



REPUBLIC OF KENYA

MINISTRY OF AGRICULTURE AND LIVESTOCK DEVELOPMENT
NATIONAL AGRICULTURAL LABORATORIES
KENYA SOIL SURVEY

AN ASSESSMENT OF THE IRRIGATION SUITABILITY
OF THE SOILS OF THE IDR P FARM, MWEA
(KIRINYAGA DISTRICT)

by
F.M. Shitakha

SITE EVALUATION REPORT No. P54, JUNE 1984

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1. INTRODUCTION

The request to carry out soil investigations on the Irrigation and Drainage Research Project (IDRP) farm, Mwea in Kirinyaga District was received from the Head, IDRP. It was thought that a quick soil survey indicating only major soil patterns and with emphasis on soil depth, texture, sodicity/salinity would serve their purpose.

An examination of the soils was carried out on 2nd and 3rd April 1982 and 20th and 21st May, 1982.

The author acknowledges the co-operation and assistance of all the people who worked with him during the course of the fieldwork.

2. ENVIRONMENTAL CONDITIONS

2.1. Location and communications

The survey area lies in Kirinyega District, Central Province, approximately 40 km East of Murang'a. It is located about 4 km to the north of Wanguru market and about 1 km to the south of Kimbimbi market. It is roughly intersected by longitude 37° 17'E and latitude 0° 30'N. The elevation of the area is 1190 m (3,900 ft) a.s.l.

The total acreage of IDRP farm is approximately 21 ha.

The area is well served by the Thika-Embu tarmac road.

2.2. Climate

Mwea experimental rainfall station (90 37112) has been taken as representative for the survey area. It is located about 4 km to the south of the survey area at an altitude of 1160 m. The station has rainfall data of 13 years (1961 - 73).

2.2.1. Average annual and seasonal rainfall

The mean annual rainfall of the station is 887 mm. The area has two rainy seasons, namely, the long rains (March - May) and the short rains (October - December). The average rainfall over the long rains is 436 mm and that of the short rains is 333 mm. From table 1, it can be observed that 49% of the average annual rainfall is received during the long rains and 38% during the short rains.

Table I: The mean monthly rainfall of Mwea experimental station (90.37112).

Month	J	F	M	A	M	J	J	A	S	O	N	D	YR
Rainfall (mm)	38	33	74	208	154	13	11	10	13	90	197	51	887

2.2.2. Mean temperatures

The mean annual temperature of the study area is 23°C as calculated with the equation $T^{\circ}C = 30.2 - 0.00650 \cdot h$ where h is altitude in metres (EAMD, 1970). With similar equations the mean maximum and mean minimum temperatures are estimated as 29°C and 17°C respectively.

2.2.3. Evaporation, evapotranspiration and agro-climatic zonation.

The calculated mean annual potential evaporation (Eo) for the survey area is 2007 mm. This is based on Woodhead's (1968)

equation for the potential evaporation in Kenya which he expressed as $E_o = 2422 - 0.358 h$, where E_o is in millimetres and h is the station altitude in metres. The mean annual potential evapotranspiration (E_t) of the area is 1338 mm, which is estimated as 2/3 of the potential evaporation (E_o).

The ratio of the mean annual rainfall to mean annual potential evaporation (r/E_o) in the study area is 66%, therefore it lies in agro-climatic zone IV, which according to Sombroek et al (1982) is classified as semi-humid to semi-arid with a medium potential for an adapted maize crop.

2.2.4. Seasonal rainfall probabilities

The probability as calculated according to Braun (1977) to receive enough rainfall to meet the water requirements for a three months' growing crop during the long rains season is 82%. For a similar crop the probability is 25% during the short rains season. The above calculated probabilities mean that during the long rains there is enough rainfall on average for a three months' crop in 4 out of 5 years. During the short rains, a similar crop receives enough rainfall on average once every 4 years.

2.3. Geology and physiography

The soils of the area are primarily developed from the Thibe olivine basalts which are Miocene in age (Fairburn, 1966).

The survey area has two main physiographic units, namely volcanic plains and a minor valley. The relief of the plains varies from very gently undulating to gently undulating (slopes 0-3%). The minor valley is very gently undulating (slopes 0-2%).

2.4. Present Land use

The survey area is fallow land that apparently has not been under arable farming for some time. The local inhabitants are presently using the area for grazing their livestock.

3. SURVEY METHODS

A topographical map of scale 1:1,000, supplied by the IDRP was used as a base map. Observation points were selected and located on the map. Soil augerings were made to a depth of 2 m (soil depth permitting). The following soil properties were examined: depth, colour, texture, mottling, consistency, calcareousness (by HCl reaction, soil reaction (pH) and salinity (by EC meter). A total of 17 augerhole observations was made.

Sites were selected for representative profile pits in the soil mapping units. A total of 3 profile pits were dug and described in detail according to the KSS standards, which are based on the FAO "Guidelines for Soil Profile Description" (FAO, 1977). Soil samples were taken from the natural soil horizons of all the profile pits. Composite top soil samples were taken from the area around the profile pits. The soil samples were brought to the National Agricultural Laboratories for chemical and physical analysis. For more detail about the methodology applied in the Laboratory see Hinga et al. (1980).

After the fieldwork, the final soil map and legend were drawn and constructed.

4. SOILS

It should be noted that no previous soil information at a reasonable detail was available.

4.1 Systematics and nomenclature

Each mapping unit on the soil mapping identified by a code for which a code system is used. The first letter in the code denotes physiography, the second letter geology and the third or numerical figure various soil characteristics. The slope class is indicated by the letter(s) appearing below the symbols.

The following codes are used:-

Physiography

P - plains

V - minor valley

Geology (parent material)

B - basalts

Soils

r - red soils

1, 2 - various soil characteristics

Soils are classified according to the legend of the Soil Map of the World (FAO - Unesco, 1974). Modifications to this system, known as Kenya Concepts, are marked with an asterisk.

4.2. Description of the soil mapping units

P - Soils of the volcanic plains

Mapping unit PBr

Extent and slope : 19 ha, slopes 0-3%.

General : This mapping unit constitutes approximately 90% of the farm. The relief is flat to gently undulating. The mapping unit is presently not under cultivation and is occasionally used for grazing.

Soils : These are well drained, extremely deep, dark red to dark reddish brown (2.5YR 3/6-5YR 3/3) friable clay soils. The pH is about 6.3. The EC ranges from 0.03 mmhos/cm in the subsoil. The organic C% ranges from 1.21 in the topsoil to 0.6 in the subsoil. The CEC ranges between 33 and 21 me/100g. Base saturation is 57% in the topsoil and decreases to 34% in the subsoil. The soils are classified as humic NITISOLS^K.

Mapping unit PBrP

Extent and slope : 2 ha, slopes 3-5%

General : This mapping unit is a narrow sloping zone that runs more or less parallel to the Murubera river. The relief is undulating. Erosion is negligible because the ground is covered with grass. The land is uncultivated and occasional cattle grazing is done in the unit.

Soils : This unit is comprised of well drained, shallow to moderately deep soils with a dark reddish brown colour (5YR 3/3). The soils consist of friable clays.

The pH ranges from 6.2 - 6.5 and the EC varies from 0.03 to 0.16 mmhos/cm. C% decreases with 16 and 28 me/100g and the base saturation varies from 70 to 40%. The soils are classified as orthic LUVISOLS.

V Soils of the minor valley

Mapping unit VBI

Extent and slope : 0.6 ha, slopes 0-2%.

General : This mapping unit lies in the western corner of the survey area.

The relief is flat to very gently undulating and the soils are seasonally flooded. The present land use is grazing, when the unit is not flooded.

Soils : One auger hole observation (no.17) was made in the mapping unit. The soils are poorly drained, deep, very dark grey (2.5Y 3/0), very firm, cracking clays. Dark brown (7.5YR 3/2) mottles were observed in the soils. The pH ranges from 7.2 in the topsoil to 7.7 in the subsoil. The EC varies from 2.4 mmhos/cm in topsoil to 3.1 mmhos/cm in the subsoil. The soils are classified as pellic VERTISOLS, saline phase.

4.3. Soil fertility status

The appraisal of the soil fertility has been done on the basis of chemical data derived from composite topsoil (0-30cm) samples that were taken at the sites of representative profile pits. This appraisal should be regarded as a general one due to the limited number of samples analysed. The analytical data on the available nutrients are presented in table 2.

Table 2: Available nutrients (0-30 cm).

Mapping unit	PBr	PBr	PBrP
Field designation (profile pit No.)	135 - 59	135 - 60	135 - 61
Le. No./82	6307	6308	6309
pH	5.9	5.9	5.8
Na _i (me/100g)	0.06	0.06	0.04
K "	1.10	1.16	1.00
Ca "	4.6	4.0	2.6
Mg "	4.3	4.6	5.2
Mn "	0.95	0.92	0.78
P (ppm)	238	250	116
N %	0.10	0.12	0.11
C %	0.63	1.35	1.03

The soils are moderately acid (pH 5.8-5.9) and are sufficiently supplied with basic plant nutrients such as potassium (K), sodium (Na), calcium (Ca), magnesium (Mg), and manganese (Mn).

The soils have sufficient supplies of available phosphorus (P). The organic carbon (C) % is low and hence the soils are deficient in nitrogen (N).

For optimum production of crops nitrogen fertilizers should be applied.

5. LAND SUITABILITY FOR SURFACE IRRIGATION

In table 3 the suitability for surface irrigation per mapping unit together with major constraints is given.

Table 3: Land suitability for surface irrigation

Mapping	Acreage (ha)	Suitability	Major constraints
PBr	19	suitable	none
PBrP	2	marginally suitable	slope and soil depth in places saline subsoil.
VBl	0.6	suitable	poorly drained and poor workability.

From the above table, only unit PBrP is unsuitable while the rest of the farm can be considered as suitable for surface irrigation.

6. CONCLUSIONS AND RECOMMENDATIONS

The soils of the mapping unit PBr can support most crops as long as they are regularly replenished with the necessary nutrients. The soils of the mapping unit PBrP are shallow to moderately deep and hence marginally suitable for most commonly grown crops. Soils of the minor valley are poorly drained and have a poor workability.

It is recommended that to maintain the level of phosphorus and to raise the level of Nitrogen, appropriate fertilizers should be applied. Farm yard manure may also be applied to improve soil fertility. Preparation of the field in the minor valley should be done at the beginning of wet season when the workability of the soils is better.

7. REFERENCES

- Acland, J.D.,
1971. :East African crops. FAO-longman, London.
- Braun, H.M.H.,
1977. :Seasonal and monthly rainfall probability tables for the East-Central, Northern, Western and Coast and Coast regions of Kenya. Misc paper No.13, Kenya Soil Survey, Nairobi.
- Braun, H.M.H.,
in prep. :Estimating annual and monthly potential evaporation in Kenya. Misc. paper, Kenya Soil Survey, Nairobi
- E.A.M.D.
1970 :Temperature data for stations in East Africa, part 1, Kenya, E.A.M.D., Nairobi.
- E.A.M.D.
1973 :Summary of rainfall in Kenya, E.A.M.D., Nairobi.
- Farburn, W.A.,
1966 :Geology of the Fort Hall area (with coloured map, scale 1:25,000), Report No.73; Geological survey of Kenya, Nairobi.
- FAO
1977 :Guidelines for soil profile description. FAO, Rome.
- FAO-UNESCO
1974 :Soil map of the world, Vol.I, legend. Unesco, Paris.
- Hinga, G., F.N.Muchena,
C. Njithia (ed)
1980 :Physiocal and chemical methods of soil analysis. Internal document, National Agric. Labs. Nairobi.
- Muchena, F.N., G. Ngeri
1975 :Soils of the proposed Wamumu extension. Detailed soil survey Report No.D2. Kenya Soil Survey, Nairobi.
- Sombroek W.G., H.M.H Braun,
B.J.A. Van der Pouw.
1982 :Exploratory soil map and Agro-climatic zone map of Kenya. Report No.E1, Kenya Soil Survey, Nairobi.
- Woodhead, T.,
1968 :Studies of potential evaporation in Kenya. E.A.A.F.R.O. Nairobi.

A P P E N D I X 1

Description of representative soil
profiles and analytical data.

LABORATORY DATA OF PROFILE DESCRIPTION No. 1

Observation no: 135-59

Mapping unit: PBr Soil classification: humic NITISOL*

Laboratory no. /82	6310	6311	6312
Horizon	A1	Bt1	Bt2
Depth (cm)	0-15	15-70	70-135
pH-H ₂ O (1:2.5 v/v)	6.4	6.3	6.3
pH-KCl "	5.0	5.2	5.3
EC (mmho/cm) "	0.03	0.05	0.10
CaCO ₃ (%)			
CaSO ₄ (%)			
C (%)	1.09	0.75	0.60
N (%)			
C/N			
CEC (me/100g), pH 8.2	33.3	22.7	20.9
CEC " " pH 7.0			
Exch. Ca (me/100g)	8.0	5.3	5.3
" Mg "	4.5	4.3	3.7
" K "	4.2	1.2	0.5
" Na "	0.2	0.2	0.2
Sum of cations	16.9	11.0	9.7
Base sat. %, pH 8.2	51	48	46
" " %, pH 7.0			
ESP at pH 8.2			

Texture (limited pretreatment)			
Gravel % (>2.0mm)			
Sand % (2.0-0.05mm)	18	16	14
Silt % (0.05-0.002mm)	28	20	16
Clay % (0.002-0mm)	54	64	70
Texture class	C	C	C

Fertility aspects		0 - 30 cm		Laboratory no. 6307/82	
General		Available nutrients			
pH-H ₂ O (1: v/v)	5.9	Na/me/100g	0.06	Mn (me/100g)	0.95
Exch. acidity (me/100g)		K "	1.10	P (ppm)	238
C %	0.63	Ca "	4.6	P-Olsen (ppm)	
N %	0.10	Mg "	4.3		

Remarks:

PROFILE DESCRIPTION NO.1.

General site information

Mapping unit : PBr
Soil classification : humic NITISOL*
Observation No. /date : 135-59; 21-5-1982
Parent material : Basalt
Physiography : Plain
Relief, macro : Nearly flat
Slope at site : 1-2%
Vegetation/Land use : Grasses and shrubs/Idle land
Erosion : Very slight rainsplash
Groundwater level : Very deep (inferred)
Drainage class : Well drained

Profile description

A1 0-15 cm
Dark reddish brown (5YR 3/2, moist); clay; moderate, fine to medium, sub-angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet. very few very fine pores. common fine roots; clear and smooth boundary to:
(Lab. no. 6310/82)

Bt1 15 - 70 cm
Dark reddish brown (5YR 3/3, moist); clay; moderate, medium sub-angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; broken moderately thick cutans; common very fine pores; common very fine pores; common, very fine roots; clear and smooth boundary to:
(Lab. no. 6311/82)

Bt2 70 - 135 cm
Dark reddish brown (5YR 3/3; moist); clay; moderate, medium sub-angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; broken moderately thick cutans; common very fine pores; very few fine roots;
(Lab. no. 6312/82)

LABORATORY DATA OF PROFILE DESCRIPTION No. 2

Observation no: 135-60 Mapping unit: PBr Soil classification: humic NITISOL*

Laboratory no. / 82	6313	6314	6315			
Horizon	A1	Bt1	Bt2			
Depth (cm)	0-31	31-70	70-139			
pH-H ₂ O (1: 2.5 v/v)	6.5	6.3	6.4			
pH-KCl "	5.3	5.3	5.3			
EC (mmho/cm) "	0.03	0.04	0.03			
CaCO ₃ (%)						
CaSO ₄ (%)						
C (%)	1.21	0.78	0.69			
N (%)						
C/N						
CEC (me/100g), pH 8.2	32.0	27.1	28.0			
CEC " " pH 7.0						
Exch. Ca (me/100g)	9.0	5.2	5.3			
" Mg "	5.6	4.3	2.9			
" K "	3.6	3.0	1.2			
" Na "	0.1	0.1	0.1			
Sum of cations	18.3	12.6	9.5			
Base sat. %, pH 8.2	57	46	34			
" " %, pH 7.0						
ESP at pH 8.2						
<u>Texture (limited pretreatment)</u>						
Gravel % (>2.0mm)						
Sand % (2.0-0.05mm)	14	14	16			
Silt % (0.05-0.002mm)	32	22	14			
Clay % (0.002-0mm)	54	64	70			
Texture class	C	C	C			
<u>Fertility aspects</u>			0 - 30 cm		Laboratory no. 6308 / 82	
<u>General</u>			<u>Available nutrients</u>			
pH-H ₂ O (1: 1 v/v)	5.9	Na (me/100g)	0.06	Mn (me/100g)	0.92	
Exch. acidity (me/100g)		K "	1.16	P (ppm)	250	
C %	1.35	Ca "	4.0	P-Olsen (ppm)		
N %	0.12	Mg "	4.6			
<u>Remarks:</u>						

PROFILE DESCRIPTION NO.2

General site information

Mapping unit : PBr
Soil classification : humic NITISOL
Observation No. /date : 135-60; 21-5-82
Parent material : Basalt
Physiography : Plain
Relief, macro : Gently undulating
Slope at site : 3.0%
Vegetation/Land use : Grasses/fallow land
Erosion : slight rainsplash
Groundwater level : deep (inferred)
Drainage class : well drained.

Profile description

A1 0 - 31 cm Dark reddish brown (5YR 3/2, moist); clay; moderate, fine to medium, sub-angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; very few fine pores; common very fine and few fine roots; gradual and smooth boundary to:
(Lab. no. 6313/82)

Bt1 31 - 70 cm Dark reddish brown (5YR 3/3, moist); clay; moderate, fine to medium, sub-angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; patchy thin cutans; common fine and few medium pores; few fine roots; clear and smooth boundary to:
(Lab. no. 6314)

Bt2 70 - 139 cm Dark reddish brown (5YR 3/3, moist); clay; moderate, fine to medium, sub-angular blocky structure; friable when moist, sticky and plastic when wet; patchy thin cutans; common fine and very few medium pores; very few very fine roots.
(Lab. no. 6315)

LABORATORY DATA OF PROFILE DESCRIPTION NO. 3

Observation no: 135-61 Mapping unit: FBrP Soil classification: orthic LUVISOL

Laboratory no.	/ 82	6316	6317				
Horizon		A1	Bt				
Depth (cm)		0-17	17-72				
pH-H ₂ O (1: 2.5 v/v)		6.2	6.2				
pH-KCl	"	5.2	5.1				
EC (mmho/cm)	"	0.03	0.16				
CaCO ₃ (%)							
CaSO ₄ (%)							
C (%)		1.18	0.69				
N (%)							
C/N							
CEC (me/100g), pH 8.2		28.0	15.7				
CEC " " pH 7.0							
Exch. Ca (me/100g)		7.0	5.3				
" Mg "		4.5	5.0				
" K "		2.0	0.5				
" Na "		0.2	0.2				
Sum of cations		13.7	11.0				
Base sat. %, pH 8.2		49	70				
" " %, pH 7.0							
ESP at pH 8.2							
<u>Texture (limited pretreatment)</u>							
Gravel % (>2.0mm)							
Sand % (2.0-0.05mm)		16	14				
Silt % (0.05-0.002mm)		24	26				
Clay % (0.002-0mm)		60	60				
Texture class		C	C				
<u>Fertility aspects</u>				0 - 30 cm		Laboratory no. 6309 / 82	
<u>General</u>		<u>Available nutrients</u>					
pH-H ₂ O (1: 1 v/v)	5.8	Na/me/100g)	0.04	Mn (me/100g)	0.78		
Exch. acidity (me/100g)		K "	1.00	P (ppm)	116		
C %	1.03	Ca "	2.6	P-Olsen (ppm)			
N %	0.11	Mg "	5.2				
<u>Remarks:</u>							

PROFILE DESCRIPTION NO. 3

General site information

Mapping unit : PBrP
Soil classification : orthic LUVISOL
Observation No. /date : 135-61. 21-5-82
Parent material : Basalts
Physiography : Plains
Relief, macro : Undulating
Slope at site : 3.4%
Vegetation/Land use : Grasses/fallow land
Erosion : Very slight rainsplash
Groundwater level : Deep (inferred)
Drainage class : Well drained

Profile description

A1 0 - 17 cm Dark reddish brown (5YR 3/2, moist).
clay; moderate, medium, sub-angular
blocky structure; slightly hard when dry,
friable when moist, sticky and plastic
when wet; common fine pores; common
fine and few very fine roots; gradual
and smooth boundary to:
(Lab. no. 6316/82)

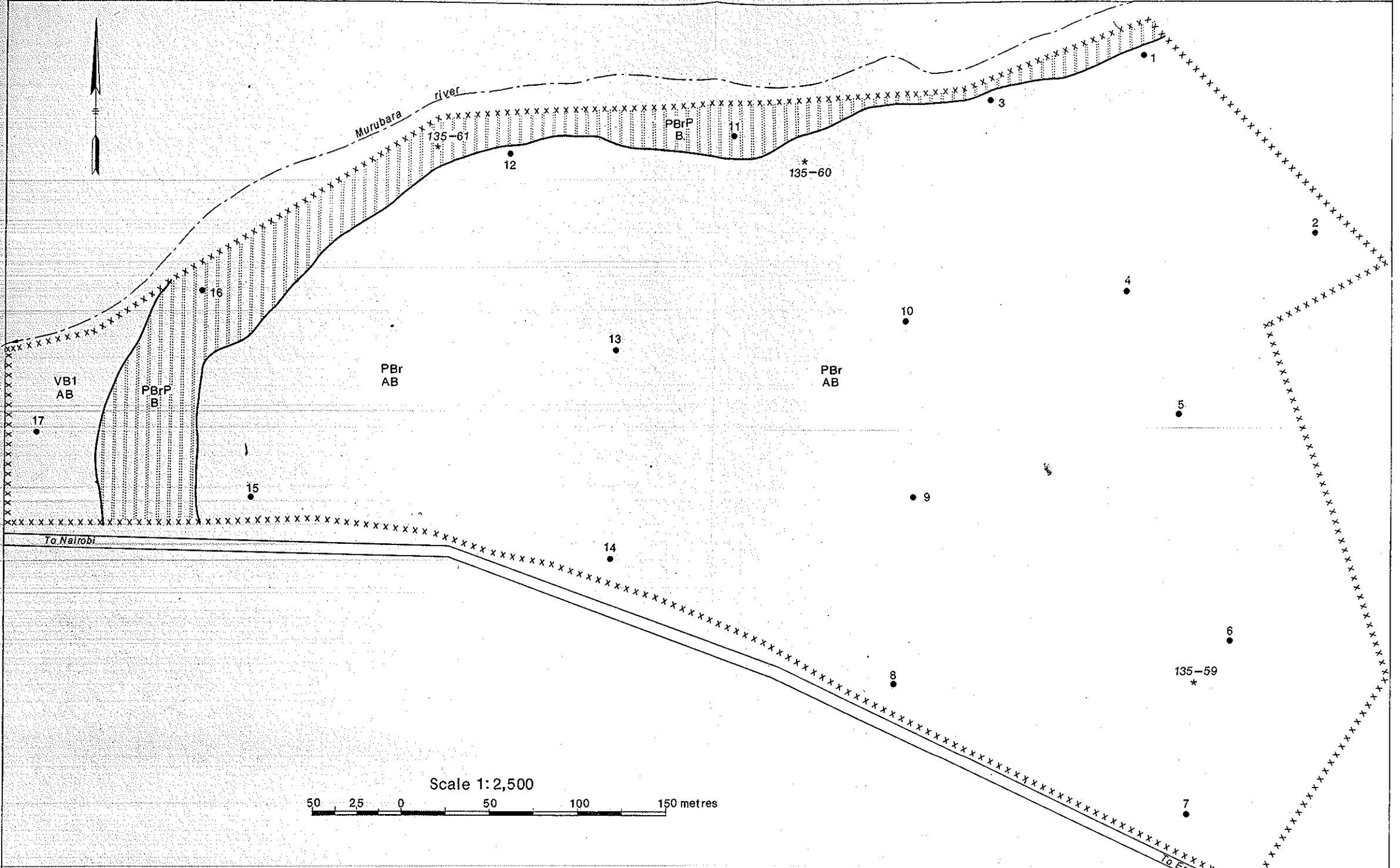
Bt 17 - 72 cm Dark reddish brown (5YR 3/2, moist):
clay; moderate, medium, sub-angular
blocky structure; slightly hard when
dry, friable when moist, sticky and
plastic when wet; patchy thin cutans;
common fine and few medium pores; few
fine roots:
(Lab. no. 6317/82)

R 72 cm Rock

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PRELIMINARY SOIL MAP OF THE IRRIGATION AND DRAINAGE PROJECT FARM, MWEA (KIRINYAGA DISTRICT)

Appendix 2 to report No. P54



LEGEND

P PLAINS (slopes 0-3%)

PB Soils developed on basalts

PBr well drained, extremely deep, dark red to dark reddish brown, friable clay

PBrP as in PBr, but shallow to moderately deep

V MINOR VALLEYS (slopes 0-2%)

VB Soils developed on basalts

VB1 poorly drained, deep, very dark grey, very firm cracking clays

KEY TO SLOPE CLASSES

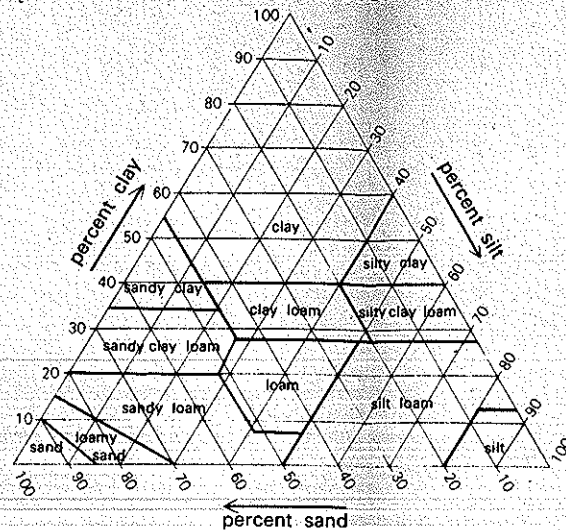
slope %	slope class code	name of macrorelief
0-2	A	flat to very gently undulating
2-5	B	gently undulating

KEY TO DEPTH CLASSES

thickness soil in cm	symbol and code ⁺		name
	over rock	over petro-plinthite	
0-50			shallow
50-80			moderately deep
80-120			deep
120-180			very deep
more than 180			extremely deep

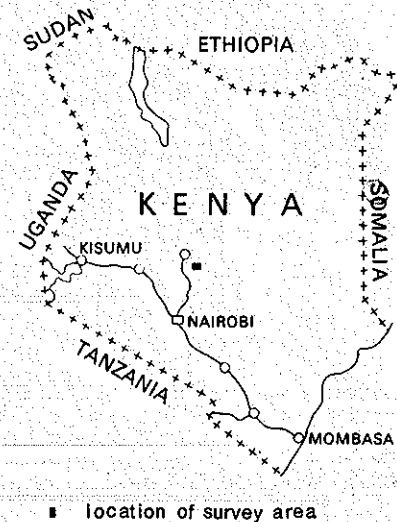
⁺ If a complex of depth classes occurs within one unit, only the symbol of the shallowest depth class is indicated

TEXTURAL CLASSES



KEY

- soil mapping code
- PBrP** depth class code
- A B** slope class code
- * 135-59** profile pit, with reference number
- 6** augerhole, with reference number
- soil boundary
- survey area boundary
- main road
- stream
- 1 sq. cm
- 0.0625 ha**



soil survey..... F. Shitakha
 map correlation..... R. Rachilo and T. Gicheru
 cartography..... L. Mikisi

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