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KENYA SOIL SURVEY

DETAILED SOIL SURVEY OF THE BEEF RESEARCH STATION LANET

(NAKURU DISTRICT)

by

W. N. Wamicha, M. M. Gatahi and D. N. Mungai

DETAILED SOIL SURVEY REPORT No.D15, 1981

Kenya Soil Survey
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1. INTRODUCTION

The report describes soil conditions of ~~a part of the Lanet~~ Beef Research Station. A detailed soil survey was carried out at the request of the Officer-in-Charge of the Station.

The area surveyed is about 98.5 hectares. The fieldwork was carried out within 14 non-consecutive days in months of September and October 1978. The topographical map at scale 1:5,000 of Wanyonyi et al (1968) was used as a basemap.

The authors greatly acknowledge the co-operation of the Officer-in-Charge and his staff. Acknowledgement is also given to the Project Manager and staff of the Kenya Sorghum and Millet Development Project (Lanet), for providing information on the cropping history of the area. Finally we thank the staff of the Soil Chemistry Section, National Agricultural Laboratories (NAL) for analysing the soil samples.

2. THE ENVIRONMENT

2.1. Location and Communication

The area is approximately bound by latitudes $0^{\circ}16'$ to $0^{\circ}17'$S and longitudes $36^{\circ}11'$E to $36^{\circ}12'$E. It is situated about 15km east of Nakuru town (see figure 1).

The farm is accessible by murram roads from the Nairobi-Nakuru and Nakuru-Nyahururu main roads. There are motorable tracks in the farm.

2.2. Geology and Physiography

The survey area is covered by Recent superficial deposits and volcanic soils (McCall, 1967). The superficial deposits are mainly pyroclastic in nature consisting mainly of tuff, ash and pumice, which are mixed with lacustrine sediments. Ash, tuff and pumice were encountered in all profile pits. A red sandstone mixed with tuffaceous material was encountered at depth in the mapping unit PP3 (see appendix 1 profile pit 119/3-5).

Underlying the Recent superficial deposits are Mbaruk basalts and Bahati tuffs. The basalts and tuffs outcrop further to the east of the survey area (van de Weg et al. 1976, Siderius and Muriuki, 1977).

In the southern part of the survey area are Volcanic Plains and a Floodplain with slopes between 0-2%.. The plains are covered by the soils of mapping units PP1, PP2, PP3 and the Floodplain by AAb. In the north are Uplands and a Minor Valley. The Uplands have slopes from 1 to 5% and are covered by the soils of mapping units UPb1 and UPb2. The Minor Valley has slopes from 0 to 5 % and is covered by the soils of mapping unit VVp.

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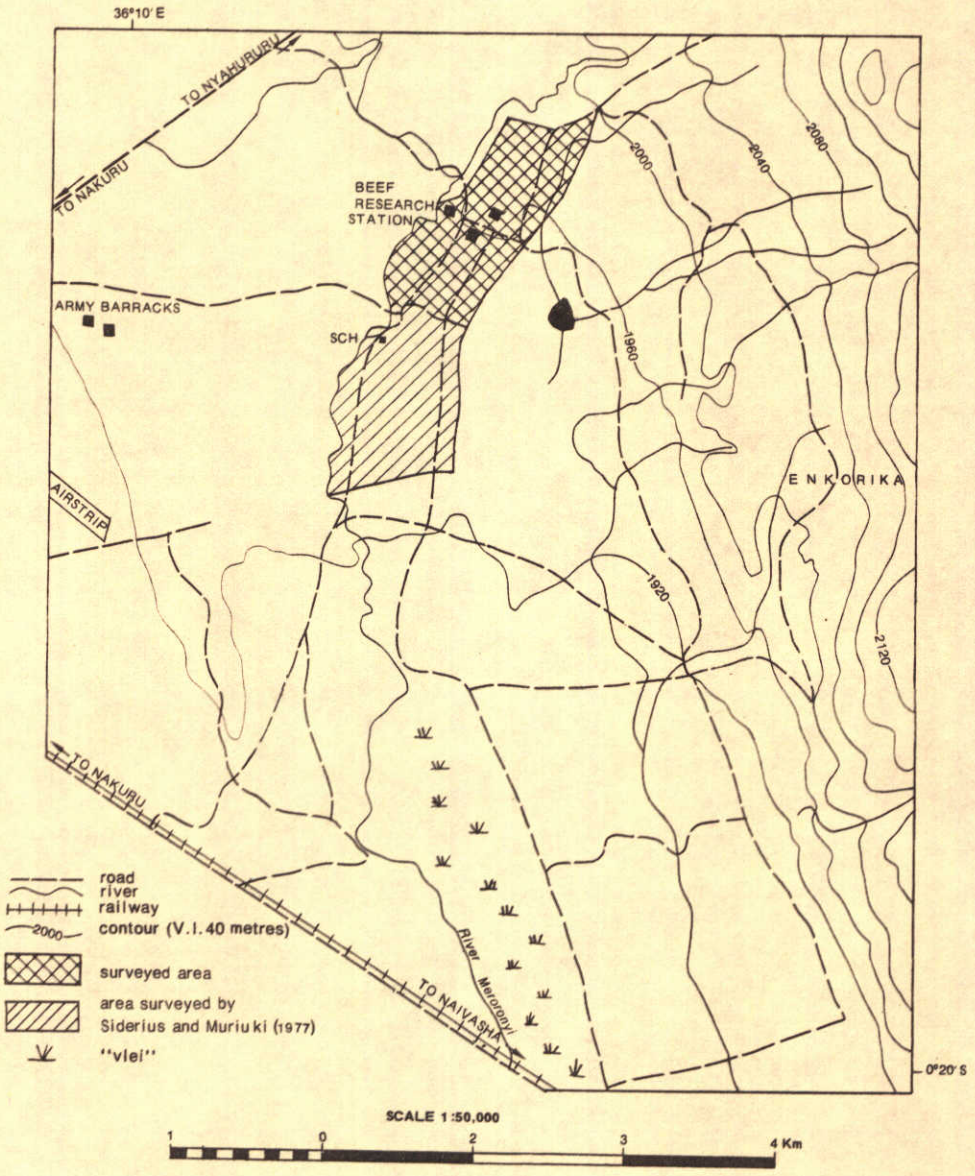
Fig. 1

LOCATION OF SURVEY AREA



Drawing No. 78068

2.3. Climate

In general, the area is divisible into two rainfall regions: the area to the east and north of the Bahati escarpment (above 2000m) has an average annual rainfall of more than 1000mm while the area to the south and west (lower altitude and in the rain shadow) has an average annual rainfall of less than 1000mm. In the survey area itself which is in the vicinity of the Bahati escarpment, the average annual rainfall is approximately 900-1000mm. The new Gakoe Farm Station (Top End Farm), has an average annual rainfall of 957mm (25 years' records, up to 1972), while Crumlin Station (90.36095) and Lanet Police Post (90.36236) have 985mm and 909mm of average annual rainfall respectively. The Beef Research Station and field 2*(ADC) recorded 943mm and 887mm respectively of average annual rainfall in the four years between 1974 and 1977.

The rainfall distribution in the year is concentrated in the period between April and November but with a peak in April- May and minor ones in August and November. The driest period is between December and March (see table 1).

The (computed) mean monthly and annual temperatures for the area are shown in table 2, together with the average of 2 years measured at Beef Research Station for comparison. There are no great seasonal temperature variations but it is quite clear that the period September-March has higher temperatures compared to the April-August period.

The mean annual potential evaporation (E_o) is 1720mm (Woodhead, 1968). The monthly potential evaporation is substantially higher in the period from December to March, than during the rest of the year. For the greatest part of the year, rainfall is less than the estimated crop-water requirement (2/3Eo). Only in April-May, August and November does rainfall exceed 2/3Eo. The probabilities that rainfall in the April-August, September-March and January-March periods is less than 2/3Eo (the estimated crop-water requirement during the growing seasons) are 29%, 97% and 100% respectively (see table 3). There is a mean positive moisture balance of 113mm from April to August and 74mm from April to December. Whether or not the surplus (rain) water can be stored in the soil for sustained crop growth depends on the depth and moisture-holding characteristics of the soil.

The r/Eo ratio (where r is average annual rainfall and Eo is average annual potential evaporation) of 56% puts the area in climatic zone III which is an area of medium high potential according to the "Proposed boundary criteria of Agroclimatological zones" (Braun, 1977).

*ADC - The Agricultural Development Corporation farm at Lanet

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TABLE 1 Climatic Data of Lanet Beef Research Station

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Rainfall	27	25	50	160	122	79	83	105	90	79	90	47	957
E_o	172	189	189	120	120	138	138	138	138	138	103	138	1721
Et	115	126	126	80	92	92	92	92	92	92	69	92	1160
$r-E_t$	-88	-101	-76	80	30	-13	-9	13	-2	-13	21	-45	-203

Notes:

1. Source of rainfall data E.A. Met. Dept. (1974)
2. Potential evaporation was estimated using Woodhead's equation, E_o-2422 - 0.358h, where E_o=annual potential evaporation of open water in mm and h is altitude in metres.
3. The monthly distribution of E_o was estimated from the measured pan evaporation of Lanet Airfield in EAMD (1975).
4. Potential evapotranspiration (E_t) was estimated to be $2/3E_o$.

TABLE 2 Temperature data of Beef Research Station area (°C)

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
measured	18.0	18.7	19.5	18.9	18.1	17.2	16.7	16.8	17.5	18.2	18.1	18.1	18.1
computed	17.9	18.5	18.8	18.3	17.5	16.6	16.1	16.2	16.9	17.6	17.6	17.4	17.5

The temperature data was computed using altitude-related equations in E.A. Met. Dept. (1970). Measured temperature data (2 years) at the station are included for comparison.

TABLE 3 Seasonal rainfall and potential evaporation

Season	Rainfall	$2/3E_o$ (or Et)	Pr (less) $2/3E_o$
April-August	549mm	448mm	29%
September-March	400mm	700mm	97%
January-March	102mm	332mm	100%

Notes:

1. Potential evapotranspiration (Et) was estimated as in table 1.
2. The probability that the rainfall is less than the estimated crop-water requirement, i.e. P(r 2/3Eo) was estimated using Braun's (1977) tables.

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3. SURVEY METHODS

The topographical map of Wanyonyi (loc. cit.) at scale 1:5,000 was used as a base map on which observations were also plotted. Auger holes to a depth of about 150cm were made following a grid system of about 100 metres square. In some parts, additional observations were made to check the soil boundaries.

The soil characteristics examined include depth, colour, texture, consistence and drainage. Soil information and site characteristics for each observation were recorded on standard Kenya Soil Survey auger hole description sheets. Representative sites were then selected in each of the mapping units and profile pits dug. The profile pits were described and sampled for physical and chemical analysis at N.A.L. Composite soil samples were taken near each representative profile pit for fertility analysis.

4. THE SOILS

4.1. Systematics and nomenclature

Each mapping unit has a symbol consisting mainly of three letters. The first letter denotes physiography, the second lithology (geology) and the third a soil characteristic. The code used is as follows:

Physiography

U - Uplands (slopes 1-5%)

P - Plains (slopes (0-2%)

A - Floodplains (slopes 0-2%)

V - Minor Valleys (slopes 0-5%)

Lithology (geology) - parent material

P - Soils developed on Pyroclastic rocks

A - Soils developed on Alluvial deposits

V - Soils developed on various volcanic rocks

Soils characteristics

b - brown colour

p - moderately deep soil (50 - 80cm)

Numerical figures e.g. 1, 2 and 3 are used further to subdivide the soils in the same physiography - geology mapping unit, for example PP1, PP2 and PP3. The slope class is also given under the mapping symbol. The slope classes used are as follows:-

A - slope between 0-2%

B - slope between 2-5%

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The depth classes used are:

Very shallow	0-25cm
Shallow	25-50cm
Moderately deep	50-80cm
Deep	80-120cm
Very deep	more than 120cm

4.2. General properties of the soils

The soils in the survey area can be divided into four groups:

- well drained soils of the Uplands
- well drained soils of the Volcanic Plains
- poorly drained soils of the Floodplains
- poorly drained soils of the Minor Vallyes

Mapping units UPb1 and UPb2 consist of the soils of the Uplands. These soils are well drained and have clay texture with friable moist consistence. The structure is in general moderate subangular to angular blocks and the fertility is high (see 4.4.2).

Mapping units PP1, PP2 and PP3 comprise of the soils of the volcanic plains. These soils are similar to the Lanet Series of Siderius and Muriuki (loc.cit). They are well drained and have gravelly sandy clay texture. The moist consistence is in general friable and the structure weak to moderate, subangular blocky while the fertility is moderate. The mapping units PP1, PP2 and PP3 have been differentiated largely on the basis of the depth at which the gravelly texture starts.

Mapping unit AAb consists of the soils of the Flood Plains. These soils are poorly drained and have a silty clay texture with friable moist consistence. The structure is weak to moderate subangular to angular blocky while the fertility is moderate.

The mapping unit VVP consists of the soils of the Minor Valleys. These soils are poorly to very poorly drained with gravelly clay to clay texture and friable moist consistence. The structure is weak to moderate subangular, blocky, while the fertility is moderate.

4.3. Description of the soil mapping units

4.3.1. Soils of the Uplands

The soils are developed on pyroclastic rocks (mainly tuff). The macro relief is gently undulating (slope, 2-5%).

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Mapping unit UPb1 Extent 15.4 ha

These soils are well drained, very deep, dark reddish brown to dark brown, friable silt clay to clay, with 20-30cm very dark greyish brown to dark brown, silty clay topsoil.

Range of soil characteristics

The depth of the soils up to the tuff is generally over 120cm. The topsoil has moderate granular structure and the subsoil has moderate angular blocky structure. The texture of the topsoil ranges from silty clay to clay, while that of the subsoil ranges from gravelly clay loam to clay. The colour of the topsoil varies from dark brown (7.5YR 3/2*) to very dark greyish brown, (10YR 3/2). While colour of the subsoil ranges from dark reddish brown (5YR 3/3) to very dark greyish brown (10YR 3/2). Both the topsoil and subsoil are friable when moist. The pH-H_2O (1:2½ suspension) ranges from 5.2 in the topsoil to 6.6 in the subsoil. The pH-KCl (1:2½ suspension) ranges from 4.5 in the topsoil to 5.2 in the subsoil. The cation exchange capacity (CEC) are high (more than 16 m.e /100g soil) except for the burried horizon. The base saturation is high (over 50%) for all horizons, it is over 100% in the burried horizon. The exchangeable sodium percentage (ESP) is low (less than 6%) in the topsoil and less than 15% in the subsoil.

Additional remarks

Soils of this unit have burried B horizons (Bb), which are recognised due to difference in the type of gravels. The area was cultivated during the time of survey and was under rainfed maize and sorghum. This unit is affected by soil erosion and shallow rills could be seen. For a description of a representative profile pit and analytical data see Appendix 1 profile No. 119/3-69.

Mapping unit UPb2

These soils are well drained, very deep, dark reddish brown to dark brown, friable clay.

Range of soil characteristics

The depth of the soils up to the tuff is in general over 130cm. The structure of the topsoil is moderate crumb when that of the subsoil is weak subangular blocky. The texture of the topsoil varies from clay loam to clay,

*Unless otherwise indicated colour given is in the moist state and is according to the Munsell colour charts

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whereas that of the subsoil varies from gravelly clay to clay. The colour of the topsoil ranges from dark reddish brown (5YR 3/2) to brown (7.5YR 5/4) The topsoil and subsoil are friable when moist.

The pH-H_2O (1:2½ suspension) ranges from 5.3 in the topsoil to 6.9 in the subsoil. The pH-KCl (1:2½ suspension) ranges from 4.9 in the topsoil to 6.0 in the subsoil. The cation exchange capacity is generally high (over 16 m.e/ 100g soil) in the topsoil and subsoil. The base saturation is also high (over 50%) both in the topsoil and in the subsoil. Exchangeable sodium percentage (ESP) is low (less than 6%) both in the topsoil and subsoil.

Additional remarks

In places, where there are steep slopes (slope class B) the soils are susceptible to erosion. Shallow rills could be seen in these areas. During the time of survey most of the unit was under maize and sorghum while some parts were under grass. For the description of representative profile pits and analytical data see Appendix 1 Nos. 119/3-70 and 119/3-73.

4.3.2. Soils of the Volcanic Plains

The soils are developed on tuffs that were partly waterlaid (partly lacustrine in origin). The macrorelief is flat to very gently undulating (slopes, 0-2%).

Mapping unit PP1 Extent: 36.6 ha

These soils are well drained, deep to very deep, dark brown, friable, gravelly clay, with 20-30cm sandy clay loam topsoil.

Range of soil characteristics

The depth of the soils to the tuff is in general over 80cm. The structure of the topsoil is strong subangular blocky while the subsoil has mainly moderate subangular blocky structure. The texture of the topsoil ranges from gravelly sandy clay to clay. The colour of the topsoil and the subsoil varies from dark brown (7.5YR 3/2) to very dark greyish brown (10YR 3/2). Both the topsoil and the subsoil are friable when moist.
The pH-H_2O (1:2½ suspension) ranges from 5.8 in the topsoil to 6.4 in the subsoil. The pH-KCl (1:2½ suspension) ranges from 5.2 in the topsoil to 5.6 in the subsoil. The cation exchange capacity is generally high (over 16 m.e./100g soil). The base saturation is also over 50% in both the topsoil and the subsoil. The exchangeable sodium percentage is low (less than 6%).

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Additional remarks

The soils of the Volcanic Plains are similar to the Lanet Series of Siderius and Muriuki (loc.cit.). In unit PP1, gravelly texture commences below 50cm depth. For the description of a representative profile and analytical data see Appendix 1 profile No. 119/3-71.

Mapping unit PP2 Extent: 3.6ha

These soils are similar to those of the mapping unit PP1 except that they have gravelly texture starting between 25-50cm. For the description of a representative profile pit and analytical data see Appendix 1 profile No. 119/3-76.

Mapping unit PP3 Extent: 2.0 ha

These soils are generally similar to those of mapping units PP1 and PP2, except that they have gravelly texture starting between 0-25cm. For the description of a representative profile pit and analytical data see Appendix 1 profile No. 119/3-75.

4.3.3. Soils of the Flood plains

The soils have developed on alluvial deposits of River Meroronyi (see fig. 1). The macrorelief of the Floodplain is flat to very gently undulating (slopes from 0 to 2%).

Mapping unit AAb Extent: 7.3ha

These soils are poorly drained, deep to very deep, dark reddish brown, mottled, friable silty clay, with 25-35cm dark brown topsoil.

Range of soil characteristics

The depth of the soil to the river alluvial deposits is in general over 80cm. The structure of the topsoil is moderate subangular blocky and the subsoil has strong angular blocky structure. The texture of the topsoil ranges from clay loam to silt clay while that of subsoil ranges from clay to silty clay. The colour of the topsoil and subsoil ranges from dark reddish brown (5YR 3/4) to dark brown (7.5YR 3/4).
Both the topsoil and the subsoil are friable to firm when moist. The pH-H_2O (1:2½ suspension) ranges from 6.0 in the topsoil to 7.3 in the B-horizon and 5.4 in the BC-horizon. The pH-KCl (1:2½ suspension) ranges from 5.1 in the topsoil to 5.9 in the B-horizon and 4.1 in the BC-horizon.

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The cation exchange capacity (CEC) is high (more than 16 m.e./100g soil) both in the topsoil and in the subsoil. The base saturation is also high (more than 50%) both in the topsoil and in the subsoil. The exchangeable sodium percentage (ESP) is less than 15% in both the topsoil and the subsoil.

Additional remarks

From the augerhole observations some places near the River Meroronyi have stratified alluvial land. During the time of survey the unit was under grass and was being used for grazing. For the description of a representative profile pit and analytical data see Appendix 1 profile No. 119/3-72.

4.3.4. Soils of the Minor Valleys

The soils have developed on colluvial-alluvial deposits delivered from various volcanic rocks. The macrorelief is flat to gently undulating (slopes from 0-5%).

Mapping unit VVp

The soils of this unit are poorly drained to very poorly drained, moderately deep, very dark greyish brown to dark brown, mottled, friable, gravelly clay, 20-30cm clay topsoil.

Range of soil characteristics

The depth of the soil to the parent material is in general between 70-95cm. The topsoil has moderate crumb structure and the subsoil has weak subangular blocky structure. The texture of the topsoil ranges from clay loam to clay, whereas that of the subsoil ranges from gravelly sandy clay loam to clay. The colour of the topsoil and the subsoil varies from dark brown (7.5 YR 3/2) to very dark greyish brown (10YR 3/2). The topsoil is friable to very dark greyish brown (10YR 3/2). The topsoil is friable to firm when moist while the subsoil is friable.
The pH-H_2O (1:2½ suspension) ranges from 5.4 in the topsoil to 5.2 in the B-horizon and 6.0 in the BC-horizon. The pH-KCl (1:2½ suspension) ranges from 5.1 in the topsoil to 4.7 in the B-horizon and 5.2 in the BC-horizon. The cation exchange capacity (CEC) is high (over 16 m.e/100g soil) in the topsoil and the subsoil. The base saturation is also high (over 50%) in both the topsoil and the subsoil. The exchangeable sodium percentage (ESP) is low (less than 6%) in both the topsoil and the subsoil.

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Additional remarks

This unit has old termite mounds which have deeper soils. The unit was under unimproved pastures at the time of survey. For the description of a representative profile pit and analytical data see Appendix 1 profile No. 119/3-74.

TABLE 4 MEHLICH ANALYSIS - CHEMICAL RESULTS

Field designation 119/3-	-69	-70	-71	-72	-73	-74	-75	-76
Mapping unit	UPb1	UPb2	PP1	AAb	UPb2	VVp	PP3	PP2
Lab No./78	11637	11638	11639	11640	11641	11642	11643	11644
Composite topsoil sample-depth cm	0-30	0-30	0-30	0-30	0-30	0-30	0-30	0-30
Na (m.e./100g)	0.06	0.12	0.06	0.46	0.09	0.10	0.4	0.02
K "	1.48	1.54	1.32	2.15	1.34	0.78	0.90	0.53
Ca "	4.20	11.80	4.80	5.60	4.80	7.20	5.20	2.20
Mg "	2.20	3.20	2.00	4.00	2.50	3.00	2.20	1.40
Mn "	1.80	1.14	1.66	2.00	2.40	1.60	0.82	1.52
P (ppm)	9.00	242.0	54.0	12.00	10.00	6.00	8.00	14.00
N %	0.23	0.21	0.22	0.25	0.20	0.24	0.19	1.45
C %	2.66	2.55	2.68	2.59	2.14	2.62	1.92	1.45
Hp (m.e./100g)	0.10	-	0.10	-	0.10	-	-	0.10

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LAND EVALUATION ASPECTS

5.1. Present land use

From 1974, most of the survey area was being used for experimental plots by the Kenya Sorghum and Millet Development Project. The soil mapping units PP1, PP2, PP3 and the southern part of mapping unit UPb2 were cultivated in 1974 and since then, have been under maize and sorghum in rotation. From 1977 to the time of survey, improved pastures were planted in some parts of mapping units PP1, PP2, PP3 and UPb2. Urea, CAN and compound fertilizers were applied in the experimental plots (Project Manager, personal communication).

A larger part of mapping units UPb1 and UPb2 was cultivated in 1977 and up to the time of the survey, the units were under maize and sorghum. In these units, only Urea was being used as a fertilizer. The remaining part of units UPb1 and UPb2 was still under grass.

Soil mapping units AAb and VVb had not been cultivated. Unit AAb was under grass and was being used for rearing of calves. Unit VVp has poor pastures, but according to the Officer-in-Charge, there was a plan to improve the pastures.

5.2. Soil fertility status

The appraisal of the soil fertility has been based on chemical data derived from composite samples, (see Table 4). The appraisal gives the general tendencies only. For most crops, nutrients are rated as adequate if in the following amounts:

Nitrogen (N)	0.2%
Phosphorus (P)	30 p.p.m
Calcium (Ca)	30 m.e per 100g
Magnesium (Mg)	1.0 per 100g
Potassium (K)	0.2 m.eper 100g

In general the soils have moderate to high organic matter content (organic carbon of 1.4% to 2.68%. The Nitrogen content is more than 0.2% in most of the soils, apart from soils of mapping units PP2 and PP3. Available phosphorous is more than 30 ppm for soils of units UPb2 and PP2 only. The available Calcium is more than 3.0 m.e.%, Magnesium (Mg more than 1.9m.e%) and Potassium (K more than 0.2m.e.%) are adequate in all the soils. Generally the soils have high cation exchange capacity (CEC more than 16 m.e/100g soil) and high base saturation (more than 50%).

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Using the above rating application of ~~Nitrogen~~ fertilizer is necessary for mapping units PP2 and PP3. Fertilizers containing phosphorous are necessary for all mapping units except units UPb2 and PP2. Application of manures is necessary for all mapping units to maintain high organic matter content.

5.3. Land suitability

For the quantitative land suitability classification of the survey area, the following land utilization types have been taken into account:-

- rainfed maize for silage production, advanced technology*,
- rainfed sorghum for silage production, advanced technology,
- grazing (improved pastures)

For the suitability classification, the following factors which could act as limitations have been taken into account:-

- soils
- topography (erosion hazard)
- drainage

(i) Soils

The soil characteristics that may be limiting are:-

(a) Soil fertility

(b) Soil structure, texture and consistence

(a) Soil fertility

This mainly concerns whether the nutrients in the soil are in sufficient quantities which are available for plant growth. Deficiency may be corrected by the use of fertilizers.

(b) Soil structure, texture and consistence

These affect mainly the behaviour of soils under different management practices. Soils with low structure stability may erode very easily. Soils with gravelly texture may be difficult to work. Soils which are hard when dry, firm when moist and sticky and plastic when wet have poor workability.

(ii) Topography and erosion hazard

Soils of mapping units UPb1 and UPb2 are susceptible to erosion especially where the slopes are steep (slope class B). For the management of these soils, precautions against soil erosion should be considered.

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* 'advanced technology takes into account the use of fertilizers, improved seeds and good husbandry.

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(iii) Drainage

This is assessed using the depth and colour of mottling and also waterlogging of the soil. If there is excess water in the soil profile, the soil becomes waterlogged and/or flooded. Waterlogging leads to poor aeration in the soil. Different crops respond differently to waterlogged conditions, for example, sorghum may withstand waterlogged conditions better than maize (Project Manager, personal comm.).

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TABLE 5 Land suitability classification

Mapping unit	Limitation	Suitability classification		
		maize	sorghum	grazing
UPb1	soil fertility, slight erosion hazard	moderately suitable	moderately suitable	highly suitable
UPb2	soil fertility, slight erosion hazard	suitable	suitable	highly suitable
PP1	soil fertility	highly suitable	highly suitable	highly suitable
PP2	soil fertility	highly suitable	highly suitable	highly suitable
PP3	soil fertility, gravelly soil texture (poor workability)	moderately suitable	moderately suitable	highly suitable
AAb	soil fertility, soil structure and consistence, drainage (workability poor aeration)	marginally suitable	marginally suitable	moderately suitable
VVp	soil fertility, soil structure and consistence (workability), drainage (poor aeration)	unsuitable	unsuitable	marginally suitable

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5.4. Conclusions and Recommendations

1. All soil mapping units except unit AAb and unit VVp have favourable structure and consistence for workability.
2. Soil mapping units PP3 and PP2 have gravel starting at 0-25cm and 25-50cm respectively. The occurrence of gravel is not considered a major limitation except in unit PP3 where the use of hand farming tools may be hampered.
3. In places where there is slope class B in units UPb1 and UPb2, erosion may occur. Measures should be taken to prevent it; such measures include:-
   (a) contour ploughing and planting of grass strips along the contours
   (b) the farm machinery should move along rather than across the contours
4. Soil mapping units AAb and VVp are poorly drained. For the development of unit VVp, drainage has to be done by either opening up the natural drainage way or by planting of highly transpiring vegetation e.g. eucalyptus trees.
5. All soil mapping units show various nutrient deficiencies. Therefore fertilizers should be used for optimum growth of plants.
6. Supplementary irrigation may be necessary during the October-December growing season.

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APPENDIX 1

Detailed descriptions of representative soil profile pits, with analytical data.

LABORATORY DATA OF PROFILE DESCRIPTION No:

FIELD OBSERVATION No: MAPPING UNIT:

Laboratory no. ...../78	11637	11638	11639	11640	11641	
Horizon	A	B	C	D	E	
Depth (cm)	0-25	25-47	47-79	79-105	105-150	
pH-H_2O (1: 2½ v/v)	5.2	4.7	5.6	6.6	7.8	
pH-KCl ,,	4.5	4.0	4.4	5.2	6.3	
EC (mmho/cm) ,,	0.13	0.10	0.12	0.19	0.19	
$CaCO_3$ (%)						
$CaSO_4$ (%)						
C (%)	2.42	0.80	0.54	0.43	0.11	
N (%)						
C/N						
CEC (me/100g), pH 8.2	17.2	23.0	23.4	23.8	11.4	
CEC ,, ,, pH 7.0						
Exch.Ca (me/100g)	6.80	6.3	10.15	12.75	7.93	
,, Mg ,,	1.78	2.08	3.39	3.45	1.15	
,, K ,,	2.83	1.91	1.91	3.98	3.43	
,, Na ,,	0.08	0.10	1.06	2.16	1.63	
Sum of cations	11.5	10.4	16.5	22.3	14.1	
Base sat. %, pH 8.2	70	50	70	94	100+	
,, ,, %, pH 7.0						
ESP at pH 8.2	-	-	5	9	14	
Saturation extract:						
Moisture %						
pH-paste						
ECe (mmho/cm)						
Na (me/l)						
K ,,						
Ca ,,						
Mg ,,						
Sum of cations (me/l)						
CO_3 (me/l)						
HCO_3 ,,						
Cl ,,						
SO_4 ,,						
Sum of anions (me/l)						
Adj. SAR						
Clay mineralogy:						
SiO_2/Al_2O_3 (mol/mol)						
SiO_2/R_2O_3 ,,						
Fe_2O_3 (mmol%)						
X-ray report:						

SOIL CLASSIFICATION:

Depth (cm)	0-25	25-47	47-79	79-105	105-150	
Gravel %						
Texture, limited pretreatment:						
Sand % 2.0 - 0.05 mm	48	42	36	42	62	
Silt % 0.05-0.002mm	22	18	20	24	26	
Clay % 0.002-0 mm	30	40	44	34	12	
Texture class	SCL	SC	C	CL	SL	
Dispersed clay %						
Flocculation index						
Texture USDA:						
Sand % 2.0 - 1.0mm						
,, ,, 1.0 - 0.50mm						
,, ,, 0.50 - 0.25mm						
,, ,, 0.25 - 0.10mm						
,, ,, 0.10 - 0.05mm						
Total sand %						
Silt %						
Clay %						
Texture class						
Bulk density						
Moisture % w/v at:						
pF 0						
pF 2.0						
pF 2.3						
pF 2.7						
pF 3.0						
pF 3.7						
pF 4.2						

Fertility aspects: (0- cm) Laboratory no. /

Ca (me/100g)	Available	Total
Mg ,,		
K ,,		
P (ppm)		
Mn (me/100g)		
Exch. acidity (me/100g)		
pH-H_2O (1: v/v)		
C%		
N%		

Kenya Soil
Drawing

Profile No. 149/1-69

Mapping unit	:	UPb1
Soil classification	:	haplic Phaeozem
Ecological zone	:	III
Observation	:	119/3-69, Nakuru, 24/10/78
Parent material	:	Tuff
Physiography	:	Upland
Relief, macro	:	Gently undulating
" , meso	:	Nil
" , micro	:	Plough ridges
Land use	:	Cultivation (sorghum) and grazing
Erosion	:	Slight, shallow rills
Surface stoniness /rockiness	:	Nil
Flooding	:	Nil
Groundwater level	:	Deep
Slope gradient/position on slope	:	4%, middle
Salinity/sodicity	:	Slightly sodic
Surface cracking	:	Nil
Drainage class	:	Well drained

Ap 0-25cm — Very dark greyish brown (10 YR 4/3 dry, 10YR 3/2 moist); sandy clay loam; moderate, medium, granular structure; slightly hard when dry, friable when moist, sticky and plastic when wet; few, very fine pores; many, very fine, few, fine roots; pH 5.2; clear and wavy boundary to:

(sample no. 119/3-69a)

Bu1 25-47cm — Dark reddish brown (5YR 3/4 moist); sandy clay; moderate, medium to coarse, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; few, fine pores; common, very fine roots; few feldspars; pH 4.7; clear and wavy boundary to:

(sample no. 119/3-69b)

Bu2 47-79cm — Dark reddish brown (5YR 3 /2 moist); clay; strong, medium to coarse, augnlar blocky structure; slightly hard when dry, friable when moist, sticky and plastic

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When wet; few, fine pores; common very fine to fine roots; many feldspars; pH 5.6; diffuse and wavy boundary to:

(sample no. 119/3-69c)

BC	79-105cm	Dark reddish brown (5YR 3/2 moist); gravelly clay loam; weak, medium to coarse, angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few, fine pores; few, very fine roots; many feldspars; pH 6.6; clear and wavy boundary to: (sample no. 119/3-69d)
Bb	105-150+cm	Dark brown (10YR 3/3 moist); gravelly sandy loam; massive breaking to single grains; slightly hard when dry, friable when moist, non-sticky and non-plastic when wet, few, very fine roots; pH 7.8; (sample no. 119/3-69e)

Bb has different gravels from those of BC which indicate different materials. Also the analytical data shows sharp differences.

LABORATORY DATA OF PROFILE DESCRIPTION No:

FIELD OBSERVATION No: **MAPPING UNIT:**

Laboratory no...../78	11642	11643	11644	11645	11646	
Horizon	A	B	C	D	E	
Depth (cm)	0-22	22-41	41-79	79-120	120-150	
pH-H_2O(1: 2½v/v)	5.8	5.9	6.1	6.6	6.9	
pH-KCl "	5.1	5.2	5.5	5.7	6.0	
EC(mmho/cm) "	0.13	0.11	0.20	0.12	0.15	
$CaCO_3$(%)						
$CaSO_4$(%)						
C (%)	2.62	1.42	1.00	0.74	0.63	
N (%)						
C/N						
CEC (me/100g), pH 8.2	23.0	23.8	23.0	24.3	23.5	
CEC " " pH 7.0						
Exch.Ca (me/100g)	12.5	12.75	14.0	16.05	16.40	
" Mg "	2.26	2.88	2.73	2.58	3.18	
" K "	3.33	1.97	2.63	3.68	4.53	
" Na "	0.16	0.08	0.29	0.20	0.37	
Sum of cations	17.8	17.7	19.7	22.5	24.5	
Base sat. %, pH 8.2	77	74	85	93	100+	
" " %, pH 7.0						
ESP at pH 8.2	1	-	1	1	2	
Saturation extract:						
Moisture %						
pH-paste						
ECe (mmho/cm)						
Na(me/l)						
K "						
Ca "						
Mg "						
Sum of cations(me/l)						
CO_3(me/l)						
HCO_3 "						
Cl "						
SO_4 "						
Sum of anions(me/l)						
Adj. SAR						
Clay mineralogy:						
SiO_2/Al_2O_3(mol/mol)						
SiO_2/R_2O_3 "						
Fe_2O_3(mmol%)						
X-ray report:						

SOIL CLASSIFICATION:

Depth (cm)	0-22	22-41	41-79	79-120	120-150	
Gravel %						
Texture, limited pretreatment:						
Sand % 2.0 - 0.05 mm	40	36	38	38	34	
Silt % 0.05-0.002mm	28	24	24	24	30	
Clay % 0.002-0 mm	32	40	38	38	36	
Texture class	CL	CL/C	CL	CL	CL	
Dispersed clay %						
Flocculation index						
Texture USDA:						
Sand % 2.0 - 1.0mm						
" " 1.0 - 0.50mm						
" " 0.50 - 0.25mm						
" " 0.25 - 0.10mm						
" " 0.10 - 0.05mm						
Total sand %						
Silt %						
Clay %						
Texture class						
Bulk density						
Moisture % w/v at:						
pF 0						
pF 2.0						
pF 2.3						
pF 2.7						
pF 3.0						
pF 3.7						
pF 4.2						

Fertility aspects: (0- cm) Laboratory no. /

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

Kenya Soil Su
Drawing No.

Profile No. 119/3-70

Mapping unit	:	UPb2
Soil classification	:	haplic Phaeozem
Ecological zone	:	III
Observation	:	119/3-70, Nakuru, 24/10/78
Parent material	:	Tuff
Physiography	:	Upland
Relief, macro	:	Gently undulating
" , meso	:	Nil
" , micro	:	Plough ridges
Land use	:	Cultivation (maize and sorghum) and grazing
Erosion	:	Slight, sheet
Surface stoniness /rockiness	:	Nil
Flooding	:	Nil
Groundwater level	:	Deep
Slope gradient/position on slope	:	3½%, top
Salinity/sodicity	:	Nil
Surface cracking	:	Nil
Drainahe class	:	Well drained

Ap	0-22cm	Very dark grey (7.5YR 5/2 dry, 10YR 3/1 moist); clay loam; medium, crumb structure; slightly hard when dry, friable when moist, sticky and plastic when wet; few, medium pores; common fine, few coarse roots; few feldspars; pH 5.8; clear and smooth boundary to: (sample no. 119/3-70a)
AB	22-41cm	Very dark grey (10YR 3/1 moist); clay; weak, medium, subangular blocky, slightly hard when dry, friable when moist, sticky and plastic when wet; few, medium pores; common fine, few coarse roots; few feldspars; pH 5.9; clear and smooth boundary to: (sample no. 119/3-70b)
Bul	41-79cm	Dark brown (7.5YR 3/2 moist); clay loam; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many, fine pores; common, very fine to fine roots; few feldspars; pH 6.1; gradual and

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smooth boundary to:

(sample no. 119/3-70c)

Bu2	79-120 cm	Dark brown (7.5YR 4/4 moist); clay loam; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many, fine pores; few very fine roots; few feldspars, pH 6.6; clear and swavy boundary to: (sample no. 119/3-70d)
BC	120-150+ cm	Strong brown (7.5YR 5/6 moist); gravelly clay loam; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, non-sticky and non-plastic when wet; few, very fine pores; few fine roots; pH 6.9; (sample no. 119/3-70e)

LABORATORY DATA OF PROFILE DESCRIPTION No:

FIELD OBSERVATION No: MAPPING UNIT:

Laboratory no. ...../78	11647	11648	11649	11650		
Horizon	A	B	C	D		
Depth (cm)	0-24	24-51	51-94	94-135		
pH-H_2O (1:2½ v/v)	5.8	5.8	5.9	6.4		
pH-KCl "	5.2	5.1	5.1	5.6		
EC (mmho/cm) "	0.11	0.12	0.14	0.13		
$CaCO_3$ (%)						
$CaSO_4$ (%)						
C (%)	2.16	0.97	0.78	0.48		
N (%)						
C/N						
CEC (me/100g), pH 8.2	14.6	19.2	19.2	15.0		
CEC " " pH 7.0						
Exch. Ca (me/100g)	7.42	9.10	10.87	10.05		
" Mg "	1.46	1.08	2.26	1.87		
" K "	2.83	1.68	1.35	3.03		
" Na "	Trace	0.10	0.20	0.10		
Sum of cations	11.7	13.0	14.7	15.0		
Base sat. %, pH 8.2	80	68	76	100		
" " %, pH 7.0						
ESP at pH 8.2	-	-	1	1		
Saturation extract:						
Moisture %						
pH-paste						
ECe (mmho/cm)						
Na (me/l)						
K "						
Ca "						
Mg "						
Sum of cations (me/l)						
CO_3 (me/l)						
HCO_3 "						
Cl "						
SO_4 "						
Sum of anions (me/l)						
Adj. SAR						
Clay mineralogy:						
SiO_2/Al_2O_3 (mol/mol)						
SiO_2/R_2O_3 "						
Fe_2O_3 (mmol%)						
X-ray report:						

SOIL CLASSIFICATION:

Depth (cm)	0-24	24-51	51-94	94-135		
Gravel %						
Texture, limited pretreatment:						
Sand % 2.0 - 0.05 mm	62	54	48	68		
Silt % 0.05-0.002mm	18	14	16	10		
Clay % 0.002-0 mm	20	32	36	22		
Texture class	SCL	SCL	SC	SCL		
Dispersed clay %						
Flocculation index						
Texture USDA:						
Sand % 2.0 - 1.0mm						
" " 1.0 - 0.50mm						
" " 0.50 - 0.25 mm						
" " 0.25 - 0.10mm						
" " 0.10 - 0.05mm						
Total sand %						
Silt %						
Clay %						
Texture class						
Bulk density						
Moisture % w/v at:						
pF 0						
pF 2.0						
pF 2.3						
pF 2.7						
pF 3.0						
pF 3.7						
pF 4.2						

Fertility aspects: (0- cm) Laboratory no. /

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

Profile no. 119/3-71

Mapping unit	: PPl
Soil classification	: haplic Phaeozem
Ecological zone	: III
Observation	: 119/3-71, Nakuru, 25/10/78
Parent material	: Tuff
Physiography	: Plain
Relief, macro	: Flat to very gently undulating
" , meso	: Nil
" , micro	: Plough ridges
Land use	: Cultivation and grazing
Erosion	: Nil
Surface stoniness/rockiness	: Nil
Flooding	: Nil
Ground water level	: Deep
Slope gradient/position on slope	: 1%, middle
Salinity/sodicity	: Nil
Surface cracking	: Nil
Drainage class	: Well drained

Ap	0-24cm	Very dark greyish brown (10YR 4/3 dry, 10YR 3/2 moist); sandy clay; strong, coarse, subangular blocky, with moderate, medium to coarse, crumb structure; slightly hard when dry, friable when moist, sticky and plastic when wet; common, fine pores; common fine roots; few feldspars; pH 5.8; gradual and smooth boundary to: (sample no. 119/3-71a)
Bu_1	24-51cm	Dark brown (7.5YR 3/2 moist); sandy clay loam; weak, fine to coarse, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; common very fine, many fine roots; few feldspars; pH 5.8; gradual and smooth boundary to: (sample no. 119/3-71b)
Bu_2	51-94cm	Dark brown (7.5YR 3/2 moist); sandy clay; moderate, medium to coarse, subangular blocky structure;

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slightly hard when dry, friable when moist, sticky and plastic when wet; many, very fine to fine pores; common very fine to fine, few, coarse roots; few quartz, few feldspars; pH 5.9; abrupt and wavy boundary to:

(sample no. 119/3-71c)

BC 94-135+ cm Dark reddish brown (5YR 3/4 moist); gravelly sandy loam massive breaking to single grains; slightly hard when dry, friable when moist, non-sticky and non-plastic when wet; common very fine to fine pores; few very fine roots; pH 6.4;

(sample no. 119/3-71d)

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LABORATORY DATA OF PROFILE DESCRIPTION No:

FIELD OBSERVATION No: **MAPPING UNIT:**

Laboratory no. ...../78	11651	11652	11653	11654	11655	
Horizon	A	B	C	D	E	
Depth (cm)	0-23	23-49	49-78	78-115	115-155	
pH–H_2O (1: 2½ v/v)	6.0	6.2	7.3	5.9	5.4	
pH–KCl ,,	5.1	5.0	5.9	4.4	4.1	
EC (mmho/cm) ,,	0.15	0.17	0.35	0.35	0.08	
$CaCO_3$ (%)						
$CaSO_4$ (%)						
C (%)	2.25	0.51	0.48	0.51	0.60	
N (%)						
C/N						
CEC (me/100g), pH 8.2	23.8	18.4	22.6	26.0	23.8	
CEC ,, ,, pH 7.0						
Exch.Ca (me/100g)	9.10	6.86	10.86	7.93	7.43	
,, Mg ,,	2.88	1.46	1.78	1.15	1.15	
,, K ,,	5.03	1.89	1.68	1.14	1.18	
,, Na ,,	0.45	2.00	3.03	2.63	3.03	
Sum of cations	17.5	12.2	17.2	12.9	13	
Base sat. %, pH 8.2	73	66	77	50	54	
,, ,, %, pH 7.0						
ESP at pH 8.2	2	11	13	10	13	
Saturation extract:						
Moisture %						
pH–paste						
ECe (mmho/cm)						
Na (me/l)						
K ,,						
Ca ,,						
Mg ,,						
Sum of cations (me/l)						
CO_3 (me/l)						
HCO_3 ,,						
Cl ,,						
SO_4 ,,						
Sum of anions (me/l)						
Adj. SAR						
Clay mineralogy:						
SiO_2/Al_2O_3 (mol/mol)						
SiO_2/R_2O_3 ,,						
Fe_2O_3 (mmol%)						
X–ray report:						

SOIL CLASSIFICATION:

Depth (cm)	0-23	23-49	49-78	78-115	115-155	
Gravel %						
Texture, limited pretreatment:						
Sand % 2.0 – 0.05 mm	24	24	36	30	28	
Silt % 0.05–0.002mm	40	44	28	26	24	
Clay % 0.002–0 mm	36	32	36	44	48	
Texture class	CL	CL	CL	C	C	
Dispersed clay %						
Flocculation index						
Texture USDA:						
Sand % 2.0 – 1.0mm						
,, ,, 1.0 – 0.50mm						
,, ,, 0.50 – 0.25 mm						
,, ,, 0.25 – 0.10mm						
,, ,, 0.10 – 0.05mm						
Total sand %						
Silt %						
Clay %						
Texture class						
Bulk density						
Moisture % w/v at:						
pF 0						
pF 2.0						
pF 2.3						
pF 2.7						
pF 3.0						
pF 3.7						
pF 4.2						

Fertility aspects: (0– cm) Laboratory no. /

	Available	Total
Ca (me/100g)		
Mg ,,		
K ,,		
P (ppm)		
Mn (me/100g)		
Exch. acidity (me/100g)		
pH–H_2O (1: v/v)		
C%		
N%		

Profile No. 119/3-72

Mapping unit	: AAb
Soil classification	: eutric Gleysols
Ecological zone	: III
Observation	: 119/3-72, Nakuru, 25/10/78
Parent material	: Alluvial material
Physiography	: Alluvial plain
Relief, macro	: Flat to very gently undulating
" , meso	: Nil
" , micro	: Camber beds
Land use	: Grazing
Erosion	: Nil
Surface stoniness/rockiness	: Nil
Flooding	: Seasonal
Ground water level	: Deep
Slope gradient/position on slope	: 1%, middle
Salinity/sodicity	: Slightly sodic
Surface cracking	: Nil
Drainage class	: Poorly drained

Ap	0-23cm	Dark reddish brown (5YR 4/5 dry, 5YR 3/4 moist); common, medium, faint, dark red (2.5YR 3/6) mottles; clay loam; moderate, fine, subangular blocky structure; slightly hard when dry, firm to friable when moist, sticky and plastic when wet; common fine pores; common fine roots; pH 6.0; clear and smooth boundary to: (sample no. 119/3-72a)
Bgl	23-49	Reddish brown (5YR 4/3 moist); common, medium, faint, yellowish red (5YR 5/6) mottles; clay loam; strong, medium, angular blocky structure; very hard when dry, firm to friable when moist, sticky and plastic when wet; common, thin humus coatings; few, fine pores; few manganese concretions (3-5mm); common fine roots; pH 6.2; clear and smooth boundary to: (sample no. 119/3-72b)

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Bg2 49–78 cm

Dark reddish brown (5YR 3/2 moist); common, fine, distinct, yellowish red (5YR 5/6) mottles; clay loam; strong, fine, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; few, fine pores; common manganese concretions (4–5 mm); few, fine roots; pH 7.3; gradual and smooth boundary to:

(sample no. 119/3-72c)

Bg3 78–115 cm

Reddish brown (5YR 5/3 moist); common, medium, faint, yellowish red (5YR 5/6) mottles; clay; strong, medium, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; common thin humus coatings; few, fine pores; common, manganese concretions (2–3 mm); few fine roots; pH 5.9; clear and smooth boundary to:

(sample no. 119/3-72d)

BCg 115–155+ cm

Dark reddish brown (5YR 4/3 dry, 5YR 3/2 moist); common, fine to medium distinct, yellowish red (5YR 5/6) mottles; clay; strong, medium, subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few fine pores; pH 5.4;

(sample no. 119/3-72e)

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LABORATORY DATA OF PROFILE DESCRIPTION No:

FIELD OBSERVATION No: MAPPING UNIT:

Laboratory no. ...../ 78	11656	11657	11658	11659	11660	
Horizon	A	B	C	D	E	
Depth (cm)	0-30	30-50	50-90	90-112	112-160	
pH-H_2O(1: 2½v/v)	5.3	5.5	5.6	6.1	6.3	
pH-KCl "	4.9	4.9	4,9	5.4	5.4	
EC(mmho/cm) "	0.08	0.13	0.18	0.19	0.09	
$CaCO_3$(%)						
$CaSO_4$(%)						
C (%)	1.94	0.46	0.68	0.51	0.34	
N (%)						
C/N						
CEC (me/100g), pH 8.2	17.6	19.5	16.8	13.1	24.7	
CEC " " pH 7.0						
Exch. Ca (me/100g)	7.40	7.20	7.20	7.45	10.15	
" Mg "	1.69	2.26	2.58	2.03	2.80	
" K "	1.97	2.48	1.52	3.03	5.33	
" Na "	Trace	Trace	0.16	0.45	1.33	
Sum of cations	11.06	12.0	11.5	13.0	20.0	
Base sat. %, pH 8.2	63	61	68	99	79	
" " %, pH 7.0						
ESP at pH 8.2	-	-	1	3	5	
Saturation extract:						
Moisture %						
pH-paste						
ECe (mmho/cm)						
Na (me/l)						
K "						
Ca "						
Mg "						
Sum of cations(me/l)						
CO_3 (me/l)						
HCO_3 "						
Cl "						
SO_4 "						
Sum of anions(me/l)						
Adj. SAR						
Clay mineralogy:						
SiO_2/Al_2O_3(mol/mol)						
SiO_2/R_2O_3 "						
Fe_2O_3(mmol%)						
X-ray report:						

SOIL CLASSIFICATION:

Depth (cm)	0-30	30-50	50-90	90-112	112-160	
Gravel %						
Texture, limited pretreatment:						
Sand % 2.0 - 0.05 mm	44	40	38	48	40	
Silt % 0.05-0.002mm	28	24	22	36	30	
Clay % 0.002-0 mm	28	36	40	16	30	
Texture class	CL	CL	C	L	CL	
Dispersed clay %						
Flocculation index						
Texture USDA:						
Sand % 2.0 - 1.0mm						
" " 1.0 - 0.50mm						
" " 0.50 - 0.25mm						
" " 0.25 - 0.10mm						
" " 0.10 - 0.05mm						
Total sand %						
Silt %						
Clay %						
Texture class						
Bulk density						
Moisture % w/v at:						
pF 0						
pF 2.0						
pF 2.3						
pF 2.7						
pF 3.0						
pF 3.7						
pF 4.2						

Fertility aspects: (0- cm) Laboratory no. /

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

Kenya Soil Su
Drawing No.

Profile No. 119/3-73

Mapping unit	:	UPb2
Soil classification	:	haplic Phaeozem
Ecological zone	:	III
Observation	:	119/3-73, Nakuru, 25/10/78
Parent material	:	Tuff
Physiography	:	Upland
Relief, macro	:	Gently undulating
" , meso	:	Nil
" , micro	:	Plough ridges
Land use	:	Cultivation
Erosion	:	Very slight sheet
Surface stoniness/rockiness	:	Nil
Flooding	:	Nil
Ground water level	:	Deep
Slope gradient/position on slope	:	1%, Bottom
Salinity/sodicity	:	Nil
Surface cracking	:	Nil
Drainage class	:	Well drained

Ap 0-30 cm

Dark reddish brown (5YR 4/3 dry, 5YR 3/2 moist); clay loam; medium, fine, crumb structure; slightly hard when dry, friable when moist, sticky and plastic when wet; common, fine pores; many, fine to medium roots; few feldspars; pH 5.3; gradual and smooth boundary to:

(sample no. 119/3-73a)

AB 30-50 cm

Dark reddish brown (5YR 3/2 moist); clay loam; weak, fine, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common, medium pores; many fine to medium roots; pH 5.5; gradual and smooth boundary to:

(sample no. 119/3-73b)

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Bug 50-90 cm

Dark reddish brown (5YR 3/3 moist); clay; moderate, medium, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many, fine to medium pores; common, fine to medium roots; many feldspars; common, pH 5.6; gradual and smooth boundary to:

(sample no. 119/3-73b)

Bu2 90-112 cm

Dusky red (2.5YR 3/2 moist); gravelly loam; massive structure; loose when dry, loose when moist; non-sticky and non-plastic when wet; pH 6.1; clear and broken boundary to:

(sample no. 119/3-73c)

BC 112-160 cm

Dark reddish brown (2.5YR 3/4 moist); gravelly clay loam; massive structure; slightly hard when dry, friable when moist, non-sticky and non-plastic when wet; pH 6.3; clear and broken boundary to tuff;

(sample no. 119/3-73d)

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LABORATORY DATA OF PROFILE DESCRIPTION No:

FIELD OBSERVATION No: **MAPPING UNIT:**

Laboratory no. ...../78	11661	11662	11663	11664		
Horizon	A	B	C	D		
Depth (cm)	0-18	18-41	41-75	75-85		
pH-H_2O(1:2½ v/v)	5.4	5.2	5.2	6.0		
pH-KCl ,,	5.1	4.6	4.7	5.2		
EC(mmho/cm) ,,	0.20	0.04	0.18	0.11		
$CaCO_3$(%)						
$CaSO_4$(%)						
C (%)	2.22	1.31	0.65	0.68		
N (%)						
C/N						
CEC (me/100g), pH 8.2	19.9	17.4	16.4	23.0		
CEC ,, ,, pH 7.0						
Exch.Ca (me/100g)	8.30	6.30	6.30	12.75		
,, Mg ,,	2.64	1.78	1.53	2.80		
,, K ,,	1.41	0.80	0.53	0.35		
,, Na ,,	0.08	0.08	0.24	0.79		
Sum of cations	12.4	9.0	9.0	17		
Base sat. %, pH 8.2	62	51	52	73		
,, ,, %, pH 7.0						
ESP at pH 8.2	-	-	2	3		
Saturation extract:						
Moisture %						
pH-paste						
ECe (mmho/cm)						
Na (me/l)						
K ,,						
Ca ,,						
Mg ,,						
Sum of cations(me/l)						
CO_3 (me/l)						
HCO_3 ,,						
Cl ,,						
SO_4 ,,						
Sum of anions(me/l)						
Adj. SAR						
Clay mineralogy:						
SiO_2/Al_2O_3(mol/mol)						
SiO_2/R_2O_3 ,,						
Fe_2O_3(mmol%)						
X-ray report:						

SOIL CLASSIFICATION:

Depth (cm)	0-18	18-41	41-75	75-85		
Gravel %						
Texture, limited pretreatment:						
Sand % 2.0 - 0.05 mm	34	28	50	36		
Silt % 0.05-0.002mm	38	42	20	34		
Clay % 0.002-0 mm	28	30	30	30		
Texture class	CL	CL	SCL	CL		
Dispersed clay %						
Flocculation index						
Texture USDA:						
Sand % 2.0 - 1.0mm						
,, ,, 1.0 - 0.50mm						
,, ,, 0.50 - 0.25 mm						
,, ,, 0.25 - 0.10mm						
,, ,, 0.10 - 0.05mm						
Total sand %						
Silt %						
Clay %						
Texture class						
Bulk density						
Moisture % w/v at:						
pF 0						
pF 2.0						
pF 2.3						
pF 2.7						
pF 3.0						
pF 3.7						
pF 4.2						

Fertility aspects: (0- cm) Laboratory no. /

Ca (me/100g)	Available	Total
Mg ,,		
K ,,		
P (ppm)		
Mn (me/100g)		
Exch. acidity (me/100g)		
pH-H_2O (1: v/v)		
C%		
N%		

Kenya Soil
Drawing

Profile No. 119/3-74

Soil mapping unit	:	VVp
Soil classification	:	eutric Gleysols
Ecological zone	:	III
Observation	:	119/3-74, Nakuru, 25/10/78
Parent material	:	Various volcanic rocks
Physiography	:	Minor Valley
Relief, macro	:	Flat to very gently undulating
" , meso	:	Nil
" , micro	:	Termite mounds
Land use	:	Grazing
Erosion	:	Nil
Surface stoniness /rockiness	:	Nil
Flooding	:	Seasonal
Ground water level	:	Shallow
Slope gradient/position on slope	:	1%, middle
Salinity/sodicity	:	Nil
Surface cracking	:	Nil
Drainage class	:	Poorly drained

Ap 0-18 cm — Dark brown (7.5YR 4/2 dry, 7.5YR 3/2 moist); clay loam; moderate, fine to medium, crumb structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many fine to medium pores; many, fine, few, coarse roots; pH 5.4; gradual and smooth boundary to:

(sample no. 119/3-74a)

Bg1 18-41 cm — Dark brown (7.5YR 3/2, moist); common, medium, faint, very dusky red (2.5YR 2.5YR) mottles; clay loam; weak, fine, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many, fine to medium pores; common, manganese concretions (2-3mm); many fine roots; few feldspars; pH 5.2; gradual and smooth boundary to:

(sample no. 119/3-74b)

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Bg2	41–75 cm	Dark brown (7.5YR 3/2 moist); common, medium, distinct, very dusky red mottles (2.5YR 2.5/2); sandy clay loam; weak, fine, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many, fine pores; many, manganese concretions (3–4 mm); common, fine to medium, few, coarse roots; many feldspars; pH 5.2; gradual and smooth boundary to: (sample no. 119/3-74c)
BC	75–85 cm	Very dark greyish brown (10YR 3/2 moist); common, fine, distinct, red (2.5YR 5/8) mottles; gravelly clay loam weak, fine, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few, manganese concretions (3–4mm); many feldspars; pH 6.0; abrupt and wavy boundary to tuff: (sample no. 119/3-74d)
R	85–90+	Tuff

LABORATORY DATA OF PROFILE DESCRIPTION No:

FIELD OBSERVATION No: **MAPPING UNIT:**

Laboratory no. ...../78	11665	11666	11667	11668	11669	
Horizon	A	B	C	D	E	
Depth (cm)	0-20	20-31	31-88	88-100	100-110	
pH-H_2O (1: 2½ v/v)	6.0	5.3	5.5	6.0	6.3	
pH-KCl ,,	5.7	4.8	5.0	5.4	5.5	
EC (mmho/cm) ,,	0.09	0.05	0.05	0.06	0.11	
$CaCO_3$ (%)						
$CaSO_4$ (%)						
C (%)	2.56	1.57	0.77	1.00	0.40	
N (%)						
C/N						
CEC (me/100g), pH 8.2	14.2	17.2	16.8	14.2	15.3	
CEC ,, ,, pH 7.0						
Exch. Ca (me/100g)	8.30	6.86	7.00	7.20	10.00	
,, Mg ,,	2.03	1.78	2.33	2.26	3.13	
,, K ,,	1.60	0.91	1.24	1.60	3.23	
,, Na ,,	Trace	0.04	0.68	0.16	0.33	
Sum of cations	12.0	9.6	11.3	11.2	16.7	
Base sat. %, pH 8.2	84	56	67	79	100+	
,, ,, %, pH 7.0						
ESP at pH 8.2	-	-	4	1	2	
Saturation extract:						
Moisture %						
pH-paste						
ECe (mmho/cm)						
Na (me/l)						
K ,,						
Ca ,,						
Mg ,,						
Sum of cations (me/l)						
CO_3 (me/l)						
HCO_3 ,,						
Cl ,,						
SO_4 ,,						
Sum of anions (me/l)						
Adj. SAR						
Clay mineralogy:						
SiO_2/Al_2O_3 (mol/mol)						
SiO_2/R_2O_3 ,,						
Fe_2O_3 (mmol%)						
X-ray report:						

SOIL CLASSIFICATION:

Depth (cm)	0-20	20-31	31-88	88-100	100-110	
Gravel %						
Texture, limited pretreatment:						
Sand % 2.0 - 0.05 mm	64	60	48	52	66	
Silt % 0.05-0.002mm	16	14	24	24	14	
Clay % 0.002-0 mm	20	26	28	24	20	
Texture class	SCL	SCL	SCL	SCL	SCL	
Dispersed clay %						
Flocculation index						
Texture USDA:						
Sand % 2.0 - 1.0mm						
,, ,, 1.0 - 0.50mm						
,, ,, 0.50 - 0.25mm						
,, ,, 0.25 - 0.10mm						
,, ,, 0.10 - 0.05mm						
Total sand %						
Silt %						
Clay %						
Texture class						
Bulk density						
Moisture % w/v at:						
pF 0						
pF 2.0						
pF 2.3						
pF 2.7						
pF 3.0						
pF 3.7						
pF 4.2						

Fertility aspects: (0- cm) Laboratory no. /

Ca (me/100g)	Available	Total
Mg ,,		
K ,,		
P (ppm)		
Mn (me/100g)		
Exch. acidity (me/100g)		
pH-H_2O (1: v/v)		
C%		
N%		

Profile No. 119/3-75

Mapping unit	:	PP3
Soil classification	:	haplic Phaeozem
Ecological zone	:	III
Observation	:	119/3-75, Nakuru, 26/10/78
Parent material	:	Tuff and Red Sandstone
Physiography	:	Plain
Relief, macro	:	Flat to very gently undulating
" , meso	:	Nil
" , micro	:	Plough ridges
Land use	:	Cultivation (maize)
Erosion	:	Nil
Surface stoniness/rockiness	:	Nil
Flooding	:	Nil
Ground water level	:	Deep
Slope gradient/position on slope	:	2½%, middle
Salinity/sodicity	:	Nil
Surface cracking	:	Nil
Drainage class	:	Well drained

Ap 0-20 cm — Dark brown (7.5YR 5/2 dry, 7.5YR 3/2 moist); gravelly clay loam; weak, fine to medium, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few, fine, few medium pores; many, fine to medium, few, coarse roots; few feldspars; pH 6.0; clear and smooth boundary to:

(sample no. 119/3-75a)

Bw 20-31 cm — Dark reddish brown (5YR 3/4 moist); gravelly sandy clay loam, single grains; loose when dry, loose when moist, non-sticky and non-plastic when wet; few, fine to medium pores; few fine roots; pH 5.3; clear and wavy boundary to:

(sample no. 119/3-75b)

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Bx	31-88 cm	Dark reddish brown to dark brown (5YR 3/3 and 10YR 3/2 moist); gravelly sandy clay loam; moderate, fine, subangular blocky structure; hard when dry, firm when moist, non-sticky and non-plastic when wet; many manganese concretions (5mm); few, very fine roots; many feldspars; pH 5.5; abrupt and wavy boundary to: (sample no. 119/3-75c)
BC	88-100 cm	Dark brown (7.5YR 4/4 moist); gravelly sandy clay loam; weak very fine, subangular blocky structure; slightly hard when dry, friable when moist, non-sticky and non-plastic when wet; few very fine to fine roots; many feldspars; pH 6.0; abrupt and wavy boundary to: (sample no. 119/3-75d)
C	100-122 cm	Dark reddish brown (5YR 3/2 moist); gravelly sandy clay loam; massive breaking to single grains; very hard when dry, friable when moist, non-sticky and non-plastic when wet; many quartz sand grains; pH 6.3; abrupt and wavy boundary to tuffaceous red sandstone. (sample no. 119/3-75e)
R	122-130+ cm	Tuffaceous red Sandstone.

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LABORATORY DATA OF PROFILE DESCRIPTION No:

FIELD OBSERVATION No: **MAPPING UNIT:**

Laboratory no. ...../78	11670	11671	11672	11673		
Horizon	A	B	C	D		
Depth (cm)	0-25	25-50	50-96	96-145		
pH-H_2O(1: 2½v/v)	5.1	5.4	5.6	6.0		
pH-KCl ,,	4.8	5.0	5.0	5.2		
EC(mmho/cm) ,,	0.06	0.05	0.07	0.10		
$CaCO_3$(%)						
$CaSO_4$(%)						
C (%)	1.62	0.60	0.80	0.43		
N (%)						
C/N						
CEC (me/100g), pH 8.2	10.3	14.2	15.4	15.0		
CEC ,, ,, pH 7.0						
Exch.Ca (me/100g)	4.50	6.50	7.93	8.70		
,, Mg ,,	0.93	1.87	2.26	1.93		
,, K ,,	0.93	0.91	0.63	0.60		
,, Na ,,	Trace	0.08	0.20	0.20		
Sum of cations	6.4	9.4	11.0	12.4		
Base sat. %, pH 8.2	62	66	72	83		
,, ,, %, pH 7.0						
ESP at pH 8.2	-	1	1	1		
Saturation extract:						
Moisture %						
pH-paste						
ECe (mmho/cm)						
Na (me/l)						
K ,,						
Ca ,,						
Mg ,,						
Sum of cations(me/l)						
CO_3(me/l)						
HCO_3 ,,						
Cl ,,						
SO_4 ,,						
Sum of anions(me/l)						
Adj. SAR						
Clay mineralogy:						
SiO_2/Al_2O_3(mol/mol)						
SiO_2/R_2O_3 ,,						
Fe_2O_3(mmol%)						
X-ray report:						

SOIL CLASSIFICATION:

Depth (cm)	0-25	25-50	50-96	96-145		
Gravel %						
Texture, limited pretreatment:						
Sand % 2.0 – 0.05 mm	70	60	60	70		
Silt % 0.05–0.002mm	10	18	14	10		
Clay % 0.002–0 mm	20	22	26	20		
Texture class	SCL	SCL	SCL	SCL		
Dispersed clay %						
Flocculation index						
Texture USDA:						
Sand % 2.0 – 1.0mm						
,, ,, 1.0 – 0.50mm						
,, ,, 0.50 – 0.25 mm						
,, ,, 0.25 – 0.10mm						
,, ,, 0.10 – 0.05mm						
Total sand %						
Silt %						
Clay %						
Texture class						
Bulk density						
Moisture % w/v at:						
pF 0						
pF 2.0						
pF 2.3						
pF 2.7						
pF 3.0						
pF 3.7						
pF 4.2						

Fertility aspects: (0– cm) Laboratory no. /

Ca (me/100g)	Available	Total
Mg ,,		
K ,,		
P (ppm)		
Mn (me/100g)		
Exch. acidity (me/100g)		
pH-H_2O (1: v/v)		
C%		
N%		

Kenya Soil Su
Drawing No.

Profile No. 119/3-76

Mapping unit	: PP2
Soil classification	: haplic Phaeozem
Ecological zone	: III
Observation	: 119/3-76, Nakuru, 26/10/78
Parent material	: Tuff
Physiography	: Plain
Relief, macro	: Flat to very gently undulating
" , meso	: Nil
" , micro	: Plough ridges
Land use	: Cultivation (sorghum and maize)
Erosion	: Nil
Surface stoniness/rockiness	: Nil
Flooding	: Nil
Ground water level	: Deep
Slope gradient/position on slope	: 1%, bottom
Salinity/sodicity	: Nil
Surface cracking	: Nil
Drainage class	: Well drained

Ap 0-25 cm

Dark brown (7.5YR 4/2 dry, 7.5YR 3/2 moist); sandy clay loam; moderate, medium to coarse crumb structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many, very fine, common fine, few coarse pores; few feldspars; pH 5.1; clear and smooth boundary to:

(sample no. 119/3-76a)

AB 25-50 cm

Dark reddish brown (5YR 3/2 moist); gravelly sandy clay loam, moderate, medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many, very fine to fine, few, coarse pores; few, manganese concretions (2-3mm); many very fine, few, fine roots; many feldspars; pH 5.4; abrupt and smooth boundary to:

(sample no. 119/3-76b)

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Bw 50-96 cm

Dark reddish brown (5YR 3/3 moist); gravelly sandy loam; massive breaking to single grains; slightly hard when dry, loose when moist, non-sticky and non-plastic when wet; many, fine to fine, few coarse pores; common, manganese concretions (3-4mm); few, very fine roots; many feldspars; pH 5.6; clear and smooth boundary to:

(sample no. 119/3-76c)

C 96-145+ cm

Dark reddish brown (5YR 3/2 moist); gravelly sandy single grains; loose when dry, loose when moist, non-sticky and non-plastic when wet; many very fine pores; few, very fine roots; pH 6.0;

(sample no. 119/3-76d)

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DETAILED SOIL MAP OF PART OF LANET BEEF RESEARCH STATION

Appendix 2 to Report No. D15

Location of surveyed area

KEY

- soil mapping symbol
- VVp ..... depth class symbol
- A ..... slope class symbol
- soil boundary
- slope class boundary
- x x x x boundary of surveyed area
- ★76 profile pit with number
- augerhole observation
- 6080 / 6070 contour V. I. 10ft
- fencing
- farm road
- drainage way
- building
- built-up area
- 1 Sq cm = 0.25ha

Prepared and drawn by Kenya Soil Survey in December, 1978.

Base map compiled and simplified from: Topographical map of Lanet Beef Research Station, 1968

LEGEND

U UPLANDS (slopes from 1-5%)

UP Soils developed on pyroclastic rocks (tuffs)

- UPb1 — well drained, very deep, dark reddish brown to dark brown, friable, silty clay to clay, with 20-30cm very dark greyish brown to dark brown, silty clay topsoil
- UPb2 — well drained, very deep, dark reddish brown to dark brown, friable clay

P VOLCANIC PLAINS (slopes from 0-2%)

PP Soils developed on pyroclastic rocks (tuffs, partly water laid)

- PP1 — well drained, deep to very deep, dark brown, friable, gravelly sandy clay, with 20-30cm sandy clay loam topsoil
- PP2 — like PP1, but with gravel starting between 25-50cm
- PP3 — like PP1, but with gravel starting between 0-25cm

A FLOODPLAINS (slopes from 0-2%)

AA Soils developed on river alluvial deposits (partly tuff)

- AAb — poorly drained, deep to very deep, dark reddish brown, mottled, friable silty clay, with 25-35 cm dark brown topsoil

V MINOR VALLEYS (slopes from 0-5%)

VV Soils developed on various volcanic rocks

- VVp — poorly drained to very poorly drained, moderately deep, very dark greyish brown to dark brown, mottled, friable gravelly clay, with 20-30cm clay topsoil

KEY TO SLOPE CLASSES

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

KEY TO DEPTH CLASSES

thickness soil in cm	symbol: over rock	symbol: over petro-plinthite	name
0-25			very shallow
25-50			shallow
50-80	p		moderately deep
80-120			deep
more than 120			very deep

Drawing No. 78067