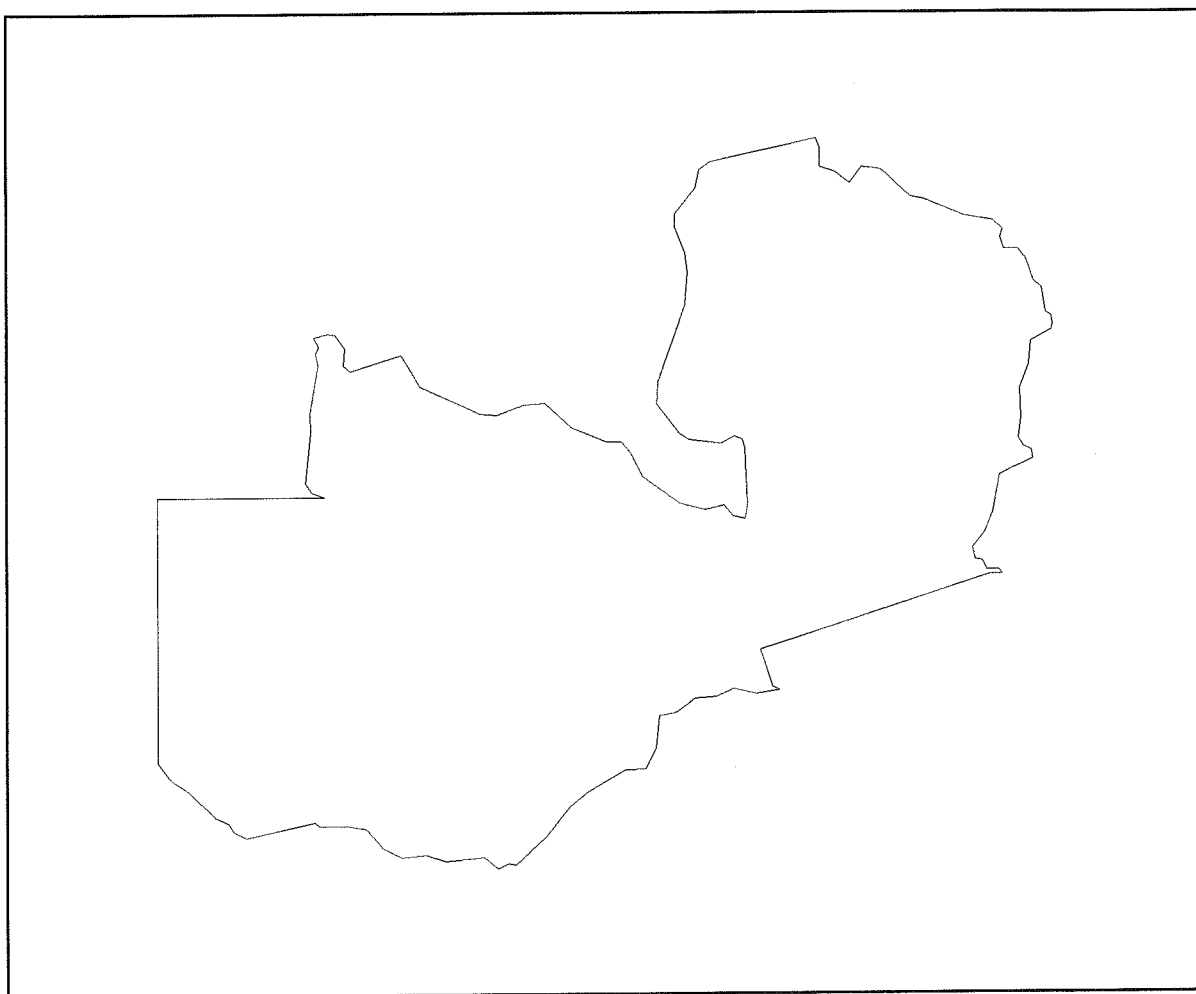


Soil Reference Profiles of Zambia

Field and Analytical Data



International Soil Reference and Information Centre



ISPIC

July 1994

Soil Reference Profiles of Zambia

Field and Analytical Data

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International Soil Reference and Information Centre

July 1994

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FOREWORD

National Soil Reference Collection and Database of Zambia

The objective of this Country Report is to provide comprehensive field and analytical data of a number of reference soils representative for some major soils of Zambia. The soils were carefully selected, described and sampled by the Zambian Soil Survey Unit and ISRIC. The reference profiles ZM001 to ZM010 which were collected in 1977, were analyzed in the ISRIC laboratory, while analytical data for ZM011, described in 1985 as one of Zambia's benchmark soils, were generated by the USDA's National Soil Survey Laboratory, Lincoln, Nebraska, USA, and ISRIC.

The soils described are located in the Northern, Copperbelt, Western and Lusaka Provinces. The sites were selected on a number of criteria, such as major soil type representative for one of Zambia's major ecological zones ("rainfall zones"), production potential, typical parent material and advanced stage of weathering.

At present the collection comprises 11 reference soil profiles. From each soil an undisturbed column was taken, and specially preserved and prepared into a soil monoliths, ready for exposition. These monoliths are included in ISRIC's world soil collection in the Netherlands. No national collection exists in Zambia.

The eleven soils do not provide a complete overview of Zambia's main soils. Important soils from the central part of the country (well developed, "hard-setting" Acrisols with a sharp clay increase), the northwestern part (extremely leached Ferralsols), the southern part (only slightly leached Lixisols) and the eastern part (only moderately weathered Cambisols, Luvisols and Acrisols), as well as the hydromorphic soils from dambos and dambo margin (Gleysols, Arenosols, Plinthosols) typical for the plateau depressions in Zambia, are still lacking.

A Zambian soil information system (ZAMSIS) is installed at the headquarters of the Soil Survey Unit at the Mount Makulu Central Research Station near Chilanga. This pedon data base contains profile descriptions and analyses of soils collected during recent surveys, as well as the Zambian benchmark soils.

International Soil Reference Collection and Database

The International Soil Reference and Information Centre (ISRIC), founded in 1966 as an initiative of the International Society of Soil Science (ISSS) has a mandate to collect and disseminate scientific knowledge about soils for the purpose of a better understanding of their formation, characterization, classification, distribution and capability for sustained land use at local, national, and global scales. One of ISRIC's main objectives is to assemble soil profiles, soil samples and associated information to illustrate the units of the FAO-Unesco Soil Map of the World. To date, the world soil collection consists of over 800 reference soils from 60 countries, accompanied by soil and environmental data. The collection is supported by a soil map collection, soil reports library, a thin section collection and a slide collection.

The National Soil Reference Collection Programme (NASREC), supported by the Directorate General for International Cooperation of the Netherlands within the Action Plan of National Soil Policies of UNEP, and through ISRIC's own budget has been instrumental to achieve this objective.

The collected information of the reference soil profiles is stored in ISRIC's Soil Information System (ISIS), a database management system for storing and retrieving data on geology, geomorphology, hydrology, soil morphology, soil chemical and physical characteristics, and climate.

To disseminate its data, ISRIC has combined the different types of information into several publication series. Each series aims to address the varying needs of those working in one of many fields of research using soils data and soil related data. One of this series is the Country Reports.

The Country Reports, containing all ISRIC held data on soils and associated information of a specific country are generated by ISIS. Additional information on literature references, small scale maps, and a list of slides available in the ISRIC Slide Database is included. Country reports are, whenever possible, jointly published by the national institution involved in the collection and ISRIC. A list of Country Reports (in press) is given on the back cover of this report. We are very pleased to release the draft Zambian Country Report at the occasion of the XVth World Congress of Soil Science.

Any comments on the Country Report series in general or on the presentation of the data in particular is highly appreciated and may be communicated to the director of ISRIC.

Dr. L.R. Oldeman, Director ISRIC

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 Reference soil
 Meteorological station
 Town
 State boundary
 River
 Ocean, lake

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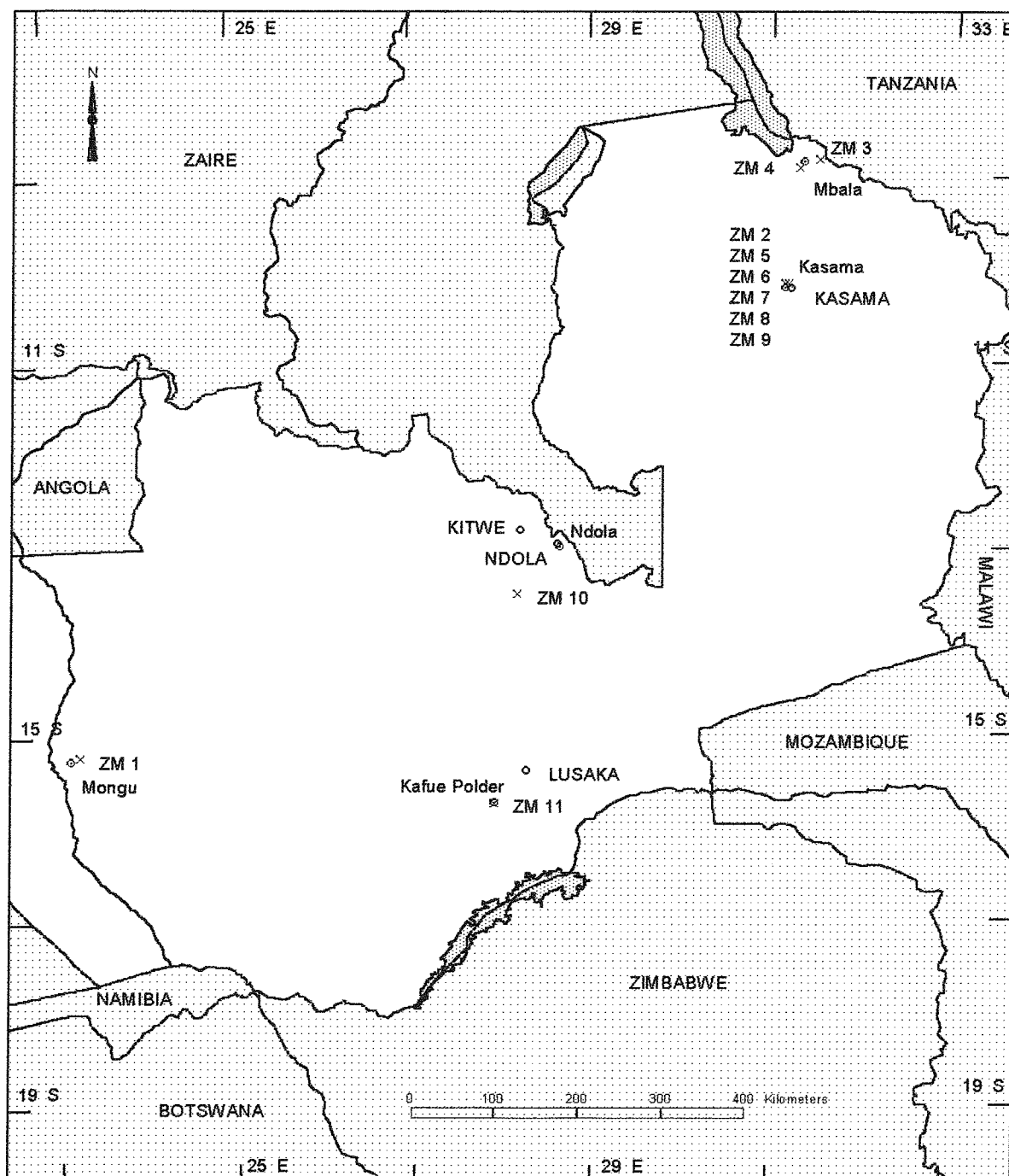
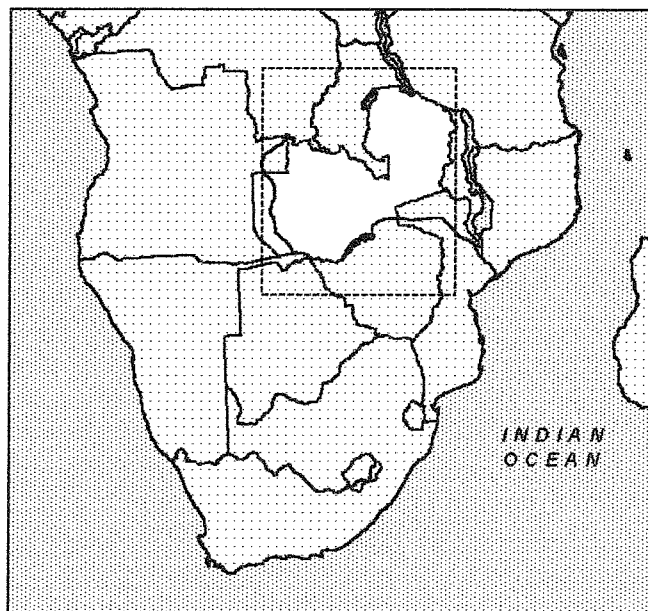


Table 1. Summarized information on the reference soils ZM001 to ZM011

ISIS_ID	FAO (1988)	FAO (1974)	USDA Soil Taxonomy (1992)	MODE	CLIM	LNDRG	LUT	VET	DRAIN	ALT
ZM001	Carbic Podzol	Humic Podzol	Arenic Alorthod	olian deposits	Aw	plateau	woodland, grazed	woodland	somewhat excessive	1000
ZM002	Haplic Ferralsol	Orthic Ferralsol	Rhodic Haplustox	residual material	Aw	plateau	woodland, grazed	deciduous woodland	well	1385
ZM003	Haplic Acrisol	Ferric Acrisol	Paleustult	residual material	Aw	plateau		grassland	well	1750
ZM004	Haplic Ferralsol	Orthic Ferralsol	Inceptic Haplustox	residual material	Aw	plateau	fallow		well	1700
ZM005	Xanthic Ferralsol	Xanthic Ferralsol	Typic Haplustox	residual material	Aw	plateau	woodland, grazed	deciduous woodland	well	1384
ZM006	Ferralic Cambisol	Ferralic Cambisol	Ustoxic Dystrypept	colluvium	Aw	plateau	woodland, grazed	deciduous woodland	well	1384
ZM007	Dystric Regosol	Dystric Regosol	Thapto-Ultic Ustifluent	colluvium	Aw	plateau	woodland, grazed	deciduous woodland	well	1384
ZM008	Haplic Ferralsol	Orthic Ferralsol	Typic Kandistult	residual material	Aw	plain	shrubland, grazed	deciduous shrub	well	1384
ZM009	Xanthic Ferralsol	Xanthic Ferralsol	Typic Haplustox	residual material	Aw	valley	(semi-) natural vegetation	deciduous forest	moderately well - well	1384
ZM010	Rhodic Ferralsol	Rhodic Ferralsol	Typic Haplustox	residual material	Aw	plateau	(semi-) natural vegetation	woodland	well	1200
ZM011	Eutric Vertisol	Chromic Vertisol	Udic Haplustert	lacustrine sediments	Aw	lacustrine plain	semi-natural grassland, grazed		poor	990

SOILS OF ZAMBIA¹

R.N. Magai²

Natural environment

Zambia lies between 8 and 18° S and has a climate affected by the altitude of its land surface, its continental position within Central and Southern Africa and the absence of high mountain ranges. The pronounced seasonal climate is characteristic of the savannah regions of Africa.

Most of Zambia lies over 1000 m a.s.l. and therefore experiences lower temperatures compared to areas of similar latitudes. The mean annual temperatures are between about 18 and 24° C. Monthly means range between 14-17° C in June/July and 22-26° C in September/October. Due to its flatness, it can generally be stated that the temperature shows little variation over the country, with the exception of the hottest valleys like the Luangwa and Gwembe.

The soil temperature regime for most of the country is isohyperthermic. In the south a hyperthermic soil temperature prevails while high altitude areas experience an isothermic soil temperature regime.

The annual rainfall exceeds 1400 mm in the extreme north of the North-Western Province and the west of Northern Province. The rainfall gradient shows a marked decrease southward to less than 700 mm along the southern portion of the country. Most of Western, southern Central and Eastern Provinces an annual total below 1000 mm. The area north of the 1000 mm isohyet is generally known as the "high rainfall zone".

Dominant soil moisture regimes are ustic and to a minor extent aquic in valleys and dambos. Locally udic soil moisture regimes occur depending in groundwater behavior and seepage, while isolated in the low rainfall zone soils may have an aridic soil moisture regime, due to low soil moisture storage capacity, low infiltration rates and the erratic character of the rainfall.

Zambia is underlain by ancient Archean rocks, which constitute the basement complex and consist mainly of metamorphosed gneisses, schists, quartzites, limestones and shales, with intrusive granites. Western Province is occupied by a mantle of sands known as the Kalahari formation. Biotite-rich gneisses are found in the southeast of Eastern Province, passing into more acidic gneisses, schists and quartzites of the basement complex in the north. The youngest rock formations, the Karroo sediments, are found in major river valleys which have escaped removal by denudation. Recent alluvium occurs widely in the upper Zambezi floodplain, the Kafue flats, in the Luangwa valley and in the Bangweulu and Lukanga swamps.

It is believed that regardless of long-continued weathering in areas where annual precipitation is less than 1000 mm, the influence of the parent material becomes more apparent. There is a close relationship between the soil and underlying rock or parent material, particularly with regard to soil texture, colour, structure and other morphological features.

Soils

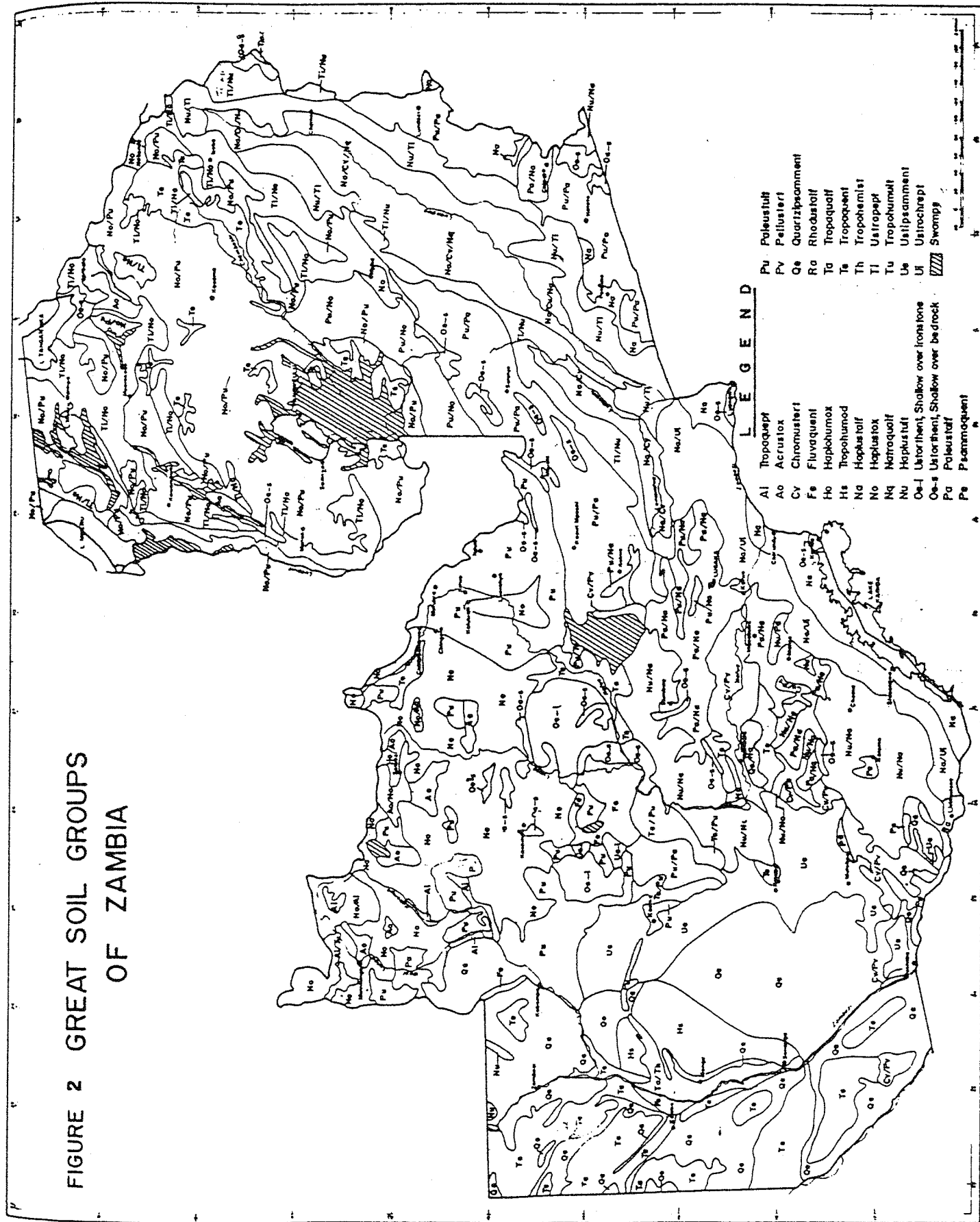
It has been established that Zambia contains all ten soil orders³, although in varying extents. The 1983 soil map of Zambia (scale 1:2,500,000) has been used to estimate the occurrence of the soil orders and soil families of Soil Taxonomy (Figure 2). Table 2 shows the extent of soil orders.

¹ Reproduced from: Woode P.R. (Ed.). 1988. Proceedings of the XIth International Forum on Soil Taxonomy and Agrotechnology Transfer, Zambia, July 15th to August 1st, 1985. p 136-140. The FAO (1988) soil names have been added by the compilers of this country report.

² Former Senior Soil Surveyor, Soil Survey Unit, Mount Makulu, Chilanga, Zambia.

³ The Soil Taxonomy edition referred to in this paper is the one of 1975.

FIGURE 2 GREAT SOIL GROUPS
OF ZAMBIA



LEGEND

- | | | | |
|----|----------------|------|-------------|
| Pu | Polestult | Al | Tropoquent |
| Pv | Pellustri | Ao | Acruox |
| Qe | Quartzipammant | Cv | Chromustri |
| Ra | Rhodustall | Fe | Fluvaquent |
| To | Tropoquent | Ho | Haplohumox |
| Te | Tropoquent | Hs | Haplohumod |
| Th | Tropoquent | Na | Haplohumox |
| Ti | Tropoquent | Nq | Haplohumox |
| Tu | Tropoquent | Nu | Haplohumox |
| Ue | Ustipammant | Oe-I | Ustipammant |
| Uo | Ustipammant | Oe-s | Ustipammant |
| Uu | Ustipammant | Pa | Polestult |
| Uv | Ustipammant | Pe | Pammament |
| Ux | Ustipammant | | |
| Uy | Ustipammant | | |
| Uz | Ustipammant | | |
- Oe-I Ustipammant Shallow over ironstone
Oe-s Ustipammant Shallow over bedrock
Pa Polestult
Pe Pammament

Table 2. Extent of the soil orders in Zambia

Entisols	25%
Inceptisols	24%
Oxisols	15%
Ultisols	15%
Alfisols	10%
Vertisols	7%
Spodosols	3%
Mollisols	< 1%
Aridisols	< 1%
Histosols	< 1%

Entisols (FAO (1988): mainly Leptosols, Regosols, Fluvisols and Arenosols) are one of the largest orders. They are soils that have slight development or have not developed horizons, other than perhaps the darkening of the topsoil by organic matter or the bleaching of sand grains. Their physical properties are determined largely by the parent material. These are generally soils in young alluvium, (sedimentary) siliceous sands or rocky hill slopes.

The commonly occurring suborders of Entisols are the non-wet sandy soils subjected to movement by wind if dry enough - the Psammments. The most widespread soil family in the suborder is the acid, isohyperthermic Ustic

Quartzipsamment (mainly Ferralic Arenosols), found in Western and North Western Provinces. These soils are formed in the Kalahari sand cover.

In the floodplains soils occur formed on sediments, the Fluvents (Fluvisols) and the wet Entisols, the Aquepts (Gleysols). Also occurring in Zambia are Entisols that are developed on youthful erosional geomorphic surfaces - the Orthents (Leptosols, Regosols). They typically occur on surfaces subject to erosion rather than deposition.

Inceptisols (FAO (1988): mostly Cambisols) are relatively young soils in which the parent material has been sufficiently altered by weathering, or by other soil forming processes, to have lost its original structure, but which has not been sufficiently altered by leaching or accumulation of clay, iron or humus to warrant recognition in an order of more developed soils.

Inceptisols are the second largest order. The most widespread soil family belongs to the loamy- and clayey-skeletal, mixed, isohyperthermic/isothermic/hyperthermic Lithic Ustropepts (mainly Ferralic, Dystric or Chromic Cambisols, lithic phase), as found on the hill ranges bordering the major valleys and on isolated hill ranges on the plateau. These soils have hardly been studied in detail.

Less widespread but still common subgroups are the Aeris and Typic Tropaquepts (Umbric and Dystric Gleysols), which constitute some dambo soils with either a loamy or clayey texture, and which occur in low-lying areas or depressions that are usually waterlogged, appearing everywhere on the plateau.

Oxisols (FAO (1988): mainly Ferralsols, but also Acrisols and Ferralic Cambisols) form the third largest order. This order contains intensively weathered soils on old land surfaces. They are characterized by low silica/sesquioxide ratios, low cation exchange capacities, low activity of clays and low content of weatherable minerals.

Oxisols in Zambia occur on a variety of physiographic positions and are also developed on a variety of parent materials. Most of them are found on the plateau, gently dissected older peneplains and non-dissected or erosional plains.

The loamy and clayey, kaolinitic isohyperthermic Ultic Haplustox (mostly Ferric and Haplic Acrisols) is the most widespread soil family. These soils are formed on acid metamorphic and sedimentary rocks. Next in line is the Typic Haplustox (dominantly Rhodic, Xanthic and Haplic Ferralsols, but also Ferralic Cambisols), mostly kaolinitic, but probably in North Western and Northern Provinces siliceous, is found on sedimentary rocks. Other important great soil groups are the Acrustox (Geric Ferralsols) and Haplohumox (Humic Ferralsols).

The new proposal for establishing kandic taxa would drastically reduce the extent of Oxisols by as much as 60% as most soils will classify as Kandistults. The new percentages of Oxisols and Ultisols would then be 6 and 24%, respectively.

Ultisols (FAO (1988): Alisols and Acrisols and some Nitisols) are soils in which a significant amount of clay has been leached from the topsoil into the subsoil but which, unlike Alfisols, have been strongly leached of bases. The presence of an argillic horizon and a low base status in the lower part of the soil is characteristic for the order.

The Oxic Paleustult (mainly various kinds of Acrisols) forms the major soil type in the Central and Southern Provinces where they are locally known as "Sandveldt soils". On the northern Plateau the Oxic Paleustult prevails interspaced with Oxic Haplustult and Ultic Haplustox. Other Ultisols in Zambia are various Aquults (Gleyic Alisols and Acrisols and some Planosols) and the Tropohumults (Humic Alisols and Acrisols) of the Nyika Plateau.

Alfisols (FAO (1988): mostly Nitisols, Luvisols and Lixisols) are characterized by prominent horizons of eluviation and illuviation. These are the soils in which a significant amount of clay has been leached from the topsoil into the subsoil but which have not been strongly leached of bases.

Examples of Alfisols occurring in Zambia are loamy and fine, kaolinitic isohyperthermic Oxic Hapustalfs (Ferric and Haplic Lixisols) and fine, mixed, isohyperthermic Typic Paleustalfs (mostly Ferric, Chromic and Haplic Luvisols and some Nitisols). These soils occur in the southern and eastern parts of the country. The typic Paleustalfs are probably the most productive soils in Zambia. The Haplustalfs are mainly found in the Southern Province.

Another important Alfisol is the Tropaqualf (Gleyic and Stagnic Luvisols and Lixisols), mainly occurring on the large river floodplains, for instance of the Zambezi.

Vertisols are heavy, strongly cracking, clay-textured soils, usually dark-coloured and often containing lime concretions at some depth in the subsoil. They occur in hot climates in lower-lying areas in the medium and low rainfall zones (less than 1000 mm).

They develop from a wide range of parent materials, but are commonly derived from calcareous rocks. Vertisols are also typically developed on alluvial material in flat land areas or depressions.

The fine, mixed, isohyperthermic Typic Pellustert and the fine, mixed, isohyperthermic Typic Chromustert (both Calcic and Eutric Vertisols) are the most commonly occurring families.

Spodosols (FAO (1988): Podzols) are soils developed in sandy to loamy material and are extremely acid soils in which the humus and/or iron and/or aluminium have been leached from the topsoil (leaving bleached sand behind), and deposited to form a darker or browner layer in the subsoil. The occurrence of these soils is confined to the Kalahari sands in the Western and North Western Provinces. In Zambia Spodosols are formed in materials almost devoid of iron and they belong mainly to the Typic and Arenic Tropohumods (Carbic Podzols).

Mollisols (FAO (1988): in Zambia chiefly Phaeozems) are soils which have a mollic epipedon and are relatively unleached with a thick dark coloured humus-rich friable topsoil. They cover a very limited area and are therefore hardly known. Ustolls occur to a limited areal extent in Lusaka, Southern and Eastern Provinces, often in association with Oxic Paleustalfs and Typic Pellusterts. Dominant Mollisols in Zambia belong to the Argiustoll (Luvic Phaeozems) great group.

Aridisols are very rare in Zambia. Only recently one of the driest parts near Luangwa may classify as Aridisol.

Histosols are comprised of soils derived primarily from organic parent material. They are classified according to defined states of decomposition and are recognized for organic materials. Their occurrence in Zambia is confined to swamps, lakes, dambos and river plains constituting a poorly drained environment. Most classify as Tropohemist, with Terric and Typic subgroups (FAO (1988): Terric Histosols). The soils are of limited coverage and underutilized for agricultural production.

Table 3. Occurrence of soil families in Zambia.

Land area	Soil Taxonomy (1975)	FAO (1988)
Widespread (10-20%)	acid, (iso)hyperthermic, uncoated Ustic Quartzipsamment	Arenosols
	loamy & clayey, kaolinitic, isohyperthermic Ultic Haplustox	Acrisols
	clayey-skeletal, mixed, (iso)hyperthermic Lithic Ustropept	Ferralsols
	clayey, kaolinitic, isohyperthermic Oxidic Paleustult	Cambisols
Very common (5-10%)	loamy, kaolinitic, isohyperthermic Aerit/Typic Tropaquept	Acrisols
	clayey, kaolinitic, (iso)hyperthermic Oxidic Haplustult	Ferralsols
Common (1-5%)	clayey, kaolinitic, isohyperthermic Typic Haplustox	
	loamy & fine, kaolinitic, hyperthermic Oxidic Haplustalf	Lixisols
	siliceous (acid), hyperthermic Humic Psammaquent	Arenosols
	fine-loamy, siliceous, (iso)hyperthermic Ultic Haplustox	Acrisols
	fine, mixed, isohyperthermic Typic Chromustert	Vertisols
	sandy & loamy, siliceous, isohyperthermic Typic Tropaquept	Gleysols

SOIL INFORMATION SHEETS

Generated by the ISRIC Soil Information System (ISIS, version 4.0)

FAO/UNESCO (1988) : Areni-Carbic Podzol
 USDA/SCS SOIL TAXONOMY (1992) : Arenic Alorthod, sandy, siliceous, isohyperthermic (1974 : Humic Podzol)
 LOCAL CLASSIFICATION : Kaande sand (1975 : Ustic Arenic Tropohumod)

DIAGNOSTIC CRITERIA FAO (1988) : umbric A, spodic B horizon
 USDA/SCS (1992) : umbric epipedon, spodic horizon
 Soil moisture regime : ustic
 Soil temperature regime : isohyperthermic

LOCATION : 14 km E of Mongu along Lusaka-Mongu road, 9 km E of signpost Mongu, Western Province
 Latitude : 15°13'45" S Longitude : 23°16' 0" E Altitude : 1000 m a.s.l.
 AUTHOR(S) : J.H.V. van Baren et al Date (mm/yy) : 2/77

GENERAL LANDFORM : plateau Topography : flat or almost flat
 PHYSIOGRAPHIC UNIT : near margin of valley
 SLOPE Gradient : 1%
 POSITION OF SITE : crest
 MICRO RELIEF Kind : none
 SURFACE CHAR. Rock outcrop : nil Stoniness : nil
 Cracking : nil Slaking/crusting : nil
 Salt : nil Alkali : nil
 SLOPE PROCESSES Soil erosion : slight wind

PARENT MATERIAL : eolian deposits
 Texture : sandy

EFFECTIVE SOIL DEPTH : 200 cm

WATER TABLE : no watertable observed
 DRAINAGE : somewhat excessive
 PERMEABILITY : high; no slow permeable layer(s)
 FLOODING Frequency : nil
 MOISTURE CONDITIONS PROFILE : 0 - 10 cm moist 10 - 200 cm dry

LAND USE : woodland, grazed; no irrigation
 VEGETATION Type : woodland Status : primary
 Landuse/vegetation remarks : sparse grasses, sedges

ADDITIONAL REMARKS :

CLASSIFICATION: FAO: Coarse textured. USDA (1975): Ustic Arenic Haplohumod, this is a tentative new subgroup due to the ustic moisture regime (normally udic). According to laboratory data org C is less than 0.6% in the upper 30 cm of the spodic B horizon --> entic subgroup? / PARENT MATERIAL: Kalahari (Barotse) sands of Mid-Tertiary to Early Pleistocene age (Dixey, 1944; Spaargaren, 1987). / PHYSIOGRAPHY: Terrace-like landscape (see H. Brammer, Geoderma 10, 1973. pp 249-250). SURFACE CHARACTERISTICS: leaf litter discontinuous on the soil surface, mostly concentrated under trees. / HYDROLOGY : depth groundwater: several meters. / HUMAN INFLUENCE: the monolith was taken in a dug-out sand pit. / CLIMATE: data have been copied from Müller (1983).

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- Müller, M.J. et al, 1983. Handbuch ausgewählter Klimastationen der Erde.
- Spaargaren, W.Th, 1987.
- Soil Correlation Section SSU, 1987. The Zambian Soil Series.

CLIMATE :		Köppen: Aw													
Station: MONGU		15 15 S/ 23 10 E				1052 m a.s.l				10 km W of site				Relevance: good	
		No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
EP Thorntwaite	mm	10	109	97	102	89	67	46	50	74	115	141	119	109	1118
relative humidity	%	10	77	80	75	65	56	50	42	34	31	40	64	75	57
precipitation	mm	30	217	211	145	37	1	0	0	0	2	35	102	222	972
no. of raindays		30	17	16	12	4	0	0	0	0	0	4	11	17	81
T mean	°C	11	24.2	24.4	24.2	23.9	21.5	19.2	19.1	21.8	25.8	27.2	26.1	24.2	23.5
T max	°C	22	28.0	28.0	28.0	29.0	28.0	26.0	26.0	29.0	33.0	34.0	31.0	29.0	29.0
T max abs	°C	22	34.0	33.0	34.0	33.0	33.0	32.0	32.0	36.0	37.0	39.0	38.0	37.0	39.0
T min	°C	22	19.0	19.0	18.0	17.0	13.0	10.0	9.0	12.0	16.0	18.0	18.0	18.0	16.0
T min abs	°C	22	13.0	14.0	12.0	9.0	2.0	0.0	-2.0	2.0	7.0	7.0	12.0	13.0	-2.0
windspeed(at 2m)	m/s	7	2.4	2.3	2.5	2.8	3.3	3.3	3.8	4.0	4.0	3.1	2.4	2.4	3.0
precip. max.	mm	30	419.0	483.0	341.0	165.0	22.0	16.0	0.0	11.0	28.0	135.0	264.0	380.0	1379.0
precip. min.	mm	30	68.0	73.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.0	92.0	604.0
precip. 24h max.	mm	30	85.0	114.0	89.0	51.0	8.0	14.0	0.0	11.0	28.0	41.0	71.0	84.0	114.0
bright sunshine	h/m	12	167.0	154.0	205.0	267.0	301.0	291.0	304.0	310.0	282.0	260.0	206.0	177.0	2924.0

PROFILE DESCRIPTION :

Very deep, somewhat excessively drained, very dark gray to very dark brown sandy soil developed in Kalahari (Barotse) sands. The black topsoil contains bleached sand grains and is covered by a thin layer of bleached sand where litter accumulation is lacking. The very dark gray (eluvial) part of the subsoil also contains some bleached sand grains and overlies a thick, very dark brown (illuvial) layer stained by organic coatings. The soil reaction is extremely acid in the eluvial layers and strongly to very strongly acid in the illuvial and lower layers.

Ah	0 - 28 cm	Black (10YR 2/1, moist) sand; single grain; non sticky, non plastic, loose, loose; many micro to fine continuous interstitial pores; highly porous; many fine and medium roots and few coarse roots; clear smooth boundary to
E	28 - 59 cm	Very dark gray (10YR 3/1, dry) sand; single grain; non sticky, non plastic, loose; many micro to fine continuous interstitial pores; highly porous; many fine and medium roots and few coarse roots; abrupt wavy boundary to
EB	59 - 74 cm	Very dark gray (10YR 3/1, dry) sand; single grain; non sticky, non plastic, loose; many micro to fine continuous interstitial pores; highly porous; many fine and medium roots and few coarse roots; wavy humic lamellae; clear wavy boundary, locally irregular with tongues extending into the B2h horizon, to
Bh1	74 - 104 cm	Very dark brown (10YR 2/2, dry) sand; weakly coherent massive; non sticky, non plastic, loose; broken thin humus cutans on grains; many micro to fine continuous interstitial pores; highly porous; many fine and medium roots; dark reddish brown lamellae; abrupt irregular boundary to
Bh2	104 - 175 cm	Very dark brown (10YR 2/2, dry) sand; weakly coherent massive; non sticky, non plastic, very friable, loose; broken thin humus cutans on grains; narrow tongues of bleached sand and humic lamellae penetrate from the Bh1 horizon; many micro to fine continuous interstitial pores; highly porous; many fine (few below 147 cm) and few medium and coarse roots; gradual smooth boundary to
BC	175 - 200 cm	Dark yellowish brown (10YR 3/4, dry) sand; weakly coherent massive; non sticky, non plastic, very friable, loose; patchy thin humus cutans on grains; many micro to fine continuous interstitial pores; highly porous; few medium and coarse roots; gradual smooth boundary to
C	200 cm +	Brown (10YR 5/3, dry) sand; weakly coherent massive; non sticky, non plastic, very friable, loose; few faint yellow brown mottles; many micro to fine continuous interstitial pores; highly porous; few fine and medium roots

ANALYTICAL DATA :

Hor. no.	Top - Bot	>2 mm	2000 1000	1000 500	500 250	250 100	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 µm	DISP	BULK DENS	pH- 0.0	1.0	1.5	2.0	2.3	2.7	3.4	4.2
1	0 - 3	-	0	8	70	17	2	98	0	2	2	0	-	-	-	-	-	-	-	-	-	-
2	0 - 10	-	0	8	69	19	3	99	0	1	1	0	-	-	-	-	-	-	-	-	-	-
3	10 - 28	-	0	8	70	17	3	99	0	1	1	0	-	-	-	-	-	-	-	-	-	-
4	28 - 47	-	0	7	67	21	5	99	0	1	1	0	-	-	-	-	-	-	-	-	-	-
5	47 - 59	-	0	7	65	22	5	99	1	0	1	0	-	-	-	-	-	-	-	-	-	-
6	59 - 74	-	0	7	64	24	5	99	0	1	1	0	-	-	-	-	-	-	-	-	-	-
7	74 - 88	-	0	7	63	24	5	99	0	0	1	1	-	-	-	-	-	-	-	-	-	-
8	88 - 104	-	0	7	67	22	3	99	0	0	1	1	-	-	-	-	-	-	-	-	-	-
9	104 - 120	-	0	6	55	29	7	97	1	0	1	2	-	-	-	-	-	-	-	-	-	-
10	120 - 140	-	0	5	59	29	6	98	0	0	1	1	-	-	-	-	-	-	-	-	-	-

Hor. no.	pH- H2O	-- KCl	CaCO3 %	ORG- C %	MAT. N %	EXCH Ca	CAT. Mg	----- K	----- Na	----- sum	EXCH H+Al	AC. Al	CEC soil	----- clay	----- OrgC	----- ECEC	BASE SAT %	Al SAT %	EC 2.5 mS/cm	EXTR. AC. KCl/TEA (pH 8.2)
1	4.4	3.5	-	1.90	0.15	1.9	0.5	0.1	-	2.5	0.8	0.3	9.0	-	6.6	3.3	28	3	0.12	5.0
2	4.2	3.1	-	1.67	0.10	0.2	0.0	0.0	-	0.2	1.3	0.4	7.0	-	5.8	1.5	3	6	0.07	6.8
3	4.3	3.2	-	0.86	0.05	0.1	0.0	0.0	-	0.1	1.5	1.0	3.2	-	3.0	1.6	3	31	0.03	3.8
4	4.6	3.7	-	0.52	0.02	0.1	0.0	0.0	-	0.1	1.0	0.6	2.8	-	1.8	1.1	4	21	0.02	3.4
5	4.7	3.9	-	0.37	0.02	0.1	0.0	0.0	-	0.1	0.7	0.4	2.0	-	1.3	0.8	5	20	0.02	3.4
6	5.0	4.3	-	0.36	0.01	0.1	0.0	0.0	-	0.1	0.6	0.3	1.0	-	1.3	0.7	10	30	0.02	3.0
7	5.0	4.4	-	0.56	0.02	0.1	0.0	0.0	-	0.1	0.7	0.4	1.6	320	2.0	0.8	6	25	0.02	3.6
8	5.1	4.6	-	0.51	0.02	0.1	0.0	0.0	-	0.1	0.5	0.3	2.2	275	1.8	0.6	5	14	0.01	3.4
9	5.3	4.7	-	0.42	0.02	0.1	0.0	0.0	-	0.1	0.4	0.3	1.0	62	1.5	0.5	10	30	0.01	2.8
10	5.2	4.7	-	0.36	0.01	0.1	0.0	0.0	-	0.1	0.3	0.2	1.8	164	1.3	0.4	6	11	0.01	2.2

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe Al Si (by AMM. OXALATE(o), Na DITHION(d) & PYROPHOSP(p))

Hor. no.	MI	VE	CH	SM	KA	HA	ML	QU	FE	GI	GO	HE	MX	Fe(o)	Al(o)	Si(o)	Fe(d)	Al(d)	Fe(p)	Al(p)
1	-	-	-	-	4	-	-	2	-	-	-	-	2	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2	-	-	-	-	4	-	-	2	4	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	-	-	-	-	4	-	-	4	-	-	-	-	-	0.0	0.0	0.0	0.0	0.1	0.0	0.1
4	-	-	-	-	4	-	-	4	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.1
5	-	-	-	-	4	-	-	4	-	-	-	-	2	0.0	0.0	0.0	0.0	0.0	0.0	0.1
6	-	-	-	-	4	-	-	3	-	-	-	-	-	0.0	0.0	0.0	0.0	0.1	0.0	0.1
7	-	-	-	-	4	-	-	4	-	-	-	-	4	0.0	0.1	0.0	0.0	0.1	0.0	0.1
8	-	-	-	-	4	-	-	3	-	-	-	-	2	-	-	-	-	-	-	-
9	-	-	-	-	4	-	-	4	-	-	-	-	2	-	-	-	-	-	-	-
10	-	-	-	-	4	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-

ANALYTICAL DATA :

ELEMENTAL COMPOSITION OF TOTAL SOIL (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/Al2O3	SiO2/Fe2O3	SiO2/R2O3	Al2O3/Fe2O3
1	96.1	0.4	0.0	0.01	0.00	0.01	-	0.03	0.00	0.00	2.3	408	****	408	****
2	96.8	0.3	0.0	0.00	0.00	0.01	-	0.04	0.00	0.00	2.7	548	****	548	****
3	98.8	0.3	0.0	0.00	0.00	0.00	-	0.04	0.00	0.00	1.4	559	****	559	****
4	98.9	0.3	0.0	0.00	0.00	0.00	-	0.03	0.00	0.00	0.7	560	****	560	****
5	98.5	0.4	0.1	0.00	0.00	0.00	-	0.04	0.00	0.00	0.6	418	2622	361	6.3
6	99.0	0.4	0.0	0.00	0.00	0.00	-	0.04	0.00	0.00	0.5	420	****	420	****
7	98.2	0.5	0.1	0.00	0.00	0.00	-	0.04	0.00	0.00	0.9	333	2614	296	7.8
8	97.6	0.7	0.1	0.00	0.00	0.00	-	0.06	0.00	0.00	1.3	237	2598	217	11.0
9	97.9	0.7	0.0	0.00	0.00	0.01	-	0.06	0.00	0.00	1.0	237	****	237	****
10	90.0	0.7	0.0	0.00	0.00	0.01	-	0.07	0.00	0.00	8.9	218	****	218	****

ELEMENTAL COMPOSITION OF TOTAL CLAY (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	BaO	SiO2/Al2O3	SiO2/Fe2O3	SiO2/R2O3	Al2O3/Fe2O3
2	36.9	15.9	1.7	0.13	0.12	0.18	-	3.05	0.03	0.18	32.6	7.70	-	-	-	-
3	32.2	23.7	2.8	0.07	0.14	0.17	-	4.50	0.01	1.31	22.9	11.26	-	-	-	-
4	28.5	25.9	3.3	0.05	0.14	0.14	-	4.13	0.01	1.68	20.1	12.75	-	-	-	-
5	29.3	27.0	4.1	0.05	0.14	0.14	-	3.95	0.01	1.36	19.3	11.02	-	-	-	-
6	28.9	29.9	4.9	0.03	0.14	0.14	-	3.31	0.01	1.27	20.4	9.76	-	-	-	-
7	24.6	31.1	3.6	0.01	0.10	0.17	-	2.72	0.00	0.79	29.1	5.77	-	-	-	-
8	24.4	31.0	2.7	0.01	0.12	0.12	-	2.50	0.01	0.84	27.7	6.60	-	-	-	-
9	22.7	27.2	1.9	0.02	0.10	0.27	-	1.94	0.00	0.66	29.7	7.29	-	-	-	-
10	26.4	31.1	2.2	0.01	0.12	0.13	-	2.42	0.00	0.77	28.1	7.17	-	-	-	-

FAO/UNESCO (1988) : Acris-Haplic Ferralsol (Alumic)
 USDA/SCS SOIL TAXONOMY (1992) : Rhodic Haplustox, fine-loamy, siliceous, isohyperthermic (1974 : Orthic Ferralsol)
 LOCAL CLASSIFICATION : Katito sandy clay loam (1975 : Typic Haplustox)

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, argic B, ferralic B horizon
 USDA/SCS (1992) : ochric epipedon, oxic horizon
 Soil moisture regime : ustic
 Soil temperature regime : isohyperthermic

LOCATION : Misamfu Regional Research Station, Kasama District, Northern Province
 Latitude : 10°10' S Longitude : 31°10' E Altitude : 1385 m a.s.l.
 AUTHOR(S) : Van Baren, J.H.V. et al Date (mm/yy) : 2/77

GENERAL LANDFORM : plateau Topography : undulating
 PHYSIOGRAPHIC UNIT : slope
 SLOPE Gradient : 3%
 POSITION OF SITE :
 MICRO RELIEF Kind : none Pattern : none
 SURFACE CHAR. Rock outcrop : nil Stoniness : nil
 Cracking : nil Slaking/crusting : nil
 Salt : nil Alkali : nil
 SLOPE PROCESSES Soil erosion : nil Aggradation : nil
 Slope stability : stable

PARENT MATERIAL : residual material derived from sandstone

EFFECTIVE SOIL DEPTH : >200 cm

WATER TABLE : no water table observed
 DRAINAGE : well
 PERMEABILITY : moderate; no slow permeable layer(s)
 FLOODING Frequency : nil Run off : medium
 MOISTURE CONDITIONS PROFILE : 0 - 130 cm moist

LAND USE : woodland, grazed
 VEGETATION Type : deciduous woodland Status : secondary
 Landuse/vegetation remarks : Brachystegia, Julbernardia

CLIMATE : Köppen: Aw
 Station: KASAMA 10 13 S/ 31 8 E 1384 m a.s.l. 10 km S of site Relevance: good

	No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
relative humidity %		82	82	81	75	65	59	55	49	45	43	63	77	60
precipitation mm		280	233	245	70	9	1	1	0	2	23	149	266	1360
no. of raindays		21	19	18	5	1	0	0	0	0	2	13	22	101
T mean °C		19.8	19.9	20.1	20.3	18.8	17.1	16.9	18.8	21.6	23.4	21.7	20.1	19.8
T max °C		26.0	26.1	26.1	26.3	25.6	24.6	24.7	26.8	29.4	31.4	28.7	26.5	26.9
T max abs °C		31.1	30.0	30.0	31.1	29.4	30.6	28.9	32.8	34.4	35.0	35.0	32.8	35.0
T min °C		16.2	16.3	16.2	15.3	12.6	10.0	9.6	11.1	13.8	16.1	16.5	16.3	15.8
T min abs °C		13.3	12.8	12.2	10.6	6.7	3.9	4.4	2.8	6.1	11.7	13.3	12.8	2.8

PROFILE DESCRIPTION :

Very deep, well drained, dark red sandy clay loam derived from sandstone. The soil has weakly to moderately developed subangular blocky structures throughout. The organic carbon content is medium and the overall soil reaction is acid.

Ah	0 - 7 cm	Dark reddish brown (5 YR 3/3, moist) sandy loam; weak to moderate subangular blocky structure; many very fine pores; many fine roots; clear wavy boundary to
BA	7 - 24 cm	Dark reddish brown to dark red (2.5 YR 3/5, moist) sandy clay loam; weak to moderate medium to coarse subangular blocky structure; sticky, slightly plastic, very friable, soft; common very fine pores; many fine and medium roots; diffuse smooth boundary to
Bt1	24 - 40 cm	Dark red (2.5 YR 3/6, moist) sandy clay loam; weak to moderate medium to coarse subangular blocky structure; sticky, slightly plastic, friable, soft; patchy thin clay cutans; common very fine to fine pores; many fine roots; diffuse smooth boundary to
Bt2	40 - 70 cm	Dark red (2.5 YR 3/6, moist) sandy clay loam; weak fine to medium subangular blocky structure; sticky, plastic, very friable, soft; patchy thin clay cutans; common very fine to fine pores; common fine and medium roots; diffuse smooth boundary to
Bt3	70 - 100 cm	Dark red (2.5 YR 3/6, moist) sandy clay loam; weak fine to medium subangular blocky structure; sticky, plastic, very friable, soft; patchy thin clay cutans; common very fine to fine pores; common fine and medium roots; diffuse smooth boundary to
Bt4	100 - 130 cm	Red (2.5 YR 4/6, moist) sandy clay loam; weak fine to medium subangular blocky structure; sticky, plastic, very friable, soft; patchy thin clay cutans; common very fine to fine pores; common fine and medium roots

ANALYTICAL DATA :

Hor. no.	Top - Bot	>2 mm	2000 1000	500 250	100 50	TOT SAND	50 20	TOT SILT	<2 µm	DISP	BULK DENS	pH	1.0	1.5	2.0	2.3	2.7	3.4	4.2	SPEC. SOIL	SURF. m2/g
1	0 - 7	-	1	2	8	33	27	71	6	3	9	21	1.5	-	-	-	-	-	-	-	34
2	7 - 20	-	1	2	8	33	26	70	5	4	9	21	2.0	-	-	-	-	-	-	-	32
3	20 - 40	-	1	2	8	32	25	68	5	2	7	26	0.5	-	-	-	-	-	-	-	32
4	40 - 70	-	1	2	8	32	23	66	4	2	6	27	0.5	-	-	-	-	-	-	-	33
5	70 - 100	-	1	2	7	31	24	66	5	2	7	28	0.5	-	-	-	-	-	-	-	33
6	100 - 130	-	1	2	7	30	25	65	5	3	8	27	0.5	-	-	-	-	-	-	-	32
7	130 - 155	-	1	2	7	31	24	65	5	2	8	27	0.5	-	-	-	-	-	-	-	32

Hor. no.	pH-H2O	CaCO3 KCl	CaCO3 %	ORG-C %	MAT. N %	EXCH. Ca	CAT. Mg	----- K	----- Na	sum	EXCH. H+Al	AC. Al	CEC soil	----- clay	----- OrgC	ECEC	BASE SAT %	Al SAT %	EC 2.5 mS/cm	EXTR. AC. KCl/TEA pH 8.2
1	5.0	4.3	-	2.70	0.18	1.6	0.3	0.0	0.2	2.1	0.8	0.5	7.1	34	9.5	2.9	30	7	0.22	8.7
2	5.0	4.1	-	1.20	0.17	0.6	0.1	0.0	0.1	0.8	1.3	1.0	5.2	24	4.2	2.1	15	19	0.04	8.1
3	5.1	4.2	-	0.40	0.13	0.1	0.0	0.0	0.1	0.2	1.0	0.8	2.6	10	1.4	1.2	8	31	0.03	3.8
4	5.2	4.3	-	0.20	0.02	0.4	0.1	0.0	0.1	0.6	0.7	0.8	2.4	9	0.7	1.3	25	33	0.02	3.2
5	5.0	4.3	-	0.10	0.14	0.0	0.1	0.0	0.0	0.1	0.8	0.6	1.9	7	0.4	0.9	5	32	0.01	3.0
6	4.9	4.2	-	0.20	0.21	0.1	0.0	0.0	0.0	0.1	0.9	0.6	1.7	6	0.7	1.0	6	35	0.01	3.4
7	5.1	4.2	-	0.10	0.54	0.1	0.0	0.0	0.0	0.1	0.8	0.7	1.7	6	0.4	0.9	6	41	0.01	3.4

remarks (hor. 1 - 7): CEC/bases determined at pH 8.2

ELEMENTAL COMPOSITION OF TOTAL SOIL (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/Al2O3	SiO2/Fe2O3	SiO2/R2O3	Al2O3/Fe2O3
1	86.5	8.5	4.9	0.03	0.01	0.21	-	0.73	0.03	0.08	-	17.3	47.0	12.6	2.7
2	87.5	7.5	4.7	0.08	0.03	0.20	-	0.74	0.03	0.09	-	19.8	49.6	14.1	2.5
3	84.3	10.1	5.3	0.01	0.01	0.22	-	0.78	0.02	0.04	-	14.2	42.3	10.6	3.0
4	83.0	10.8	5.4	0.00	0.00	0.23	-	0.79	0.01	0.04	-	13.0	40.9	9.9	3.1
5	83.3	10.9	5.4	0.00	0.01	0.23	-	0.81	0.01	0.02	-	13.0	41.1	9.9	3.2
6	83.4	10.6	5.4	0.00	0.02	0.23	-	0.80	0.01	0.02	-	13.4	41.1	10.1	3.1
7	82.4	10.6	5.3	0.00	0.02	0.23	-	0.80	0.01	0.02	-	13.2	41.4	10.0	3.1

ELEMENTAL COMPOSITION OF TOTAL CLAY (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/Al2O3	SiO2/Fe2O3	SiO2/R2O3	Al2O3/Fe2O3
1	43.3	39.8	10.9	0.06	0.2	0.9	-	1.4	0.01	0.7	-	1.8	10.6	1.6	5.7
2	43.3	40.7	11.1	0.02	0.2	0.9	-	1.4	0.10	0.5	-	1.8	10.4	1.5	5.8
3	44.6	40.7	11.4	0.01	0.2	0.8	-	1.4	0.03	0.3	-	1.9	10.4	1.6	5.6
4	43.7	40.2	11.4	0.00	0.2	0.8	-	1.4	0.01	0.3	-	1.8	10.2	1.6	5.5
5	43.6	40.1	11.3	0.00	0.1	0.8	-	1.4	0.02	0.3	-	1.8	10.3	1.6	5.6
6	43.8	40.4	11.5	0.00	0.1	0.8	-	1.4	0.01	0.2	-	1.8	10.1	1.6	5.5
7	43.2	40.0	11.4	0.00	0.1	0.8	-	1.4	0.01	0.2	-	1.8	10.1	1.6	5.5

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTR Fe Al Si (by AMM. OXALATE(o), Na DITHION(d) & PYROPH(p) / AVAIL P (Olsen)

Hor. no.	MI	VE	CH	SM	KA	HA	ML	QU	FE	GI	GO	HE	Fe(o)	Al(o)	Si(o)	Fe(d)	Al(d)	Fe(p)	Al(p)	P mg/kg
1	2	-	-	-	6	-	2	-	-	-	4	-	0.1	0.1	-	1.8	0.2	0.1	0.1	45.5
2	2	-	-	-	6	-	2	-	-	-	4	4	0.1	0.2	-	2.2	0.2	0.1	0.2	17.8
3	2	-	-	-	6	-	2	-	-	-	4	-	0.1	0.1	-	2.3	0.2	0.1	0.1	3.5
4	2	-	-	-	6	-	2	-	2	-	4	-	0.1	0.1	-	2.3	0.2	0.0	0.0	0.7
5	2	-	-	-	6	-	2	-	-	-	4	4	0.0	0.1	-	2.3	0.2	0.0	0.0	1.9
6	2	-	-	-	6	-	2	-	-	-	4	-	0.0	0.1	-	2.3	0.2	0.0	0.0	0.2
7	2	-	-	-	6	-	2	-	-	-	4	-	0.0	0.1	-	2.2	0.2	0.0	0.0	0.0

SAND MINERALOGY

Hor. no.	HEAV	LIGH	light fraction	heavy fraction	QU	FE	PL	RE	OP	TOUR	ZIRC	RUT	ANAT	HORN	STAU	AND	HYP
1	-	-	100	0	0	0	0	0	52	43	37	4	15	1	0	0	0
2	-	-	99	1	0	0	0	0	55	39	33	5	22	1	0	0	0
3	-	-	100	0	0	0	0	0	73	50	21	3	24	1	1	0	0
4	-	-	99	1	0	0	0	0	50	33	50	5	12	0	0	0	0
5	1.5	98.5	100	0	0	0	0	0	49	50	37	5	8	0	0	0	0
6	-	-	100	0	0	0	0	0	52	38	42	5	13	0	0	1	1
7	-	-	100	0	0	0	0	0	46	31	48	7	14	0	0	0	0

Key : light fraction: QU=quartz; FE=feldspar; PL=plagioclase; RE=rest group.

heavy fraction: OP=opaque; TOUR=tourmaline; ZIRC=zircon; RU=rutile; ANAT=anatase; HORN=green hornblende; STAU=staurolite; AND=andalusite; HYP=hypersthene.

Remarks (hor. 5) : many Fe-concretions in the opaque grains.

FAO/UNESCO (1988) : Vetit-Haplic Acrisol
 USDA/SCS SOIL TAXONOMY (1992) : Paleustult, clayey, kaolinitic, isothermic (1974 : Ferric Acrisol)
 LOCAL CLASSIFICATION : Mbala loam (1975 : Oxic Haplustult)

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, argic B horizon
 USDA/SCS (1992) : ochric epipedon, argillic horizon
 Soil moisture regime : ustic
 Soil temperature regime : isothermic

LOCATION : 2.5 km W of Kawimbe Mission along Mbala-Kawimbe road, Mbala District, Northern Province
 Latitude : 8°50' S Longitude : 31°30' E Altitude : 1750 m a.s.l.
 AUTHOR(S) : J.H.V. van Baren & L.A. van Sleen Date (mm/yy) : 2/77

GENERAL LANDFORM : plateau Topography : undulating
 PHYSIOGRAPHIC UNIT : gentle slope
 SLOPE Gradient : 3%
 POSITION OF SITE : slope
 MICRO RELIEF Kind : termite mounds Height : 400 cm
 SURFACE CHAR. Rock outcrop : nil Stoniness : nil
 Cracking : nil Slaking/crusting : nil
 Salt : nil Alkali : nil
 SLOPE PROCESSES Soil erosion : nil Aggradation : nil
 Slope stability : stable

PARENT MATERIAL : residual material derived from coarse-intermediate igneous (porphyry)

EFFECTIVE SOIL DEPTH : >150 cm

WATER TABLE : no watertable observed
 DRAINAGE : well
 PERMEABILITY : moderate; no slowly permeable layer(s)
 FLOODING Frequency : nil Run off : medium
 MOISTURE CONDITIONS PROFILE : 0 - 140 cm moist

VEGETATION Type : grassland
 Landuse/vegetation remarks : Elephant grass with *Triumfetta trifida*

ADDITIONAL REMARKS :
 CLASSIFICATION: FAO : medium textured; no ferrallitic B horizon because of (1) too high CEC, (2) too high silt/clay ratio. /
 MICRORELIEF: termite mounds average base diameter 8 m, distance 80 m; reddish coloured. / HUMAN INFLUENCE: ploughing, as indicated by an abrupt boundary at 25 cm.

CLIMATE :		Köppen: Aw													
Station: MBALA		8 51 S/ 31 20 E			1673 m a.s.l.			13 km W of site			Relevance: moderate				
		No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
relative humidity	%		86	85	85	81	67	61	55	50	48	51	71	81	68
precipitation	mm		250	215	222	120	9	2	0	0	3	12	143	243	1219
no. of raindays			20	18	19	10	1	1	0	0	1	3	7	12	93
T mean	°C		17.8	17.9	18.1	18.3	18.1	16.4	16.3	18.1	19.9	20.7	19.2	18.0	18.2
T max	°C		22.8	23.2	23.9	24.5	24.7	23.9	23.9	25.6	27.1	27.8	25.3	23.2	24.7
T max abs	°C		28.9	28.3	27.8	27.8	27.8	27.2	27.2	29.4	30.6	31.7	31.1	30.6	31.7
T min	°C		14.6	14.7	14.8	14.7	12.3	10.7	10.6	11.8	13.6	15.2	15.3	14.8	13.6
T min abs	°C		12.2	12.2	12.2	11.1	7.8	5.6	5.6	6.1	10.6	11.7	11.7	12.2	5.6

PROFILE DESCRIPTION :

Deep, well drained, reddish brown to yellowish red clay derived from porphyric weathering products. The soil has a moderately developed subangular blocky structure, becoming weaker with depth. The organic carbon content is low and the soil reaction is slightly acid to neutral throughout. The upper part of the subsoil becomes extremely hard upon drying ("hard-setting").

Ap	0 - 25 cm	Dark brown (8YR 4/4, moist) loam; moderate fine to medium subangular blocky structure; slightly hard; many micro to fine pores; common fine and medium roots; frequent biological activity; abrupt smooth boundary to
AB	25 - 45 cm	Reddish brown (5YR 4/4, moist) clay; moderate medium to coarse subangular blocky structure; extremely hard; many micro to very fine pores; few fine roots; gradual wavy boundary to
Bt1	45 - 82 cm	Yellowish red (5YR 4/8, moist) clay; weak to moderate medium to coarse subangular blocky structure; soft; many micro to fine pores; diffuse smooth boundary to
Bt2	82 - 140 cm	Yellowish red (5YR 4/8, moist) clay loam; soft; many micro pores

ANALYTICAL DATA :

Hor. no.	Top - Bot	>2 mm	2000 1000	1000 500	500 250	250 100	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 µm	DISP	BULK DENS	pF- 0.0	1.0	1.5	2.0	2.3	2.7	3.4	4.2	SPEC. SOIL	SURF. m2/g
1	0 - 17	-	1	7	13	11	8	40	31	6	38	22	9.5	1.22	48	46	37	27	23	19	7	6		32
2	17 - 28	-	2	7	12	9	7	38	29	8	37	25	9.5	-	-	-	-	-	-	-	-	-	-	35
3	28 - 45	-	1	6	9	6	5	27	26	6	32	41	13.0	1.41	38	39	34	28	25	22	15	14		54
4	45 - 60	-	1	5	8	6	5	25	25	5	30	45	4.5	-	-	-	-	-	-	-	-	-	-	58
5	60 - 80	-	1	5	8	6	5	25	26	6	32	43	1.5	-	-	-	-	-	-	-	-	-	-	56
6	80 - 120	-	1	6	6	6	6	25	29	7	36	39	4.5	1.24	47	46	38	28	24	21	13	12		51

Hor. no.	pH-H2O	--KCl	CaCO3 %	ORG-C %	MAT-N %	EXCH Ca	CAT. Mg	-----K	-----Na	sum	EXCH H+Al	AC. Al	CEC soil	-----clay	-----OrgC	ECEC	BASE SAT %	AL SAT %	EC 2.5 mS/cm	EXTR. AC. KCl/TEA pH 8.2
1	5.8	4.7	-	0.90	-	1.2	0.6	0.3	0.0	2.1	0.2	0.2	8.1	36	3.1	2.3	26	2	0.05	1.3
2	5.8	4.6	-	0.75	-	1.2	0.5	0.4	0.0	2.1	0.2	0.1	7.9	31	2.6	2.3	27	1	0.05	2.0
3	6.0	4.6	-	0.49	-	0.4	0.6	0.5	0.0	1.5	0.2	0.1	8.4	20	1.7	1.7	18	1	0.03	2.7
4	6.0	4.7	-	0.32	-	0.8	0.8	0.5	0.0	2.1	0.2	0.0	9.2	21	1.1	2.3	23	0	0.03	2.8
5	5.8	4.8	-	0.23	-	0.0	0.8	0.4	0.0	1.2	0.1	0.0	8.6	20	0.8	1.3	14	0	0.02	2.6
6	6.1	5.0	-	0.15	-	0.2	0.7	0.3	0.0	1.2	0.1	0.0	6.8	17	0.5	1.3	18	0	0.02	2.2

ELEMENTAL COMPOSITION OF TOTAL SOIL (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/Al2O3	SiO2/Fe2O3	SiO2/R2O3	Al2O3/Fe2O3
1	85.2	8.3	2.8	0.04	0.07	0.80	-	0.40	0.05	0.02	4.5	17.4	81.0	14.3	4.6
2	83.7	9.5	3.2	0.05	0.08	0.91	-	0.44	0.05	0.02	4.8	15.0	69.6	12.3	4.7
3	76.3	14.6	4.1	0.03	0.10	0.82	-	0.57	0.03	0.03	6.1	8.9	49.5	7.5	5.6
4	74.2	15.6	4.2	0.03	0.07	0.75	-	0.59	0.02	0.02	6.3	8.1	47.0	6.9	5.8
5	74.7	15.5	4.2	0.01	0.08	0.78	-	0.58	0.02	0.01	6.0	8.2	47.3	7.0	5.8
6	77.0	13.8	3.8	0.01	0.08	0.80	-	0.56	0.02	0.01	5.4	9.5	53.9	8.1	5.7
7	58.8	20.1	7.5	0.87	1.22	3.80	-	0.77	0.12	0.13	8.1	5.0	20.9	4.0	4.2

remarks (hor. 7) : sample of parent material

ELEMENTAL COMPOSITION OF TOTAL CLAY (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/Al2O3	SiO2/Fe2O3	SiO2/R2O3	Al2O3/Fe2O3
2	42.5	34.8	8.2	0.03	0.22	0.96	-	1.28	0.15	0.25	13.8	2.1	13.9	1.8	6.7
3	42.8	36.0	8.3	0.02	0.19	0.88	-	1.21	0.06	0.14	13.4	2.0	13.7	1.8	6.8
4	40.2	34.6	8.1	0.00	0.20	0.79	-	1.16	0.04	0.12	13.5	2.0	13.2	1.7	6.7
5	39.0	33.7	8.0	0.01	0.19	0.78	-	1.13	0.04	0.10	14.0	2.0	12.8	1.7	6.6
6	40.5	34.4	8.1	0.00	0.20	0.86	-	1.19	0.03	0.11	13.5	2.0	13.2	1.7	6.6

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe Al Si (by AMM. OXALATE(o), Na DITHION(d) & PYROPHO(p))

Hor. no.	MI	VE	CH	SM	KA	HA	ML	QU	FE	GI	GO	HE	MX	Fe(o)	Al(o)	Si(o)	Fe(d)	Al(d)	Fe(p)	Al(p)
1	2	-	-	-	8	-	-	1	-	-	3	-	-	0.1	0.1	0.0	1.4	0.2	0.1	0.1
2	3	-	-	-	8	-	-	1	-	-	3	-	-	0.1	0.1	0.0	1.6	0.2	0.1	0.1
3	3	-	-	-	8	-	-	1	-	-	3	-	2	0.1	0.1	0.0	1.8	0.3	0.1	0.1
4	3	-	-	-	8	-	-	1	-	-	3	-	-	0.1	0.1	0.0	1.9	0.3	0.1	0.1
5	3	-	-	-	8	-	-	1	-	-	3	-	-	0.1	0.1	0.0	1.8	0.3	0.0	0.0
6	3	-	-	-	8	-	-	1	-	-	3	-	-	0.1	0.1	0.0	1.7	0.3	0.0	0.0

FAO/UNESCO (1988) : Vetii-Haplic Ferralsol
 USDA/SCS SOIL TAXONOMY (1992) : Inceptic Haplustox, very fine, kaolinitic, isothermic (1974 : Orthic Ferralsol)
 LOCAL CLASSIFICATION : Malashi clay (1975 : Tropeptic Haplustox)

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, ferralic B horizon
 USDA/SCS (1992) : ochric epipedon, oxic horizon
 Soil moisture regime : ustic
 Soil temperature regime : isothermic, bordering isohyperthermic

LOCATION : Kleynhans/Kilima farm, 12 km W of Mbala-Kasama road, Northern Province
 Latitude : 8°55' S Longitude : 31°17' E Altitude : 1700 m a.s.l.
 AUTHOR(S) : Van Baren, J.H.V. et al Date (mm/yy) : 2/77

GENERAL LANDFORM : plateau Topography : undulating
 PHYSIOGRAPHIC UNIT : floor of rather steeply and deep incised valley
 SLOPE Gradient : 1%
 POSITION OF SITE : flat
 MICRO RELIEF Kind : none
 SURFACE CHAR. Rock outcrop : little rocky Pattern : none
 Cracking : nil Stoniness : nil
 Salt : nil Slaking/crusting : nil
 Soil erosion : nil Alkali : nil
 Slope stability : stable Aggradation : nil

PARENT MATERIAL : residual material derived from fine-basic igneous rock (dolerite of the Kibaran System)
 EFFECTIVE SOIL DEPTH : >150 cm

WATER TABLE : no watertable observed
 DRAINAGE : well
 PERMEABILITY : moderate; no slowly permeable layer(s)
 FLOODING Frequency : nil Run off : medium
 MOISTURE CONDITIONS PROFILE : 0 - 12 cm dry 12 - 150 cm moist

LAND USE : fallow
 Landuse/vegetation remarks : formerly wheat trials/potatoes

ADDITIONAL REMARKS :
 CLASSIFICATION : the Bt1, Bt2 and Bt3 horizons are considered as ferralic B horizon (FAO, 1988), although the Bt2 horizon just fails to meet the required silt/clay ratio (0.2 or less: Bt1 0.2, Bt2 0.3, Bt3 0.2). Soil temperature regime (USDA, 1992): assumed to be isothermic (elevation about 1700 m a.s.l.) bordering isohyperthermic. / REFERENCES: Van Sleen L.A., 1978. Detailed soil survey of the Uningi seed potato area (and two soils studied in Kleynhans' farm), Northern Province. Soil Survey Report no. 60, Soil Survey Unit, Kasama. (profile K-1, p. 27-28, and Appendix 4, Brief petrographic description of rock sample K-1). / PARENT MATERIAL: brief petrographic description of rock sample K-1: Dolerite. A typical fine grained ophitic texture of augite and labradorite plagioclase - with scattered skeletal opaques. The two major minerals show retrogression in patches to amphibole and kaolinite. (Source: Laboratory report, Geological Survey Department of Zambia. 29 October 1976, by J. Tether, mineralogist).

CLIMATE :		Köppen: Aw													
Station: MBALA		8 51 S/ 31 20 E					1673 m a.s.l			15 km NE of site			Relevance: good		
		No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
relative humidity	%	86	85	85	81	67	61	55	50	48	51	71	81	68	
precipitation	mm	250	215	222	120	9	2	0	0	3	12	143	243	1219	
no. of raindays		20	18	19	10	1	1	0	0	1	3	7	12	93	
T mean	°C	17.8	17.9	18.1	18.3	18.1	16.4	16.3	18.1	19.9	20.7	19.2	18.0	18.2	
T max	°C	22.8	23.2	23.9	24.5	24.7	23.9	23.9	25.6	27.1	27.8	25.3	23.2	24.7	
T max abs	°C	28.9	28.3	27.8	27.8	27.8	27.2	27.2	29.4	30.6	31.7	31.1	30.6	31.7	
T min	°C	14.6	14.7	14.8	14.7	12.3	10.7	10.6	11.8	13.6	15.2	15.3	14.8	13.6	
T min abs	°C	12.2	12.2	12.2	11.1	7.8	5.6	5.6	6.1	10.6	11.7	11.7	12.2	5.6	

PROFILE DESCRIPTION :

Ap	0 - 12 cm	Reddish brown (5YR 4/4, moist) clay; weak coarse subangular blocky structure; slightly sticky, non plastic, firm, very hard; common medium pores; few fine and coarse roots; abrupt smooth boundary to
BA	12 - 30 cm	Yellowish red (5 YR 4/8, moist) clay; moderate medium subangular blocky structure; sticky, plastic, firm, slightly hard; many very fine pores; common fine and few coarse roots; gradual smooth boundary to
Bt1	30 - 54 cm	Dark red (2.5 YR 3/6, moist) clay; moderate medium to coarse subangular blocky structure; sticky, plastic, friable, slightly hard; many very fine to fine pores; common fine and few coarse roots; diffuse smooth boundary to
Bt2	54 - 80 cm	Dark red (2.5 YR 3/6, moist) clay; moderate fine to medium subangular blocky structure; sticky, plastic, friable, slightly hard; many very fine and common fine pores; few fine roots; diffuse smooth boundary to
Bt3	80 - 110 cm	Red (2.5 YR 4/6, moist) clay; moderate medium subangular blocky structure; sticky, plastic, friable, slightly hard; patchy thin clay and sesquioxides cutans; common very fine to fine pores; few fine roots; diffuse smooth boundary to
Bt4	110 - 150 cm	Red (2.5 YR 4/6, moist) clay; moderate medium subangular blocky structure; sticky, plastic, friable, slightly hard; patchy thin clay and sesquioxides cutans; common very fine to medium pores; few fine roots; very few very fine weathered dolerite fragments

ANALYTICAL DATA :

Hor. no.	Top - Bot	>2 2000 1000 500 250 100 50	TOT SAND	50 20 2	TOT SILT	<2 μm	DISP	BULK DENS	pF- 0.0 1.0 1.5 2.0 2.3 2.7 3.4 4.2	SPEC. SURF. SOIL m2/g		
1	0 - 6	- 1 3 6 13 8 30 9 9 19 51	26.6	-	-	-	-	-	-	79		
2	6 - 12	- 1 2 5 12 7 28 5 7 12 60 32.5	1.20	51	50	44	36	32	29	19	18	80
3	12 - 30	- 1 3 5 11 7 26 7 7 14 60 7.5	1.17	54	54	47	35	31	27	19	17	76
4	30 - 54	- 1 3 4 10 6 24 6 8 13 63 0.5	-	-	-	-	-	-	-	-	-	78
5	54 - 80	- 1 3 5 11 6 26 8 8 16 59 0.5	1.03	55	53	45	32	29	24	18	16	74
6	80 - 110	- 1 2 5 10 6 25 8 6 14 61 0.0	-	-	-	-	-	-	-	-	-	72
7	110 - 150	- 1 2 5 10 6 24 7 9 16 60 1.0	1.10	52	49	42	33	30	27	19	18	75
8	par. mat.	- 7 11 12 20 11 61 10 8 18 22 14.0	-	-	-	-	-	-	-	-	-	-

Hor. no.	pH- H2O	-- KCl	CaCO3 %	ORG- C %	MAT. N %	EXCH Ca	CAT. Mg	----- K	----- Na	sum	EXCH H+Al	AC. Al	CEC soil	----- clay	----- OrgC	----- ECEC	BASE SAT %	AL SAT %	EC 2.5 mS/cm	EXTR. AC. KCl/TEA pH 8.2
1	5.5	4.4	-	2.10	-	1.8	0.8	0.0	0.3	2.9	0.7	0.5	14.8	29	7.4	3.6	20	3	0.06	7.7
2	5.9	4.6	-	1.30	-	1.2	1.1	0.0	0.3	2.6	0.3	0.2	13.5	22	4.5	2.9	19	1	0.05	7.3
3	6.3	5.0	-	0.70	-	1.0	0.9	0.0	0.2	2.1	0.1	0.0	11.1	19	2.4	2.2	19	0	0.04	7.3
4	5.7	5.3	-	0.50	-	0.6	1.0	0.0	0.2	1.8	0.1	0.0	9.5	15	1.8	1.9	19	0	0.04	5.8
5	5.8	5.5	-	0.30	-	0.6	0.9	0.0	0.2	1.7	0.0	0.0	9.4	16	1.1	1.7	18	0	0.04	4.6
6	6.0	5.6	-	0.30	-	0.1	1.0	0.0	0.3	1.4	0.1	0.0	9.5	15	1.1	1.5	15	0	0.05	3.8
7	5.5	5.2	-	0.40	-	1.6	0.8	0.0	0.2	2.6	0.1	0.1	10.0	17	1.4	2.7	26	1	0.06	4.6

ELEMENTAL COMPOSITION

ELEMENTAL COMPOSITION OF TOTAL SOIL (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/ Al2O3	SiO2/ Fe2O3	SiO2/ R2O3	Al2O3/ Fe2O3
1	49.7	19.6	15.1	0.08	0.10	0.18	-	4.53	0.18	0.09	11.4	4.3	8.8	2.9	2.0
2	47.2	20.8	15.3	0.07	0.10	0.16	-	4.32	0.17	0.07	11.0	3.9	8.2	2.6	2.1
3	48.5	22.4	16.0	0.05	0.13	0.15	-	4.27	0.17	0.07	10.5	3.7	8.1	2.5	2.2
4	46.3	23.3	15.9	0.04	0.10	0.14	-	4.04	0.15	0.06	10.5	3.4	7.8	2.4	2.3
5	47.9	21.9	15.8	0.02	0.09	0.05	-	4.29	0.15	0.05	9.6	3.7	8.1	2.5	2.2
6	47.0	23.0	15.8	0.01	0.09	0.05	-	4.19	0.14	0.04	10.0	3.5	7.9	2.4	2.3
8	91.0	4.1	1.0	0.05	0.06	0.00	-	0.32	0.02	0.03	4.2	37.7	242	32.6	6.4

ELEMENTAL COMPOSITION OF TOTAL CLAY (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/ Al2O3	SiO2/ Fe2O3	SiO2/ R2O3	Al2O3/ Fe2O3
1	32.2	33.1	15.1	0.04	0.12	0.17	-	1.63	0.10	0.17	14.7	1.7	5.7	1.3	3.4
2	33.5	34.4	15.0	0.02	0.12	0.16	-	1.58	0.09	0.16	14.6	1.7	5.9	1.3	3.6
3	32.3	33.4	15.1	0.02	0.12	0.15	-	1.58	0.10	0.15	14.5	1.6	5.7	1.3	3.5
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	31.8	33.6	15.0	0.01	0.13	0.14	-	1.57	0.07	0.13	14.5	1.6	5.6	1.3	3.5
6	31.9	33.7	15.2	0.00	0.11	0.14	-	1.57	0.06	0.10	14.3	1.6	5.6	1.2	3.5
7	31.9	33.4	15.3	0.00	0.13	0.14	-	1.61	0.07	0.11	14.4	1.6	5.6	1.3	3.4

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe Al Si (by AMM. OXALATE(o), Na DITHION(d) & PYROPHO(p))

Hor.

no.	MI	VE	CH	SM	KA	HA	ML	QU	FE	GI	GO	HE	Fe(o)	Al(o)	Si(o)	Fe(d)	Al(d)	Fe(p)	Al(p)
1	-	-	-	-	8	-	-	-	-	4	3	-	0.3	0.3	0.0	5.2	0.5	0.2	0.2
2	-	-	-	-	8	-	-	-	-	4	3	-	0.3	0.3	0.0	5.2	0.5	0.1	0.1
3	-	-	-	-	8	-	-	-	-	4	3	-	0.2	0.3	0.0	5.4	0.5	0.1	0.1
4	-	-	-	-	8	-	-	-	-	4	3	-	0.2	0.2	0.0	5.4	0.5	0.0	0.0
5	-	-	-	-	8	-	-	-	-	4	3	-	0.2	0.2	0.0	5.2	0.5	0.0	0.0
6	-	-	-	-	8	-	-	-	-	4	3	2	0.2	0.2	0.0	5.4	0.5	0.0	0.0
7	-	-	-	-	8	-	-	-	-	4	3	2	0.2	0.2	0.0	5.3	0.5	0.0	0.1

SAND MINERALOGY

Hor. no.	HEAV	LIGH	light fraction				heavy fraction			
			QU	FE	PL	RE	OP	ZIRC	HYP	
6	17.6	82.4	100	0	0	0	100	tr	0-tr	

Key : Light minerals: QU=quartz; FE=feldspar; PL=plagioclase; RE=rest group.
Heavy minerals: OP=opaque; ZIRC: zircon; HYP: hypersthene.

FAO/UNESCO (1988) : Vetit-Xanthic Ferralsol (1974 : Xanthic Ferralsol)
 USDA/SCS SOIL TAXONOMY (1992) : Typic Haplustox, fine-loamy, siliceous, isohyperthermic (1975 : Typic Haplustox)
 LOCAL CLASSIFICATION : Misamfu sandy loam

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, ferralic B horizon
 USDA/SCS (1992) : ochric epipedon, oxic horizon
 Soil moisture regime : ustic
 Soil temperature regime : isohyperthermic

LOCATION : Misamfu Regional Research Station, Kasama District, Northern Province
 Latitude : 10°10' S Longitude : 31°10' E Altitude : 1384 m a.s.l.
 AUTHOR(S) : Van Baren, J.H.V. et al Date (mm/yy) : 2/77

GENERAL LANDFORM : plateau Topography : undulating
 PHYSIOGRAPHIC UNIT : summit
 SLOPE Gradient : 1%
 POSITION OF SITE : flat
 MICRO RELIEF Kind : Pattern : none
 SURFACE CHAR. Rock outcrop : nil Stoniness : nil
 Cracking : nil Slaking/crusting : nil
 Salt : nil Alkali : nil
 SLOPE PROCESSES Soil erosion : nil Aggradation : nil
 Slope stability : stable

PARENT MATERIAL : residual material derived from noncalcareous sandstone of the Kibaran System

EFFECTIVE SOIL DEPTH : >150 cm

WATER TABLE : no watertable observed
 DRAINAGE : well
 PERMEABILITY : no slowly permeable layer(s)
 FLOODING Frequency : nil Run off : medium
 MOISTURE CONDITIONS PROFILE : 0 - 160 cm moist

LAND USE : woodland, grazed
 VEGETATION Type : deciduous woodland Status : secondary
 Landuse/vegetation remarks : Brachystegia, Julbernardia, Anyophyllea

CLIMATE :	Köppen: Aw													
Station: KASAMA	10 13 S/ 31 8 E	1384 m a.s.l	10 km S of site										Relevance: good	
	No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
relative humidity %		82	82	81	75	65	59	55	49	45	43	63	77	60
precipitation mm		280	233	245	70	9	1	1	0	2	23	149	266	1360
no. of raindays		21	19	18	5	1	0	0	0	0	2	13	22	101
T mean °C		19.8	19.9	20.1	20.3	18.8	17.1	16.9	18.8	21.6	23.4	21.7	20.1	19.8
T max °C		26.0	26.1	26.1	26.3	25.6	24.6	24.7	26.8	29.4	31.4	28.7	26.5	26.9
T max abs °C		31.1	30.0	30.0	31.1	29.4	30.6	28.9	32.8	34.4	35.0	35.0	32.8	35.0
T min °C		16.2	16.3	16.2	15.3	12.6	10.0	9.6	11.1	13.8	16.1	16.5	16.3	15.8
T min abs °C		13.3	12.8	12.2	10.6	6.7	3.9	4.4	2.8	6.1	11.7	13.3	12.8	2.8

PROFILE DESCRIPTION :

Ah	0 - 12 cm	Dark yellowish brown (10YR 3/4, moist) sandy loam; weak fine to medium subangular blocky structure; non sticky, non plastic, very friable, soft; many very fine pores; many fine and medium roots; gradual smooth boundary to
AB	12 - 32 cm	Brown (7.5 YR 4/4, moist) sandy loam; very weak fine to medium subangular blocky structure; non sticky, non plastic, very friable, soft; many very fine pores; common fine roots; diffuse smooth boundary to
Bw1	32 - 72 cm	Strong brown (7.5 YR 5/6, moist) sandy clay loam; very weak fine to medium subangular blocky to crumb structure; slightly sticky, slightly plastic, friable, soft; many very fine pores; common fine and medium roots; diffuse smooth boundary to
Bw2	72 - 106 cm	Strong brown (7.5 YR 5/6, moist) sandy clay loam; very weak fine subangular blocky to crumb structure; slightly sticky, slightly plastic, friable, soft; many very fine pores; few fine and medium roots; diffuse smooth boundary to
Bw3	106 - 160 cm	Strong brown (7.5 YR 5/6, moist) sandy clay loam; very weak fine subangular blocky to crumb structure; slightly sticky, slightly plastic, friable, soft; many very fine pores; few fine and medium roots

ANALYTICAL DATA :

Hor. no.	Top	Bot	>2 mm	2000 1000	1000 500	500 250	250 100	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 µm	DISP	BULK DENS	pF- 0.0	1.0	1.5	2.0	2.3	2.7	3.4	4.2	SPEC. SOIL	SURF. m2/g
1	1	12	-	0	4	20	44	11	80	2	2	4	16	1.3	1.28	46	45	33	19	17	15	13	11		20
2	12	32	-	1	4	20	42	10	76	3	3	5	19	1.5	1.28	47	46	26	16	14	12	10	10		21
3	32	50	-	0	4	18	37	11	70	2	3	5	25	2.5	-	-	-	-	-	-	-	-	-		25
4	50	72	-	0	3	17	37	11	68	4	2	5	27	2.0	-	-	-	-	-	-	-	-	-		26
5	72	106	-	0	4	16	36	11	67	5	1	6	27	1.0	1.28	46	45	31	19	16	14	12	12		26
6	106	130	-	0	4	16	36	11	67	6	2	8	25	0.5	-	-	-	-	-	-	-	-	-		25
7	130	160	-	1	4	16	35	11	66	5	3	8	26	0.5	-	-	-	-	-	-	-	-	-		26

Hor. no.	pH- H2O	-- KCl	CaCO3 %	ORG- C %	MAT. N %	EXCH. Ca	CAT. Mg	----- K	----- Na	sum cmol(+)/kg	EXCH. H+Al	AC. Al	CEC soil	----- clay	----- OrgC	----- ECEC	BASE SAT %	Al SAT %	EC 2.5 mS/cm	EXTR. AC. KCl/TEA pH 8.2
1	5.5	4.3	-	0.91	0.03	0.4	0.3	0.0	0.5	1.2	0.7	0.5	3.5	21	3.2	1.9	34	14	0.03	3.5
2	5.1	4.3	-	0.38	0.03	0.0	0.3	0.0	0.0	0.3	0.8	0.7	3.5	19	1.3	1.1	9	20	0.02	3.1
3	5.2	4.3	-	0.26	0.04	0.2	0.3	0.0	0.0	0.5	0.5	0.4	2.3	9	0.9	1.0	22	17	0.02	1.8
4	5.1	4.2	-	0.20	0.00	0.0	0.3	0.0	0.0	0.3	0.8	0.5	2.2	8	0.7	1.1	14	23	0.02	1.4
5	5.0	4.2	-	0.14	0.03	0.0	0.0	0.0	0.0	0.0	0.8	0.7	2.8	10	0.5	0.8	0	25	0.01	2.1
6	5.0	4.2	-	0.14	0.03	0.0	0.0	0.0	0.0	0.0	0.8	0.7	1.9	8	0.5	0.8	0	37	0.01	2.4
7	5.0	4.2	-	0.06	0.04	0.0	0.0	0.0	0.0	0.0	0.8	0.6	2.0	8	0.2	0.8	0	30	0.01	2.4

ELEMENTAL COMPOSITION OF TOTAL SOIL (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/ Al2O3	SiO2/ Fe2O3	SiO2/ R2O3	Al2O3/ Fe2O3
1	88.0	6.5	1.6	0.00	0.01	0.06	-	0.47	0.01	0.03	4.0	23.0	146	19.9	6.4
2	85.8	7.8	1.7	0.00	0.02	0.06	-	0.51	0.01	0.01	3.6	18.7	134	16.4	7.2
3	84.7	9.9	2.0	0.00	0.03	0.08	-	0.60	0.00	0.01	4.2	14.5	113	12.9	7.8
4	82.8	10.2	2.0	0.00	0.02	0.08	-	0.62	0.00	0.01	4.3	13.8	110	12.2	8.0
5	82.1	10.8	2.1	0.00	0.02	0.08	-	0.67	0.00	0.01	4.3	12.9	104	11.5	8.1
6	82.1	10.9	2.2	0.00	0.02	0.09	-	0.69	0.00	0.01	4.2	12.8	99.3	11.3	7.8
7	80.9	11.4	2.2	0.00	0.02	0.08	-	0.73	0.00	0.01	4.3	12.0	97.9	10.7	8.1

ELEMENTAL COMPOSITION OF TOTAL CLAY (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/ Al2O3	SiO2/ Fe2O3	SiO2/ R2O3	Al2O3/ Fe2O3
1	40.9	37.2	5.4	0.02	0.12	0.29	-	1.60	0.05	0.32	13.9	1.9	20.3	1.7	10.9
2	41.1	37.5	5.4	0.00	0.12	0.27	-	1.56	0.03	0.19	13.9	1.9	20.1	1.7	10.8
3	41.5	37.7	5.4	0.00	0.10	0.26	-	1.52	0.01	0.15	13.9	1.9	20.3	1.7	10.9
4	41.2	37.4	5.4	0.00	0.11	0.26	-	1.53	0.01	0.14	13.8	1.9	20.1	1.7	10.8
5	41.4	37.2	5.4	0.00	0.08	0.26	-	1.51	0.01	0.10	13.8	1.9	20.4	1.7	10.8
6	41.4	37.4	5.4	0.00	0.08	0.26	-	1.53	0.01	0.09	13.7	1.9	20.4	1.7	10.9
7	41.0	37.2	5.4	0.00	0.10	0.26	-	1.50	0.01	0.09	14.0	1.9	20.4	1.7	10.9

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe Al Si (by AMM. OXALATE(o), Na DITHION(d) & PYROPHO(p))

Hor. no.	MI	VE	CH	SM	KA	HA	ML	QU	FE	GI	GO	HE	Fe(o)	Al(o)	Si(o)	Fe(d)	Al(d)	Fe(p)	Al(p)
1	2	-	-	-	8	-	2	-	2	-	4	-	0.0	0.1	0.0	0.6	0.0	0.1	0.1
2	2	-	-	-	8	-	2	-	-	-	4	-	0.0	0.1	0.0	0.6	0.0	0.2	0.1
3	2	-	-	-	8	-	2	-	-	-	4	-	0.0	0.1	0.0	0.7	0.0	0.1	0.1
4	-	-	-	-	8	-	2	-	-	-	4	-	0.0	0.1	0.0	0.8	0.0	0.1	0.1
5	-	-	-	-	8	-	2	-	-	-	4	-	0.0	0.1	0.0	0.8	0.1	0.0	0.0
6	-	-	-	-	8	-	2	-	-	-	4	-	0.0	0.1	0.0	0.8	0.1	0.0	0.0
7	-	-	-	-	8	-	2	-	-	-	4	-	0.0	0.1	0.0	0.8	0.1	0.0	0.0

SAND MINERALOGY

Hor. no.	HEAV	LIGH	light fraction	heavy fraction	QU	FE	PL	RE	OP	TOUR	ZIRC	RUT	ANA	DIS
5	0.2	99.8	100	0	0	0	0	33	48	32	9	10	1	

Key light fraction: QU=quartz; FE=feldspar; PL=plagioclase; RE=rest group

Key heavy fraction: OP=opaque; TOUR=tourmaline; ZIRC=zircon; RUT=rutile; ANA=anatase; DIS=disthene

FAO/UNESCO (1988) : Chromi-Ferralic Cambisol (1974 : Ferralic Cambisol)
 USDA/SCS SOIL TAXONOMY (1992) : Ustoxic Dystropept, coarse-loamy, mixed, isohyperthermic (1975 : Ustoxic Dystropept)
 LOCAL CLASSIFICATION : Mwiemba loamy sand

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, cambic B horizon; ferralic properties
 USDA/SCS (1992) : ochric epipedon, cambic horizon
 Soil moisture regime : ustic
 Soil temperature regime : isohyperthermic

LOCATION : Misamfu Regional Research Station, Kasama District, Northern Province
 Latitude : 10°10' S Longitude : 31°10' E Altitude : 1384 m a.s.l.
 AUTHOR(S) : J.H.V. van Baren & L.A. van Sleen Date (mm/yy) : 2/77

GENERAL LANDFORM : plateau Topography : undulating
 PHYSIOGRAPHIC UNIT : Piedmont slope
 SLOPE Gradient : 1%
 POSITION OF SITE : slope
 MICRO RELIEF Kind : Pattern : none
 SURFACE CHAR. Rock outcrop : nil Stoniness : nil
 Cracking : nil Slaking/crusting : nil
 Salt : nil Alkali : nil
 SLOPE PROCESSES Soil erosion : nil Aggradation : present
 Slope stability : stable

PARENT MATERIAL : colluvium

EFFECTIVE SOIL DEPTH : >180 cm

WATER TABLE : no watertable observed
 DRAINAGE : well
 PERMEABILITY : high; no slowly permeable layer(s)
 FLOODING Frequency : nil Run off : rapid
 MOISTURE CONDITIONS PROFILE : 0 - 180 cm moist

LAND USE : woodland, grazed
 VEGETATION Type : deciduous woodland Status : secondary
 Landuse/vegetation remarks : woodland more open than normal due to frequent cutting for fire wood

ADDITIONAL REMARKS :

PARENT MATERIAL: Precambrian of the Kibaran System (= Upper Basement Complex). Dominantly kaolinitic clay mineralogy, some primary feldspates left. / LAND USE AND VEGETATION: open woodland savannah with Julbernardia paniculata, Uapaca kirkiana, Securidaca longepedunculata, Anisophyllea boehmi, Parinari curatellifolia and Uapaca benguelensis. / HYDROLOGY: the area of the research station area is drained by the Sheshei and Misamfu tributaries of the Milima stream, north-east from the station, which finally drains towards the Chambeshi river. / REFERENCES: Van Sleen, L.A., 1976. Detailed Soil Survey of the Misamfu Regional Research Station, Northern Province. Soil Survey Report no. 41, prof. no. M-45.

CLIMATE :	Köppen: Aw													
Station: KASAMA	10 13 S/ 31 8 E	1384 m a.s.l					10 km S of site						Relevance: good	
	No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
relative humidity %		82	82	81	75	65	59	55	49	45	43	63	77	60
precipitation mm		280	233	245	70	9	1	1	0	2	23	149	266	1360
no. of raindays		21	19	18	5	1	0	0	0	0	2	13	22	101
T mean °C		19.8	19.9	20.1	20.3	18.8	17.1	16.9	18.8	21.6	23.4	21.7	20.1	19.8
T max °C		26.0	26.1	26.1	26.3	25.6	24.6	24.7	26.8	29.4	31.4	28.7	26.5	26.9
T abs max °C		31.1	30.0	30.0	31.1	29.4	30.6	28.9	32.8	34.4	35.0	35.0	32.8	35.0
T min °C		16.2	16.3	16.2	15.3	12.6	10.0	9.6	11.1	13.8	16.1	16.5	16.3	15.8
T abs min °C		13.3	12.8	12.2	10.6	6.7	3.9	4.4	2.8	6.1	11.7	13.3	12.8	2.8

PROFILE DESCRIPTION :

Ah	0 - 20 cm	Dark brown (7.5YR 3/2, moist) loamy fine sand; weak fine subangular blocky structure, almost single grain; non sticky, non plastic, soft; many very fine to fine pores; highly porous; many very fine to coarse roots; gradual wavy boundary to
BA	20 - 43 cm	Yellowish red (5YR 4/6, moist) loamy fine sand; weak fine subangular blocky parting to single grain structure; non sticky, non plastic, soft; slightly cemented, easily breaking into single grain; many very fine to fine pores; highly porous; many very fine to coarse roots; diffuse smooth boundary to
Bw1	43 - 75 cm	Red (2.5YR 4/6, moist) loamy fine sand; weak medium subangular blocky parting to single grain structure; slightly sticky, non plastic, soft; slightly cemented; many very fine to fine pores; highly porous; common fine and medium roots; diffuse smooth boundary to
Bw2	75 - 180 cm	Red (2.5YR 4/8, moist; 2.5YR 5/8, dry) fine sandy loam; weak medium subangular blocky parting to single grain structure; soft; slightly cemented; many very fine to fine pores; few fine and medium roots

ANALYTICAL DATA :

Hor. no.	Top	Bot	>2 mm	2000 1000	500 250	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 µm	DISP	BULK DENS	pF- 0.0	1.0	1.5	2.0	2.3	2.7	3.4	4.2	SPEC. SOIL	SURF. m2/g	
1	0	10	-	0	3	11	54	16	84	4	2	6	10	5.5	1.19	51	50	33	17	14	12	7	7	20
2	10	20	-	0	3	11	56	15	85	3	2	5	10	5.0	-	-	-	-	-	-	-	-	-	14
3	20	43	-	0	3	11	54	14	82	3	2	6	12	5.0	1.33	47	45	44	12	10	9	7	7	14
4	43	70	-	0	3	10	54	14	81	3	3	6	13	3.5	1.35	44	44	28	13	11	9	7	6	15
5	70	120	-	0	3	12	50	12	77	4	1	4	19	0.5	-	-	-	-	-	-	-	-	-	20
6	120	150	-	0	3	11	49	14	76	1	1	2	19	0.5	-	-	-	-	-	-	-	-	-	22

Hor. no.	pH- H2O	-- KCl	CaCO3 %	ORG- C %	MAT. N %	EXCH Ca	CAT. Mg	---- K	---- Na	--- sum	EXCH AC. H+Al Al	CEC soil clay	---- OrgC	--- ECEC	BASE SAT %	Al SAT %	EC 2.5 mS/cm	EXTR. AC. KCl/TEA pH 8.2		
1	5.9	4.8	-	1.54	0.08	1.3	0.8	0.2	0.1	2.4	0.2	0.0	6.0	59	5.4	2.6	40	0	0.10	4.4
2	6.2	4.7	-	0.59	0.08	1.3	0.8	0.2	0.1	2.4	0.3	0.0	6.0	59	2.1	2.7	40	0	0.04	3.0
3	6.1	4.5	-	0.25	0.04	0.5	0.5	0.2	0.1	1.3	0.3	0.1	2.8	23	0.9	1.6	46	4	0.03	1.8
4	6.0	4.5	-	0.15	0.00	0.4	0.6	0.1	0.1	1.2	0.2	0.0	2.4	18	0.5	1.4	50	0	0.02	1.4
5	5.5	4.3	-	0.09	0.00	0.2	0.5	0.1	0.1	0.9	0.6	0.4	2.6	14	0.3	1.5	35	15	0.02	2.6
6	5.3	4.2	-	0.07	0.00	0.2	0.5	0.1	0.0	0.8	0.8	0.6	3.0	16	0.2	1.6	27	20	0.02	2.5

ELEMENTAL COMPOSITION OF TOTAL SOIL (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/ Al2O3	SiO2/ Fe2O3	SiO2/ R2O3	Al2O3/ Fe2O3
2	92.2	4.4	1.0	0.00	0.00	0.21	-	0.34	0.01	0.02	2.5	35.6	246	31.1	6.9
3	91.3	5.2	1.2	0.00	0.00	0.23	-	0.36	0.01	0.01	2.3	29.8	203	26.0	6.8
4	91.3	5.5	1.3	0.00	0.03	0.25	-	0.37	0.01	0.00	2.2	28.2	187	24.5	6.6
5	88.4	7.1	1.5	0.00	0.02	0.29	-	0.37	0.00	0.00	2.7	21.1	157	18.6	7.4
6	87.6	7.3	1.6	0.00	0.02	0.28	-	0.38	0.00	0.00	2.7	20.4	146	17.9	7.2

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe Al Si (by AMM. OXALATE(o), Na DITHIONITE(d) & PYROPH(p))

Hor. no.	MI	VE	CH	SM	KA	HA	ML	QU	FE	GI	GO	HE	Fe(o)	Al(o)	Si(o)	Fe(d)	Al(d)	Fe(p)	Al(p)
1	4	-	-	-	8	-	4	-	2	4	4	-	0.0	0.1	0.0	0.5	0.1	0.1	0.1
2	4	-	-	-	8	-	4	-	2	4	4	-	0.0	0.1	0.0	0.5	0.1	0.1	0.1
3	4	-	-	-	8	-	4	-	2	4	4	-	0.0	0.1	0.0	0.6	0.1	0.1	0.1
4	4	-	-	-	8	-	4	-	2	4	4	-	0.0	0.1	0.0	0.6	0.1	0.1	0.0
5	4	-	-	-	8	-	4	-	2	4	4	-	0.0	0.1	0.0	0.9	0.1	0.0	0.0
6	4	-	-	-	8	-	4	-	2	4	4	-	0.0	0.1	0.0	0.9	0.1	0.0	0.0

FAO/UNESCO (1988) : Abrupti-Dystric Regosol (Hyperferralic) (1974 : Dystric Regosol)
 USDA/SCS SOIL TAXONOMY (1992) : Thapto-Ultic Ustifluvent, sandy over loamy, mixed, isohyperthermic
 (1975) : Thapto-Ultic Ustifluvent
 LOCAL CLASSIFICATION : unnamed

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, argic B horizon (buried); abrupt textural change, ferralic properties
 USDA/SCS (1992) : ochric epipedon, argillic horizon
 Soil moisture regime : ustic
 Soil temperature regime : isohyperthermic

LOCATION : Misamfu Regional Research Station, Kasama District, Northern Province
 Latitude : 10°10' S Longitude : 31°10' E Altitude : 1384 m a.s.l.
 AUTHOR(S) : J.H.V. van Baren & L.A. van Sleen Date (mm/yy) : 2/77

GENERAL LANDFORM : plateau Topography : undulating
 PHYSIOGRAPHIC UNIT : piedmont

SLOPE Gradient : 2%
 POSITION OF SITE : middle slope

MICRO RELIEF Kind : Pattern : none
 SURFACE CHAR. Rock outcrop : nil Stoniness : nil
 Cracking : nil Slaking/crusting : nil
 Salt : nil Alkali : nil
 SLOPE PROCESSES Soil erosion : nil Aggradation : present
 Slope stability : stable

PARENT MATERIAL 1 : colluvium derived from : sandstone
 2 : residual material derived from : sandstone
 Depth lithological boundary : 63 cm

EFFECTIVE SOIL DEPTH : >150 cm

WATER TABLE : no watertable observed
 DRAINAGE : well
 PERMEABILITY : high; no slowly permeable layer(s)
 FLOODING Frequency : nil Run off : medium
 MOISTURE CONDITIONS PROFILE : 0 - 160 cm moist

LAND USE : woodland, grazed
 VEGETATION Type : deciduous woodland Status : secondary
 Landuse/vegetation remarks : open savannah: species - Brachystegia boehmi, Anisodrylles boehmi, Terminalia mollis.
 Poor arable land, mainly dry due to textural limitations.

ADDITIONAL REMARKS :

PARENT MATERIAL/GEOLOGY: Precambrian of the Kibaran System (= Upper Basement Complex). / HYDROLOGY: the research area is drained by the Sheshei and Misamfu tributaries of the Milima stream, North-East from the station, which finally drains towards the Chambesi river. / REFERENCES: Van Sleen, L.A., 1976. Soil Survey Report no. 41: Detailed Soil Survey of the Misamfu Regional Research Station, Northern Province, prof. no. M-58.

CLIMATE :	Köppen: Aw													
Station: KASAMA	10 13 S/ 31 8 E	1384 m a.s.l.			10 km S of site						Relevance: good			
	No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
relative humidity %		82	82	81	75	65	59	55	49	45	43	63	77	60
precipitation mm		280	233	245	70	9	1	1	0	2	23	149	266	1360
no. of raindays		21	19	18	5	1	0	0	0	0	2	13	22	101
T mean °C		19.8	19.9	20.1	20.3	18.8	17.1	16.9	18.8	21.6	23.4	21.7	20.1	19.8
T max °C		26.0	26.1	26.1	26.3	25.6	24.6	24.7	26.8	29.4	31.4	28.7	26.5	26.9
T abs max °C		31.1	30.0	30.0	31.1	29.4	30.6	28.9	32.8	34.4	35.0	35.0	32.8	35.0
T min °C		16.2	16.3	16.2	15.3	12.6	10.0	9.6	11.1	13.8	16.1	16.5	16.3	15.8
T abs min °C		13.3	12.8	12.2	10.6	6.7	3.9	4.4	2.8	6.1	11.7	13.3	12.8	2.8

PROFILE DESCRIPTION :

Ah	0 - 16 cm	Very dark grayish brown (10YR 3/2, moist), dark brown (10YR 4/3, dry) fine sand; single grain; non sticky, non plastic, very friable to loose, soft; many very fine to medium pores; highly porous; common fine and medium roots; clear smooth boundary to
AC	16 - 30 cm	Brown (7.5YR 4/4, moist), brown (7.5YR 5/4, dry) fine sand; single grain; non sticky, non plastic, very friable, very soft; many very fine to fine pores; common very fine to coarse roots; gradual wavy boundary to
C	30 - 63 cm	Yellowish red (5YR 5/6, moist), reddish yellow (7.5YR 6/6, dry) loamy sand; single grain; non sticky, non plastic, loose, very soft; many very fine to fine pores; few fine and medium roots; clear smooth boundary to
2Btb	63 - 160 cm	Red (2.5YR 4/6, moist), light red (2.5YR 6/8, dry) sandy clay loam; weak medium and coarse subangular blocky structure; sticky, plastic, friable, very hard; patchy thin clay and sesquioxide cutans; many very fine to fine pores; few fine roots

ANALYTICAL DATA :

Hor. no.	Top	-	Bot	>2 mm	2000 1000	1000 500	500 250	250 100	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 µm	DISP	BULK DENS	pH	---	---	---	---	---	---	---	---	---	SPEC. SOIL	SURF. m2/g
	0.0	1.0	1.5	2.0	2.3	2.7	3.4	4.2																				
1	0	-	16	-	0	2	10	50	20	83	5	3	8	9	2.5	-	-	-	-	-	-	-	-	-	-	-	-	15
2	16	-	30	-	0	2	10	52	19	83	6	2	7	10	1.5	-	-	-	-	-	-	-	-	-	-	-	-	12
3	30	-	50	-	0	2	10	49	19	80	6	1	7	14	2.0	1.50	39	39	27	12	9	8	8	7	-	-	16	
4	50	-	63	-	0	2	10	51	21	84	5	2	7	9	2.0	-	-	-	-	-	-	-	-	-	-	-	10	
5	63	-	94	-	0	3	10	37	13	64	5	2	7	29	0.5	1.51	38	38	32	27	24	22	18	17	-	-	37	
6	94	-	120	-	1	3	10	33	12	58	5	1	5	37	1.0	-	-	-	-	-	-	-	-	-	-	-	44	

Hor. no.	pH-H2O	--KCl	CaCO3 %	ORG-C %	MAT. N %	EXCH. Ca	CAT. Mg	-----K	-----Na	sum	EXCH. H+Al	AC. Al	CEC soil	-----clay	-----OrgC	ECEC	BASE SAT %	Al SAT %	EC 2.5 mS/cm	EXTR. AC. KCl/TEA pH 8.2
1	5.5	4.3	-	0.90	0.06	1.1	0.4	0.2	0.1	1.8	0.3	0.1	4.8	52	3.1	2.1	38	2	0.11	3.0
2	6.0	4.4	-	0.45	0.03	0.4	0.4	0.1	0.1	1.0	0.3	0.2	2.7	27	1.6	1.3	37	7	0.04	1.0
3	6.0	4.3	-	0.15	0.02	0.4	0.4	0.1	0.1	1.0	0.3	0.1	2.2	16	0.5	1.3	45	5	0.02	1.7
4	6.1	4.3	-	0.09	0.00	0.4	0.4	0.1	0.1	1.0	0.1	0.1	2.2	25	0.3	1.1	45	5	0.02	1.1
5	5.6	3.9	-	0.17	0.00	0.4	0.6	0.2	0.1	1.3	2.0	1.5	4.8	16	0.6	3.3	27	31	0.01	2.0
6	5.5	3.9	-	0.13	0.00	0.4	0.4	0.3	0.1	1.2	2.0	1.7	5.2	14	0.5	3.2	23	33	0.01	4.4

ELEMENTAL COMPOSITION OF TOTAL SOIL (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/Al2O3	SiO2/Fe2O3	SiO2/R2O3	Al2O3/Fe2O3
1	91.7	4.1	1.0	0.02	0.00	0.27	-	0.40	0.02	0.01	2.8	38.0	244	32.9	6.4
2	93.2	3.8	0.9	0.01	0.01	0.26	-	0.40	0.01	0.00	1.9	41.6	276	36.2	6.6
3	90.8	5.2	1.2	0.00	0.02	0.32	-	0.43	0.01	0.00	2.0	29.6	201	25.8	6.8
4	94.9	3.7	0.9	0.00	0.00	0.26	-	0.43	0.00	0.00	1.3	43.5	281	37.7	6.4
5	82.6	11.0	2.1	0.00	0.06	0.57	-	0.50	0.00	0.01	3.9	12.7	105	11.4	8.2
6	79.5	13.3	2.5	0.00	0.07	0.68	-	0.53	0.00	0.01	4.7	10.1	84.7	9.1	8.3

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe Al Si (by AMM. OXALATE(o), Na DITHIONITE(d) & PYROPH(p))

Hor. no.	MI	VE	CH	SM	KA	HA	ML	QU	FE	GI	GO	HE	Fe(o)	Al(o)	Si(o)	Fe(d)	Al(d)	Fe(p)	Al(p)
1	4	-	-	-	8	-	3	-	2	-	4	-	0.0	0.1	0.0	0.5	0.1	0.1	0.1
2	4	-	-	-	8	-	3	-	2	-	4	-	0.0	0.1	0.0	0.4	0.1	0.1	0.1
3	4	-	-	-	8	-	3	-	2	-	4	-	0.0	0.0	0.0	0.5	0.1	0.1	0.1
4	4	-	-	-	8	-	3	-	2	-	4	-	0.0	0.0	0.0	0.4	0.1	0.0	0.0
5	4	-	-	-	8	-	3	-	2	-	4	-	0.0	0.1	0.0	1.0	0.2	0.1	0.0
6	4	-	-	-	8	-	3	-	2	-	4	-	0.0	0.1	0.0	1.1	0.2	0.0	0.0

FAO/UNESCO (1988) : Acri-Haplic Ferralsol (1974 : Orthic Ferralsol)
 USDA/SCS SOIL TAXONOMY (1992) : Typic Kandistult, clayey, kaolinitic, isohyperthermic (1975 : Typic Haplustox)
 LOCAL CLASSIFICATION : Mufilira sandy loam

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, ferralic B horizon
 USDA/SCS (1992) : ochric epipedon, kandic horizon
 Soil moisture regime : ustic
 Soil temperature regime : isohyperthermic

LOCATION : Namayakulu, TBZ phase IIA, Munkonge, Kasama, Northern Province
 Latitude : 10°10' S Longitude : 31° 8' E Altitude : 1384 m a.s.l.
 AUTHOR(S) : Van Baren, J.H.V. et al Date (mm/yy) : 3/77

GENERAL LANDFORM : plain Topography : flat or almost flat
 PHYSIOGRAPHIC UNIT :
 SLOPE Gradient : 1%
 POSITION OF SITE : flat
 MICRO RELIEF Kind : Pattern : none
 SURFACE CHAR. Rock outcrop : nil Stoniness : nil
 Cracking : nil Slaking/crusting : nil
 Salt : nil Alkali : nil
 SLOPE PROCESSES Soil erosion : nil Aggradation : nil
 Slope stability : stable

PARENT MATERIAL : residual material derived from coarse-acid igneous rock

EFFECTIVE SOIL DEPTH : 150 cm

WATER TABLE : no watertable observed
 DRAINAGE : well
 PERMEABILITY : moderate; no slowly permeable layer(s)
 FLOODING Frequency : nil Run off : slow
 MOISTURE CONDITIONS PROFILE : 0 - 160 cm moist

LAND USE : shrubland, grazed
 VEGETATION Type : deciduous shrub
 Landuse/vegetation remarks : Brachystegia, Parinari, Marquesia

CLIMATE :	Köppen: Aw														
Station: KASAMA	10 13 S/ 31 8 E			1384 m a.s.l			10 km N of site							Relevance: good	
	No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	
relative humidity %		82	82	81	75	65	59	55	49	45	43	63	77	60	
precipitation mm		280	233	245	70	9	1	1	0	2	23	149	266	1360	
no. of raindays		21	19	18	5	1	0	0	0	0	2	13	22	101	
T mean °C		19.8	19.9	20.1	20.3	18.8	17.1	16.9	18.8	21.6	23.4	21.7	20.1	19.8	
T max °C		26.0	26.1	26.1	26.3	25.6	24.6	24.7	26.8	29.4	31.4	28.7	26.5	26.9	
T max abs °C		31.1	30.0	30.0	31.1	29.4	30.6	28.9	32.8	34.4	35.0	35.0	32.8	35.0	
T min °C		16.2	16.3	16.2	15.3	12.6	10.0	9.6	11.1	13.8	16.1	16.5	16.3	15.8	
T min abs °C		13.3	12.8	12.2	10.6	6.7	3.9	4.4	2.8	6.1	11.7	13.3	12.8	2.8	

PROFILE DESCRIPTION :

Ah	0 - 10 cm	Dark brown (7.5YR 3/3, moist) sandy clay loam; weak to moderate fine to medium subangular blocky to crumb structure; slightly hard; many very fine pores; moderately porous; many fine and medium roots; gradual smooth boundary to
AB	10 - 36 cm	Brown (7.5YR 5/4, moist) sandy clay; weak to moderate fine to medium subangular blocky to crumb structure; slightly hard; many very fine to fine pores; moderately porous; common fine and medium roots; gradual smooth boundary to
Bt1	36 - 72 cm	Strong brown (7.5YR 5/6, moist) sandy clay; fine to medium subangular blocky to crumb structure; slightly hard; many very fine to fine pores; moderately porous; few fine and medium roots; diffuse smooth boundary to
Bt2	72 - 130 cm	Yellowish red (5YR 5/6, moist) sandy clay; weak medium subangular blocky to crumb structure; friable, soft; common very fine pores; moderately porous; few fine roots; diffuse smooth boundary to
Bt3	130 - 160 cm	Yellowish red (5YR 5/7, moist) sandy clay; massive structure; friable, soft; common very fine pores; moderately porous; few fine roots

ANALYTICAL DATA :

Hor. no.	Top - Bot	>2 mm	2000 1000	500 250	250 100	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 µm	DISP	BULK DENS	pH	1.0	1.5	2.0	2.3	2.7	3.4	4.2	SPEC. SOIL	SURF. m2/g
1	0 - 10	-	1	4	25	35	8	73	4	2	6	21	6.5	-	-	-	-	-	-	-	-	-	27
2	10 - 36	-	1	3	18	27	8	58	5	2	6	36	10.5	-	-	-	-	-	-	-	-	-	33
3	36 - 72	-	1	3	14	22	9	49	5	1	6	46	0.5	-	-	-	-	-	-	-	-	-	39
4	72 - 100	-	1	3	13	22	9	48	5	1	6	45	1.5	-	-	-	-	-	-	-	-	-	38
5	100 - 130	-	1	3	13	22	10	48	4	3	7	45	0.5	-	-	-	-	-	-	-	-	-	38

Hor. no.	pH-H2O	--KCl	CaCO3 %	ORG-C %	MAT. N %	EXCH. Ca	CAT. Mg	----	----	----	EXCH. H+Al	AC. Al	CEC soil	----	----	----	BASE SAT %	AL SAT %	EC 2.5 mS/cm	EXTR. AC. KCl/TEA pH 8.2
1	4.8	4.0	-	1.72	0.13	0.2	0.7	0.0	0.1	1.0	1.1	0.5	6.5	31	6.0	2.1	15	8	0.16	6.5
2	4.8	4.2	-	0.56	0.01	0.0	0.3	0.0	0.1	0.4	1.3	0.9	3.6	10	2.0	1.7	11	25	0.08	4.1
3	4.7	4.1	-	0.35	0.01	0.0	0.3	0.0	0.0	0.3	1.3	1.0	2.8	6	1.2	1.6	11	36	0.03	3.9
4	4.9	4.2	-	0.20	0.00	0.0	0.3	0.0	0.0	0.3	1.2	1.1	3.2	7	0.7	1.5	9	34	0.02	3.4
5	5.1	4.2	-	0.13	0.03	0.0	0.0	0.0	0.0	0.0	1.2	1.0	3.0	7	0.5	1.2	0	33	0.02	3.3

ELEMENTAL COMPOSITION OF TOTAL SOIL (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/Al2O3	SiO2/Fe2O3	SiO2/R2O3	Al2O3/Fe2O3
1	85.2	7.1	1.9	0.01	0.02	0.07	-	0.46	0.02	0.04	5.6	20.4	119	17.4	5.9
2	79.2	12.8	2.8	0.00	0.04	0.10	-	0.69	0.01	0.03	5.8	10.5	75.3	9.2	7.2
3	71.2	17.2	3.4	0.00	0.03	0.13	-	0.85	0.01	0.03	7.1	7.0	55.8	6.2	7.9
4	72.2	17.1	3.5	0.00	0.03	0.13	-	0.88	0.01	0.02	6.6	7.2	54.9	6.3	7.7
5	71.9	17.3	3.5	0.00	0.03	0.14	-	0.90	0.01	0.02	6.8	7.1	54.7	6.2	7.8

ELEMENTAL COMPOSITION OF TOTAL CLAY (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/Al2O3	SiO2/Fe2O3	SiO2/R2O3	Al2O3/Fe2O3
6	40.9	36.0	6.2	0.01	0.10	0.31	-	1.69	0.07	0.25	14.0	1.9	17.5	1.7	9.1
7	41.4	36.9	6.3	0.00	0.10	0.27	-	1.57	0.02	0.16	13.8	1.9	17.5	1.7	9.2
8	41.1	36.6	6.3	0.00	0.09	0.25	-	1.49	0.01	0.13	13.8	1.9	17.4	1.7	9.2
9	40.4	36.0	6.2	0.00	0.07	0.26	-	1.49	0.01	0.14	13.8	1.9	17.3	1.7	9.1
10	41.7	36.7	6.3	0.00	0.08	0.27	-	1.50	0.01	0.11	13.7	1.9	17.6	1.7	9.1

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe Al Si (by AMM. OXALATE(o), Na DITHIONITE(d) & PYROPH(p))

Hor. no.	MI	VE	CH	SM	KA	HA	ML	QU	FE	GI	GO	HE	Fe(o)	Al(o)	Si(o)	Fe(d)	Al(d)	Fe(p)	Al(p)
1	-	-	-	-	8	-	-	-	-	-	4	-	0.1	0.1	0.0	0.7	0.0	0.2	0.1
2	-	-	-	-	8	-	-	-	-	-	4	-	0.1	0.1	0.0	0.9	0.0	0.3	0.1
3	-	-	-	-	8	-	-	-	-	-	4	-	0.1	0.1	0.0	1.0	0.0	0.1	0.1
4	-	-	-	-	8	-	-	-	-	-	4	-	0.1	0.1	0.0	1.1	0.0	0.1	0.0
5	-	-	-	-	8	-	-	-	-	-	4	-	0.1	0.1	0.0	1.1	0.0	0.0	0.0

SAND MINERALOGY

Hor. no.	HEAV	LIGH	light fraction	heavy fraction	QU	FE	PL	RE	OP	TOUR	ZIRC	RUT	ANA	STAU	DIS	AND	SIL
5	0.2	99.8	100	0	0	0	0	37	36	49	4	7	1	1	1	1	1

Key light minerals: QU=quartz; FE=feldspar; PL=plagioclase; RE=rest group

key heavy minerals: OP=opaque; TOUR=tourmaline; ZIRC=zircon; RUT=rutile; ANA=anatase; STAU=staurolite; DIS=disthene; AND=andalusite; SIL=sillimanite (fibrous)

FAO/UNESCO (1988) : Vetit-Xanthic Ferralsol (1974 : Xanthic Ferralsol)
 USDA/SCS SOIL TAXONOMY (1992) : Typic Haplustox, fine-loamy, kaolinitic, isohyperthermic (1975 : Typic Haplustox)
 LOCAL CLASSIFICATION : Misamfu sandy loam

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, cambic B, ferralic B horizon
 USDA/SCS (1992) : ochric epipedon, cambic horizon, oxic horizon
 Soil moisture regime : ustic
 Soil temperature regime : isohyperthermic

LOCATION : Misamfu Regional Research Station, Kasama District, Northern Province
 Latitude : 10°10' S Longitude : 31°10' E Altitude : 1384 m a.s.l.
 AUTHOR(S) : Van Baren, J.H.V. et al Date (mm/yy) : 2/77

GENERAL LANDFORM : valley Topography : flat or almost flat
 PHYSIOGRAPHIC UNIT : slope adjacent to dambo
 SLOPE Gradient : 2%
 POSITION OF SITE : lower slope
 MICRO RELIEF Kind : Pattern : none
 SURFACE CHAR. Rock outcrop : nil Stoniness : nil
 Cracking : nil Slaking/crusting : nil
 Salt : nil Alkali : nil
 SLOPE PROCESSES Soil erosion : nil Aggradation : not apparent
 Slope stability : stable

PARENT MATERIAL : residual material derived from sandstone/shale of the Kibaran system
 Texture : sandy clay

EFFECTIVE SOIL DEPTH : >130 cm

WATER TABLE : no watertable observed
 DRAINAGE : moderately well to well
 PERMEABILITY : high; no slowly permeable layer(s)
 FLOODING Frequency : nil Run off : medium
 MOISTURE CONDITIONS PROFILE : 0 - 130 cm moist

LAND USE : (semi-) natural vegetation
 VEGETATION Type : deciduous forest Status : secondary
 Landuse/vegetation remarks : Brachystegia, Parinari, Uapaca, Protea

ADDITIONAL REMARKS :

REFERENCES: Van Sleen, L.A., 1976. Detailed soil survey of the Misamfu Regional Research Station, Northern Province. Soil Survey Report no. 41, prof. no. M-65. Soil Survey Unit, Mt. Makulu, Chilanga.

CLIMATE :	Köppen: Aw													
Station: KASAMA	10 13 S/ 31 8 E	1384 m a.s.l		12 km N of site							Relevance: good			
	No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
relative humidity %		82	82	81	75	65	59	55	49	45	43	63	77	60
precipitation mm		280	233	245	70	9	1	1	0	2	23	149	266	1360
no. of raindays		21	19	18	5	1	0	0	0	0	2	13	22	101
T mean °C		19.8	19.9	20.1	20.3	18.8	17.1	16.9	18.8	21.6	23.4	21.7	20.1	19.8
T max °C		26.0	26.1	26.1	26.3	25.6	24.6	24.7	26.8	29.4	31.4	28.7	26.5	26.9
T max abs °C		31.1	30.0	30.0	31.1	29.4	30.6	28.9	32.8	34.4	35.0	35.0	32.8	35.0
T min °C		16.2	16.3	16.2	15.3	12.6	10.0	9.6	11.1	13.8	16.1	16.5	16.3	15.8
T min abs °C		13.3	12.8	12.2	10.6	6.7	3.9	4.4	2.8	6.1	11.7	13.3	12.8	2.8

PROFILE DESCRIPTION :

Ah	0 - 14 cm	Very dark grayish brown (10YR 3/2, moist) sandy loam; weak fine to medium subangular blocky structure; soft; many micro to fine pores; common fine and medium roots; clear smooth boundary to
AB	14 - 40 cm	Dark yellowish brown (10YR 4/4, moist) sandy clay loam; weak fine subangular blocky structure; soft; many micro to medium pores; common fine roots; gradual smooth boundary to
Bw1	40 - 60 cm	Yellowish brown (10YR 5/6, moist) sandy clay loam; weak fine subangular blocky structure; soft; many micro to medium pores; many fine roots; diffuse smooth boundary to
Bw2	60 - 110 cm	Yellowish brown (10YR 5/6, moist) sandy clay loam; porous massive structure; loose; many micro to medium pores; common fine roots; diffuse smooth boundary to
Bw3	110 - 130 cm	Strong brown (7.5YR 5/6, moist) sandy clay loam; porous massive structure; loose; many micro to medium pores; few fine roots

ANALYTICAL DATA :

Hor. no.	Top - Bot	>2 mm	2000 1000	1000 500	500 250	250 100	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 µm	DISP	BULK DENS	pF- 0.0	1.0	1.5	2.0	2.3	2.7	3.4	4.2	SPEC. SOIL	SURF. m2/g
1	0 - 20	-	1	4	18	45	12	79	4	0	5	17	2.0	-	-	-	-	-	-	-	-	-	21	
2	20 - 40	-	0	3	16	39	10	68	4	0	4	28	4.5	-	-	-	-	-	-	-	-	-	28	
3	40 - 60	-	1	3	15	35	10	64	7	0	7	29	0.5	-	-	-	-	-	-	-	-	-	30	
4	60 - 110	-	1	4	14	35	12	65	1	0	1	34	0.5	-	-	-	-	-	-	-	-	-	32	

Hor. no.	pH- H2O	-- KCl	CaCO3 %	ORG- C %	MAT. N %	EXCH Ca	CAT. Mg	----- K	----- Na	sum	EXCH H+Al	AC. Al	CEC soil	----- clay	----- OrgC	ECEC	BASE SAT %	Al SAT %	EC 2.5 mS/cm	EXTR. AC. KCl/TEA pH 8.2
1	5.7	4.2	-	0.71	-	0.6	0.3	0.0	0.1	1.0	0.7	0.4	6.8	40	2.5	1.7	15	6	0.03	3.8
2	5.8	4.1	-	0.39	-	0.4	0.2	0.0	0.1	0.7	0.8	0.6	6.0	21	1.4	1.5	12	10	0.02	2.6
3	5.9	4.3	-	0.19	-	0.3	0.2	0.0	0.1	0.6	0.5	0.2	4.9	17	0.7	1.1	12	4	0.01	2.7
4	5.4	4.1	-	0.16	-	0.0	0.2	0.0	0.1	0.3	0.9	0.6	4.8	14	0.6	1.2	6	12	0.02	2.9

ELEMENTAL COMPOSITION OF TOTAL SOIL (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/ Al2O3	SiO2/ Fe2O3	SiO2/ R2O3	Al2O3/ Fe2O3
1	90.0	6.9	0.9	0.00	0.01	0.08	-	0.50	0.01	0.01	3.7	22.1	266	20.4	12.0
2	83.1	10.1	1.1	0.00	0.00	0.10	-	0.63	0.01	0.01	4.4	14.0	201	13.1	14.4
3	83.5	10.8	1.2	0.00	0.01	0.10	-	0.67	0.00	0.00	4.3	13.1	185	12.3	14.1
4	82.6	12.1	1.3	0.00	0.00	0.11	-	0.75	0.00	0.00	4.7	11.6	169	10.8	14.6
5	99.7	1.7	0.3	0.00	0.00	0.07	-	0.04	0.00	0.00	0.7	99.5	885	89.5	8.9

remarks (hor. 5) : rock sample

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe Al Si (by AMM. OXALATE(o), Na DITHIONITE(d) & PYROPH(p))

Hor. no.	MI	VE	CH	SM	KA	HA	ML	QU	FE	GI	GO	HE	Fe(o)	Al(o)	Si(o)	Fe(d)	Al(d)	Fe(p)	Al(p)
1	-	-	-	-	8	-	2	-	-	-	4	-	0.0	0.1	0.0	0.3	0.1	0.1	0.1
2	-	-	-	-	8	-	2	-	2	-	4	-	0.0	0.1	0.0	0.4	0.1	0.1	0.1
3	-	-	-	-	8	-	2	-	2	-	4	-	0.0	0.1	0.0	0.3	0.1	0.0	0.0
4	-	-	-	-	8	-	2	-	2	-	4	-	0.0	0.1	0.0	0.4	0.1	0.0	0.0
5	-	-	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0.0	0.0	0.1	0.0	0.0

remarks (hor. 5) : rock sample

SAND MINERALOGY

Hor. no.	HEAV	LIGH	light fraction	QU	FE	PL	RE
4	0.1	99.9	100	0	0	0	0

Key light minerals: QU=quartz; FE=feldspar; PL=plagioclase; RE=rest group.

Remarks : not enough material available for heavy mineral count. In transparent minerals many tourmaline and zircon, also a few rutile.

FAO/UNESCO (1988) : Vetit-Rhodic Ferralsol (1974 : Rhodic Ferralsol)
 USDA/SCS SOIL TAXONOMY (1992) : Typic Haplustox, very fine, mixed, isohyperthermic (1975 : Tropeptic Haplustox)
 LOCAL CLASSIFICATION : Malashi clay

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, ferralic B horizon
 USDA/SCS (1992) : ochric epipedon, oxic horizon
 Soil moisture regime : ustic
 Soil temperature regime : isohyperthermic

LOCATION : Mpongwe Block 1, traverse B2-0m, Ndola Rural East District, Copperbelt Province
 Latitude : 13°31' S Longitude : 28°11' E Altitude : 1200 m a.s.l.
 AUTHOR(S) : Van Baren, J.H.V. et al Date (mm/yy) : 3/77

GENERAL LANDFORM : plateau Topography : flat or almost flat
 PHYSIOGRAPHIC UNIT :
 SLOPE Gradient : 2% Aspect : N
 POSITION OF SITE :
 MICRO RELIEF Kind : Pattern : none
 SURFACE CHAR. Rock outcrop : nil Stoniness : nil
 Cracking : nil Slaking/crusting : nil
 Salt : nil Alkali : nil
 SLOPE PROCESSES Soil erosion : nil Aggradation : nil
 Slope stability : stable

PARENT MATERIAL : residual material derived from dolomitic limestone

EFFECTIVE SOIL DEPTH : >200 cm

WATER TABLE : no watertable observed
 DRAINAGE : well
 PERMEABILITY : moderate; no slowly permeable layer(s)
 FLOODING Frequency : nil Run off : slow
 MOISTURE CONDITIONS PROFILE : 0 - 200 cm moist

LAND USE : (semi-) natural vegetation
 VEGETATION Type : woodland Status : cut over
 Landuse/vegetation remarks : Miombo woodland

ADDITIONAL REMARKS :

CLIMATE: no. of rain days applies to no. of days with more than 1 mm rainfall. / REFERENCES: Heilman P.G., 1978. Semi-detailed soil survey of Mpongwe Block I and II GRZ/EEC irrigated wheat scheme, Copperbelt Province. Soil Survey Report no. 53, prof. no. COP 2/77. Soil Survey Unit, Mt. Makulu, Chilanga.

CLIMATE :	Köppen: Aw													
Station: NDOLA	13 0 S/ 28 39 E		1270 m a.s.l		100 km NE of site								Relevance: poor	
	No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
act. evaporation mm	7	115	109	166	164	172	153	172	214	251	256	183	128	2083
relative humidity %	18	82	82	77	71	61	58	52	45	41	43	65	79	61
precipitation mm	30	307	245	183	39	3	1	0	1	2	20	131	280	1212
no. of raindays	30	21	17	11	3	1	0	0	0	0	3	13	21	90
tot.glob.rad. MJ/m2	30	19.7	19.5	21.0	22.6	21.3	20.0	20.9	23.2	25.2	25.8	22.6	19.8	261.6
T mean °C	27	20.5	20.4	20.5	20.0	17.6	15.6	15.8	18.3	21.6	23.6	22.2	20.7	19.7
T max °C	27	26.2	26.2	26.7	27.1	25.7	24.3	24.7	26.8	29.8	31.6	28.8	26.6	27.1
T min °C	27	16.8	16.8	16.1	13.6	9.6	6.7	6.4	8.9	12.5	15.3	16.8	16.8	13.1
bright sunshine h/d	30	4.5	4.4	5.8	7.9	8.5	8.7	9.0	9.5	9.0	8.8	6.1	4.7	7.1

PROFILE DESCRIPTION :

Ah	0 - 6 cm	Dark reddish brown (2.5YR 3/4, moist), reddish brown (2.5 YR 4.0/4.0, dry) sandy clay; weak fine subangular blocky and crumb structure; slightly sticky, slightly plastic, friable, slightly hard; many fine to medium and few coarse pores; moderately porous; common fine and few medium roots; clear smooth boundary to
BA	6 - 25 cm	Red (10R 4/6, moist; 1.25YR 4/6, dry) clay; moderate fine to medium subangular blocky structure; sticky, plastic, friable, hard; broken moderately thick clay and sesquioxide cutans; common fine and few medium pores; moderately porous; common fine and few medium roots; gradual smooth boundary to
Bt1	25 - 68 cm	Red (10R 3.5/6, moist; 10R 4.5/6, dry) clay; moderate fine, medium and coarse subangular blocky structure; sticky, plastic, friable, hard; broken moderately thick clay and sesquioxide cutans; common fine and few medium pores; moderately porous; few fine and medium roots; few weathered green schist fragments; diffuse smooth boundary to
Bt2	68 - 200 cm	Red (10R 3.5/6, moist; 10R 4.5/6, dry) clay; weak fine, medium and coarse subangular blocky structure; sticky, plastic, friable, hard; broken moderately thick clay and sesquioxide cutans; common fine to medium pores; moderately porous; very few fine roots; few weathered green schist fragments

ANALYTICAL DATA :

Hor. no.	Top - Bot	>2 mm	2000 1000	1000 500	500 250	250 100	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 μm	DISP	BULK DENS	pF- 0.0	1.0	1.5	2.0	2.3	2.7	3.4	4.2	SPEC. SOIL	SURF. m2/g
1	0 - 6	-	1	2	5	16	11	34	11	9	19	47	-	-	-	-	-	-	-	-	-	-	-	64
2	6 - 25	-	0	2	3	10	8	23	7	7	15	62	-	-	-	-	-	-	-	-	-	-	-	68
3	25 - 68	-	1	1	2	7	7	19	7	5	12	69	-	-	-	-	-	-	-	-	-	-	-	72
4	68 - 100	-	1	1	2	8	8	19	8	6	14	67	-	-	-	-	-	-	-	-	-	-	-	66
5	100 - 150	-	1	1	2	8	8	19	7	6	13	68	-	-	-	-	-	-	-	-	-	-	-	62
6	250 - 300	-	1	1	1	6	8	17	9	7	15	68	-	-	-	-	-	-	-	-	-	-	-	71
7	par. rock	-	4	15	17	19	36	90	9	0	9	1	-	-	-	-	-	-	-	-	-	-	-	1

Hor. no.	pH- H2O	-- KCl	CaCO3 %	ORG- C %	MAT. N %	EXCH Ca	CAT. Mg	----- K	----- Na	sum	EXCH H+Al	AC. Al	CEC soil	----- clay	----- OrgC	ECEC	BASE SAT %	Al SAT %	EC 2.5 mS/cm	EXTR. AC. KCl/TEA pH 8.2
1	5.2	4.2	-	1.81	0.11	0.8	0.7	0.0	0.2	1.7	1.2	0.8	9.3	20	6.3	2.9	18	9	-	9.0
2	5.0	4.1	-	0.81	0.07	0.2	0.7	0.0	0.1	1.0	1.5	1.2	8.6	14	2.8	2.5	12	14	-	7.8
3	5.1	4.2	-	0.42	0.04	0.4	0.3	0.0	0.0	0.7	1.1	0.3	6.7	10	1.5	1.8	10	4	-	7.0
4	5.3	4.6	-	0.29	0.04	0.6	0.7	0.0	0.0	1.3	0.4	0.0	6.7	10	1.0	1.7	19	0	-	5.0
5	5.4	4.8	-	0.20	0.03	0.8	0.7	0.0	0.1	1.6	0.2	0.0	5.4	8	0.7	1.8	30	0	-	4.8
6	5.5	5.0	-	0.22	0.03	1.0	0.7	0.0	0.0	1.7	0.2	0.0	5.8	9	0.8	1.9	29	0	-	4.1

ELEMENTAL COMPOSITION OF TOTAL SOIL (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/ Al2O3	SiO2/ Fe2O3	SiO2/ R2O3	Al2O3/ Fe2O3
1	60.0	17.8	10.5	0.04	0.32	0.92	-	2.13	0.07	0.18	2.6	5.7	15.2	4.2	2.7
2	52.2	21.8	11.9	0.02	0.33	0.96	-	1.77	0.06	0.15	8.8	4.1	11.7	3.0	2.9
3	50.5	24.6	13.0	0.01	0.36	1.03	-	1.64	0.06	0.12	9.1	3.5	10.3	2.6	3.0
4	51.0	23.8	12.7	0.02	0.35	1.05	-	1.65	0.05	0.08	8.6	3.6	10.7	2.7	2.9
5	51.2	24.4	13.2	0.03	0.36	1.09	-	1.74	0.05	0.08	8.5	3.6	10.3	2.6	2.9
6	51.2	25.3	13.1	0.03	0.35	1.13	-	1.57	0.05	0.06	8.8	3.4	10.4	2.6	3.0

ELEMENTAL COMPOSITION OF TOTAL CLAY (in weight %) AND MOLAR RATIOS

Hor. no.	SiO2	Al2O3	Fe2O3	CaO	MgO	K2O	Na2O	TiO2	MnO2	P2O5	IGN. LOSS	SiO2/ Al2O3	SiO2/ Fe2O3	SiO2/ R2O3	Al2O3/ Fe2O3
1	33.8	32.9	16.6	0.03	0.45	1.40	-	0.99	0.10	0.40	11.9	1.7	5.4	1.3	3.1
2	34.2	33.4	16.2	0.01	0.42	1.25	-	0.91	0.07	0.30	12.1	1.7	5.6	1.3	3.2
3	34.5	33.5	16.2	0.00	0.39	1.18	-	0.91	0.06	0.23	12.3	1.8	5.7	1.3	3.2
4	34.1	33.3	16.3	0.00	0.37	1.25	-	0.92	0.06	0.15	12.4	1.7	5.6	1.3	3.2
5	34.2	33.4	16.4	0.01	0.40	1.27	-	0.94	0.05	0.18	12.3	1.7	5.6	1.3	3.2
6	33.8	33.2	16.1	0.00	0.40	1.25	-	0.92	0.05	0.15	12.4	1.7	5.6	1.3	3.2

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe Al Si (by AMM. OXALATE(o), Na DITHIONITE(d) & PYROPH(p))

Hor. no.	MI	VE	CH	SM	KA	HA	ML	QU	FE	GI	GO	HE	Fe(o)	Al(o)	Si(o)	Fe(d)	Al(d)	Fe(p)	Al(p)
1	2	-	-	-	6	-	4	-	-	4	2	-	0.4	0.3	0.0	5.3	0.4	0.2	0.1
2	2	-	-	-	6	-	4	-	-	4	2	-	0.4	0.3	0.0	6.6	0.5	0.1	0.1
3	2	-	-	-	6	-	4	-	-	4	2	-	0.4	0.3	0.0	7.0	0.5	0.0	0.1
4	2	-	-	-	6	-	4	-	-	4	2	-	0.4	0.2	0.0	6.8	0.4	0.0	0.0
5	2	-	-	-	6	-	4	-	-	4	2	-	0.4	0.2	0.0	7.0	0.4	0.0	0.0
6	2	-	-	-	6	-	4	-	-	4	2	-	0.3	0.2	0.0	7.2	0.4	0.0	0.0

FAO/UNESCO (1988) : Hyposodi-Eutric Vertisol (1974 : Chromic Vertisol, sodic phase)
 USDA/SCS SOIL TAXONOMY (1992) : Udic Haplustert, fine, mixed, hyperthermic (1975 : Udic Chromustert)
 LOCAL CLASSIFICATION : Kafue clay

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, cambic B horizon; slickensides
 USDA/SCS (1992) : ochric epipedon, cambic horizon; slickensides, high linear extensibility
 Soil moisture regime : ustic
 Soil temperature regime : hyperthermic

LOCATION : Harthoorn's farm, 10km W of Kafue, Lusaka Province (see additional remarks)
 Latitude : 15°46' S Longitude : 27°55' E Altitude : 990 m a.s.l.
 AUTHOR(S) : C. Kalima, D. Hallbick & O. Spaargaren Date (mm/yy) : 11/83
 GENERAL LANDFORM : lacustrine plain Topography : flat or almost flat
 PHYSIOGRAPHIC UNIT : broad plain
 SLOPE Gradient : 0%
 POSITION OF SITE :
 MICRO RELIEF Kind : gilgai Pattern : polygonal Height : 20 cm
 SURFACE CHAR. Rock outcrop : nil Stoniness : nil
 Cracking : large cracks Slaking/crusting : nil
 Salt : nil Alkali : nil
 SLOPE PROCESSES Soil erosion : nil Aggradation : nil
 Slope stability : stable

PARENT MATERIAL : lacustrine sediments

EFFECTIVE SOIL DEPTH : 150 cm

WATER TABLE : no watertable observed
 DRAINAGE : poor
 PERMEABILITY : slow; no slowly permeable layer(s)
 FLOODING Frequency : yearly, stagnant water Run off : very slow
 MOISTURE CONDITIONS PROFILE : 0 - 100 cm dry 100 - 154 cm moist

LAND USE : semi-natural grassland, grazed

ADDITIONAL REMARKS :

LOCATION: pit located about 250 m SE of fish farm offices. / CRACKING: length of time of open cracks is uncertain, therefore USDA/SCS classification may be Typic Haplustert. At time of description cracks were 4 cm wide at a depth of 50 cm. Polygon diameter measured about 90 to 100 cm. / REFERENCES: Woode P.R. (Ed.), 1988. Proceedings of the XIth International Forum on Soil Taxonomy and Agrotechnology Transfer, Zambia, July 15th to August 1st, 1985, pedon 10, pp 420-427.

CLIMATE : Köppen: Aw
 Station: 15 46 S/ 27 55 E 978 m a.s.l 1 km S of site Relevance: very good
 KAFUE POLDER
 No. years of record Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Annual
 (no data available yet)

PROFILE DESCRIPTION :

A	0 - 8 cm	Very dark grayish brown (2.5Y 3/2, moist), dark grayish brown (2.5Y 4/2, dry) clay; strong medium and coarse granular structure; very sticky, very plastic, hard; common fine prominent yellowish red (5YR 5/8) mottles; many very fine to fine pores; slightly porous; many fine and medium roots throughout; few medium spherical ferruginous nodules (ironstone); clear smooth boundary to
Bw	8 - 24 cm	Dark olive gray (5Y 3/2, moist), olive (5Y 4/3, dry) clay; strong medium and coarse subangular blocky structure; very sticky, very plastic, hard; common medium prominent yellowish red (5YR 5/8) mottles; continuous thin pressure faces on peds and few intersecting slickensides; many fine to medium discontinuous tubular pores; slightly porous; many fine and medium roots throughout; few large spherical ferruginous nodules (ironstone) and very few medium spherical calcareous nodules; clear smooth boundary to
Bk1	24 - 74 cm	Dark olive gray (5Y 3/2, moist), olive gray (5Y 4/2, dry) clay; strong medium and coarse angular blocky structure; hard; continuous thin pressure faces on peds and many intersecting slickensides; common very fine to fine discontinuous tubular pores; slightly porous; many fine roots throughout; few large spherical calcareous and ferruginous (ironstone) nodules; gradual wavy boundary to
Bk2	74 - 133 cm	Dark olive gray (5Y 3/2, moist), olive gray (5Y 4/2, dry) clay; strong medium and coarse angular blocky structure; very friable, hard; continuous thick pressure faces on peds and many intersecting slickensides; common very fine to fine discontinuous tubular pores; slightly porous; common fine roots throughout; frequent large spherical calcareous nodules and few medium spherical ferruginous nodules (ironstone); gradual smooth boundary to
Bck	133 - 154 cm	Olive (5Y 4/3, moist) clay; moderate medium and coarse angular blocky structure; very friable; broken thick pressure faces on peds and common intersecting slickensides; few fine discontinuous tubular pores; slightly porous; common fine roots throughout; frequent large spherical calcareous nodules and frequent medium spherical ferruginous nodules (ironstone)

ANALYTICAL DATA :

Hor. no.	Top	Bot	>2 mm	2000 1000	1000 500	500 250	250 100	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 μm	DISP	---BULK DENS---	pF-	---	---	---	---	---	---	---	COLE cm/cm
															pF 2.5 Oven dry	0.0	1.0	1.5	2.0	2.5	3.4	4.2		
1	0	8	1	1	2	5	13	9	30	11	10	22	49	-	1.40	1.73	-	-	-	-	27	-	17	0.073
2	8	24	-	1	2	4	9	7	24	8	12	20	57	-	1.55	1.93	-	-	-	-	23	-	16	0.076
3	24	74	3	1	2	4	9	7	23	9	10	19	57	-	1.57	2.10	-	-	-	-	23	-	17	0.100
4	74	105	1	1	2	4	10	7	24	8	11	19	57	-	1.57	2.03	-	-	-	-	24	-	19	0.089
5	105	133	3	1	2	4	9	7	22	8	12	20	58	-	1.53	1.99	-	-	-	-	26	-	19	0.090
6	133	154	4	1	2	4	9	7	22	9	11	20	58	-	1.53	1.99	-	-	-	-	27	-	20	0.090

Hor. no.	pH- H2O	-- KCl	CaCO3 %	CaSO4 .2H2O %	ORG- C %	MAT. N %	EXCH Ca	CAT. Mg	---- K	---- Na	---- sum	EXCH AC. H+Al	AC. Al	CEC soil	---- clay	---- OrgC	---- ECEC	BASE SAT %	Al SAT %	EC 2.5 mS/cm
1	7.3	5.8	0.7	-	1.88	0.19	17.3	11.3	0.4	0.9	29.9	-	-	34.2	70	6.6	29.9	87	-	0.19
2	7.9	6.5	0.8	-	0.63	0.07	17.4	10.8	0.2	0.8	29.2	-	-	33.8	60	2.2	29.2	86	-	0.16
3	8.8	7.2	1.7	-	0.44	0.05	18.3	12.8	0.2	2.3	33.6	-	-	32.5	57	1.5	33.6	103	-	0.22
4	8.8	7.5	4.0	-	0.48	0.00	16.8	14.1	0.2	4.3	35.4	-	-	33.0	58	1.7	35.4	107	-	0.42
5	8.6	7.5	4.0	1	0.46	0.00	17.8	15.6	0.1	3.9	37.4	-	-	33.8	58	1.6	37.4	111	-	0.96
6	8.0	7.4	4.0	1	0.35	0.00	28.2	15.3	0.1	3.9	47.5	-	-	32.0	55	1.2	47.5	148	-	2.66

WATER SOLUBLE SALTS

Hor. no.	CA	MG	NA	K	SUM CATIONS	CO3	HCO3	CL	SO4	NO3	SUM ANIONS	PH	EC5	ECE	SAR
					mol(+)/l						mmol(-)/l			mS/cm	
1	1.9	1.7	1.1	0.1	4.8	-	2.6	0.6	1.5	-	4.7	6.6	-	0.51	-
2	0.6	0.5	1.3	-	2.4	-	1.8	0.3	0.3	-	2.4	7.2	-	0.27	-
3	0.5	0.2	3.7	-	4.4	-	3.1	0.4	0.7	-	4.2	8.0	-	0.47	-
4	1.1	1.2	13.8	-	16.1	-	3.2	0.5	12.9	-	16.6	8.1	-	1.67	-
5	19.1	17.2	43.1	0.1	79.5	-	1.7	4.7	74.2	-	80.6	7.7	-	6.19	-
6	18.7	17.0	47.7	0.1	83.5	-	1.4	3.9	78.1	-	83.4	7.8	-	6.51	-

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe Al Si (by AMM. OXALATE(o) & Na DITHIONITE(d))

Hor. no.	MI	VE	CH	SM	KA	HA	ML	QU	FE	GI	GO	HE	Fe(o)	Al(o)	Si(o)	Fe(d)	Al(d)
1	-	-	-	-	-	-	-	-	-	-	-	-	0.4	0.2	0.1	2.1	0.2
2	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.2	0.1	2.4	0.3
3	-	1	-	3	4	-	-	-	-	2	-	-	0.1	0.2	0.1	2.5	0.3
4	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.1	0.1	2.3	0.3
5	-	1	-	3	4	-	-	-	-	2	-	-	0.1	0.1	0.1	2.2	0.3
6	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.1	0.1	2.2	0.3

Remarks: bulk density, pF, COLE, CaSO4.2H2O and water soluble salts data are produced by the National Soil Survey Laboratory, USDA/SCS, Lincoln, Nebraska, USA

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APPENDIX 2 FIELD METHODS

The soils are described in the field according to ISRIC's Guidelines for the description and coding of soil data (van Waveren & Bos, 1988; 1994). These guidelines follow closely those for soil description given by FAO (1977) and FAO-ISRIC (1990). Soil colours are determined using either the Munsell Soil Color Charts or the Revised Standard Soil Color Charts (Oyama & Takehara, 1967).

Soil columns are taken for monolith preparation using the methods described by van Baren & Bomer (1979). In addition, disturbed and undisturbed samples are collected for physical, chemical and mineralogical analyses and for thin section preparation, where possible using the guidelines for the sampling of soil horizons for a soil reference collection (NASREC Newsletter no. 1 (March, 1991).

Of all sites slides and photographs are taken showing the landscape, vegetation, land use, soil profile and important profile details. Furthermore, data are collected with each pedon on climate, land use history, crops and crop yields, soil management practices, etc.

Soils are classified according to the FAO-Unesco Legend of the Soil Map of the World (1974) and its Revised Legend (FAO, 1988). Soil subunit modifiers ("third level") were added using the proposals given by Nachtergaele et al. (1994). In addition soil were given their classification according to Soil Taxonomy (Soil Survey Staff, 1975; 1992), and, if available, the local classification.

All data are stored in ISIS version 4.0 (ISRIC, 1994), ISRIC's soil pedon data management system for micro computers. The information given on the soil data sheets in this publication have been generated from the ISIS files.

APPENDIX 3 ANALYTICAL METHODS

Preparation

Each sample is air-dried, cleaned, crushed (not ground), passed through 2 mm sieve, homogenized. Moisture content is determined at 105° C.

pH H₂O

(1:2.5): 20 g of soil is shaken with 50 ml of deionised water for 2 hours, electrode in upper part of suspension.

pH-KCl

Likewise but shaken with 1M KCl.

EC

(1:2.5): Conductivity of pH-H₂O suspension.

Particle-size distribution

Soil is treated with 15% hydrogen peroxide overnight in the cold, then on waterbath at about 80°C. Then boiled on hot plate for 1 hour. Washings until dispersion. Dispersing agent is added (20 ml solution of 4% Na-hexametaphosphate and 1% soda) and suspension shaken overnight. Suspension sieved through 50 µm sieve. Sand fraction remaining on sieve dried and weighed. Clay and silt determined by pipetting from sedimentation cylinder.

Water-dispersable clay

Pipetting after shaking 20 g of soil overnight (16 hours) with deionized water.

Specific surface area

Saturation with ethylene glycol monoethyl ether (EGME), excess removal by vacuum suction. Mass of retained monomolecular layer of EGME is measure for surface area.

Exchangeable bases and CEC

Percolation with 1M ammonium acetate pH7 using automatic extractor.

(If EC>0.5mS pre-leaching with ethanol 80%). Cations are determined in the leachate by AAS.

CEC: saturation with sodium acetate 1M pH7; washed with ethanol 80% and then leached with ammonium acetate 1M pH7. Na determined by FES.

Exchangeable acidity and aluminium

The sample is extracted with 1M KCl solution and the exchange acidity (H+Al) titrated with NaOH. Al is measured by AAS.

Carbonate

Piper's procedure. Sample is treated with dilute acid and the residual acid is titrated.

Organic carbon

Walkley-Black procedure. The sample is treated with a mixture of potassium dichromate and sulphuric acid at about 125°C. The residual dichromate is titrated with ferrous sulphate. The result expressed in % carbon (because of incomplete oxidation a correction factor of 1.3 is applied).

Total nitrogen

Micro-Kjeldahl. Digested in H₂SO₄ with Se as catalyst. Then ammonia is distilled, trapped in boric acid and titrated with standard acid.

P-Bray 1

Phosphate is extracted with a mixture of 0.025M HCl + 0.03M NH₄F and determined colorimetrically.

P-Olsen

Phosphate is extracted with 0.5M NaHCO₃ solution pH 8.5 and determined colorimetrically.

P-retention

Blakemore et al. Shaken with (KH₂PO₄ + NaAc) solution, 1000 mg/L P pH 4.6 for 16 hours.

Determination of residual P colorimetrically after centrifuging.

pH-NaF

To 1g of soil 50 ml of NaF 1M is added and stirred for 1 minute.

Reading pH by continuous stirring exactly 2 minutes after adding NaF solution.

Extractable iron, aluminium, manganese and silicon

All determinations by AAS.

1. "Free" (Fe, Al, Mn): Holmgren Shaken with sodium citrate (17%) + sodium dithionite (1.7%) solution for 16 hours.
2. "Active" (Fe, Al, Si): Shaken with acid ammonium acetate 0.2M pH 3 for 4 hours in the dark.
3. "Organically bound" (Fe, Al): Shaken with sodium pyrophosphate 0.1M for 16 hours.

Clay mineralogy

Clay is separated as indicated for particle-size analysis.

about 10-20 mg of clay is brought on porous ceramic tile by suction and analyzed using a Philips diffractometer.

Soluble salts

Measuring pH, EC, cations and anions in water extracts.

1. 1:5 extract. Shaking 30 g of fine earth + 150 ml of water for 2 hours.
2. saturation extract. Adding to 200-1000 g fine earth just enough water to saturate the sample. Standing overnight.

After filtration Ca, Mg, Na, K are measured by AAS. Cl with the Chlorocounter and SO₄ turbidimetrically.

Gypsum

To 10 g of fine earth 100 ml of water is added, shaken overnight and centrifuged.

Precipitation by adding acetone. Precipitate redissolved in water and determination of Ca by AAS.

Elemental composition

The fine earth is dried, ignited and fused with lithium tetraborate.

The formed bead is analyzed by X-ray fluorescence spectroscopy.

Moisture retention

Moisture determinations on undisturbed core samples in silt box (pF1.0; 1.5; 2.0) and kaolinite box (pF2.3; 2.7) respectively and on disturbed samples in high pressure pan (pF3.4; 4.2).

Bulk density obtained from dry weight of core sample.

APPENDIX 4 SLIDE LIST OF THE REFERENCE PROFILES

This list contains details about the slides in the ISRIC collection for the profiles CN001 to CN033. Slides of later profiles have been taken but their particulars have not been processed to date. Slides from this list may be ordered from ISRIC at cost price plus administration- and shipping costs.

Ref. soil	Slide nr.	Subject	Remarks
ZM002	2692	profile	ZM002, profile
ZM002	2693	vegetation	ZM002, vegetation
ZM002	2694	vegetation	ZM002, vegetation
ZM002	2695	other	small anthill near ZM002
ZM002	2696	vegetation	vegetation, groundcover
ZM008	2644	landscape	landscape ZM008, Munkonge
ZM008	2645	other	ditto
ZM008	2646	land use	land use ZM008
ZM008	2647	other	ditto
ZM008	2648	other	ditto
ZM008	2649	landscape	landscape near ZM008
ZM009	2680	landscape	landscape near ZM009
ZM009	2681	landscape	landscape near ZM009
ZM009	2682	landscape	landscape near ZM009
ZM009	2683	landscape	ditto, groundcover
ZM009	2684	profile	ZM009, profile
ZM009	2685	profile details	ZM009, detail of profile
ZM009	2686	landscape	landscape near ZM009, grasses
ZM009	2687	landscape	landscape near ZM009, grasses
ZM010	2701	profile	ZM010, taking profile
ZM010	2702	vegetation	ZM010, vegetation
ZM010	2703	vegetation	
ZM010	2704	vegetation	
ZM010	2705	other	grass cover
ZM010	2706	other	ditto, grasscover
ZM010	2707	vegetation	
ZM010	2708	vegetation	
ZM010	2709	vegetation	
ZM010	2710	vegetation	
ZM010	2711	vegetation	
ZM010	2714	other	lake near ZM010
ZM010	2715	other	lake near ZM010

Country Reports¹
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No.	Country	No. of soils	No.	Coutry	No. of soils
1	Cuba	22	15	Gabon	6
2	P.R. of China	51	16	Ghana	in prep.
3	Turkey	15	17	Philippines	6
4	Côte d'Ivoire	7	18	Zimbabwe	13
5	Thailand	13	19	Spain	20
6	Colombia	18	20	Italy	17
7	Indonesia	48	21	Greece	in prep.
8	Ecuador	in prep.	22	India	in prep.
9	Brazil	28	23	Kenya	in prep.
10	Peru	21	24	Mali	in prep.
11	Nicaragua	11	25	Nigeria	in prep.
12	Costa Rica	12	26	Mozambique	in prep.
13	Zambia	11	27	Botswana	in prep.
14	Uruguay	10	28	Malaysia	18

¹ as of June 1995