

REPUBLIC



OF ZAMBIA

THIRD MEETING OF THE EASTERN AFRICAN
SUB-COMMITTEE FOR SOIL CORRELATION AND
LAND EVALUATION
ZAMBIA, 23 - 30 APRIL, 1978

EXCURSION GUIDE



DEPARTMENT OF AGRICULTURE

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SOIL SURVEY UNIT

LAND USE BRANCH

MINISTRY OF LANDS AND AGRICULTURE

1978

184 = 33990

SITE 1: MOUNT MAKULU

near to Sul Basin, Entebbe

Location: Mount Makulu Central Research Station

Series Name: Makeni

Soil Classification FAO: *Curic Phaeozem (Pierot)*

USDA: *typic Regimstoll (Conrad)*

FRENCH: *sol fersiallitique typique, limoneux, modelé*

Land Capability Classification: C2se

Site Characteristics:

Altitude: 1200m

Rainfall 800mm

Physiography: Undulating plateau, middle slope

Slope: gently sloping (3-5%)

Parent material: 11imestone (calcite)

Drainage: well drained

Land-Use: Research trial site

Profile Description:

Ap ₁	0-9cm	Dark reddish brown (5YR 3/3) moist; clay loam; strong fine and medium subangular blocky structure; plastic, sticky, friable moist; common fine, few medium and coarse pores; many fine, common medium roots; few fine gravels; clear smooth boundary.
Ap ₂	9-25cm	Dark reddish brown (5YR 3/3) moist; clay; moderate fine and medium subangular blocky structure; friable moist, sticky, plastic when wet; common fine, few medium and coarse pores; many fine and few medium roots; few fine gravels; clear smooth boundary.
Bt ₁	25-45cm	Dark reddish brown (5YR 3/4) moist; clay; moderate fine and medium subangular blocky structure; friable moist; sticky, plastic when wet; broken moderately thick clay cutans; many fine, few medium and coarse pores; many fine roots; few fine and coarse gravels; diffuse smooth boundary.
Bt ₂	45-72cm	Dark reddish brown (5YR 3/4) moist clay; moderate fine and medium subangular blocky structure; friable moist; sticky and plastic wet; broken moderately thick clay cutans; many fine pores; many fine roots; few fine gravels; diffuse smooth boundary.
Bt ₃	72-120cm	Dark reddish brown (2.5YR 3/4) moist; clay; moderate fine and medium subangular blocky structure; slightly firm moist, sticky, plastic when wet; broken moderately thick clay cutans; many fine, few medium and coarse pores; common fine roots; few fine and coarse gravels; abrupt broken boundary.
R	120-160+cm	Many hard stones and boulders of limestone (calcite)

Remarks: Soils on Mount Makulu Research Station are continuously contaminated by lime fall-out from nearby cement factory.

mollie, ustic, argillic

normal pH 5.5-6.0

(mollie nitrocal, leptic phase)

"best soil of Lambini"

some fine lime

*workability
fragmentation for large scale farming
very hard when dry
very sticky when wet*

*newest
FAO/ISS symbols!*

*facies (Aubert)
loesslike
structure comparable
to Terra Rossa/
Red Tropical
Soil on bare
crystalline rocks*

*shiny
faces*

Soil physical data:

	<u>Field capacity</u> (0-33 bar)	<u>Wilting point</u> (15 bar)	<u>Moisture Saturation</u> %	<u>Coeff. of a.p.</u> %
topsoil (0-15cm)	32	12	37	83
upper subsoil(30-45cm)	26	10	35	86
lower subsoil(60-90cm)	28	14	37	84

Water infiltration rates(cm): topsoil: 7.3(1st hr.)
 (accumulated rates for 3.1(2nd hr.)
 the succeeding hours) 2.6(3rd hr.)

Soil chemical data:

Lab. No.	Depth (cm)	Clay < 0.002 %	<u>Grain size, mm</u>				C.sand 0.50 -2.00 %	Tex. (USDA)
			Silt 0.002 -0.0 %	F.sand 0.05 -0.25 %	M.sand 0.25 -0.50 %			
Api	18/632	0-9	32	25	36	5	2	CL
Ap ₂	33	9-25	40	24	27	7	2	C/CL
Bt ₁	675	25-45	38	17	37	6	2	SC/CL
Bt ₂	76	45-72	45	21	24	6	4	C
Bt ₃	635	72-120	51	23	15	8	3	C

Lab. No.	Depth (cm)	Ex. Ca m.e.%	Ex. Mg m.e.%	Ex. K m.e.%	Ex. Na m.e.%	C.E.C. m.e.%	C.E.C m.e.% 100g clay
78/632	0-9	31.00	0.70	0.58	0.18	15.3	47.8
33	9-25	20.50	0.78	0.21	0.15	17.7	44.3
675	25-45	11.75	0.73	0.14	0.17	16.4	43.2
76	45-72	11.00	0.73	0.13	0.12	17.8	39.6
635	72-120	11.25	0.60	0.10	0.08	15.7	30.8

Lab. No.	Depth (cm)	Org. C %	Total N %	Avail. P ppm	pH (CaCl ₂)	Base Sat %	Free Fe ppm
78/632	0-9	1.33	0.10		7.4	100	
33	9-25	1.17	0.08		7.2	100	
675	25-45	1.07	0.05		6.6	78.0	
76	45-72	0.70	0.05		6.1	67.3	
635	72-120	ND	ND		6.2	76.6	

ND: Not determined

Common crop yields (Kg/ha): Commercial Management

Maize: 6 - 7,000.

Soya beans: 2,000

Sunflower: 1500

Irrigated wheat: 5,000

Groundnuts: 2,500 - 3,000

Cotton: 2,000

See also enclosed "CROP MEMO" for agronomic data.

Land capability:

C2se

L slope

ITINERARY

1st Day: 26th April: LUSAKA - MONZE (235 km)

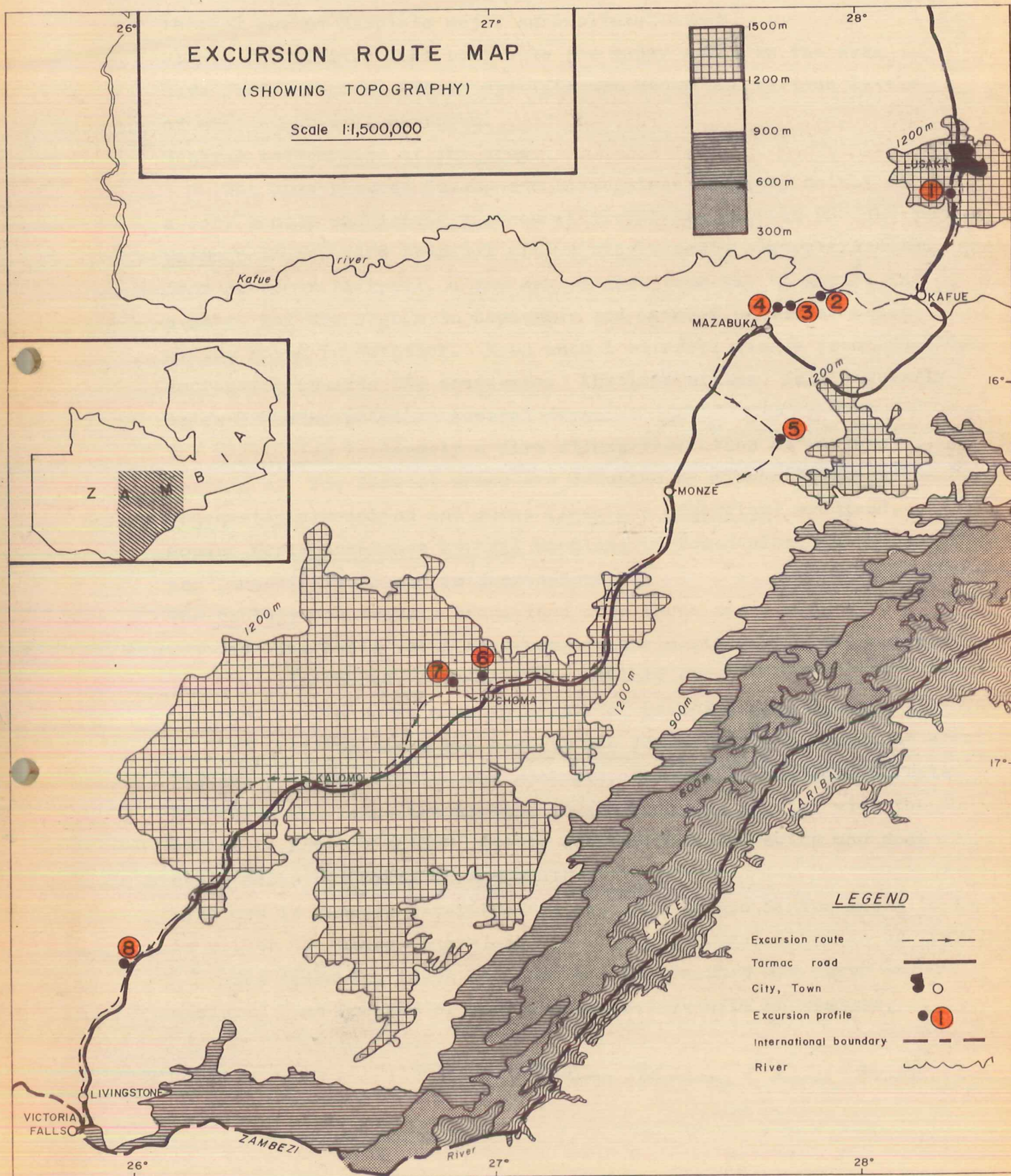
08.00 hours	Departure Andrews Motel
08.00 - 09.30 hrs.	Motel - Irrigation Research Station (105 km)
09.30 - 10.30 hrs.	Stop 2 : Nanga
10.30 - 11.00 hrs.	Irrigation Research Station - Nakambala Sugar Estates (25 km)
11.00 - 13.00 hrs.	Stop 3: Nakambala 1
	Stop 4: Nakambala 2
13.00 - 14.30 hrs.	Lunch by Nakambala Sugar Estates.
14.30 - 15.40 hrs.	Nakambala - Family Farms Settlement (60 km)
15.40 - 16.40 hrs.	Stop 5: Mbaya / Musuma
16.40 - 17.30 hrs.	Settlement - Monze (45 km)

Night stop at Zambia College of Agriculture, Monze.

20.00 - 21.30 hrs. Films about Zambia.

2nd Day: 27th April: MONZE - LIVINGSTONE (360 km)

07.30 hours	Departure Zambia College of Agriculture
07.30 - 09.10 hrs.	Monze - Popota Tobacco Scheme (110 km)
09.10 - 10.10 hrs.	Stop 6: Popota
10.10 - 10.50 hrs.	Popota - Commercial Farm (40 km)
10.50 - 12.00 hrs.	Stop 7: Dankwert
12.00 - 13.00 hrs.	Lunch Break
13.00 - 15.00 hrs.	Choma - Rural Reconstruction Centre (150 km)
15.00 - 16.00 hrs.	Stop 8: Kabuyu
16.00 - 17.00 hrs.	Rural Reconstruction Centre - Livingstone (Victoria Falls) 60 km.



Introduction

The excursion will take place between Lusaka and Livingstone through one of Zambia's major agricultural areas. Within the limited time available the major soils in the area have been selected. Their specific use under the various levels of management will be shown.

General information of the area

The area between Lusaka and Livingstone consists mainly of a very gently undulating plateau at elevations between 900 and 1200m. Climate is moderate tropical with a single rainy season extending from November to April, a dry cool season from May to August and a short hot dry season in September and October until the onset of the rains in November. Mean annual rainfall ranges from 650-800mm decreasing towards the southwest. Absolute minima fall regularly below freezing point on several days.

The vegetation is largely a fire climax vegetation of various woodlands. The largest areas are occupied by miombo (Julbernardia-Brachystegia) woodland and munga (Acacia - Combretum) woodland. Mopane (Colophospermum mopani) woodland is found along the Kafue and Zambezi Rivers and in depressions.

The geology can broadly be divided into three major rock types:

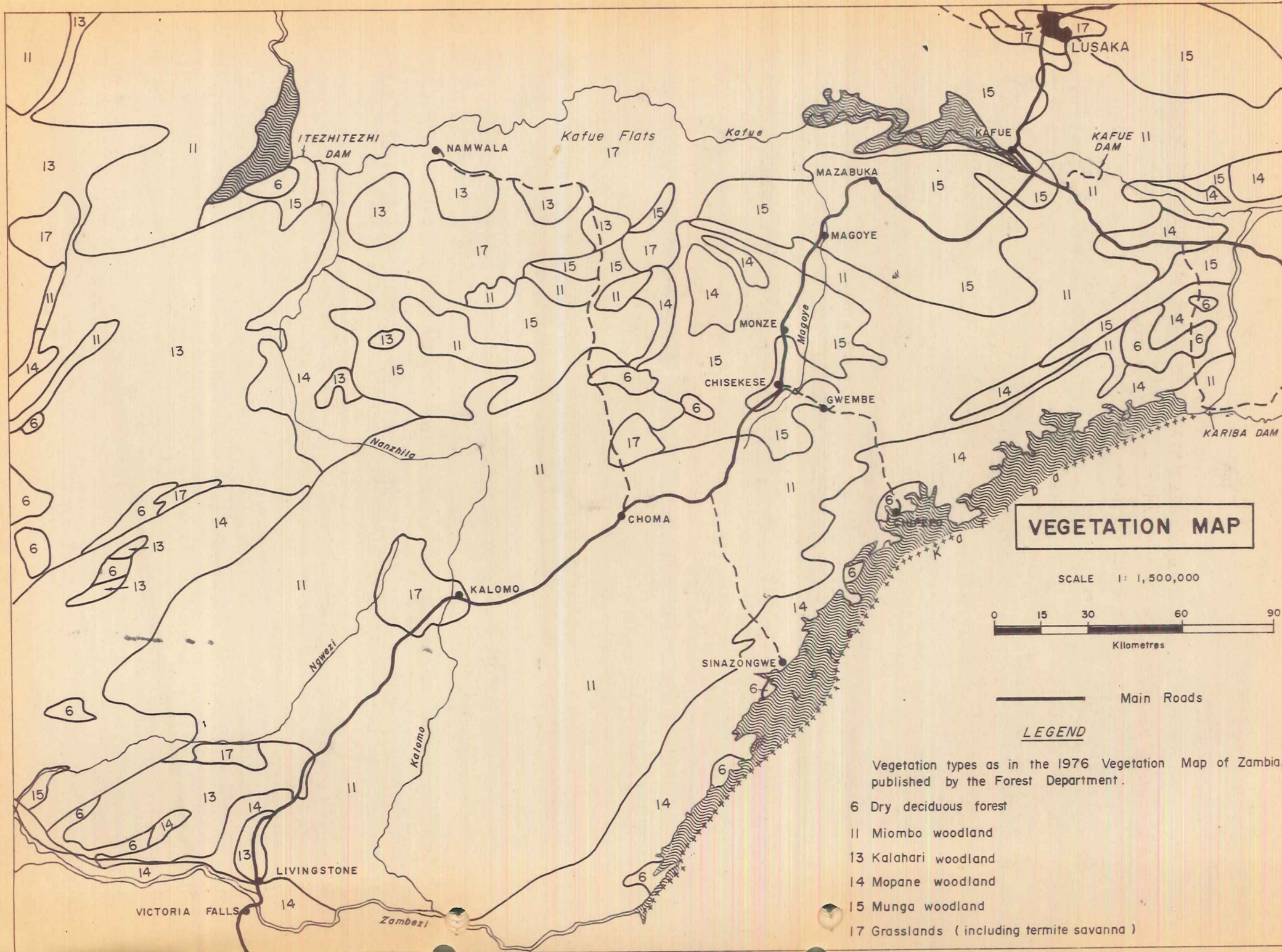
- a) The basic rocks occurring in the north (mainly dolomites, limestones, calc-silicate schists etc.)
- b) Acidic rocks such as granites, gneisses etc. towards the south.
- c) Barotse sands and basalts are found in the Livingstone area.

The soils follow closely the geology. Therefore, the more fertile red clays and loams are located in the northern portion with the so called "sandveldt soils", mainly coarser textured soils and deep sandy soils occurring in the south.

Land use is largely determined by the Land Tenure System which in Zambia is either Statutory (Stateland) or Tribal/Communal (Reserve or Trustland).

The following types of land uses as described and found on enclosed Land Use Map of Zambia Schultz, 1974 will be visited.

& also S. Tanzania, Rhodesia, S. Zaire, Mozambique



- 1) Direct Production Schemes (primarily aimed at increased national production). Stateland only.

Site 1 and 2: Research Stations

Site 3 and 4: Sugar estate

Site 6 : Tobacco scheme

Site 8 : Rural Reconstruction Centre.

- 2) Settlement Schemes (primarily aimed at rural development).
on Stateland and Reserve/Trustland.

Site 5: Mbaya - Musuma (Family Farms)

Site 6: Tobacco Family Farming Scheme

- 3) Private Commercial Farms on Stateland only

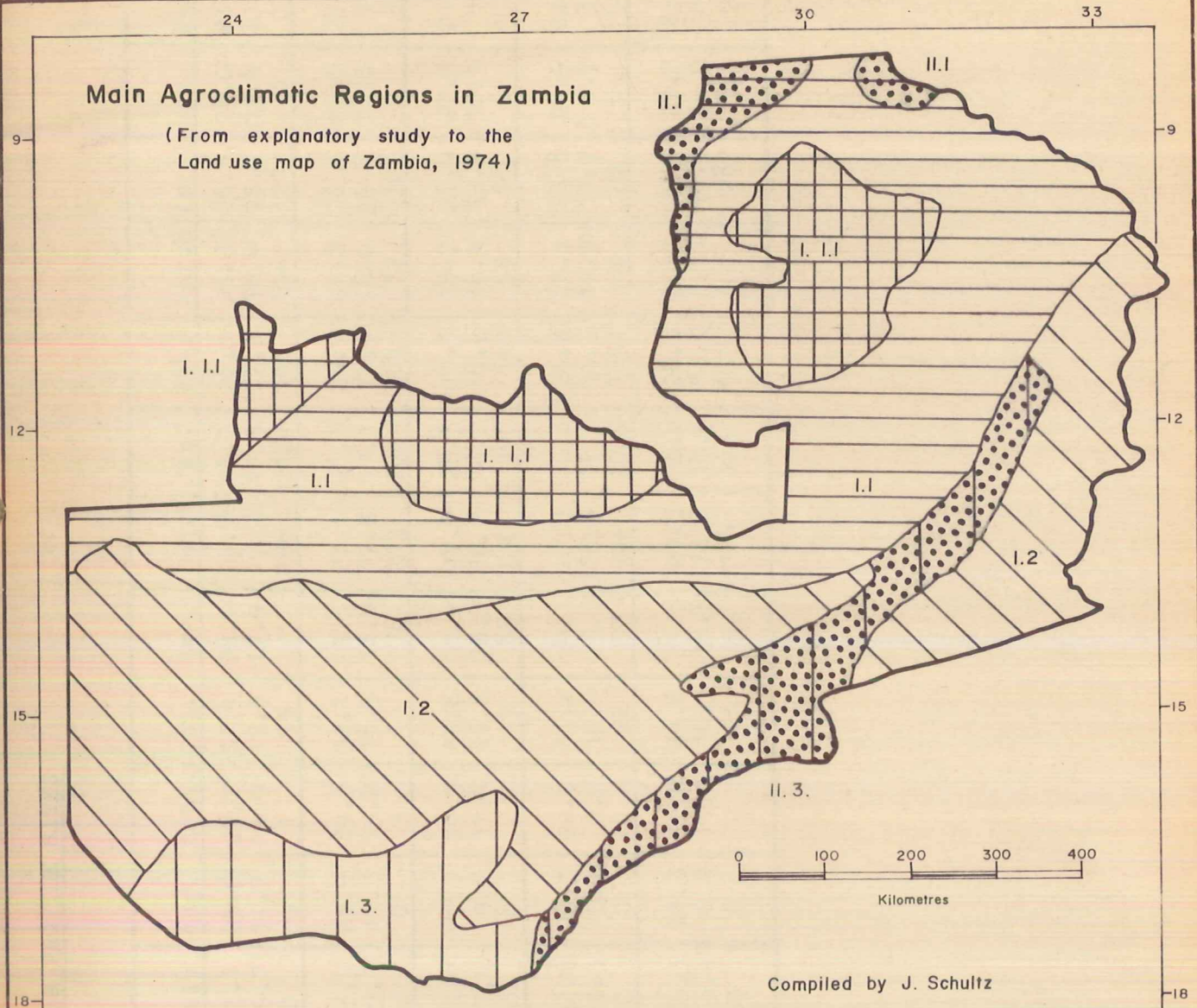
Site 7: Dankwert Farm

Main cash crops by acreage and value are maize, Sugar cane, Virginia tobacco, beef.

Important other crops are groundnuts, sunflower, cotton, mainly amongst the smaller farmers.

Main Agroclimatic Regions in Zambia

(From explanatory study to the
Land use map of Zambia, 1974)



Compiled by J. Schultz

	I	Moderate	} tropical temperatures, {	17,5–22,5
	II	Hot		annual means (C°) >22,5
	1	Wet	} mean annual rainfall (mm)	>1000 ¹⁾ R>0,5Eo
	2	Moderate wet.		800–1,000 R=0,5Eo
	3	Dry		<800 R<0,5Eo

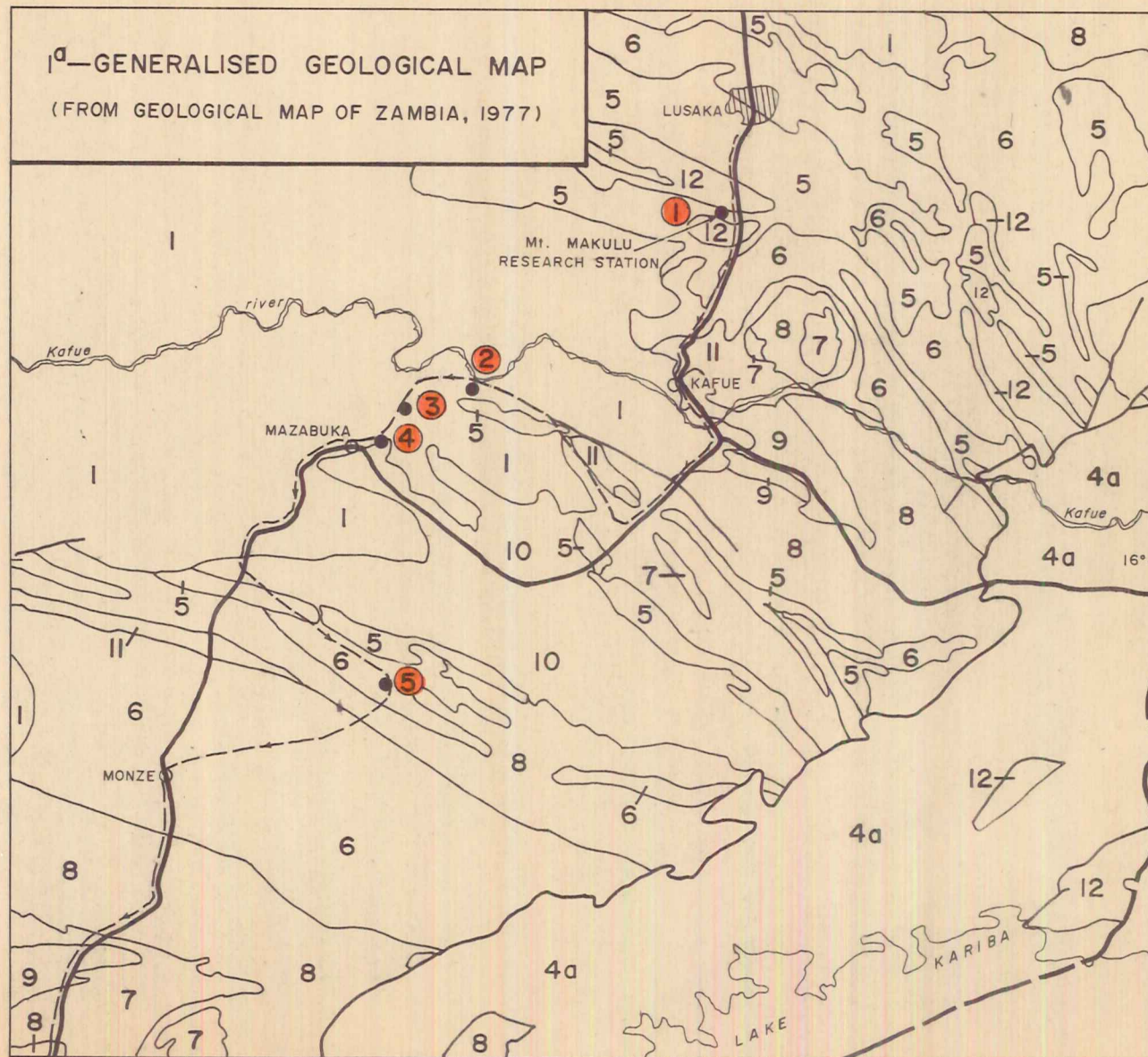
1) I.1 : >1200

Eo = Evaporation (after PENMAN)




TEMPERATURES (°C) AND RAINFALL (mm) NEAR PROFILE SITES

STATION		July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Annual
LUSAKA	Mean Max.Temp	23.1	25.6	29.2	31.4	28.9	26.7	26.0	26.0	26.3	26.5	25.0	23.0	26.9
	Mean Min. temp.	9.7	11.7	14.9	17.9	17.9	17.4	17.3	17.2	16.4	15.0	12.4	10.2	14.8
	Rainfall	0	0	1	15	91	186	218	196	106	21	0	0	837
Mt. Makulu Central Research Station	Mean Max.Temp.	23.5	25.9	29.5	32.1	29.5	27.1	26.3	25.9	26.2	26.6	25.6	22.8	26.9
	Mean Min.Temp.	9.1	11.5	15.2	18.5	18.0	17.8	17.1	17.3	16.0	14.8	12.5	9.7	14.8
	Rainfall	0	0	3	1	76	213	208	206	72	30	9	2	820
National Irrigation Research Station, Nanga	Mean Max.Temp.	24.7	27.4	29.9	33.6	31.4	28.9	28.3	28.3	28.7	28.9	27.2	24.9	28.5
	Mean Min.Temp.	7.4	9.7	13.4	16.6	18.2	18.2	18.2	18.2	16.3	13.9	10.1	8.5	12.4
	Rainfall	0	0	2	15	85	250	197	149	55	18	6	0	777
Choma	Mean Max.Temp.	22.8	25.3	29.0	31.2	29.1	27.5	26.6	26.6	26.7	26.8	24.9	22.7	26.6
	Mean Min.Temp	3.3	5.1	9.2	12.8	15.8	16.5	16.3	16.3	14.3	11.7	6.7	3.8	10.9
	Rainfall	0	0	1	22	93	209	200	185	86	23	6	6	831
Livingstone	Mean Max.Temp.	25.3	28.3	32.0	34.6	31.6	29.5	28.9	28.8	29.7	29.7	27.7	25.1	29.3
	Mean Min.Temp.	6.4	8.8	14.2	18.3	18.8	18.8	18.6	18.6	17.1	14.9	10.0	6.9	14.3
	Rainfall	0	0	2	26	92	164	186	175	101	28	5	0	777

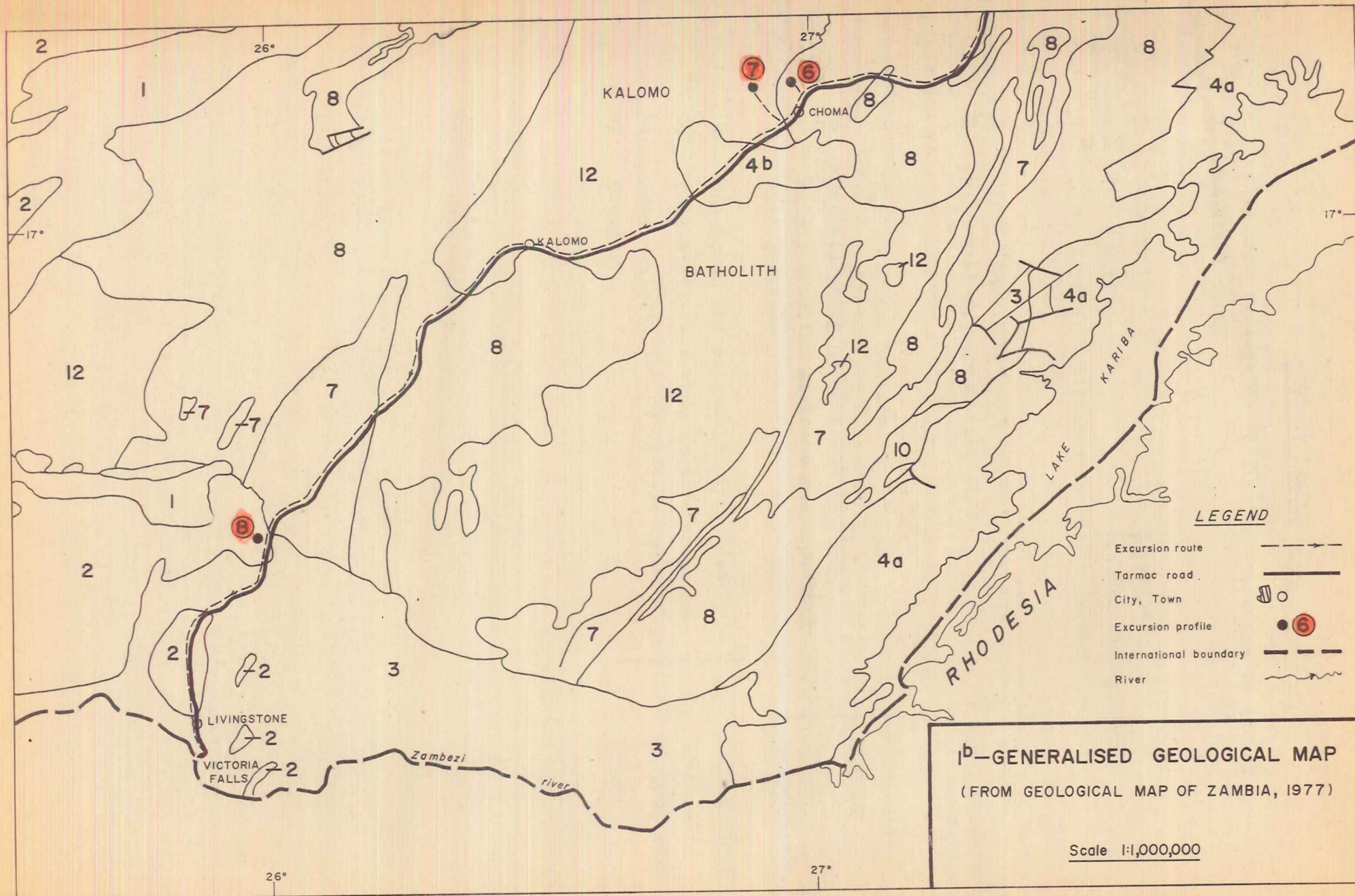
1^a—GENERALISED GEOLOGICAL MAP
(FROM GEOLOGICAL MAP OF ZAMBIA, 1977)



LEGEND

- Excursion route ———→———
- Tarmac road —————
- City, Town 
- Excursion profile 
- International boundary - - - - -
- River 

Scale 1:1,000,000

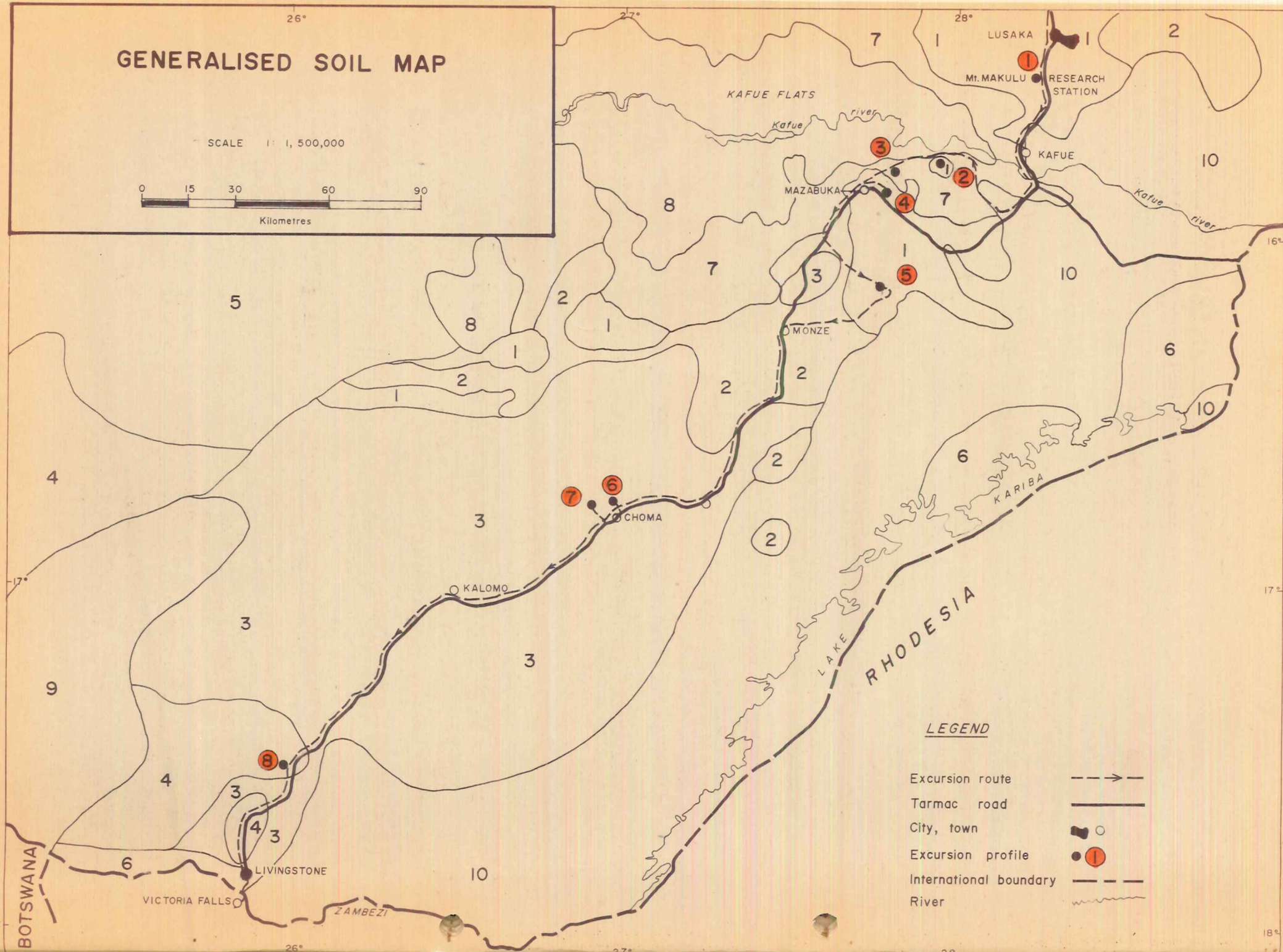
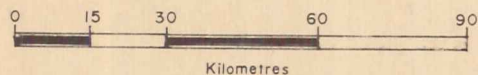


GEOLOGY LEGEND

- | | | | |
|----------------|--|---|-----------------------------------|
| 1 | Alluvium, colluvium, laterite | } | Tertiary to Recent |
| 2 | Kalahari Group | | |
| 3 | Basalts | } | Karoo |
| 4 ^a | Upper Karroo | | |
| 4 ^b | Lower Karroo, undifferentiated | | |
| | | | (Upper Carboniferous to Jurassic) |
| 5 | Upper Roan, typically dolomite and argillite | } | KATANGA |
| 6 | Mine Series, undifferentiated | | |
| | | | (Late Precambrium and |
| | | | (?) Lower Paleozoic) |
| 7 | Pre - Katanga schists | } | PROBABLY |
| 8 | Undifferentiated Basement Complex, | | |
| | mainly granitic gneisses and migmatites with | | |
| | some granites | | |
| | | | LARGELY |
| | | | OLDER |
| | | | PRECAMBRIAN |
| 9 | Volcanics and meta-volcanics, acid type | } | LITHOLOGICAL |
| 10 | Calc-Silicate rocks, undifferentiated | | |
| 11 | Meta - Quartzites of various ages | | |
| 12 | Granite | | |
| | | | UNITS OF |
| | | | VARIOUS AGES |

GENERALISED SOIL MAP

SCALE 1:1,500,000



LEGEND

- Excursion route
- Tarmac road
- City, town
- Excursion profile
- International boundary
- River

SOIL LEGEND

A. SOILS DEVELOPED ON BASIC SEDIMENTARY AND METAMORPHIC ROCKS

(mainly limestones, dolomites, calc-silicate and biotite schists)

UNIT 1: Predominantly deep and moderately deep, well drained, red to reddish brown friable clay loams and clays with a dark (reddish) brown hard, when dry and sticky, when wet (sandy) clay loam topsoil; slightly to strongly acid.

(Eutric Nitosols-Chromic Luvisols-Luvic Phaeozems).

UNIT:2 Mostly deep, well drained, reddish brown to brown friable (sandy) clay loams with dark brown sandy loam topsoils; slightly to strongly acid. (Chromic - Ferric Luvisols)

B. SOILS DEVELOPED ON ACID IGNEOUS AND METAMORPHIC ROCKS

(mainly granites, gneisses, schists, migmatites)

UNIT 3: Predominantly deep to moderately deep, well drained, friable sandy loams and sandy clay loams with dark brown sandy topsoils. Gravels common in subsoil. Strongly to medium acid. (Ferric Acrisols - Luvisols)

C. SOILS DEVELOPED ON BAROTSE SANDS

UNIT: 4: Deep, excessively drained, red to yellowish red sands and loamy sands; medium acid (Ferralic/Cambic Arenosols)

UNIT 5: Deep, excessively drained, dark gray to pale brown sands and loamy sands; strongly acid (Cambic Arenosols).

D. SOILS DEVELOPED FROM BASE RICH KARROO ROCKS

UNIT 6: Predominantly deep, well drained friable sandy clay loams with sand to sandy loam topsoils; neutral to alkaline (Eutric Cambisols) and deep, very poorly drained, clay loam soils; alkali (Gleyic Solonetz).

E. SOILS DEVELOPED ON KAFUE AND ZAMBEZI ALLUVIUM

UNIT 7: Association of deep, well to moderately ~~drained~~ well drained, reddish brown sandy clay loams to clays on elevated positions (Ferric Luvisols-Chromic Luvisols) and imperfectly to poorly drained clay loams and clays in depressional areas developed on older alluvium (Pellic Vertisols).

UNIT:8 Deep, very poorly to poorly drained black and dark gray (cracking) clays and sandy clays; neutral to strongly alkaline. (Pellic Vertisols - Vertic Gleysols - Solodic Planosols-Eutric Fluvisols)

UNIT 9: Deep, very poorly drained, black to dark gray clays and sandy clay loams; strongly alkaline (Gleyic Solonetz-Pellic Vertisols - Solodic Planosols).

F. SOILS DEVELOPED ON ESCARPMENTS

UNIT 10: Predominantly shallow, well drained, gravelly and stony reddish brown sandy (clay) loams of the Zambezi escarpment. (Lithosols - Rankers)

SITE 2: NANGA

Location: National Irrigation Research Station

Series Name: Nakambala

Soil Classification FAO:

(+ferralic)
ferric Luvisol (Santonne)

USDA: ~~eric~~ paleustalfs (Natchez)

FRENCH: ~~sol ferrugineux tropicaux, levis et~~

Land Capability Classification: C1

(ferrallitique) appauvri,

Site Characteristics:

Altitude: 990m

Rainfall: 780mm

Physiography: upland, middle slope

Slope: very gently sloping (1-3%)

Parent material: Old Kafue alluvium overlying dolomitic limestone.

Drainage: Well drained

Land-Use: Research trial site.

Profile Description:

Ap	0-18cm	Very dark grayish brown (10YR 3/2) moist and dark yellowish brown (10YR 4/4) dry; sandy clay loam; essentially massive in the upper 5cm thereafter moderate fine and medium subangular blocky structure; hard dry, friable moist, slightly plastic, slightly sticky; common fine, few medium and coarse pores; many fine and medium roots; clear smooth boundary.
Bt1	18-35cm	Yellowish red (5YR 4/6) moist and (5YR 5/6) dry; sandy clay loam; moderate medium and coarse subangular blocky structure; very hard dry, friable moist, sticky and plastic when wet; patchy moderately thick clay cutans; many very fine; few medium and coarse pores; few fine roots; gradual smooth boundary.
Bt2	35-100cm	Yellowish red (5YR 4/6) moist and (5YR 5/6) dry; clay; strong medium and coarse subangular blocky structure; very hard dry, friable moist, sticky and plastic when moist; broken moderately thick clay cutans; many very fine, few medium and coarse pores; few fine roots; diffuse smooth boundary.
Bt3	100-140cm	Yellowish red (5YR 4/6) moist clay with few diffuse coarse red mottles; strong medium and coarse subangular blocky structure; very hard dry, friable moist, plastic and sticky when wet; broken moderately thick clay cutans; many fine, few medium and coarse pores; few fine roots; few fine quartz and laterite gravels; diffuse smooth boundary.
Bt4	140-170+cm	Yellowish red (5YR 4/8) moist; clay; moderate fine and medium subangular blocky structure; friable moist, sticky and plastic when wet; broken moderately thick clay cutans decreasing with depth; common fine, few medium and coarse pores; few fine roots; very few gravels.

Soil physical data

Depth	Field capacity% (0-33 bar)	Wilting Point% (15 bar)	Moisture saturation%	Coeff of agg- regat- ion %
topsoil(0-15cm)	36	12	42	85
upper subsoil(30-45cm)	36	14	44	92
lower subsoil(60-90)	38	15	45	91
water infiltration rates(cm): topsoil	7.3(1st hr.)			
(accumulated rates for	3.1(2nd hr.)			
the succeeding hrs.)	2.6(3rd hr.)			

Soil chemical data.

		Grain size,mm					TEXTURE (USDA)
Lab. No.	Depth (cm)	Clay < 0.002 %	Silt 0.002 -0.05 %	F.sand 0.05 -0.25 %	M.sand 0.25 -0.50 %	C.sand 0.50 -2.00 %	
78/636	0-18	21	16	40	17	6	SCL
637	18-35	29	15	36	16	4	SCL
638	35-70	47	12	22	14	5	C
639	70-100	55	16	14	11	4	C
640	100-140	52	16	16	12	4	C
641	140-170+	50	17	20	10	3	C

Lab. No.	Depth (cm)	Ex.Ca m.e.%	Ex.Mg m.e.%	Ex.K m.e.%	Ex.Na m.e.%	C.E.C m.e.%	C.E.C.m.e.% 100g clay
78/636	0-18	2.45	3.90	0.79	0.12	5.2	24.8
637	18-35	3.00	1.75	0.64	0.13	6.7	23.1
638	35-70	3.50	2.00	0.48	0.13	9.4	20.0
639	70-100	5.10	3.00	0.44	0.11	10.5	19.1
640	100-140	5.70	3.05	0.42	0.09	10.4	20.0
641	140-170+	5.45	3.05	0.38	0.08	9.6	19.2

Lab. No.	Depth (cm)	Org.C %	Total N %	Avail.P ppm	pH (CaCl ₂)	Base Sat %
78/636	0-18	0.70	0.07		5.5	100
637	18-35	0.47	0.05		4.4	82.4
638	35-70	N.D.	0.05		4.2	65.0
639	70-100	N.D.	N.D.		4.5	82.4
640	100-140	N.D.	N.D.		4.8	89.0
641	140-170+	N.D.	N.D.		5.1	93.3

ND: Not determined

Agronomic data:

Crops	Fertilizer Kg/ha		Irrigation mm net	Yields T/ha
	basal-	topdressing		
wheat	600 D-mix	100 Urea	450	4.5-5.0
maize	400 "	100 "	150(suppl)	7.5-8.0
sunflower	400 "	100 "	-	1.1
groundnuts	400 "	- "	220(suppl)	3.0
soyabeans	400 "	- "	-	1.0

Location: Nakambala Sugar Estates, Mazabuka

Series Name: Kembe

Soil Classification FAO: *pellic Vertisols*
USDA: *typic pellicvert*
FRENCH: *Vertisol a drainage externe pauvre, granuleux,*

Land Capability Classification: Gw

Site Characteristics

Altitude: 990m

Rainfall: 780mm

Physiography: Depression on older terrace

Slope: flat (0-1%)

Parent material: Older Kafue alluvium over calc-Silicate Schist?

Drainage: Very poorly when wet.

Land-Use: Irrigated sugar cane

Profile Description

Ap	0-15	Very dark gray (N2.5/-) moist; clay; strong fine and medium subangular blocky structure; very firm moist, sticky and plastic when wet; common fine, few medium and coarse pores; many fine and medium roots; noncalcareous matrix; common hard small and medium CaCO_3 concretions; gradual wavy boundary.
Ack1	15-40cm	Very dark gray (N3/-) moist; clay; strong medium and coarse angular blocky structure; very firm moist, very sticky and very plastic wet; pressure faces on peds; noncalcareous matrix; common fine and few medium pores; few fine and medium roots; common small hard CaCO_3 concretions;
Ack2	40-80cm	Very dark gray (N3/-) moist; clay; strong fine, medium and coarse angular blocky (wedge-shaped); firm moist, very sticky, very plastic wet; many pressure faces and small slickensides; noncalcareous matrix; few fine and medium pores; common fine, few medium roots; common small hard CaCO_3 concretions; diffuse boundary.
Ack3	80-160+cm	Very dark gray (N3/-) moist clay; strong fine and medium angular blocky structure (wedge-shaped); very firm moist, very sticky and very plastic wet; many small and large slickensides; noncalcareous matrix; few fine pores; common fine roots mainly on slickenside faces; common small hard CaCO_3 concretions;

*for yield data
see after profile 8*

*few cartoons show
at site 4*

*Land P needed
but only 70% H₂O
without no yield*

sprinkling

*3 inch / 10 days
(too soon no
sufficient cracking
for root develop-
ment)*

*3 months grain
if not irrigated
in dry season*

Soil physical data:

Depth	Field	Wilting	Moisture	Coeff. of
	capacity%	Point%	saturation%	
	0 33 bar	15 bar		aggregation %
topsoil(0-15cm)	39	16	51	76
upper subsoil(30-45cm)	41	16	53	85
lower subsoil(60-90cm)	42	17	60	87

Water infiltration rates(cm): topsoil: 3.4(1st hr)
 (accumulated rates for 1.7(2nd hr)
 the succeeding hours) 1.5(3rd hr)

Soil chemical data

Lab. No.	Depth (cm)	Clay < 0.002 %	Silt 0.002 - 0.05 %	Grain size, mm			Texture (USDA)
				F.sand 0.05 - 0.25 %	M.sand 0.25 - 0.50 %	C.sand 0.50 - 2.00 %	
78/647	0-15	52	17	21	5	5	C
48	15-40	56	14	23	4	3	C
49	40-80	49	13	27	7	4	C
50	80-160+	52	20	19	6	3	C

Lab. No.	Depth (cm)	Ex. Ca	Ex. Mg	Ex. K	Ex. Na	C.E.C.	C.E.C.m.e.%
		m.e.%	m.e.%	m.e.%	m.e.%	m.e.%	100g clay
78/647	0-15	34.50	1.60	0.22	0.52	37.3	71.7
48	15-40	33.75	1.38	0.12	0.59	29.0	51.8
49	40-80	31.50	1.55	0.14	0.88	38.0	77.6
50	80-160+	31.00	1.55	0.26	4.00	38.0	73.1

Lab. No.	Depth (cm)	Org. C	Total N	Avail. P	pH	Base Sat	Free Fe
		%	%	ppm	(CaCl ₂)	%	ppm
78/647	0-15	1.40	0.10		7.1	98.8	
48	15-40	0.82	0.05		7.2	100	
49	40-80	N.D	0.05		7.2	73.0	
50	80-160	N.D	0.01		7.4	96.9	

ND: Not determined.

*(Sol ferrugineus tropicum
hydromorphe,
modifié)*

*Common in the region
under sugar
period from
deep plowed
1 from furrows to
bank vegetation*

SITE 4 - NAKAMBALA-2

Location: Nakambala Sugar Estates, Mazabuka

Series Name: Mwembeshi

Soil Classification FAO: *lune Phaeom (Pérot), phaeatic phase*

USDA: *basic calcustoll*

FRENCH: *bimodal (à deux faces), terre ord*

Land Capability Classification: C2w

Site Characteristics:

Altitude: 990m

Rainfall: 780mm

Physiography: Older terrace, middle slope

Slope: very gently sloping (1-3%)

Parent material: Older Kafue alluvium over calc-silicate schists?

Drainage: Moderately well

Depth of groundwater table: 120cm at the end of rainy season

Land-Use: irrigated sugarcane. *(10 years ago hyperhemic grassland)*

Profile Description:

Ap1	0-17cm	Very dark brown (10YR 2/2) moist and dark grayish brown (10YR 4/2) dry; clay loam; weak coarse and medium subangular blocky structure; very hard dry, friable moist, plastic, sticky wet; common medium and coarse, many fine pores; common fine, few medium roots; clear smooth boundary.
Ap2	17-32cm	Very dark grayish brown (10YR 3/2) moist and dark grayish brown (10YR 4/2) dry; clay loam; few fine faint mottles; weak fine and medium subangular blocky structure; friable moist, sticky and plastic wet; common fine, few medium pores; few fine roots; gradual smooth boundary.
BA	32-58cm	Very dark grayish brown (10YR 3/2) moist; clay; common fine and medium faint mottles; moderate medium and coarse subangular blocky structure; friable moist, sticky and plastic wet; broken moderately thin clay cutans; many fine, few medium and coarse pores; few fine roots; clear smooth boundary.
Bt1 <i>g</i>	58-80cm	Brown to dark brown (7.5YR 4/4) moist; clay with common medium and coarse diffuse to prominent yellowish red (5YR 4/8) moist and dark grayish brown (2.5Y 4/2) moist mottles; moderate medium subangular blocky structure; friable moist, sticky and plastic wet; patchy moderately thin clay cutans; common fine, few medium and coarse pores; few fine roots; gradual smooth boundary.
Bt2 <i>g</i>	80-120+cm	Yellowish red (5YR 4/8) moist and dark grayish brown (2.5Y 4/2) moist coarse and medium mottled clay; weak to moderate medium prismatic to subangular blocky structure; friable moist, sticky and plastic wet; patchy thin clay cutans; common fine and few medium pores; few fine roots, Groundwater level at 120cm.

12 tons sugar per ha

*(7.5 tons of cane per ton of sugar)
110-115 tons*

; seasons for 9 years!

Soil physical data

Depth	Field capacity% (0.33 bar)	Wilting Point% (15 bar)	Moisture saturation%	Coeff. of aggr.%
topsoil(0-15cm)	48	12	52	85
upper subsoil(30-45cm)	42	14	54	92
lower subsoil(60-90cm)	50	19	60	91
Water infiltration rates(cm): topsoil:13.6(1st hr.)				
(accumulated rates for the 6.5(2nd hr.)				
succeeding hours) 4.3(3rd hr.)				

Soil Chemical data:

Lab. No.	Depth (cm)	Grain size, mm					TEXTURE (USDA)
		Clay < 0.002 %	Silt 0.002 - 0.05 %	F.sand 0.05 - 0.25 %	M.sand 0.25 - 0.50 %	C.sand 0.50 - 2.00 %	
78/651	0-17	38	26	33	2	1	CL
52	17-32	34	22	40	1	3	CL
53	32-58	48	21	29	1	1	C
54	58-80	47	17	33	1	2	C
55	80-120+	56	15	25	1	3	C

Lab. No.	Depth (cm)	Ex. Ca m.e.%	Ex. Mg m.e.%	Ex. K m.e.%	Ex. Na m.e.%	C.E.C. m.e.%	C.E.C. m.e.% 100g clay
78/651	0-17	6.75	0.60	0.26	0.21	11.3	29.7
52	17-32	4.50	0.43	0.31	0.16	10.2	30.0
53	32-58	6.25	0.78	0.26	0.25	13.1	27.3
54	58-80	5.00	0.75	0.24	0.18	8.4	17.9
55	80-120+	6.15	7.60	0.23	0.18	11.3	20.2

Lab. No.	Depth (cm)	Org. C %	Total N %	Avail. P ppm	pH (CaCl ₂)	Base Sat %
78/651	0-17	1.48	0.09		4.6	69.2
52	17-32	1.29	0.08		4.3	52.9
53	32-58	1.13	0.07		5.4	57.6
54	58-80	0.86	0.06		5.6	73.5
55	80-170+	0.55	0.04		5.9	100

ND: Not determined.

(over)
S: Red (lime) Phosphorus
glycerol

Embarras

SITE 5: MBAYA-MUSUMA

Location: Mbaya-Musuma settlement of Family Farms Ltd., Magoye

Soil Classification FAO: *Leuc Phaeozem*

USDA: *Paleustoll*

FRENCH:

Land Capability Classification: C2s *Sol ferralitique ss. (intergrade to ferruginous)*
peu lessive, nodal, iso humique

Site Characteristics

Altitude: 1150m

Rainfall: 900mm

Physiography: undulating plateau, *"foothills"*

Slope: gently sloping (3-5%)

Parent material: dolomite

Drainage: well drained

Land - Use: maize

Profile Description:

<i>A₁</i>	Ap	0-13cm	Dark brown (7.5YR 3/2) moist; sandy clay loam; weak fine and medium subangular blocky structure; friable moist, slightly plastic, sticky when wet; common fine, few medium and coarse pores; common fine and medium roots; clear smooth boundary.
<i>A₂</i>	AB	13-34cm	Very dark brown (7.5YR 2/3) moist; sandy clay loam; moderate medium subangular blocky structure; friable moist, sticky, plastic when wet; few clay cutans; many fine, common medium and few coarse pores; common fine, few medium and coarse roots; few fine gravels; gradual smooth boundary.
<i>B₁</i>	Bt1	34-60cm	Dark reddish brown (5YR 3/4) moist; sandy clay; moderate fine and medium subangular blocky structure; friable moist, sticky and plastic wet; patchy thin clay cutans; many fine, common medium and few coarse pores; common to few fine roots; few fine gravels, gradual smooth boundary.
<i>B₂</i>	Bt2	60-100cm	Yellowish red (5YR 4/6) moist; sandy clay loam with common fine faint red mottles; moderate fine and medium subangular blocky structure friable moist, sticky and plastic wet; broken thin clay cutans; many fine, common medium and few coarse pores; few fine roots; few fine and coarse gravels and soft Fe-Mn concretions; diffuse smooth boundary.
<i>B₃</i>	Bt3	100-150+cm	Dark red (2.5YR 3/6) moist; clay loam with many fine faint reddish brown mottles; moderate fine and medium subangular blocky structure; friable moist, sticky and plastic when wet; broken moderately thin clay cutans; many fine, common medium and few coarse pores; few fine roots; common fine gravels few coarse gravels and stones; many soft Fe-Mn concretions; abrupt broken boundary.
	R		Weathering and hard rock (dolomite)

S. malic Nitrol?

Soil Chemical data:

Lab. No.	Depth (cm)	Grain size, mm					TEXTURE (USDA)
		Clay < 0.002	Silt 0.002 - 0.05	F.sand 0.05 - 0.25	M.sand 0.25 - 0.50	C.sand 0.50 - 2.00	
		%	%	%	%	%	
78/ 670	0-13	20	17	54	8	1	SCL/SL
71	13-34	34	17	42	6	1	SCL
72	34-60	37	17	37	7	2	SC
73	60-100	32	17	42	8	1	SCL
74	100-150	37	22	34	6	1	CL

Lab. No.	Depth (cm)	Ex.Ca m.e.%	Ex.Mg m.e.%	Ex.K m.e.%	Ex.Na m.e.%	C.E.C. m.e.%	C.E.C.m.e.% 100g clay
78/ 670	0-13	5.18	6.50	0.37	0.03	7.0	35.0
71	13-34	6.10	8.45	0.14	0.02	10.3	30.3
72	34-60	5.25	8.50	0.11	0.02	10.0	27.0
73	60-100	5.45	8.50	0.10	0.04	10.0	31.3
74	100-150	6.23	9.30	0.08	0.04	11.0	29.7

Lab. No.	Depth (cm)	Org.C %	Total N %	Avail.P ppm	pH (CaCl ₂)	Base Sat %
78/ 670	0-13	1.01	0.7		5.2	100
71	13-34	0.86	0.06		5.7	100
72	34-60	0.78	0.04		6.0	100
73	60-100	0.70	N.D.		6.2	100
74	100-150	0.59	N.D.		6.4	100

ND: Not determined.

Agronomic data

Crops	Fertilizer(Kg/ha)		Yield kg/ha
	Basal	topdressing	
Maize	200 R-mix	200 Urea	3300
Groundnuts	-	-	1000(unshelled)
Sunflower	-	-	125
Soya beans	200 D-Mix + inoculum		900
Cotton	200 D-Mix		250

- many large overgrown shrub mounds
- moderate surface sealing
SITE 6: POPOTA

Location: Popota Tobacco Training Scheme Choma.

Series Name: Choma

Soil Classification FAO: *luniv Arund / furie Beckind / plinthic*

USDA: *late Alf, azic (Cenrol)*

FRENCH: *Ferrallique, saturation moyenne, leoné, indur*

Land Capability Classification: S1

Site Characteristics

Altitude 1280m

Rainfall: 800m

Physiography: Undulating plateau

Slope: Very gently sloping (1-3%)

Parent material: Granitic gneisses of Basement Complex

Drainage: Well drained.

Land-Use/vegetation: Edge of tobacco field/miombo woodland *dry pool, mids, lot of*

Profile Description:

A1

0-15cm

Brown to dark brown (10YR 4/3) moist; loamy sand; weak fine and medium subangular blocky structure; very friable moist, slightly sticky, non plastic when wet; many fine, common medium and few coarse pores; many fine, few medium and coarse roots; few fine quartz gravels; clear smooth boundary.

Bt1

15-35cm

Yellowish red (5YR 5/6) moist; sandy loam; weak fine and medium subangular blocky structure; friable moist, slightly sticky, slightly plastic when wet; patchy thin clay cutans; many very fine, few medium and coarse pores; common fine, few medium and coarse roots; few fine gravels; gradual smooth boundary.

Bt2

35-80cm

Yellowish red (5YR 5/6) moist sandy loam; weak fine and medium subangular blocky structure; friable moist, slightly sticky, slightly plastic; broken thin clay cutans; common fine, few medium and coarse pores; common medium, few fine and coarse roots; few fine quartz gravels; diffuse smooth boundary.

Bt3

80-120cm

Yellowish red (5YR 4/8) moist; sandy clay loam; weak fine and medium subangular blocky structure; friable moist; sticky, slightly plastic wet; broken moderately thin clay cutans; common fine, few medium and coarse pores; common medium and coarse, few fine roots; few fine quartz gravels; *clear boundary*

Bt4

120-170+cm

Yellowish red (5YR 4/8) moist; sandy clay loam with many medium diffuse red (10R 4/8) moist and brownish yellow (10YR 6/6) moist mottles; massive firm moist, sticky and plastic when wet; clay cutans suspected; many fine, few medium and coarse pores; few fine roots; few fine and coarse gravels and stones; many soft Fe-Mn concretions.

S *lixie horizon!*

(FAO *supra* *offic* *Ferrall*)

Soil physical data

Depth

topsoil(0-15cm)
upper subsoil(30-45cm)
lower subsoil(60-90cm)
water infiltration rate cm):
(accumulated rates for
the succeeding hours)

Field capacity%	Wilting Point%	Moisture saturation	Coeff.of aggregate
(0 - 33 bar)	(15 bar)	%	%
10	3	18	58
8	3	17	55
14	7	32	67
topsoil:	7.3 (1hr)		
	3.1 (2nd hr)		
	2.6 (3rd hr)		

Soil Chemical data

Grain size,mm

Lab. No.	Depth (cm)	Clay < 0.002	Silt 0.002 - 0.05	F.sand 0.05 - 0.25	M.sand 0.25 - 0.50	C.sand 0.50 - 2.00	TEXTURE (USDA)
		%	%	%	%	%	
78/656	0-15	8	12	40	27	13	LS
657	15-35	16	9	40	26	9	SL
658	35-80	16	9	39	26	10	SL
659	80-120	28	15	27	18	12	SCL
660	120-170	26	21	24	16	13	SCL

Lab. No.	Depth (cm)	Ex.Ca m.e.%	Ex.Mg m.e.%	Ex.K m.e.%	Ex.Na m.e.%	C.E.C m.e.%	C.E.C m.e.% 100g clay
78/656	0-15	0.88	0.90	0.13	0.08	2.0	25.0
657	15-35	0.25	0.35	0.21	0.04	1.6	10.0
658	35-80	0.15	0.30	0.20	0.06	1.7	10.6
659	80-120	0.18	0.40	0.26	0.03	2.7	10.0
660	120-170	0.28	0.73	0.33	0.02	3.1	12.0

Lab. No.	Depth (cm)	Org.C %	Total N %	Avail.P ppm	pH (CaCl ₂)	Base Sat %
78/656	0-15	0.47	0.02		5.2	33.1
657	15-35	0.20	0.01		4.6	41.8
658	35-80	N.D.	N.D.		4.6	32.2
659	80-120	N.D.	N.D.		4.5	43.9
660	120-170	N.D.	N.D.		4.7	71.0

ND: Not determined.

Agronomic data:

Crop

Fertilisers (Kg/ha)

Yield(Kg/ha)

	basal	topdressing	
Virginia Tobacco	600 V-mix	200 Am. Nitrate	900-1200
Maize			3500-4500

Common tall orange-brown termite mounds

market tobacco, pasture (share grass)
plowing once in 6 or 8 years.
shiping (and f dry sun)
no termite

erosion
summit
(with post destroyed)
cleared from
Banksia oleacea
woodland

SITE 7: DANKWERT

Location: Dankwert Farm, Choma

Series Name: Kalom

Soil Classification FAO:

USDA:

FRENCH:

Land Capability Classification: S2d

Site characteristics

Altitude: 1300m

Physiography: Undulating plateau, crest

Slope: Very gently sloping (1-3%)

Parent material: Granite

Drainage: Well drained

Land-Use: Starr grass pasture

Profile Description:

Ap	0-23cm	Dark yellowish brown (10YR 4/4) moist and pale brown (10YR 6/3) dry; sand; weak fine and medium subangular blocky structure; friable moist, non sticky, non plastic wet; many fine, common medium and few coarse pores; many fine, common medium roots; abrupt smooth boundary.
Bt1	23-55cm	Strong brown (7.5YR 5/6) moist; loamy sand; weak fine and medium subangular blocky structure; friable moist, slightly sticky, non plastic wet; patchy thin clay cutans; many fine and medium, few coarse pores; common fine roots; gradual smooth boundary.
Bt2	55-85cm	Strong brown (7.5YR 5/6) moist; sandy loam; weak fine and medium subangular blocky structure; friable moist, slightly sticky, non plastic wet; patchy thin clay cutans; common fine pores; common fine roots; abrupt smooth boundary.
2C	85-150cm	Very gravelly sandy loam, quartz gravels,
3C	150-170cm	Soft weathering rock, very porous.

Luvic ~~histic~~ Arenozol
Arenic + ~~dark~~ Haplustalf
Sol ferralitique non-désaturé
lessivé, nodal, de
matériau argineux, sur matériau
granitique

structure of ferruginous
i.e. poor

Cover sand?

mid ch pm

clay nodules
sparsely
(concrete)

+ stones

Soil chemical data:

Lab. No.	Depth (cm)	Clay < 0.002 %	Silt 0.002 - 0.05 %	Grain size, mm		C.sand 0.50 - 2.00 %	TEXTURE (USDA)
				F.sand 0.05 - 0.25 %	M.sand 0.25 - 0.50 %		
78/661	0-23	4	9	45	29	13	S
662	23-55	8	14	43	25	10	SL/LS
663	55-85	13	13	36	35	3	SL

Lab. No.	Depth (cm)	Ex.Ca m.e.%	Ex.Mg m.e.%	Ex.K m.e.%	Ex.Na m.e.%	C.E.C m.e.%	C.E.Cm.e.% 100g clay
78/661	0-23	1.10	0.63	0.20	0.12	1.4	35.0
662	23-55	0.70	0.10	0.22	0.06	1.2	15.0
663	55-85	0.58	0.40	0.10	0.02	1.3	10.0

Lab. No.	Depth (cm)	Org.C %	Total N %	Avail.P ppm	pH (CaCl ₂)	Base Sat %
78/661	0-23	0.43	0.03		5.3	100
662	23-55	0.08	0.01		5.0	90
663	55-85	N.D.	N.D.		5.0	84.6

ND: Not determined.

Crop	Fertilizers Kg/ha		Yield Kg/ha
	basal	topdressing	
Virginia Tobacco	600 V-mix	25 Am.Nitrate	1500-2,000
Maize	300 D-mix	300 Urea	4500-5500

Lime is applied occasionally at 1000 Kg/ha.

crop rotation: tobacco-seed maize-6 years star grass-
2 years maize - 6 years love grass back to tobacco.

scaling slight

SITE 8: KABUYU

Location: Sinde Rural Reconstruction Centre, Kabuyu

Series Name: Kabuyu

Soil Classification FAO:

USDA:

FRENCH:

Land Capability Classification: S3t

Site Characteristics

Altitude: 1000m

Rainfall: 780mm

Physiography: Undulating plateau, upper slope

Slope: very gently sloping (1-3%)

Parent material: Barotse sand over granite

Drainage: excessively

Land-Use: windbreak in between fallow fields

Profile Description:

Ah	0-20cm	Black (10YR 2/1) moist; loamy sand; weak fine and medium subangular blocky structure; very friable moist, non sticky, non plastic wet; many fine, common medium and few coarse pores; many fine, few medium and coarse roots; clear smooth boundary.
BA	20-45cm	Dark reddish brown (5YR 3/4) moist; loamy sand some sand grains bleached; massive structure; very friable moist, non sticky, non plastic wet; many fine, few medium and coarse pores; common fine, few medium and coarse roots; gradual smooth boundary.
Bw1	45-68cm	Yellowish red (5YR 4/6) moist; loamy sand; weak fine and medium subangular blocky structure; friable moist, non sticky, non plastic wet; very patchy thin clay cutans; many fine, few medium pores; common fine few medium and coarse roots; gradual smooth boundary.
Bw2	68-120cm	Dark red (2.5YR 3/6) moist; loamy sand; weak fine and medium subangular blocky structure; friable moist, non plastic, slightly sticky wet; broken thin clay cutans; many fine, few medium pores; few fine, medium and coarse roots; diffuse smooth boundary.
Bw3	120-170+cm	Red (2.5YR 4/6) moist; sandy loam; weak fine and medium subangular blocky structure; friable moist, non sticky, slightly plastic wet; broken thin clay cutans; many fine, few medium pores; few fine, medium and coarse roots;

abandoned
Canadian
wheat
scheme
(because of
disease)

dry hard

dry hard

pm →

(soil & water management)
ferric arenosol

Ferrallitique (Ferruginous Tr), satini,

typique, peu appauvri,
facies ferrugineuse
tropicaux,

Kalahari

Lab. No.	Depth (cm)	Clay ≤ 0.002 %	Silt 0.002 -0.05 %	Grain size, mm		C.sand 0.50 -2.00 %	TEXTURE (USDA)
				F.sand 0.05 -0.25 %	M.sand 0.25 -0.50 %		
78/642	0-20	7	7	50	25	11	LS
643	20-45	7	8	53	21	11	LS
644	45-68	8	5	39	29	19	LS
645	68-120	11	5	44	27	13	LS
646	120-170+	13	4	38	32	13	SL/LS

Lab. No.	Depth (cm)	Ex.Ca m.e.%	Ex.Mg m.e.%	Ex.K m.e.%	Ex.Na m.e.%	C.E.C m.e.%	C.E.Cm.e% 100g clay
78/642	0-20	3.35	0.40	0.10	0.08	3.4	48.6
643	20-45	0.65	0.28	0.14	0.05	1.2	17.1
644	45-68	0.60	0.20	0.12	0.04	1.0	12.5
645	68-120	0.80	0.30	0.10	0.02	1.3	11.8
646	120-170+	1.30	0.48	0.08	0.03	1.3	10.0

Lab. No.	Depth (cm)	Org.C %	Total N %	Avail.P ppm	pH (CaCl ₂)	Base Sat %
78/642	0-20	0.70	0.04		5.2	100
643	20-45	0.23	0.02		5.1	93.3
644	45-68	N.D.	N.D.		4.9	96
645	68-120	N.D.	N.D.		4.9	93.8
646	120-170+	N.D.	N.D.		5.3	100

ND: Not determined.

THE ZAMBIA SUGAR COMPANY LTD

NAKAMBALA ESTATE

RESEARCH DEPARTMENT.

HISTORY OF THE FIELDS.

1. YIELD DATA

A - FIELD 518 NAKAMBALA-1

Area - 10.12 Hectares
Variety - NCO. 376.

SOIL TYPE: Pellic Vertisol
CLASS 13

<u>YEAR</u>	<u>TC/Ha</u>	<u>AGE AT HARVEST</u>	<u>TCHM</u>	<u>CLASS</u>
1974	129.00	20.9	6.17	SORP
1975	81.37	15.7	5.18	1R
1976	96.05	11.8	8.14	2R
1977	78.49	14.9	5.27	3R
1978	-	-	-	4R

B - FIELD 801: NAKAMBALA-2

Area - 9.07 Hectares
Variety - NCO 376.

SOIL TYPE: Luvic Phaeozem
CLASS 2

<u>YEAR</u>	<u>TC/Ha</u>	<u>AGE AT HARVEST</u>	<u>TCHM</u>	<u>CLASS</u>
1974	-	-	8.94	6R
1975	109.71	12.9	8.50	7R
1976	85.95	11.7	7.35	8R
1977	89.18	16.7	5.34	9R
1978	-	-	-	10R

SORP = Stand-over Replant

TC/Ha = Tons of cane per Hectare.

TCHM = Tons of cane per Hectare per month.

R = Ratoon.

2. FERTILIZER APPLICATION

These two fields are subjected to the following fertilizer applications.

- (i) UREA - 156KgN/Ha. The nutrient is split supplied to the soil. The Initial Application (85KgN/ha) is either at the time of planting or just after the fields have been harvested. The Second Application (Top Dressing) at the rate of 71KgN/ha follows about three months after the Initial Application.
- (ii) TRIPPLE SUPER PHOSPHATE - 81.5Kg P₂O₅ per ha. The fertilizer is supplied in one single application at the time of planting or just after the fields have been reaped.
- (iii) No Potash is supplied to the fields just like any where else on the Estate because these soil show more than the adequate quantities of this Nutrient.

3. IRRIGATION PRACTICES

On the Estate there are two Irrigation Systems (i) SPRINKLER and (ii) SURFACE FURROW METHOD.

- (i) SPRINKLER IRRIGATION - Field 518 belongs to the block of fields on the Estate where the Sprinkler System of Irrigation is in use. A total of 675.96ha are under this system of irrigation. This is a SEMI-PORTABLE sprinkler system. The irrigators can quickly shift the portable lateral pipelines and sprinklers because of the ease with which the pipes are uncoupled and moved a length at a time to new locations and recoupled. There are 3 Booster Stations on Farm 4 and Booster C acts as a pumping plant to create the necessary pressure (45 psi) to facilitate proper function of the sprinklers for field 518. The spacing of the risers is 36.6m (120ft) and the wetted diameter of spray circle is 36.6m. The lateral line spacing depends on the irrigation cycle. The nozzles are 3" in size and have Discharge Capacity of 5.8gpm. The field has an average furrow length of about 425m.
- (ii) SURFACE IRRIGATION - FURROW METHOD

Field 801 is irrigated by the furrow irrigation method, representative of approximately 9,000ha. Siphon tubes convey the water over the ditch bank into the furrows. The irrigators move the siphons to the next furrows once the water reaches the end of the fields. The field has an average furrow length of 400m.

FREQUENCY OF IRRIGATION AND HOW MUCH

The control of irrigation on the Estate is not on field by field basis, but rather a system of Common Irrigation Cycles for the various Sugar Cane Ages (0, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, Ripening and Full Canopy) produced weekly is used.

Each Single Irrigation supplies 76.2mm (3") of water and with an Irrigation Efficiency of 80%, the net water applied per Irrigation is 60.96mm (2.4")

The irrigation cycle is calculated on the basis of the rate of evaporation from an open tank (class A pan). If we take as an example an evaporation rate of 3.9mm daily at a Canopy factor of 0.9, the calculation is as follows:

$$\frac{60.96}{3.9 \times 0.9} = 17 \text{ days}$$

The factors used for Cane Canopy as follows:-

0.5	-	0- $\frac{1}{4}$ Canopy
0.6	-	$\frac{1}{2}$ Canopy
0.70	-	Ripening
0.75	-	$\frac{3}{4}$ Canopy
0.90	-	Full Canopy

P.C. Mwiinde
Estate Agronomist

SOIL PHYSICAL METHODS

I. WATER INFILTRATION

Water infiltration measurements are conducted with two concentricring infiltrometers (height 22cm). Infiltrometers are installed with the help of an iron plate and a heavy hammer. During placement of the infiltrometers, unnecessary disturbance of natural structural conditions are avoided. The inner (12.5cm diameter) and outer (25cm diameter) infiltrometers are driven into the soil to a depth of 8 and 6cm respectively. Just before starting the actual infiltration studies, the buffer zone is filled with water, then the water is poured into the central ring and it is maintained at maximum levels in both the rings. Levels of receding water are recorded for three hours or more at regular intervals of 5 minutes and later at 10 and 30 minutes by reference to a fixed graduated ruler in the inner infiltrometer which is refilled with water when necessary. Efforts are made to ensure that the soil is not disturbed during water additions. Polythene sheets or grass are used to avoid such disturbances and also to prevent clogging of soil pores by movement of fine soil particles.

Total accumulated water infiltration rates in cm are calculated for the succeeding hours.

2. BULK DENSITY

Samples for bulk density determination are taken with a specially designed corer. Sampling is achieved by driving the corer into the soil either vertically (in the case of topsoil samples) or horizontally (in the case of subsoil samples - within the pits).

Weight of oven-dry soil (105°C) is divided by the volume of core sampler to calculate the weight of soil in grams per cubic centimeter (cc) of soil.

3. PARTICLE DENSITY

Particle density is calculated from two measured quantities:-

- (i) Mass of the soil particles
- (ii) Volume of the soil particles

The mass is determined by weighing of a dry sample and the volume from the water displaced by the sample in the pycnometer.

The particle density of a soil can be determined using the pycnometer method.

4. POROSITY.

Porosity is calculated using the following relationship

$$\text{Porosity (\%)} = \frac{(\text{particle density} - \text{bulk density})}{\text{particle density}} \times 100$$

5. SOIL MOISTURE RETENTION AT 0.33 (field capacity) AND 15 BARS (wilting point) AND AVAILABLE MOISTURE.

The soil samples were passed through a 2mm sieve and were saturated with water on a porous ceramic plate before extraction at required pressure. At both pressures the removal of excess moisture from the soil samples is accomplished without disturbing the soil on the plates, using Soil Moisture Equipment, Santa Barbara, California.

When equilibrium is reached at 0.33 or 15 bars pressure, the soil samples are oven-dried at 105°C to determine the moisture percentage. The difference in the two moisture contents is calculated and it is designated as available moisture.

6. SOIL PARTICLE-SIZE ANALYSIS.

It is done by Bouyoucos Hydrometer Method. The soil is dispersed with a solution of sodium hexametaphosphate and sodium-carbonate.

7. AGGREGATION OF SOIL PARTICLES.

The procedure measures the degree of aggregation of the silt and clay particles less than 20 microns as given in USDA Handbook. No. 60, 1954.

Wet sieving method proposed by Yoder is also used, using 2 - 4mm aggregates.

8. SOIL MOISTURE SATURATION

2mm sieved soil is soaked with about 200g of enough distilled water and allowed to stand for one hour. After mixing, the sample is again allowed to stand for 1 hour and then the criteria for saturation is checked. Adjustment of water and soil is made as given in U.S.D.A. Handbook No.60. Results are expressed on oven-dry basis (105°C).

The following methods were used in obtaining the analytical data quoted for each profile described:

Particle-size classes: After grinding; samples down to a depth of 40-50cm were pretreated with hydrogenperoxide to correct for organic matter. Samples high in carbonates (pH > 7.0) are also treated with hydrochloric acid. Then after dispersion by calgon (sodium hexametaphosphate + sodium carbonate), clay and silt were determined by the hydrometer method and sand classes by wet sieving. The limit between the silt and sand fractions is 0.05 mm.

Organic Carbon: For mineral soil layers, organic carbon percentage was determined by the Walkley-Black method, the results being multiplied by 1.3 to arrive at a total carbon figure assuming 77% efficiency. In order to convert organic carbon figures to organic matter percentage, the carbon figures should be multiplied by 1.72.

Nitrogen: Total Nitrogen percentage was determined by the Kjeldahl method using a copper catalyst.

Cation Exchange Capacity (CEC) and exchangeable cations: These were determined on the ammonium acetate extract at pH 7.0. CEC was determined by leaching out the excess ammonium acetate with alcohol and final leaching with a sodium chloride solution to replace absorbed ammonia. Exchangeable Ca and Mg were determined by atomic absorption. Exchangeable K and Na were measured on an EEL flame photometer.

Base Saturation percentage (BSP): BSP was calculated as

$$\frac{\text{Me Ca} + \text{Me Mg} + \text{Me K} + \text{Me Na}}{\text{CEC}} \times \frac{100}{1}$$

pH: Soil reaction was determined by glass electrode in 0.01 M. CaCl_2 using a Soil to CaCl_2 solution ratio of 1:5.

Available Phosphorus: So-called "available P" was determined by Bray's No. 1 method.

Free iron: Free iron oxides are when requested determined on the sodium-citrate and sodium dithionate extract by atomic absorption.

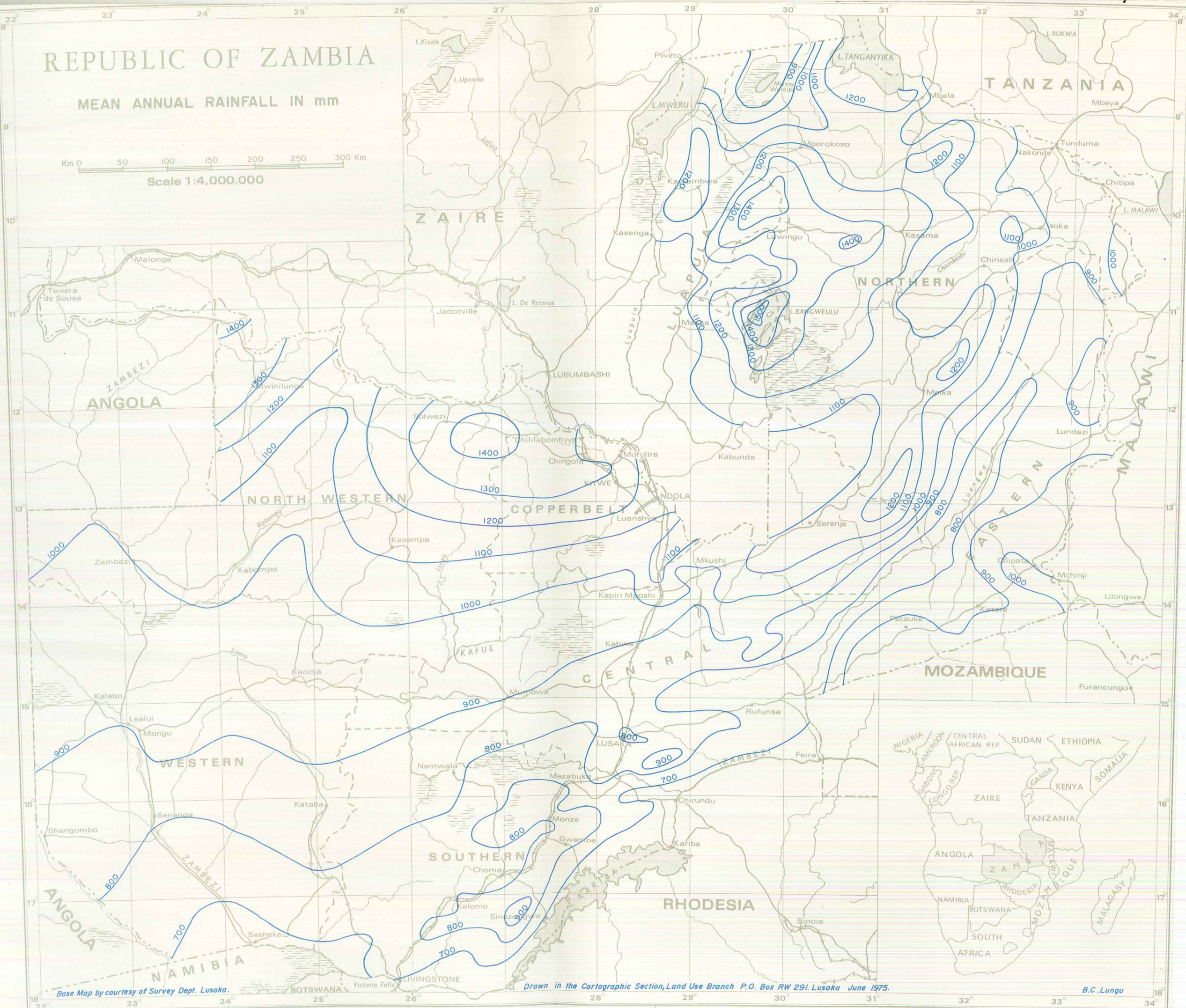
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REPUBLIC OF ZAMBIA

MEAN ANNUAL RAINFALL IN mm

Km 0 50 100 150 200 250 300 Km

Scale 1:4,000,000



Base Map by courtesy of Survey Dept. Lusaka.

Drawn in the Cartographic Section, Land Use Branch P.O. Box RW 291. Lusaka June 1975.

B.C. Lungu

LIST OF PROFILES

Site No. 1

FAO: Luvic Phaeozem

USDA: -Typic Argiustoll

French: Fersiallitique Lessive modal ā facies
isohumique Sur Calcaire -

Site No. 2

FAO: Ferric Luvisol

USDA: Oxic - Paleustalf

French: Ferrugineux - tropical -appauvri modal
Sur materiau alluvial -argileux

Site No. 3

FAO: Pellic Vertisol

USDA: -typic Pellustert

French: Vertisol -ā drainage externe reduit
-ā structure arrondie faciēs alcalise
Sur materiau alluvial -argileux

Site No. 4

FAO: Luvic Phaeozem

USDA: Pachic Paleustoll

French: Ferrugineux - tropical -peu lessive'
hydromorphe -ā facies -anthropique
Sur alluvions -argileuses et
materiau -d'apport -

Site No. 5

FAO: Luvic Phaeozem

USDA: Udic Pateustoll

French: Fersiallitique - peu lessive' modal
-a- facies isohumique sur dolomite

Site No. 6

FAO: Plinthic Acrisol

USDA: Oxic Paleustalf

French: Ferrallitique moyennement desature'
lessive' indure' sur -granito - gneiss

Site No. 7

FAO: Luvic Arenosol

USDA: Arenic Haplustalf

French: Ferrugineux -tropical -peu lessive'
sur materiau d'alteration ferral - litique -

Site No. 8

FAO: Ferrallic Arenosol

USDA: typic Usticpsamment

French: Ferrallitique sature' -typique
faiblement -appauvri -a- facies
ferrugineux -tropical sur
materiau sableux ferrallitique -