; broken moderately thick clayskins; common medium and fine pores; friable, very sticky and very plastic; common fine and few medium roots; clear smooth transition to:
Bt1	30-55 cm	Dark reddish brown (2.5YR3/4) in peds, dark red (2.5YR3/6) on peds when moist; clay; strong medium angular blocky structure; continuous moderately thick clayskins; common medium and fine pores; firm, sticky and slightly plastic; few fine and few medium roots; clear smooth transition to:
Bt2	55-85 cm	Dark red (2.5YR3/6) when moist; clay; strong medium angular blocky structure; continuous

moderately thick clayskins; few fine and few medium pores; very firm, sticky and slightly plastic; few fine and very few medium roots; gradual smooth transition to:

Bt3 85-150 cm Dark red (2.5YR3/6) when moist; clay; moderate coarse angular blocky structure; broken moderately thick clayskins; very few medium and fine pores; firm, slightly sticky and slightly plastic; very few fine and very few medium roots.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 26

Field Observation No.: 122/3-65 Soil Classification: dystric NITISOL

Lab. no. .../85	8304	8305	8306	8307
Horizon designation	Ap	Bt1	Bt2	Bt3
Depth (cm)	0-15	30-55	55-85	85-100
pH-H2O (1:2.5)	4.9	4.9	4.9	4.7
pH-M KCl (1:2.5)	4.7	4.7	4.7	4.4
EC (mS/cm; 1:2.5)	0.05	0.04	0.03	0.04
C (%)	1.6	0.7	0.4	0.3
CEC cmol(+)/kg, pH 8.2	19.3	16.5	12.5	10.5
Exch. Ca cmol(+)/kg	4.1	2.7	2.4	2.3
,, Mg ,,	3.7	2.5	2.8	2.5
,, K ,,	2.1	1.5	1.0	0.9
,, Na ,,	0.1	0.1	0.1	0.1
Sum cations	10.0	6.8	6.3	5.8
Base sat. at pH 8.2	52	41	50	55
ESP at pH 8.2	<1	<1	1	1
Gravel % >2mm	0	0	0	0
Sand % 2-0.05mm	16	10	12	8
Silt % 50-2 um	19	9	11	7
Clay % <2 um	65	81	77	85
Texture class	C	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 places)

Depth (cm)	0-20	40-60
Lab. no. .../85	8475	8476
Ca cmol(+)/kg	4.0	1.6
Mg ,,	2.8	2.1
K ,,	1.6	1.1
Mn ,,	1.9	2.0
Exch. acid. ,,	<0.1	0.3
P ug/g	6	3
C %	1.8	n.d.
N %	0.13	n.d.
pH-H2O (1:2.5)	5.6	5.3
CEC = 12 cmol(+)/kg clay		
CEC = 700 ,, carbon		

PROFILE DESCRIPTION 27

Date/ season	: 11-10-1985; cold season
Sheet-observation no	: 122/3-68
Coordinates	: 99656E, 3405N
Elevation	: 1760 m
Authors	: E. Oren
Soil classification	: chromic Acrisol
Geology	: Mt Kenya volcanics
Local petrography (parent material)	: Pyroclastic agglomerate
Physiography	: Mountain footridge
Macro-relief	: Mountainous
Slope (length, shape and pattern)	: 300m; convex; regular
Slope gradient	: 39%
Position on slope	: middle slope
Meso and micro-relief	: nil
Vegetation/ Landuse	: forest with undercover
Erosion	: slight
Rock outcrops	: nil
Surface stoniness	: nil
Overwash	: nil
Surface runoff	: medium
Surface sealing/crusting/cracking	: nil
Drainage class	: well drained
Flooding	: none
Groundwater level (actual)	: deep
Presence of salts/ alkali	: none
Soilfauna influences	: moderate termite activity
Expected rooting depth	: deep

Horizons:

Ah1	0-10 cm	Dark reddish brown (5YR3/5) when moist; clay; moderate, fine and medium, subangular blocky; few fine and few medium pores; sticky and plastic; many fine and medium roots; clear and smooth to:
Ah2	10-35cm	Dark reddish brown (5YR 3/4) when moist; clay; strong, medium and coarse subangular blocky; weak, common cutans; common, fine pores; slightly sticky and slightly plastic; common fine and many medium roots; clear and smooth to:
BAw	35-50 cm	Reddish brown (5YR 4/4) when moist; clay; moderate very coarse angular blocky and moderate medium, subangular blocky; no cutans; common fine pores; common fine and common medium roots; sticky and plastic; gradual and wavy to:
Bw	50-120cm	Yellowish red (5YR 4/6) when moist; gravelly clay; moderate medium subangular blocky; no cutans; few medium and many fine roots; sticky and plastic; few fine and common medium roots; abrupt and smooth to:

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 27

Field Observation No.: 122/3-68 Soil Classification: chromic Acrisol

Lab. no. .../86	1119	1120	1121	1122	1123
Horizon designation	Ah1	Ah2	BAw	Bw	Bw
Depth (cm)	0-10	10-35	35-50	50-110	110-120
pH-H ₂ O (1:2.5)	4.0	4.4	4.6	4.5	4.6
pH-M KCl (1:2.5)	3.7	4.0	3.9	3.8	5.1
EC (mS/cm; 1:2.5)	0.35	0.10	0.05	0.03	0.03
C (%)	4.4	2.3	1.5	1.0	0.9
CEC cmol(+)/kg, pH 8.2	32.5	23.0	20.0	18.3	12.3
Exch. Ca cmol(+)/kg	0.5	0.4	0.3	0.2	0.1
,, Mg ,,	0.4	0.2	0.2	0.2	0.1
,, K ,,	0.3	0.2	0.1	0.1	0.1
,, Na ,,	<0.1	<0.1	<0.1	<0.1	<0.1
Sum cations	1.2	0.8	0.6	0.5	0.3
Base sat. at pH 8.2	4	4	3	3	3
ESP at pH 8.2	<1	<1	<1	<1	<1
Gravel % >2mm	0	0	0	?	?
Sand % 2-0.05mm	31	13	13	14	26
Silt % 50-2 um	16	14	10	10	12
Clay % <2 um	53	73	77	76	62
Texture class	C	C	C	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../86	1135	1136
Ca cmol(+)/kg	<0.1	<0.1
Mg ,,	0.6	0.6
K ,,	0.5	0.2
Mn ,,	0.4	0.2
Exch. acid. ,,	-	-
P ug/g	30	8
C %	3.2	2.0
N %	0.98	0.57
pH-H ₂ O (1:2.5)	5.7	5.9

CEC= 18 cmol(+)/ kg clay
 CEC= 500 ,, carbon

PROFILE DESCRIPTION 28

Date/ season : 11-10-1985; cold season
Sheet-observation no : 122/3-69
Coordinates : 99696E, 3364N
Elevation : 2035 m
Authors : E. Oren
Soil classification : chromic Cambisol
Geology : Mt Kenya volcanics
Local petrography (parent material): Pyroclastic agglomerate
Physiography : Mountain footridge
Macro-relief : Mountainous
Slope (length, shape and pattern) : 200m; convex; regular
Slope gradient : 10%
Position on slope : upper slope
Meso and micro-relief : nil
Vegetation/ Landuse : coffeee and forest
Erosion : nil
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : slow
Surface sealing/crusting/cracking : nil
Drainage class : well drained
Flooding : none
Groundwater level (actual) : very deep
Presence of salts/ alkali : none
Soilfauna influences : termite activity
Expected rooting depth : very deep

Horizons:

Ah1	0-5 cm	Dark reddish brown (5YR 3/3) when moist; clay; fine subangular blocky; sticky and plastic; many very fine and fine roots; abrupt and wavy transition to:
Ah2	5-30 cm	Dark reddish brown (2.5YR 3/4) when moist; clay; strong, very coarse subangular blocky; abundant fine and many medium pores; many fine and many medium roots; sticky and plastic; clear and smooth transition to:
BA	30-110 cm	Dark red (2.5YR 3/6) when moist; clay; strong, coarse and medium, angular blocky; weak common cutans; common fine and common medium pores; common fine and common medium roots; sticky and plastic; diffuse and wavy transition to:
Bt	110-150+ cm	Yellowish red (5YR 4/6) when moist; clay; strong, very coarse, angular blocky; moderate common cutans; very few fine pores; very few, very fine roots; sticky and plastic.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 28

Field Obs. No.: 122/3-69 Soil Classification: chromic CAMBISOL

Lab. no. .../86	1124	1125	1126
Horizon designation	Ah1	Ah2	BA
Depth (cm)	0-5	5-30	30-110

pH-H2O (1:2.5)	3.9	3.6	4.4
pH-M KCl (1:2.5)	3.7	3.9	4.2
EC (mS/cm; 1:2.5)	0.45	0.19	0.03
C (%)	5.5	5.5	2.2
CEC cmol(+)/kg, pH 8.2	38.5	41.0	75.5
Exch. Ca cmol(+)/kg	0.7	0.5	0.3
,, Mg ,,	0.5	0.4	0.1
,, K ,,	0.6	0.4	0.1
,, Na ,,	0.1	0.1	<0.1
Sum cations	1.9	1.4	0.5
Base sat. at pH 8.2	5	3	1
ESP at pH 8.2	<1	<1	<1
Gravel % >2mm	0	0	0
Sand % 2-0.05mm	54	30	20
Silt % 50-2 um	18	20	12
Clay % <2 um	28	50	68
Texture class	SCL	C	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../86	1137	1138

Ca cmol(+)/kg	<0.1	<0.1
Mg ,,	0.8	1.0
K ,,	0.5	0.2
Mn ,,	0.5	0.2
Exch. acid. ,,	0.2	?
P ug/g	25	11
C %	5.4	2.7
N %	0.99	0.64
pH-H2O (1:2.5)	5.4	5.6

CEC = 30-100 cmol(+)/ kg clay at:

CEC = 500 ,, carbon, indicating the presence of appreciable amounts of allophane in the subsoil

PROFILE DESCRIPTION 29

Date/season : 22/10/85; beginning of the rainy season
Sheet observation no : 122/4-77
Coordinates : 3650 - 99650
Elevation : 950 m
Authors : Philip Visser and Tom Veldkamp
Soil mapping unit : PA
Soil classification-FAO : chromic VERTISOL, sodic phase
-USDA :
Geology : non recent alluvium
Local petrography/ parent material : Alluvium
Physiography : dissected river terrace
Macro relief : gently undulating
Slope, length, shape, pattern : 300 m, convex, regular.
Slope gradient : 3%
Position on slope : middle slope
Meso- and micro relief : gilgai
Vegetation/landuse : dense bushland as fallow period adjacent to cotton field
Erosion : nil
Rock outcrops : nil
Surface stoniness : at spots some boulders and calcareous gravel.
Overwash : nil
Surface runoff : very slow
surface (sealing, crusting, cracking) : polygonal pattern of cracks at 40cm distance of each other, cracks 5-10cm wide at depth of 50 cm
Drainage class : well to somewhat excessively drained
Flooding : nil
Groundwater level : always deep
Presence of salts/alkali : not visible
Soilfauna influences : 0-20 cm some ant activity.
Expected rooting depth : very deep (> 1.50m)

Horizons:

Ah1 0 - 30 cm Dark brown (7.5YR 3/2) when moist; clay; compound strong very coarse, angular blocky structure, and strong porous massive fine granules; thin continuous, pressure faces; firm, sticky and slightly plastic; many medium and fine pores; few medium and coarse roots; diffuse and wavy transition to:
Ah2 30 - 150+cm Very dark greyish brown (10YR 3/2); clay; few soft calcareous concretions (5-10 mm); strong, very coarse prismatic structure; common thin continuous pressure faces; firm, sticky and slightly plastic; few fine pores; few fine roots.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 29

Field Obs.No.:122/4-77 Soil Classification:chromic VERTISOL,sodic phase

Lab. no. .../86	3698	3699	1128	3700
Horizon designation	Ah1	Ah2	Ah2	Ah2
Depth (cm)	0-30	30-60	60-120	120-160
pH-H ₂ O (1:2.5)	6.5	7.3	7.7	7.4
pH-M KCl (1:2.5)	5.9	6.6	6.7	7.0
EC (mS/cm; 1:2.5)	0.30	0.05	0.50	0.16
C (%)	2.2	1.6	1.2	1.0
CEC cmol(+)/kg, pH 8.2	51.2	49.6	60.5	39.2
Exch. Ca cmol(+)/kg	19.4	20.6	26.2	17.0
,, Mg ,,	24.0	30.4	35.0	28.0
,, K ,,	0.2	0.2	0.1	0.1
,, Na ,,	0.2	0.8	3.7	5.6
Sum cations	43.8	52.0	65.0	50.7
Base sat. at pH 8.2	86	100+	100+	100+
ESP at pH 8.2	<1	2	6	14
Gravel % >2mm	0	0	0	0
Sand % 2-0.05mm	18	20	18	20
Silt % 50-2 um	16	10	10	6
Clay % <2 um	66	70	72	74
Texture class	C	C	C	C

CEC = 70 cmol(+)/kg clay
 CEC = 300 ,, carbon

PROFILE DESCRIPTION 30

Date/ season : 11/11/85; rainy season
Sheet-observation no : 122/4-78
Coordinates : 3705 E, 99514 N
Elevation : 780 m
Authors : John Pulles
Soil mapping unit : UFCh, FQbs, HQph
Soil classification : calcaric PHAEOZEM
(FAO, soil taxonomy)
Geology : Basement System
Local petrography/ parent material : gneisses rich in ferro-magnesian minerals
Physiography : Uplands
Macro-relief : undulating
Slope (length, shape and pattern) : 200 m, convex, regular
Slope gradient : gently sloping
Position on slope : lower slope
Meso- and micro-relief : nil
Vegetation/ Landuse : extensive grazing in fallow period
Erosion : nil
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : medium
Surface sealing/crusting/cracking : slight crust (\pm 2 mm)
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : -
Expected rooting depth : deep

Horizons:

Ah1 0-20 cm Very dark brown (10 YR 2/2) when moist; silt loam; moderate fine to medium subangular blocky, few crumb; friable, slightly sticky and slightly plastic; few coarse, few medium, common fine and very fine pores; clear and smooth transition to:

Ah2 20-45/55 cm Dark brown (7.5 YR 3/2) when moist; silty clay loam; moderate fine to medium subangular blocky, few crumb; hard, friable, slightly sticky and slightly plastic; few medium, fine and very fine pores; in lower part calcic pseudomycelia, strong effervescence to HCl; clear and wavy transition to:

Bck 45/55-55/70 cm Dark brown (7.5 YR 3/2) when moist; structure, pores, consistency and texture not determinable; very frequent calcic concretions, \emptyset 10 mm.

CR 55/70-90+ cm Rotten rock.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 30

Field Obs. No.: 122/4-78

Soil Classification: calcare PHAEOZEM

Lab. no. .../86	538	539	54070
Horizon designation	Ah1	Ah2	Bck
Depth (cm)	0-20	20-45	50-770
pH-H2O (1:2.5)	7.7	7.7	8.1
pH-M KCl (1:2.5)	6.0	6.0	6.3
EC (mS/cm; 1:2.5)	0.30	0.45	0.47
C (%)	0.3	0.5	0.5
CEC cmol(+)/kg, pH 8.2	11.7	14.8	15.6
Exch. Ca cmol(+)/kg	10.2	12.4	14.6
,, Mg ,,	2.4	2.2	2.1
,, K ,,	<0.1	<0.1	<0.1
,, Na ,,	0.2	0.2	0.2
Sum cations	12.8	14.8	16.9
Base sat. at pH 8.2	100+	100+	100+
ESP at pH 8.2	1	1	1
Gravel % >2mm	0	0	0
Sand % 2-0.05mm	69	67	63
Silt % 50-2 um	10	8	12
Clay % <2 um	21	25	25
Texture class	SCL	SCL	SCL

CEC= 50 cmol(+)/ kg clay
 CEC= 500 ,, carbon

PROFILE DESCRIPTION 31

Date/ season : 11/11/85; rainy season
 Sheet-observation no : 122/4-79
 Coordinates : 3706 E, 99517 N
 Elevation : 790 m
 Authors : John Pulles
 Soil mapping unit : UFCh
 Soil classification : calcic CAMBISOL
 (FAO, soil taxonomy)
 Geology : Basement System
 Local petrography/ parent material : gneisses rich inferro-magnesian minerals
 Physiography : Uplands
 Macro-relief : undulating
 Slope (length, shape and pattern) : 300 m, convex, regular
 Slope gradient : gently sloping
 Position on slope : upper slope
 Meso- and micro-relief : nil
 Vegetation/ Landuse : extensive grazing in fallow period
 Erosion : moderate sheet erosion
 Rock outcrops : nil
 Surface stoniness : fairly stony (boulders)
 Overwash : nil
 Surface runoff : rapid
 Surface sealing/crusting/cracking : moderate crust
 Drainage class : somewhat excessively drained
 Flooding : nil
 Groundwater level (actual) : always deep
 Presence of salts/ alkali : nil
 Soilfauna influences : high termite-activity (krotovinas)
 Expected rooting depth : deep

Horizons:

Ah 0-15/20 cm Dark reddish brown (5 YR 3/3) when moist; loam; moderate fine to medium subangular blocky, common crumb and granules; hard, friable, slightly sticky and slightly plastic; patchy thin clayskins; few fine and medium, common very fine pores; abrupt and wavy transition to:

Bw 15/20-35/50 cm Dark reddish brown (2.5 YR 3/4) when moist; very gravelly loam; more than 50% rockstructure; clear and wavy transition to:

Bck 35/50-80 cm Dark reddish brown (2.5 YR 3/4) when moist; very frequent calcic concretions, ϕ 5-20 mm; clear and wavy transition to:

CR 80+ cm Rotten rock with some calcic concretions.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 31

Field Observation No.: 122/4-79 Soil Classification: calcic CAMBISOL

Lab. no. .../86	541	542	543
Horizon designation	Ah	Bw	Bck
Depth (cm)	0-15	20-35	50-80
pH-H ₂ O (1:2.5)	7.4	8.1	8.1
pH-M KCl (1:2.5)	5.8	6.2	6.7
EC (mS/cm; 1:2.5)	0.11	0.11	0.14
C (%)	0.4	0.5	0.4
CEC cmol(+)/kg, pH 8.2	17.6	19.3	21.8
Exch. Ca cmol(+)/kg	14.5	14.6	18.7
,, Mg ,,	4.0	4.6	3.3
,, K ,,	<0.1	<0.1	<0.1
,, Na ,,	0.2	0.2	0.2
Sum cations	18.7	19.4	22.2
Base sat. at pH 8.2	100+	100+	100+
ESP at pH 8.2	1	1	1
Gravel % >2mm	?	?	?
Sand % 2-0.05mm	61	61	55
Silt % 50-2 um	15	11	13
Clay % <2 um	24	28	32
Texture class	SCL	SCL	SCL

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. No. .../86	3675
Ca cmol(+)/kg	15.2
Mg ,,	5.5
K ,,	0.1
Mn ,,	0.4
Exch. acid. ,,	0.2
P ug/g	241
C %	0.6
N %	0.12
pH-H ₂ O (1:2.5)	7.1

CEC = 62 cmol(+)/ kg clay

CEC = 500 ,, carbon, indicating the presence of appreciable amounts of smectites.

PROFILE DESCRIPTION 32

Date/ season : 12/11/85; rainy season
Sheet-observation no : 122/4-80
Coordinates : 3739 E, 99503 N
Elevation : 720 m
Authors : John Pulles
Soil mapping unit : UFEs
Soil classification : chromic LUVISOL
(FAO, soil taxonomy)
Geology : Basement System
Local petrography/ parent material : gneisses rich inferro-magnesian minerals
Physiography : Uplands
Macro-relief : gently undulating
Slope (length, shape and pattern) : 300 m, straight, regular
Slope gradient : 3 %
Position on slope : middle slope
Meso- and micro-relief : very slight due to water erosion
Vegetation/ Landuse : fallow land (extensive grazing)
Erosion : slight rill, severe sheet erosion
Rock outcrops : nil
Surface stoniness : stony (boulders)
Overwash : nil
Surface runoff : rapid
Surface sealing/crusting/cracking : moderate thin sealing
Drainage class : somewhat excessively drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : many small ants, also termite activity
Expected rooting depth : deep

Horizons:

Bt 0-15/20 cm Dark reddish brown (2.5 YR 3/4) when moist; slightly gravelly clay; moderate medium to coarse subangular blocky structure, and common crumb; slightly hard, friable, slightly sticky and slightly plastic; broken thin clayskins; few medium and fine pores; clear and wavy transition to:

Bt/CR 15/20-50/60 cm Dark reddish brown (2.5 YR 3/4) when moist; clay; more than 50% rockstructure, rest moderate fine to medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; patchy thin clayskins; few fine, common very fine pores; diffuse and wavy transition to:

CRk 50/60+ cm Rotten rock; in parts petrocalcic visible; reaction with HCl.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 32

Field Observation No.: 122/4-80

Soil Classification: chromic LUVISOL

Lab. no. .../86	544	545	546
Horizon designation	Bt	Bt/CR	CRk
Depth (cm)	0-15	20-50	60-70
-----	-----	-----	-----
pH-H ₂ O (1:2.5)	7.3	7.3	8.1
pH-M KCl (1:2.5)	5.8	6.0	6.9
EC (mS/cm; 1:2.5)	0.10	0.07	0.12
C (%)	0.7	0.3	0.4
CEC cmol(+)/kg, pH 8.2	18.3	11.2	12.1
Exch. Ca cmol(+)/kg	11.2	8.5	11.3
,, Mg ,,	3.9	2.8	1.6
,, K ,,	0.1	<0.1	<0.1
,, Na ,,	0.3	0.2	0.2
Sum cations	15.5	11.5	13.1
Base sat. at pH 8.2	100+	100+	100+
ESP at pH 8.2	2	2	2
Gravel % >2mm	?	?	?
Sand % 2-0.05mm	55	65	67
Silt % 50-2 um	13	11	11
Clay % <2 um	32	24	22
Texture class	SCL	SC;	SCL

CEC = 46 cmol(+)/kg clay

CEC = 500 ,, carbon

No fertility data available

PROFILE DESCRIPTION 33

Date/ season : 14/11/85; rainy season
Sheet-observation no : 122/4-81
Coordinates : 3768E, 99488N
Elevation : 650 m
Authors : John Pulles
Soil mapping unit : UUES/CD
Soil classification : chromic Cambisol
(FAO, soil taxonomy)
Geology : Basement System
Local petrography/ parent material : gneiss-rich in ferromagnesian minerals
Physiography : Uplands
Macro-relief : undulating
Slope (length, shape and pattern) : ca. 150 m, convex, regular
Slope gradient : sloping (9%)
Position on slope : middle slope
Meso- and micro-relief : nil
Vegetation/ Landuse : shifting cultivation (fallow period)
Erosion : moderate water erosion
Rock outcrops : nil
Surface stoniness : very few stones, slightly gravelly
Overwash : nil
Surface runoff : medium
Surface sealing/crusting/cracking : slight
Drainage class : well drained
Flooding : absent
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : slight
Expected rooting depth : deep

Horizons:

Bw1 0 - 33 cm Reddish brown (5 YR 4/4) when moist; moderate medium subangular blocky structure, common crumb; no cutans; few medium, fine and very fine pores; sandy loam to sandy clay loam; slightly hard, friable, slightly sticky and slightly plastic; clear and smooth transition to

Bw2 33-70/80 cm Reddish brown (5 YR 4/4) when moist; weak fine sub- angular blocky; few pores; very gravelly sandy clay loam; rounded quartz is present, mixed with different gneisses, probably colluvial material with remnants of old Tana terraces; clear and wavy transition to

2B+CR 70/80-100 cm Reddish brown (5 YR 4/4) when moist; more than 50% rock structure; sandy clay loam.

In B-horizon rounded quartz, mixed with different gneisses, is present. Probably colluvial material with remnants of old Tana terraces.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 33

Field Obs. No.: 122/4-81

Soil Classification: chromic CAMBISOL

Lab. no. .../86	547	548	549
Horizon designation	Bw1	Bw2	2B+CR
Depth (cm)	0-33	33-70	80-100
pH-H ₂ O (1:2.5)	7.3	7.5	8.1
pH-M KCl (1:2.5)	6.3	6.2	6.4
EC (mS/cm; 1:2.5)	0.05	0.07	0.09
C (%)	0.4	0.1	0.3
CEC cmol(+)/kg, pH 8.2	16.1	13.5	9.1
Exch. Ca cmol(+)/kg	13.0	10.9	10.5
,, Mg ,,	3.7	3.1	3.5
,, K ,,	0.1	<0.1	<0.1
,, Na ,,	0.2	0.2	0.3
Sum cations	17.0	14.2	14.3
Base sat. at pH 8.2	100+	100+	100+
ESP at pH 8.2	1	1	3
Gravel % >2mm	?	?	?
Sand % 2-0.05mm	67	73	79
Silt % 50-2 um	9	9	9
Clay % <2 um	24	18	12
Texture class	SCL	SL	SL

FERTILITY ASPECTS (composite sample from at least five places)

Depth (cm)	0-20	30-50
Lab. no. .../86	3676	3677
Ca cmol(+)/kg	12.4	10.8
Mg ,,	3.8	2.6
K ,,	0.1	0.1
Mn ,,	0.1	0.1
Exch. acid. ,,	-	-
P ug/g	207	224
C %	0.3	n.d.
N %	0.10	n.d.
pH-H ₂ O (1:2.5)	8.0	7.8

CEC= 65 cmol(+)/ kg clay at:
 CEC= 500 ,, carbon

PROFILE DESCRIPTION 34

Date/ season : 26/11/85; rainy season
Sheet-observation no : 122/4-84
Coordinates : 3754 E, 99485 N
Elevation : 685 m
Authors : John Pulles
Soil mapping unit : UFea2
Soil classification : chromic LUVISOL
(FAO, soil taxonomy)
Geology : Basement System
Localpetrography/ parent material : gneissesrich inferro-magnesian
(Parent material) minerals
Physiography : Uplands
Macro-relief : undulating
Slope (length, shape and pattern) : 200 m, convex, regular
Slope gradient : 6 %
Position on slope : upper slope
Meso- and micro-relief : nil
Vegetation/ Landuse : fallow period in shifting
cultivation, herbs dominant
Erosion : slight rill erosion
Rock outcrops : nil
Surface stoniness : very few stones
Overwash : evidence of overwash in first 3 cm
Surface runoff : rapid
Surface sealing/crusting/cracking : moderately thin crust
Drainage class : well to somewhat excessively
drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfaunainfluences : hightermite-activity
Expected rooting depth : > 110 cm

Horizons:

Ah 0-15 cm Dark reddish brown (2.5 YR 3/4) when moist; sandy loam; weak fine subangular blocky structure, frequent crumb; very friable, very slightly sticky and non-plastic; few medium, common fine and very fine pores; clear and smooth transition to:

Bt1 15-48/55 cm Dark red (2.5 YR 3/6) when moist; sandy clay loam; weak coarse angular blocky structure, common crumb; hard, friable, slightly sticky and slightly plastic; few medium, common fine and very fine pores; clear and wavy transition to:

Bt2 48/55-80/90cm Dark red (2.5 YR 3/6) when moist; gravelly sandy clay loam; especially the upper 10 cms are gravelly, the rest of the horizon contains rotten gneisses, in the gravelly phase even rounded quartz appears. (traces of old riverterrace?); friable, slightly sticky

and slightly plastic; patchy thin clayskins;
gradual and wavy transition to:

Bt3 80/90 - 100 cm Red (2.5 YR 4/6) when moist; sandy clay loam;
weak cm fine subangular blocky structure,
common crumb; friable, slightly sticky and
slightly plastic; patchy thin clayskins; few
medium, common fine and very fine pores.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 34

Field Observation No.: 122/4-84 Soil Classification: chromic LUVISOL

Lab. no. .../86	557	558	559	560
Horizon designation	Ah	Bt1	Bt2	Bt3
Depth (cm)	0-15	15-48	55-80	90-110
pH-H ₂ O (1:2.5)	6.6	6.8	7.1	7.9
pH-M KCl (1:2.5)	5.3	5.6	5.8	6.2
EC (mS/cm; 1:2.5)	0.08	0.07	0.17	0.17
C (%)	0.4	0.3	0.2	0.1
CEC cmol(+)/kg, pH 8.2	13.6	16.3	13.8	12.3
Exch. Ca cmol(+)/kg	7.9	8.3	8.7	8.9
,, Mg ,,	2.9	4.7	3.8	4.1
,, K ,,	0.2	0.1	<0.1	<0.1
,, Na ,,	0.2	0.2	0.2	0.1
Sum cations	11.2	13.3	12.7	13.1
Base sat. at pH 8.2	82	82	92	100+
ESP at pH 8.2	2	1	1	1
Gravel % >2mm	?	?	?	?
Sand % 2-0.05mm	69	61	67	61
Silt % 50-2 um	9	9	9	13
Clay % <2 um	22	30	24	26
Texture class	SCL	SCL	SCL	SCL

CEC = 50 cmol(+)/ kg clay
CEC = 5 ,, carbon

No fertility data available

PROFILE DESCRIPTION 35

Date/ season : 26/11/85; rainy season
Sheet-observation no : 122/4-85
Coordinates : 3760 E, 99489 N
Elevation : 685 m
Authors : John Pulles
Soil mapping unit : FQbes/CD
Soil classification : calcic Cambisol
(FAO, soil taxonomy)
Geology : Basement System
Local petrography/ parent materail : gneisses rich in ferromagnesian minerals
Physiography : Footslope
Macro-relief : rolling
Slope (length, shape and pattern) : 200 m, convex, regular
Slope gradient : strongly sloping (12%)
Position on slope : middle slope
Meso- and micro-relief : nil
Vegetation/ Landuse : extensive grazing during fallow period, vegetation is wooded bushland.
Erosion : moderate sheeterosion
Rock outcrops : nil
Surface stoniness : slightly gravelly, fairly stony
Overwash : nil
Surface runoff : rapid
Surface sealing/crusting/cracking : moderate thin crust, for about 80% covered with 'algen'crust.
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : not noticable
Expected rooting depth : > 90 cm

Horizons:

Ah 0 - 20/35cm Dark brown (7.5 YR 3/4) when moist; moderate fine subangular blocky structure; few medium, fine and very fine pores; siltloam; very friable, slightly sticky and slightly plastic; reacts with HCl, calcic mycelia present; clear and irregular transition to

Bck 20/35 - 90 cm Strong brown (7.5 YR 4/6) when moist; structure, pores, texture and consistence not determinable; reaction with HCl; very frequent calcium carbonate concretions, \emptyset 3 to 10 mm; in parts rockstructure still present.

Remarks: The rockstructure consists of dark rotten gneisses, and lighter, more metamorphic (harder) gneisses. The Bck is a pisocalcic phase.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 35

Field Observation No.: 122/4-85

Soil Classification: calcic CAMBISOL

Lab. no. .../ 86	561	562
Horizon designation	Ah	Bck
Depth (cm)	0-20	35-90

pH-H ₂ O (1:2.5)	8.4	8.2
pH-M KCl (1:2.5)	6.5	7.0
EC (mS/cm; 1:2.5)	0.12	0.17
C (%)	0.6	0.2
CEC cmol(+)/kg, pH 8.2	17.5	14.7
Exch. Ca cmol(+)/kg	16.9	18.8
,, Mg ,,	1.2	1.5
,, K ,,	0.1	<0.1
,, Na ,,	0.2	0.2
Sum cations	18.4	20.6
Base sat. at pH 8.2	100+	100+
ESP at pH 8.2	1	1
Gravel % >2mm	?	?
Sand % 2-0.05mm	55	49
Silt % 50-2 um	15	21
Clay % <2 um	30	30
Texture class	SCL	SCL

CEC = 47 cmol(+)/ kg clay
 CEC = 500 ,, carbon

No fertility data available

PROFILE DESCRIPTION 36

Date/ season : 26/11/85; rainy season
 Sheet-observation no : 122/4-86
 Coordinates : 3742 E, 99501 N
 Elevation : 715 m
 Authors : John Pulles
 Soil mapping unit : UFeal, UFps
 Soil classification : chromic LUVISOL
 (FAO, soil taxonomy)
 Geology : Basement System
 Local petrography/ parent material : gneisses rich inferro-magnesian minerals
 Physiography : Uplands
 Macro-relief : gently undulating
 Slope (length, shape and pattern) : 400 m, convex, regular
 Slope gradient : 2 %
 Position on slope : upper slope
 Meso- and micro-relief : termite mound at 20 m
 Vegetation/ Landuse : bushland, extensive grazing
 Erosion : severe sheet, moderate rill erosion
 Rock outcrops : nil
 Surface stoniness : gravelly, fairly stony (boulders)
 Overwash : slight overwash
 Surface runoff : medium
 Surface sealing/crusting/cracking : slight thin crust
 Drainage class : somewhat excessively drained
 Flooding : nil
 Groundwater level (actual) : always deep
 Presence of salts/ alkali : nil
 Soilfauna influences : very high termite activity, sheetings
 Expected rooting depth : deep

Horizons:

Bt1	0-48 cm	Dark red (2.5 YR 3/6) when moist; clay; medium prismatic falling apart to moderate fine to medium angular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; continuous thin clayskins; few coarse, few medium and common fine and very fine pores; clear and smooth transition to:
Bt2	48-64 cm	Dark red (2.5 YR 3/6) when moist; very gravelly clay (in top the gravel is coarser); clear and smooth transition to:
B+CR	64-100 cm	Dark red (2.5 YR 3/6) when moist; clay; more than 50% rock structure; few medium pores; termite activity still present.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 36

Field Observation No.: 122/4-86 Soil Classification: chromic LUVISOL

Lab. no. .../86	563	564	565
Horizon designation	Bt1	Bt2	B+CR
Depth (cm)	0-48	48-64	64-100
pH-H ₂ O (1:2.5)	6.2	7.2	6.9
pH-M KCl (1:2.5)	5.0	6.2	5.8
EC (mS/cm; 1:2.5)	0.06	0.15	0.10
C (%)	0.1	0.2	0.2
CEC cmol(+)/kg, pH 8.2	28.6	8.9	21.8
Exch. Ca cmol(+)/kg	14.9	4.8	11.8
,, Mg ,,	3.8	3.4	4.1
,, K ,,	0.2	0.1	0.2
,, Na ,,	0.2	0.4	0.4
Sum cations	19.1	8.7	16.5
Base sat. at pH 8.2	67	98	76
ESP at pH 8.2	1	4	2
Gravel % >2mm	?	?	?
Sand % 2-0.05mm	27	75	39
Silt % 50-2 um	11	7	15
Clay % <2 um	62	18	46
Texture class	C	SL	C

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../86	3678	3679

Ca cmol(+)/kg	6.6	4.8
Mg ,,	4.0	4.8
K ,,	0.3	0.3
Mn ,,	0.8	1.0
Exch. acid. ,,	<0.1	<0.1
P ug/g	14	42
C %	0.4	n.d.
N %	0.10	n.d.
pH-H ₂ O (1:2.5)	6.0	6.3

CEC = 45 cmol(+)/ kg clay
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 37

Date/ season : 27/11/85; rainy season
Sheet-observation no : 122/4-89
Coordinates : 3743 E, 99505 N
Elevation : 700 m
Authors : John Pulles
Soil mapping unit : UFCh
Soil classification : calcic CHERNOZEM
(FAO, soil taxonomy)
Geology : Basement System
Local petrography/ Parent material : gneisses
Physiography : Uplands
Macro-relief : gently undulating
Slope (length, shape and pattern) : 200 m, convex, regular
Slope gradient : 5 %
Position on slope : lower slope
Meso- and micro-relief : nil
Vegetation/ Landuse : extensive grazing during fallow
period
Erosion : slight rill erosion
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : medium
Surface sealing/crusting/cracking : weak thin crust
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : moderate; krotovinas
Expected rooting depth : deep

Horizons:

Ah1 0-30 cm Dark brown (10 YR 2/2) when moist; sandy loam; weak fine to medium subangular blocky structure, common crumb; very friable, slightly sticky and slightly plastic; few medium and fine, common very fine pores; slight effervescence with HCl; gradual and smooth transition to:

Ah2 30-50 cm Dark brown (7.5 YR 3/4) when moist; clay loam; weak fine to medium subangular blocky structure, common crumb; very friable, slightly sticky and slightly plastic; few fine and frequent very fine pores; slight effervescence with HCl, pseudomycelia visible; clear and smooth transition to:

Bck 50-95 cm Dark reddish brown (5 YR 3/4) when moist; very gravelly clay loam; strong effervescence with HCl; very frequent calcic concretions, \emptyset 0.5-2 cm; clear and smooth transition to:

Bck+CR 95-100 cm Rock structure dominating.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 37

Field Obs. No.: 122/4-89

Soil Classification: calcic CHERNOZEM

Lab. no. / 86	572	573	574
Horizon designation	Ah1	Ah2	Bck
Depth (cm)	0-30	30-50	50-95

pH-H ₂ O (1:2.5)	7.9	8.2	8.1
pH-M KCl (1:2.5)	6.8	7.1	7.1
EC (mS/cm; 1:2.5)	0.11	0.15	0.15
C (%)	0.7	0.3	0.4
CEC cmol(+)/kg, pH 8.2	13.3	14.6	14.8
Exch. Ca cmol(+)/kg	11.7	14.1	14.5
,, Mg ,,	2.3	1.0	1.1
,, K ,,	0.1	0.2	<0.1
,, Na ,,	0.2	0.2	0.2
Sum cations	14.3	15.5	15.8
Base saturation, pH 8.2	100+	100+	100+
ESP, pH 8.2	1	1	1
Gravel % >2mm	?	?	?
Sand % 2-0.005mm	58	56	54
Silt % 50-2 um	19	18	18
Clay % <2 um	23	26	28
Texture class	SCL	SCL	SCL

CEC = 46 cmol(+)/ kg clay

CEC = 500 ,, carbon

PROFILE DESCRIPTION 38

Date/ season : 3/12/85; rainy season
 Sheet-observation no : 122/4-91
 Coordinates : 3741 E, 99495 N
 Elevation : 715 m
 Authors : John Pulles
 Soil mapping unit : UFet
 Soil classification : chromic LUVISOL
 (FAO, soil taxonomy)
 Geology : Basement System
 Local petrography/ parent material : gneisses rich inferro-magnesian minerals
 Physiography : Uplands
 Macro-relief : undulating
 Slope (length, shape and pattern) : 150 m, convex, regular
 Slope gradient : 6 %
 Position on slope : upper slope
 Meso- and micro-relief : slight due to erosion, few termite mounds
 Vegetation/ Landuse : extensive grazing
 Erosion : severe sheet- and rill erosion, moderate gully erosion
 Rock outcrops : nil
 Surface stoniness : very gravelly, fairly stony
 Overwash : nil
 Surface runoff : rapid
 Surface sealing/crusting/cracking : nil
 Drainage class : somewhat excessively drained
 Flooding : nil
 Groundwater level (actual) : always deep
 Presence of salts/ alkali : nil
 Soilfauna influences : moderate; krotovinas in 2nd horizon
 Expected rooting depth : deep

Horizons:

AB 0-10 cm Dark red (10 R 3/6) when moist; slightly gravelly clay; moderate fine angular blocky structure; friable, plastic and slightly sticky; continuous thin clayskins; few medium and fine, frequent very fine pores; clear and smooth transition to:
 Bt 10-60 cm Red (10 R 4/6) when moist; slightly gravelly clay; moderate fine angular blocky structure; friable, plastic and slightly sticky; continuous thin clayskins; few medium, common fine and frequent very fine pores; gradual and smooth transition to:
 Bw 60-100 cm Red (10 R 4/8) when moist; slightly gravelly to gravelly clay; weak very fine to fine angular blocky structure; very friable, slightly sticky and slightly plastic; common very fine pores; reaction with HCl; few soft

Mn-concretions, ϕ 3 mm; gradual and wavy transition to:

B+CR 100-120 cm Red soil (10 R 4/6) when moist; major part rotten rock; soil reacts with HCl.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 38

Field Observation No.: 122/4-91 Soil Classification: chromic LUVISOL

Lab. no. .../86	577	578	579
Horizon designation	AB	Bt	Bw
Depth (cm)	0-10	10-60	60-100
pH-H ₂ O (1:2.5)	6.5	6.8	8.1
pH-M KCl (1:2.5)	5.3	5.6	6.7
EC (mS/cm; 1:2.5)	0.11	0.20	0.11
C (%)	0.3	<0.1	0.2
CEC cmol(+)/kg, pH 8.2	21.8	18.7	10.3
Exch. Ca cmol(+)/kg	11.8	10.9	10.5
,, Mg ,,	3.2	4.1	3.2
,, K ,,	0.4	0.1	0.1
,, Na ,,	0.2	0.2	0.2
Sum cations	15.6	15.3	14.0
Base sat. at pH 8.2	72	82	100+
ESP at pH 8.2	1	1	2
Gravel % >2mm	?	?	?
Sand % 2-0.05mm	50	44	56
Silt % 50-2 um	8	12	22
Clay % <2 um	42	44	22
Texture class	SC	C	SCL

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../86	3680	3681
Ca cmol(+)/kg	8.2	9.2
Mg ,,	3.4	3.4
K ,,	0.4	0.2
Mn ,,	0.3	0.2
Exch. acid. ,,	-	-
P ug/g	14	9
C %	0.5	n.d.
N %	0.12	n.d.
pH-H ₂ O (1:2.5)	6.3	6.0

CEC = 43 cmol(+)/ kg clay
 CEC = 500 ,, carbon

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 39

Field Observation No.: 122/4-95 Soil Classification: chromic LUVISOL

Lab. no. .../86	588	589
Horizon designation	Ap	Bw
Depth (cm)	0-15	15-40

pH-H ₂ O (1:2.5)	7.0	5.9
pH-M KCl (1:2.5)	6.6	4.5
EC (mS/cm; 1:2.5)	0.10	0.03
C (%)	1.0	0.5
CEC cmol(+)/kg, pH 8.2	9.7	10.3
Exch. Ca cmol(+)/kg	3.5	4.4
,, Mg ,,	2.6	2.5
,, K ,,	0.7	0.3
,, Na ,,	0.2	0.2
Sum cations	7.0	5.4
Base sat. at pH 8.2	72	52
ESP at pH 8.2	2	2
Gravel % >2mm	?	?
Sand % 2-0.05mm	74	68
Silt % 50-2 um	10	10
Clay % <2 um	16	22
Texture class	SL	SCL

CEC = 32 cmol(+)/ kg clay
 CEC = 500 ,, carbon

No fertility data available

PROFILE DESCRIPTION 40

Date /season : 10/12/85 / rainy season
 Sheetobservation no : 122/4-96
 Coordinates : 3873E , 99526N
 Elavation : 579 m
 Authors : Richard Kraayvanger
 Soilmappingunit : UFprT1/D+E
 Soilclassification : chromic LUVISOL
 Geology : precambrium metamorfites
 Local petrography/ Parentmaterial : diorites
 Physiography : uplands
 Macrorelief : rolling to hilly
 Slope (lenght, shape and pattern) : 100m, convex and regular
 Slopegradient : 8-13%
 Position on slope : upper slope
 Meso and microrelief : deep gullies
 Vegetation and landuse : forest and extensive grazing
 Erosion : severe rill erosion
 Rockoutcrops : fairly rocky
 Surface stoniness : very stoney
 Overwash : -
 Surface runoff : medium
 Surface sealing/crusting/cracking : -
 Drainage class : excessively well drained
 Flooding : -
 Groundwaterlevel : >200cm
 Presence of salts/alkali : -
 Soilfauna influences : ants
 Expected rooting depth : 50 cm

Horizons:

Ah	0-10 cm	Dark reddish brown (5YR 4/4) when moist; moderate medium granular and crumb structure; common medium and fine pores; very gravelly sand; friable, non sticky, non plastic; clear and smooth transition to
Bu	10-40 cm	Dark reddish brown (5YR 4/6) when moist; moderate medium subangular blocky structure; common medium and fine pores; very gravelly clay; firm, slighthly sticky, slightly plastic; clear and broken transition to
B+CR	40-100cm	Dark reddish brown (2.5YR 4/6) when moist; rockstructure; few medium and fine pores; very gravelly clay (B material) -gravel consists of quartz and is part of stoneline; firm, slightly sticky, slightly plastic

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 40

Field Obs. No.: 122/4-96

Soil Classification: chromic LUVISOL

Laboratory number /86	590	591
Horizon designation	Ah	Bt
Depth, cm	0-10	10-40
pH-H ₂ O (1:2.5)	6.7	6.1
pH-M KCl (1:2.5)	5.6	4.7
EC mS/cm (1:2.5)	0.06	0.04
C%	0.6	0.3
CEC cmol(+)/kg, pH 8.2	8.0	13.8
Exch. Ca cmol(+)/kg	2.6	2.5
, Mg ,	2.1	3.1
, K ,	0.4	0.6
, Na ,	0.3	0.2
Sum cations	5.4	6.4
Base saturation, pH 8.2	68	46
ESP, pH 8.2	4	1
Gravel % > 2mm	?	?
Sand % 2- 0.05 mm	78	62
Silt % 50- 2 um	8	4
Clay % < 2 um	14	34
Texture class	SL	SCL

CEC = 36 cmol(+)/ kg clay
 CEC = 500 , , carbon

No fertility data available

LABORATORY DATA OF PPROFILE DESCRIPTION NO.: 41

Field Obs. No.: 122/4-97

Soil Classification: chromic LUVISOL

Laboratory number /86	592	593	594
Horizon designation	Ah1	Ah2	Bt
Depth, cm	0-10	10-25	25-65
pH-H ₂ O (1:2.5)	7.4	6.1	6.1
pH-M KCl (1:2.5)	6.6	5.1	4.6
EC mS/cm (1:2.5)	0.06	0.16	0.06
C %	0.5	0.3	0.1
CEC cmol(+)/kg, pH 8.2	6.0	12.1	9.8
Exch Ca cmol(+)/kg	2.6	3.0	3.0
,, Mg ,,	1.3	2.7	2.9
,, K ,,	0.4	0.2	0.1
,, Na ,,	0.2	0.2	0.2
Sum cations	4.5	6.1	6.2
Base saturation, pH 8.2	75	50	63
ESP, pH 8.2	3	2	2
Gravel % 2 mm	?	?	?
Sand % 2- 0.05 mm	78	66	72
Silt % 50-2 um	12	10	10
Clay % <2 um	10	24	18
Texture class	SL	SCL	SL

CEC= 48 cmol(+)/kg clay

CEC= 300 ,, carbon

No fertility data available

PROFILE DESCRIPTION 42

Date/ season	: 15/01/1986
Sheet-observation no	: 122/4-106
Coordinates	: 3778 E, 99648 N
Elevation	: 665 m
Authors	: R. Kraayvanger
Soil mapping unit	: LBar/A
Soil classification (FAO)	: ferric LUVISOL
Geology	: Nyambeni basalts
Local petrography/Parent material	: Basalts
Physiography	: plateau
Macro-relief	: flat
Slope (length, shape, pattern)	: -
Slope gradient	: 0 %
Position on slope	: -
Meso- and micro-relief	: few termite mounds
Vegetation/ Landuse	: wooded bushland; limited grazing and some shambas with cowpeas
Erosion	: nil
Rock outcrops	: nil
Surface stoniness	: nil
Overwash	: nil
Surface runoff	: very slow
Surface sealing/crusting/cracking	: slight crusting
Drainage class	: excessively drained
Flooding	: absent
Groundwater level (actual)	: > 200 cm
Presence of salts/ alkali	: nil
Soilfauna influences	: ants, termites and millipedes
Expected rooting depth	: very deep, > 120 cm

Horizons:

Ah	0 - 15cm	Dark reddish brown (2.5 YR 3/2) when moist; clay; medium granular to fine subangular blocky structure; firm, slightly sticky, slightly plastic; many medium and fine pores; clear and smooth transition to
Bt	15 - 50cm	Dark reddish brown (2.5YR 3/4) when moist; clay; medium granular to fine subangular blocky structure; firm, slightly sticky, slightly plastic; common thin clayskins; smooth and clear transition to
Bcs	50 - 100 cm	Dark reddish brown (2.5YR 3/4) when moist; clay; common medium pores; dominant ferromanganese (murrum) concretions, ϕ 10 mm.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 42

Field Observation No.: 122/4-106 Soil Classification: ferric LUVISOL

Lab. no. .../86	2180	2181	2182
Horizon designation	Ah	Bt	Bcs
Depth (cm)	0-15	15-50	50-100
pH-H ₂ O (1:2.5)	6.8	6.2	6.2
pH-M KCl (1:2.5)	5.5	4.6	5.0
EC (mS/cm; 1:2.5)	0.04	0.02	0.02
C (%)	1.3	0.8	0.4
CEC cmol(+)/kg, pH 8.2	17.3	13.9	9.5
Exch. Ca cmol(+)/kg	8.6	5.4	4.0
,, Mg ,,	4.8	3.0	2.2
,, K ,,	0.9	0.2	0.1
,, Na ,,	0.2	0.2	0.2
Sum cations	14.5	8.8	6.5
Base sat. at pH 8.2	84	63	68
ESP at pH 8.2	1	1	2
Gravel % >2mm	?	?	?
Sand % 2-0.05mm	32	28	48
Silt % 50-2 um	18	12	4
Clay % <2 um	50	60	48
Texture class	C	C	SC

CEC = 15 cmol(+)/ kg clay
 CEC = 700 ,, carbon

No fertility data available

PROFILE DESCRIPTION 43

Date/ season : 13/02/1986; dry season
 Sheet-observation no : 122/4-110
 Coordinates : 3865 E, 99647 N
 Elevation : 480 m
 Authors : J. Pulles
 Soil mapping unit : PA2/A
 Soil classification (FAO) : chromic LUVISOL
 Geology : pleistocene upper Tana deposits
 Local petrography/ Parent material : pleistocene alluvial deposits
 Physiography : floodplain
 Macro-relief : flat
 Slope (length, shape, pattern) : -
 Slope gradient : 0 %
 Position on slope : -
 Meso- and micro-relief : nil
 Vegetation/ Landuse : grassland to wooded bushland;
 extensive grazing
 Erosion : nil
 Rock outcrops : nil
 Surface stoniness : nil
 Overwash : nil
 Surface runoff : slow
 Surface sealing/ crusting/cracking : nil
 Drainage class : well drained
 Flooding : nil
 Groundwater level (actual) : deep
 Presence of salts/ alkali : nil
 Soilfauna influences : sheetings of termites (microtermes
 spp.)
 Expected rooting depth : deep

Horizons:

Ah	0 - 20 cm	Dark reddish brown (5 YR 3/4) when moist; sand; weak medium subangular blocky structure, with common crumb; soft, loose, non sticky and non plastic; no cutans; few medium, few fine pores; gradual and smooth transition to
Bt	20 - 70 cm	Yellowish red (5 YR 5/6) when moist; loamy sand, slightly gravelly; porous massive structure, strongly coherent; slightly hard, very friable, slightly sticky and non plastic; oriented clay bridges; few fine, common very fine pores; gradual and smooth transition to
BC	70 - 130 cm	Reddish yellow (5 YR 6/6) when moist; sand, slightly gravelly; weak medium to coarse subangular blocky structure; soft, loose, non sticky and non plastic; no pores.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 43

Field Obs. No.: 122/4-110 Soil Classification: chromic LUVISOL

Lab. no. .../86	2183	2184	2185
Horizon designation	Ah	Bt	BC
Depth (cm)	0-20	20-70	70-130
pH-H ₂ O (1:2.5)	6.8	6.6	6.3
pH-M KCl (1:2.5)	5.8	4.7	4.6
EC (mS/cm; 1:2.5)	0.04	0.02	0.03
C (%)	0.4	0.1	0.2
CEC cmol(+)/kg, pH 8.2	7.8	1.7	6.3
Exch. Ca cmol(+)/kg	2.9	0.4	2.7
,, Mg ,,	3.7	0.8	2.1
,, K ,,	0.3	<0.1	0.1
,, Na ,,	0.1	0.1	0.1
Sum cations	7.0	1.3	5.0
Base sat. at pH 8.2	90	76	79
ESP at pH 8.2	1	(6)	1
Gravel % >2mm	?	?	?
Sand % 2-0.05mm	80	94	80
Silt % 50-2 um	8	2	8
Clay % <2 um	12	4	12
Texture class	SL	S	SL

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../86	2195	2196
Ca cmol(+)/kg	2.6	3.0
Mg ,,	4.0	7.6
K ,,	1.3	0.2
Mn ,,	0.9	0.3
Exch. acid. ,,	-	-
P ug/g	15	168
C %	1.5	0.2
N %	0.2	0.1
pH-H ₂ O (1:2.5)	5.6	6.5

CEC = 40 cmol(+)/ kg clay
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 44

Date/ season : 13/02/1986; dry season
 Sheet-observation no : 122/4-111
 Coordinates : 3866 E, 99643 N
 Elevation : 490 m
 Authors : J. Pulles
 Soil mapping unit : UFr/BC
 Soil classification (FAO) : chromic LUVISOL
 Geology : Basement System
 Local petrography/ parent material : gneisses rich in ferromagnesian minerals
 Physiography : uplands
 Macro-relief : gently undulating to undulating
 Slope (length, shape, pattern) : 200 m, convex, regular
 Slope gradient : gently sloping to sloping (6%)
 Position on slope : middle slope
 Meso- and micro-relief : nil
 Vegetation/ Landuse : dense bushland; extensive grazing and little charcoal exploitation
 Erosion : slight sheet erosion; severe rill erosion in case of charcoal exploitation
 Rock outcrops : nil
 Surface stoniness : nil
 Overwash : nil
 Surface runoff : rapid
 Surface sealing/crusting/cracking : slight crusting, 5 mm thick
 Drainage class : somewhat excessively drained
 Flooding : nil
 Groundwater level (actual) : always deep
 Presence of salts/ alkali : nil
 Soilfauna influences : termite burrows
 Expected rooting depth : deep

Horizons:

Bt1	0 - 20 cm	Red (2.5 YR 4/6) when moist; sandy clay loam; moderate fine to medium angular to subangular blocky structure, common crumb; slightly hard, friable, sticky and plastic; common thin clay skins; few coarse, common fine, few very fine pores; gradual and smooth transition to
Bt2	20 - 80 cm	Red (2.5 YR 4/6) when moist; sandy clay; moderate coarse angular blocky structure; very hard, firm, sticky and plastic; continuous thin clay skins; frequent very fine, few medium, few fine pores; clear and smooth transition to
Bt3	80 - 100 cm	Red (2.5 YR 4/8) when moist; sandy clay; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; few thin clay skins; few coarse pores; slight effervescence with HCl; clear and smooth transition to

CR 100- 110cm

Very gravelly (quartz); predominantly rock structure.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 44

Field Observation No.: 122/4-11

Soil Classification: chromic LUVISOL

Lab. no. .../86	2186	2187	2188
Horizon designation	Bt1	Bt2	Bt3
Depth (cm)	0-20	20-80	80-100
pH-H ₂ O (1:2.5)	6.6	6.5	7.7
pH-M KCl (1:2.5)	5.2	4.5	6.3
EC (mS/cm; 1:2.5)	0.04	0.07	0.19
C (%)	0.2	0.2	0.2
CEC cmol(+)/kg, pH 8.2	10.8	15.6	15.2
Exch. Ca cmol(+)/kg	4.5	6.5	10.6
,, Mg ,,	3.3	3.7	4.1
,, K ,,	0.2	0.1	0.1
,, Na ,,	0.1	0.1	0.1
Sum cations	8.1	10.4	14.9
Base sat. at pH 8.2	75	67	98
ESP at pH 8.2	1	1	1
Gravel % >2mm	?	?	?
Sand % 2-0.05mm	68	58	58
Silt % 50-2 um	6	8	12
Clay % <2 um	26	34	30
Texture class	SCL	SCL	SCL

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../86	2197	2198
Ca cmol(+)/kg	4.0	6.2
Mg ,,	3.1	5.7
K ,,	0.2	0.1
Mn ,,	0.3	0.5
Exch. acid. ,,	<0.1	<0.1
P ug/g	18	21
C %	0.3	0.1
N %	0.09	n.d.
pH-H ₂ O (1:2.5)	6.8	6.4

CEC = 40-45 cmol(+)/ kg clay at:
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 45

Date/ season : 13/02/1986; dry season
Sheet-observation no : 122/4-112
Coordinates : 3858 E, 99644 N
Elevation : 490 m
Authors : J. Pulles
Soil mapping unit : UUES/CD
Soil classification (FAO) : chromic LUVISOL
Geology : Basement System
Local petrography/ Parent material : undifferentiated Basement System rocks
Physiography : Uplands
Macro-relief : undulating to rolling
Slope (length, shape, pattern) : 75 m, convex, regular
Slope gradient : gently sloping (3%)
Position on slope : upper slope
Meso- and micro-relief : moderate dense very slight meso-relief
Vegetation/ Landuse : charcoal exploitation; extensive grazing; few shifting cultivation of millet
Erosion : severe sheet, slight rill erosion
Rock outcrops : in places fairly rocky
Surface stoniness : gravelly
Overwash : nil
Surface runoff : rapid
Surface sealing/crusting/cracking : slight crusting
Drainage class : somewhat excessively drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : many termite sheetings on bush vegetation
Expected rooting depth : shallow

Horizons:

Bt	0 - 10 cm	Red (2.5 YR 4/6) when moist; sandy clay, slightly gravelly; moderate fine to medium subangular blocky structure; slightly hard, firm, sticky and slightly plastic; few thin clay skins; clear and smooth transition to
B+CR	10 - 45 cm	Red (2.5 YR 4/6) when moist; sandy clay, very gravelly to gravel; predominantly rock structure; sticky and plastic; continuous thin clay skins; gradual and broken transition to
CR	45 - 70 cm	Predominantly rotten rock.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 45

Field Observation No.: 122/4-112 Soil Classification: chromic LUVISOL

Lab. no. .../86	2189	2190
Horizon designation	Bt	B+CR
Depth (cm)	0-10	10-45

pH-H ₂ O (1:2.5)	6.8	6.6
pH-M KCl (1:2.5)	5.5	4.7
EC (mS/cm; 1:2.5)	0.05	0.06
C (%)	0.2	0.3
CEC cmol(+)/kg, pH 8.2	14.3	16.5
Exch. Ca cmol(+)/kg	5.3	5.5
,, Mg ,,	5.5	4.6
,, K ,,	0.4	0.1
,, Na ,,	0.3	0.2
Sum cations	11.5	10.4
Base sat. at pH 8.2	80	63
ESP at pH 8.2	2	1
Gravel % >2mm	?	?
Sand % 2-0.05mm	68	62
Silt % 50-2 um	8	8
Clay % <2 um	24	30
Texture class	SCL	SCL

FERTILITY ASPECTS (Composite sampe from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../86	2199

Ca cmol(+)/kg	4.8
Mg ,,	5.3
K ,,	0.4
Mn ,,	0.5
Exch. acid. ,,	<0.1
P ug/g	46
C %	0.1
N %	0.12
pH-H ₂ O (1:2.5)	6.7

CEC = 50 cmol(+)/ kg clay at:
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 46

Date/ season : 13/02/1986; dry season
Sheet-observation no : 122/4-113
Coordinates : 3854 E, 99635 N
Elevation : 495 m
Authors : J. Pulles
Soil mapping unit : UA/AB
Soil classification (FAO) : orthic LUVISOL
Geology : Basement System
Local petrography/ parent material : subrecent alluvial sandy deposits
Physiography : Uplands
Macro-relief : flat to gently undulating
Slope (length, shape, pattern) : 50 m, convex, regular
Slope gradient : very gently sloping (1%)
Position on slope : upper slope
Meso- and micro-relief : nil
Vegetation/ Landuse : shifting cultivation of millet;
extensive grazing
Erosion : very slight sheet erosion
Rock outcrops : nil
Surface stoniness : in places slightly gravelly
Overwash : nil
Surface runoff : slow
Surface sealing/crusting/cracking : nil
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : nil
Expected rooting depth : very deep

Horizons:

Ah	0 - 20 cm	Dark brown (7.5 YR 3/4) when moist; sand; weak medium subangular blocky structure; soft, loose, non sticky and non plastic; no cutans; few medium, few fine, few very fine pores; gradual and smooth transition to
AB	20 - 40 cm	Dark brown to brown (7.5 YR 4/2) when moist; sand; weak medium subangular blocky structure; soft to slightly hard, loose, non sticky and non plastic; few medium, few fine, few very fine pores; clear and smooth transition to
Bt	40 - 130 cm	Dark brown to brown (7.5 YR 4/2) when moist; loamy sand; porous massive structure, strongly coherent; hard, very friable, slightly sticky and non plastic; oriented clay bridges; few fine, frequent very fine pores.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 46

Field Observation No.: 122/4-113 Soil Classification: orthic LUVISOL

Lab. no. .../86	2191	2192	2193	2194
Horizon designation	Ah	AB	Bt1	Bt2
Depth (cm)	0-20	20-40	40-80	80-130
pH-H ₂ O (1:2.5)	6.9	6.8	6.7	6.7
pH-M KCl (1:2.5)	5.7	5.5	4.9	5.0
EC (mS/cm; 1:2.5)	0.04	0.04	0.03	0.04
C (%)	0.3	0.2	0.2	0.2
CEC cmol(+)/kg, pH 8.2	4.2	6.1	8.6	9.6
Exch. Ca cmol(+)/kg	2.5	3.0	3.5	4.4
,, Mg ,,	1.0	1.7	2.3	2.3
,, K ,,	0.3	0.4	0.4	0.2
,, Na ,,	0.3	0.1	0.1	0.1
Sum cations	4.1	5.2	6.3	7.0
Base sat. at pH 8.2	98	85	73	73
ESP at pH 8.2	7	2	1	1
Gravel % >2mm	0	0	0	0
Sand % 2-0.05mm	80	78	70	68
Silt % 50-2 um	12	10	12	12
Clay % <2 um	8	12	18	20
Texture class	LS	SL	SL	SL/SCL

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../86	2200	2201
Ca cmol(+)/kg	3.2	3.6
Mg ,,	1.4	1.9
K ,,	0.5	0.4
Mn ,,	0.3	0.2
Exch. acid. ,,	<0.1	<0.1
P ug/g	225	226
C %	0.3	0.3
N %	0.10	0.07
pH-H ₂ O (1:2.5)	6.6	6.7

CEC = 35-70 cmol(+)/ kg clay, increases with depth

CEC = ca 500 ,, carbon

PROFILE DESCRIPTION 47

Date/ season : 12/02/1986; dry season
 Sheet-observation no : 122/4-114
 Coordinates : 3865 E, 99635 N
 Elevation : 740 m
 Authors : J. Pulles
 Soil mapping unit : UQ2/DE
 Soil classification (FAO) : orthic LUVISOL
 Geology : minor intrusives Basement System
 Local petrography/ parent material : granitoid gneisses
 Physiography : uplands
 Macro-relief : rolling to hilly
 Slope (length, shape, pattern) : 200 m, convex, irregular
 Slope gradient : moderately steep (23%)
 Position on slope : upper slope
 Meso- and micro-relief : nil
 Vegetation/ Landuse : wooded bushland; charcoal exploitation; shifting cultivation of millet
 Erosion : severe sheet, slight rill erosion
 Rock outcrops : rocky
 Surface stoniness : gravelly, stony and bouldery; in places very bouldery
 Overwash : nil
 Surface runoff : rapid
 Surface sealing/crusting/cracking : slight thin crust
 Drainage class : somewhat excessively drained
 Flooding : nil
 Groundwater level (actual) : always deep
 Presence of salts/ alkali : nil
 Soilfauna influences : some biopores present
 Expected rooting depth : moderately deep

Horizons:

Ah	0 - 10 cm	Dark brown to brown (7.5 YR 4/2) when moist; sand, slightly gravelly; weak fine to medium subangular blocky structure; soft, very friable, non sticky and non plastic; no cutans; few fine, few very fine pores; gradual and smooth transition to
AB	10 - 20 cm	Dark brown (7.5 YR 3/4) when moist; sand, slightly gravelly; weak fine to medium subangular blocky structure; slightly hard, very friable, non sticky and non plastic; some clay bridging; few fine, few very fine pores; clear and wavy transition to
Bt	20 - 40 cm	Reddish brown (5 YR 4/4) when moist; sandy clay loam, slightly gravelly; weak fine to medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; patchy thin clay skins and clay bridging; few medium, few fine, few very fine pores; clear and wavy transition to
B+CR	40 - 60 cm	Reddish brown (5 YR 4/4) when moist; sandy

clay loam, very gravelly; predominantly rock structure; slightly hard, friable, slightly sticky and slightly plastic; patchy thin clay skins and bridging.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 47

Field Observation No.: 122/4-114 Soil Classification: orthic LUVISOL

Lab. no. .../86	2150	2151	2152	2153
Horizon designation	Ah	AB	Bt	B+CR
Depth (cm)	0-10	10-20	20-40	40-60
pH-H ₂ O (1:2.5)	6.8	6.4	6.1	6.3
pH-M KCl (1:2.5)	5.8	5.1	4.8	5.2
EC (mS/cm; 1:2.5)	0.04	0.03	0.03	0.05
C (%)	0.6	0.4	0.4	0.4
N (%)	0.07	0.06		
CEC cmol(+)/kg, pH 8.2	3.8	3.4	4.9	6.0
Exch. Ca cmol(+)/kg	1.7	1.0	1.8	2.2
,, Mg ,,	0.8	0.7	1.2	1.7
,, K ,,	0.5	0.4	0.2	0.1
,, Na ,,	0.1	0.1	0.1	0.1
Sum cations	3.1	2.2	3.3	4.1
Base sat. at pH 8.2	82	65	67	68
ESP at pH 8.2	3	3	2	2
Gravel % >2mm	?	?	?	?
Sand % 2-0.05mm	84	84	78	72
Silt % 50-2 um	7	7	5	7
Clay % <2 um	9	9	17	21
Texture class	LS	LS	SL	SCL

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20
Lab. no. .../86	2154
Ca cmol(+)/kg	1.5
Mg ,,	0.9
K ,,	0.2
Mn ,,	?
Exch. acid. ,,	<0.1
P ug/g	?
C %	0.4
N %	0.11
pH-H ₂ O (1:2.5)	6.5

CEC = 23 cmol(+)/kg clay
 CEC = 300 ,, carbon

PROFILE DESCRIPTION 48

Date/ season : 17/02/1986; dry season
Sheet-observation no : 122/4-115
Coordinates : 3865 E, 99640 N
Elevation : 480 m
Authors : J. Pulles
Soil mapping unit : PA1/A
Soil classification (FAO) : eutric Fluvisol
Geology : recent upper Tana deposits
Local petrography/ parent material : recent alluvial deposits
Physiography : floodplain
Macro-relief : flat
Slope (length, shape, pattern) : -
Slope gradient : flat (0%)
Position on slope : -
Meso- and micro-relief : nil
Vegetation/ Landuse : wooded grassland; extensive grazing; cropping of millet, maize, sugarcane, bananas and papaya
Erosion : nil
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : slow
Surface sealing/ crusting/cracking : nil
Drainage class : well drained
Flooding : flooded during long rainy season
Groundwater level (actual) : very deep
Presence of salts/ alkali : nil
Soilfauna influences : many biopores, termite burrows
Expected rooting depth : very deep

Horizons:

Ah1 0 - 40 cm Dark brown (7.5 YR 3/4) when moist; clay loam; weak fine to medium subangular blocky structure; soft, friable, slightly sticky and plastic; few medium, few to common fine, common to frequent very fine pores; sharp and smooth transition to

Ah2 40 - 65 cm Yellowish red (5 YR 5/6) when moist; loamy fine sand; weak fine to medium subangular blocky structure; soft, slightly friable, slightly sticky and slightly plastic; common fine, frequent very fine pores; sharp and smooth transition to

Ah3 65 - 80 cm See Ah1. Gradual and smooth transition to

Ah4 80 - 130 cm Dark brown (7.5 YR 3/4) when moist; sandy clay loam; weak coarse subangular blocky structure; soft, slightly friable, sticky and plastic; few fine, few medium, frequent very fine pores; sharp and smooth transition to

Bw 130 - 150 cm Reddish brown (5 YR 4/4) when moist; coarse sandy, gravelly (50%); structureless, porous massive, weakly coherent; slightly hard, very friable, non sticky and non plastic.

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 48

Field Observation No.: 122/4-115 Soil Classification: eutric FLUVISOL

Lab. no. .../86	2155	2156	2157	2158	2159
Horizon designation	Ah1	ah2	Ah2	Ah3	Bw
Depth (cm)	0-40	40-65	65-80	80-130	130-150
pH-H ₂ O (1:2.5)	6.3	7.2	7.1	7.1	7.5
pH-M KCl (1:2.5)	5.5	6.0	6.0	6.2	6.4
EC (mS/cm; 1:2.5)	0.08	0.08	0.11	0.12	0.05
C (%)	1.0	0.9	0.9	0.5	0.2
CEC cmol(+)/kg, pH 7.0	13.6	14.5	11.7	10.1	1.6
Exch. Ca cmol(+)/kg	7.4	8.3	6.6	6.4	1.0
,, Mg ,,	2.6	2.9	2.0	2.1	0.4
,, K ,,	0.5	0.4	0.3	0.5	0.1
,, Na ,,	0.2	0.2	0.2	0.2	0.1
Sum cations	10.7	11.8	9.1	9.2	1.6
Base sat. at pH 8.2	79	81	78	91	100
ESP at pH 8.2	1	1	2	2	6
Gravel % >2mm	0	0	0	5	52
Sand % 2-0.05mm	32	42	58	48	95
Silt % 50-2 um	37	27	17	21	1
Clay % <2 um	31	31	25	31	4
Texture class	CL	CL	SCL	SCL	S

FERTILITY ASPECTS (Composite sample from at least 5 locations)

Depth (cm)	0-20	40-60
Lab. no. .../86	2160	2161
Ca cmol(+)/kg	5.7	5.5
Mg ,,	2.4	2.2
K ,,	0.6	0.5
Mn ,,	n.d.	n.d.
Exch. acid. ,,	<0.1	<0.1
P ug/g	n.d.	n.d.
C %	0.6	0.6
N %	0.12	n.d.
pH-H ₂ O (1:2.5)	7.2	7.4

CEC = 28 cmol(+)/ kg clay
 CEC = 500 ,, carbon

PROFILE DESCRIPTION 49

Date/ season : 03/12/85; rainy season
Sheet-observation no : 122/4-92
Coordinates : 3743 E, 99494 N
Elevation : 715 m
Authors : John Pulles
Soil mapping unit : UFEs, UUs
Soil classification (FAO) : luvic PHAEZEM
Geology : Basement System
Local petrography (parent material) : gneisses rich in ferro-magnesian minerals
Physiography : Uplands
Macro-relief : undulating
Slope (length, shape and pattern) : 150 m, convex, regular
Slope gradient : 1 %
Position on slope : summit
Meso- and micro-relief : nil
Vegetation/ Landuse : shifting cultivation, recently cultivated
Erosion : none to very slight
Rock outcrops : nil
Surface stoniness : nil
Overwash : nil
Surface runoff : medium
Surface sealing/crusting/cracking : slight thin crust
Drainage class : well drained
Flooding : nil
Groundwater level (actual) : always deep
Presence of salts/ alkali : nil
Soilfauna influences : moderate; krotovinas
Expected rooting depth : very deep

Horizons:

Ah 0-20 cm Dark reddish brown (5 YR 3/3) when moist; sandy loam; weak fine subangular blocky structure, few crumb; very friable when moist, slightly sticky and slightly plastic when wet; very few medium, few fine and common very fine pores; gradual and smooth transition to:

Bt 20-80 cm Dark reddish brown (2.5 YR 3/4) when moist; slightly gravelly clay loam; moderate fine to medium angular to subangular blocky structure; friable when moist, slightly sticky and slightly plastic when wet; broken thin clayskins; few fine, common very fine pores; clear and wavy transition to:

B+CR 80-100 cm Rotten rock structure dominant; soil in-between reacts with HCl (darker gneiss.)

LABORATORY DATA OF PROFILE DESCRIPTION NO.: 49

Field observation No.: 122/4-92 Soil Classification: luvic PHAEOZEM

Laboratory number /86	580	581	582
Horizon designation	Ah	Bt	B+CR
Depth, cm	0-20	20-50	50-80
pH-H ₂ O (1:2.5)	7.6	7.4	8.0
pH-M KCl (1:2.5)	6.6	6.4	6.9
EC mS/cm (1:2.5)	0.05	0.07	0.13
C%	0.4	0.2	0.1
CEC cmol(+)/kg, pH 8.2	14.1	18.3	19.3
exchang. Ca cmol(+)/kg	7.2	10.3	13.6
,, Mg ,,	2.7	4.4	4.7
,, K ,,	0.3	0.1	0.1
,, Na ,,	0.1	0.2	0.2
Sum cations	12.3	15.0	18.6
Base sat. at pH 8.2	87	82	96
ESP	1	1	1
Sand%	66	60	56
Silt%	12	12	14
Clay%	22	28	30
Texture class	SCL	SCL	SCL

CEC = 60 cmol(+)/kg clay

CEC = 500 ,, carbon

APPENDIX C

THIRD APPROXIMATION FOR RATING OF LAND QUALITIES

The rating of land qualities has been done according to the "proposal for 3rd Approximation for Rating of Land qualities" (A. Weeda, 1985). The water availability is not yet developed in this approximation. So this rating will be done according to the 2nd Approximation (Braun and van de Weg, 1977)

Availability of water

The availability of water is thought to be dependent of the climate or ecological zone (climate characteristics) and the moisture storage capacity of the soil (soil characteristics).

The climatic factor is the ratio between the annual precipitation (r) and the annual average evapotranspiration (E_o). With this ratio an estimation can be made of the amount of days per year with full moisture, according to:

$$\text{amount of days full moisture} = 365/0.8 \times r/E_o.$$

Sombroek et al. (1982) distinguish 7 agro-ecological zones for moisture availability (see table 1.1). The need for a continuous moist period is not regarded here.

The soil factor consists of the total productive available moisture (TPAM in mm) and the hindrance to root development (effective soil depth, bulkdensity).

Because no reliable pF-data are available, the TPAM must be estimated from the table below, based on correlations graphically found between water and clay content.

Table 1. TPAM for different soil depths and textures.

depth (cm)	LS	T E SL	X	T SCL	U	R SC	E C
25 very shallow	8	10		14		20	28
50 shallow	15	20		28		40	55
80 mod. deep	24	32		44		64	88
120 deep	36	48		66		96	132
150 very deep	45	60		83		120	165
180 extr. deep	54	72		99		144	198

Table 2. Rating soil moisture storage capacity.

rating	description	TPAM (mm)
1	very high	160 - 200
2	high	120 - 160
3	moderate	80 - 120
4	low	40 - 80
5	very low	< 40

The final rating is to be adjusted when there is sufficient hindrance to root development. There is no adjustment in case of slight hindrance (an oxic, argillic or cambic horizon). The rating is downgraded with one class in case of moderate hindrance (a pronounced argillic horizon or pronounced sedimentary stratification), and with two classes in case of strong hindrance (planic horizon with abrupt textural change, natric horizon or impermeable layer).

Temperature

A distinction is made of nine temperature zones, each considered for the mean annual temperature, the mean maximum temp., the mean minimum temp. and the absolute minimum temp. Also the chance of night frost is taken into account.

A relation has been found by Braun (Sombroek et al., 1982) between the mean annual temperature and the altitude for the whole of Kenya. The equation is

$$T = 30.2 - 0.0065 * \text{altitude (m)}$$

Table 3. Temperature zones

temp. zone	mean ann.T	mean max.T	mean min.T	abs. min.T	chance frost
1	24-30	30-36	18-24	10-16	-
2	22-24	28-30	16-18	8-10	-
3	20-22	26-28	14-16	6-8	-
4	18-20	24-26	12-14	4-6	-
5	16-18	22-24	10-12	2-4	very rare
6	14-16	20-22	8-10	0-2	rare
7	12-14	18-20	6-8	-2-0	occasional
8	10-12	16-18	4-6	-4--2	common
9	<10	<16	<4	<-4	very common

Availability of nutrients

For the soil fertility several components are considered based on the analysis normally executed by the NAL for fertility purposes.

The components are:

1. cation exchange capacity (CEC in cmol(+)/kg soil)
2. organic C%
3. available P ($\mu\text{g/g}$ Mehlich/Olsen)
4. exchangeable K, Ca, Mg (cmol(+)/kg soil)
5. pH-H₂O (1:2.5)

The rating for organic carbon is related with the temperature zone because of the large influence of this zone on the formation and oxidation of organic matter.

The most limiting factor defines the rating. In case of presence of stones or gravel in the soil, the analysis data have to be corrected with the corresponding volume percentage. The final rating is determined by the topsoil, unless the subsoil (20-50 cm) differs more than one unit from the topsoil. In that case the rating is up/down graded with one class.

Table 4. Rating of availability of nutrients.

rating	CEC	%C in temperature zones			P($\mu\text{g/g}$)	
		1-3	4-6	7-9	Mehlich	Olsen
1 high	>16	>2.0	>2.5	>4.0	>60	>20
2 moderate	6-16	1.1-2.0	1.6-2.5	2.6-4.0	21-60	11-20
3 low	3-5	0.5-1.0	1.0-1.5	1.5-2.5	10-20	5-10
4 very low	<3	<0.5	<1.0	<1.5	<10	<5

rating	exch.K exch.Ca exch.Mg cmol(+)/kg			pH-H ₂ O (1:2.5)
	1 high	>0.50	>6.0	
2 moderate	0.21-0.50	3.0-6.0	1.1-3.0	4.6-5.5 , 7.3-8.0
3 low	0.10-0.20	1.0-2.9	0.5-1.0	4.0-4.5 , 8.1-9.0
4 very low	<0.10	<1.0	<0.5	<4.0 >9.0

Hindrance by salinity and/or alkalinity

Most limiting factor method.

Table 5. Salinity and Alkalinity rating criteria.

rating	highest value ECe at depth (cm)		highest value ESP at depth	
	0 - 30	30 - 120	0 - 30	30 - 120
1	< 2	< 4	< 6	< 6
2	2 - 4	4 - 8	6 - 10	6 - 15
3	4 - 8	8 - 15	10 - 15	15 - 40
4	8 - 15	15 - 30	15 - 40	> 40
5	> 15	> 30	> 40	> 40

Resistance to erosion

The rating for resistance to erosion consists of four factor ratings for climate, slope, soil and plant. The final rating is obtained by summation of the factor ratings. The climate factor is the rainfall erosivity. It is strongly related with the kinetic energy of 15 min. for rainfall intensities of over 25 mm/hr. There is also a relation with the agro-climatic zone. The slope factor combines slope class and slope length.

The soil factor is formed by four subratings, namely organic matter, bulk density, silt/clay ratio and flocculation index (topsoil characteristics). This factor rating is obtained by summation of the subratings.

The plant cover factor is determined by the average plant cover during the rainy seasons.

Table 6. Rating of resistance to erosion.

rating climate	KE ₁₅ >25				agro-climatic zone (KSS)		
1	< 5000				VI, VII		
2	5000 - 10000				III, IV, V		
3	> 10000				I, II		

rating slope	slope %						
slope length (m)	0-2	2-5	5-8	8-16	16-30	30-45	>45
< 50	1	1	3	3	5	5	7
50-100	1	3	3	5	5	7	7
100-200	1	3	5	5	7	7	9
>200	3	5	5	7	7	9	11

rating plant cover	plant cover %
1	> 70
2	50 - 70
4	20 - 49
7	< 20

rating	organic matter %OM	matter %C	bulkdensity g/cm ³	silt/clayratio hydrometermethod	floccul. index
1	>5	>3.0	<1.20	<0.20	>70
2	2-5	1.2-3.0	1.20-1.50	0.20-0.59	40-70
3	<2	<1.2	>1.50	0.60-1.00	10-39
4				>1.00	
6					<10

Table 7. Final rating "resistance to erosion".

rating	sum factor
1	< 11
2	11 - 15
3	16 - 20
4	> 20

Availability of oxygen for root growth

Table 8. Rating for oxygen availability

rating	soil drainage class
1 high	well to excessively drained
1 high	moderately well drained
2 moderate	imperfectly drained
3 low	poorly drained
4 very low	very poorly drained

Possibilities for land preparation

The possibilities for landpreparation through mechanization or use of other agricultural implements is dependent of five factors:

1. steepness of the slope
2. stoniness/rockiness
3. depth of the soil
4. workability of the soil
5. size and shape of the field

Each factor receives a subrating. The final rating for the possibility of mechanization is done for three types of farm power (hand, oxen and tractor) and is determined by the most limiting factor.

Table 9. Subrating for factors determining the possibilities for land preparation.

sub rating	slope %	stoniness/rockiness	soildepth cm	fieldsize/form length (m) width	
1	0-8	non	>50	>200	>100
2	8-16	fairly stony/rocky	25-50	50-200	50-100
3	16-30	stony/rocky	<25	<50	<50
4	30-70	very stony/rocky			
5	>70	exceedingly			

subrating workability	wet	consistency topsoil(0-25 cm)	moist	dry
1	non to slightly plastic/sticky	loose to friable	loose to sl.hard	
2		firm	hard	
3	very	extr.firm	very hard	

Table 10. Final rating for land preparation with hand (h), oxen (o) or tractor (t)

rating	steepness slope			stoniness rockiness			depth of soil			workability of soil			size&form of field		
	h	o	t	h	o	t	h	o	t	h	o	t	h	o	t
1	2	1	1	3	2	1	2	1	1	1	1	1	3	2	1
2	3	1	2	3	3	2	2	2	1	2	1	1	3	3	1
3	4	3	2	4	4	3	3	2	2	2	2	2	3	3	2
4	5	4	3	5	5	4	3	2	3	3	3	3	3	3	3
5	5	5	4	5	5	5	3	3	3	3	3	3	3	3	3

Hindrance of natural vegetation

The hindrance of natural vegetation is important for clearing of the land for agriculture, or for the accessibility by animals.

Table 11. Rating for natural vegetation

rating	physiognomic type
1	grassland (G) cultivated land, bushed wooded grassland (BWG), wooded grassland (WG)
2	bushland (B), wooded bushed grassland (WBG)
3	bushland (B), wooded bushland (WB), bushed woodland (BW), woodland (W)
4	dense bushland (Bd), dense wooded bushland (WBd), dense bushed woodland (BWd), dense woodland (Wd), bushland thicket Bt), wooded bushland thicket (WBt).

Hindrance of overgrazing

This rating is based on visual observations and estimates.

Table 12. Rating for overgrazing.

rating	% of optimal grass cover
1	> 50
2	20 - 50
3	0 - 20

APPENDIX D

SUITABILITY CLASSIFICATION

mapunit	maize	millet	sorghum	cowpeas	beans	cassava	cotton	coffee	tea
MFps/F	N	N	N	N	N	N	N	N	N
MGPS/EF	limited moisture storage and available nutrients, stoniness, high erosion risk							climate	
MUPs/DF	N	S3	N	N	N	N	N	N	N
HBst/E(F)	limited moisture storage and available nutrients, stoniness, high erosion risk							climate	
HBPT/E	N	N	N	N	N	N	N	N	N
HBPs/EF	limited moisture storage and available nutrients, stoniness, high erosion risk							climate	
HFpr/CD	N	S3	N	N	N	N	N	N	N
/DE	limited moisture storage and available nutrients, stoniness, high erosion risk							climate	
/E	erosion risk								
HFps/E	N	N	N	N	N	N	N	N	N
HGPs/EF	limited moisture storage and available nutrients, stoniness, high erosion risk							climate	
HQps/EF	N	S3	N	N	N	N	N	N	N
HQph/EF	limited moisture storage and available nutrients, stoniness, high erosion risk							climate	
HVCS/EF	N	N	N	N	N	S3	N	N	N
	limited moisture storage and available nutrients, stoniness, high erosion risk							climate	
LBar/A	S3	S2	S3	S3	S3	S3	N	N	N
LBas/AB	limited moisture storage and available nutrients							climate	
LVm/BC	N	N	N	N	N	N	N	N	N
LVm+r/AB	limited moisture storage and available nutrients							climate	
LVMp/AB									
LVr/AB	S3-N	S2-N	S2-N	S2-N	S2-N	S2	S2-N	N	N
/BC	Phosphorus deficiency							climate	
RiVhn/AB	S3-N	N	S3	S3	S3	S2	S2-S3	S2	S3
/AC	nutr	climate	pH	pH	pH	temp	nutr.	temp, nutr	nutr.
RiVhn/BD	N	N	S3	N	N	S3	N	S2	N-S3
/DF	nutr	climate	temp.	nutr.	nutr.	temp.	nutr.	nutr.	nutr.
RiVnl/AB	N	N	S3	N	S3-N	S3-N	N	N	S2
/AC	pH, nutr.	climate	temp, pH	pH	pH	temp.	temp.	temp, nutr	nutr.
/BD									
/DF									
RiVn2/AB	S3-N	N	S3	N	S3	S2-S3	S3-N	S2	S2-S3
/AC									
/BD	nut.	climate	pH	pH	pH	temp	nut.	temp, nutr	temp, nutr
/DF									

RiVCs/DF	S3-N	S2-S3	S3-N	S3-N	S3-N	S3	S3-N	N	N	
	moisture	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	
	nut.	nut,temp								
RaVhn/AC	S2-S3	N	S2-3	S2-3	S2-3	S2	S2-3	S2	N	
	nut.	moisture	pH	pH,nutr	pH,nutr.	temp.	nut.	temp,nut	climate	
RaVhn/EF	N	N	S3	N	N	S3	N	N	N	
	nutrient	moisture	temp.	nutrient	nutrient	temp.	moisture	climate	climate	
RaVn/EF	N	S2-N	S3	S2-3	S2-3	S2	S1-3	S3	N	
	nutrient	climate	erosion	Ca	climate	climate	climate	temp.	climate	
RaVCV/EF	S3-N	S2-N	S3	S2-3	S2-3	S2	S1-3	S3	N	
	stor.nutr	climate	erosion	climate	climate	climate	climate	temp.	climate	
FQps/D	N	S3	N	N	N	N	N	N	N	
FQst/BC	stor.nutr	moisture	moisture storage and limited nutrients						climate	climate
FQbs/CD										
AAar/A	N = non irrigated (limited moisture and limited nutrients)							N	N	
	S2= irrigated (limited nutrients or high salinity)							climate	climate	
BVr/AB	N	S2	S2	S2	S2	S2	S3	N	N	
	nutrients	nutrients	nutrients	nutrient	temp.	nutrients	nutrients	climate	climate	
BVg/AB	N	S2	S3	N	N	N	N	N	N	
	nutrients	oxygen	oxygen	nutrient	nutrient	nutrients	nutrients	climate	climate	
UAae/BC	N	S2-S3	N	N	N	S3	N	N	N	
	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	
	nut.	nut.								
UAa/AB	N	S3	S3	N	N	S3	S3-N	N	N	
/D	nut.	nut.	nut.	nut.	nut,temp	nut.	nut.	climate	climate	
UAap/B	N	S3	N	N	N	N	N	N	N	
	moist.nutr	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	
UBps/B	N	S2-S3	N	N	N	S3	N	N	N	
/BC			moisture storage						climate	climate
/CD										
UFar/AB	N	N	N	N	N	N	N	N	N	
	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	
	K,C	C,K	C,K	C,K	C,K		zone,C,K			
UFar/B(C)	N	S2-S3	S3	S3	S3	S3	N	N	N	
/CD	nut.	nut.	moisture	moisture	moisture	moisture	moisture	climate	climate	
			nut.	nut.	nut.					

UFb/C	N	S3	N	N	N	N	N	N	N	
UFea/AB	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	
UFer1/(A)B										
UFer1/BC										
UFer2/B										
UFes/BC	N	S2-S3	N	N	N	S3	N	N	N	
/C(D)	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	
UFpe/A(B)										
/BC										
/C(D)										
UFpr/CD	N	S3	N	N	N	N	N	N	N	
	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	
UFps/BC	N	S2-S3	N	N	N	S3	N	N	N	
UFpT/DE	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	
UFrt/AB	N	S2-S3	N	N	S3-N	S3	N	N	N	
/B	moisture	moisture	moisture	moisture	climate	moisture	moisture	climate	climate	
/BC										
/CD										
UFst/AC	S3-N	S2	S3-N	S3-N	N	S3	S3-N	N	N	
/CD	moisture	climate	moisture	moisture	climate	moisture	moisture	climate	climate	
UFch/AB	N	S2-S3	N	N	N	S3	N	N	N	
	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	
UFCEp/D	N	S3	N	N	N	N	N	N	N	
U(F+Q)CV/		moisture						climate	climate	
BD										
UPPT/AB								N	N	
UQPT/DE								climate and		
UQES/C(D)								nutrients		
UQet/DE	Unsuitable for all crops because of limited moisture storage									
UQPT/DE	(stoniness) and nutrients. Erosion hazard is still serious.									
UQpE/BC										
UQPe/AC										
/CD										
/EF										
UQps/BC										
/DE										
UUap/C	N	S2-3	N	N	N	S3	N	N	N	
	nutr.	moist,nutr	moisture	moisture	moisture	moisture	moisture	climate	climate	
UUES/BC	N	S2-S3	N	N	N	S3	N	N	N	
/CD	moisture	moisture	moisture	moisture	climate	climate	moisture	climate	climate	
/DE										
UUs/B	N	S3	N	N	N	N	N	N	N	
	storgae	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	

UUCE/B	N	S3	N	N	N	N	N	N	N	N
	moisture	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate
UVat/AB	N	S3	S3	S3	S3	S3	S3	N	N	N
	moisture	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate
UVh/B	N	S3	S3	S3	S3	S2-S3	S3	N	N	N
/CD	C,Ca	C,Ca	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate
			C,Ca	C,Ca	C,Ca	Ca,C	C,Ca			
UVhp/BC	N	S3	N	N	N	N	N	N	N	N
	moisture	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate
UVhr/B	S2	S3	S3	S3	S3	S2	S3	N	N	N
	moisture	C,Ca	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate
	C,Ca		C,Ca	C,Ca	C,Ca	Ca,C	C,Ca			
UVmp/C	S2	S1	S2	S2	S3	S2	S2	N	N	N
					moisture	moisture	moisture	climate	climate	
UVn/AB	N	S2	S2	S3	S2	S2	S3	N	N	N
/BD		(Ca)	climate	Ca	temp.,Ca	Ca	Ca	climate	climate	
UVnr/AB	S3	S2	S2-S3	S2	S2	S2	S2	S2-S3	N	N
	nut.	temp	pH	nutr,pH	nutr,pH	nutr.	nutr.	climate	climate	
UVpr/AB	N	S2-S3	N	N	N	S3	N	N	N	N
	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	
UVr/AB	S3	S2	S3	S3	S3	S2	S3	N	N	N
/B(C)	moisture	C,Ca	moisture	moisture	moisture	moisture	moisture	climate	climate	
UVst/(A)B	N	S2	N	N	N	S3-N	N	N	N	N
/BC	storage	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	
/C(D)										
UVCs/CD	S3	S2	S2-S3	S2	S2	S2	S2	S3-N	N	N
	moisture	climate	pH	nutr,pH	nutr,pH	nutrients	nutrient	moisture	climate	
	nutrient									
PA1/A	S2-S3	S2	S2	S2	N	S2	S3	N	N	N
	nutrient	nutrient	nutrient	nutrient	nutrient	nutrients	moisture	climate	climate	
PA2/A	N	S3	N	N	N	N	N	N	N	N
	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	
PAd/AB	N	S3	S3	S3	S3	S3	N	N	N	N
	pH	pH	pH	pH	pH	moisture	pH	climate	climate	
PAp/AB	N	S2-S3	N	N	N	S3	N	N	N	N
PVat/AB	moisture	moisture	moisture	moisture	moisture	moisture	moisture	climate	climate	