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KENYA SOIL SURVEY

DETAILED SOIL SURVEY OF THE HVA-SITE AT RIARA RIDGE

(KIAMBU DISTRICT)

by

A. Weeda and D. N. Mungai

DETAILED SOIL SURVEY REPORT No. D31, JULY 1983

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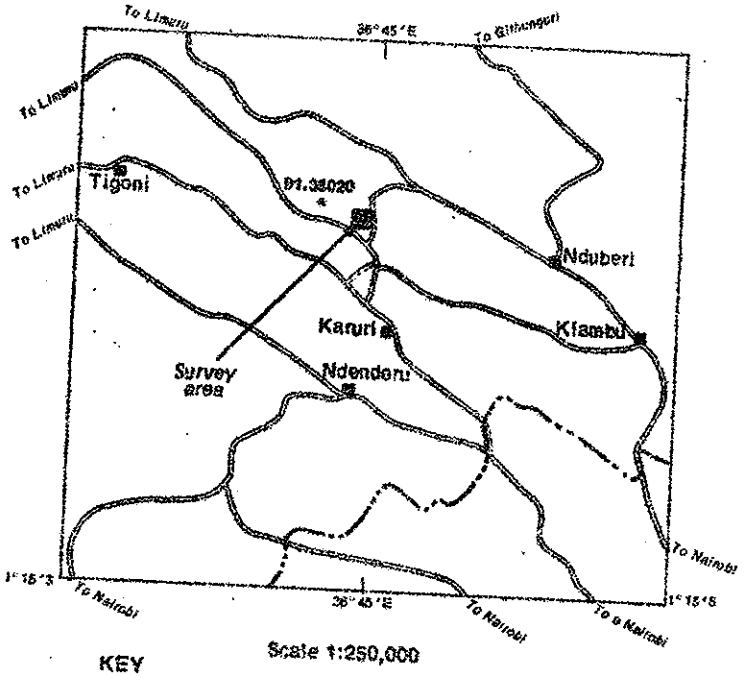
Fig. 1 Location of survey area



Scale 1:250,000

KEY

01.38020 Ehothia farm rainfall station

road

provincial boundary

Drawing No. 83060

INTRODUCTION

At the request of HVA Kenya Ltd. a detailed soil survey was carried out at the Riara Ridge, some 20km NW of Nairobi. The total area of the farm is about 16 ha. According to the requirements of the planned agricultural activities by HVA some 4 ha were excluded in the planning phase of the survey due to excess slope (in the southern part), or size and location of the northern part across the road. The survey was carried out at the beginning of June 1983 during a 3 day fieldwork. Only a general agricultural interpretation of the data was carried out because of lack of crop specifications (requirement) of the agricultural use planned.

The authors greatly acknowledge the collaboration given by NAL Chemistry Section and the Irrigation and Drainage Research Project for the analysis of the samples.

1. Environment

1.1. Location

The area of the farm of approximately 16 ha., is located at 20km NW of Nairobi, north of the Riara Ridge Road with the following coordinates $1^{o}07'S$ and $36^{o}45'E$; its north-eastern boundary is formed by the Riara Ditch. Its elevation is 1980m above sea level.

1.2. Climate

The nearest rainfall station to the survey area is Ehothia Farm, station no. 91.36020 which is some 2km to the west. The station has rainfall data for 56 years upto 1972 (EAMD, 1974).

The mean annual rainfall is 1273mm. The rainfall distribution in the year is bimodal with the main rains occurring during the "long rains" period (March-May) and the "short rains" season (October-December) see table 1. The proportion of mean annual rainfall in four somewhat arbitrarily defined periods i.e. January-February, March-May, June-September and October-December is 9%, 50%, 13% and 28% respectively.

The mean monthly rainfall and potential evapotranspiration (Et) data for Ehothia Farm are given in table 1 below.

Table 1. Rainfall (r) and potential evapotranspiration (Et) estimates for Ehothia Farm (91.36020). Ehothia Farm's data are considered representative for the survey area. Data in mm.

	J	F	M	A	M	J	J	A	S	O	N	D	YEAR
r	58	59	126	294	214	63	26	37	38	86	171	101	1273
Et	127	116	116	93	81	69	58	69	104	116	93	116	1737

Potential evapotranspiration (Et) is calculated as Et = 2/3 Eo*. The potential evaporation Eo is calculated using the Woodhead's (1968) equation; the distribution throughout the year was derived from data from various stations in the region (EAMD, 1975).

According to the existing data the probability that rainfall during the "long rains" season is less than the estimated crop-water requirement (2/3Eo) is 2%, while it is about 47% during the "short rains" season. Thus, on average, the long rains can be expected to provide enough rainfall for seasonal crop production in nearly all the years, while the short rains can be expected to provide enough rainfall about half of the time. The period from June to August has low evaporation rates and this, together with a large soil moisture storage capacity can mitigate the effects of low rainfall during this time of the year. January and February are rather dry.

The annual rainfall-evaporation ratio of the survey area is 73%. The mean annual temperature is 16-18°C. From the considerations of water availability (r/Eo) and temperature, the survey area falls in agro-climatic zone II-5 (Sombroek et al., 1982). From the agroclimatological point of view, the area has high potential for rainfed agriculture. The occurrence of night frosts is very rare.

1.3. Geology and parent material

According to Saggerson (1971), geologically the studied area belongs to Pleistocene formations: Limuru Trachytes and Quartz Trachytes (intermediate volcanic rocks).

It is assumed that volcanic ashes form an important portion of the parent material, on which the present soils had been formed.

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* For most annual crops grown in Kenya, the crop-water requirement is approximately 2/3Eo over the whole growing season.

1.4. Physiography

The surveyed area is located on the middle part of the footridge physiographic unit. The latter are the dissected lower slopes of major older volcanoes and mountains. The studied area is on the summit and the upper lateral slopes on one of these footridges. The slopes vary from flat on the summit to hilly on the sides (0-25%). The excluded part of the farm belongs to the middle lateral slope with inclinations of 50% or more.

1.5. Actual vegetation and land use

Due to its altitude and climatic characteristics present in the area, coffee and tea are the principal cash crops, specifically on the slopes and summits of the footridges. Also maize, potatoes and vegetables can be found. Cattle grazing takes place on the valley bottoms principally.

The survey area has been abandoned already during a year or more. Evidence of ploughing can still be seen. At present the vegetation consists mainly of grasses (Kikuyu grass) with shrubs - in variable proportions - as secondary vegetation. Some cattle grazing is present at the farm.

1.6. Hydrology

The survey area is bordered in the north by the Riara Ditch - an all - year water containing small river. See for chemical analysis of the water appendix 2.

2. The Soils

2.1. Survey methods

After a preliminary field visit a programme of work was established with technical specifications for a survey with a working and publication scale of 1:5,000.

Office work

Data on comparable soils in the surrounding were collected (Siderius and Muchena, 1977). No aerial photographs could be used due to the scale of the existing photographs.

Field work

It was agreed with the HVA Kenya Ltd that the fieldwork would be executed with a 100m grid-system in such a way that 21 auger observations would be made (upto 1.20m). Also additional augerings were made to 2.20m. The preliminary field trip and the fieldwork itself showed the necessity of making two detailed field observations in the form of pits which were described and their horizons sampled. The soils were described according to the standards of KSS, which are based on the "Guidelines for Soil Profile Description" (FAO, 1977). Additional sampling was done for analysis of the fertility status and for physical characteristics. For the fertility for each of the mapping units, a composite sample from 0-30 cm depth was taken. For bulk density and low pF determinations, samples were taken from the main horizons of the representative soil pits. Also disturbed samples were collected for the determination of the high pF-values for the same horizons. For soil classification purposes the legend of the "Soil map of the world" (FAO-UNESCO, 1974) was used.

Laboratory methods

Analysis were executed mainly by NAL and in minor proportion by KSS, according to NAL methodology. The methods are briefly described below. For more detail see Hinga et al. (1980).

texture : hydrometer method

pH-H_2O : 1:2.5 soil-water suspension

pH-KCl : 1:2.5 soil-N KCl suspension

EC : 1:2.5 soil-water suspension

Org. C% : Walkley and Black method

ECE and exch. cations : 1 N ammonium acetate pH 8.2, cations determined by flame-photometer/atomic absorption spectrophotometer

bulk density : determination of ovendry (105°C) weight of given soil volume

pF values : determination of moisture percentages at pF 2.0, 2.3, 2.7, 3.7 and 4.2.

fertility analysis : available nutrients (Mehlich method) soil in 0.1 N HCl and 0.25N H_2SO_4

determination Ca, K, Na : flamephotometer

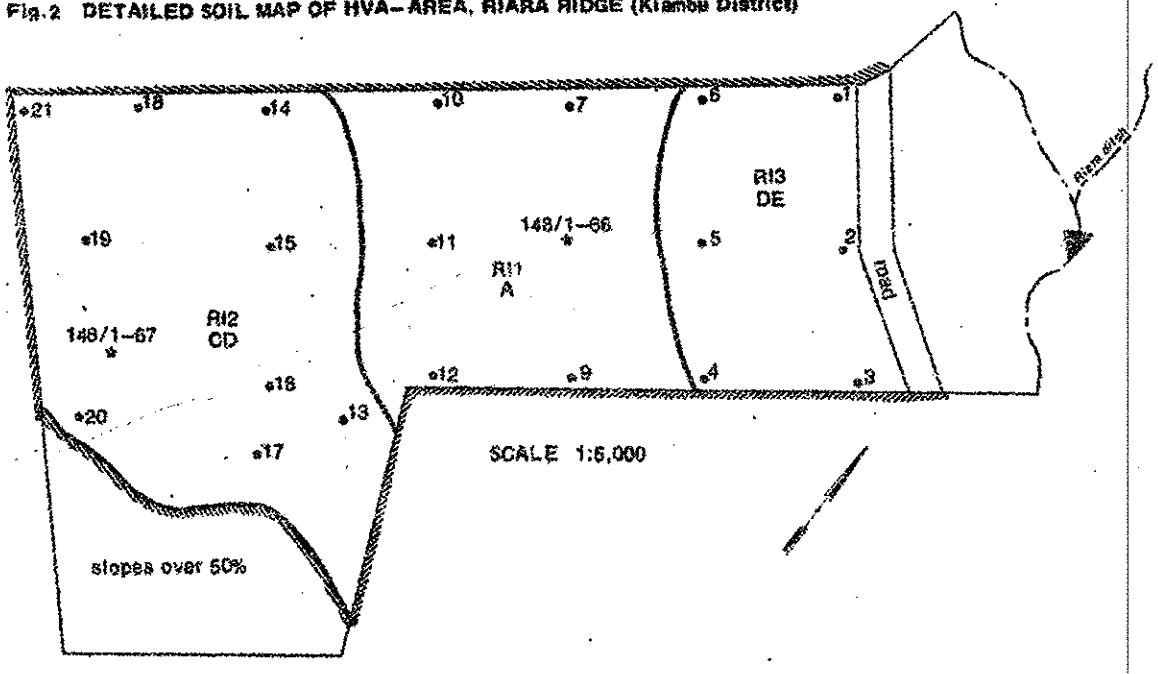
Mn : phosphoric acid potassium periodate

- phosphorus : P-Olsen method
- soil in 0.1 N HCl :

determination Fe, Zn, Cu : atomic absorption spectrophotometer

water analysis: USDA Salinity Lab. methods.

Fig. 2 DETAILED SOIL MAP OF HVA–AREA, RIARA RIDGE (Kiambu District)



LEGEND

R FOOTRIDGES (slopes 0–25%)

RI Soils developed on intermediate igneous rocks

RI1 — well drained, deep, dusky red, friable clay, with clay loam topsoil; slopes 0–2% (dystric NITOSOLS)

RI2 — well drained, deep, dusky red to dark reddish brown, friable clay, with very few small manganese concretions from about 60cm; slopes 6–10% (dystric NITOSOLS)

RI3 — well drained, deep, dusky red to dark reddish brown, friable clay; slopes 10–25% (dystric NITOSOLS)

KEY TO SLOPE CLASSES

%	code	name of the macrorelief
0–2	A	flat to very gently undulating
2–6	B	gently undulating
6–8	C	undulating
8–16	D	rolling
16–30	E	hilly

KEY

RI2.....soil mapping code
CD.....slope class code
soil boundary
•10 augerhole observation, with reference number
148/1–67 ✶ soil profile pit, with reference number
1 sq cm = 0.25 ha
survey area boundary
farm boundary

Drawing No. 33054

2.2. Description of soils and their properties

The soils are described according to the mapping units to which they belong:

Mapping unit RI_1

Extent	:	approximately 4 ha
Parent material	:	intermediate volcanic material
Ecological zone	:	II - 5
Relief	:	flat to very gently undulating (slopes 0-2%)
Position	:	summit of the Footridge
Land use	:	abandoned cultivation, Kikuyu grass and shrubs (secondary growth) in variable proportions
Susceptibility to erosion	:	very low
Drainage	:	well drained
Soils, general	:	These are strongly weathered deep dusky red clay soils. In the Bt horizon common thin clay skins are present. The boundaries of the horizons of the Ah-AB-Bt sequence are diffuse and smooth.
colour	:	topsoil: dark reddish brown (5YR and 2.5YR)
		subsoil: dusky red (10R)
texture	:	topsoil: mainly clay loam, with tendency to clay
		subsoil: clay
structure	:	topsoil: medium to coarse moderate subangular blocky
		subsoil: coarse moderate subangular blocky
consistence	:	topsoil: friable when moist; slightly plastic, slightly sticky when wet
		subsoil: friable when moist; slightly plastic, slightly sticky when wet
depth variation	:	Ah + AB: 0-70cm
		Bt : 50-120+cm

Chemical properties*:

%C	topsoil	2.9
	subsoil	0.5

* mainly based on data from the representative soil profile

pH-H_2O	topsoil	6.2-6.4
	subsoil	6.5
pH-KCl	topsoil	5.3-5.4
	subsoil	5.8
CEC(pH 8.2)	topsoil	31.3-33.5
(me/100g soil)	subsoil	15.7-16.1
base saturation	topsoil	45-52
%	subsoil	36

Physical properties*

depth(cm)	pF (vol.%)					pF 2.0-4.2	bulk density
	2.0	2.3	2.7	3.7	4.2	(vol.%)	(gr/cm^3)
20	37	33	31	28	26	11	0.83
50	39	33	32	27	25	14	0.80
100	47	41	-	34	31	16	0.93

The bulk densities are low, water holding capacity is moderate to high.

Fertility aspects
(0-30cm)

		interpretation
pH	6.4	slightly acid
Na me%	0.16	-
K me%	1.36	moderate
Ca me%	4.4	moderate
Mn me%	0.7	-
P ppm	12	low
Cu ppm	0.9	low
Fe ppm	5.0	-
Zn ppm	13.0	-
CEC me/100g soil	33.5	high
C %	2.95	high

The status depends on the agricultural use, but the deficiencies of P and Cu might be corrected.

Classification : dystric NITOSOL

For a detailed description and analytical data of representative soil profile (148/2-1-66) see appendix 1.

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* mainly based on data from the representative soil profile

Mapping unit RI_2

Extent	:	approximately 6 ha
Parent material	:	intermediate volcanic material
Ecological zone	:	II-5
Relief	:	undulating to rolling (slopes 6-10%)
Position	:	upper lateral slope of the Footridge
Land use	:	abandoned cultivation, grasses and shrubs in variable proportions
Susceptibility to erosion	:	low
Drainage	:	well drained
Soils, general	:	These are strongly weathered, deep, dusky red to dark reddish brown clay soils with abundant thin clayskins in the Bt-horizon. From about 60cm depth very few small manganese concretions are present. The boundaries of the horizons of the Ah-AB-Bt sequence are diffuse and smooth.
colour	:	topsoil: dark reddish brown (5YR) subsoil: dusky red (10R) to dark reddish brown (2.5YR)
texture	:	topsoil: clay subsoil: clay
structure	:	topsoil: medium moderate subangular blocky subsoil: fine weak angular blocky
consistence	:	topsoil: friable when moist, slightly plastic, slightly sticky when wet subsoil: friable when moist, slightly plastic, slightly sticky when wet
depth variation	:	Ah + AB 0-80cm Bt 50-120+cm

Chemical aspects*

%C	topsoil	2.6-1.4
	subsoil	0.5-0.4
pH-H_2O	topsoil	6.4-6.6
	subsoil	6.0
pH-KCl	topsoil	5.3-5.4
	subsoil	5.0

* mainly based on data from the representative soil profile

CEC(pH 8.2)	topsoil	34.0-27.9
(me/100g soil)	subsoil	16.5
base saturation %	topsoil	35-38
	subsoil	39

Physical properties*

depth(cm)	pF(vol. %)					pF 2.0-4.2	bulk density
	2.0	2.3	2.7	3.7	4.2	(vol. %)	(gr/cm^3)
7	41	34	32	30	27	14	0.93
28	40	35	34	29	25	15	0.88
100	47	41	41	37	30	17	0.94

It can be seen that the bulk density is rather low, and the available water holding capacity is moderate to high.

Fertility aspects

(0-30cm)

		interpretation
pH	6.4	slightly acid
Na me %	0.16	-
K me %	1.64	high
Ca me %	5.2	moderate
Mn me %	1.08	-
P ppm	12	low
Cu ppm	1.2	-
Fe ppm	6.0	-
Zn ppm	19.5	-
CEC me/100g soil	34.0	high
C %	2.81	high

The status depends on the agricultural use, but the deficiency of P will have to be corrected.

Classification : dystric NITOSOL

For a detailed description and analytical data of representative soil profile (148/1-67) see appendix 1.

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* mainly based on data from the representative soil profile

Mapping unit RI_3

Extent	:	approximately 2 ha
Parent material	:	intermediate volcanic material
Ecological zone	:	II-5
Relief	:	rolling to hilly (slopes 10-25%)
Position	:	upper lateral slope of the Footridge
Land use	:	abandoned area, shrubs (dominating) and grasses
Susceptibility to erosion	:	low to moderate
Drainage	:	well drained
Soils, general	:	These are strongly weathered, deep, dusky red to dark reddish brown clay soils with abundant thin clay cutans in the Bt-horizon. The boundaries of the horizons of the Ah-AB-Bt sequence are diffuse and smooth.
colour	:	topsoil: dark reddish brown (5YR and 2.5YR) subsoil: dusky red (10R) to dark reddish brown (2.5YR)
texture	:	topsoil: clay subsoil: clay
structure	:	topsoil: medium moderate subangular blocky subsoil: not observed
consistence	:	topsoil: friable when moist, slightly plastic, slightly sticky when wet subsoil: friable when moist, slightly plastic, slightly sticky when wet
depth variation	:	Ah + Bt 0-60cm Bt 15-120+cm

As soils of this unit are rather similar to soils of the previous units, no detailed pit description or sampling has been done.

Fertility aspects

(0-30cm)

		interpretation
pH	6.0	medium
Mn me %	0.14	-
K me %	0.92	moderate
Ca me %	1.8	low
Mn me %	0.75	-
P ppm	10	low
C %	3.04	high

Classification : dystric NITOSOL

3. Conclusions

The soils of the HVA-site at Riara Ridge are well drained deep soils with good physical properties for plant growth including the high water retention of the soil (pF 2-4.2). The chemical characteristics are acceptable, taking into account the estimated moderate fertilization requirement to suppress some deficiencies (to be established in detail according to plant requirements). On the steeper slopes like in soil mapping unit RI_3 surface levelling will be required to facilitate intensive use of the land without erosion problems. The quality of the water of the Riara ditch for additional water supply in critical periods is good for plant growth.

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Appendix 1. DESCRIPTION OF REPRESENTATIVE PROFILES WITH ANALYTICAL DATA.

Profile no. 148/1-66

General site information

Soil classification	:	dystric NITOSOL
Observation date/authors	:	9/6/83; D.N. Mungai/A. Weeda
Location/altitude	:	Riara Ridge (Kiambu); 36°45'E & 1°07'S; 1980m
Ecological zone	:	II-5
Geology & parent material	:	Pleistocene volcanics; Limuru trachyte
Physiography	:	Footridge (R)
Relief	:	hilly
Slope at site	:	0-1% (summit)
Vegetation/Land use	:	secondary vegetation: shrubs 30%, Kikuyu grass 70%; abandoned
Erosion	:	not observed
Surface stoniness+rockiness	:	nil
Surface sealing	:	nil
Drainage class	:	well drained

Profile description

Ah 0-30cm dark reddish brown (2.5YR 3/2 dry, 5YR 3/2 moist); clay; coarse moderate subangular blocky; friable when moist, slightly plastic and slightly sticky when wet; common medium and few fine roots; diffuse smooth boundary

(lab. no. 4374)

AB 30-75cm dark reddish brown (2.5YR 3/4 dry, 2.5YR 2.5/4 moist); clay; coarse moderate subangular blocky; friable when moist, slightly plastic and slightly sticky when wet; common thin clay cutans; few fine and medium roots; diffuse smooth boundary

(lab. no. 4375)

Bt 75-140+cm dusky red (10R 3/6 dry, 10R 3/4 moist); clay; coarse moderate subangular blocky, composed of medium moderate angular blocks; friable when moist, slightly plastic and slightly sticky when wet; common thin clay cutans; few fine and medium roots, very few small Mn concretions

(lab. no. 4376)

LABORATORY DATA OF PROFILE DESCRIPTION No. 148/1-66

Observation no: 148/1-66 Mapping unit: RI_1 Soil classification: dystric NITOSOL

Laboratory no. /83	4374	4375	4376			
Horizon	Ah	AB	Bt			
Depth (cm)	0-30	30-75	75-140			
pH-H_2O (1:2.5 v/v)	6.4	6.2	6.5			
pH-KCl "	5.4	5.3	5.8			
EC (mmho/cm) "	0.09	0.05	0.17			
$CaCO_3$ (%)						
$CaSO_4$ (%)						
C (%)	2.93	0.83	0.54			
N (%)						
C/N						
CEC (me/100g), pH 8.2	33.5	22.3	16.1			
CEC " " pH 7.0						
Exch. Ca (me/100g)	8.6	4.2	3.1			
" Mg "	5.0	1.9	1.9			
" K "	3.95	3.95	0.75			
" Na "	0.10	0.07	0.07			
Sum of cations						
Base sat. %, pH 8.2	52	45	36			
" " %, pH 7.0						
ESP at pH 8.2						

Texture (limited pretreatment)						
Gravel % (>2.0mm)						
Sand % (2.0-0.05mm)	34	16	14			
Silt % (0.05-0.002mm)	24	16	8			
Clay % (0.002-0mm)	42	68	78			
Texture class	clay	clay	clay			

Fertility aspects 0 - cm Laboratory no. /

General		Available nutrients			
pH-H_2O (1: v/v)		Na/me/100g)		Mn (me/100g)	
Exch. acidity (me/100g)		K "		P (ppm)	
C %		Ca "		P-Olsen (ppm)	
N %		Mg "			

Remarks:

Profile no. 148/1-67

General site information

Soil classification	:	dystric NITOSOL
Observation date/authors	:	10/6/83; A. Weeda/ D.N. Mungai
Location/altitude	:	Riara Ridge (Kiambu); 36°45'E, 1°07'S; 1980m
Ecological zone	:	II-5
Geology & parent material	:	Pleistocene volcanics; Limuru trachyte
Physiography	:	Footridge (R)
Relief	:	hilly
Slope at site	:	5% (upper slope)
Vegetation/Land use	:	secondary vegetation: shrubs 30%, Kikuyu grass 70%; abandoned
Erosion	:	not observed
Surface stoniness/rockiness	:	nil
Surface sealing	:	no
Drainage class	:	well drained

Profile description

Ah_1 0-25cm dark reddish brown (7.5YR 3/2 dry, 5YR 3/2 moist); clay; medium moderate subangular blocky; friable when moist, slightly plastic and slightly sticky when wet; very few thin clay cutans; few fine and common medium roots; diffuse smooth boundary

(lab. no. 4377)

Ah_2 25-45cm dark reddish brown (2.5YR 3/2 dry, 2.5YR 2.5/4 moist); medium weak subangular blocky, composed of fine weak subangular blocks; friable when moist, slightly plastic and slightly sticky when wet; very few thin clay cutans; few fine and medium roots; diffuse smooth boundary

(lab. no. 4378)

Bt_1 45-120cm dusky red (10R 3/4 dry, 10R 3/3 moist); clay; medium weak subangular blocky; friable when moist, slightly plastic and slightly sticky when wet; common thin clay cutans; few fine and medium roots; very few small Mn concretions; diffuse smooth boundary

(lab. no. 4379)

Bt_2 120-150+cm dusky red (10R 3/6 dry, 10R 3/4 moist); clay; fine weak angular blocky; friable when moist, slightly plastic and slightly sticky when wet; abundant thin clay cutans; few fine roots; very few to few small Mn concretions.

(lab. no. 4380)

LABORATORY DATA OF PROFILE DESCRIPTION No. 148/1-67

Observation no: 148/1-67 Mapping unit: RI_2 Soil classification: dystric NITOSOL

Laboratory no. /83	4377	4378	4379	4380		
Horizon	Ah_1	Ah_2	Bt_1	Bt_2		
Depth (cm)	0-25	25-45	45-120	120-150		
pH-H_2O (1:2.5 v/v)	6.4	6.6	6.2	6.0		
pH-KCl "	5.3	5.4	4.9	5.0		
EC (mmho/cm) "	0.09	0.08	0.06	0.05		
$CaCO_3$ (%)						
$CaSO_4$ (%)						
C (%)	2,61	1,43	0.74	0,40		
N (%)						
C/N						
CEC (me/100g), pH 8.2	34.0	27,9	17,5	16.5		
CEC " " pH 7.0						
Exch. Ca (me/100g)	8.2	6.3	6.7	4.2		
" Mg "	2.6	2.4	1.7	1.9		
" K "	2.15	0,96	0.31	0.23		
" Na "	tr	0.08	tr	0.08		
Sum of cations						
Base sat. %, pH 8.2	38	35	49	39		
" " %, pH 7.0						
ESP at pH 8.2						
Texture (limited pretreatment)						
Gravel % (>2.0mm)						
Sand % (2.0-0.05mm)	28	14	18	16		
Silt % (0.05-0.002mm)	26	26	16	10		
Clay % (0.002-0mm)	46	60	66	74		
Texture class	clay	clay	clay	clay		

Fertility aspects 0 - cm Laboratory no. /

General		Available nutrients			
pH-H_2O (1: v/v)		Na/me/100g)		Mn (me/100g)	
Exch. acidity (me/100g)		K "		P (ppm)	
C %		Ca "		P-Olsen (ppm)	
N %		Mg "			

Remarks:

Appendix 2

Analysis of Water From the Riara Ditch (For Irrigation Suitability)

Ref 22/6/83

Lab. No. /83	4367
pH	7.3
Conductivity micro mhos/cm	55
Sodium me /litre	0.28
Potassium me/litre	0.08
Calcium " "	0.06
Magnesium " "	0.10
Carbonates " "	NIL
Bicarbonates "	0.32
Chlorides " "	0.16
Sulphate " "	0.02
Nitrates " "	
Fluorides " "	
Sodium Adsorption Ratio	0.99

REMARKS

The water from the above source can be used on most crops and most soils. There is little likelihood of this water causing development of either a soil salinity of water penetration problem except on soils previously irrigated with poor quality water (Mr. P.G. Otieno, NAL).