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(676.2)



REPUBLIC OF KENYA

MINISTRY OF AGRICULTURE—NATIONAL AGRICULTURAL LABORATORIES
KENYA SOIL SURVEY

SOILS OF TRANS NZOLA DISTRICT

by

W. Siderius and E.B. Njeru

No. 28 JULY 1976

SURVEYS: KENYA KEN

ACCESSION No.
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LOCATION
SURVEYS: KENYA KEN

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1 Introduction

The request for a soil survey of the Trans Nzoia District originated from the Senior Maize Agronomist of the National Agricultural Research Station at Kitale, Mr. P.K. Kusewa, and was subsequently carried out by members of the KSS within the frame-work of a training programme for TAs.

The area was visited from 29 March to the 3rd of April 1976 and information was gathered at broad reconnaissance level. Emphasis was put on the southern and western part of the District as the Eastern region is fully covered by the Reconnaissance Soil Survey of the Kapenguria area (sheet 75, 1:100.000 reference no. 7).

The accompanying soil map in this report should enable research officers to select different sites for experiments, whose purpose the requests for the survey was originally formulated. It is however advisable that more detailed soil examination be carried out once the sites have been selected for agronomic experiments or other uses.

2. Acknowledgement

A number of Technical Assistants collaborated with two senior staff of the KSS during the execution of the survey. They are the following: R.G. Muriuki, S.K.N. Mwangi, S. Nyamori, B.G.M. Mwangi, H.M. Onyono, D.N. Gathui and J.S. Wataka. Their co-operation is warmly appreciated.

3. Physiography

3.1. Location and Communications

The boundary of the survey area coincides with that of the District, except for the western region where the boundary of the Mt. Elgon Natural Park and the Forest Reserve are taken. The area as such is part of Rift Valley Province and comprises 206270..ha (515675. acres) which is ^{54.2}.% of the District.

The natural boundaries are the Cherangani Hills in the East, the Nzoia River in the South and the Mt. Elgon area in the West, while the watershed with the Lake Turkana drainage area forms part of the boundary in the North. The area falls within longitudes $34^{\circ} 34'E$ and $34^{\circ} 21'E$; and latitudes $00^{\circ} 48'N$ and $01^{\circ} 16'N$.

Communications are good by road, rail and air to Kitale from where a dense network of roads and tracks reach the farthest corners of the District. Main centres of population are Kitale (the District capital), Endebess, Kiminini and Cherangani. Most of the District's population, approximately 138.000, however live spread over the countryside; town and village populations make up roughly 10% of the total. The original people of the area, the Pokot, have faced a growing number of settlers from other parts of the Republic, notably the Kikuyu and the Abaluhya people. This change was partly brought about by the availability of land after the decolonization of large farms (Ref. No. 14)

3.2. Geology and Parent Materials

Detailed information on the hard geology of the region may be extracted from a number of Geological Reports published by the Geological Survey viz.: Searle, 1952 (no. 19), Miller, 1956 (no. 35), Gibson, 1954 (no. 26), Sanders, 1963 (no. 64). The following formations may be recognized (see Fig. 1):

- Tertiary (P): Mt. Elgon volcanic rocks; lower and middle Pyroclastic series; agglomerates, breccias and tuff
- " (B): lower lava series; melane-nephelinite
- Pre-Cambrium-Basement System Rocks
- Archaean (F): banded microcline augen-gneiss with granite sheet and vein reticulation
- " (N): quartz-feldspatic para-gneisses and biotite para-gneisses with thin hornblende para-gneisses
- " (U): microcline-oligoclase-biotite-hornblende-migmatites with granite sheet and vein reticulation

Exposures of volcanic rock are common in the Mt. Elgon area while Basement System Rock outcrops are a regular sight in the Cherangani Hills. Rock exposure is often brought about by rivers cutting down into their streambeds. In view of the importance of the composition of the various rock types with regard the supply of (micro) nutrients, detailed information is given below. Within the volcanic rocks there exists considerable variation in composition, (Table 1), with regard to the acid extrusive rocks (trachyte) and the basic ones. However nephelinite is most extensive in the Mt. Elgon area. It is assumed that apart from differences in major elements, the variation and amount of minor elements of these rocks is not negligible.

fig.1

GEOLOGY AND ALTITUDE

34° 45' E

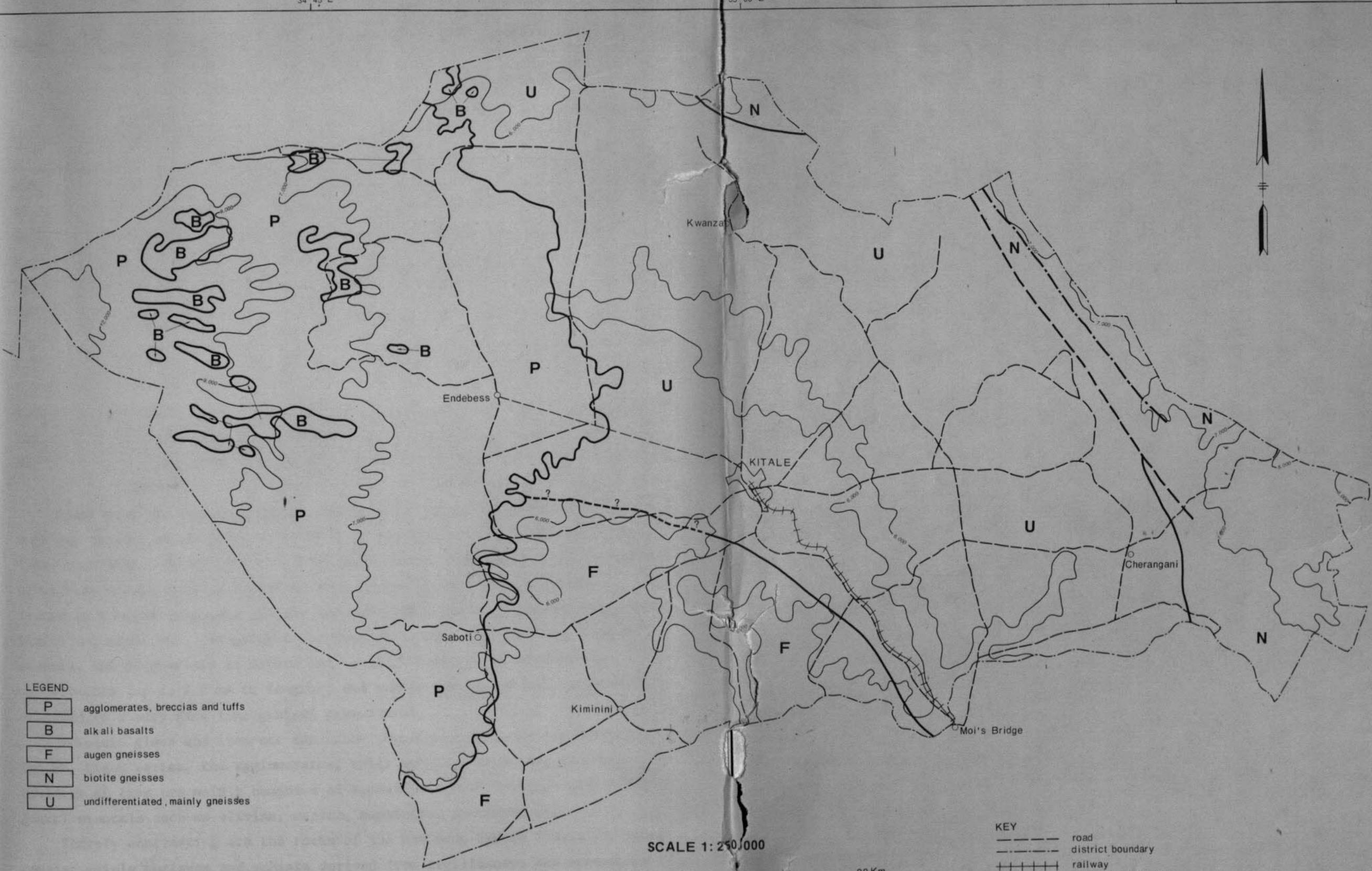
35° 00' E

35° 15' E

1° 15' N

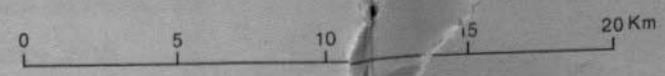
1° 00' N

0° 45' N



- LEGEND**
- P agglomerates, breccias and tuffs
 - B alkali basalts
 - F augen gneisses
 - N biotite gneisses
 - U undifferentiated, mainly gneisses

SCALE 1: 250,000



- KEY**
- road
 - district boundary
 - railway
 - contour lines in feet
 - village
 - geological boundary, not confirmed
 - major fault
 - quartzite ridges

Prepared and drawn by Kenya Soil Survey in August, 1976
Drawing No 76021

34° 45' E

35° 00' E

35° 15' E

Table 1. Chemical composition of some lavas of Elgon (according to Searle (1952); in weight percentages)

	olivine nephelinite	phonolite	trachyte	nephelinite
	1	2	3	4
SiO ₂	41.69	48.40,	64.30	44.08
Al ₂ O ₃	5.77	19.56	19.48	10.07
Fe ₂ O ₃	8.38	4.11	0.19	8.85
FeO	5.60	3.64	0.21	3.37
MgO	12.26	1.44	0.13	7.97
CaO	17.97	5.09	0.36	14.31
Na ₂ O	1.24	6.48	6.40	3.17
K ₂ O	0.96	6.52	7.72	2.10
H ₂ O ±	2.94	3.75	0.76	3.79
P ₂ O ₅	0.59	0.17	0.18	0.96
TiO ₂	2.74	1.14	0.48	1.49
MnO	<u>0.33</u>	<u>0.10</u>	<u>0.03</u>	<u>0.36</u>
	100.47	100.31	100.19	100.51

Apart from the trachyte (no.3), which is an "intermediate" rock, the other ones are classified as basic to Ultra basic on the basis of their low SiO₂ (less than 54%). Except for Si and Al as building elements in rock formation other base metals such as Fe and Mg are present in addition to calcium. The latter is a major component in the nephelinites. Common minerals are olivine, augite and nepheline. In general the texture of the lavas is fine; larger crystals are porphyritic in nature and usually consists of porphyritic nephelinites (up to 2.2 mm in length), and augite (up to 2.8 mm), generally embedded in a very dark fine grained ground-mass.

Volcanic glass and iron-ore are other components commonly encountered. Of the the Mt. Elgon series, the agglomerates, tuffs and lava bands are dominant. The boulders of lava are mainly composed of nephelinite that contains many mafic (dark) minerals such as olivine, augite, magnetite, pyroxenes etc.

Sharply contrasting are the rocks of the Basement System (Table 2), which consist mainly of gneisses and schists derived from argillaceous and arenaceous sediments. These were transformed by dynamo-thermal metamorphism, and recrystallization took place into quartz and feldspar rich rocks with much biotite, hornblende and garnet.

In Table 2 the elemental composition of some Basement System rocks is given.

Table 2. Chemical composition of some Basement System Rocks in weight percentages (according to Sanders, 1964)

	<u>gneissose granite</u>	<u>gneissose granodiorite</u>	<u>migmatitic granodiorite</u>
SiO ₂	72.34	67.76	68.95
Al ₂ O ₃	14.73	15.77	15.44
Na ₂ O	2.94	4.06	5.18
K ₂ O	5.54	4.98	1.82

All these rocks are classified as acid, because they contain more than 65% silica. The mineralogical composition of these rocks and some other common Basement System rocks is given in Table 3.

Table 3. Micrometric analyses in volumetric percentages of some common rocks of the Basement system (Sanders, 1964 and Shackelton, 1946)

	<u>gneissose granite</u>	<u>gneissose granodiorite</u>	<u>migmatitic granodiorite</u>	<u>biotite gneiss</u>
quartz	32.4	28.8	38.6	30
microcline	36.3	28.5	9.2	25
plagioclase	27.1	36.7	44.9	30
biotite	3.9	4.4	6.6	10
muscovite	0.2	0.2	0.2	
apatite	-	0.1	0.3	
chlorite	0.1	-	0.2	
ore	-	0.3	-	

	<u>biotite garnet gneisses</u>	<u>hornblende gneisses</u>	<u>biotite hornblende gneisses</u>
quartz	30	20	10
oligoclase	15	44	41
orthoclase	30	-	-
microcline	10	-	-
garnet	5	-	-
biotite	10	-	20
hornblende	-	30	22
epidote	-	3	3
apatite	-	2	1
staurolite	-	1	-
sphene	-	-	3

The sub-divisions of the geology as shown on Figure 1 and mentioned at the beginning of this chapter are mainly based on the various percentages of biotite hornblende and feldspars present.

The weathering products of the named rocks form the parent material for most of the soils developed in the District, which are mainly mineral soils. Organic soil material does however occur in Ecological Zones I and II (see chapter 3.4) and also in the zones III and IV where it is encountered in the bottomlands called peat. Due to a relatively high amount of Fe-bearing minerals in the soil material, reddish colours are dominant in well drained soils. In poorly drained areas dark colours are common partly caused by anaerobic conditions and partly by the presence of much organic matter, causing dark humus coatings on soil particles and aggregates.

Textural differences of soils derived from the two basic differing sources of parent material are evident in the sand and silt fraction. Rocks of the Basement System tend to have lower silt fractions but have higher sand fractions than those soils developed on volcanic material. Accumulation of carbonates as well as sodium in the soils is possible (see Tables 1 and 2). Soils developed on basic rocks are likely to have a higher pH and higher base saturation. Although data on trace elements is scarce, it is assumed that the above indicated differentiation in rock source plays a vital role.

The supply of major plant nutrients such as N, P, K, Ca may be satisfactorily fulfilled, except for N. Parent materials rich in iron and/or calcium could induce phosphorus fixation thus causing a limited availability of this element for plant growth.

3.3 Topography and Land forms

On the basis of altitude the following regions are distinguished (see also Fig. 1):

- over 8000 ft: Mt. Elgon area proper, Kapcherop, isolated hills in the Cherangani,
- 7000-8000 ft: Mt. Elgon lower slopes, Cherangani Hills
- 6000-7000 ft: majority of the Kitale "plains"
- lower 6000ft: Kiminini area and some of the major valleys and bottomlands

The topography is hilly over 7000 ft where rivers have caused steep slope gradients due to deep incisions. However the larger part of the District has subdued topography where "plains" are repeatedly divided by river valleys, thus causing soils to occur in some kind of ^{topo}sequence. On the soil legend the geomorphology is used as a first key to the sub-division of the units.

The following landforms are recognized:

- M : mountains and major scarps
- H : hills and minor scarps
- L : plateaus
- F : footslopes
- U : uplands, dissected peneplains at various levels
- A : river terraces and floodplains
- V : minor valleys and bottomlands

Apart from overall differences in altitude the unit M has a relief intensity of more than 300 m while this value is less than 300m for unit H. The footslope areas are confined to the Mt. Elgon region where they occur in association with scarps, hills and ridges.

Slopes are commonly 2.7%. The plateaus are also confined to the southern part of the Mt. Elgon area, which seem to be mainly of tectonic origin, occur at an altitude of about 1970m ^{and} are usually gently sloping to the East. Slopes are from 1.8 - 6%; commonly 3-4%.

Of special interest are the uplands, often referred to as pre-Miocene erosion levels (Scott et al, 1971) ^{which} occur at various altitudes and cover the largest part of the geomorphological units. The following subdivision is used (see also Gelens et al. 1976):

- a) Kapenguria level at about 2300 m, rolling to hilly, confined to the extreme East of the District.
- b) Kitale level at 1900-1920 m, with very gently undulating to undulating topography, believed to be part of a Pre-Miocene peneplain, in the Endebess area found at 1860 m;
- c) Kiminini level at 1800 m, occurring in the south-western part of the district and with similar topography as the Kitale level, however believed to be developed on different parent rock;
- d) undifferentiated level encountered in the extreme north of the District at an altitude of around 1900 m, but dropping sharply to the North towards the West Suk lowlands.

Slope gradients on the often broad interfluves of the plains depend on the direction in which they are measured. Lengthwise slopes are usually 1-2.5% to 2-4%, measured across they may vary from 2.5- 8% but range usually from 2-4.5%. The steeper sloping areas are often associated with the river valleys. The valley bottom is however flat to very gently undulating.

The river terraces and bottomlands occur along the major rivers such as the Suam in the north-western part and along the Koitobos and some of its tributaries.

As the term indicates, this landform includes the minor valleys proper as well as the broad flat bottomlands that are so characteristic for the area northwest of Kitale. The latter are often subject to flooding and water tends to pond for a considerable time because of poor drainage and little gradient.

3.4 Climate, Vegetation and Ecological Zones

For the mountaneous and hilly areas the climate is described as equatorial (zone 2, according to ref. no. 10), humid to dry sub-humid, with a moisture index (P/Eo) not less than 10.

The majority of the area however falls into class 3, referred to as dry sub-humid to semi-arid climate, with a moisture index of 10-30.

For this area the climatic records from Kitale are taken as representative (Table 4). The combined data of rainfall (P), temperature (T) and potential evaporation (Eo) are illustrated in Fig. 2 (Ref. no. 5).

The departures from these data for other zones than zone 3 is also illustrated in Fig. 3.

Table 5. Climatic data for Kitale

	J	F	M	A	M	J	J	A	S	O	N	D	Year	
	24	42	88	151	157	108	139	165	97	102	73	45	1191	P
	27.1	27.1	26.2	25.2	24.6	24.0	22.9	23.5	24.4	24.8	24.4	25.8	25.0	Tmax
	10.4	11.8	12.1	12.8	12.7	11.3	11.8	11.3	10.7	11.4	11.2	10.0	11.5	Tmin
	18.8	19.2	19.2	18.5	18.7	17.7	17.4	17.4	17.6	17.6	17.8	17.9	18.3	Tm
	18.7	19.1	19.4	19.3	18.7	17.7	17.2	17.3	17.7	18.3	18.0	18.1	18.0	T-W
	171	167	170	143	148	128	126	135	147	166	152	159	1812	Eo

Remarks:

P: mean monthly rainfall in mm; period 1947-1970

Tmean: mean monthly air temperature in °C; period 1966-1970

Tmax: maximum mean monthly air temperatures in °C; same period

Tmin: minimum " " " " " " " "

T-W : mean monthly air temperature according to Woodhead; 1947-1962 & 1966

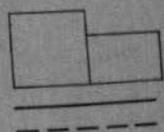
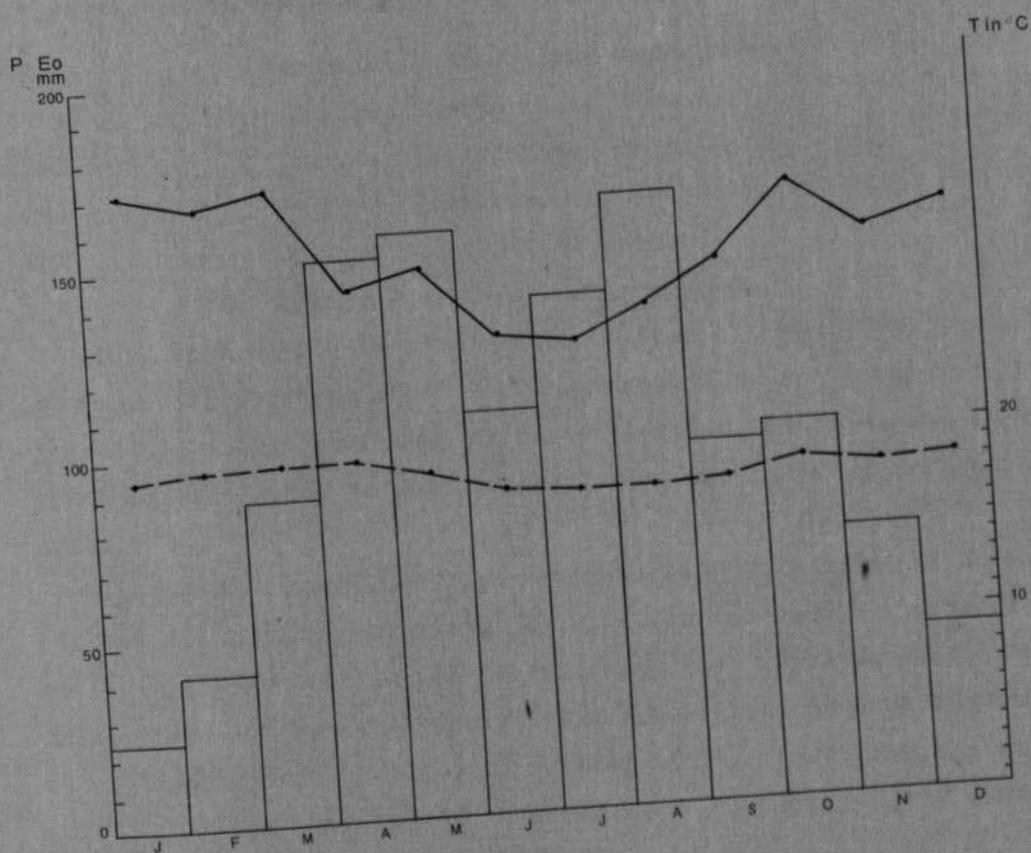
Eo : mean monthly potential evaporation according to Woodhead; same period.

Station particulars

number: 88.35/024, Kitale airfield, latitude 1°00'N, longitude 35°00'E, altitude 1896 m.

Climate Data Kitale

Fig. 2



mean monthly rainfall in mm (P)
 mean monthly evaporation in mm (Eo)
 mean monthly air temperature in °C (T)

Prepared and drawn by Kenya Soil Survey in August, 1976
 Drawing No. 76022a

According to the USDA "Soil Taxonomy" the soil moisture regime is classified as Ustic⁽¹⁾, while the soil temperature regime is Isothermic.⁽²⁾ As is also indicated in Ref. No. 14 there is considerable deviation from the Kitale data going northwards and towards the higher lying areas in the West and East of the District. To the North rainfall decreases by about 200 mm per annum, while the latter areas may receive 100 mm more than the yearly average for Kitale. December, January and February are commonly fairly dry, while April/May and July/August receive maximum amounts of rainfall as seen from long term records and illustrated in Fig. 2. The rainfall distribution is such that one crop can be planted and harvested during one year. Variations in the duration of crop maturity are mainly due to differences in air (soil) temperature, in that for the higher areas this period is considerably prolonged (see also Ref. No. 7, for detailed information).

On the vegetation map of western Kenya sheet 1 (DOS 1969) the following information is relevant, see Fig. 3.

- H1 : Mountain Moorland and Heath Zones
- BF1 : Mountain Bamboo Forest Zones
- MS1 & MS2 : Montane Scalerrophyl Forest Zones (3)
- WS1 & WS2 : Western Combretum Savannah Zones (4)
- WM2 : Western Moist Forest Zones
- UB1 : Upland Evergreen Bushland Zones

This description is more elaborate than the one given in the National Atlas of Kenya (1970) where the following vegetations are described: a) Wooded grasslands which cover most of the peneplains, while on the b) mountaneous areas forests occur as well as dwarf shrub grassland (moorland) in the highest areas.

The present conditions are somewhat different from the above descriptions. Most of the natural vegetation in the District except the gazetted forest areas on the Mt. Elgon and in the Cherangani Hills; has been cleared to make way for cultivation. However, especially in the eastern part of the District, there is a tendency for uncontrolled cutting of the forest for the cultivation of maize. Although good yields are obtained during the first two or three years,

(1) Ustic: Limited moisture, but present at a time (season) when (soil) conditions are suitable for plant growth

(2) Isothermic: mean annual soil temperature at 50 cm depth is 15°C or higher but lower than 22°C; difference between mean summer and winter temperatures is less than 5°C.

(3) MS1—is composed of montane Acacia vegetation of probable forest origin and montane Scherophyl forest with Pedocarpus milanjanus and mixed Podo. MS2—consists mainly of montane Acacia vegetation with broad leaved savanna types of probable forest origin.10

without the necessary soil conservation measures the land falls prey to erosion and depletion of soil nutrients thereby resulting in serious damage of the water divide area and causing everlasting damage to the waterbalance of the region.

The results of the interacting climate and vegetation led to the formation of certain zones, which are also defined as ecological zones or climatic zones or even clima-ecological zones. Their recognition is based on the ratio of rainfall to potential evaporation (P/E_o), the temperature, altitude and vegetation. The text below is summarised in Table 6 and Fig. 5.

The following zones are described, they coincide approximately with the vegetation zones (fig. 4):

Ecological Zone I - Afro-Alpine Climate

Mountain Moorland and Heath Zones, largely undifferentiated, with high mountain shrubs, also referred to as "Highland Rain Forest" by Barnes (1955).

Ecological Zone IIc - Cold Equatorial Climate

In the Mt. Elgon region bamboo forests are common. In the lower areas of Mt. Elgon the vegetation is similar to the one described for the south-eastern part of the Cherangani Hills: montane sclerophyl forest commonly occurs with montane Acacia vegetation derived from this forest and with *Podocarpus gracilior* and mixed Podo types.

Ecological Zone IIw - Warm Equatorial Climate

Dominant trees are *Acacia lahai*, with *A. abessinica* and *Digitaria Scalarum* but much of the forests has been cleared.

Ecological Zone III - Dry Sub-humid to Semi-arid

This zone occurs most extensively in the District and covers most of the central and southern area. Most of the original vegetation has been cleared for cultivation. However, dominant natural physiognomic types include Moist Combretum Woodland and allied vegetation on the higher ground in association with Upland evergreen bushland types. The common Combretum species is *C. molle*; it occurs often with *Farea* spp. and *Terminalia mollis*. *Hyparrhenia* grass is common as ground cover.

Ecological Zone IV - Semi-Arid

This zone is evident in the northern part of the District. Dry Combretum Woodland with allied vegetation is dominant. Common trees are *C. molle*, *Terminalia brownii* and *A. nilotica*.

Within zone III a large area occurs with soils of poor drainage. In the western part of this area *A. gerrardii* is common in association with vlel and drainage-line type vegetation with evergreen clump grass or undifferentiated vlel grassland, the latter dominant in the eastern part.

- (4)
- WS1: dry forms of woodland and savanna
 - WS2: wood/bushland, broad-leaved, wooded grassland.

Table 6. Particulars of the Ecological Zones for the Trans Nzoia District ⁽¹⁾

	P in mm	Eo in mm	P/Eo ratio	altitude in meters	vegetation	T in gr. C	frost occurrence
ae	1200-1400	1200-1400	85-120	3000-3350	moorland or bamboo	6-9	common
ic	1200-1400	1400-1600	75-100	2400-3000	cedar forest or bamboo	9-13	occasional
lw	1200-1600	1600-1800	67-100	1850-2400	moist forest	13-17	very rare
li	1000-1200	1800-1900	53-66	1750-2200	moist savannah	15-18	absent
	700-1000	1900-2100	38-52	1150-2000	dry savannah	16-22	absent

(1) adapted and extended from Gelens et al. (1976)

The above indicates that not only farm management practices but also the location of experimental sites should be related to the variation in environmental conditions when conducting management and crop research.

3.5. Hydrology

Two main drainage basins are distinguished, the Lake Victoria one and the Lake Turkana one. The former is fed by the Nzoia river and its tributaries of which the most important one is the Koitobos. Although most of these streams carry water the whole year around occasionally they may dry up for a short time of the year. This is apparently not the case for the Suam river which downstream is also called the Turkwell and which at least near its source at Mt. Elgon, has continuous flow. The water divide between these two drainage systems is formed by the boundary between unit U7 and unit U4 in the northern part of the District and by the Cherangani Hills in the eastern part. Barnes supplies the following flow data on some of the rivers of the Nile catchment area:

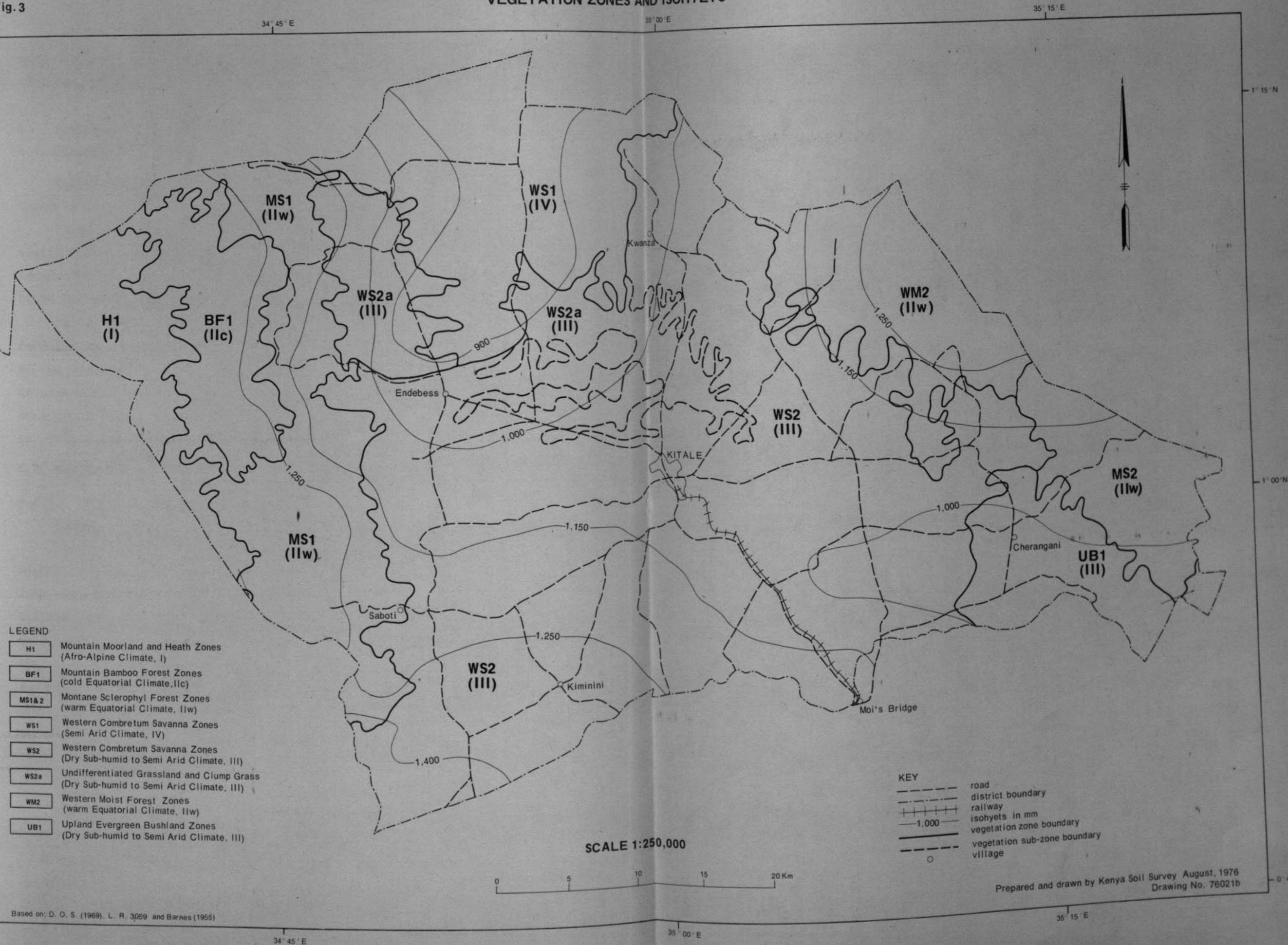
average annual streamflow (1950-1955)

Koitobos	12.00 cusecs
Fongai	6.63 "
Noigamaget	25.40 "
Nzoia	21.00 "

Numerous dams have been built in the District for the storage of water for human and animal consumption. This practice gains importance in the drier northern part where stockdams are a necessity to keep livestock. A detailed hydrological survey may provide more data on the availability of water for irrigation for example in the footslopes / ^{area} of Mt. Elgon and Cherangani Hills. Pollution of some of the streams, especially near centres of population is already evident and should be safeguarded against as much as possible by local councils and the water authorities.

Fig. 3

VEGETATION ZONES AND ISOHYETS



Based on: D. O. S. (1969), L. R. 3059 and Barnes (1955)

3.8 Conclusions

On basis of the above it is evident that geology, climate and ecology must be taken into account to make optimum use of the soils that are here-in described in the next chapter.

4. Description of the Soil Mapping Units

4.1. General

Delineation of the various units was largely based on elaborate photo-interpretation of aerial photographs at a scale 1:50,000.

Field work was subsequently carried out to check the various units and to verify the soil boundaries conceived from the first photo interpretation. Soil boundaries as existing on the Kapenguria Reconnaissance Soil Map at scale 1:100,000 were copied without further checking.

The 1:50,000 soil field maps were then reduced to 1:100,000 and compiled to form the accompanying map in this report. The legend provides a short description of the major soils in the map units. In the paragraphs below this description is elaborated while full profile descriptions of the various soils and laboratory data may be found in the Appendix, if indicated, and on the attached soil map at scale 1:100,000.

4.2. Map Unit Description

4.2.1. Soils of the Mountains and Major Scarps

Map Unit: MPh

Area: 3990 ha

This unit is restricted to the Mt. Elgon area where it is encountered at high altitude and in dissected topography. The major soil is a well drained, deep, dark red, friable clay that has an appreciable amount of organic matter in the surface horizon, giving rise to a humic topsoil. Soils of this kind are commonly developed on the Pyroclastic rocks of the Tertiary Mt. Elgon volcanics. They may be associated with shallower depth phases of the said soil and/or with rock outcrops. Under the prevailing environmental conditions they support tea plantations, but also maize and occasional potatoes. Full profile description and fertility data are presented in the Appendix (88/2-4).

4.2.2. Soils of the Hills and Minor Scarps

Map Unit: HGh1

Area: .270...ha

These soils occur in the extreme/^{east} of the District in the Cherangani Hills area, but to a very limited extent. Because of cool, moist conditions an accumulation of organic matter is reported, resulting in an acid, humic topsoil of 20-40 cm thickness. This horizon overlies a well drained, moderately deep to deep, dark reddish brown, friable sandy clay to clay. For a full description and analytical data one is referred to Gelens et al (1976).

Area:....2610....ha

Map Unit: HGh2

Soils of this unit are also confined to the Cherangani Hills where they are encountered in an elongated stretch. The non acid, humic topsoil is more pronounced than in unit HGh1, but the subsoil is comparable. Included in this map unit are moderately deep and shallow phases, the latter occasionally associated with rock outcrops. Detailed description of this unit can be found in the Kapanguria report (Ref. no. 7).

Area:....11810.....ha

Map Unit: HPh

Soils in this unit are developed from Pyroclastic volcanic rocks of the Mt. Elgon area, that may be ashes, tuffs and agglomerates. They are commonly encountered on the lower slopes of the mountain under varying slope conditions but with relief intensities of 100-300m, and are often associated with colluvium. The soils on the whole are well drained, deep, dark reddish brown, friable and of a silty loam to silty clay loam texture and have an organic topsoil of 20-40cm thick. In this unit are also incorporated shallower phases of the described soils as well as rock outcrops. A full description and fertility data is given in the Appendix (profile 74/3-2).

4.2.3. Soils of the Plateaus

Area:....3120.....ha

Map Unit: LBh

This unit is only encountered in the Mt. Elgon area where soils developed on the nephelinite at an altitude ranging from 2000-2300m on 2-6% slopes. The soils are well drained, deep to very deep, dark red to red, occasionally dark reddish brown and of a sandy clay texture. Enrichment of the topsoil with organic matter gives rise to a humic A horizon of 20-40 cm thick. At depth petroplinthite ("murrum") may be encountered (Scott et al., 1971).

4.2.4. Soils of the Footslopes

Area:....3030.....ha

Map Unit: FP

These soils occur on the footslopes of the Mt. Elgon and are mainly developed on colluvium derived from various volcanic rocks in the region, in sloping position. The major soil consists of a well drained, deep, dark brown to dark reddish brown, friable, sandy clay to clay. Their fertility is considered to be above average because of lateral nutrient supply from the nearby hills and ridges.

The topsoil is commonly very dark coloured, reflecting an accumulation of organic matter. A full profile description is to be found in the Appendix (profile 88/2-3).

4.2.5. Soils of the Uplands

4.2.5.1. Kapenguria Level, altitude around 2300m, rolling to silly

Map Unit: U3Gh/D Area: 1370.....ha

This unit occurs in the extreme East of the survey area and occupies only a very small area. The dominant soils are well drained, deep, dark reddish brown to dark brown, friable and have a sandy clay loam to clay texture with more than 30 cm and acid humic topsoil. For full description one is referred to the Kapenguria report (Ref. No. 7)

Map Unit: U3GC1/D Area: 100 ha

As with the previous unit of the Kapenguria level this unit comprises only a very small acreage. The catenary sequence of soils of this unit is described in the Kapenguria report.

Map Unit: U3GC2 Area: 400 ha

This map unit occurs in the northeastern part of the District and covers a very small area. The soils are encountered in a catena as with unit U3GC1, but have a less deep, clayey subsoil of a brown to reddish brown colour. More details in the report by Gelens et al (1976).

4.2.5.2. Kitale Level, altitude around 1900m, gently undulating to undulating

Map Unit: U4Ur Area: 73480 ha*

Soils of this unit occur extensively in the Kitale area and support intensive cultivation of a variety of crops. The topography is normally gently undulating (2.5% slope), occasional somewhat steeper (slope 5-8%), while on interfluves 0-2% slopes may be encountered. The dominant soil is well drained, deep to very deep, red to dark red, very friable to friable and has a clay texture. Structural development is weak to moderate in the topsoil and tends to decrease in the subsoil. The CEC at pH 7.0 varies from 7-17meq. while the base saturation varies from 39-73 in the A horizon and from 20-69% in the B. Chemically these soils are leached, with low mineral reserve, but they do have good physical properties. This map unit may have inclusions of somewhat browner soils of map unit U4U_t and towards the valleys may be associated with soils of the minor valleys and bottomlands. For full profile description and chemical data see the appendix. More information may also be extracted from the report by Michiaka and Oswago (detailed soil survey of Kitale Research Station, map unit 1,2,4 and are concerned) as well as from the Kapenguria Reconnaissance Soil Report.

Map Unit: U4Ub Area: 5920.....ha**

These soils represent the browner variant of unit U4Ur and are mainly encountered in the north-eastern part of the District in close association with their redder counterpart, map unit U4Ur. Usually they occur at lower and steeper topography bordering soils of units VC and Agc.

*U4Ur/A: 1700ha; U4Ur/B: 55630ha; U4Ur/C: 17030ha; U4Ur/D: 120ha

**U4Ub/B: 2690ha; U4Ub/C: 3190ha; U4Ub/D: 40ha

Soils of unit U4Ub are well drained, deep to very deep, dark reddish brown to yellowish red, friable and have a clay texture. Structural development is weak and tend to be porous massive with depth. CEC at pH 7.0 is between 6-10 meq, the base saturation is 41-51% in the A and ranges from 40-68 in the B2. Detailed information is to be found in the Appendix (profile 75/3-18).

Map Unit: U4Pr

Area: 13700...ha*

Soils of this map unit occur extensively in the Endeless area and are developed from Pyroclastic rocks of the Mt. Elgon volcanics. Their morphology is very similar to soils of unit U4Ur, (with whom they are but chemically are richer associated). They are deep to very deep, friable to very friable and have a clay loam to sandy clay loam texture. The soils have good physical properties but to arrive at sustained optimum yields they will need additional fertilizer application of N and P. Profile 74/4-3 provides a soil description and a summary of fertility data.

4.2.5.3. Kiminini Level, altitude about 1800, gently undulating

Map Unit: U8Gr

Area: 19480...ha**

This level is separated from the Kitale level because of its lower altitude and is in addition underlain by a different country rock, being more gneissose. The general topography is gently undulating while flatter areas may be encountered on the broad interfluves. The common soils is well drained, very deep, dark red to dark reddish brown, very friable when moist and usually has a sandy clay loam texture. A full description and fertility data is presented in the Appendix, profile 88/2-2.

4.2.5.4. Undifferentiated levels, various altitude and topography.

Map Unit: U7Bbc/p

Area: 19870...ha

The unit occurs in the very north of the District on the watershed between the Lake Victoria and Lake Turkana drainage basins. The terrain is clearly incised and has undulating topography. This region falls into Ecological Zone IV and is mainly used for grazing. Soils are varied, predominantly developed on biotite gneiss. They are well drained, may be shallow or moderately deep, brown to dark yellowish brown. A firm consistence when moist is common, texture is a sandy clay. Consult profile 75/1-60 in the Appendix for detailed information.

4.2.6. Soils of the River terraces and Flood-plains

Map Unit: Agc

Area: ...3430.....ha

This unit covers the river terraces and flood plains where soil development takes place on sub-recent and recent deposits, of alluvial origin. The soils tend to be moderately well to poorly drained. Their internal drainage is restricted by a dense B2 horizon that underlies abruptly an A2.

*U4Pr/A: 20ha; U4Pr/B: 13680ha

**U8Gr/A: 1100ha; U8Gr/B: 18380ha

The soils are usually deep, show mottling and have a greyish brown to brown colour. The consistence is firm while the texture in the E is sandy clay to clay. The soils are subject to flooding and because of slow runoff may be water-logged for some time during the year. If properly drained however these lands can be put to profitable economic use. Profile 5 in the Appendix illustrates this soil. Within the map unit inclusions of map units AC, Vgc and Vd may be encountered.

Map Unit: AC

Area: 1130...ha

The alluvial soils that comprise this unit are complex in geography and vary considerably in characteristics from one place to another. This concerns especially the soil texture, colour and drainage conditions. The occurrence of this complex is limited in the District. For a full profile description one is referred to the Kapenguria Soil Reconnaissance Report, profile 507.

4.2.7. Soils of the Minor Valleys and Bottomlands

Map Unit: Vgc

Area: 2920...ha

The map unit covers the soils encountered in the wider parts of the minor valleys and bottomlands and which are developed from various parent materials. The drainage is poor, but soil depth is considerable. Temporary waterlogging caused anaerobe conditions favourable for the development of gley, resulting in the occurrence of mottles often within 60 cm depth from the soil surface. Texture of the soils is mainly sandy clay to clay; dry consistence is hard, moist consistence firm to very firm. Occasionally carbonates are encountered in the subsoil, EC_e values are low, but ESP varies usually between 10-15% from 100-200 cm. Profile 75/3-3 as given in the Appendix is representative for a soil in this unit.

Map Unit: VC

Area: 33160...ha

This soil association is commonly encountered throughout the District and occurs in narrower parts of the minor valleys and bottomlands. The dominant soils on the flat valley bottoms are subject to water-logging and have a fluctuating groundwater level. These soils may have a considerable amount of peaty material in the A horizon, are very poorly drained, show mottles due to gleying and are very dark to dark greyish brown. The texture is clay throughout.

On the slopes the soils are associated with soils of units U4Ur, U4Ub, U4P, U8G3; that have 20-40 cm acid humic topsoil occurring at the lower valley sides. In this case slopes of up to 16% may be encountered, however normal slopes are from 2-8%.

A mollic Gleysol (Appendix, profile 75/3-4) is described as a common example of the major soil in this unit.

Map Unit: Vd

Dominant soils of this unit are poorly drained, very deep, black to dark grey, very fine clays. They usually show cracks during the dry season, but expand considerably when ^{wet} rise up and become very sticky. These are the Vertisols of the bottomlands, which often occur in association with map units Vgc and VC and may also border to soils of the river terraces and flood plains. The dark cracking clay soils cover an extensive area, especially (north) west of Kitale, where they are mainly under grass and the land is utilized for grazing. Although fairly rich in nutrients these soils have a poor workability if not managed at the right (moist) soil condition..

Profile 74/4-1 in the Appendix describes this kind of soil.

5. Land Evaluation

5.1. Present Land Use

The Trans Nzoia District is well known for its intensive and diverse use of its lands for agricultural production. According to a report from the Extension Service of the Ministry of Agriculture at Kitale (Ref. No. 14/82) 82% of the total area is registered agricultural land; forest reserves and the Mt. Elgon National Park make up respectively 9.5% and 6.4%, while Kitale township (0.7%) and government reserves bring the total to 100%.

Most of the registered agricultural lands fall in the category "Farm under Extension Service" (44%), other farms 32.9%, while ADC farms, Government Farms and Settlement Schemes make up 10.8%, 3.1% and 8.5% respectively.

It is cautioned that several so-called large farms are owned by partnership, which results in some cases to an average acreage per owner that is lower than reported from the settlement schemes.

A breakdown of the District into farming regions is given on page 3 of Reference No. 14 . They are:

- a) Endebess Plains map unit U4P
- b) Mount Elgon Slopes map units MPh, HPh, LBh
- c) Kitale Plains (inclusive Kiminini area) U4Ur, U4Ub, U8Gr, VC, Vd, Vgc, Apc
- d) Cherangani map units U3gC1, U3gC2, Hgh1, Hgh2, VC

It is not suprising that this subdivision corresponds with some of the major soil mapping units. It is also clear however that differences between the units are far more outspoken than one is lead to believe from the quoted report. This may now be evident from the foregoing chapters. Although a number of cash-crops are cultivated in the District there is variation in the time of planting, the duration of the maturing period and time of harvesting mainly depending on the corresponding eco-climatic zone.

Higher altitude crops include pyrethrum, irish potatoes, wheat and tea. Medium altitude crops concern mainly coffee and maize, while at lower elevation (i.e. on the "Kitale plain") maize, sunflower, seed grass are dominant. Livestock is a valuable contributor to farm income and consists mainly of dairy cattle in the central part of the area. North-wards however where the climate tends to be drier the number of beef cattle exceeds the number of dairy stock.

5.2. Land Suitability

Detailed information concerning an assessment of the present situation and the possibilities for improved agricultural output is presented in the Kapenguria Report and also in various inter governmental reports (2,14). On the whole, the District shows limited ecological restraints. It is however of utmost importance to prevent the deterioration of various land qualities to avoid substantial decrease in agricultural production.

The deterioration concerns mainly the soil erosion in once forested regions that are presently being brought under maize cultivation, as well as too much emphasis on mono-culture which lead to serious depletion of soil nutrients.

Traditionally the various uplands (e.g. map units U4Ur, U4Ub, U4Pr and U8Gr) are cultivated as large scale mixed arable rainfed farms. The size of the farm is important to make it an economic profitable unit and may vary according to its location. Farms at the lower slopes of Mt. Elgon and associated terrain (map units LBh, HPh and U4Pr) situated on the red volcanic soils had an average farm size of 500 acres while farms in the eastern uplands covered 900 acres (Barnes, 1955). Yields in the Mt. Elgon area were recorded as being 20 bags of hybrid maize/acre and 10 bags of wheat/acre in a crop rotation of (maize)-(green manure, wheat)-(maize). Little fertilizer was applied as the soils were able to sustain this cropping pattern on baiss of their natural fertility.

In the plains around Kitale an average of 12 bags of maize/acre was recorded with some fertilizer application in a crop rotation pattern of (maize)-(sunflower)-(maize)-(grass ley or clover) 3X-(maize). Thus depletion of soils nutrients was avoided and conetracted by means of some fertilizer application, mainly as double super phosphate in the rate of 70-100 lb/acre.

Thus the land was able to give satisfactory returns. These data are similar to those given by de Jong (1976) who in addition gives valuable new information on land use, inputs and outputs. He also emphasized that the continuation of this type of large scale farming is only warranted if a high standard of husbandry is maintained so as to justify the large capital expenditure and the low labour input.

With a high standard of husbandry the following goals may be achieved:
1) production of hybrid maize see, 2) production of wheat, 3) improvement of livestock, 4) production of adequate food surpluses in case of famine.

It is however noted that a decline in the high level of management is evident, especially in cases of group-ownership of large farms. Under this circumstance, an alternative use of the land could be the small-holders, rainfed arable mixed farming with advanced technology. It may be stated again that good management is a must for sustained high yields. In this respect de Jong points out that the production level can be raised by as much as 50%, as was proved by experiments conducted at the National Agricultural Research Station, Kitale.

Low lying land often with poorly drained soils can be put to more profitable use if surface drainage is applied where feasible and the natural grasses are improved through sown grass leys. The production of livestock either as dairy cattle or as beef cattle can thus be improved upon.

This holds especially true for the map units Agc, AC.

Soils of the units Vd and VC may be utilized for vegetation or fruit production (bananas) as is done on a limited scale already.

Their (perched) groundwater table within the rooting zone (less than 150 cm from the surface) can be tapped by roots of plants which can withstand "wet feet" for a considerable time of the year.

Watershed protection should be of prior concern in the areas of the Cherangani Hills and also in newly developed agricultural areas of the Mt. Elgon. Silviculture is recommended as a way to achieve this. In the extreme northern part of the survey area (map unit U7Bbc/p) ranching is recommended although some areas may be suitable for the rainfed cultivation of cereals (sorghum). Destruction of the natural forests arises mainly because of their apparent low profitability and therefore preference to bring the land under cultivation. This cultivation by crop minded people, who see more use of the valuable land in terms of food crop production, results in a pressure on the forested areas. Although the destruction of the natural forest seems a natural development which is caused by the population pressure, it is an extremely dangerous one, since its long term effect on the watershed, which once destroyed is highly time and money consuming to rectify. It is therefore necessary to have a clear forest management policy so as to ascertain and clarify the profitable use of the forest areas in the District. This will not only benefit the present population but even more so the future generation(s).

6. Recommendations

- a) The siting of agronomic experiments be based on the various mapping units in combination with the different ecological zones.
- b) The utilization of streams coming from Mt. Elgon could be intensified with regard to stockdam building and possible minor irrigation schemes.
- c) Improved drainage could make the soils of the bottomlands to be productive for shallow rooted crops (e.g. vegetables) or improved grass leys.
- d) Large scale farms should be maintained if their level of management warrants their existence.

7. Summary

This report deals with the major soils in the Trans Nzoia District which are shown on the accompanying soil map at scale 1:100,000. The introductory chapters provide the necessary back ground information upon which the differentiation of the map units is based. Special attention is given to the subjects geology and climate as it was felt that these two contribute, to a large extent, to the variation and geography of soils.

In total 19 map units are described while the Appendix provides detailed information on the major units. A short list of references may prove useful if more detailed information is needed. Lastly it has been pointed out that more intensive soil examination will be necessary once a preliminary choice of the sites for specific agricultural use or fertilizer experiments will have been made.

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Profile description

Profile	Depth in cm	Description
A11	0-15	Dark reddish brown (2.5YR3/3) dry, dusky red (2.5YR3/1) moist, sandy loam with occasional stones and coarse gravel, very fine weak roots, soil dry, very friable moist, non sticky and non plastic wet, very fine and medium pores; sandy roots; pH 5.1; clear smooth boundary.
A12	15-30	dusky red (2.5YR3/2) dry, very dusky red (2.5YR2.5/2) moist, clay loam, strong angular blocky, blocky friable moist, sticky and slightly plastic wet, many fine and medium pores; sandy roots; common very clay skins; low water and bicarbonate activity; pH 5.0; gradual smooth boundary.
A13	30-50	dark reddish brown (2.5YR3/4) dry, very red (2.5YR2.5/4) moist, coarse angular blocky, very hard dry, friable moist, sticky and plastic wet; many fine, coarse and medium pores; many thick clay skins; pH 5.4; gradual smooth boundary.

descriptions according to the guidelines for soil profile description (United Nations, 1968) and also described in reference 2.

Appendix: Detailed Soil Profile Descriptions* and Analytical Data

Map Unit: MPh

Profile: 88/2-4

Soil Classification: Humic Nitosol

Ecological Zone: IIc

Location: approximately 8 km West of Saboti, Mt. Elgon Area

Geological formation: Lower and Middle Pyroclastic Series of Mt. Elgon

Local petrography: colluvium of volcanic material

Physiography: mountainous, altitude 2200m

Relief-macro: deep incised valleys, commonly V-shaped with very steep slopes; site on middle slope 17-20%

Relief-micro: slightly hummocky

Vegetation/land use: original forest montane vegetation (among which podo) cleared, presently in use as grassland

Drainage: well drained, class 4

Profile description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
A11	0-15	Dark reddish brown (2.5YR3/4) dry, dusky red (2.5YP3/2) moist, sandy loam with occasional stones and coarse gravel; very fine weak crumb; soft dry, very friable moist, non sticky and non plastic wet; many fine and medium pores; many roots; pH 6.1; clear smooth boundary.
A12	15-30	dusky red (2.5YR3/2) dry, very dusky red (2.5YR2.5/2) moist, clay loam; strong, medium subangular blocky; hard dry, friable moist; sticky and slightly plastic wet; many fine and medium pores; many roots; common weak clay skins; few mica and biotite; much animal activity; pH 6.0; gradual smooth boundary.
A3	30-50	dark reddish brown (2.5YR3/4) dry and moist, clay; strong, coarse angular blocky; very hard dry, friable moist, sticky and plastic wet; many fine, common medium pores; many roots; many thick clay skins; pH 5.4; gradual smooth boundary.

descriptions according to FAO Guidelines for Soil Profile Description; colours according to Munsell Soil Colour Charts; Map Units U4Ur, U4Ub, U7Bbc/p, Agc, Vgc and VC are also described in reference 7. Fertility analyses according to Mehlich.

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
B21	50-90	dark red (2.5YR3/6) dry and moist, clay; moderate medium subangular blocky; very hard dry, friable moist; sticky and plastic wet; many very fine and fine pores; many roots; common medium, many thick clay skins; many aggotubules; pH 5.0; distinct smooth boundary,
B22	90-150+	dark red (2.5YR3/6) dry, dusky red (10R3/4) moist, clay; weak, fine subangular blocky; consistence as B21; many very fine, fine and medium pores; many thick clay skins; common manganese and iron concretions up to 0.5 cm in diameter; many aggotubules; pH 4.5.

Fertility Tests Results

<u>Horizon</u>	<u>Depth in cm.</u>	<u>pH</u>	<u>Na</u>	<u>K</u>	<u>Ca</u>	<u>Mg</u>	<u>Mn</u>	<u>P</u>	<u>N</u>	<u>C</u>
			<u>m.e.%</u>			<u>ppm</u>	<u>%</u>	<u>%</u>		
A12	15-30	6.0	0.18	1.42	10.2	6.6	0.50	11	0.32	3.29
B22	90-150	4.9	0.03	0.60	tr	0.7	0.36	11	-	-

Map Unit: HPh

Profile: 74,4-2

Soil Classification: Humic Nitosol

Ecological Zone: IIw

Location: just before turnoff Mt. Elgon Forest Road on the road from Endeless to Suam river

Geological formation: Pyroclastic rocks of Mt. Elgon

Local petrography: colluvium

Physiography: foothills colluvium; altitude 1940 m

Relief-macro: undulating, upper part of convex slope; gradient length-wise 5-6%, across 25-30%

Relief-micro: nil

Vegetation/land use: original forest cleared but replaced by pine in 1951, 1954 and 1960

Drainage: well drained, class 4

Profile description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
A11	0-10	Dark reddish brown (5YR3/3) dry and moist, sandy loam; medium very fine crumb; hard dry, friable moist, sticky and plastic wet; many micro, few very fine pores; many roots; pH 5.6; gradual wavy, in some places abrupt, boundary,
A12	10-40	dark reddish brown (5YR3/4) dry and moist, silty clay loam; moderate to strong fine subangular blocky; hard dry, friable moist, slightly sticky and plastic wet; few fine clay skins, pH 5.2; few fine Mn concretions; clear smooth boundary,
B1	40-70	dark reddish brown (2.5YR3/4) dry, dusky red (2.5YR3/2) moist, silty clay to silty clay loam; moderate medium subangular blocky; hard dry, friable moist, slightly sticky and plastic wet; few fine, common medium pores; common roots; common moderate clay skins; few fine Mn concretions; pH 5.3.

Fertility test results (7 samples) of the topsoil (0-15 cm)

	<u>aver.</u>	<u>range</u>		<u>aver.</u>	<u>range</u>	<u>m.e.%</u>
pH	5.7	5.5-5.9	Na	0.14	tr-0, 23	
NZ	0.23	0.19-0.26	K	1.07	0.84-1.50	
CZ	1.82	1.34-2.29	Ca	10.3	3.8-18.1	
Pppm	28	17-66	Mg	5.0	3.6-6.0	
			Mn	0.71	0.57-0.86	

Map Unit: FPb

Profile: 88/2-3

Soil Classification: Humic Cambisol

Ecological Zone: 11w

Location: 10 km southwest of Kiminini

Geological formation: Pyroclastic rocks and banded microcline augen-gneiss

Local petrography: mixed colluvium of above named rocks

Physiography: footslopes at the base of a minor scarp, altitude 1780 m

Relief-macro: upper part of straight slope of 400m; gradient 5-6%

Relief-micro: plough ridges

Vegetation/land use: original woodland vegetation cleared to make way for maize cultivation on large scale

Drainage: well drained, class 4

Profile description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
Alp	0-25	Dark brown (7.5YR3/2) dry, very dark brown (7.5YR2/2) moist, sandy clay loam, weak fine crumb; hard dry, friable moist, sticky and slightly plastic wet; many very fine and fine pores; many roots; common mica; pH 6.6; diffuse boundary,
A3	25-50	dark brown (7.5YR3/2) dry, very dark brown (7.5YR2/2) moist, sandy clay; hard dry, slightly firm moist, slightly sticky and plastic wet; common roots; common mica; many very fine and fine pores; pH 6.7; diffuse boundary,
B1	50-80	dark brown (7.5YR3/2) dry, very dark brown (7.5YR 2/2) moist, sandy clay; hard dry, friable moist, sticky and plastic wet; many very fine and fine pores; slight effervescence with HCl; common mica; pH 6.7, diffuse boundary,
B2	80-120+	Dark reddish brown (5YR3/3) dry, dusky red (2.5YR3/2) moist, clay. hard dry, friable moist, very sticky and plastic wet; many very fine and fine pores; few mica; pH 4.0.

Map Unit: U4Ur

Profile: 75/3-2

Soil Classification: Rhodic Ferralsol

Ecological Zone: III

Location: appr. 15 km North of Kitale along the Kitale-Kapenguria Road

Geological formation: Undifferentiated Basement System

Local petrography: mainly gneisses rich in quartz and feldspars

Physiography: upland, altitude appr. 1960 m

Relief-macro: gently undulating, convex slopes; gradient 2%

Relief-micro: regular; some termite mounds

Vegetation/land use: original Combretum vegetation cleared, presently under grass

Drainage: well drained, class 4

Profile Description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
A1	0-18	Dark reddish brown (2.5YR3/4) dry, dusky red (2.5YR3/2) moist, clay; moderate, fine and medium subangular blocky; slightly hard dry, slightly firm moist, sticky and plastic wet; common very fine pores; many fine roots; smooth clear boundary, (sample 75/3-2a),
B1	18-43	dusky red (2.5YR3/6) dry, dark reddish brown (2.5YR3/4) moist, clay; structure and consistence as the A1; few very fine, common micro pores; many very fine roots; gradual smooth boundary, (sample 75/3-2b),
B21	43-113	dark red (10R3/6) dry, dusky red (10R3/4) moist, clay; weak (very) fine subangular blocky; friable moist, sticky and plastic wet; few to common very fine pores; few very fine roots; smooth diffuse boundary, (sample 75/3-2c),
B22	113-174	dusky red (10R3/4) moist, clay; structure, consistence and pores as B21; few thin clay skins in the lower part of the horizon, (sample 75/3-2d).

LABORATORY DATA

PROFILE NO: 75/3-2

AREA: TRANS NZOIA Map Unit; U4Ur

Lab.no.	depth in cm	horizon	weight% >2 mm	particle size distribution (mu)						weight % clay <2
				sand			silt			
				2000- 1000	1000- 500	500- 250	250- 100	100- 50	50- 20	
75/3-2a (8819)	0-18	A1	0.4	3.8	11.3	9.0	0.1	15.8	59.6	
75/3-2b (8820)	18-43	B1	0.5	3.7	9.9	8.1	0.3	13.0	64.5	
75/3-2c (8821)	43-113	B21	0.5	3.7	7.8	7.4	0.2	12.3	68.1	
75/3-2d (8822)	113-174	B22	0.5	2.5	6.0	7.7	1.8	11.7	69.8	

depth in cm	pH		C %	N %	C/N	exchangeable cations					CEC pH7.0	Base sat. %	Avail. P ₂ O ₅ ppm
	H ₂ O	KCl				Ca	Mg	K	Na	sum			
	meq/100 g soil												
0-18	5.4	4.3	1.07	0.17	7.6	1.8	1.8	1.0	0	4.6	9.2	50	12
18-43	5.5	4.4	1.07	0.08	13.4	1.6	1.7	0.6	0.2	4.1	9.4	44	
43-113	5.7	4.6				1.5	2.0	0.5	0	4.0	8.4	48	
113-174	5.9	4.9				1.4	1.7	0.5	0.6	4.2	8.3	51	

depth in cm	bulk densi- ty	particle density	porosity	available nutrients m.e.%					Hp	SiO ₂ Al ₂ O ₃	SiO ₂ Fe ₂ O ₃	Fe ₂ O ₃ %
				Na	K	Ca	Mg	Mn				
				(Mehlich)								
0-18	1.19	2.6	0.54	0.04	0.54	1.2	1.4	0.80	0.4			
18-43	1.15	2.6	0.56									
43-113	1.11	2.6	0.57							1.7	1.3	16.5
113-174										1.6	1.2	19.2

Remarks:

Map Unit: U4Ub

Profile: 75/3-18

Soil Classification: Orthic/Humic Ferralsol

Ecological Zone: III

Location: 1 km southeast of Knights Corner

Geological formation: Undifferentiated Basement System Rocks

Local petrography: gneisses rich in quartz and K-feldspars

Physiography: upland, altitude appr. 1980 m

Relief-macro: rolling, concave slope of 800 m, gradient 14%

" -micro: some an hills

Vegetation/land use: original moist Combretum woodland cleared and presently under grass

Drainage: well drained, class 4

Profile description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
A1	0-22	Dark reddish brown (5YR3/2) moist, sandy clay; weak, fine to medium subangular blocky; slightly firm moist, sticky wet; common fine and medium pores; many fine and medium, few coarse roots; clear smooth boundary. (sample 75/3-18a),
B1	22-33	dark reddish brown(5YR3/3) moist, clay; weak to moderate, fine to medium angular blocky; friable moist, sticky wet; few fine and medium pores; common fine, few medium roots; gradual smooth boundary, (sample 75/3-18b),
B21	33-69	dark reddish brown (5YR3/4) moist, clay; moderate, fine to medium angular blocky; friable moist, sticky wet; few fine pores; common fine roots; few insect channels; diffuse smooth boundary, (sample 75/3-18c),
B22	69-193	yellowish red (5YR4/6) moist, clay; weak, fine to medium subangular blocky; friable moist, sticky wet; few very fine pores; few fine roots; (sample 75/3-18d).

Remarks: pockets of charcoal occur occasionally in the A1 and B1 horizons.

VIII

LABORATORY DATA

PROFILE NO: 75/3-18 AREA: TRANS NZOLA Map Unit:U4Ub

lab. no.	depth in cm	horizon	weight % > 2 mm	particle size distribution (mu)						
				weight %						
				sand			silt		clay	
2000- 1000	1000- 500	500- 250	250- 100	100- 50	50- 20	20- 2	2			
3586	0-22	A1		52					8	40
3587	22-33	B1		48					8	44
3588	33-69	B21		40					8	52
3589	69-193	B22		34					18	60

depth in cm	pH		C %	N %	C/N	exchangeable cations					CEC pH7.0	Base sat. %	availab P ₂ O ₅ ppm
	H ₂ O	KCl				Ca	Mg	K	Na	sum			
	meq/100 g soil												
0-22	5.7	4.7	1.68	0.16	10.5	3.2	1.4	0.4	0.1	5.1	10.1	51	7
22-33	5.6	4.7	1.39	0.10	13.9	3.0	1.4	0.4	0.3	5.1	9.8	52	
33-69	5.8	4.8				3.2	1.3	0.3	0.3	5.1	8.6	59	
69-193	6.1	5.3				3.6	2.5	0.5	0.3	6.9	10.2	68	

depth in cm	bulk den- sity	particle density	porosity	available nutrients m.e.%					SiO ₂	SiO ₂	Fe ₂ O ₃
				Na	K	Ca	Mg	Mn	Al ₂ O ₃	Fe ₂ O ₃	%
				(Mehlich)							
0-22				0.10	0.24	2.2	1.4				
22-33	1.26	2.6	0.52								
33-69	1.23	2.6	0.53					2.4	2.2	9.6	
69-193	1.18	2.6	0.55					2.4	2.1	12.5	

Remarks:

Map Unit: U4Pr

Profile: 74/4-3

Soil Classification: Eutric Nitosol

Ecological Zone: III

Location: 10 km North of Endebess

Geological formation: Pyroclastic Rocks of Mt. Elgon Volcanic

Local petrography: weathering products of these rocks

Physiography: upland, altitude 1860 m

Relief-macro: top of interfluve, straight slope of 2%

Relief-micro: nil

Vegetation/land use: original moist Combretum woodland cleared, presently under grass

Drainage: well drained, class 4

Profile description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
A1	0-20	Yellowish red (5YR4/6) dry, dark reddish brown (5YR3/3) moist, sandy clay; moderate, fine subangular blocky; very hard dry, friable moist, sticky and plastic wet; many very fine and fine pores; pH 5.8; gradual boundary,
B1	20-50	dark red (2.5YR3/6) dry, dark reddish brown (2.5YR3/4) moist, sandy clay loam; many very fine and fine pores; hard dry, friable moist, sticky and plastic wet; pH 5.6; gradual boundary,
B21	50-90	dark red (2.5YR3/6) dry, dark reddish brown (2.5YR3/4) moist, sandy clay loam; consistence and pores as B1; diffuse boundary; pH 5.2,
B22	90-125	dark red (2.5YR3/6) moist, clay loam; many very fine and fine pores; slightly hard dry, friable moist, sticky and plastic wet; pH 5.2; diffuse boundary,
B3	125+	dark reddish brown (2.5YR3/4) moist, fine gravelly clay loam; slightly hard dry, friable moist, sticky and plastic wet; pH 5.2; many very fine and fine Mn concretions.

Soil fertility data unit U4R

	Na		K		Ca		Mg		In	
	mean	range								
topsoil										
0-15cm	0.13	0.02-- 0.28	0.80	0.16-- 1.68	5.2	0.2-- 16.4	3.8	0.7-- 7.4	0.36	0.19-- 0.55
(18 samples)										
	Hp		Pppm		ZN		ZC			
	mean	range	mean	range	mean	range	mean	range		
	0.5	0.2-- 1.5	20	7-40	0.16	0.07-- 0.26	1.72	0.58-- 3.25		

	Na		K		Ca		Mg			
	mean	range	mean	range	mean	range	mean	range		
subsoil										
23-45cm	0.08	tr-0.9	0.67	0.12-0.96	2.2	0.2-16.4	2.6	1.2-4.8		
(10 samples)										
	Mn		Pppm		Hp					
	mean	range	mean	range	mean	range				
	0.46	0.23-0.57	16	7-21	0.8	0.4-1.1				

Remarks: for mean read "average"

Map Unit: U8Cr

Profile: 38/2-2

Soil Classification: (Ferralsol)

Ecological Zone: III

Location: 8 km NNW of Kiminini

Geological formation: Basement System Rocks

Local petrography: banded augen gneiss

Physiography: upland, altitude 1820 m

Relief macro: gently undulating, site on upper part of straight slope

" micro: nil

Vegetation/land use: planted Eucaliptus near arable field

Drainage: well drained, class 4

Profile Description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
A1	0-20	Reddish brown (5YR4/3) dry, dark reddish brown (5YR3/3) moist, sandy clay; fine moderate crumb; hard dry, friable moist, sticky and plastic wet; common fine and medium roots; many pores; many aggotubules; pH 5.8; clear smooth boundary,
B1	20-40	dark reddish brown (2.5YR3/4) dry and moist, sandy clay; medium moderate subangular blocky; hard dry, friable moist, sticky and plastic wet; common roots; common micro and fine pores; few moderate pressure faces; many aggotubules; pH 5.4; diffuse smooth boundary,
B21	40-70	dark red (2.5YR3/6) dry, dark reddish brown (2.5YR3/4) moist, sandy clay loam; weak fine and medium subangular blocky; consistence as B1; common roots; many fine and medium pores; common moderate pressure faces; many aggotubules; pH 5.6, diffuse smooth boundary,
B22	70-120	red (2.5YR4/6) dry, dark red (2.5YR3/6) moist, sandy clay loam, weak fine subangular blocky, slightly hard dry, very friable moist, sticky and slightly plastic wet; few to common roots; many medium and coarse pores; few thin clay skins; pH 5.6; diffuse smooth boundary,
B23	120-150	red (2.5YR4/6) dry, dark red (2.5YR3/6) moist, sandy clay loam, weak medium subangular blocky; consistence, pores and cutans as B22; many aggotubules; pH 5.5.

XII.

Fertility tests results from topsoil and subsoil (7 and 3 samples respectively)

	<u>topsoil (0-20 cm)</u>		<u>subsoil (20-40 cm)</u>	
	<u>Average</u>	<u>range</u>	<u>average</u>	<u>range</u>
pH	5.1	4.8-5.7	5.2	5.0-5.3
N%	0.13	0.10-0.16	-	-
C%	2.23	1.44-3.80	-	-
Pppm	16	14-25	12	11-14
Na	0.05	0.02-0.06)	(0.10	0.05-0.16
K	0.46	0.34-0.67)	(0.27	0.24-0.30
Ca	1.5	0.8-3.2)	(0.7	0.2-1.4
Mg	1.3	0.9-1.7)	(1.2	n.a
Mn	0.52	0.42-0.70)	(0.49	0.46-0.52
Hp	0.6	0.1-0.8)	(0.3	n.a

m.e
%

Very dark brown (10YR/2) clay, very dark brown (10YR/2) clay, sandy loam, moderate fine and medium angular blocks, hard dry, friable when moist, sticky and slightly plastic (pl. very sticky, some fine pores, many fine and medium roots, rather weak boundary. (sample 75/1-20)

Very dark brown (10YR/2) clay, very dark brown (10YR/2) clay, sandy loam, moderate fine and medium angular blocks, hard dry, very sticky when moist, sticky and slightly plastic (pl. very sticky, some fine pores, many fine roots, some medium and large, all cracked, moderate boundary. (sample 75/1-20)

Light yellowish brown (10YR/6) clay, dark yellowish brown (10YR/5) clay, sandy clay loam, moderate fine and medium angular blocks, hard dry, friable when moist, sticky and slightly plastic (pl. very sticky, some fine pores, many fine roots, some medium and large, all cracked, moderate boundary. (sample 75/1-20)

Light yellowish brown (10YR/6) clay, brown (10YR/5) clay, sandy clay, coarse angular blocks with a tendency to shattering, very hard dry, friable when moist, sticky and plastic (pl. very sticky, some fine pores, some fine roots, some medium and large, all cracked, moderate boundary. (sample 75/1-20)

XIII

Map unit: U7Bbc/p

Profile: 75/1-60

Soil classification: Orthic Luvisol

Ecological Zone: III

Location: about 3 km southwest of Kisiannet (outside mapped area)

Geological formation: Biotite Gneiss of the Basement System

Local petrography: biotite gneisses

Physiography: upland, altitude about 6500 ft

Relief-macro: undulating to rolling; site on higher part of convex slope,
length 100 m; gradient 6%

" micro: few termite mounds, 10-20 m apart

Vegetation/land use: cleared forest or glades; used for extensive grazing

Drainage: well drained, class 4

Remark: strong surface sealing (3-5mm)

Profile description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
A1	0-15	Greyish brown (10YR5/2) dry, very dark greyish brown (10YR3/2) moist, sandy loam; moderate fine and medium subangular blocky; hard dry, friable moist, sticky and slightly plastic wet; many micro, common fine pores; many fine and medium roots; pH 5.6; clear smooth boundary; (sample 75/1-60a).
B1	15-35	brown (10YR5/3) dry, dark brown (10YR3/3) moist, sandy clay loam; massive; hard dry, very friable moist, slightly sticky and slightly plastic wet; many micro pores; few fine roots; much biotite and mica; pH 5.5; gradual smooth boundary; (sample 75/1-60b).
B21	35-70	yellowish brown (10YR5/4) dry, dark yellowish brown (10YR4/4) moist, sandy clay loam; massive; consistence, pores and roots as the B1; few thin clay skins; many dark dark minerals; pH 6.0; distinct smooth boundary; (sample 75/1-60c).
B22	70-105	light yellowish brown (10YR6/4) dry, brown (7.5YR4/4) moist, sandy clay; coarse angular blocky with a tendency to massive; very hard dry, friable moist, sticky and plastic wet; many micro, common very fine pores; common clay skins, mainly bridges; many dark minerals pH 6.4; abrupt boundary; (sample 75/1-60d).

XIV

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
B3	105-115	stone line, consisting of quartz stones, micaceous rock fragments and hornblende gneiss
C	115-145	mixture of soil material and semi-weathered rock
C/R	145-170	semi weathered rock

Traces of glauconite.

lab. no.	depth in cm	horizon	weight% > 2 mm	particle size distribution (mu)							weight% clay		
				sand								silt	
				2000-1000	1000-500	500-250	250-100	100-50	50-20	20-2		2	
009	0-15	A1		1.8	10.2	26.6	24.0	5.1	9.0	23.3			
010	15-35	B1		1.6	10.1	18.6	20.8	7.2	10.2	31.5			
011	35-70	B21		1.9	7.6	17.4	20.0	4.8	16.1	32.2			
012	70-105	B22		3.1	9.1	16.2	18.0	5.1	16.0	38.5			

depth in cm	pH		C %	N %	C/N	exchangeable cations					CEC pH 7.0	Base sat % pH 7.0	total P ₂ O ₅ ppm	si/c ratio
	Ca	Mg				K	Na	sum						
	meq/100 g soil	meq/100 g soil				meq/100 g soil	meq/100 g soil	meq/100 g soil						
0-15	5.4	4.2	0.94	0.10	9.4	1.2	1.3	0.2	0.0	2.7	5.6	48	60	1.14
15-35	5.4	4.2	0.94	0.08	11.7	1.8	1.6	0.2	0.1	3.7	7.6	49		0.76
35-70	5.8	5.3				2.6	2.4	0.2	0.2	5.4	7.2	75		0.48
70-105	6.2	4.6				2.8	2.6	0.3	0.4	6.1	8.3	73		0.27

depth in cm	EC mmhos/cm	Bulk density	particle density	available nutrients m.e.% (lehigh)					P ₂ O ₅ ppm	% Fe ₂ O ₃	SiO ₂ Al ₂ O ₃	SiO ₂ Fe ₂ O ₃
				Na	K	Ca	Mg	Mn				
0-15	0.08			0.09	0.26	0.8	1.1	0.12	5			
15-35	0.06	1.54	2.6									
35-70	0.06	1.50	2.6						7.1	2.0	1.8	
70-105	0.06	1.53	2.6						6.8	2.2	1.9	

Remarks: Kaolinite dominant clay mineral; some illite, may be changing in vermiculite traces of gibbsite.

Map Unit: Agc

Profile: 75/3-5

Soil classification: (ploughed) Eutric Planosol

Ecological Zone: III

Location: 1½ km North of McGalle Bridge

Geological Formation: Undifferentiated Basement System Rocks

Local petrography: alluvium rich in quartz and K-feldspars

Physiography: alluvial terrace about 5m above the valley bottom

Relief-macro: flat to very gently undulating (0-2% slope)

Relief-micro: numerous termite mounds

Vegetation/land use: vlei grassland, grazing

Drainage: poorly drained, class 2

Profile description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
Alp	0-18	Dark grey (5YR4/1) dry, very dark grey (5YR3/1) moist, slightly gravelly sandy clay loam; moderate, fine and medium clods; slightly hard dry, firm moist, sticky and plastic wet; few pores; common fine roots; clear, wavy to irregular boundary; (sample 75/3-5a),
(A2+B) p	18-49	dark brown (7.5YR3/2) dry, (7.5YR4/2) moist, gravelly clay, moderate fine and medium subangular blocky; very hard dry, friable moist, sticky and plastic wet, few pores; common fine and very fine roots; common, distinct medium reddish brown mottles; common iron and manganese concretions; distinct smooth boundary; (sample 75/3-5b),
B2lg	49-68	brown (10YR5/3) dry and moist, clay with many medium and coarse, distinct and prominent reddish brown and yellowish red mottles; moderate to strong fine and medium prisms; few pores; few fine roots; very hard dry, very firm moist, very sticky wet; very sticky wet; few concretions; distinct smooth boundary; (sample 75/3-5c),

XVII

Horizon	Depth in cm	Description
B22g	68-138	brown (10Y 4/3) moist, clay with many coarse, prominent yellowish brown mottles; strong, medium to very coarse prisms; extremely hard dry, extremely firm moist, very sticky wet, many strong slickensides; few concretions; gradual smooth boundary; (sample 75/3-5d).
B3g	138-177	greyish brown (10YR 5/2) moist, clay; mottles, structure, consistence and slickensides as B2g, common iron and manganese concretions; (sample 75/3-5e).

XVIII

LABORATORY DATA

PROFILE NO. 75/3-5 AFEA TRANS NZOIA

MAP UNIT: Agc

lab.no.	depth in cm	Horizon	weight% > 2 mm	particle size distribution (mu)							
				weight %					silt		clay
				2000-1000	1000-500	500-250	250-100	100-50	50-20	20-<2	
2029	0-18	A1p	5	10.3	11.0	20.6	12.2	3.3	12.6	30.0	
2030	18-49	(A2+B)p	20	8.5	8.5	12.8	8.2	2.4	8.0	51.6	
2031	49-68	B21g		6.4	7.4	10.2	9.0	2.0	11.4	53.3	
2032	68-138	B22g		2.8	4.6	10.7	11.5	1.0	15.4	54.0	
2033	138-177	B3g		0.9	2.8	12.2	15.4	4.8	11.0	52.9	

depth in cm	pH		C %	N %	C/N	exchangeable cations					CEC pH7.0	Base sat. % pH7.0	total P ₂ O ₅ ppm	Avail P ₂ O ₅ ppm
	H ₂ O	KCl				Ca	Mg	K	Na	sum				
0-18	5.6	4.3	1.60	0.16	10.0	2.2	2.0	0.3	0.1	4.6	9.6	48	96	8
18-49	5.3	4.2				5.2	1.3	0.3	0.2	7.0	14.4	49		
49-68	6.0	4.7				6.5	3.5	0.4	0.3	10.7	15.2	70		
68-138	6.4	5.4				8.2	4.6	0.5	0.3	13.6	15.0	91		
138-177	7.1	5.9				9.2	5.0	0.6	0.4	15.2	15.4	99		

depth in cm	EC mmhos/cm	ESP	CaCO ₃ %	available nutrients m.e.% (Nehlich)					Hp	Si/C ratio
				Na	K	Ca	Mg	Mn		
0-18	0.05			0.04	0.12	1.8	2.0	0.48		0.38
18-49	0.13									0.21
49-68	0.10									0.15
68-138	0.30									0.20
138-177	0.32									0.23

Remarks:

Map Unit: Vgc
 Profile: 75/3-3
 Soil Classification: Eutric/Dystric Gleysol
 Ecological Zone: III
 Location: 200 m northeast of McGalls Bridge
 Geological formation: Undifferentiated Basement System Rocks
 Local petrography: alluvium of gneisses rich in quartz and K-feldspar
 Physiography: bottomlands
 Relief-macro: almost flat with slight slope towards the river
 " -micro: occasional termite mounds
 Vegetation/land use: vlei-grassland
 Drainage: poorly drained, class 2
 Remark: strongly alkali, thick surface crust and crack pattern

Profile description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
A1	0-14	Dark grey (10YR4/1) dry, very dark grey (10YR3/1) moist, clay; strong coarse prisms; very hard dry, very firm moist and sticky wet; few thin pressure faces; few pores; many fine roots; occasionally medium and coarse rounded quartz gravel; pH 6.4; gradual smooth boundary; (sample 75/3-3a).
B21g	14-106	dark grey (10YR4/1) dry and moist, clay; common yellowish brown (10YR5/8) mottles, strong, coarse angular blocky; very hard dry, very firm moist, sticky wet; few micro pores; few fine roots; many moderate and strong pressure faces; few fine and medium CaCO ₃ and Mg concretions; pH 6.5; gradual smooth boundary; (sample 75/3-3b).
B22g	106-143	dark grey (10YR4/1) moist, clay; distinct fine and medium yellowish brown (10YF5/8) mottles; strong, very coarse prisms; breaking down into strong coarse and medium angular blocky; many strong slickensides; very few, very fine roots; few, fine and medium CaCO ₃ and Mg concretions; consistence as B21g; gradual smooth boundary; (sample 75/3-3c).
B3g	143-166+	dark greyish brown (10YF4/2) moist, clay; moderate, coarse prisms; very firm moist, very sticky and very plastic wet; many slickensides; concretions as B22g many, distinct and prominent, medium strong brown (7.5YF5/6) mottles; (sample 75/3-3d).

LABORATORY DATA

PROFILE NO. 75/3-3

AREA: TRANS NZOLA

MAP UNIT: Vgc

s. no.	depth in cm	horizon	weight% >2 mm	particle size distribution (mu)							
				weight %					silt		clay
				2000-- 1000	1000-- 500	500-- 250	250-- 100	100-- 50	50-- 20	20-- 2	<2
13	0-14	A1		0.9	1.7	8.3	15.2	3.1		23.1	47.7
14	14-106	B21g		1.0	1.1	7.0	10.0	0.9		15.6	64.4
15	106-143	B22g		1.4	1.8	5.5	8.8	0.9		17.1	65.3
16	143-166	B3g		1.7	2.3	4.9	9.5	0.6		15.6	65.4

depth in cm	pH		C %	N %	C/N	exchangeable cations					CEC pH7.0	Base sat. % pH7.0	total P ₂ O ₅ ppm	Avail. P ₂ O ₅ ppm
	H ₂ O	KCl				Ca	Mg	K	Na	sum				
14	5.4	4.3	2.13	0.17	12.5	9.0	7.4	1.2	1.0	18.6	33.1	56	52	12
14-106	6.8	5.1				12.4	11.7	1.0	2.5	27.6	42.2	66		
106-143	8.0	6.4				14.4	14.0	1.4	5.4	35.2	42.3*	84*		
143-166	8.0	6.5				16.2	14.4	1.3	5.5	37.4	40.4*	94*		

depth in cm	EC mmhos/ cm	ESP pH8.2	CaCO ₃ %	available nutrients m.e.%					Hp	SiO ₂ Al ₂ O ₃	SiO ₂ Fe ₂ O ₃	Fe ₂ O ₃ %
				Na	K	Ca	Mg	Mn				
14	0.17	-		0.26	0.38	7.6	6.0	1.14				
14-106	0.15	5.6										
106-143	0.35	12.8							3.0	2.2	16.0	
143-166	0.40	13.8							2.8	2.2	16.2	

Remarks: * at pH 8.2; montmorillonite dominant, traces of well crystallized kaolinite

Map Unit: Vd

Profile: 74/4-1

Soil Classification: Pellic Vertisol

Ecological Zone: III

Location: 1 km North of turnoff Kitale-Endebess road to Nai Swamp

Geological Formation: Basement System Rocks

Local Petrography: alluvium derived from Basement and Volcanic Rocks

Physiography: valley bottom

Relief-micro: flat

Relief-micro: occasional hummocky and termite mounds, 10 m apart,
2-3m in diameter, 0.5m high

Vegetation/land use: grassland used for extensive grazing

Drainage: poorly drained, class 2

Profile description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
A11	0-25	Very dark grey (10YF3/1) dry, black (10YR2.5/1) moist, clay; strong, fine and medium subangular blocky; very hard dry, firm moist, sticky and plastic wet; few micro and fine pores; common fine manganese concretions; rust colouring along root channels; few mica; pH 6.0 gradual boundary; (sample 74/4-1a),
A12	25-60	black (10YR2.5/1) dry, very dark grey (10YR3/1) moist, clay; common medium distinct yellowish brown (10YR5/6) mottles; very hard dry, very firm moist, sticky and plastic wet; common fine manganese concretions; pH 7.2; diffuse boundary,
A13	60-100	dark grey (10YR4/1) moist, clay; common to many fine to coarse distinct strong brown (7.5YR5/6) mottles; very hard dry, firm moist, sticky and plastic wet; strong effervescence with diluted HCl due to presence of carbonates, few fine Mn and Fe concretions; pH 7.5, diffuse boundary,
A14	100-160	dark olive brown (2.5Y3/3) dry, dark greyish brown (2.5Y4/2) moist, clay; common coarse distinct olive brown (2.5Y4/4) and many fine prominent very dark grey (10YR3/1) mottles; very hard dry, very firm moist, sticky and plastic wet; common carbonates; many fine Mn concretions; pH 7.7; diffuse boundary; (sample 74/4-1b);

Horizon	Depth in cm	Description
A3	160-220	light olive brown (2.5Y5/4) moist, clay; many very dark grey (10YR3/1) mottles; very hard dry, firm moist, sticky and plastic wet; many carbonates; pH matrix 7.4, pH CaCO ₃ spots 8.2.

Fertility test results according to Mehlig

Depth	pH	Na	K	Ca	Mg	Mn	Pppm	ZN	ZC
				m.e.%					
0-20	5.7	0.15	1.22	9.4	6.2	0.71	14	0.20	4.13
100-120	6.7	1.75	0.54	6.8	5.8	0.44	16	"	"

Map Unit: VC

Profile: 75/3-11

Soil Classification: Mollic Gleysol

Ecological Zone: III

Location: at bridge over Koitobos river

Geological Formation: Undifferentiated Basement System

Local Petrography: alluvium of rocks rich in quartz and K-feldspars

Physiography: valley bottom

Relief-macro: depressional area, flat topography

Relief-micro: nil

Vegetation/land use: vlei-grassland used for grazing

Drainage: poorly drained, class 2

Profile Description

<u>Horizon</u>	<u>Depth in cm</u>	<u>Description</u>
A1	0-8	Black (10YR2.5/1) moist, clay; many, medium and coarse, distinct red (2.5YR4/6) mottles, massive; firm moist, sticky wet; few fine pores; common roots; diffuse, smooth boundary; (sample 75/3-11a),
B21g	8-32	very dark grey (10YR3/1) moist, clay, many, fine and medium, distinct, yellowish red (5YR5/6) mottles; moderate, fine to medium prisms; firm moist, sticky wet; many moderate to thick pressure faces; few fine pores; few fine and medium roots, smooth, gradual boundary; (sample 75/3-11b),
B22g	32-80	very dark grey (7.5YR3/0) moist, clay, many, medium distinct, yellowish red (5YR5/6) mottles; weak to moderate, coarse prisms; firm moist, sticky wet, pressure faces as B21g; very few fine pores; smooth gradual boundary; (sample 75/3-11c),
B3g	80-115	dark grey (7.5YR 4/0) moist, clay; many, medium faint and distinct, yellowish red mottles; moderate coarse prisms, firm moist, sticky wet, many strong pressure faces; (sample 75/3-11d).

LABORATORY DATA Mollic Gleysol

PROFILE NO. 75/3-11

AREA: KAPENGURIA

Lab. no.	depth in cm	horizon	weight% >2 mm	particle size distribution (mu)							
				weight %					silt		clay
				2000- 1000	1000- 500	500- 250	250- 100	100- 50	50- 20	20- 2	
2059	0-8	A1		0.1	0.2	0.3	0.4	0.3	35.8	62.9	
2060	8-32	B21g		0.1	0.2	0.5	0.8	0.8	22.3	73.3	
2061	32-80	B22g		0.1	0.6	1.1	1.8	0.6	19.6	19.6	
2062	80-115	B3g		0.2	1.9	1.7	1.3	1.0	20.8	20.8	

depth in cm	pH		C %	N %	C/N	exchangeable cations					CEC pH 7.0	Base sat % pH7.0	P ₂ O ₅ total ppm	P ₂ O ₅ avail. ppm
	H ₂ O	KCl				Ca	Mg	K	Na	sum				
	meq/100g soil													
0-8	5.2	4.5	6.02	0.65	9.3	13.2	9.6	1.3	1.1	25.2	35.2	72	560	24
8-32	5.2	4.3	2.23	0.35	9.4	11.0	10.6	0.5	0.7	22.8	35.3	65		
32-80	5.7	4.5				10.9	12.0	0.5	0.7	24.1	34.8	69		
80-115	6.3	5.2				14.2	15.1	0.5	1.4	31.2	35.6	88		

depth in cm	EC mmhos/ cm	ESP/CaCO ₃ %	available nutrients m.e.%					Hp
			Na	K	Ca	Mg	Mn	
			(Mehlich)					
0-8	0.35		0.70	0.54	12.3	6.8	1.25	0.7
8-32	0.20							0.9
32-80	0.10							
80-115	0.08							

Remarks:

Appendix II: Aspects of Soil Classification

A first approach to the classification of the soils in the District was made by Gethin Jones in 1932 (Ref. no. 9). He recognised the following main units: a) light reddish soils of the Basement System (metamorphic Archaen Rocks) occurring on the Kitale Plains, b) dark reddish soils on volcanic rock in elevated and undulating areas and c) alluvial soils. The latter are very much richer in phosphates and less acid. He also found volcanic soils heavier in texture (probably because of higher silt content), less acid and redder in colour than soils developed from the Basement. The average topsoil pH was 6.0.

It is noted that this division is still valid today although it was not geographically expressed on a soil map. However this was done by Barnes (1955) who describes nine (9) soil units which are represented on a soil map at scale 1:125,000, which is unfortunately rather incorrect and incomplete. In addition to the main soils as recognized by Jones he also indicated the mountain soils and the swamp soils, and made a further subdivision in the plain soils on the basis of the climate (mainly rainfall), which according to him would reflect the texture and fertility status. The data are fully incorporated in this soil report.

Gethin Jones (in Atlas of Kenya, 1970) based his major division of Kenya's soils on the drainage conditions. This led to a grouping of soils on the 1:3M soil map that only partly reflects the true situation as encountered in the landscape. It is realized however that at the map scale of 1:3M a considerable amount of information can not be given. The following soils are concerned:

- 1) Lithosols and Regosols (shallow stony soils with rock outcrop) in the Mt. Elgon area, the Cherangani Hills and isolated hills,
- 2) Alpine Meadow Soils (shallow and peaty loams with rock outcrop) in the Mt. Elgon higher areas and the top and flats of the Cherangani Hills)
- 3) Latosolic Soils (dark red friable clays) on the Kitale Plains associated with Gleysoils (poorly drained dark clays),
- 4) Latosolic clays and (humic) Cley soils of the Kiminini area.

The soil geography of Kenya as pictured on the 1:5M Soil Map of the World (part VI-3) draws heavily on the information as supplied in the Atlas of Kenya.

For the Trans Nzoia area there are considerable differences especially with regard to the soils of the uplands, which on the FAO/Unesco map are mainly indicated as Humic Nitosols of medium texture. This however may only be true for part of the Endeless area. The majority of the soils belong to the Rhodic Ferralsols. The majority of the soils belong to the Rhodic Ferralsols.

In addition the extent to which the Andosols seem to occur on the Soil Map of the World is somewhat exaggerated, but this may also be due to scale effect. Andosols are believed to occur in the higher regions of the Mt. Elgon.

As can be deduced from the soil map at scale 1:100,000 the extent of the various map units as based on the definitions set out by the FAO/Unesco (1974) was improved upon considerably as compared with previous soil classification attempts. The shown differentiation corresponds largely with the variation in environmental conditions as outlined in the first chapters of the report. For detailed information relating to the FAO/Unesco classification system one is referred to the literature concerned (Ref. No. 6).

Classification in accordance with this system is presented in Table 7.

Table 7. Soil Map Units and their Classification

<u>Map Unit</u>	<u>Classification</u>
MPa	humic Nitosols
HCh1	humic Cambisols
HCh2	luvic Phaeozems
MPb	humic Nitosols
FPb	eutric Cambisols
LBh	humic Nitosols
U3Ch	humic Acrisols to Cambisols
U3GC1	Ferral-chromic Acrisols; Ferral-humic Acrisols
U3GC2	Ferral-orthic Acrisols; Ferral-humic Acrisols
U4Ur	rhodic Ferralsols
U4Ub	orthic to humic Ferralsols
U4Pr	eutric Nitosols
U8Cr	rhodic Ferralsols
U7Bbc/p	orthic Luvisols
Agc	eutric Planosols
AC	eutric Fluvisols
Vgc	eutric to dystic Gleysols
Vd	pellic Vertisols
VC	dystic Histosols-mollic Gleysols-humic Ferralsols

RECONNAISSANCE SOIL MAP OF THE TRANS NZOIA DISTRICT



LEGEND

MOUNTAINS AND MAJOR SCARPS (high relief intensity, slopes over 10%)

MP Soils developed on pyroclastic rocks, moderately well to poorly drained, very deep, mottled, dark greyish brown to brown, firm, sandy clay to clay, on low terraces (eutric **NITOSOLS**)

MPn well drained, deep, dark red, friable clay with 20 to 40 cm humic topsoil (humic **NITOSOLS**)

HILLS AND MINOR SCARPS (low relief intensity, slopes in general over 10%)

HG Soils developed on various gneisses and quartzites, well drained, deep, brown to dark reddish brown, friable, sandy clay loam to clay, with 25 to 60 cm humic topsoil, in places moderately deep or shallow and rocky (eutric **PHAEZOZEMES**)

HGh1 well drained, moderately deep to deep, dark reddish brown, friable, sandy clay loam to clay, with 20 to 44 cm acid humic topsoil (humic **CAMBISOLS**)

HGh2 well drained, deep, dark reddish brown, friable, silt loam to silty clay loam, with 20 to 40 cm humic topsoil (humic **NITOSOLS**)

HP Soils developed on pyroclastic rocks, well drained, deep, dark reddish brown, friable, silt loam to silty clay loam, with 20 to 40 cm humic topsoil (humic **NITOSOLS**)

HPn well drained, deep, dark reddish brown to dark brown, friable, sandy clay loam to clay, with 20 to 40 cm humic topsoil (eutric **CAMBISOLS**)

FOOTSLOPES (at the foot of mountains and hills, slopes predominantly 3-8%)

FP Soils developed on colluvium predominantly derived from pyroclastic rocks, well drained, deep, dark reddish brown to dark brown, friable, sandy clay loam to clay, with 20 to 40 cm humic topsoil (eutric **CAMBISOLS**)

PLATEAUS (altitude between 2,000-2,300 m, slopes between 4-6%)

LB Soils developed on nephelinite, well drained, very deep, dark red to red, friable clay with 20 to 40 cm humic topsoil (humic **NITOSOLS**)

UPLANDS (dissected plateaus at various levels)

KAPENGURIA LEVEL (altitude about 2,300 m, rolling to hilly)

U3G Soils developed on various gneisses and quartzites, well drained, predominantly deep, dark reddish brown to dark brown, friable, sandy clay loam to clay, with more than 30 cm acid humic topsoil (humic **ACRISOLS** to **CAMBISOLS**)

U3Gh well drained, deep, dark red to dark red, friable clay; on crests truncated or with only thin topsoil, downslope with acid humic topsoil of increasing thickness (FERRAL: chromic **ACRISOLS** - FERRAL: humic **ACRISOLS**)

U3Gc1 catenary sequence of well drained, deep, red to dark red, friable clay; on crests truncated or with only thin topsoil, downslope with acid humic topsoil of increasing thickness (FERRAL: orthic **ACRISOLS** - FERRAL: humic **ACRISOLS**)

U3Gc2 catenary sequence like U3Gc1 but with moderately deep to deep, brown to reddish brown, friable to firm (compact), sandy clay loam to clay loam underlying the topsoil (FERRAL: orthic **ACRISOLS** - FERRAL: humic **ACRISOLS**)

KITALE LEVEL (altitude about 1,800 m, gently undulating to undulating)

U4U Soils developed on undifferentiated Basement System rocks, well drained, very deep, red to dark red, very friable to friable, clay (rhodic **FERRALSOLS**)

U4Ub well drained, deep to very deep, dark reddish brown to yellowish red, friable clay (orthic to humic **FERRALSOLS**)

U4Uc well drained, deep to very deep, dark red, friable to very friable, sandy clay loam to clay (eutric **NITOSOLS**)

KIMININI LEVEL (altitude about 1,800 m, gently undulating)

U8G Soils developed on various gneisses, well drained, very deep, dark red to dark reddish brown, very friable, sandy clay loam (rhodic **FERRALSOLS**)

U8Gr well drained, deep to very deep, dark red to dark reddish brown, very friable, sandy clay loam (orthic **LUVISOLS**)

UNDIFFERENTIATED LEVELS (various altitudes, various macro-reliefs)

U7B Soils developed on predominantly basic granites, well drained, shallow to moderately deep, brown to dark yellowish brown, firm sandy clay loam (eutric **LUVISOLS**)

RIVER TERRACES AND FLOODPLAINS

Agc moderately well to poorly drained, very deep, mottled, dark greyish brown to brown, firm, sandy clay to clay, on low terraces (eutric **PLANOSOLS**)

AC complex of stratified and non-stratified soils of various textures, colours and drainage conditions; floodplains and on terraces of various levels (eutric **FLUVISOLS**)

MINOR VALLEYS AND BOTTOMLANDS

Soils developed on various parent materials

Vgc imperfectly to poorly drained, very deep, mottled, dark grey to greyish brown, firm, sandy clay to clay, in places calcareous at subsurface (eutric **GLEYSOLS**)

Vd poorly drained, very deep, black to dark grey, very firm clay (pellic **VERTISOLS**)

VC association of soils ranging from peat and very poorly drained, deep, mottled, very dark grey to dark greyish brown clay on the valley bottom, to soils of units U4Ur, U4Ub, U4Pr and U8Gr, but with 20 to 40 cm acid humic topsoil, on the valley sides (eutric **HISTOSOLS** to pellic **GLEYSOLS** - humic **FERRALSOLS**)

KEY

- all weather road
- railway line
- provincial boundary
- district boundary
- international boundary
- village
- dam
- river
- scarp
- hill
- soil boundary
- soil boundary (uncertain)
- slope class boundary
- U7Bbc... slope class symbol
- p-E... depth class symbol
- *750-2 reference soil profile and number

KEY TO SLOPE CLASSES

slope %	slope class symbol*	name of macro-relief
0-2	A	flat to very gently undulating
2-5	B	gently undulating
5-8	C	undulating
8-16	D	rolling
16-30	E	hilly

* not indicated for mountains, hills, river terraces, floodplains, minor valleys and bottomlands

KEY TO DEPTH CLASSES

thickness soil in cm	symbol#	name
0-25	P	very shallow
25-50	P	shallow
50-80	P	moderately deep
more than 80	P	deep

if a complex of depth classes occurs in one unit, only the symbol of the shallowest depth class is indicated



SCALE 1:100,000