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UGANDA PROTECTORATE

DEPARTMENT OF AGRICULTURE

MEMOIRS OF THE RESEARCH DIVISION

SERIES I : SOILS

Number 4

THE SOILS AND LAND USE OF BUGANDA

A Reconnaissance Survey

by

S. A. Radwanski M.A. (Cantab.)

U G A N D A P R O T E C T O R A T E

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THE SOILS AND LAND-USE OF BUGANDA

A Reconnaissance Survey

by S. A. Radwanski

GENERAL

INTRODUCTION

The reconnaissance soil and land-use surveys of Buganda are part of systematic surveys of the whole of Uganda, which were initiated in 1956 as a result of the recommendations of the Agricultural Productivity Committee (Watson et al., 1954) under a Five-Year (1956-1960) Capital Development Plan. The purpose of the survey was to classify and map the soils of the country with the object of assessing their present and potential productivity.

The Kingdom of Buganda, which is administratively one of the four provinces of the Uganda Protectorate (see Map 1) is situated on both sides of the equator north and west of Lake Victoria and has an area of 17,080 square miles, excluding swamp and open water. According to the 1948 census* its population was about 1,300,000 of which 98 per cent. were Africans and most of the remaining 2 per cent were Asians with only about 2,000 Europeans.

With the exception of the capital town, Kampala, where most of the light industry is concentrated, practically the whole area is devoted to agriculture of which the peasant type characterized by mixed cropping alternating with grass fallow carried out on small 2 to 5-acre plots is dominant. Such farms or shambas are often fragmented and may consist of several small plots scattered throughout the settlement area. There are, however, several Asian-owned, monocultural plantations of tea, robusta coffee and sugar cane. Most of these plantations are confined to a strip of the country adjoining Lake Victoria and approximately 30 miles wide. A form of estate agriculture, mainly of robusta coffee, has also been adopted to a certain extent by a few wealthy African farmers and this has led to the establishment in some areas of small African-owned coffee plantations varying in size from 10 to 30 acres. However, the bulk of the two main cash crops, robusta coffee and cotton, comes from small (up to 5 acres) family farms where these crops are grown in plots often less than 1 acre in size. As will be shown later in this memoir, Buganda is agriculturally the most important province in the Protectorate. Robusta coffee production, in particular, amounts to well over 90 per cent. of the Protectorate total.

Field work in the Province began in January 1957 and most of it was completed in the middle of 1959. The survey consisted of inspecting all the available roads, tracks and a number of footpaths along which observations regarding soils and present land use were

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* A new census was initiated at the time of writing of this memoir (1959).

made. Two hundred and twenty three profile pits to a depth of 6 ft. or more were dug and sampled and, in addition, 408 composite surface samples were also collected from various soil types classified during the survey. Each composite sample consisted of 10 six-inch cores taken at random from an area of about ½ acre and collected into one soil bag. Most of the soil samples collected were subsequently analysed in the laboratory of the Chemistry Section, Kawanda. The number of soil sampling sites and the total length of recorded traverses of this survey in relation to the total area of the Kingdom are shown in Table 1, and the distribution of sampling sites and recorded traverses are shown on Map 2.

Field data assembled during the survey were plotted onto the 1:250,000 base maps published by the Lands and Surveys Department, Uganda. A new and thoroughly revised edition of these maps is due to be published shortly, and the present soil map will be printed in colour using the new sheets as a base.

In compiling the present soil map extensive use was made of aerial photos at the scale of about 1:30,000 and the print lay-downs of these photos prepared by the Directorate of Colonial Surveys, London. By using them it was possible to delineate roughly the units of different topography always associated with distinct groups of soils, before the field work began. It was also possible to separate the drainage network, or at least the major rivers and streams, from the uplands. Consequently, most of the valley soils, though often representing the lowermost components of soil catenas which comprise a complete soil sequence from summit to valley bottom, are mapped separately and their approximate extent and distribution was checked with the aid of the print lay-downs. However, owing to the reconnaissance nature of the survey and shortage of time it was impossible to compile detailed soil maps.

CLIMATE

Although Buganda lies within the tropical belt both temperatures and humidities typical of such regions are considerably modified by a relatively high general altitude ranging from 3,500 to just over 5,000 ft. above sea level with a majority of hill summits at about 4,000 ft.

The climatological data shown in Table 2 are typical of the southern and south-western belt of the Kingdom, curving along Lake Victoria but excluding the 15 to 20-mile wide strip immediately adjacent to the lake. In the following paragraphs some outstanding similarities and differences between the various climatic regions in Buganda will be dealt with in the light of recent investigations carried out by a number of workers.

The rainfall in Buganda is characterized by a bi-modal distribution associated with the inter-tropical convergence zone with the rainy peaks generally falling between mid-March and mid-May

TABLE 1

District	Area in square miles	No. of profile pits	No. of composite samples	Total No. of sampling sites	Average sampling density	Total of recorded* traverses (miles)	Average density of recorded traverses
Masaka	3933	74	153	227	1 per 17 sq.miles	1062	1 mile per 3.9 sq.miles
Mubende	2680	66	73	139	1 per 19 sq.miles	835	1 mile per 3.2 sq.miles
Mengo	10467	83	182	265	1 per 39 sq.miles	2500	1 mile per 4.2 sq.miles
Buganda Total Area	17080	223	408	631	1 per 25 sq.miles	4397	1 mile per 3.7 sq.miles

* Recorded traverse includes roads, tracks and foot-paths inspected during the survey.

TABLE 2

Meteorological Data from Kampala Station. Altitude 4,306 feet

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Mean temperature of the air (°F.)	72.4	72.4	69.8	69.9	68.9	68.7	67.2	67.4	67.7	68.8	69.9	69.0	69.3
Mean maximum temperature	82.7	82.7	79.7	78.9	77.6	77.6	76.4	77.5	78.6	79.8	80.2	79.7	79.3
Mean minimum temperature	64.7	65.0	63.3	63.3	63.2	62.9	61.5	61.4	61.6	62.1	62.7	62.9	62.9
Absolute maximum temperature	90.1	91.6	86.9	85.1	84.0	84.8	84.6	84.0	85.3	84.2	86.5	84.9	86.0
Absolute minimum temperature	58.1	56.7	57.3	58.8	59.2	57.9	57.0	56.0	56.7	57.2	57.6	57.6	57.5
Mean daily range of temperature	18.0	17.7	16.4	15.3	14.4	14.7	14.8	16.1	17.0	17.7	17.5	16.8	16.4
Mean % humidity of the air at 8 a.m.	75	72	82	87	88	86	89	89	86	84	81	82	83
Mean % humidity of the air at 2.30 p.m.	52	49	63	68	72	66	68	68	69	66	61	66	64
Mean monthly rainfall (inches)	1.82	1.64	6.90	7.39	4.52	2.15	2.15	2.90	4.85	4.60	3.39	3.81	3.84

Annual Mean Rainfall = 46.12 inches.

('long rains') and from September till early October ('short rains'). The peaks are not well defined and considerable variations occur from one year to another. During the intervening dry periods light showers or even heavy rain storms are not infrequently experienced and this accounts for a relatively favourable distribution of rain throughout the year.

The average annual rainfall and its approximate distribution is shown on Map 3. The highest average, of up to 80 inches per year, occurs in the Sesse Islands. The rainfall diminishes to the north and west and the lowest average, that of 30 inches or less, is obtained in an area lying approximately half way between Masaka and Mubende.

According to Henderson's classification (1949) the following climatic zones are found in Buganda.

Lake Victoria Zone. This zone includes all the lake islands and extends 20 or 30 miles inland. It is characterized by comparatively small seasonal variations in temperature, humidity and wind throughout the year. Due to a high rate of evaporation from the lake surface, estimated at 4 to 5 mm. per day, and to the regular winds which drift across the lake from east to west at all seasons, the average annual rainfall is high, ranging from over 60 in. on the lake shore to 45 in. at the inland boundary of the zone. The rain falls on 160 to 170 days each year, with two peaks in March-April-May and October-November. There are two relatively dry seasons; between December and March and another in June-July but both are frequently broken by showers.

Ankole-Buganda Zone. This zone extends beyond the Lake Victoria zone and includes most of Buganda with the exception of the north-western corner, north of Mubende. The average annual rainfall ranges between just over 30 to 40 in. falling on 90 to 130 days in a year and attaining two peaks in April-May and September-October, the second peak tending to exceed the first. There are two relatively pronounced dry seasons in June-July and in December-February but the latter is frequently broken by showers.

Toro-Bunyoro (Western Uganda) Zone. The north-western corner of Buganda north of Mubende is included in this zone which remains under the influence of air masses of the Belgian Congo and is characterized by the average annual rainfall of 40 to 50 in. attaining two peaks - April-May and September to early November - the second peak being higher than the first. Of the two intervening dry seasons in December-February and June-July, the former is more severe than the latter.

Lake Albert Zone. This zone is represented by a very narrow expanse along the shore of Lake Albert in the extreme north-western tip of Buganda. Owing to its altitude of just over 2,030 ft. above sea level, this zone is the lowest and probably the hottest in Uganda. The average annual rainfall is about 35 in. or less, falling on 80 to 100 days and there are two severe dry seasons.

Sansom (1954) in his evaluation of climate based on seasonal precipitation and water-storage capacity of the soil in relation to Thornthwaite's formula for potential evapo-transpiration, produced two generalized climatic maps of East Africa. The first map based on Thornthwaite's Moisture Index (defined on p. 11 of Sansom's memoir) shows that most of Buganda lies within humid and moist sub-humid climatic types characterized by a Moisture Index ranging from 60 to 100. The two exceptions to the above are: an area in the south-west of Buganda and the north-western tip touching the shore of Lake Albert. These areas are under a dry, sub-humid type of climate with a negative Moisture Index of -20 to 0. The second map compiled by Sansom shows seasonal variations of effective moisture which is calculated as water surplus during the rainy season in dry climatic zones or as water deficiency during the dry season in moist climatic zones. According to this map, most of Buganda lies within a moist climatic region with small or no seasonal moisture deficiency. The exceptions are roughly the same as those in the first map. These areas are defined as dry climatic zones with little or no seasonal surplus of moisture.

Manning (1956) has established statistically the rainfall probability limits for Uganda. According to his map, in the area close to the shore of Lake Victoria there is a 9:1 probability that in any given year the total rainfall will be either between 45 and 70 in. (in areas very close to the shore) or between 40 and 60 in. Further inland, the middle, the north-eastern and the south-western parts of Buganda have lower rainfall probabilities of 33 to 48 in. in 9 years out of 10. In a small area approximately half way south of Mubende and north-west of Masaka the 9:1 rainfall probability is between 15 and 50 in. This narrows down again in the north-west of Buganda, north of Mubende, where it reaches the proportions similar to those of the Lake Victoria zone.

There is thus a fairly good agreement between various assessments of climate in Buganda as obtained by these different approaches to the problem. Furthermore, the rainfall map shows that the areas possessing the highest rainfall are those adjoining the shore of Lake Victoria and those lying in the north-western corner of Buganda.

One discrepancy, however, may be mentioned, namely, the unusually high rainfall shown on the map around the 55-inch isohyet in the south of Buganda. This is probably derived from the records of a station at Rakai, which was closed after a few years and may have provided unreliable figures. It is, therefore, quite likely that the 45 to 50-inch isohyets should run south in a more or less straight line instead of branching off to the west.

VEGETATION

A separate ecological survey of Buganda was carried out by I. Langdale-Brown and the detailed description of the vegetation will be published in a separate memoir (Langdale-Brown, 1960). In the

account that follows only broad physiognomic divisions of vegetation will be mentioned briefly in so far as they affect the corresponding broad groups of soils.

The vegetation of Buganda may be divided into two major divisions based on topography: upland communities, i.e., those occurring on summits and slopes of hills; and lowland communities occurring on valley slopes and bottoms.

Upland Vegetation

Included in this group are many plant communities ranging from moist deciduous forest to short-grass savanna under a moist or dry climate. There is very little, if any, vegetation that has not been affected by man's acitivies such as cultivation, grazing and seasonal fires. Consequently, the existing plant communities are mostly secondary or deflected plant successions or fire climaxes. Further subdivisions of the upland vegetation could be made as follows.

Moist evergreen forest. With the exception of a few scattered and small expanses in the south-east and north-west of the Kingdom, forest has been replaced by post-cultivation communities. What has remained is now confined to forest reserves but even these consist largely of relatively young forest regrowth with dense and unstratified canopies of low trees and a thick understorey of shrubs and woody creepers.

High grass. Large areas in the south-east and north-west of the Kingdom are at present under a high-grass fallow associated with cultivation. The dominant grass in these communities is Pennisetum purpureum (elephant grass) which often occurs in almost pure stands and grows up to 10 to 15 ft. in height. In other relatively less fertile areas Hyparrhenia rufa growing to the height of 6 ft. or more occurs instead of elephant grass. On shallow and stony soils confined to the summits and upper slopes of hills a short-grass savanna with Cymbopogon afronardus has established itself, particularly where seasonal fires are a regular feature. A large proportion of the high-grass zone was probably once covered by closed forest as shown by the presence of scattered forest trees such as Chlorophora excelsea ('mvule') which have been preserved by people for various reasons. Furthermore, wherever an elephant-grass fallow is left undisturbed for a few years, there is often a noticeable tendency to forest regeneration; the grass is invaded, gradually overgrown and eliminated by woody shrubs and small trees with the resulting appearance of forest thicket.

Short grass in low-rainfall areas. Short-grass savanna and the associated post-cultivation communities occur mainly in drier parts of the Kingdom in the south-west and north-east. Two major types of savanna have been recognized. In the south-west, comprising the whole of the western portion of Masaka district and the southern tip

of Mubende, Themeda triandra and Cymbopogon afronardus are the dominant grass species and these are associated with fire-tolerant shrubs and trees. In the north-east the dominant grass is Hyparrhenia filipendula with Loudetia arundinacea being locally common, and fire-tolerant shrubs and small trees also occur in abundance.

Short grass in high-rainfall areas. In the south-eastern part of the lake shore east and north of Masaka township another type of short-grass savanna is found. This consists mainly of Loudetia kagarensis and Eragrostis spp., with scattered evergreen forest trees confined to the remnants of lake terraces and to termite mounds. Although the annual rainfall in this area is 45-50 in. or more and is well distributed, the dominant soil type consists of highly leached quartzose sands incapable of supporting any other type of vegetation. There are, however, a few small areas of reserved forest growing on lacustrine sands underlain by a clayey stratum at the depth of 2 ft. or less. The establishment of these forest communities must have been an extremely slow process in which an undisturbed succession of plants has built up enough fertility in the first few inches of the surface so that larger trees could get a firm hold. Once the tree stage was reached, even on a poor soil, the forest can maintain itself in a closed cycle with dead trees decaying to provide organic matter and plant nutrients for the growing species. It is possible that a large part of the short-grass Loudetia savanna zone was once under forest which was subsequently destroyed, but, unlike the areas at present under high grass, the soils here having lost their forest cover, deteriorated so rapidly that forest regeneration, even through a high-grass stage, was impossible and new grass communities better adapted to poor soil conditions have replaced the previous vegetation. There is also evidence of comparatively recent and drastic changes in soil conditions on the lake shore which have been brought about by fluctuations in lake level. These are discussed on p. 16.

As already mentioned, short-grass savanna of a type similar to that occurring in the low-rainfall areas of the Kingdom with Themeda triandra, Andropogon dummeri or Cymbopogon afronardus is also found on summits and steep upper slopes of most of the hills in the high-grass area. Here again the controlling factor is the soil type. Shallow and rocky soils on these sites are not capable of supporting forest or high grass which are confined to more gentle slopes or pediments possessing deep soils.

Lowland Vegetation

Valley slopes and valley bottoms in Buganda display a variety of vegetation types ranging from well-graded swamp communities to fringing forest and grassland.

Swamp Communities. These are generally associated with high-rainfall areas under high grass or forest. In fully developed and

undisturbed swamps, such as occur on the lake shore, there is a well-defined gradation of plant communities controlled by the depth of water (Eggeling, 1934 and 1935; Carter, 1955). The following vegetation zones have been recognized:

(a) the water-lily zone characteristic of a comparatively clear surface water 10 to 15 ft. deep.

(b) the fern and sedge zone on more shallow water.

(c) the papyrus zone characteristic of waterlogged ground in which a thick layer of peat bound by root mat has accumulated. The papyrus is often replaced by Miscanthidium sp. on a less swampy ground.

(d) the palm zone (Pheonix reclineata) on an intermittently flooded ground.

Eleswhere, due to an abrupt slope break between the pediment and the valley, the succession of communities described above may be absent and the upland vegetation merges directly into a papyrus or Miscanthidium swamp.

Fringing forest. In high-rainfall areas the swamp communities in the valley bottoms often grade into narrow belts of swamp forest bordering the swamp on either side of the valley. The forest consists of relatively small trees with a dense and difficultly penetrable understorey comprising woody shrubs and thorny climbers. Wild date palm (Phoenix reclineata) is a very common feature of these forest communities.

Grassland. Most of the valleys in low-rainfall areas under a short-grass savanna are subject to extreme seasonal fluctuations of water table which appears above the surface only for a short time during the wet season. In the dry season water tables may recede several feet (10 to 30 ft. or more) below the surface and the valley soils dry up completely to a considerable depth. Periodic and intermittent flooding is not sufficient to maintain swampy vegetation and the grassland that develops on such valleys is not much different in respect of the dominant species from the adjoining upland savanna. The grasses are burned annually to provide fresh grazing material for cattle and this causes the appearance of fire-tolerant shrubs and trees.

GEOLOGY

A detailed geological survey of Uganda is being carried out at present by the Geological Department on the scale 1:50,000. Some of these maps concerning Buganda have already been printed (Pallister, 1959) and the account that follows is based on all the available data presented in published and some unpublished reports of the Geological Department.

All the three major divisions of rocks, i.e., sedimentary, igneous and metamorphic are represented in Buganda but the latter constitute the largest proportion. With very few exceptions all the

geological formations are of pre-Cambrian age and consist of the Basement Complex system as the oldest, overlain in places by a succession of sedimentary strata which have undergone a variable degree of dynamothermal metamorphism. These major geological formations are characterized by the presence of younger intrusive rocks - mostly acidic and less commonly basic. The youngest formations of Pleistocene to recent age are represented by the Kaiso Beds and sands, silts ands clays of alluvial or lacustrine origin. The geological background of Buganda is shown on Map 4 which was compiled at the request of the writer by Mr. R. Johnson, Senior Geologist, and is included with this memoir by permission of the Director, Geological Department, Uganda.

Absolute age of the pre-Cambrian formations has not been determined with any accuracy and their chronological relationship to one another often remains obscure but in the brief descriptions that follow they are arranged in a sequence from the oldest rocks to the most recent unconsolidated deposits, though in some cases, particularly with some post-Basement Complex formations, the evidence of their relative age is still inadequate.

Basement Complex (B.C.)

This formation occupies large areas not only in Buganda but throughout East Africa. It consists of a variety of metamorphic largely granitoid rocks, acid gneisses, schists and foliated granites. Most of these rocks are highly weathered and, where exposed, give rise to relatively low and gentle relief.

Toro System (T_1, T_2, T_3)

This is a large and heterogeneous group of ancient sediments overlying the Basement Complex rocks and showing a variable degree of metamorphism. The Toro rocks have been divided into three sub-groups mainly according to their lithological composition and the degree of metamorphism:

T_1 : Buganda Series consisting of quartzites, mudstones, slates, phyllites and schists.

T_2 : undifferentiated gneisses and schists.

T_3 : mica, schists and metamorphosed sandstones.

The upper strata of the Toro system appear to be predominantly argillaceous and the lower strata mainly coarse arenaceous sediments.

The other two important characteristics of the Toro system are: the presence of granites and gneisses which bear evidence of granitization (King, 1959) and the presence of basic intrusions, particularly in the Buganda Series.

Karagwe-Ankolean System (K.A.)

The rocks belonging to this system are much younger and generally less altered than the Toro group with the exception of the upper facies of the Buganda Series containing phyllites, slates and mudstones which also occur in the Karagwe-Ankolean System. However,

recent age determinations of pegmatites cutting the Buganda rocks give values ranging from 2,300 to 2,600 million years as compared with the Karagwe-Ankolean rocks estimated at about 1,000 million years (Holmes and Cahen, 1955). The Karagwe-Ankolean rocks are mostly argillaceous and a small proportion of higher grade metamorphics, mainly mica (serecite) schists.

Post-Karagwe-Ankolean Granites

After consolidation and hardening of the Karagwe-Ankolean sediments, huge granite intrusions (batholiths) were emplaced at depth and subsequently exposed through erosion. In Buganda the areas of granite are represented by the Mubende batholith (M.B.) forming a characteristic tor landscape in the north-west, by the Singo batholith (S.B.) north of Lake Wamala and by a small expanse of Nkonge granite (N.G.) in the west. Nkonge granite consists mainly of muscovite granite with tourmaline and both Mubende and Singo batholiths are represented by coarse-grained predominantly quartzose and feldspathic granites with subsidiary muscovite and a little biotite, associated with porphyries, pegmatites and quartz dykes. Many tors are composed of giant porphyry granite but it is likely that the inter-tor areas, now occupied by weathered rock, were originally of finer texture than the outcropping fresh rock.

The Bukoba System

The planing down of the Karagwe-Ankolean and other formations led to the deposition and emergence of the Bukoba sediments, mainly sandstones characterized by a comparatively low degree of metamorphism and subjected to only slight distortion and gentle folding. Scattered areas of this formation occur in the south-east of Buganda close to Lake Victoria and around Lake Wamala where they are known as the Singo and Mityana Series. The Singo Series is represented by flat or gently inclined beds overlying with distinct unconformity the older phyllites, quartzites and granites. The base of the series consists of white and pink quartzitic sandstones with scattered, rounded stones and is overlain by either "pink and cream current-bedded sandstone or by coarse-grained arkose sandstone interbedded with siltstones in which some ovate impressions possibly, but not certainly, derived from organic remains have been found" (King, 1947). The sandstones in the close vicinity of Lake Wamala and north-west of this lake constitute a very coarse facies of the system (Mityana Series), i.e., conglomerates and arkoses which were probably derived from weathering and deposition of coarse-grained parent materials.

Basic Intrusions

These came into being at various periods following the consolidation and hardening of the successive sedimentary deposits but a large proportion is dated as post-Bukoba. They typically occur in scattered small bodies which represent the remnants of liquid magma

that had forced itself into cracks, joints and bed planes of the pre-existing rocks and on cooling and crystallization formed dykes or sills. There is some evidence that at least some of these intrusions have been derived from inter-bedded lava (Pallister, 1959). The basic rocks and derived metamorphics vary in texture and composition from coarsely crystalline through fine-grained massive types to greenish-grey very fine-grained amphibolite schists. The associated thin banks of quartzite are impure and may be described as quartz-amphibole schists or quartz-pyroxene schists.

Karroo Beds of Entebbe

These are the oldest fossiliferous beds so far discovered in Buganda (Wayland, 1921) and consist of blue and white shales with plant remains dating these rocks as belonging to the Ecca division of the Karroo system at the end of the Cretaceous period. The Karroo Beds could not be shown on Map 4 owing to its small scale.

Pleistocene and Recent Formations (K.B. and L.D.)

These deposits have been laid during the period extending from the Pleistocene to the present day as the result of fluctuations in the level of the inland lakes and the lowering of the base level of rivers. They consist of superficial strata of sand, silt, clay and pebbles alternating with one another and occurring at various heights above the present level of rivers and lakes. The present position and occurrence of these deposits in relation to other landscape features will be discussed in the following section.

GEOMORPHOLOGY

The present landscape of Buganda is the result of a number of ancient denudation processes which have left a series of old erosion levels throughout the Province. The account of the geomorphic history of Buganda, which is also applicable to large parts of East, Central and South Africa, may conveniently begin from the end of the Karroo era when, owing to a long period of quiescence, Buganda and other parts of Africa began to be reduced to a plain of sub-aerial erosion with little or no relief. This almost perfect peneplanation was followed by a slow uplift and the consequent dissection by the rejuvenated drainage system. As a result of these changes an elevated and dissected plateau consisting of a series of flat-topped hills and intervening valleys was formed by the middle of the Tertiary period. The remnants of these hills are still well preserved, particularly in the south of Buganda but as the elevation, regional warping and subsequent erosion were by no means uniform over the whole area, the present level of the mid-Tertiary peneplain remnants varies from just over 4,000 to 5,000 ft.

The interpretation of the present land forms in Buganda and elsewhere in Africa has been the subject of many and often controversial scientific publications (Wayland, 1934; Dixey, 1944 and 1946;

King, 1951). More recently Pallister (1956, 1957 and 1958) has summarized the investigations of the Geological Survey Department on this problem. As far as Buganda is concerned, three major erosion levels have been recognized and these are described as follows.

The Mid-Tertiary or Buganda Surface (Gondwana land of King (1951).)

The remnants of this surface are well preserved in the form of flat-topped hills in the southern and central part of Buganda. The general altitude of hill summits is between 4,200 and 4,400 ft. but there are some notable departures from this level. Thus the hill summits in vicinity of Lake Victoria display the altitude of 4,000 ft. or less while some of the hill ranges in the south and central part of the Province have been raised to 4,600 to 4,800 ft. with several peaks attaining 5,000 ft. The causes of such a range in altitudes are the warping in the late-Tertiary times and localized arching induced by rift valley formation. Differential resistance of rocks to weathering has also been an important controlling factor. The dating of a hill range in the south-west of Buganda known as the Koki range is still a subject of controversy. These hills attain a height of 4,600 to 5,000 ft. standing well above the surrounding relief. The Koki hills are regarded by some authors (McConnell, 1955) as the remnants of a surface older than the mid-Tertiary and related to Dixey's Cretaceous Surface (1944) and King's post-Gondwana cycle (1951). According to this theory, they represent a downwarped part of an older surface which extends westwards to Ankole District where it attains the height of 6,000 ft. or more. On the other hand, the rocks that have given rise to these hills are more resistant to weathering and erosion than the adjacent geological formation, so that the difference in height may be accounted for by differential erosion. Furthermore, the recognition of pedeplain characteristics common to both the Koki and the adjacent hills (Pallister, 1956) and the presence of "arenas", i.e., scattered expanses of much lower hills (about 4,000 ft.) usually derived from the Basement Complex rocks within the Koki range, would suggest that this range is a part of the Buganda Surface.

The End-Tertiary or Tanganyika Surface (African Surface of King (1951).)

This surface is the most extensive and most widespread in Buganda and its development and distribution follows a classic erosion pattern as described by King (1951). Where the remnants of the Buganda Surface have withstood erosion the Tanganyika Surface is represented by hill slopes and pediments surrounding the flat-topped hills of the Buganda Surface. Its local base level is between 3,800 and 3,900 ft. but in the north, where pedimentation and the associated lowering of summits were more effective, it is between 3,500 and 3,600 ft. Several stages of erosion of the Buganda Surface, brought about mainly by parallel slope retreat, are well illustrated in the present shape of hill summits and slopes. These are marked by a gradual disappearance of the flat tops, more extensive and more gentle pediments until the latter become coalescent to form an almost flat pedeplain.

The Pleistocene or Acholi Surface

The erosion cycle responsible for the formation of the Tanganyika Surface was brought to a close by an uplift and the rejuvenation of streams in the early Pleistocene. The resulting erosion surface may be defined as a valley-floor peneplain with its base level at 3,400 ft., represented by the bottom of Lake Kyoga from which it fingers out in wide or narrow valleys to higher levels throughout Buganda.

Earth Movements in the Pleistocene

The formation of the river valleys and other depressions of the Acholi Surface was associated with two important physiographic changes, namely, the appearance of the Western Rift system due to faulting, and the downwarping of the Buganda Surface to the south-west which resulted in the formation of Lake Victoria. These movements had a profound influence on the present landscape and particularly on the drainage pattern in Buganda.

Drainage

The main elements of the drainage system in Buganda are extremely old and their establishment was largely controlled by the underlying rock structure subsequently modified by post-Karroo earth movements such as uplift faulting, warping etc.

Prior to the formation of the post-Tertiary Rift Valley system, most of the rivers in Buganda flowed west as tributaries of the Congo but, as a result of arching associated with faulting and rift valley formation in the west and the downwarping of the Buganda Surface to the south-east, the direction of water flow was reversed. Many rivers in Buganda are now flowing east to Lake Victoria from which a discharge takes place along the Victoria-Nile to Lake Albert and the White Nile.

With the exception of immature water courses in the Koki and Singo highlands, most of the rivers in Buganda are characterized by a low gradient and comparatively broad valley floors. The relative relief between hill summits and valley bottoms varies from about 1,000 ft. in the above-mentioned hill ranges through 200 to 500 ft. in the hills associated with remnants of the mid-Tertiary Surface to 50 ft. or less in the Tanganyika pedeplain. All the valleys display a variable degree

(continue page 15)

of aggradation which attains its maximum in the north-eastern pedeplain, but river meanders characteristic of mature water courses elsewhere are strikingly absent except in the Kagera river valley at the boundary between Buganda and Tanganyika in the south. Owing to alluvial aggradation, low gradient and frequent local tilting, many valley floors have become seasonal or permanent swamps. In the south and south-west of the Province the pediment slopes show an abrupt steepening in their lower sections adjacent to swamps. The flat and extensive valley floors possess slightly incised, narrow water courses which are obviously of quite recent origin. A number of these water courses, particularly in the south, are free flowing throughout the year but the majority are characterized by an intermittent flow controlled by seasonal changes of rainfall.

In the north and north-west, where topography is very subdued and the valleys even more aggraded, the pediment slopes merge almost imperceptibly into flat valley floors. Surface streams and water courses are often entirely absent from such valleys and even in the rainy season there is little or no free flow of water, though the water table emerges above the surface to form temporary stagnant pools.

Evidence of a much more vigorous activity of streams and rivers, probably associated with the pluvial periods in the Pleistocene, may be inferred from the presence of remnants of old river terraces and large water-worn quartz pebbles. For example, scattered but fairly well-preserved remanants of river terraces have been identified along the river Kafu. Their present altitude ranges from 10 to 30 ft. and from 30 to 100 ft. above the most recent flood plain of this river. These so-called "high level gravels" (Pallister, 1958) have been identified in many sites all over the Province. They occur at 3,700, 3,750, 3,800, 3,850 and occasionally at 3,900 ft., and have been related to the Tanganyika (end-Tertiary) Surface. As suggested by Pallister, most of these gravels and small boulders have been removed by the incision of the old valleys during the rejuvenation of drainage in the post-Tertiary times.

Lake Shores

The shore belt of Lake Victoria may be divided into two main physiographic sections. In the eastern section corresponding approximately to the extent of the physiographic division No. 2 (see p. 18) the shore line is controlled by the structure of quartzites and sandstones dipping into the lake at the inclinations of 30° to 60°. Extensive lacustrine deposits are generally absent except in a very narrow ($\frac{1}{4}$ mile or less) and discontinuous strip immediately adjacent to the water surface. The drainage divide between the Lake Victoria basin and the rivers flowing north towards Lake Kyoga runs relatively close to the shore and is marked by a series of low hills with the headwaters of the opposite drainage systems very close to each other. The watershed con-

tinuing the extreme eastern part of Busoga District where it is practically non-existent and the headwaters of the two drainage systems often interdigitate or even form through valleys as a result of mutual river capture. Lake Victoria with its level of 3,720 ft. lies well above the north-eastern pedeplain at 3,500 to 3,600 ft. and the two areas are separated by a low watershed of about 3,860 ft.

In the west the lake shore is very extensive with lake deposits extending several miles inland and forming a flat to gently undulating plain characterized by the presence of drowned river valleys. One of the best examples of drowning is the valley of the Bukora river which takes its origin from the Koki highlands (Physiographic unit No. 1B) and flows eastwards to the lake. The highlands consist mostly of phyllites and shales which give rise on weathering to clayey alluvial material deposited along the river course of the Bukora. Farther to the east, however, the clayey alluvium is buried under a progressively thicker layer of lacustrine sand. The thickness of the sandy layer in the vicinity of the lake is at least 50 ft. The last deposit of lacustrine sand is of comparatively recent age as is shown by the buried soil profiles near the lake. These display an immature topsoil only slightly stained with humus, and underlain by a layer of loose grey sand 3 to 5 feet thick, which rests on another better-developed humose horizon with some remnants of plant roots. This horizon in turn overlies layers of sand of considerable thickness.

Several old lake terraces have been identified in the west. They occur at various levels ranging from 15 to over 100 ft. above the present water surface. Some of these benches have been strongly lateritized and subsequently eroded and can easily be spotted as horizontal or slightly inclined platforms rising vertically from the shore plain.

In the extreme north-western corner the area of Buganda narrows to a small strip of land touching the shore of Lake Albert. The lake originated on the floor of the Western Rift valley and its present altitude is 2,030 ft. The adjoining shore plain forms an extension of the flat base of the rift escarpment.

Physiographic Divisions

Almost every stage of the geomorphic history of Buganda has left its mark on the present landscape. The physiographic divisions shown on Map 5 and in Figure 1 are the result of prolonged processes of weathering and erosion, both ancient and contemporary, acting on the pre-existing geological strata which have offered varying resistance to planation.

Following Davis (1899), landscape formation in Buganda may be analysed in terms of "structure, process and time". The main factors are:

Under process:

(a) climate including its past fluctuations and effect on weathering

(b) erosion by rivers and parallel slope retreat and consequent deposition of eroded material

(c) downwarping to form Lake Victoria

(d) intermittent uplift

(e) faulting and arching to form the rift valley and its escarpment.

Under structure:

(a) mineralogical composition and texture of the rocks

(b) the configuration or stratigraphic disposition such as folding or horizontal bedding

(c) laterite capping as a protection against rock weathering.

As shown on Map 5 the time factor has been used to group the physiographic divisions in a chronological sequence:-

Well-preserved remnants of the Buganda Surface (mid-Tertiary)

1A	4,600 - 4,800 ft.	Flat summits; steep and short pediments.
1B	4,600 - 4,800 ft.	Rounded summits; steep and short pediments.
2	4,200 - 4,400 ft.	Flat summits; distinct pediments.
2A	4,000 - 4,200 ft.	Rolling ridges; distinct pediments.

Occasional remnants of the Buganda Surface

3	3,700 - 4,000 ft.	Gently rolling hills; long and gentle pediments.

The Tanganyika Surface (end-Tertiary)

4	3,500 - 3,700 ft.	Gentle undulations; coalescing pediments; scattered inselbergs.

Structurally controlled erosion levels

5	Tor landscape.
6	Prominent quartzite ridges.

Pleistocene and recent levels

7	Valley floors and flood plains. Base level 3,400 ft.
8	Lake Victoria plain. 3,720 ft.
9	Lake Albert plain. 2,030 ft.
10	Rift Valley escarpment.

Divisions 1A, 1B, 2, 3 and 4 represent a progressive planation culminating in the end-Tertiary pedeplain (Tanganyika Surface) in the north. In divisions 1A, 1B and 2A rock structure has to a certain extent modified the effect of erosion but did not prevent pedimentation of hill slopes. Divisions 7, 8 and 9 belong to the Pleistocene and recent times and consist of the valley floor peneplain (7) and lake shore plains (8 and 9). The shore plain of Lake Albert in the north-west (9) has developed on the floor of the Rift Valley and is closely associated with the Rift Valley escarpment (10). Division 5 representing the granite tors and Division 6 quartzite ridges do not clearly show the

effect of planation even though they are probably related to the oldest erosion level, i.e., the Buganda Surface. This is because of the very resistant nature of the rocks.

Physiographic divisions associated with extensive remnants of the Buganda Surface

1A. This division comprises the Butalaga and Singo highlands in the western and central part of Buganda. The remnants of the Buganda Surface occur at 4,600 to 4,800 ft. above sea level in the form of flat-topped and often strongly lateritized summits. Geologically, the division consists of horizontal or sub-horizontal beds of sandstone with subordinate bodies of phyllites, shales and quartzites. The topography is generally well accentuated with steep slopes and imperfectly developed pediments. With the exception of a few major rivers, most of the streams possess a relatively steep gradient and immature narrow valleys. These hill ranges stand a few hundred feet above the level of the surrounding hills and it is clear that the preservation of the mid-Tertiary surface on the dissected plateau is mainly due to the horizontal disposition of the underlying rocks.

1B. This division is represented by the Koki highlands which are very similar in respect of altitude and relief to 1A but most of the hill summits are rounded or dome shaped with very smooth outlines. Extensive sheets of laterite are absent but there are frequent surface fragments and boulders of ferruginized rock. The pediments are better developed though still short and steeply inclined in comparison with those of Division 2. There are several mature river valleys with relatively broad floors and Lake Kijanebalola in the middle of the range, into which most of the rivers discharge. The Bukora river is the only one flowing east to Lake Victoria through a narrow gorge in the south-eastern part of the range. A similar narrow passage in the west connects the lake with the drainage system of Ankole of the Western Province of Uganda. The dominant rocks are phyllites and shales traversed by locally numerous quartz veins. There are also inextensive and scattered bodies of Basement Complex gneisses and these being less resistant to weathering give rise to relatively gentle and subdued undulations (arenas) closely surrounded by higher and steeper hills. Unlike the hills of Division 1A, the Koki highlands owe their existence to the underlying phyllites and shales which are probably more resistant to weathering and erosion than the neighbouring gneisses and schists because of thicker cappings of laterite.

2. In this division the remnants of the Buganda Surface form a series of flat summits at 4,200 to 4,400 ft. but towards the shore of Lake Victoria, where the surface was considerably downwarped, the summit heights are reduced to about 4,000 ft. or even less. Some of the more extensive summits contain laterite often in massive sheets 20 to 30 ft. thick. The slope elements are well developed with a steep upper slope merging abruptly into a long and gentle pediment which is usually

dissected by a relatively broad valley. The drainage system consists of mature rivers with aggraded valleys of a low gradient.

2A. This division is a modification of No. 2 due to rock structure which consists of numerous closely curved folds giving rise to rolling ridges with shorter and relatively steeper slopes.

Physiographic divisions associated with strongly dissected remnants of the Buganda Surface

3. For the purpose of this account only one division has been established but this is a broad and inclusive unit which could be further subdivided on more detailed analysis. The common and overriding feature of this division is the fact that it represents a transitional stage between the relatively well-preserved remnants of the Buganda Surface and the end-Tertiary pedeplain (Division 4) in the north.

There are very few flat tops in this division which consists of gentle hills or ridges at 3,700 to just over 4,000 ft. above sea level, with long pediments developed at the expense of the summits. The proportion of summit and upper slope area to pediment area is a quarter or less, while in Division 2 it is often more than one-third. The valleys are correspondingly wider and even more aggraded than those of Division 2.

Physiographic division associated with the Tanganyika Surface

4. This division is much less inclusive and more uniform than No. 3 though here again a few subdivisions could be recognized, one of the criteria being the relative frequency of inselbergs in any given area.

The process of parallel slope retreat has achieved its ultimate objective in this area and most of the hill summits (sensu stricto) have disappeared under coalescing pediments forming a series of gentle undulations at 3,500 to 3,600 ft., separated by broad and highly aggraded valleys. Where rocks have resisted weathering and erosion, rocky inselbergs have originated and these form scattered prominent features rising sharply above the surrounding pedeplain.

Physiographic divisions associated with rocks highly resistant to weathering

5. These are tor landscape areas consisting of rolling to strongly rolling hills at 4,200 to 4,500 ft. with large outcrops of resistant coarse-grained porphyry granite occurring on summits and occasionally on middle and lower slopes of hills.

6. In these areas quartzite ridges stand well above the level of adjoining hills and often form elongated ridges.

Physiographic divisions associated with the Pleistocene to recent levels

7. The valley floor peneplain of the Acholi Surface is represented by a network of river valleys extending throughout the Province. The base level of this surface is at 3,400 ft. Only a few major rivers are shown on the map owing to its very small scale.

8. The Lake Victoria shore plain is a flat to gently undulating area with scattered remnants of old lake terraces.

9. The Lake Albert shore plain is developed on the floor of the Rift Valley and only a small fraction of this plain comes within the boundaries of Buganda.

10. The Rift Valley escarpment forms a prominent feature along the Rift Valley.

SOILS

Previous Work

The first provisional classification of soils of the Uganda Protectorate was presented by Milne et al. (1936). As far as Buganda is concerned two different catenary complexes were distinguished; one on the sedimentary rocks of the Karagwe-Ankolean system and the other on the Basement Complex rocks and newer granites. The latter catena, known as the Buganda Catena, was described as consisting of four kinds of soils:- hill brow series; red earth; swamp-fringe series; and swamp soils.

Milne's fundamental contribution to modern pedology is his concept of a soil catena which is a topographic sequence of soil types repeating itself from summit to valley under a given set of relief conditions. The introduction of a catenary mapping unit has enormously facilitated the field mapping of soils and has enabled the soil surveyor to make a new approach to the study of inter-relationships between various components of a catena.

Martin, ap Griffith and Wayland (1940) and ap Griffith (1948) have elaborated Milne's classification a little further and established four inclusive soil groups in Buganda, which are described briefly on pp. 17-18 of ap Griffith's paper. Because of the generalized nature of these descriptions and the absence of examples of typical profiles in each of the groups no attempt will be made to correlate ap Griffith's units with the soil catenas mapped during the present survey.

A more systematic soil survey as a subsidiary to a detailed ecological survey was carried out in North Mengo by Langdale-Brown (1957) who distinguished the Buruli Catena and Lwampanga Series described in detail later in this memoir.

The latest account of the soils of Buganda prior to the present memoir is given by Chenery in Pallister's report "The Geology of Southern Mengo" (1959). Chenery describes briefly the Buganda Catena and, following Kellogg's and Davol's terminology, distinguishes "shallow lithosols" and red earths or red latosols as the upland components. The two lowland components of this catena are referred to as "grey sandy soils" derived from hillwash or river alluvium and "grey clays" of the valley bottoms. Chenery has also observed "a distinctly mappable variant due to parent rock in the Mabira Forest and neighbourhood." This he refers to as a bright red clay derived from amphibolite (see Mabira and Nakabango Catenas on pp. 53 and 54). The other two soil groups recognized by Milne are "Plateau soils" in the north, representing a catenary sequence of

reddish-brown sandy loams and grey loamy fine sands (Buruli Catena of Langdale-Brown) and "Entebbe soils". The latter group is confined to about a half-mile belt of the lake shore and to the lake islands and consists of sandy lacustrine soils with outcropping laterite (see Sango and Katera Series on pp.81-4). Chenery observed that these soils, despite their extreme acidity and deficiency in boron and magnesium, are unusually rich in available phosphorus, and to account for it suggests that the unusually high content of available phosphorus may be due to guano residues from thousands of years' droppings of fish-eating birds.

General Description

A detailed account of the soils of Buganda is presented later in this memoir. In this introductory section only general soil features, in relation to the environment already described, will be discussed.

For convenience of description the soils of Buganda may be divided into the two broad groups of upland soils occurring on hill summits, slopes or pediments and lowland soils found in alluvial or lacustrine plains and in river valleys.

The upland soils are more or less free draining and have developed from a variety of rocks ranging from basic through acid igneous formations to metamorphic sediments under a wide range of climatic conditions. The present vegetal cover comprises such extremes as semi-deciduous moist forest, swamp communities and dry savanna with fire-tolerant woody species.

Two easily recognizable morpho-genetic groups can be distinguished among the upland soils according to the depth of weathering and the presence of the main genetic soil horizons: the "immature" or skeletal soils with an imperfect structural horizon development but an abundance of fresh minerals; and the "mature" deep soils derived from rocks which have been thoroughly weathered to a great depth containing no primary minerals. It is interesting to note that there is little or no transition between these two groups so that the shallow profiles are immediately adjacent to the deep ones. This may be explained by the long-continued and intensive process of weathering which has thoroughly altered all but the most resistant rocks. The latter constitute the parent rocks of the skeletal soils which are developed directly from them and characteristically occur on summits and steep upper slopes of hills. Fragments and boulders of the respective parent rocks can easily be identified at shallow depths within the profiles of these soils. They represent almost all the types of rocks found in Buganda and also relic laterite sheets which are undergoing disintegration.

The associated deep soils occur on relatively gentle middle slopes and pediments. Their original parent rocks have been weathered beyond recognition and consequently it is more appropriate to refer to their parent materials. The deep soils have some outstanding characteristic common to them all irrespective of the type of their parent

material. These are: red or brown (depending on internal drainage) colour of the subsoil, the presence of varying quantities of quartz gravel and stones either scattered throughout the profile or forming distinct stony layers (stone lines), the presence of finely divided free sesquioxides (mostly iron) and, frequently, ironstrone concretions, commonly known as murram. Their texture varies from clay to loamy sand and the surface humose topsoil (A horizons) contain variable amounts of organic matter depending on the type of vegetation.

In high-rainfall areas and under undisturbed conditions these deep soils usually have a uniform subsoil exceeding 6 ft. and sometimes reaching 10 ft. or more. The presence of numerous termite mounds is a very characteristic surface feature and the uniformity of the subsoil is no doubt maintained by constant resorting and binding of the soil material and repeated mound building alternating with a collapse of old and abandoned structures. Many of these soils contain mottled and slightly indurated, lateritic horizons at depth. These horizons originate as a result of precipitation of iron oxides from solution in the lower parts of the subsoil, usually at the junction between the weathered bedrock and the overlying parent material. The lateritic horizons may be exposed to the surface by severe sheet erosion, particularly in the lower sections of the pediments, and, once exposed, they either harden into massive benches of ironstone or disintegrate into soft earth mixed with iron concretions. Profile truncation due to erosion of this kind is common in densely populated areas where soils are intensively cultivated but it also takes place under dry savanna conditions where the ground is only sparsely covered by grasses so that torrential rains in the wet season cause a great deal of surface run-off.

The origin of the deep soils is complex and is not yet completely understood. It is certain that they are extremely old and that they have been subjected to more than one cycle of weathering and erosion in past geologic eras (Ollier, 1959). Owing to intense and thorough weathering, the parent materials of these soils consist mainly of kaolinite, with or without some illite, and of iron oxides, and contain little or no primary minerals except the most resistant ones such as quartz, zircon and tourmaline. The absence or scarcity of unweathered but weatherable minerals which release, on decomposition, mineral plant nutrients such as calcium, magnesium and potassium largely limits the source of fertility of these soils to the contributions of plants to the organic matter in the surface soil. Consequently the plant nutrient supply in these soils is mainly dependent on the type and amount of organic matter in the surface few inches of the soil.

A separate genetic group is represented by the lowland soils occurring in plains and in river valleys. Their outstanding feature is a seasonally fluctuating water table which causes impeded drainage conditions. These soils are developed from transported parent materials varying in texture from heavy clay to coarse-quartzose sand, and in

colour from yellow-grey to grey and occasionally black. The most common profile consists of a layer of sand of varying thickness overlying silty and mottled clay. The sandy layers often show signs of podzolization with ill-defined bleached layers below the surface humose topsoils and with deposits of humus and iron oxides just above the clayey horizons.

As in the case of upland soils, several distinct soil series have been recognized in this group and these are described later. The distinguishing criteria, apart from those already mentioned, are relative topographic position which controls the internal drainage and type of humus which depends on how long the soil is submerged in the wet season and the nature of the consequent vegetation.

With the exception of lacustrine soils on the shore plain of Lake Albert, the lowland soils are generally very acid and poorly supplied with exchangeable bases though the content of organic matter is often high. The organic deposits in swamps consist largely of peat or at least raw humus which, owing to prevailing anaerobic conditions, are not sufficiently mineralized to be of immediate value to crop plants. The peat layer is usually less than 2 ft. thick.

DESCRIPTION OF SOIL MAPPING UNITS

INTRODUCTION

In this section the soil mapping units will be described in detail. The basic unit in Buganda is the catena as originally conceived by Milne (1935). The catena may be defined as a regular repetition of a certain sequence of soil profiles from summit to valley over an area of similar relief. Each of the different profiles in the sequence is separated approximately at the soil series level by criteria similar to those used by the United States Soil Survey (U.S.D.A., 1951) except that the units presented in this report are often more inclusive and may be split into two or more soil series proper in later detailed mapping.

The distribution of the different catenas in Buganda is shown on Map 6 (generalized, 1:1,000,000) and Map 7 (more detailed, 1:500,000). Each catena is given a local name of a town or district in which it was first identified and the component soil series receive a compound name consisting of the catena name with an outstanding characteristic of the soil series. By applying this system the number of local names used is reduced and each name is made to convey something of the soil's actual character in the field. There are, however, two exceptions to this rule where separate series names are given, namely (i) all alluvial soils which, although components of catenas, could be mapped separately with the aid of aerial photographs and which constitute a separate genetic group together with lacustrine soils, and (ii) upland soils which are so dominant over their other catenary associates that they form separate mapping units, e.g., the Tolero Series which occupies more than 70 per cent. of the uplands of the south of the area of Koki Catena.

Owing to the small scale of mapping it was not always possible to separate each of the soil catenas and, consequently, some soil complexes were established. These consist either of two or more catenas or of one catena and one soil series shown as one mapping unit.

Some soils such as those developed from lake deposits do not form catenary sequences and are classified and mapped as individual soil series or complexes consisting of two or more soil series.

For the same reason boundaries between the catenas and between soil series with a catena should be regarded as provisional. Furthermore, there are often extensive transitional areas in which one soil unit gradually merges into another.

In the description of the soils the standard nomenclature of the United States Soil Survey (U.S.D.A., 1951) was adopted wherever possible. Any other terms employed are either self-explanatory or their meaning is explained in the text. Munsell colour notations of air-dry soil are used in describing the colour of horizons and the assessment of soil texture is based primarily on the handling characteristics of the soil material in the field. The data for the mechanical analysis are shown in Appendix A. but these represent the separates of the fine-earth fraction (< 2 mm.) only. In some soils with a high clay content, the coarse fraction, mainly quartz gravel, may constitute as much as 50 per cent. or even more of the total soil material and this explains why they behave like light-textured loams. Similarly, soils with a high clay content, developed from strongly lateritized parent materials, have a tendency to form very stable aggregates of ferruginous clay which behave as coarse particles in the field imparting a lighter texture to the soil.

Gradients are defined in terms of percentage slope with an appropriate description, e.g., undulating, rolling, etc., as explained in the United States Soil Survey Manual.

Owing to the presence of extensive transitions between the main genetic horizons, particularly in the upland soils, it was possible to standardize the depth of soil sampling within narrow limits without sacrificing much accuracy as regards the thickness and distribution of these horizons. With some exceptions the thickness and arrangement of the main horizons in well-developed soils of Buganda are as follows:

A_1 : 0-2-3 in. A thin A_{00} horizon is often present in forest soils and a degraded gravelly A in some savanna soils.

A_3 or transition between A_1 and A_3 or transition between A_1 and B : Down to 8 or 10 in.

B if present or transition to C : Down to 16 or 20 in. or down to 30 or 36 in.

The underlying C horizon is often several feet thick.

Other common horizons such as those consisting of indurated lateritic materials or stonelines have always been sampled separately.

For convenience and clarity of presentation the soil mapping units are grouped according to various erosion or aggradation levels (shown on Map 5 and in Figure 1) with which they are associated. A summary of their more important characteristics is given in Table 3 preceding the detailed descriptions of soils. Later in the memoir several other classification systems, both regional and inter-territorial, will be discussed.

Fifty profiles are described in detail and numbered consecutively. The figures following the profile numbers are the laboratory ledger numbers.

The analytical data of the soil profiles described in the text are presented in Appendix A.

SUMMARY OF THE MAJOR CHARACTERISTICS OF BUGANDA SOILS

MAPPING UNIT	SOIL TYPES	LITHOLOGY	THICKNESS OF P.M.	COLOUR	DRAINAGE	CARBON %	pH	B.E.C. %	B.S. %	LATERITIZATION
			Soils Associated with Extensive Remnants of the Buganda Surface							
1. Kasolo Catena	"Deep" Sandy Clay Loam	Sandstone	6-10 ft.	Red 2.5YR,4/8	Somewhat excessive	2.5-3.0	Medium acid	15-20	50-60	Occasional relic murram in the subsoil
1A. Nzia Series	Ironstone Boulders	Massive laterite	-	Reddish-brown 5YR,4/3	-	-	-	-	-	Relic ironstone
2. Koki Catena	"Red" Clay	Phyllite	3-5 ft.	Yellow-red 5YR,5/8	Moderate	2.5-3.0	Medium acid	10-15	40-50	Very slight or absent
	"Brown" Clay	Phyllite	3-5 ft.	Light yellow-brown 10YR,6/4	Slow	2.0-2.5	Medium acid	10-15	50-60	Very slight or absent
	"Yellow" Clay	Phyllite and shale	2-4 ft.	Pale yellow 5Y,9/4	Slow	2.0-2.5	Strongly acid	10-15	30-40	Very slight or absent
2A. Tolero Series	Brashy Rock	Phyllite	-	-	-	-	-	-	-	Iron-coated rock fragments
3. Buganda Catena	"Ferruginized" Sandy Loam	Iron concretions	½-2 ft.	Strong brown 7.5YR,5/6	Free to impeded	3.5-4.0	Slightly acid	20-25	50-60	Abundant murram over massive ironstone
	Loam	Quartzite veins	4-6 ft.	Red 2.5YR,5/8	Somewhat excessive	2.0-2.5	Medium acid	15-20	60-75	Very slight or absent
	Clay Loam	Schists	6-10 ft.	Red 2.5YR,4/8	Free	2.5-3.0	Medium acid	20-25	50-75	Murram and incipient laterite at depth

MAPPING UNIT	SOIL TYPES	LITHOLOGY	THICKNESS	COLOUR	DRAINAGE	CARBON %	pH	B.E.C. %	B.S. %	LATERITIZATION
3. Buganda Catena (cont'd.)	"Brown Ferruginized" Sandy Loam	Iron concretions	½-2 ft.	Reddish-brown 5YR,3/4	Free to impeded	2.0-2.5	Strongly acid	10-15	30-40	Abundant murram over massive ironstone
3A. Kyebe Catena	"Red" Sandy Loam	Quartzite	4-6 ft.	Red 2.5YR,4/8	Somewhat excessive	1.5-2.0	Medium acid	10-15	40-60	Occasional relic murram
3B. Bowa Catena	Loamy Sand	Quartzite	1-3 ft.	Yellow 10YR,7/6	Excessive	-	-	-	-	Occasional relic murram
		Soils Associated with Strongly Dissected Remnants of the Buganda Surface								
4. Kabira Catena	"Medium" Sandy Loam	Gneisses and granites	3-5 ft.	Yellow-red 5YR,4/8	Free to impeded	2.5-4.0	Very strongly acid	20-25	20-30	Semi-hard lateritic horizon at depth
	"Ferruginized" Sandy Loam	Iron concretions	½-3 ft.	Yellow-red 5YR,5/8	Free to impeded	2.5-4.0	Strongly acid	10-15	30-40	Abundant murram over massive ironstone
5. Mirambi Catena	"Brown Deep" Sandy Loam	Gneisses and granites	4-6 ft.	Strong brown 7.5YR,5/6	Free to impeded	1.5-2.5	Slightly acid	10-15	50-60	Semi-hard lateritic horizon at depth
6. Mawogola Catena	"Medium" Gravelly Loam	Gneisses and granites	4-6 ft.	Strong brown 7.5YR,5/6	Somewhat excessive	1.0-1.5	Strongly acid	10-15	30-40	Slight or absent
	"Hillwash" Loamy Sand	Gneisses and granites	1-3 ft.	Pale brown 10YR,6/3	Somewhat excessive	1.0-1.5	Medium acid	15-20	50-60	Absent
7. Makole Series	Gravelly Loam	Granites	2-4 ft.	Brown 10YR,5/3	Excessive	1.0-1.5	Slightly acid	10-15	50-60	Absent
8. Mityana Catena	"Red" Gravelly Loam	Arkose	2-4 ft.	Red 2.5YR,4/8	Somewhat excessive	1.5-2.0	Medium acid	10-15	50-70	Relic murram at depth
9. Mabira Catena	"Red" Clay	Phyllite	4-6 ft.	Red 2.5YR,4/6	Slow	-	-	-	-	Abundant murram at depth

MAPPING UNIT	SOIL TYPES	LITHOLOGY	THICKNESS OF P.M.	COLOUR	DRAINAGE	CARBON %	pH	B.E.C. %	B.S. %	LATERITIZATION
9. Mabira Catena (cont'd.)	"Yellow" Clay	Phyllite	2-4 ft.	Yellow 10YR, 7/6	Slow	-	-	-	-	Very slight or absent
10. Nakabango Catena	"Medium" Clay	Amphibolite	2-3 ft.	Dark yellow-brown 10YR, 4/2	Slow	4.0-7.0	Neutral	30-40	80-95	Absent
	"Red" Clay	Amphibolite	4-6 ft.	Dark red 10R, 3/6	Slow	4.0-7.0	Neutral	25-35	80-95	Relic murram at depth
10A. Kamusene Series	Clay	Basic rocks	6-10 ft.	Red 10R, 4/8	Slow	3.0-4.0	Medium acid	20-25	60-75	Very slight or absent
10B. Kibula Series	Clay	Basic rocks	4-6 ft.	Dark red 2.5YR, 3/6	Free	1.5-2.0	Medium acid	15-20	40-50	Murram and incipient soft laterite at depth
11. Lukaya Series	Loam	Quartz-mica schists	4-6 ft.	Yellow-red 5YR, 5/6	Free	1.5-2.0	Medium acid	10-15	30-40	Very slight or absent
				Soils Associated with the Tanganyika Pedeplain						
12. Buyaga Catena	"Red Deep" Clay Loam	Gneisses and granites	6-10 ft.	Red 2.5YR, 5/8	Free	2.5-3.0	Slightly acid	15-20	50-75	Iron concretions and soft laterite
12A. Lubumba Series	Sandy Loam	Gneisses and granites	2-4 ft.	Red 2.5YR, 4/8	Free to slow	1.5-2.0	Medium acid	10-15	40-60	Semi-hard lateritic horizon at depth
13. Buruli Catena	"Red Deep" Sandy Loam	Gneisses and granites	4-6 ft.	Red 2.5YR, 4/8	Free to slow	0.5-1.0	Strongly acid	5-10	30-40	Semi-hard lateritic horizon at depth
	"Ferruginized" Loamy Sand	Iron concretions	½-2 ft.	Red 2.5YR, 4/8	Free to impeded	0.5-1.0	Strongly acid	5-10	40-50	Abundant murram over iron-stone
13A. Lwampanga Series	Loamy Sand	~~Gneisses and granites~~ ALLUVIUM	4-6 ft.	Reddish-yellow 7.5YR, 6/8	Excessive to impeded	0.5-1.0	Strongly acid	5-10	25-30	Semi-hard, massive laterite at depth

MAPPING UNIT	SOIL TYPES	LITHOLOGY	THICKNESS OF P.M.	COLOUR	DRAINAGE	CARBON %	pH	B.E.C. %	B.S. %	LATERITIZATION
Soils Associated with Rocks Resistant to Weathering										
14. Metu Series	Rock Boulders	Gneisses and granites	-	Rock boulders	-	-	-	-	-	Absent
15. Buwekula Catena	"Shallow" Loam	Granites	2-3 ft.	Light brown 7.5YR,6/4	Somewhat excessive	1.5-2.0	Medium acid	10-15	35-45	Absent
	"Red" Clay Loam	Granites	4-6 ft.	Red 2.5YR,5/8	Somewhat excessive	1.5-2.0	Strongly acid	10-15	35-45	Slightly indurated lateritic horizon at depth
	"Brown" Gravelly Clay Loam	Granites	4-6 ft.	Yellow-red 5YR,5/8	Somewhat excessive	1.5-2.0	Strongly acid	10-15	35-45	Slightly indurated lateritic horizon at depth
16. Mubende Catena	"Deep" Gravelly Loam	Quartzite	4-6 ft.	Reddish-yellow 5YR,6/8	Somewhat excessive	1.5-2.0	Very strongly acid	5-10	25-30	Absent
Soils Derived from Pleistocene to Recent Alluvial Deposits										
17. Mulembo Series	Sand	Alluvium	Not determined	Pale yellow 5Y,7/3	Seasonally waterlogged	1.5-2.0	Strongly acid	2-5	10-15	Absent
	"Yellow" Loamy Sand	Alluvium	n.d.	Brownish-yellow 10YR,6/6	Free to impeded	1.5-2.0	Medium acid	10-15	50-70	Absent
17A. Kifu Series	Sand	Alluvium	n.d.	Light grey 10YR,7/2	Permanently waterlogged	4.0-7.0	Extremely acid	15-20	2-5	Absent
18. Bukora Series	Clay	Alluvium	n.d.	Light grey 10YR,7/2	Seasonally waterlogged	1.5-2.0	Strongly acid	10-15	40-50	Absent
	"Yellow" Clay	Alluvium	n.d.	Yellow 2.5Y,3/8	Slow	1.5-2.0	Strongly acid	5-10	40-50	Absent

	MAPPING UNIT	SOIL TYPES	LITHOLOGY	THICKNESS OF P.M.	COLOUR	DRAINAGE	CARBON %	pH	B.E.C. %	B.S. %	LATERITIZATION
18A.	Kaku Series	Clay	Alluvium	Not determined	Grey 5Y,6/1	Permanently waterlogged	4.0-7.0	Strongly acid	30-40	40-60	Absent
19.	Liga Series	Clay	Alluvium	n.d.	Light olive brown 2.5Y,5/4	Seasonally waterlogged	4.0-8.0	Slightly acid	30-40	60-65	Absent
				Soils Derived from Lake Alluvium Deposits							
20.	Sango Series	"Deep" Sand	Lake deposit	Not determined	Grey 5Y,5/1	Excessive	0.5-1.0	Strongly acid	2-5	5-10	Absent
		"Shallow" Sand on Clay	Lake deposit	1-3 ft.	Grey 5Y,6/1	Excessive to impeded	1.0-1.5	Strongly acid	10-15	15-20	Absent
21.	Katera Series	Loamy Sand	Lake deposit	Not determined	Strong brown 7.5YR,5/6	Somewhat excessive	0.5-1.0	Strongly acid	2-5	5-10	Indurated lateritic horizon at depth
		"Ferruginized" Loam	Lake deposit	1-3 ft.	Reddish-yellow 7.5YR,6/8	Free to impeded	1.5-2.0	Strongly acid	5-10	30-40	Abundant iron concretions over indurated lateritic horizon
22.	Wasa Series	Clay	Lake deposit	Not determined	Dark grey 5Y,4/1	Impeded	4.0-6.0	Medium acid to mildly alkaline	30-40	80-95	Absent
	Kyoga Series	Clay	Lake deposit	n.d.	Dark grey brown 10YR,4/2	Impeded	4.0-6.0	Neutral	30-40	80-95	Absent
				Soils of the Sesse Islands							
23.	Sesse Series	"Red" Loams	Quartzites and sandstones	4-6 ft.	Red 2.5YR,5/8	Free to slow	1.5-4.0	Extremely acid	10-15	20-30	Murram and ironstone

MAPPING UNIT	SOIL TYPES	LITHOLOGY	THICKNESS OF P.M.	COLOUR	DRAINAGE	CARBON %	pH	B.E.C. %	B.S. %	LATERITIZATION
23. Sesse Series (cont'd.)	"Brown" Sandy Loams	Quartzites and sand-stones	4-6 ft.	Yellow-red 5YR,4/6	Free to slow	1.5-2.0	Very strongly acid	5-10	20-30	Murram and ironstone
24. Bugoma Series	Sandy Loams	Gneisses and schists	1-3 ft.	Light yellow-brown 10YR,6/4	Somewhat excessive	1.5-2.0	Very strongly acid	5-10	20-30	Soft lateritic horizon
25. Kikwayu Series	Gravelly Loams	Lake terrace material	4-6 ft.	Strong brown 7.5YR,5/8	Somewhat excessive	1.5-2.0	Very strongly acid	5-10	30-40	Occasional murram
Kinyu Series	Sand	Lake deposit	1-3 ft.	Yellow-brown 10YR,5/6	Seasonally waterlogged	1.5-2.0	Very strongly acid	5-10	Not de-termined	Ironstone at depth

Lithology refers to parent or associated rocks.
P.M. = Unconsolidated parent material, the C horizon below the solum.
The assessment of colour and texture refers to the non-humose subsoil.
The range of data for organic carbon, pH, exchange capacity, base saturation, refers to the surface (A_1) horizon only.

pH Terminology (USDA, 1951)

Extremely acid	Below 4.5	Slightly acid	6.1 - 6.5
Very strongly acid	4.5 - 5.0	Neutral	6.6 - 7.3
Strongly acid	5.1 - 5.5	Mildly alkaline	7.4 - 7.8
Medium acid	5.6 - 6.0.	Moderately alkaline	7.9 - 8.4

B.E.C. = Base (Cation) Exchange Capacity.
B.S. = Base Saturation.

DESCRIPTION OF THE SOILS OF BUGANDA

Soils Associated with Extensive Remnants of the Buganda Surface (mid-Tertiary)

1. Kasolo Catena

This unit occurs on hill ranges between 4,600 and 4,800 ft. and constitutes a part of physiographic division 1A as shown on Map 5.

The main topographic characteristics of the catena are steep slopes (30 to 50 per cent.), moderately steep (10 to 25 per cent.) and short pediments and frequent shallow depressions between summits which are distinctly flat and often extensive. They are covered by thick sheets of relic laterite undergoing slow disintegration. Some of the sheets are detached into massive fragments and give rise to horizontal steps or benches.

Geologically the area consists of fine-grained sandstones which are often horizontally bedded, thus providing favourable conditions for the formation and preservation of the thick deposits of laterite.

The average annual rainfall in the area is 45 to 50 in. with relatively mild dry seasons and the natural vegetation on deeper soils of hill pediments is rain forest or deflected plant successions leading to forest regrowth through elephant-grass fallow.

A catenary component that has developed over massive laterite is referred to as the Nzia Series and owes its separate name to the fact that in some cases it was possible to show it separately on the Soil Map (1A). The Nzia Series is a skeletal soil consisting of a thin surface layer of humose loam overlying either solid laterite or its broken up fragments and boulders. It remains under a very sparse, short-grass savanna often mixed with sedges. Occasional woody shrubs are confined to deep cracks in the laterite along which small termite mounds are also found.

The "deep" associates of this catena occur in depressions and on short pediments (See Figure 2). A typical profile is described below.

Profile 1 (16762-7): Kasolo "Deep"

Three miles north-east of Buta; upper slope, altitude 4,800 ft.; rainfall 50 in. p.a., under *Themeda triandra*, *Cymbopogon excavatus* with occasional *Pennisetum purpureum*.

0-3"	Dark reddish-brown (5YR,3/3) stained with humus, sandy-clay loam. Crumbly and firm. Frequent grass roots. A_1.
3-8"	Dark reddish-brown (5YR,3/4) slightly stained with humus, sandy-clay loam. Weak crumbs. Firm. Less frequent roots. A_3.
8-18"	Weak red (2.5YR,4/2) very slightly stained with humus, sandy-clay loam with occasional coarse-quartz gravel. Weak sub-angular blocks. Firm. Incipient B.
18-36"	Red (2.5YR,4/8) loam + frequent fine- and coarse-quartz gravel. Structureless, friable and loose. C.
36-48"	As above with occasional transported boulders of relic laterite and coarse-grained sandstone. C.
48"+	As above.

This profile consists of deeply and thoroughly weathered parent material which may be transported as indicated by detached and worn boulders of massive laterite and resistant sandstone, the main agency responsible for the movement being soil creep.

Analytical Data. Though the clay content of the fine-earth fraction (< 2 mm.) is relatively high, particularly in the lower horizons, a large proportion of sand and fine gravel is responsible for a relatively light texture of this soil and its somewhat excessive internal drainage.

The supply of the exchangeable calcium and magnesium in the topsoil is adequate (7.0 m.e. and 4.2 m.e., respectively) but the potassium may be low (0.21 m.e.). There is also a serious deficiency in the available phosphorus (10 p.p.m.). With the exception of the two uppermost horizons (A_1 and A_3) which, though acid, display a relatively high exchange capacity and more than 50 per cent. base saturation, the underlying subsoil is strongly leached. A good supply of bases in the top horizons is connected with a high content of organic matter (6.84 per cent.) and this shows that the reserve of major nutrients in the Kasolo Series is almost entirely dependent on the contributions made by decomposing plant remains.

Agricultural characteristics. Owing to the high and well-distributed rainfall and the high content of organic matter in the topsoil, Kasolo soils are initially productive for both annual and perennial crops but their inherent fertility tends to be exhausted fairly soon as a result of continuous cultivation without manuring. The main agricultural limitations apart from the probable deficiency of potassium and phosphorus are steep slopes and excessive internal drainage.

2. Koki Catena

Some of the components of this catena enter into a complex with the soils of the Mubonde and Kasolo Catenas but in the south-west of the Kingdom the Koki Catena is dominant over a large part of the area (See Division 1B on Map 5) to the virtual exclusion of other soils. The altitude and, to some extent, the shape of hills are similar to those of the Kasolo Catena but the summits are distinctly rounded and very smooth in outline. The pediments are often longer than those of the Kasolo Catena and, on the whole, more gently inclined. The dominant geological formation consists of phyllites and shales intruded by numerous quartz veins and dykes and all the catenary components are developed from weathering products of these rocks. Climatically, the unit is much drier than the Kasolo Catena, with an average annual rainfall of about 35 in. and a rather severe dry season. Vegetation consists of short-grass savanna with a fire-tolerant species of shrubs and trees, and of subordinate expanses of tall grasses like Pennisetum purpureum and Beckeropsis uniseta which are confined to the deep red or brown associates of the catena.

The upland catenary sequence (See Figure 3) is much better developed in this unit than in the Kasolo and consists of 4 distinct

soil series, one of which, i.e., the Tolero Series (2A), was mapped separately in some cases as it is often decidedly dominant over the others and in some places, particularly in the south, occupies up to 80 per cent. of the uplands. The individual catenary components are described as follows:

The Tolero Series occurs on summits and steep upper slopes of hills and is a skeletal soil. There is very little or no massive laterite and the series consists of a 2- or 3-in. layer of humose material overlying abundant fragments and boulders of phyllite. Though laterite as such is not present, the surface and sub-surface fragments of rock are often coated with iron oxides forming a thin surface crust. As direct lateritization of the fresh rock is impossible under the present conditions of good drainage and aeration, the origin of the ferruginous surface crust may be related to an ancient process of lateritization as evidenced by the few relic boulders of laterite still present on some of the summits. It is possible, therefore, that the Tolero Series has developed from the base or bedrock once underlying a sheet of laterite and that the ferruginous crust was formed from precipitated iron solutions resulting from disintegration and dissolution of the overlying laterite. The iron-coated rock fragments occur in the first foot or two of the soil only.

The soil series occurring on hill pediments are Koki "Red", Koki "Brown" and Koki "Yellow" in order of sequence from the upper to the lowest section of the pediment. A typical profile of each of these series is given below.

Profile 2 (14560-5): Koki "Red"

Mile 1½ from Lulagala to Bugoma; upper pediment, altitude 4,400 ft.; rainfall 35 in. p.a.; under savanna with herbs.

0-3"	Dark brown (7.5YR,4/4) stained with humus, sandy clay. Crumbly and firm. Frequent grass roots. A_1.
3-8"	Yellow-red (5YR,5/6) slightly stained with humus, clay. Weak crumbs. Slightly compact. A_3.
8-18"	Yellow-red (5YR,5/8) very slightly stained with humus, clay. Sub-angular blocks. Slightly compact. Transition to B.
18-36"	Yellow-red (5YR,5/8) clay. Sub-angular blocks of varying size and stability. Compact. B.
36-60"	Yellow-red (5YR,5/8) clay. Structureless and compact. C.
60-72"	Yellow-red (5YR,5/8) clay with abundant fragments of weathered, multicoloured phyllite. Weathered bedrock.

The striking morphological features of the Koki "Red" profile are a sharp junction between the weathered subsoil and the underlying bedrock of phyllite, the scarcity of iron concretions and the absence of indurated and mottled lateritic material within the profile. The first may indicate the movement of the subsoil downslope, additional evidence for which is provided by double stonelines of phyllite fragments in some profiles. The second and third may possibly be accounted

for by heavy texture and compactness of the subsoil which inhibits the free movement of iron in solution and its precipitation in soil pores. However, in some profiles a certain amount of iron precipitation takes place but only in the upper part of the weathered bedrock just below the uniform subsoil. Here the bedrock contains numerous cracks and fissures which become partially iron coated as a result of this process. The "iron concretions" that may eventually form are, in fact, the iron-impregnated and coated fragments of phyllite rather similar to those present in the Tolero Series but generally softer and easier to break. The process of ferruginization of the weathered bedrock is not common to all the profiles and where it occurs it generally appears to be in an early stage.

Analytical Data. Mechanical analysis reveals a high content of clay (48 to 61 per cent.) in the fine-earth fraction and a relatively high content of silt (up to 18 per cent. in the A_1 horizon). Owing to the compactness and low permeability there is comparatively little clay eluviation from the A horizon. Among the exchangeable bases magnesium and calcium tend to be low. Base saturation markedly decreases below the surface horizon and there is also a corresponding but lesser decrease in pH from 5.6 to 5.2 which rises again in the bottom horizons containing the highest proportions of clay. The supply of organic matter and available phosphorus in the topsoil appears to be satisfactory (3 per cent. of carbon and 43 p.p.m. of P_2O_5).

Profile 3 (14554-8): Koki "Brown"

Mile 13 from Lwamagwa to Rakai; middle pediment, altitude 4,300 ft.; rainfall 35 in. p.a.; under grass fallow.

0-3" Greyish-brown (10YR,5/2) stained with humus, sandy clay with occasional rock fragments, some coated with iron. Weakly crumbly and firm. Frequent grass roots. A_1.

3-9" Brown (10YR,5/3) slightly stained with humus, silty clay. Weakly crumbly and firm. A_3.

9-16" Light yellow-brown (10YR,6/4) very slightly stained with humus, silty clay. Weak sub-angular blocks. Slightly compact. Incipient B.

16-36" Brownish yellow (10YR,6/6) silty clay. Structureless and compact. C.

36-60" Abundant fragments of partially decomposed phyllite.

The Koki "Brown" profile is a topohydric variant of the Koki "Red" with similar profile morphology but with slower internal drainage. The uniform and thoroughly weathered subsoil tends to be shallower than in the Koki "Red" with the underlying weathered bedrock occurring at a depth of 3 ft. or less.

Analytical Data. The Koki "Brown" contains a little less clay but the content of silt is higher than in its "red" associate (up to 24 per cent). As in the Koki "Red", exchangeable magnesium tends to be low but the content of exchangeable calcium is twice as high and the base

saturation more satisfactory than in the Koki "Red". The content of organic matter and available phosphorus tends to be lower than in the Koki "Red" (2.29 per cent. carbon and 26 p.p.m. of P_2O_5, respectively).

Profile 4 (14567-72): Koki "Yellow"

Near Rakai Rest House; lower pediment; rainfall 35 in. p.a.; under savanna with herbs.

0-4" Grey (5Y,5/1) stained with humus, sandy clay. Weakly crumbly and firm. Frequent grass roots. A_1.

4-9" Grey (5Y,6/1) slightly stained with humus, sandy clay. Weakly crumbly and firm. A_3.

9-18" Pale yellow (5Y,7/3) very slightly stained with humus, silty clay. Weak sub-angular blocks. Slightly compact. Incipient B.

18-36" Pale yellow (5Y,9/4) mottled rusty grey and brown, silty clay. Structureless and slightly compact. C.

36-53" Pale yellow (5Y,9/4) mottled rusty grey and brown, silty clay. Structureless and compact. C.

53-72" Yellow (2.5Y,8/6) stained, light brown and rusty, partially decomposed shales and phyllites.

Although the yellow colour and the presence of mottles result from the slow internal drainage, it is possible that at least in some profiles the nature of the parent rock may be the controlling factor in this respect. The underlying bedrock of Koki "Yellow" often consists of grey to almost white shales with a very low content of iron. On weathering, such rocks give rise to light coloured subsoil.

Analytical Data. Of all the components of the Koki Catena, Koki "Yellow" is the most acid and the least saturated with bases, particularly below the A_1 horizon where pH values are less than 5. Both the available phosphorus and the exchangeable bases are low and they decrease with depth more rapidly than in either Koki "Red" or "Brown".

Agricultural Characteristics. The Tolero Series is entirely unsuitable for cultivation. The short and sparse grass savanna which it supports is burned annually to provide fresh grazing and this promotes rapid sheet erosion, resulting in the presence of frequent bare rocky exposures.

Among the pediment associates two morphological features, i.e., the thickness and the colour of the subsoil, are diagnostic of present agricultural productivity. The most productive associates are those with deep red or brown subsoils. However, they occur in relatively small patches (often less than half a square mile) scattered among the much less productive yellow or eroded associates. The two notable exceptions are the areas around Kaliro and Lwamagwa in Masaka District where relatively large expanses of Koki "Red" and Koki "Brown" support numerous farms. Although the average annual rainfall in these areas is 36 in. or less and there is a relatively severe dry season, robusta coffee and plantains appear to be growing vigorously and yielding well.

Many pediment associates in the Koki Catena have been seriously affected by sheet erosion which often caused complete removal of the soil material and exposure of the underlying rock to the surface (See Figure 4). Such eroded soils resemble the Tolero Series and are of little or no value to agriculture.

3. Buganda Catena

This catena occupies a large area in the south of the province and forms one of the most important mapping units. The general altitude of hill summits is 4,300 to 4,400 ft. but in the vicinity of Lake Victoria, where the mid-Tertiary surface has been considerably downwarped, the summit levels are reduced to 4,000 ft. or less.

Flat tops covered by thick sheets of massive relic laterite are common, particularly in the centre of the area, but they merge into more or less rounded summits or ridges north and south of the central belt. The steep upper slopes are short but the pediments are very well developed and their average gradient is 8 to 10 per cent. Generally, the pediments occupy 60 to 70 per cent of the total area, the remainder being covered by the summits and valley floors.

The drainage system consists of a number of closely spaced stream courses with an average distance between them seldom exceeding 1½ miles. The relative relief, i.e., the difference in height between summit and valley, is 400 to 500 ft. - about half of that prevailing in the previously described mapping units. Most of the valleys are between a quarter and half a mile in width although a few attain one mile.

The annual rainfall is over 40 and up to 50 in., bi-modally distributed, and there is a relatively mild dry season frequently broken by showers.

Three main vegetation zones, closely related to the relief and soil pattern, can be distinguished in the area. The summits and steep upper slopes are covered by short-grass savanna, the pediments originally under forest vegetation are covered by elephant grass which is a post-cultivation community, and the valley floors are under swampy vegetation with or without narrow strips of fringing forest.

A full catenary soil sequence (See Figure 5) consists of shallow, skeletal soils developed from either quartzite or ironstone on summits and upper slopes and deep red or red-brown clay loams occurring on pediments. The latter are often associated with truncated and ferruginized soil profiles occurring in the lower sections of the pediments. Very frequently an inextensive quartz dyke may be present in the pediment and this gives rise to shallow quartzose soils similar to those occurring on the hill summits and sandy or stony soils downslope. Among the deep associates two main types may be distinguished according to the texture of the subsoil and the presence or absence of quartz stonelines, more or less indurated lateritic horizons and concretions. The first consists of a

yellow-red loam with frequent fine-quartz gravel and some quartz stones scattered throughout the subsoil which may be two to several feet deep. A distinct stoneline consisting of quartz stones and quartz, quartzite or sandstone fragments is always present at depth and is underlain by a weathered bedrock of schists. There is little or no lateritization in the lower horizons of this soil. The second type is represented by a red clay loam or clay with only occasional quartz gravel. The subsoil of a variable thickness overlies a layer of murram or a semi-indurated, mottled, lateritic horizon or both. The distinction between these two types is not always easy to make as they typically merge into each other with a number of transitional profiles between the two extremes. In a more detailed survey each of the two soils would be given a separate series name but in this memoir they are referred to as Buganda Loam and Buganda Clay Loam, respectively.

Some of the typical profiles of the Buganda Catena are described as follows.

Profile 5 (15242-7): Buganda "Ferruginized"

Mile 12½ from Ntusi to Sembabule; flat summit, altitude 4,200 ft.; rainfall 40 in. p.a.; under Themeda triandra and Cymbopogon afronardus savanna.

0-3" Very dark brown (10YR,2/2) heavily stained with humus, sandy loam with occasional dark brown, hard and polished murram. Weakly crumbly and firm. A_1.

3-7" Very dark grey-brown (10YR,3/2) stained with humus, sandy loam with frequent murram. Structureless and firm. A_3.

7-18" Dark brown (7.5YR,3/2) slightly stained with humus, coarse-sandy loam with abundant murram and small boulders. Structureless and slightly compact. C.

18-30" Strong brown (7.5YR,5/6). As above. C.

30-48" + Dark brown mottled yellow-brown and dark grey, hard and massive ironstone.

This soil is developing from relic ironstone of the Buganda Surface, which having formed as a massive bench and lost its overburden, is now undergoing slow disintegration. The progressive fragmentation and weathering of this laterite releases hard iron concretions (murram) which in turn slowly dissolve. These effects can be seen in profiles from the bottom lateritic horizon upwards into the A_1 horizon where the concretions diminish in size and quantity most likely under the influence of organic acids derived from the surface humus.

Analytical Data. These show that the Buganda "Ferruginized" profile is extremely well supplied with all the plant nutrients though the content of phosphorus appears in profile 5 to be unusually high (1440 p.p.m.) resulting in unknown additions of phosphorous material in the past. The impedence in leaching of bases created by the presence of an almost impermeable, horizontal ironstone horizon is well illustrated by a marked increase of both the pH and the percentage base saturation with depth.

Profile 6 (18652-7): Buganda Loam

Mile 4½ from Kabasanda to Kammengo; upper pediment, altitude 4,000 ft.; rainfall 45 in. p.a.; under moist, semi-deciduous forest: Forest Reserve.

0-4" Dark reddish-brown (5YR,3/4) stained with humus loam with frequent fine-quartz gravel. Crumbly and friable. A_1.

4-10" Reddish-brown (5YR,4/4) slightly stained with humus, loam with frequent fine-quartz gravel. Weakly crumbly and firm. A_3.

10-18" Yellow-red (5YR,4/8) very slightly stained with humus, loam with frequent fine-quartz gravel. Sub-angular blocks of varying size and stability. Slightly compact. Transition to B.

18-36" Red (2.5 YR,4/8) loam with fine- and coarse-quartz gravel. Structure as above, slightly compact. B.

36-60" Red (2.5YR,5/8) loam with fine- and coarse-quartz gravel. Structureless and friable. C.

60-72" Red (2.5YR,5/8) coarse-sandy loam with abundant sub-angular quartz stones and gravel, and with occasional fragments of quartzite. Stoneline.

Unlike Buganda "Ferruginized" soils, Buganda Loam displays a much better developed profile with the relatively easily distinguishable structural B horizon. The prominent stoneline (1 to 2 ft. thick) below the C horizon bears evidence of soil creep. A certain amount of quartz stones may have originated *in situ* through the accumulation of scattered pre-existing quartz veins and subsequent burying by termites which constantly bring fine soil particles to the surface. However, a number of quartz stones displaying signs of abrasion and the fragments of quartzite have been included in the profile by transportation from the summit which is made of almost solid quartzite traversed by numerous quartz veins. There is no quartzite in the weathered rock underlying the stoneline on the pediment which consists of finely grained schists. The whole stoneline is continuous in the pediment soils and becomes exposed to the surface on reaching the hill summit where it merges into a debris of residual quartzite and quartz stones derived from the underlying rock.

Analytical Data. Despite the relatively high clay content in the fine-earth fraction (23 to 46 per cent.) the soil contains a large quantity of coarse sand and gravel and this imparts to it a loamy texture. Furthermore, the A horizon shows a high degree of clay eluviation (about 50 percent.) compensated only by the presence of organic colloids. However, the content of organic matter, as shown by the organic carbon figure, tends to be comparatively low (2 per cent. or less). Of the major plant nutrients the available phosphorus and the exchangeable potassium appear to be low (14 p.p.m. and 0.14 m.e., respectively). Both the pH trend and the percentage base saturation show a very marked decrease immediately below the A_1 horizon.

Profile 7 (15215-22): Buganda Clay Loam

Mile 1 from Villa Maria to Kagologolo; middle pediment, altitude 4,000 ft.; rainfall 40 in. p.a.; under Pennisetum purpureum fallow.

0-3" Dark reddish-brown (5YR,3/3) stained with humus, clay loam with occasional fine-quartz gravel. Crumbly and firm. A_1.

3-7" Reddish-brown (5YR,4/3) slightly stained with humus, clay loam. Weakly crumbly and firm. A_3.

7-18" Yellow-red (5YR,4/6) very slightly stained with humus, clay loam with occasional minute, hard and polished, semi-spheroidal murram, sub-angular blocks of varying size and stability. Slightly compact. B.

18-30" Yellow-red (5YR,4/8) clay loam. Fe concretions, structure, texture and consistency as above. B.

30-42" Red (2.5YR,4/8) clay with occasional quartz stones and occasional semi-hard murram. Structureless and firm. Transition to C.

42-54" Red (2.5YR,4/8) as above. Structureless and increasingly friable. C.

54-66" Red (2.5YR,4/8) clay with frequent semi-indurated and small earth fragments some of which have developed a thin iron coating (immature ferruginous concretions). Structureless and friable. C.

66-78" Yellow-red (5 YR,5/8) mottled yellow, grey and brown clay. Structureless and compact. An incipient lateritic horizon.

The profile is morphologically similar to that of Buganda Loam but the quartzose stoneline is either weakly developed or almost entirely absent, most likely due to the original scarcity of quartz veins in the parent rock. Other distinguishing features of Buganda Clay Loam are: the presence of an incipient lateritic horizon at depth and the occurrence of iron concretions displaying a wide range of "maturity". The concretions begin to appear in the lower horizons as small and somewhat hardened irregular to sub-rounded lumps of clay. In the middle horizon they become iron coated and harder. In the surface horizons they become either scarce and of minute size and polished appearance or entirely absent. This shows that they are undergoing dissolution in the manner similar to that taking place in Buganda "Ferruginized". However, unlike the latter series in which the cycle of lateritization has been completed, the same process in Buganda Clay Loam appears to be operative all the time though the formation of ferruginous crust (massive laterite) is being prevented by the present free internal drainage and the topography (middle, sloping pediment) allowing for lateral downslope disposal of iron solutions.

Analytical Data. Buganda Clay Loam contains more clay (32 to 55 per cent.) and much less gravel and stones in both the topsoil and the subsoil. It is also less acid, particularly in the subsoil where the pH values are well above 5, and better supplied with organic matter (2.47 per cent. or more of carbon), exchangeable calcium (7.5 m.e.) and magnesium (3.6 m.e.), though supplies of potassium (0.14 m.e.) and available phosphorus (15 p.p.m.)

are low. The exchange capacity of 10 to 24 m.e. is much higher than that of Buganda Loam (6 to 16 m.e.).

Profile 8 (18624-7): Buganda "Brown Ferruginized"

Mile 2 from Mpigi to Kabasanda; lower pediment section; rainfall 45 in. p.a.; under savanna fringing swamp forest.

0-3" Dark reddish-brown (5YR,3/3) heavily stained with humus, sandy loam with occasional quartz gravel and occasional hard and irregular in shape murram. Weakly crumbly and firm. A_1.

3-8" Dark reddish-brown (5YR,3/4) stained with humus, sandy loam with abundant closely packed, hard murram. Structureless and firm. A_3 - C.

8-30" Red (2.5YR,4/8) sandy loam. As above. C.

30-36" Yellow-red (5YR,5/8) mottled brown, dark grey and dark yellow, massive semi-hard laterite.

This profile bears strong resemblance to Buganda "Ferruginized" soils but its mode of formation, though leading to similar results, is different. The soil occurs at the lower end of the pediment where the precipitation of iron and the cementation of the soil material takes place in the vicinity of the relatively steep slope break leading into the valley and the shallowness of the profile with the consequent proximity of laterite to the surface is due to accelerated sheet erosion causing the removal of the upper soil horizons. Tho type of laterite that is now being formed in this series may be referred to a predominantly seepage laterite.

Analytical Data. Although the clay content in the fine-earth fraction is high (40 to 68 per cent.) the dominant coarse fraction consisting of iron concretions accounts for the light texture of this series. As shown by analysis, this series is poorly supplied with practically all the major plant nutrients with a possible exception of calcium (3.1 m.e.) and only in the surface horizon. The pH trend is reflected in the very acid topsoil (pH 5.5), increased acidity in the middle horizons and a slight rise in pH in the last horizon of massive semi-hard laterite where internal drainage has become impeded.

Agricultural Characteristics. Within the Buganda Catena there are minor occurrences of sedentary yellow-brown soils derived from mica-schists. These usually have shallow solums (less than 2 ft.) and are often associated with thin micaceous quartzite or quartz-schist veins. Neither Buganda "Ferruginized" nor Buganda "Brown Ferruginized" soils are suitable for arable farming, their chief drawback being the very poor physical conditions, namely, the shallowness of the subsoil and the abundance of iron concretions throughout the profile. These soils could, however, be used for light grazing or for the production of timber, provided strict soil conservation measures are enforced.

The deep associates on pediments are the most frequently cultivated soils in Buganda. They support a wide range of crops,

both annual and perennial, and some of them have been cropped for 30 years or more. With proper management, including soil conservation and an adequate resting period under elephant grass, which may be shortened by the application of suitable fertilizers, these soils could be maintained in their present productivity with no adverse effects on their structure and nutrient status. However, in very densely populated areas they have already begun to deteriorate owing to bad management which has caused accelerated sheet and gully erosion. The effect of this erosion is not as spectacular as in the Koki Catena. Young, semi-hard laterite may appear at the surface in the lower sections of the pediments but generally, owing to great depth of the solum, the underlying strata are very seldom exposed. Nevertheless, a drastic removal of the humose topsoil which is well supplied with nutrients and near-neutral (pH 6 or more) in reaction causes the acid (pH 5 or less) subsoil to be exposed to the surface. With advanced erosion "lunyu conditions" may set in and the land has to be abandoned. Such land usually remains sparsely covered with acid-tolerant weeds or Imperata grass. Provided that the subsoil is deeper than about 4 ft., planted elephant grass will grow and eventually, with frequent burning, will built up a fertile topsoil and open up the compacted subsoil.

3A. Kyebe Catena

The soils of this catena are very closely related to Buganda soils and particularly to the loamy associates of Buganda (Buganda Loam) but they differ from the latter in respect of relief which consists of hills with rounded summits and generally steeper and shorter pediments, and in respect of vegetation which is a predominantly short-to-medium grass savanna with subordinate expanses of Pennisetum purpureum fallow and only scattered patches of forest regrowth confined to narrow depressions and mezzo-valleys.

The average annual rainfall is higher than over the Buganda Catena. Soils are lighter in texture (sandy loams) being probably derived from fine-grained sandstones and quartzites rather than schists as in the Buganda Catena, and generally shallower. Furthermore, a much greater proportion of the area is occupied by shallow, bouldery and excessively drained soils of summits and steep upper slopes. Such soils may even occur on some of the pediments.

The topographic sequence is very similar to that of the Buganda Catena and that is why only one typical pediment profile is described below.

Profile 9 (19806-10): Kyebe "Red"

Mwanga Estate; middle pediment; rainfall 55 in. p.a.; under sugar cane.

0-3" Dark red (2.5YR,3/6) stained with humus, sandy loam with frequent fine-quartz gravel. Crumbs and sub-angular blocks of varying stability. Firm. A_1.

3-8" Red (2.5YR,4/8) slightly stained with humus, sandy loam with frequent fine-quartz gravel. Weak small sub-angular blocks. Firm. A_3.

8-18" Red (2.5YR,4/8) occasionally streaked with humus, sandy loam. Large sub-angular blocks. Slightly compact. B.

18-36" Red (2.5YR,4/8) sandy loam. Structureless and increasingly friable. Transition to C.

36-60" As above. Friable. C.

60" + Red (2.5YR,4/8) coarse-sandy loam with abundant sub-angular quartz stones and some fragments of sandstone. Stoneline.

The morphology and genesis of this profile is similar to that of Buganda Loam and the main differences apart from the type of relief and vegetation are disclosed by the chemical analyses.

Analytical Data. Although the pH values and the percentage base saturation in the topsoil are satisfactory (5.95 and 63.8 per cent., respectively) Kyebe "Red" soils are generally poorer in respect of individual plant nutrients - exchangeable calcium (2.8 m.e.) and magnesium (1.3 m.e.). The levels of exchangeable potassium (0.17 m.e.) and available phosphorus (14 p.p.m.) are comparable to those of Buganda Loam but the organic carbon (1.75 per cent.) is lower. Another important characteristic of Kyebe "Red" soil is its relatively high content of exchangeable manganese, the concentration of which, particularly in a severe dry season, may reach levels toxic to many agricultural plants.

Agricultural Characteristics. The pediment soils of the Kyebe Catena are agriculturally inferior to their counterparts in the Buganda Catena. Their main limitations are a light and stony texture which despite the high rainfall (55 in. or more per year) causes the soil water to percolate through the profile thus rendering it liable to drought and excessive leaching of bases.

3B. Bowa Catena

This catena is essentially similar to the Kyebe Catena in all respects except the colour and texture of its component soils and their parent material. Shallow and bouldery associates occupy an area equal if not exceeding that of the Kyebe catena and the pediment soils consist of yellow (10YR,7/6) loamy sandy underlain by quartzose stonelines at the depth of 2 ft. or less. The parent rock of these soils consists of iron-deficient, coarse-grained quartzites or of highly quartzose muscovite schists.

The annual rainfall of about 45 in. is generally well distributed but vegetation consists mainly of short-grass savanna with only occasional patches of elephant grass and thicket.

Agriculturally, Bowa soils are of a very low productivity since they are both poorly supplied with plant nutrients and liable to severe desiccation. No detailed profile description will be given because the areas where this catena is dominant are very small (see Map 7) and the soils are easily identifiable in the field.

Soils Associated with Strongly Dissected Remnants of the Buganda Surface

4. Kabira, 5. Mirambi, 6. Mawogola Catenas

Before these catenas are dealt with separately they will be treated as a group because they share a number of striking similarities as regards the general relief, parent material and profile morphology.

They are found on gently rolling hills with rounded summits at 3,800 to 4,200 ft. (see Figure 6). Most of these summits possess broken up and disintegrated boulders of laterite instead of extensive sheets as in the Buganda Catena. The pediments are long and more gently inclined, with slope gradients between 5 to 8 per cent. and dissected by broad valleys. The proportion of the uplands occupied by the pediments is higher than in Buganda and may be as much as 80 per cent.

The parent material of the upland soil series of these catenas is derived predominantly from the weathering products of Basement Complex gneisses and granitoid rocks which give rise to red or brown loams with varying quantities of quartz gravel and stones.

Another basic similarity is the arrangement and distribution of the main soil horizons in the pediment components of each of these catenas. A humose topsoil is underlain by red or brown (depending on internal drainage) sandy or gravelly loam or clay loam to the depth of 2 to 3 ft. or more and followed by a quartzite-concretionary horizon (a stoneline) consisting of quartz stones and gravel, some murram and, occasionally, boulders of relic ironstone. This horizon is 1 to 3 ft. thick and though compact it is rarely cemented, breaking down easily on digging. The stoneline rests on a strongly-mottled and indurated-lateritic horizon, several feet thick and gradually merging into the weathered, friable rock.

The lowest pediment sections of these catenas often display "hillwash" components consisting of yellow-brown loams or sands underlain by thin stonelines which may rest directly on the weathered rock. There is little or no lateritization here, indicating that these soils are of a much more recent origin than their higher catenary associates.

Soils of summits and steep upper slopes are very similar in their profile morphology to the shallow associates of the Buganda Catena. They have developed from the broken-up relic ironstone or from only slightly weathered primary rocks and are typical skeletal soils with little horizon development.

All these similarities are counterbalanced by far-reaching differences in the type of climate and the resulting vegetation with its effect on the soils and particularly on the A_1 horizons. Furthermore, there is a slow but progressive change in texture of the subsoil from the Kabira Series which is generally the heaviest to Mawogola and its variant Makole Series which tend to be gravelly.

The upland components of the Kabira Catena with the exception of the skeletal soils, are virtually forest soils with an average rain-

fall of well over 40 and up to 55 in. per year. Even if the original forest has been destroyed for cultivation there is a well-marked tendency to forest regeneration. Signs of this regeneration are quite apparent since fallow land is rapidly invaded by woody shrubs which, if left undisturbed, grade into a forest thicket.

The organic-carbon content in the humose topsoil of the Kabira Series (2.5 to 4.0 per cent.) is typically higher than that of the Mirambi Series (1.5 to 2.5 per cent.), and is definitely much higher than either in the Mawogola or Makole Series (1.0 to 1.5 per cent.). Another characteristic feature of Kabira soils is their pH trend. They are typically very acid in the topsoil (pH of about 5 or sometimes less) and become somewhat less acid with depth.

Mirambi soils are under a lower rainfall of about 40 in. or less per annum and though there is some evidence that they may have been under forest vegetation in the past, the present plant successions are dominated by tall grasses, particularly elephant grass, forming almost pure stands on fallow land. The pH trend in the profile is the reverse to that of the Kabira Series; typically the topsoils are only slightly acid to near neutral in reaction (pH 6 or sometimes more) and there is a marked increase in acidity with depth. The amounts of exchangeable bases and the percentage base saturation are higher than in the Kabira Series though the total exchange capacities are lower: 10 to 15 m.e. in the topsoil as compared to 20 to 25 m.e. in the Kabira. It is possible that the deep-rooted grasses so readily growing on Mirambi soils are largely responsible for the mining of bases which would have been lost by leaching and that the subsequent burning of the grasses causes the deposition of these nutrients in the topsoil in the form of ash.

The average annual rainfall over the Mawogola Catena is only 30 to 35 in. and there is a relatively severe dry season.

The catena is under a short-grass savanna with Themeda triandra and Cymbopogon afronardus as the dominant grass species. The presence of scattered fire-tolerant shrubs and trees is another outstanding feature typical of the Mawogola Catena only.

The pediment associates tend to be more gravelly than their counterparts in the Mirambi Catena, with large amounts of coarse-quartz gravel in both the topsoil and subsoil. It is thought that this feature is not merely a minor textural difference but that it bears out the corresponding difference in mineral composition of the original parent rock. This is also shown in the presence of far less numerous boulders of laterite on hill summits most of which represent huge dykes of quartz which has undergone a good deal of fragmentation.

Largely due to the effect of a drier climate and savanna vegetation, the organic-carbon content in the humose topsoil of the Mawogola Series is lower than in the Mirambi. Although the pH trend in the profile shows a pattern similar to that of the Mirambi the A_1 horizons tend to be more acid than those of the Mirambi, with pH values falling below 6 in the topsoils and below 5 in the subsoils.

4. Kabira Catena

There are two main components of this catena - Kabira "Medium" and Kabira "Ferruginized" soils.

Profile 10 (14636-14641): Kabira "Medium"

Mile 3 from Kiziba to Kalisizo; upper pediment, altitude 4,000 ft.; rainfall 45 in. p.a.; under grass and shrub fallow.

0-3" Dark brown (7.5YR,3/2) humose, sandy-clay loam with occasional fine-quartz gravel. Crumbly and firm. A_1.

3-9" Dark brown (7.5YR,4/2) stained with humus, sandy-clay loam with frequent quartz gravel. Weakly crumbly and firm. A_3.

9-18" Yellow-red (5YR,4/6) slightly stained with humus, sandy-clay loam with occasional murram and quartz stones. Weak sub-angular blocky structure. Slightly compact. B.

18-27" Yellow-red (5YR,4/8) sandy-clay loam with occasional scattered murram and quartz stones. Structureless and firm. C.

27-44" Yellow-red (5YR,5/6) sandy-clay loam with frequent murram, abundant quartz stones and occasional fragments of ferruginized rock.

44-72" Reddish-yellow (7.5YR,6/6) mottled red, grey, yellow and brown, loam indurated and partly ferruginized. Lateritic horizon.

Morphologically, this profile may be regarded as a more advanced state in the development of the pediment associates of Buganda. Stonelines are generally much thicker and may attain 3 ft. or more. They are always underlain by a well-developed semi-indurated lateritic horizon (as opposed to an incipient one in Buganda), several feet thick, which gradually merges into the weathered and friable gneiss or granite. The uniform subsoil above the quartzose horizon is more gravelly and always shallower than in a typical Buganda Series. There is also evidence that the quartzose horizon in the Kabira, unlike the stoneline in the Buganda Series, has been derived largely in situ through the residual accumulalation of quartzite from numerous quartzite veins, the basal proportions of which are well preserved in the lateritic horizons. Iron concretions in the quartzose horizons are typically irregular in shape and size and were probably formed as a result of precipitation of iron in the open spaces between the quartzite stones and gravel above the difficultly permeable lateritic horizon which has prevented or at least seriously inhibited further downward percolation of the solution.

Analytical Data. The most outstanding feature of the Kabira Series is its extreme acidity (pH 5 or less); it is one of the most acid upland soils encountered in the Kingdom. The exchangeable complex shows very low percentages of base saturation (4.5 to 19.6 per cent) with potassium and magnesium being particularly deficient. On the other hand, organic matter, especially under undisturbed conditions or in an old fallow, is generally higher than in Buganda soils and the content of

phosphorus in the topsoil (43 p.p.m.) appears to be sufficient for agricultural crops.

Profile 11 (18602-6): Kabira "Ferruginized"

Mile 3½ from Kasanje to Buyege; lower pediment; rainfall 45 in. p.a.; under thicket.

0-3" Dark reddish-brown (5YR,3/3) humose, sandy loam with occasional murram. Weakly crumbly and firm. A_1.

3-7" Reddish-brown (5YR,4/3) stained with humus, sandy loam with frequent murram. Weakly crumbly and firm. A_3.

7-18" Reddish-brown (2.5YR,4/4) very slightly stained with humus, sandy loam with abundant murram. Structureless and slightly compact. Transition to C.

18-32" Red (2.5YR,4/6) sandy loam with abundant, hard and irregular in shape, murram. Structureless and slightly compact. C.

32-48" Yellow-red (5YR,5/8) mottled yellow, brown and rusty, massive laterite. Hard and ferruginized.

The morphology and origin of this profile is similar to that of the Buganda "Brown Ferruginized". If it had not been for their occurrence in different soil catenas a common series name for these two soils would have been justified.

Analytical Data. There is also a strong resemblance between this profile and the Buganda "Brown Ferruginized" in respect of major plant nutrients with the possible exception of available phosphorus in the A_1 horizon which tends to be higher in the Kabira "Ferruginized" (67 p.p.m. in the topsoil).

Agricultural Characteristics. The pediment associates of the Kabira Catena are often intensively cultivated with robusta coffee, plantains and cotton as the principal cash crops. None of these crops, however, appears to thrive on these soils and the general impression gained in the course of the survey was that the crop yields were markedly lower than in the Buganda Catena. Cotton plants, in particular, were frequently poor in appearance due, no doubt, to high acidity.

With the exception of shallow or eroded associates, the Kabira soils should prove responsive to artificial manuring in order to maintain the readily exhaustible nutrient supply and to make up for nutrient deficiencies, but in their present state they would be more suitable for the production of tea than other crops since tea plants are well adapted to growing in very acid soils.

5. Mirambi Catena

The following profile is an example of a deep Mirambi soil.

Profile 12 (14879-84): Mirambi "Brown Deep"

Near Kyanamukaka; middle pediment, altitude 4,000 ft.; rainfall 40 in. p.a.; under grass and herb fallow.

0-3" Dark grey (10YR,4/1) humose, sandy-clay loam. Crumbly and firm. A_1.

3-11" Dark brown (10YR,4/3) stained with humus, sandy clay loam with frequent fine-quartz gravel. Weakly crumbly and firm. A_3.

11-22" Light yellow-brown (10YR,6/4) slightly stained with humus, sandy loam with frequent fine-quartz gravel. Weak sub-angular blocks. Slightly compact. Transition to B.

22-34" Strong brown (7.5YR,5/6) sandy loam with frequent fine-quartz gravel. Sub-angular blocks of varying stability. Slightly compact. B.

34-54" Strong brown (7.5YR,5/6) sandy loam + frequent fine-quartz gravel and quartz stones. Stoneline.

54-72" Strong brown (7.5Yr,5/6) mottled red, grey and yellow, gravelly loam. Indurated and partially ferruginized. Lateritic horizon.

Analytical Data. In comparison with Kabira soils a typical Mirambi soil is much less acid and less leached though both the pH and percentages of base saturation which are above 6.0 and more than 50 per cent., respectively, gradually decrease with depth till they reach the levels comparable to those prevailing in the topsoil of the Kabira Series. None of the major nutrients shown by analyses appears to be in short supply, at least in the topsoil, though the content of organic matter is comparatively low (1.68 per cent. of carbon) but this may have resulted from intensive cultivation in the past and may well be the vegetation at the time of sampling.

Agricultural Characteristics. The agricultural productivity of the pediment associates of Mirambi is comparable to their counterparts in the Buganda Catena. These soils support numerous high-bearing coffee plantations, good cotton and a wide range of food crops including plantains. Crop failures on the recently cultivated phases of Mirambi are more likely to be caused by the shortage of soil moisture in a severe dry spell rather than by nutrient deficiencies though the long and continuously cultivated areas tend to lose their inherent fertility somewhat more rapidly than similar areas in the Buganda Catena owing to less favourable physical properties, i.e., higher content of gravel, less stable structure, lower content of humus and generally shallower subsoils.

6. Mawogola Catena

Two components of this catena will be described in detail - Mawogola "Medium" and Mawogola "Hillwash".

Profile 13 (14842-7): Mawogola "Medium"

Mile 1 from Lwengo to Mbirizi; middle pediment; rainfall 30-35 in. p.a.; under burned savanna.

0-3" Very dark grey-brown (10YR,3/2) stained with humus, sandy loam + frequent fine- and occasional coarse-quartz gravel. Weakly granular and firm. A_1.

3-8" Dark grey-brown (10YR,4/2) stained with humus, sandy loam + frequent fine- and coarse-quartz gravel. Weakly granular to structureless and firm. A_3.

8-18" Brown (7.5YR,5/4) gravelly loam + frequent coarse-quartz gravel. Structureless and slightly compact. Transition to C.

18-30" Strong brown (7.5YR,5/6) gravelly loam + frequent coarse-quartz gravel + occasional scattered quartz stones. Structureless and slightly compact. C.

30-48" Strong brown (7.5YR,5/6) slightly mottled red, grey and yellow, gravelly loam. Slightly indurated and slightly ferruginized. Incipient lateritic horizon.

48-60" Reddish-yellow (7.5YR,4/6) gravelly loam with frequent traces and fragments of weathered granitoid rock. Friable.

This mid-slope soil from the Mawogola Catena is essentially similar to the Mirambi, but its topsoil and subsoil are more gravelly, the quartzite horizon contains few or no iron concretions and the underlying lateritic horizon is far less pronounced and thinner, merging quickly into the weathered and friable gneiss. Due mainly to a lighter texture, a higher content of gravel inducing a more efficient internal drainage and possibly also a low content of iron-bearing minerals in the parent material, the process of lateritization has never reached the stage common in Mirambi and Kabira soils.

Analytical Data. In comparison with the Mirambi, the Mawogola Series has a much lower pH, decreasing to less than 5.0 below the topsoil, a lower percentage of base saturation (5.8 to 30.9 per cent.) and generally a low content of exchangeable bases. It is also deficient in available phosphorus (10 p.p.m. of P_2O_5) and its organic matter status is inferior to that of the Mirambi.

Profile 14 (14974-9): Mawogola "Hillwash"

Near Lwemiyaga; lower slops, altitude 3,900 ft.; rainfall 30-35 in. p.a.; under burned savanna.

0-5" Very dark grey (10YR,3/1) humose sandy loam with frequent quartz gravel. Weakly crumbly and loose. A_1.

5-12" Dark grey (10YR,4/1) stained with humus, loamy sand with frequent quartz gravel. Structureless and loose. A_3.

12-20" Dark grey-brown (10YR,4/2) slightly stained with humus, loamy sand with frequent quartz gravel. Structureless and loose. Transition to C.

20-28" Pale brown (10YR,6/3) loamy sand with frequent quartz gravel. C.

28-36" Pale yellow (2.5Y, 7/4) sand with frequent quartz gravel and quartz stones. Stoneline.

36-48" Pale yellow (2.5Y, 7/4) sand with traces of weathered bedrock.

The upper part of this profile down to the stoneline appears to consist of transported material of colluvial or alluvial origin. Many quartzite stones in the stoneline horizon are semi-rounded and show signs of wearing as a result of water transport. Apart from occasional transported iron concretions in the stoneline there is no laterite in the profile largely consisting of quartz sand with a very low content of weatherable minerals.

Analytical Data. In comparison with the upland associates Mawogola "Hillwash" soil is less acid (pH 5.76 in the topsoil) and its exchange complex shows much higher percentages of base saturation throughout the profile (39.3 to 67.6 per cent.). The content of exchangeable magnesium is very high in all the horizons (8.8 m.e. in the topsoil and never less than 3.0 m.e. in any other horizon) markedly exceeding that of calcium and potassium together. The high content of magnesium in all the soil horizons suggests an enrichment of this element due to leaching from higher catenary sites and internal downslope movement. This also applies to a certain extent to calcium and potassium which, though present in much smaller quantities, show a very similar trend of distribution in the profile.

As in the Mawogola soil, the content of organic matter and available phosphorus is very low (1.47 per cent. and 10 p.p.m., respectively).

Agricultural Characteristics. With the exception of small areas around some settlements Mawogola soils are very sparsely cultivated but their savanna is extensively grazed by locally numerous herds of cattle. Unlike Mirambi and Buganda soils they are seldom suitable for tree crops and plantains, though capable of supporting a variety of annual crops such as cotton, groundnuts, small grains and semi-perennials such as cassava and pigeon peas.

The low agricultural potential of Mawogola soils is primarily due to their inferior moisture-holding capacity aggravated by the comparatively low rainfall. Under such conditions the prospects of farming are limited and the choice of economic crops narrowed either to those which are able to survive prolonged periods of drought, or to rapid-growing annuals capable of completing their cycle of growth during the rainy season.

7. Makole Series

This series occurs within the Mawogola Catena but it is also dominant and, therefore, mapped separately over a small area in the west of the Province as shown on Map 7. The Makole differs from a normal Mawogola Series in being even more gravelly in both the topsoil and subsoil and in possessing recognizable traces of weathered rock at a comparatively shallow depth. There is very little or no lateritization within the profile and the subsoil merges into the weathered rock without being separated from it by the lateritic horizon as in the Mirambi or Kabira soils. A typical profile is described below.

Profile 15 (15011-6): Makole Series

Mile 18 from Ntusi to Mubende; middle slope; rainfall 30 in. p.a.; under Cymbopogon afronardus and Acacia spp.

0-3" Dark grey (2.5Y,4/0) stained with humus, coarse-sandy loam + frequent fine- and coarse-quartz gravel. Weakly crumbly and loose. A1.

3-9" Grey-brown (2.5Y,5/2) slightly stained with humus, coarse-sandy loam + frequent quartz gravel. Structureless and loose. A3.

9-19" Grey-brown (2.5Y,5/2) very slightly stained with humus, gravelly loam. Structureless and firm. Transition to C.

19-30" Brown (10YR,5/3) gravelly loam + abundant quartz gravel + occasional quartz stones + occasional minute flakes of muscovite. Structureless and firm. Transition to C.

30-48" Light yellow-brown (10YR,6/4) gravelly loam + abundant quartz gravel + frequent flakes of muscovite + occasional traces of weathered granite. C.

48-72" Weathered granite. C.

This profile is developed predominantly in situ through the progressive weathering of the underlying parent rock. Its two main features are: the absence of a structural or textural B horizon, the formation of which is being prevented by a rapid eluviation of clay from the upper horizons and the absence of lateritic products in any form due to excessive internal drainage and an extremely low content of ferromagnesian minerals in the parent rock.

Analytical Data. As in the case of Mawogola soils, organic carbon (1.49 per cent.) and available phosphorus (23 p.p.m.) are low but the exchangeable bases are much higher in the topsoil (calcium 2.8 m.e., magnesium 2.8 m.e., potassium 0.81 m.e.) and although they decrease in the middle horizons, where lateral eluviation and leaching are most intensive, they rise again in the bottom horizons full of weathering feldspar and mica which constantly release fresh supplies of these elements.

Agricultural Characteristics. The Makole Series is similar in its productive capacity to Mawogola soils but the presence of abundant gravel and stones causes a rapid percolation of rain water through the profile and consequently its moisture-holding capacity may even be lower than that of the Mawogola Series.

8. Mityana Catena

This catena is associated with rolling hills with summits at 4,000 and occasionally up to 4,300 ft. above sea level. Most of the summits contain boulders of massive relic laterite and the soils that have developed from them resemble those occurring on similar sites in the Buganda or the Mirambi Catenas.

The general relief is similar to that of the Mirambi Catena. Under the average annual rainfall of 40 to 45 in. the area supports tall-grass savanna with a more or less suppressed tendency to forest regrowth.

The pediment soils consist of red to yellow-brown (depending on drainage as controlled by the site) gravelly loams, similar in appearance to their topographic counterparts in the Buwokula Catena but developed from weathering products of very coarse-grained arkose sandstones. A typical profile is described below.

Profile 16 (18290-5): Mityana "Red"

Mile 18 from Mityana to Kawungera; upper pediment; rainfall 40 to 45 in. p.a.; under grass and herb fallow.

0-3" Dusky red (2.5YR,3/2) humose sandy loam + occasional quartz gravel. Granular and firm. A_1.

3-9" Dark reddish-brown (2.5YR,3/4) stained with humus, gravelly loam + frequent coarse-quartz gravel. Weakly granular and firm. A_3.

9-17" Red (2.5YR,4/6) slightly stained with humus, gravelly loam. Structureless and slightly compact. A_3.

17-36" Red (2.5YR,4/8) gravelly loam + frequent coarse-quartz gravel + abundant murram + frequent fragments of gritty ironstone. Closely packed. Concretionary stoneline.

36-54" Red (2.5YR,4/8) gravelly loam + traces of weathered arkose. Structureless and slightly compact. Transition to C.

54-72" Weathered arkose, stained pink, white, yellow and red. Friable. C.

The presence of the concretionary stoneline with sharply defined uppermost and lowermost boundaries and with relic murram and ironstone boulders such as occur on the summits of this catena may indicate that the upper part of the profile, including the stoneline, has been moved by hill creep. However, soil movements appears to have been slow, gradual and confined to the same slope so that the soil material derived from arkose sandstone of the upper slope now overlies a similar weathered sandstone lower down and not far from the place of its origin.

Analytical Data. The fine-earth fraction of this Mityana profile shows a relatively high clay content even in the eluviated A horizon (36 to 38 per cent.) but abundance of coarse-quartz gravel imparts a light loamy field texture to the soil. The high content of clay, particularly in the lower horizons, may be related to the nature of the parent sandstone which generally contains a lot of feldspar locked up between quartz crystals.

The chemical analysis of the profile shows a satisfactory supply of exchangeable bases (total 9.43 m.e. in the topsoil) but the contents of organic matter and available phosphorus are comparatively low (1.89 per cent. and 30 p.p.m., respectively). The pH of the topsoil is 5.9 but a number of composite surface samples taken from various parts of this catena show generally greater acidity with pH values of less than 5.5 and a lower supply of plant nutrients.

Agricultural Characteristics. All the common annual and perennial crops are grown on the pediment associates of the Mityana but the yields are generally much lower than in the Buganda Catena. The only exception is tea, grown in a number of plantations within this soil unit. This crop is thriving well and is producing highly economic yields.

9. Mabira Catena

The general relief of this unit is similar to that of the Mirambi Catena but the pediments are somewhat steeper and the hills themselves are more ridge-like in appearance with long and generally rounded crests.

The average annual rainfall is 45 to 50 in. and the natural vegetation, still retained in the forest reserves, is a moist semi-deciduous forest. Secondary plant successions on fallow farmland consist of elephant grass rapidly merging into a woody stage represented by forest shrubs and trees. Most of the valleys in the area are covered by swamp vegetation, mainly papyrus and the valley fringes are often occupied by swamp forest.

As with other catenas, the upland soil sequence is derived from two different kinds of parent material. The summit and upper slopes are developed over relic ironstone and the pediment soils from weathering products of phyllite with minor occurrences of amphibolite, which give rise to red or yellow clays. Unlike Koki soils the "red" associates of the Mabira Catena are strongly lateritized and contain well-developed murram horizons. Two typical profiles are described below.

Profile 17 (19794-9): Mabira "Red"

Mile 1 from Najemba to Lugazi; middle pediment; rainfall 45 to 50 in. p.a.; under forest.

$\frac{1}{4}$-0" A layer of partially decomposed leaf litter. A_{00}.

0-3" Dark reddish-brown (2.5YR,3/4) stained with humus, clay. Granular and firm. A_1.

3-8" Dark red (2.5YR,3/6) slightly stained with humus clay. Weakly granular to sub-angular structure. A_3.

8-18" Red (2.5 YR,4/6) very slightly stained with humus, clay. Sub-angular blocks. Slightly compact. B.

18-30" Red (2.5YR,4/6) clay. Structure and consistence as above. B.

30-40" Red (2.5YR,4/6) clay. Structureless and friable. C.

40-60" Red (2.5YR,4/6) clay + frequent murrum.

The profile morphology and mode of formation of this soil is similar to that of the Buganda Clay Loam, the main differences being a higher clay content (well over 60 per cent. in the lower horizons) and generally a better nutrient status particularly in respect of organic matter (4 to 6 per cent. carbon) and exchangeable bases.

However, the high fertility of Mabira soils is by no means widespread over the whole unit but characteristically confined to the vicinity of basic rock outcrops, such as amphibolite, which release large quantities of calcium and magnesium on weathering. Elsewhere, Mabira soils are far more acid and their nutrient status is comparable to that of the Koki "Red" soil. For these reasons no analytical data for Mabira profiles are given in the text since, owing to a rather wide range in fertility, it would be

very difficult to define any set of these data as typical of the upland associates of the Mabira Catena.

Profile 18 (19800-5): Mabira "Yellow"

Mile 2 from Najombe to Jinja; lower pediment, altitude 4,000 ft.; rainfall 45 to 50 in. p.a.; under forest.

¼-0" Partially decomposed leaf litter. A_{oo}.

0-3" Brown (10YR,5/3) stained with humus clay + occasional fine-quartz gravel. Granular and firm. A_1.

3-9" Light yellow-brown (10YR,6/4) slightly stained with humus, clay + occasional quartz gravel. Weak granular to sub-angular structure. Slightly compact. A_3.

9-18" Brownish-yellow (10YR,6/8) faintly streaked with humus clay + occasional quartz gravel. Structureless and slightly compact. Transition to C.

18-36" Yellow (10 YR,7/6) clay. Structureless and compact. C.

36-60" As above + occasional quartz stones and more frequent gravel.

60-72" Reddish-yellow (7.5YR,6/6) clay + abundant quartz stones and gravel. Stoneline.

Mabira "Yellow" is a topohydric variant of Mabira "Red". The well-sorted and uniform soil material above the stoneline and the stoneline itself are probably of colluvial origin but the presence of occasional rounded quartzite stones and the proximity of the profile to the river valley indicate that the soil may include the remnants of old river terrace material.

Agricultural Characteristics. Mabira soils are intensively cultivated and are generally very productive. They successfully support all the common annual and perennial crops.

10. Nakabango Catena

This catena is associated with rolling to gently rolling hills with summits at 4,000 to 4,200 ft. The general relief, climate and vegetation are very similar to that of the Mabira Catena with which Nakabango soils form a complex association elsewhere.

The parent material of the pediment soils is derived from weathering products of basic rocks, i.e., amphibolites, amphibolite schists and dolerites which give rise on weathering to bright red or reddish-brown clays. Two typical profiles are described below.

Profile 19 (20617-21): Nakabango "Medium"

Mabira Forest Reserve; upper pediment, altitude 4,200 ft.; rainfall 40 to 45 in. p.a.; under forest.

¼-0" A layer of partially decomposed leaf litter. A_{oo}.

0-3" Dark grey (10YR,4/1) stained with humus and plastic clay. Granular and slightly compact. A_1.

3-9" Dark greyish-brown (10YR,4/2) slightly stained with humus, plastic clay. Stable sub-angular to angular blocks. Compact. A_3.

9-18" Dark greyish-brown (10YR,4/2) plastic clay. Irregular cracks slightly stained with humus. Compact. B.

18-36" Dark yellow-brown (10YR,4/2) plastic clay. Irregular cracks. Compact. B.

36-72" Brownish-yellow (10YR,6/8) stained black (MnO_2) clay + abundant fragments of partially weathered amphibolite schist. Slightly compact. C.

This soil appears to have been formed largely in situ by progressive weathering of the underlying rock which occurs at relatively shallow depths. It may easily be distinguished from all the other upland soils in Buganda by its stickiness when wet and the relatively wide and irregular cracks on drying due to the almost complete absence of a quartz sand fraction.

The sites of the red Nakabango "Medium" soil (upper pediment) are normally well drained. The brown colour of this series, however, may indicate impeded internal drainage, but a low content of iron oxides which have not been fully released from ferromagnesian minerals may also be a contributing factor.

Analytical Data. The Nakabango "Medium" profile belongs to the group of the most fertile soils not only in Buganda but in Africa as a whole. One of the most characteristic features is the reaction profile; the topsoil is neutral with a pH of 7 or even a little more, decreasing very gradually with depth. A similar trend is displayed by the exchangeable bases of which magnesium may even increase with depth. Exchange capacities are twice as high as those of Buganda Clay Loam and the very high percentages of base saturation remain constant throughout the profile.

Profile 20 (20627-32): Nakabango "Red"

Mabira Forest Reserve; middle pediment, altitude 4,000 ft.; rainfall 45 to 50 in. p.a.; under forest.

¼-0" A layer of partially decomposed leaf litter.

0-3" Dusky red (2.5YR,3/2) stained with humus plastic clay. Granular and firm. A_1.

3-8" Dark reddish-brown (2.5YR,3/4) slightly stained with humus, plastic clay. Granular to sub-angular structure. Slightly compact. A_3.

8-18" Dark red (2.5YR,3/6) slightly stained with humus, plastic clay. Large sub-angular blocks. Slightly compact. B.

18-36" Dark red (10YR,3/6) clay. Large sub-angular blocks. Distinct clay skins. Compact. B.

36-58" As above. Irregular cracks. Compact. Transition to C.

58-72" As above. Less compact. Frequent traces of weathered basic rock. C.

This series differs from the Nakabango "Medium" in the higher clay content, particularly in the lower horizons (up to 75 per cent. - the highest figure in the soils of Buganda), the greater depth of weathering and the presence of easily recognizable clay skins.

Analytical Data. The fertility of the Nakabango "Red" is comparable to that of the Nakabango "Medium", as shown by the high content of plant nutrients in the topsoil and in the immediately underlying horizons. The slightly alkaline or neutral reaction in the topsoil, however, becomes progressively more acid with depth but the change is never as abrupt as in other upland soils. Both exchange capacities and percentages of base saturation, though still high when compared with Buganda soils, show a marked tendency to decrease with depth.

In general, the Nakabango "Red" soil though still possessing a reserve of minerals which release plant nutrients on weathering is, nevertheless, more dependent for its fertility on organic matter than the Nakabango "Medium".

Minor Soil Occurrences. Scattered among the catenary associates of the Nakabango and the adjoining mapping units are inextensive patches of yellow soils also derived from basic rocks (amphibolite). These soils greatly differ from the Nakabango Series in being extremely acid (pH below 5) and extremely unsaturated with bases though their total exchange capacities are high and comparable to those of Nakabango soils. The causes of such conditions are unknown at present and the problem requires special investigation.

Agricultural Characteristics. As already stated, the normal associates of the Nakabango Catena, i.e., Nakabango "Medium" and Nakabango "Red", are the most fertile soils in the Protectorate and they support a wide range of agricultural crops.

The most productive robusta coffee estates are situated on this soil as well as large portions of the two sugar estates. The most base-rich areas, such as saddles between valleys, have been found unsuitable for tea although their pH values are just below 6.0. Plantains grow luxuriantly and cacao is now being tried.

The yellow soils within this catena, such as those at Kagongo Farm, South Kyagwe, are very unproductive chiefly due to high acidity and deficiencies of nitrogen, phosphate and sulphur.

10A. Kamusene Series

This series is closely related to Nakabango "Red" soil in respect of the parent material and profile morphology but it occurs in complex association with a number of major catenas in the Province, forming small and scattered, though locally frequent, expanses. Kamusene soil is generally far more deeply and more thoroughly weathered than Nakabango "Red" and there is less clay present and fine-quartz gravel is scattered throughout the subsoil. Occasionally, the remnants of thin quartz veins are present at depth and these may indicate that the Kamusene Series may have developed from a mixture of basic and acid rocks. A typical profile is described below.

Profile 21 (17154-9): Kamusene Series

Mile 2½ from Kagadi to Sunga; lower pediment, altitude 3,900 ft.; rainfall 45 to 50 in. p.a.; under elephant grass fallow.

0-3" Dark reddish-brown (5YR,3/3) heavily stained with humus, clay. Moderately plastic when wet. Granular and firm. A_1.

3-8" Reddish-brown (5YR,4/4) stained with humus, clay. Moderately plastic when wet. Granular to sub-angular structure. Slightly compact. A_3.

8-16" Dark red (2.5YR,3/6) streaked with humus plastic clay with occasional fine-quartz gravel. Large sub-angular to angular blocks. Slightly compact. B_1.

16-36" Red (10R,4/8) plastic clay + occasional fine-quartz gravel. Large sub-angular to angular blocks. Compact. B.

36-60" Red (10R,4/8) plastic clay + frequent fine-quartz gravel and occasional quartz stones. Structureless and firm. Transition to C.

60-72" As above. Scattered, spheroidally weathered boulders of dolerite.

One of the characteristic features of the Kamusene Series is the presence of occasional spheroidal boulders of dolerite scattered in the otherwise uniform subsoil which is devoid of any visible traces of weathered rock. These boulders appear to have resisted weathering far better than the parent rock of Kamusene and their contribution to soil formation is probably negligible.

Analytical Data. Kamusene differs from Nakabango soil in being more acid (pH 6 or less), deficient in available phosphorus (15 p.p.m. of P_2O_5 in the topsoil, possessing a lower exchange capacity (20.82 m.e.) and lower percentages of base saturation (67.8 to 18.2 m.e. with depth). In all these respects Kamusene is similar to Buganda Clay Loam but the higher content of clay (up to 60 per cent.) and its still considerable plasticity together with the presence of basic rocks bring it close to Nakabango Red. In many ways the Kamusene Series appears to be transitional between Nakabango and Buganda soils.

Agricultural Characteristics. Both fertility and productivity of the Kamusene series are comparable to those of Buganda Clay Loam.

10B. Kibula Series

This series is another member of the Nakabango group of soils derived from weathering products of basic rocks. As in the case of the Kamusene Series, the Kibula appears to have developed from a mixture of basic and acid rocks with a proportion of the latter being higher than in the Kamusene.

The parent material of this soil consists of red clay with more frequent quartz gravel and stones.

Unlike the Nakabango and Kamusene which remain under forest or forest regrowth, the Kibula Series occurs in the short-grass Acacia savanna with an average annual rainfall of 30 to 35 in. A typical profile is described overleaf.

Profile 22 (14998-15003): Kibula Series

Mile 11 from Ntusi to Mubende; middle slope; rainfall 30 to 35 in. p.a.; under short-grass Acacia savanna.

0-3" Dark reddish-brown (5YR,3/2) stained with humus, clay + occasional fine-quartz gravel. Crumbly and firm. A_1.

3-8" Dark reddish-brown (5YR,3/3) slightly stained with humus, clay + occasional quartz gravel. Weakly crumbly and firm. A_3.

8-18" Dark reddish-brown (2.5YR,3/4) clay + occasional to frequent fine-quartz gravel. Sub-angular blocky structure. Slightly compact. B.

18-30" Dark red (2.5YR,3/6). As above. Compact. C.

30-42" Dark red (2.5YR3/6) clay + frequent fine- and occasional coarse-quartz gravel. Slightly plastic when wet. Structureless and increasingly friable. C.

42-60" As above. Friable. C.

The clay fraction of this series is similar in its field properties to that of Buganda Clay Loam and the whole soil when viewed in a profile box could be correlated as Buganda Series. The only morphological difference is the dark red colour of the subsoil of the Kibula, similar to that of the Nakabango and the Kamusene. Furthermore, unlike the Buganda, the Kibula Series characteristically occurs in small and scattered expanses in larger mapping units. These expanses are associated with the presence of basic dykes as in the case of the Kamusene Series.

Analytical Data. When compared to Buganda soils, the Kibula Series shows a low content of organic matter (less than 2 per cent. of carbon) and of available phosphorus (10 p.p.m.). Both the exchangeable calcium and magnesium concentrated in the surface horizon decrease with depth and are lowest in the middle horizons rising again in the bottom horizon. The amount of magnesium in the surface horizons tends to be higher than that of calcium. There is a corresponding trend in the pH values, total bases and percentage base saturation indicating the highest intensity of leaching and/or feeding zone of plants in the middle horizons.

Agricultural Characteristics. Largely because of the comparatively low rainfall, the Kibula Series is less productive than Buganda Clay Loam but is, nevertheless, agriculturally superior to Mawogola and Makole soils with which it is frequently associated. The main assets of the Kibula soils are heavy texture and deep uniform subsoil which increase its moisture-holding capacity and allow for a free penetration of plant roots. These are probably the main reasons why the Kibula series is cultivated in preference to either the Mawogola or the Makole, which results in a distinctly higher concentration of farm plots on this series. Although the Kibula series under the present level of management may not be capable of supporting high yielding tree crops it should be eminently suitable for annual crops, particularly for cotton and heavier types of tobacco.

11. Lukaya Catena

This catena occurs on gently rolling ridges with crests at 4,000 to 4,200 ft., and with occasional isolated peaks of 4,600 to 4,800 ft. The hill pediments are not as well marked as in the Buganda or the Mirambi Catenas and there is no sharp break between the summit and the remainder of the slope.

The average annual rainfall is about 40 in. or a little less and the dominant vegetation type is represented by a mixture of short and medium grasses with an unstable elephant grass regrowth on fallow land.

The catenary sequence consists of shallow, bouldery associates derived from quartzite veins and quartz-mica schists, occurring on the crests of ridges. The few scattered high hills constitute an interesting landscape feature; their summits are distinctly flat and contain boulders of relic ironstone, which may be correlated with that of the mid-Tertiary (or Buganda) Surface. These ferruginous platforms appear to rest unconformably on quartz-mica schists which are associated with the Lukaya soils elsewhere in the area.

The slope associates of the Lukaya Catena consist of brown to yellow-brown loams underlain by relatively thin (6-12 in.) but distinct stonelines often including a few semi-rounded quartz stones and some murram. Contemporary lateritization is only apparent in the lower sections of the slope where soil profiles display an incipient mottled lateritic horizon just below the stoneline. The stonelines in the upper and middle slope associates rest more or less directly on the weathered bedrock which consists of pale pink, grey and yellow, micaceous and schistose metasediments. Despite free drainage there is an almost complete absence of red associates from this catena and practically all the free-drained soils are brown in colour. The absence of the red colour is probably due to the combined effect of intensive leaching and of the mineral composition of the parent material derived from rocks poorly supplied with iron-bearing minerals. A typical upland associate is described below.

Profile 23 (16795-800): Lukaya Series

Mile 4½ from Debesa to Kitenga; middle slops, altitude 3,900 ft.; rainfall 40 in. p.a.; under grass and herb fallow.

0-3" Dark greyish-brown (10YR,4/2) stained with humus, loam with occasional quartz gravel. Crumbly and firm. A_1.

3-8" Brown (10YR,5/3) slightly stained with humus, loam + occasional quartz gravel. Weakly crumbly and firm. A_3.

8-18" Brown (7.5YR,5/4) loam with frequent fine-quartz gravel. Weak sub-angular structure. Slightly compact. (B).

18-36" Yellow-red (5YR,5/6) loam + frequent quartz gravel. Structureless and increasingly friable. C.

36-48" Yellow-red (5YR,5/6) loam + frequent fine- and coarse-quartz gravel + occasional quartz stones + occasional semi-hard murram. Structureless and friable. C.

48-60" Yellow-red (5YR,5/6) sandy loam + abundant quartz stones (some semi-rounded) + occasional hard murram.

The soil material above the stoneline appears to have been transported by creep but the movement was generally confined to the same slope so that the transported material overlies the weathered bedrock similar to that from which it was derived.

Analytical Data. The Lukaya Series is of medium to low fertility particularly in respect of organic matter (1.71 per cent. of carbon) and phosphorus (11 p.p.m.). The exchangeable bases are not only low but appear to be concentrated in the surface horizon only. The underlying soil material is both very acid (pH below 5) and extremely deficient in all plant nutrients.

Agricultural Characteristics. The middle slope or pediment types of the Lukaya Series are inferior in their agricultural potential to the corresponding associates of the Buganda and Mirambi Catenas though they have a higher moisture-holding capacity than the Mawogola soils. Although the planting of all the common crops has been attempted on these soils neither robusta coffee nor plantains are yielding well. In their present state Lukaya soils are better suited to the production of annual crops, such as groundnuts and tobacco.

Soils Associated with the Tanganyika Pedeplain (end-Tertiary)

12. Buyaga Catena

This unit is associated with a very advanced stage of erosion of the mid-Tertiary Surface and, consequently, a large part of it, particularly in the north, is classified under the heading of soils associated with the end-Tertiary or Tanganyika Surface. The landscape of the Buyaga Catena as a whole can best be described as representing a very gradual transition between the two surfaces. It begins with a series of gently rolling hills in the south and gradually merges, through a succession of more gentle hills, into the gentle undulations of the Tanganyika Surface in the north where the process of parallel slope retreat has almost reached finality and in the disappearance of many hill summits under the coalescing pediments.

The general altitude of hills is between 4,000 ft. in the south and 3,700 ft. in the north of the unit, though there are some higher and usually rocky summits reaching the height of 4,200 ft. or more.

The hills are frequently dissected by broad and highly aggraded valleys of a low gradient. Some of the larger valleys exceed one mile in width and the total area occupied by valley floors is 30 to 40 per cent.

The water flow in the valleys is sluggish and often intermittent being almost entirely controlled by seasonal rainfall. In the north-west clost to the Rift Valley escarpment the drainage system has become rejuvenated as shown by the more recent stream courses which have cut deeply into the pre-existing alluvial deposits. The average annual rainfall is 40 to 45 in. and the vegetation on the uplands consists of tall- and medium-grass savanna with almost pure stands of elephant grass on fallow land. In the north towards the boundary between the Buyaga and the Buruli Catenas a drier type of savanna which includes Hyparrhenia filipendula, and stunted

Hyparrhenia rufa begins to replace the previously mentioned vegetation.

The catenary sequence (see Figure 7) begins as usual with shallow and stony soils with or without occasional ironstone on summits of hills but their proportion to the total upland area is reduced to 20 per cent or less with the exception of scattered and small areas where resistant gneisses and quartzites have withstood erosion and now form inextensive hill ranges. Long and gentle pediments occupy the remainder of the uplands and these contain deeply weathered soil parent materials giving rise to red or brown, uniform clay loams often exceeding 10 ft. in thickness and overlying mottled and relatively soft lateritic horizons. Stonelines which occur just above the lateritic horizons consist of sub-angular quartzite stones and occasional boulders of completely ferruginized, hard laterite. Among other inclusions odd boulders of unweathered rocks are sometimes found. Such boulders have no genetic affinity with the underlying, deeply weathered bedrock or with the uniform subsoil above. They are obviously erratics belonging to different geological formations and their presence in the profiles of the Buyaga Catena may be regarded as evidence of soil drift. This is further supported by the occurrence of artifacts in the stonelines, particularly in the vicinity of major rivers such as the Kafu river in the north-west of the Province.

Lower down the pediments towards the valley slopes the soils become progressively shallower and the depth of the uniform subsoil is reduced to two feet or less. At the same time the lateritic horizons become progressively harder. At the junction between the pediment and valley slope the uniform subsoil may be completely removed and a much hardened lateritic horizon exposed to the surface forming a solid bench below which alluvial soils are found. The pediment soil sequence will, therefore, include several associates distinguished by the thickness and colour of the subsoil and the position and hardness of the lateritic horizon. A typical deep associate of the Buyaga Catena is described below.

Profile 24 (16904-11): Buyaga "Red Deep"

Mile 1½ from Bugwera Junction to Kibale; middle pediment, altitude 3,900 ft.; rainfall 40 to 45 in. p.a.; under elephant grass fallow.

0-3" Dark reddish-grey (5YR,4/2) humose clay loam + occasional fine-quartz gravel. Granular and friable. A_1.

3-8" Dark reddish-brown (5YR,3/4) stained with humus, clay loam + occasional fine-quartz gravel. Weakly granular and firm. A_3.

8-18" Reddish-brown (5YR,4/4) slightly stained with humus, clay loam + occasional quartz gravel. Sub-angular blocks of varying size and stability. Slightly compact. Transition to B.

18-36" Red (2.5YR,4/6) uniform clay loam + occasional fine-quartz gravel + occasional minute, semi-hard murram. Structure as above. Compact. B.

36-60" Red (2.5YR,5/8) uniform clay loam. Quartz gravel and murram as above. Structureless and increasingly friable. C.

60-80" Red (2.5YR,4/6). As above. Structureless and friable. C.

80-98" Red (10YR,5/8) sandy loam + frequent quartz stones and gravel + frequent hard murram + occasional boulders of relic laterite. Stoneline.

98-123" Red (10YR,5/8) mottled grey, red, yellow and brown, clay loam. Compact. Incipient lateritic horizon.

Great thickness of the uniform subsoil and the stonelines containing foreign inclusions in the form of relic boulders of laterite indicate that the Buyaga Series has been developed on a highly aggraded surface part of which at least has been derived from erosion, transportation and deposition of material that constituted the older, Buganda Surface.

Analytical Data. The nutrient status of the Buyaga Series is similar to that of Buganda Clay Loam which the Buyaga closely resembles in respect of profile morphology, clay content and the amounts of individual plant nutrients, although the supply of exchangeable potassium (1.37 m.e.) tends to be higher than in the Buganda Series.

Agricultural Characteristics. All the common perennial and annual crops are grown successfully on Buyaga soils whose agricultural productivity is similar to the pediment associates of the Buganda Catena, the main difference being a more gentle relief and a somewhat lower rainfall, particularly towards the northern boundary of the former.

12A. Lubumba Series

This series is a subordinate component of the Buyaga Catena where it occurs in small and scattered patches along with the other associates. However, in some areas, particularly where rocky hills and outcrops are common (see Map 7) the Lubumba Series becomes a dominant component of the catena and, as such, is mapped separately.

The Lubumba differs from a typical Buyaga in having a shallower and gravelly subsoil which is often red-brown or brown in colour.

Internal drainage in the upper part of the profile of the Lubumba is somewhat excessive and this may explain why the savanna vegetation associated with this series is of a drier type containing a number of species that normally occur under a more arid climate despite the fact that the average annual rainfall and its seasonal distribution closely resemble those of the Bugaya Catena. A typical profile is described below.

Profile 25 (17921-6): Lubumba Series

Mile 7 from Butemba to Hoima; middle pediment, altitude 3,800 ft.; rainfall over 40 in. p.a.; under burned savanna.

0-3" Dark reddish-brown (5YR,3/4) stained with humus, sandy loam + occasional quartz gravel. Weakly granular and firm. A_1.

3-8" Reddish-brown (5YR,4/4) slightly stained with humus, sandy loam + frequent quartz gravel. Structureless and firm. A_3.

8-18" Dark red (2.5YR,3/6) sandy loam + frequent quartz gravel + occasional quartz stones. Structureless and slightly compact. Transition to C.

18-36" Red (2.5YR,4/8) sandy loam + frequent quartz gravel + frequent quartz stones. Structureless and increasingly friable. C.

36-52" Red (2.5YR,4/8) sandy loam with abundant quartz gravel and frequent quartz stones. Structureless and firm. C.

52-72" Red (2.5YR,5/8) mottled grey, yellow and brown and indurated material. Frequent ferruginous incrustations and some irregular murram. Lateritic horizon.

A striking feature of the Lubumba Series is its lateritic horizon which, though not completely ferruginized and hardened is, nevertheless, much more pronounced that in the Buyaga Series. The development of this horizon may be accelerated by a more open structure and lighter texture of the soil material overlying it, which cause a more thorough desiccation of the soil and the consequent higher rate of precipitation of soluble iron oxides.

Analytical Data. The Lubumba Series has less clay, more fine and coarse gravel and its nutrient status is much inferior to that of the Buyaga Series. As with the Lukaya Series, all the plant nutrients are concentrated in the surface horizon underlain by an acid and highly leached subsoil.

Agricultural Characteristics. The Lubumbu Series is much less productive agriculturally than the Buyaga and could be compared in this respect to the Lukaya Series.

13. Buruli Catena

This catena occurs on undulating to gently undulating hills representing coalescent pediments. The very gentle and broadly curved hill tops at 3,500 to 3,800 ft. merge into long and gentle pediments at 1-3-5 per cent. slope which in turn grade, often almost imperceptibly, into broad- and flat-bottomed valleys. The relative relief is typically well below 100 ft. and, in extreme cases, it may be as low as 20 to 30 ft.

The drainage system consists of numerous broad and highly aggraded valleys spaced 1 to 2 miles apart, which remain dry most of the year. During the wet season, lasting 3 to 4 months, the water table rises above the surface but, owing to a very low gradient, there is little or no flow and the surface water remains stagnant until it evaporates or disappears through downward percolation.

Climatically, the Buruli Catena represents the driest part of the Province, though the average annual rainfall at 35 to 40 in. is higher than that of the middle-western portion of the Kingdom, i.e., the Ntusi area (see Map 7). Extreme and prolonged seasonal desiccation is reflected in both the type of plant communities and in the soil.

The vegetation of the Buruli Catena is represented by a dry type of savanna with Hyparrhenia filipendula and Loudetia arundinacea as the dominant grasses and by scattered but numerous fire-tolerant species of trees and shrubs. The grasses form distinct and erect clumps with bare soil surface between them and the total soil cover amounts to not more than 20 to 30 per cent.

The main pattern of the catenary soil sequence (see Figure 8) is very similar to that of the Buyaga but the shallow soils of protruding summits are even less extensive. As in the case of the Buyaga Catena, they are developed from eroded quartz veins or dykes and may contain a few boulders of relic laterite (ironstone) indicating a genetic affinity to the mid-Tertiary Surface. More commonly, however, the uppermost associates of this catena possess a relatively deep, 1 to 2 ft. subsoil overlying quartzite stones and erratics of ironstone either scattered throughout the profile or forming a stoneline.

The soils of long and gentle pediments are morphologically similar to their counterparts in the Buyaga Catena, i.e., as far as the distribution of the main horizons is concerned but there are several distinguishing features:

(a) The A_1 horizons of the Buruli are much thinner, only slightly stained with humus and often overlain by a thin and discontinuous layer of clean gravel or coarse sand washed out of the topsoil by rain. A very low content of organic matter is confirmed by chemical analysis of many samples.

(b) There is a virtual absence of structural B horizons and the resulting profile is of an A-C type.

(c) The uniform subsoil is generally shallower (3 to 5 feet or less) and both the topsoil and the subsoil are lighter in texture due to the presence of fine- and coarse-quartz gravel.

(d) The underlying lateritic horizons tend to be harder.

As with the Buyaga Catena, the main distinguishing criteria for the pediment associates are the same, i.e., the thickness and colour of the subsoil and the position and hardness of the lateritic horizon.

In the lower sections of the pediments the lateritic horizon is invariably exposed to the surface giving rise to the truncated associates. However, a distinct slope break caused by this exposure, commonly encountered in the Buyaga Catena, is often obliterated in the Buruli by alluvial deposits which have infilled the valley up to the level of the lateritic bench. In some cases the lateritic horizon is partially covered by alluvium bearing evidence of a considerable aggradation that had taken place in the pre-existing valleys.

The broadening of river valleys and the deposition of river alluvium had been effected at the expense of hill pediments which, having gained in expanse by parallel slope retreat, have themselves suffered abrasion from below by the expanding drainage channels which in turn deposited alluvium on what are now the lower slopes of hills. As a result of these processes the pediments and the associated pediment soils have retreated backwards into higher topographic positions and their former lowermost area has been replaced by soils of alluvial origin - the Lwampanga Series. In the Buruli Catena proper this series is subordinate in expanse to the red upland associates but farther north, and particularly along the major drainage channels within the Buruli

Catena, the Lwampanga soils become dominant and, as such, are mapped separately. Typical examples of Buruli soils are described below.

Profile 26 (19642-7): Buruli "Red Deep"

Mile 10 from Nakasongola to Lwampanga; upper slope, altitude 3,600 ft.; rainfall 35 to 40 in. p.a.; under savanna thicket.

1/16-0" A discontinuous layer of fine- and coarse-quartz gravel washed out of the topsoil as a result of rain-splash erosion. Degraded A_1 horizon.

0-3" Reddish-brown (5YR,4/4) slightly stained with humus, sandy loam + frequent fine- and coarse-quartz gravel. Weakly granular to structureless and loose. A_1.

3-8" Red (2.5YR,5/6) very slightly stained with humus, sandy loam + frequent quartz gravel. Structureless and firm. A_3.

8-18" Red (2.5YR,4/8) sandy loam + frequent quartz gravel. Structureless and firm. Transition to C.

18-36" Red (2.5YR,4/8) sandy loam. As above. Structureless and friable. C.

36-60" Red (2.5YR,4/8) sandy loam + frequent quartz gravel + occasional lumps of indurated earth: pseudo-concretions. Friable. Transition to the lateritic horizon.

60-72" Red (2.5YR,4/8) mottled grey, red, yellow and brown, sandy loam + occasional to frequent ferruginous incrustations. Semi-indurated lateritic horizon.

Analytical Data. The clay content in the fine-earth fraction of the Buruli is much lower than in the Buyaga or even the Lubumba Series, particularly in the upper horizons. The surface A_1 horizon contains only 12 per cent. of clay as compared with 32 per cent. and 27 per cent. for the Buyaga and the Lubumba, respectively. The clay content gradually increases with depth to reach the amounts comparable to those of the Lubumba Series. Despite advanced eluviation of clay from the upper horizons, there is no evidence of illuviation lower down in the profile and this indicates a predominantly lateral movement of fine soil particles.

The nutrient status of this Buruli profile is very inferior in all respects. The organic carbon in the A_1 horizon is generally below 1 per cent. while in the Buyaga it is well over 2 and up to 3 per cent. The soil is very acid with pH values below 5, deficient in available phosphorus and all the major exchangeable bases.

Profile 27 (19734-9): Buruli "Ferruginized"

Mile 5 from Nakasongola to Kibangya; lower pediment, altitude 3,600 ft.; rainfall 35-40 in. pa.; under Hyparrhenia filipendula savanna.

1/16-0" A discontinuous layer of fine- and coarse-quartz gravel washed out of the topsoil through rain-splash erosion. Degraded A_1.

0-3" Reddish-brown (5YR,4/3) slightly stained with humus, sandy loam + frequent fine- and coarse-quartz gravel. Weakly granular and firm. A_3.

3-8" Red (2.5YR,4/8) very slightly stained with humus, sandy loam + frequent fine- and coarse-quartz gravel. Structureless. Occasional weak granules. A_3.

8-18" Red (2.5YR,4/8) loamy sand + occasional to frequent hard ironstone concretions. Structureless and friable. Transition to C.

18-28" As above + abundant murram + frequent quartz stones. C.

28-48" Dark red (2.5YR,3/6) mottled yellow, grey, brown and black massive laterite + frequent ferruginous incrustations.

The Buruli "Ferruginized" soil is a truncated associate of the Buruli "Red Deep" soil type. Its mode of formation and morphology is similar to the truncated and ferruginized components of the Buganda and Buyaga Catenas.

Analytical Data. With the exception of slightly higher pH and the higher exchangeable calcium in the surface horizon, which may indicate lateral leaching of plant nutrients from higher catenary sites and the resulting enrichment of this profile, the nutrient status of this Series is similar to that of the Buruli "Red Deep", cf. Profile 26.

Agricultural Characteristics. There is generally very little settled agriculture on Buruli soils which are used mainly for extensive grazing by relatively numerous herds of cattle. Cropping, if practised, is generally limited to sorghum, millet, groundnuts, cassava, pigeon peas and some cotton.

The deep associates of the Buruli Catena are much inferior in their agricultural potential to their counterparts in the Buyaga Catena. Although the rainfall in the Buruli Catena is only slightly lower than in the Buyaga Catena, the dry seasons in the former tend to be longer and more severe. However, the chief drawbacks of Buruli soils apart from the poor nutrient supply are physical, such as the lack of structure and the tendency to set hard on drying. Buruli soils become so compact at the end of the dry season that water from the first rains is unable to penetrate them to more than 3 to 4 in. and the underlying horizons remain completely dry long after the onset of the wet season. Few plants are capable of establishing themselves under such conditions and even the associated Hyparrhenia - Acacia savanna is relatively sparse leaving a lot of ground uncovered by vegetation. This, together with termite activity, is the main cause of such a low content of organic matter in the topsoil of the Buruli Series.

13A. Lwampanga Series

The Lwampanga Series is the lower catenary component of the Buruli, but it is also mapped separately in areas where it becomes the dominant soil series of this catena. The process of pediment retreat has resulted in the virtual elimination of the red soils and their replacement by the Lwampanga Series in the low-lying areas adjoining the major rivers of this catena. In such areas the Lwampanga Series is found on the lower, middle and even upper slopes of hills with the red associates either confined to the highest catenary sites or absent altogether.

The Lwampanga Series probably also represents a part of the upper extension of the Acholi Surface, but because it forms an integral

catenary component of the Buruli uplands it is included with the soils associated with the Tanganyika pedeplain. A typical profile of this series is described below:

Profile 28 (19656-61): Lwampanga Series

Mile 10 from Nakasongola to Lwampanga; lower slope, altitude 3,500 ft.; rainfall 35 to 40 in. p.a.; under Hyparrhenia filipendula savanna.

1/16-0" A discontinuous layer of sand and gravel washed out of the topsoil through rain-splash erosion. Degraded. A_1.

0-3" Brown (7.5YR,5/4) slightly stained with humus, sand. Structureless with occasional weak granules. Loose. A_1.

3-8" Strong brown (7.5YR,5/6) very slightly stained with humus, sand. Structureless and firm. A_3.

8-18" Strong brown (7.5YR,5/8) faintly streaked with humus, sand. Structureless and firm. Transition to C.

18-36" Reddish-yellow (7.5YR,6/8) loamy sand. Structureless and friable. C.

36-60" Reddish-yellow (7.5YR,6/8) loamy sand + frequent quartz gravel. Structureless and friable. C.

60-72" Reddish-yellow (7.5YR,6/8) mottled brown, rusty and grey, loamy sand. Structureless and slightly compact. Transition to the lateritic horizon.

72" + Brown, mottled yellow, grey and dark brown, semi-hard and massive laterite.

The alluvial origin of the parent material of the Lwampanga Series is evidenced by the presence of scattered water-worn pebbles in some profiles and by the gradual and uninterrupted transition into the grey sandy soils of valley slopes and bottoms. The change of colour from yellow to yellow-grey and grey is determined by the present-day water table and takes place through a series of transitional profiles strikingly similar to one another in all their other morphological features.

The massive laterite underlying the Lwampanga Series is genetically different from that of the Buruli "Ferruginized". It occurs at a lower level, i.e., between the slope break and the valley bottom, and its formation may be related to the former zone of fluctuating water table which has been lowered as a result of downward cutting of the stream to a new base level.

Analytical Data. Although the clay content in the fine-earth fraction is comparable to that of the Buruli "Red Deep", the light texture of the Lwampanga is due to the presence of large quantities of coarse sand and fine gravel throughout the profile.

The chemical status of this series appears to be just as inferior as that of the Buruli with the exception of the pH in the surface horizon which tends to be higher, and high available phosphate around the Lake Kyoga littoral.

Agricultural Characteristics. Despite their very light texture Lwampanga soils are cultivated in preference to their red associates and many of them appear to be quite well suited to the production of cotton. Unlike Buruli soils, Lwampanga soils do not become so compact in the dry season and they may also be supplemented by plant nutrients laterally leached from higher ground. Furthermore, their moisture status appears to be more favourable to plants, most likely due to the presence of the very slowly permeable lateritic horizon at depth, which prevents rapid downward percolation of rain water.

Soils Associated with Rocks Resistant to Weathering

The areas containing these soils are represented by a tor landscape and prominent quartzite ridges (see Map 5). They correspond to the Buwekula and Mubende Catenas, respectively. The third unit represented by inselbergs and rocky hills associated with the Metu Series could not be shown on Map 5 owing to its small scale. However, areas where the Metu Series is dominant are indicated on the larger scale soil map (Map 7). These three soil mapping units are described below.

14. Metu Series

Throughout the Buruli and Buyaga Catenas there occur scattered rocky hills sometimes forming inextensive ranges standing 200 to 400 ft. above the general altitude of the adjoining relief. All these hills are composed of highly resistant gneisses and granitoid rocks.

Associated with these hills and ranges is the Metu Series, a skeletal soil consisting of a thin (3 to 6 in.) humose and gravelly loam underlain by either a solid or partially fragmented rock.

Apart from the hills mentioned above, the Metu Series is also found on the Rift Valley escarpment in the north-west of the Kingdom. Although the escarpment had originated in a different way, the shallow and bouldery soils associated with it and their parent rocks are similar to the Metu soils and are, therefore, classified, for the time being, as the same soil series. Owing to its shallowness and stoniness the Metu Series is entirely unsuitable for farming.

15. Buwekula Catena

This unit has been described in detail in a separate publication (Radwanski and Ollier, 1959). It consists of rolling to strongly rolling hills with summits at 4,200 to 4,400 ft. and occasionally up to 4,700 ft. The general relief of the area is typical of a tor landscape with huge bare outcrops of coarse porphyritic granite. The proportion of rocky outcrops on the summits and slopes in relation to the total area is about one-third and up to one-half in some localities. The slopes below the rocky summits appear to be pediment-like reflecting the trend of erosion common to all the upland units in the Province, but they are more steeply inclined with slope gradients between 10 and 20 per cent.

The drainage system is well developed with streams spaced 1 to 3 miles apart and relative relief between 300 and 500 ft. The

gradient of the valleys is generally steeper than that of the Buganda Catena but considerable aggradation has already taken place even in relatively narrow valleys as shown by the presence of thick alluvial deposits.

Practially the whole area is under the average, well-distributed rainfall of about 50 in. per annum. The present natural or semi-natural vegetation is often well zoned according to the type of soil and relief. At the base of the rocky outcrops on hill summits there is a narrow belt of Themeda triandra or Andropogon dummeri savanna confined to the shallow associates of the catena (Buwekula "Shallow"). The pediments, if not cultivated, support a tree savanna with numerous clumps of Cymbopogon excavatus closely interspaced by a dense carpet of Brachiara soluta and B. brizantha. In the scattered tree canopy there are low shrubs of Acacia spp. and broad-leaved Vernonia amygdalina and V. uniflora. In more remote and rarely cultivated areas the invasion of forest trees begins at the lower sections of the pediments and results in the appearance of fringing forest along the valley. The forest, if undisturbed, may gradually extend upwards into the middle sections of the pediments.

With the exception of larger and mature river valleys covered by dense stands of papyrus (Cyperus papyrus) or Miscanthidium violaceum there is no marked change in the dominant plant species between the pediments and valley bottoms, though in the latter Loudetia kagarensis and a number of sedges are intermixed with the previously mentioned grasses and shrubs.

The parent material of Buwekula soils appears to be derived from weathering products of porphyritic granite though not necessarily the type of granite that is now exposed on the hill summits. It is more than likely that the inter-tor areas now occupied by the deep soils consisted of a different and probably much finer grained granite.

Three main soil series have been recognized in the upland catenary segment (see Figure 9): Buwekula "Shallow", an immature, skeletal soil occurring at the base of the granite outcrops; Buwekula "Red", a deeply weathered soil of the upper and middle pediment sections and its topohydric variant Buwekula "Brown" which occurs on the lower sections of the pediments. There is usually a fairly sharp boundary between Buwekula "Shallow" and Buwekula "Red" but the latter merges into Buwekula "Brown" through a number of intergrades. A full catenary sequence has not developed uniformly over the whole area and sometimes one or two of its component soil series are either very subordinate in expanse or entirely absent.

Three profiles are described below.

Profile 29 (17689-94): Buwekula 'Shallow"

Near Kiyuya Junction; upper slope, altitude 4,300 ft.; rainfall 50 in. p.a.; under Themeda triandra.

0-3" .Dark grey (10YR,4/1) stained with humus, loamy sand + frequent coarse, angular quartz gravel. Weakly crumbly and loose. A_1.

3-10" Dark brown (7.5YR,4/2) slightly stained with humus, loamy sand + very frequent coarse, angular quartz gravel and frequent stones. Weakly crumbly and firm. Transition to A_2.

10-18" Light brown (7.5YR,6/4) occasionally streaked with humus, loamy sand + abundant coarse, angular quartz gravel and frequent stones. Structureless. Laterally eluviated. A_2.

18-36" Reddish-yellow (7.5YR,6/6) loam + frequent quartz gravel and stones + occasional minute fragments of feldspar + occasional minute flakes of muscovite. Slightly compact. Breaks into sub-angular blocks of low stability. Incipient. B.

36-60" Yellow-red (5YR,5/6) gravelly clay loam + abundant angular quartz stones + frequent fragments of feldspar and muscovite. Structureless and compact. C.

60-72" Yellow-red (5YR,5/8) as above. Frequent fragments of partially weathered coarse-grained granite. C.

Although the Buwekula "Shallow" is a comparatively immature soil, as shown by the presence of unweathered minerals in the 18 to 36-inch and subsequent horizons, it is characterized by the distinct A_2 horizon (10 to 18 in.) an uncommon feature among the upland soils of the Kingdom. This series occurs in the vicinity of huge rock outcrops. The bare rocks contain many cracks and fissures and thus act as water-collecting surfaces; rainwater penetrates these and often emerges down-slope as springs. The Buwekula "Shallow" situated immediately below the outcrops is thus subjected to rapid lateral drainage and consequent eluviation. This may account for the high content of residual quartz gravel and light texture in its upper horizons, partially offset by the presence of organic colloids in the surface A_1 horizon.

Analytical Data. The Buwekula "Shallow" is the least acid component of the catena but its pH values for the surface horizons still fall below 6.0 and acidity increases with depth to a pH of less than 5.0. The supply of exchangeable bases is low when compared to that of Buganda Clay Loam and there is a deficiency in available phosphorus.

Profile 30 (17683-8): Buwekula "Red"

Near Kiyuya Junction; upper pediment, altitude 4,200 ft.; rainfall 50 in. p.a.; under Cymbopogon-Brachiara savanna with frequent Vernonia spp.

0-3" Dark brown (7.5YR,4/2) humose, sandy-clay loam + frequent angular quartz gravel. Weakly crumbly and firm. A_1.

3-8" Red-brown (5YR,4/3) less humose sandy clay loam + frequent quartz gravel and occasional quartz stones. Weakly crumbly and slightly compact. A_3.

8-18" Yellow-red (5YR,4/6) slightly stained with humus, gravelly clay loam + occasional quartz stones and occasional semi-rounded, hard murram ($\frac{1}{2}$-1$\frac{1}{2}$ cm.). Slightly compact. Breaks into sub-angular blocks of low stability. Transition to B.

18-40" Red (2.5YR,5/8) sandy-clay loam. As above. Occasional humose streaks. B.

40-60" Red (2.5YR,5/8) gravelly clay loam + frequent quartz gravel and stones + occasional grey, yellow and red mottles + occasional dull brown and irregular murram. Structureless and compact. Transition to the lateritic horizon.

60-72" Red (2.5YR,5/8) strongly mottled grey-red and yellow, clay loam + occasional soft ferruginous incrustations. Structureless and slightly indurated. Lateritic horizon.

The last horizon varies in thickness from 2 to 4 ft. and merges into the loose, friable and gritty, weathered rock. The Buwekula "Red" soil occurring on steep and eroded slopes may possess a profile similar to that of the Buwekula "Shallow" with traces of weathered rock found at shallow depths and with no lateritic horizon.

With the above exceptions the Buwekula "Red" soil type differs from the Buwekula Shallow" soil type in the degree of weathering of the parent material which can be explained by a considerable difference in the type of parent rock. The latter appears to be no longer a limiting factor in the formation of this series in which an almost complete decomposition of primary minerals, mobilization of iron and the formation of the mottled and semi-indurated lateritic horizon indicate an advanced stage of weathering and pedogenesis.

Analytical Data. The clay content (29 to 35 per cent.) in the upper horizons of the Buwekula "Red" soil is higher than in the Buwekula "Shallow" soil (7 to 18 per cent.) and increases with depth to 50 per cent or more but clay eluviation has not been as effective as in the Buwekula "Shallow" soil and there is no distinct A_2 horizon which could be recognized in the field.

The pH values for the topsoil at 5.6 or less tend to be lower than in the Buwekula "Shallow" profile and the acidity increases with depth though there is a slight rise in pH in the lowermost horizons where the permeability of the soil is reduced owing to the high content of clay and compactness. The supply of the exchangeable bases and the percentages of saturation of less than 50 are comparable to those of the Buwekula "Shallow" profile. With less than 10 p.p.m. of acid-soluble P_2O_5 in the topsoil the Buwekula "Red" profile is markedly deficient in available phosphorus.

Profile 31 (17667-72): Buwekula "Brown"

Near Kiyuya Junction; lower pediment, altitude 4100 ft.; rainfall 50 in. p.a.; under Cymbopogon-Brachiara savanna with frequent Vernonia spp.

0-3" Grey-brown (10YR,5/2) humose, sandy loam + frequent fine-quartz gravel. Weakly crumbly and loose. A_1.

3-8" Red-brown (5YR,5/3) stained with humus, gravelly loam + occasional small quartz stones. Weakly crumbly to structureless. A_3.

8-20" Red-brown (5YR,5/3) slightly stained with humus, gravelly loam + frequent coarse-quartz gravel and stones. Weakly crumbly to structureless. Transition to B.

20-36" Yellow-red (5YR,5/6) gravelly clay loam + frequent dark brown streaks + occasional murram. Weak sub-angular blocks. Slightly compact. B.

36-60" Yellow-red (5YR, 5/8) gravelly clay loam + frequent dark yellow, dark grey and brown mottles and some murram. Structureless and compact. Transition to the lateritic horizon.

60-72" Reddish-yellow (7.5 YR,6/8) strongly mottled dark yellow, dark grey and brown, clay loam with occasional semi-hard ferruginous incrustations. Structureless and semi-indurated. Lateritic horizon.

This series differs from the Buwekula "Red" soils in texture and colour. A much higher content of quartz gravel in its upper layers indicates a more intensive process of clay eluviation. The change of colour from red to brown and the associated dull-coloured mottles in the lateritic horizon are not caused by impedance of drainage such as occurs in water-logged depressions. Ground water is moving laterally at much the same rate as that in the Buwekula "Red" profile but owing to the lower site a lot more water supplied from higher hill sites passes through. This process is repeated every rainy season and as a result of it the lower horizons of the Buwekula "Brown" profile remain moist longer after the rains than those of the higher situated soils though the upper light textured part of the profile is drained rather quickly. Partial hydration of the iron compounds at depth is, therefore, a more lasting process in the Buwekula "Brown" soils. Despite all these differences, the Buwekula "Brown" profile is similar to the Buwekula "Red" profile in the arrangement of its main horizons and in the type of parent material suggesting a common genesis. This series originated in the same way as the Buwekula "Red" but on a lower site. Owing to its low position on the pediment the Buwekula "Brown" is subject to excessive lateral run-off which originates on higher parts of the hill and causes considerable eluviation.

Analytical Data. Of the three main associates of the Buwekula Catena, Buwekula "Brown" is the least fertile. The content of organic matter and the supply of exchangeable bases are lower than in Buwekula "Red". There is a very sharp decrease in all the nutrients below the surface horizon which is underlain by an extremely acid and leached subsoil.

Agricultural Characteristics. The Buwekula "Shallow" Series is most frequently used for farming, though in more populated areas both Buwekula "Red" and "Brown" are brought into cultivation. The marked preference for Buwekula "Shallow" is due to two factors: firstly, its nutrient status tends to be relatively high and despite excessive internal drainage in the upper part of the profile, annual crops, particularly tobacco and cotton, appear to grow better than elsewhere. Secondly, the rocky outcrops occurring on the summits of hills almost invariably contain one or more springs which flow throughout the year. These springs have proved a more reliable source of water than the streams and rivers which dry up during the dry season. The problem of water supply seems to be at least as important as

soil type in determining the settlement and cultivation pattern - clusters of farms around the rocky summits, becoming less frequent down the slope.

Although the Buwekula "Shallow" Series supports a large variety of crops, coffee is more frequently grown on Buwekula "Red" which has a higher moisture-holding capacity and greater depth of the solum, enabling roots to expand freely. This series is also used for the growing of annual food crops, plantains and bananas.

In more populated areas the Buwekula "Brown" Series is often cultivated but neither the annual nor perennial crops seem to give satisfactory yields and farms established on this series are frequently abandoned after 2 or 3 years' cropping. One of the main reasons for early crop failures on this series is rain-splash erosion of the humose topsoil consequent upon cultivation. This results in the formation of a thin layer of quartz gravel on the surface from which the whole fine-soil fraction, including organic matter, has been removed. With repeated annual cultivations, even with hand implements, fresh portions of the humose topsoil are exposed to rain-splash erosion every season and consequently the organic-matter content may be reduced below the level required for successful crop production in the course of a few years.

16. Mubende Catena

Prominent quartzite ridges which contain the soils of the Mubende Catena may rise to altitudes similar to those of the Koki and Kasolo Catenas (up to 5000 ft.). Unlike the latter units, however, they display little or no pedimentation and the steep slopes typically merge into shallow depressions or mezzo-valleys with or without immature stream channels.

The average annual rainfall varies between 40 and 50 in. but owing to the excessive internal drainage of Mubende soils, forest vegetation is patchy and confined to depressions between summits, the remainder of the area being covered by short- and medium-grass savanna.

The parent rock of the upland soils is a coarse-grained quartzite with minor bodies of quartz-mica schist and this gives rise to shallow and quartzitic associates on the summits, steep upper and middle slopes of hills and to somewhat deeper and less stony associates occurring on the lower sites.

The shallow soils need not be described in detail; they are typical skeletal soils consisting of a thin (2-3 in.) surface humose horizon overlying abundant stones and gravel and merging into quartzite boulders at 18 in. or less. Rock outcrops and boulders are frequently encountered on the surface and such soils are of little or no value to farming.

An example of a better developed associate is presented below.

Profile 3 (17330-4): Mubende "Deep"

Mile 18 from Kakindu to Kasambya; lower slope, altitude 4400 ft.; rainfall 45 in. p.a.; under Cymbopogon afronardus with fire-tolerant shrubs.

0-3" Brown (7.5YR,5/2) stained with humus, sandy loam + frequent quartz gravel + frequent quartz stones. Weak crumbs. Firm. A_1.

3-8" Brown (7.5YR,5/4) slightly stained with humus, sandy loam + abundant quartz gravel and stones. Structureless and loose. A_3.

8-22" Reddish-brown (5YR,5/4) very slightly stained with humus, sandy loam + abundant quartz gravel and stones + occasional fragments of quartzite. Structureless and loose. Transition to C.

22-44" Reddish-yellow (5YR,6/8) loam + frequent quartz gravel + occasional quartz stones + frequent fragments of partially decomposed quartzite and sandstone. Structureless and slightly compact. C.

44-72" Reddish-yellow (5YR,7/8) loam. As above but with more frequent fragments of the weathered rock. C.

This series has been developed in situ from the weathering products of the underlying rock, the fragments of which can easily be recognized in the soil profile.

Analytical Data. The Mubende "Deep" profile is acid with pH values at or below 5 throughout. Chemical analysis has revealed a serious deficiency of all the major plant nutrients with the possible exception of exchangeable potassium.

Agricultural Characteristics. There is very little farming on the shallow associates of the Mubende Catena which are used for seasonal grazing only. The deep associates are frequently cultivated but the crops are stunted and give very low yields.

Minor Soil Occurrences. Mubende soils are sometimes mixed with the Buyaga Series which occurs in more extensive depressions between hill summits and on some edges of the quartzite hills where pedimentation has been more effective.

Soils Derived from Pleistocene to Recent Alluvial Deposits

The group of soils described under this heading may be conveniently subdivided into the soils derived from alluvial deposits and those derived from lacustrine material.

Soils Derived from River Alluvium

These soils occur in the valley bottoms, valley slopes and river flood plains throughout the Kingdom and in most cases constitute the lowland segments of the respective catenas.

With the aerial photographs it was possible to map the approximate extent and distribution of at least the major river courses and with them the expanses of alluvial soils.

As with the upland catenary components, the alluvial soils display a wide range of morphological characteristics but the main criteria used in classifying them into soil series are as follows:

(a) Texture and colour of the subsoil.

(b) The relative efficiency of internal drainage as influenced by the site and its effect on profile development.

(c) The accumulation and type of organic matter in the topsoil, controlled by drainage conditions.

(d) The relative age of a soil and the degree of pedogenic maturity achieved since the deposition of alluvial material.

No separate series names are given to the better-drained associates of the Mulembo and Bukora Series (which are more correctly half catenas) and to the soils developed from old river terrace material as these could not be shown separately on the Soil Map (Map 7). Typical representatives of each of the soil series are described below.

17. Mulembo Series

Soils of the Mulembo Series occupy the bottomlands of the western boundaries of Mubende and Masaka districts, and Bulumezi and Busarere counties of Mengo district. They are associates of the Mawogola, Lukaya, Buwekula, Mubende and Buruli Catenas and also occur in catenary association with the Makole Series.

Profile 33 (14645-51): Mulembo Series

Mile 8 from Kalisizo to Lwengo; valley bottom, altitude 3850 ft.; rainfall 35 to 40 in. p.a.; under Themeda and Andropogon savanna.

0-2" Grey (5Y,5/1) stained with humus, sand + frequent quartz gravel. Weakly granular and firmly held by grass roots. A_1.

2-8" Grey (5Y,6/1) slightly stained with humus, sand + frequent quartz gravel. Structureless and firm.

8-19" Pale olive (5Y,6/3) very slightly stained with humus, sand + frequent quartz gravel. Structureless and loose.

19-28" Pale yellow (5Y,7/3) faintly streaked with humus, sand + frequent quartz gravel. Structureless and loose.

28-34" Pale yellow (5Y,7/3) coarse sand + frequent quartz gravel. Structureless and loose.

34-48" Pale yellow (5Y,7/3) coarse sand + frequent quartz gravel + occasional quartz stones.

48-60" Pale yellow (5Y,8/3) mottled brown and yellow, sand. Structureless and firm. Gleyed C.

Owing to the sandy texture, loose consistency and almost single-grained structure except for the humose surface layers, the Mulembo Series shows little horizon development below the A_1 until the gleyed C horizon is reached at a variable depth depending on the present range of fluctuations of the water table. The dark staining extending from the A_1 horizon down to 2 ft. or more indicates the downward movement of organic matter favoured by the open structure and large pore space between sand particles.

Analytical Data. As shown by analysis, the Mulembo Series is very acid, particularly in the subsoil where the pH values are below 5.0, and extremely deficient in all the major plant nutrients with the possible exception of available phosphorus (55 p.p.m. of P_2O_5 in the topsoil).

Agricultural Characteristics. No crops are grown on this series and the only form of utilization is occasional grazing by cattle. The main drawback of the Mulembo, apart from the sandy texture and very poor

nutrient status, is the internal drainage. The Mulembo soil is subject to extreme seasonal fluctuations of moisture content ranging from seasonal waterlogging to a thorough desiccation in the dry season.

Profile 34 (18327-32): Mulembo "Yellow"

Mile ½ from Mwera to Butayunja; valley slope, altitude 3900 ft.; rainfall 45 in. p.a.; under elephant grass fallow.

0-3" Grey (10YR,5/1) stained with humus, sandy loam. Weakly granular and firm. A_1.

3-9" Greyish-brown (10YR,5/2) stained with humus, loamy sand + frequent quartz gravel. Weakly granular and firm. A_3.

9-18" Brown (10YR,5/3) slightly stained with humus, loamy sand + frequent quartz gravel. Structureless and firm. Transition to Colour B.

18-36" Brownish-yellow (10YR,6/6) loamy sand + frequent quartz gravel. Structureless and firm. Colour B.

36-60" Brownish-yellow (10YR,6/6) loamy sand + frequent quartz stones. Structureless and firm. Colour B.

60-72" Strong brown (7.5YR,5/8) strongly mottled grey, yellow and white, loamy sand. Structureless and slightly compact. C.

This series is a better-drained associate of the Mulembo half catena. It occurs on the valley slopes and merges into the Mulembo Series proper through a number of intergrades as in the case of the Lwampanga Series to which Mulembo "Yellow" is similar in respect of the mode of formation and profile morphology.

Analytical Data. The higher content of clay and silt in the Mulembo "Yellow" soil when compared to its grey sandy associate may be attributed to two main causes; enrichment in clay due to lateral eluviation from higher catenary sites and similar additions of fine soil material resulting from occasional flooding and deposition by receding water.

Mulembo "Yellow" is a comparatively fertile soil; its nutrient status in the surface layer shows no serious deficiency in any of the major plant nutrients with the exception of available phosphorus (11 p.p.m. P_2O_5). However, the underlying horizons become progressively more acid (pH below 5) and more leached with depth, but there is a slight rise in the percentage of base saturation in the lowermost horizons characterized by low permeability.

Agricultural Characteristics. The present productivity of the Mulembo "Yellow" soil is comparable to that of its respective upland associates. All the common annual and perennial crops are grown on this soil though the yields may be unsatisfactory owing to accelerated erosion caused by careless cultivation.

17A. Kifu Series

Kifu soils occupy the valley bottoms of the extreme western boundary of Mubende district, and the north-flowing rivers of the southern half of Mengo district. They comprise the lowest lying soils of the Lukaya, Buwekula and Kyebe Catenas and sometimes of the Buganda Catena.

Profile 35 (19825-30): Kifu Series

Kituza; valley bottom; rainfall 45 in. p.a.; under papyrus and Miscanthidium.

0-3" Black (10YR,2/1) humose, sandy loam mixed with raw humus and fibrous peat. Sticky and wet.

3-8" Dark grey (10YR,4/1) stained with humus, sandy loam with some raw humus. Wet.

8-14" Greyish-brown (10YR,5/2) slightly stained with humus, loamy sand + frequent quartz gravel. Wet.

14-36" Light grey (10YR,7/2) coarse sand + frequent quartz gravel + faint yellow mottles. Wet.

36-60" As above + occasional rounded quartz pebbles. Wet.

60-72" White (10YR,8/1) coarse sand. Water table.

The main difference between the Kifu and the Mulembo Series is the presence of fibrous peat and raw acid humus in the former due to swampy conditions prevailing most of the year.

Analytical Data. The relatively high content of clay and silt in the first two surface layers (0 to 3 and 3 to 8 in.) is due to seasonal additions of fine soil material brought in suspension and deposited by water after each submergence of this soil.

The Kifu Series is an extremely acid soil with pH values well below 5 in the topsoil and the acidity increasing with depth to a pH of 4 or even a little less. The exchange capacity in the humose topsoil is relatively high (up to 20 m.e.) but the percentage of base saturation is negligible and the analysis shows a serious deficiency in the exchangeable calcium and magnesium, though the exchangeable potassium appears to be high (0.69) when compared to the average upland soil. As with the Mulembo soils, there is a serious deficiency in available phosphorus (9 p.p.m.) but judging by the high content of organic matter (4.70 per cent. carbon) there ought to be a good potential supply of this element which would be released to plants with improved drainage and aeration.

Agricultural Characteristics. The Kifu Series is quite unsuitable for cultivation in its natural state. In some densely populated areas within the Buganda Catena drainage of Kifu soils has been established by the local farmers. This consists of shallow ditches dug either across or along the valley sides. Ordinary upland crops, except cotton, are planted between the ditches and generally appear to grow well.

However, detailed mapping of these soils would be essential before large-scale drainage schemes are introduced since an efficient drainage may bring about an abrupt recession of the water table in the loose sandy material and the consequent shortage of moisture for crops.

18. Bukora Series

Bukora soils occupy the broad flats of rivers draining from Lake Kijanebolola in southern Masaka district and several valleys in the southern half of Bulumezi county.

Profile 36 (15257-61): Bukora Series

Mile 6 from Kakuto Junction to Kibanda; flat river flood plain; rainfall 35 in. p.a.; under Themeda triandra, Hyparrhenia spp. savanna.

0-3" Dark grey (5Y,4/1) stained with humus silty clay. Granular and sub-angular blocky structure. Firm.

3-8" Grey (5Y,6/1) slightly stained with humus, silty clay. Weak sub-angular blocks. Slightly compact.

8-16" Pale yellow (5Y,7/3) faintly streaked with humus, silty clay. Weak sub-angular blocks. Slightly compact.

16-28" Light grey (10YR,7/2) mottled yellow, brown and grey, silty clay. Structureless and compact. Cracking when dry.

28-40" Very pale brown (10YR, 7/3) mottled yellow, brown and grey, silty clay. Structureless and compact.

In some river valleys and flood plains the Bukora Series is dominant to the virtual exclusion of other alluvial soils (see Map 7) but more commonly it occurs together with the Mulembo Series and the two soils display a number of intergrades between each other, the outstanding criterion being the thickness of the sandy horizon overlying the clay stratum.

Analytical Data. The mechanical analysis reveals a very high content of silt (28 to 36 per cent.) in the upper horizons of the Bukora, often exceeding the clay fraction (24 to 37 per cent.). Both clay and silt together are the dominant constituents throughout the profile and the remainder of the soil material consists almost entirely of fine sand. This accounts for a high degree of compactness and reduced permeability in the subsoil.

Chemical analysis reveals a moderate to good nutrient supply despite a rather high acidity. Among the exchangeable bases, magnesium (4.5 m.e.) tends to be higher than calcium (3.5 m.e.) and there are small quantities of sodium (0.3 to 0.4 m.e.) in the lowermost horizons indicating a considerable impedence in leaching. The content of available phosphorus (103 p.p.m.) tends to be much higher than in the sandy associates or even in most upland soils but the supply of nitrogen tends to be low.

Agricultural Characteristics. The Bukora Series is not cultivated at present, mainly due to extreme seasonal fluctuationsin moisture content and the difficulty in tilling the soil with hand tools. However, large expanses of this soil are probably suitable for irrigation and mechanized cultivation. A more detailed account of the agricultural potential of the Bukora Series is given later.

Profile 37 (14493-7): Bukora "Yellow"

Near Kiswere; raised flood plain; rainfall 40 in. pa.; under grass fallow.

0-4" Grey (5Y,5/1) stained with humus silty clay. Granular and sub-angular blocky structure. Firm. A_1.

4-9" Pale olive (5Y,6/3) slightly stained with humus, silty clay. Sub-angular blocks. Firm. A_3.

9-24" Pale yellow (5Y,8/4) faintly streaked with humus, silty clay. Weak sub-angular blocks. Compact.

24-44" Yellow (2.5Y,9/8) mottled brown, silty clay. Weak sub-angular blocks. Compact.

44-66" Yellow (2.5Y,8/6) mottled brown and grey, silty clay. Structureless and compact.

The Bukora "Yellow" soil originated in the valley bottoms in the same way as its grey associate but subsequent downward cutting of rivers to a new base level has raised its previous site well above the reach of the ground water table. In the absence of seasonal flooding the soil has acquired the yellow colour due to partial dehydration and oxidation of iron compounds.

Analytical Data. As in the case of the Bukora Series, the silt content in the fine-earth fraction is high, often exceeding the clay content and there is very little coarse sand and gravel in the profile.

The nutrient status of this soil appears to be much inferior to that of the Bukora Series, particularly in respect of organic matter, nitrogen, and the exchangeable calcium and magnesium.

Agricultural Characteristics. Bukora "Yellow" soils are often cultivated but the crop yields are very low. The main limitations of these soils apart from the low nutrient supply are extreme desiccation and compactness in the dry season.

18A. Kaku Series

The soils of the Kaku Series are of very local occurrence in the lower reaches of the Bukora flats and the upper reaches of north-flowing rivers arising in Kyagwe county. A typical profile is given below.

Profile 38 (14872-7): Kaku Series

Mile 1½ from Biwobolo to Lyantonde; valley bottom near river course; rainfall 35 in. p.a.; under Miscanthidium violaceum and Sorghum rigidifolium.

0-5" Black (2.5Y,2/0) heavily stained with humus, clay + raw, acid humus and fibrous peat. Granular and slightly compact.

5-12" Black (2.5YR,2/0). As above. Compact.

12-22" Dark grey (2.5Y,5/1) heavily stained with humus, clay. Angular and sub-angular blocks. Compact.

22-34" Grey (5Y,5/1) stained with humus, clay. Compact. Cracking when dry.

34-48" Grey (5Y,6/1) slightly stained with humus, clay. Occasional rusty mottles. Structureless and compact.

48-54" Light grey (5Y,7/2) streaked with humus, clay. Occasional rusty mottles. Structureless and compact.

The Kaku Series may be regarded as the Bukora Series which has remained under more or less permanently waterlogged conditions which have resulted in the reduction of the iron compounds and the consequent dull

grey colour of the subsoil. Imperfect drainage and waterlogging are also responsible for a very slow decomposition of plant remains, large quantities of which have accumulated in the topsoil in the form of fibrous peat.

Analytical Data. The organic matter content is much higher than in the Bukora Series (5.61 per cent. of carbon in the topsoil) and there are ample supplies of available phosphorus (167 p.p.m. in the topsoil) and exchangeable bases. The latter are plentiful not only in the topsoil but also in the underlying horizons. The exchangeable sodium is also higher than in the Bukora Series (0.3 to 0.6 m.e.) and is present in all the soil horizons. Although the pH values throughout are low (generally below 5.5) the percentages of base saturation are 70 to 80 throughout the profile. It is thought that this apparent anomaly may be due to the presence of excessive amounts of organic acids which have increased the acidity of the soil.

Agricultural Characteristics. The Kaku Series is not cultivated at present owing to its more or less permanent swampy conditions but with drainage and irrigation it would be capable of supporting high yielding crops.

19. Liga Series

This series is found only in eastern Mengo district as the lowest component of the Nakabango Catena. Profile 39 may be regarded as typical.

Profile 39 (20633-8): Liga Series

Mabira Forest Reserve; valley bottom; rainfall 45 to 50 in. p.a.; under rain forest with Phoenix reclineata.

0-3" Black (10YR,2/1) humose, plastic clay. Stable granules and angular blocks. Slightly compact.

3-8" Black (10YR,2/1). As above. Compact.

8-18" Dark grey-brown (10YR,4/2) stained with humus, plastic clay. Angular and sub-angular blocks. Compact. Cracks on drying.

18-31" Light olive brown (2.5Y,5/4) plastic clay. Humus stained cracks. Compact.

31-45" Light olive brown (2.5Y,5/4) plastic clay + MnO_2 stains and soft concretions. Slightly compact.

45-72" Light olive brown (2.5Y,5/4) plastic clay + frequent fragments of weathered amphibolite schist.

Although the mode of formation of the Liga Series is similar to that of other alluvial soils described in the foregoing, the parent material derived from weathering and erosion of basic rocks is entirely different. It consists of heavy clay, plastic when wet and developing wide, irregular cracks on drying. Another distinguishing feature of the Liga Series is the accumulation of manganese dioxide in the zone of the fluctuating water table.

Analytical Data. The Liga Series, when compared with the Nakabango "Red" which is derived from a similar parent material, is slightly more

acid in the topsoil (pH 6.4) with rapidly increasing acidity (pH less than 5.5) in the lower horizons. Both the organic carbon (8.23 per cent. in the topsoil) and available phosphorus (119 p.p.m.) are as high as those of the Nakabango "Red" and there is also an ample supply of exchangeable bases with the percentages of saturation above 60. As in the case of the Kaku Series, the exchangeable sodium is comparatively high (0.3 to 0.7 m.e.) and again the low pH values, probably affected by the presence of organic acids, are associated with the high percentages of base saturation.

Agricultural Characteristics. The productivity of the Liga Series is comparable to that of the Nakabango soils with which the Liga forms a full catenary sequence. Large expanses of this soil are used for the growing of sugar cane on commercial estates and the yields are up to 60 tons of cane per acre.

Soils Derived from Lake Alluvium Deposits

These soils are found on the low-lying, flat to gently undulating shore plains of Lake Victoria, Lake Kyoga and Lake Albert. Although genetically similar, i.e., having their parent materials built up by the process of lake deposition, they represent a variety of characteristics and properties lending themselves easily to classification, not only into distinct soil series but also into distinct higher categories such as Great Soil Groups.

For convenience of presentation the lacustrine soils are described below according to the lake with which they are associated.

Lake Victoria

The soils occurring on the shore plain of Lake Victoria have been divided into two soil series, Sango and Katera (see Figure 10) but these are rather inclusive units each comprising a number of intergrades and variants, some of them sufficiently distinctive to warrant the establishment of separate soil series. However, such a detailed classification would not have been justified in the present scale of mapping and the present account will be limited to a brief enumeration of the more important variations within and between the two soil series.

20. Sango Series

This series occupies 70 to 80 per cent. of the total area representing the shore plain of Lake Victoria in the east of Masaka district. It occurs on a very gently undulating or flat plain traversed by shallow and ill-defined depressions representing "drowned" river valleys. The process of drowning of rivers flowing eastwards into the lake has been described on page 16.

The average annual rainfall in the area is well distributed and over 45 in., increasing towards the lake to 55 and 60 in. Despite these favourable climatic conditions the dominant vegetation type consists of short and sparse grass savanna with Loudetia kagarensis and Eragrostis chalcantha as the dominant grass species and evergreen shrubs

or small trees confined to scattered termite mounds. Occasional patches of moist deciduous forest are confined to areas where heavier textured river alluvia or older, silty lake deposits underlie lacustrine material at comparatively shallow depths. Under present conditions the short-grass savanna is firmly established and there are no conspicuous signs of forest regeneration.

As stated before, the Sango Series is an inclusive unit embodying a range of variations reflected in its profile morphology. The most typical profile consists of grey coarse sand several feet thick and faintly to strongly mottled with depth. The upper horizons frequently show signs of podzolization (Thomas, 1942a). A typical profile is described below.

Profile 40 (14353-9): Sango "Deep"

Kyebe - Sango Bay road; gentle undulation, altitude 3750 ft.; rainfall 45 to 50 in. p.a.; under short-grass savanna: Loudetia kagarensis.

1/16-0" A discontinuous layer of fine and coarse sand and gravel washed out of the topsoil by rain-splash erosion. Degraded A_1 horizon.

0-5" Dark grey (2.5Y,4/0) stained with humus, coarse sand + frequent quartz gravel. Structureless with occasional granules. Loose. Bound by grass roots.

5-11" Dark grey (5Y,4/1) slightly stained with humus, coarse sand + frequent quartz gravel. Structureless and loose.

11-22" Grey (5Y,5/1) very slightly stained with humus, coarse sand + frequent quartz gravel. Structureless and loose.

22-29" Light grey (5Y,7/2) faintly streaked with humus, coarse sand + frequent quartz gravel. Structureless and loose.

29-48" Pale yellow (5Y,7/4) mottled rusty brown and grey, coarse sand + frequent quartz gravel. Structureless and firm.

48-67" Light grey (5Y,7/4) coarse sand + frequent quartz gravel. Structureless and loose.

67-77" Light grey (5Y,7/4) coarse sand + frequent quartz gravel + occasional to frequent rounded quartz stones. Structureless and loose. Seepage water.

Analytical Data. Mechanical analysis by the hydrometer method reveals a complete absence of either silt or clay in this profile which consists entirely of quartz sand and gravel. By the pipette method 2 per cent. clay was determined by Perrin (1959).

With the exception of available phosphorus, which is very high (121 p.p.m.), there is an acute shortage of all the major plant nutrients in this soil. Owing to intensive leaching and a very low content of organic colloids the exchangeable bases have been removed almost entirely from the profile.

Agricultural Characteristics. There is no farming on the Sango Series apart from small and scattered areas round the fishing villages on the lake shore where crops are found to be incidentally manured by fish bones and other refuse, and similar areas at the base of a few sand-

stone hills, which are likely to receive a certain amount of plant nutrients through lateral leaching from higher sites. Previous attempts to cultivate this soil, e.g., a sisal estate near Sango Bay and a coffee estate near Katera in Masaka district, have failed completely. With their very low nutrient supply and excessive internal drainage Sango soils could only be utilized for extensive grazing and possibly for the production of Bambarra groundnuts in combination with a long grass fallow.

Variants. The following variants of the Sango Series, each capable of being classified as a separate soil series, have been recognized.

(a) Swampy associates occurring in shallow depressions or buried river valleys and characterized by thick A horizons (2 ft. or more) with a proportion of raw, acid humus. These soils are subject to seasonal flooding and support swamp communities; papyrus and Miscanthidium violaceum.

(b) Forest associates possessing well-developed A_{oo} horizons consisting of partially decomposed leaf litter. These soils contain clayey or silty horizons at depth.

(c) Shallow associates consisting of a layer of grey sand 1½-3 ft. thick, underlain by mottled clay.

(d) Greyish-yellow and yellow associates containing a certain proportion of silt. These grade into the Katera Series.

(e) Immature associates developed from the most recently deposited material often overlying the relic A_1 horizons at depth. These soils display features typical of buried profiles.

A detailed description of a shallow associate is given below.

Profile 41 (14469-76): Sango "Shallow"

Mile 6½ on Kakuto - Matakula road; gentle undulation near a river course, altitude 3750 ft.; rainfall 45 in. p.a.; under short-grass savanna.

0-3" Dark grey (5Y,4/1) stained with humus, loamy sand. Weakly granular and firm.

3-7" Grey (5Y,5/1) slightly stained with humus, loamy sand + frequent quartz gravel. Structureless with occasional weak granules. Loose.

7-14" Grey (5Y,6/1) very slightly stained with humus, coarse sand. Structureless and loose.

14-19" White (5Y,9/2) faintly streaked with humus, coarse sand + frequent semi-hard, irregular in shape, murram. Sharp boundary with the underlying horizon.

19-32" Pale yellow (2.5Y,8/4) faintly streaked with humus, sandy clay + FeO_2 and MnO_2 stains. Structureless and slightly compact.

32-45" Pale yellow (2.5Y,8/4) faintly mottled grey, sandy clay. Increasingly compact.

45-49" Light grey (2.5Y,7/2) sandy clay. Compact.

49-60" White (2.5Y,8/2) sandy clay. Compact. Seepage water.

The profile is characterized by a sharp boundary between the sandy layer and the clayey material below, which also represents the

zone of the fluctuating water table where oxides of iron and manganese accumulate. These act as cementing agents with the resulting formation of iron and manganese concretions.

Analytical Data. The presence of the two contrasting soil materials is confirmed by mechanical analysis which reveals a sharp rise in the clay content beginning from the 19 to 32-inch horizon.

The exchangeable bases in the surface horizon are higher than in the Sango "Deep" but still well below the requirements of the more exacting agricultural crops. The percentages of base saturation are extremely low in the topsoil (18.2 per cent.) and become even lower with depth, but in the clayey horizons there is a distinct and progressive rise in both the exchangeable bases and saturation which reaches the levels considerably above those of the topsoil (25-28 per cent.). A similar, though not so pronounced, trend is shown by the organic carbon which is lowest in the lowermost sandy horizon and begins to rise slightly again in the clayey horizons.

Agricultural Characteristics. Sango "Shallow" soils, though still poorly supplied with plant nutrients, are nevertheless more productive than the Sango "Deep" soil mainly on account of its more favourable internal drainage conditions.

21. Katera Series

This series occurs in association with the Sango Series on the lake shore plain but it is much subordinate to the latter in expanse. It also forms a separate mapping unit in small areas in the west of the plain.

The Katera Series represents soils developed from the remnants of older lacustrine deposits standing a few to several feet above the level of the Sango Series. As with the Sango Series, these soils exhibit marked morphological variations which would serve as criteria for separating them into a number of distinct soil series.

A common profile of the Katera Series consists of a humose topsoil merging into yellow-brown or brown sandy loam or loamy sand to the depth of 3 to 5 ft. This horizon may be underlain by rounded quartz pebbles often resting on a mottled clayey stratum. On some of the older terraces the subsoil is shallow and overlies a layer of murram and massive laterite. These shallow associates are referred to as Katera "Ferruginized".

Both the Katera and Sango Series are frequently associated with the presence of horizontal benches of massive hard laterite of a variable thickness. These represent eroded remnants of older lake terraces.

Two detailed descriptions of the Katera Series, one of a normal associate and another of a "ferruginized" associate, are given overleaf.

Profile 42 (15329-34): Katera Series

Mile 6½ from Bukakata to Masaka; gentle undulation, altitude 3750 ft.; rainfall 50 in. p.a.; under short-grass savanna with scattered trees.

0-3" Dark brown (7.5 YR,3/2) stained with humus sandy loam. Weakly granular and firm. A_1.

3-8" Dark brown (7.5YR,4/4) slightly stained with humus, sandy loam. Structureless with occasional weak granules. Firm. A_3.

8-18" Dark brown (7.5YR,4/4) faintly streaked with humus, sandy loam. Structureless and firm. Transition to C.

18-33" Strong brown (7.5YR,5/6) sandy loam + frequent quartz gravel. Structureless and firm. C.

33-48" Strong brown (7.5YR,5/6) gravelly loam + occasional rounded quartz pebbles. Structureless and firm. C.

48-60" Reddish-yellow (5YR,6/8) gravelly loam + abundant quartz pebbles. C.

Analytical Data. The Katera Series contains more clay and silt than the Sango Series and, although the nutrient status of this profile shown in Appendix A. appears to be just as inferior as that of the Sango, a number of composite samples collected and analysed during the survey generally contain more exchangeable bases and a higher percentage of organic carbon, though the available phosphorus tends to be much lower than in the Sango.

Agricultural Characteristics. The Katera Series is, on the whole, more productive than the Sango Series, one of the main reasons being its comparatively better moisture-holding capacity. All the common perennial and annual crops are grown on this soil but yields are generally very low and there are frequent failures among such crops as robusta coffee, plantains and cotton.

Profile 43 (155599-603): Katera "Ferruginized"

Mile 3 from Bukakata to Masaka; flat terrace, altitude 3800 ft.; rainfall 50 in. p.a.; under short-grass savanna.

0-3" Yellow-brown (10YR,5/4) stained with humus, loam. Weakly granular and firm. A_1.

3-8" Yellow-brown (10YR,5/4) slightly stained with humus, loam. Structureless with occasional weak granules. Firm. A_3.

8-20" Yellow-brown (10YR,5/6) faintly streaked with humus, loam. Structureless and firm. Transition to C.

20-50" Reddish-yellow (7.5YR,6/8) loam + abundant murram. Structureless and slightly compact. C.

50-60"+ Reddish-yellow (7.5YR,6/8) mottled yellow, brown and grey indurated, lateritic horizon, with frequent ferruginous incrustations.

Lake Albert Flats

Only a very small fraction of the shore plain of Lake Albert comes within the boundaries of Buganda in its extreme north-western corner beyond the Rift Valley escarpment (see Maps 5 and 7). At a level of about 2030 feet the plain is the lowest in Buganda and it is probably the hottest and the driest area as well. The average annual rainfall does not exceed 35 inches, falling on 80 to 100 days, and there are two severe dry seasons. These climatic conditions are reflected in the natural vegetation of the area, consisting of sparse short-grass (mainly Andropogon dummeri) savanna with scattered shrubs grown on numerous termite mounds.

22. Wasa Series

The most common soil found on the plain is named the Wasa Series which consists of black calcareous clay, plastic when wet and cracking when dry. A typical profile is described below.

Profile 44 (17106-10): Wasa Series

Near Buhuka; flat plain, altitude 2030 ft.; rainfall 30 in. p.a.; under short-grass savanna.

0-4" Black (2.5Y,2/0) heavily stained with humus, clay. Granular and sub-angular structure. Slightly compact.

4-12" Black (2.5Y,2/0) stained with humus, plastic clay. Sub-angular blocky structure. Compact.

12-24" Dark grey (5Y,4/1) slightly stained with humus, plastic clay + occasional quartz gravel. Large angular to sub-angular blocks. Compact.

24-48" Light olive (5Y,7/2) plastic clay + occasional $CaCO_3$ concretions. Irregular cracks when dry. Compact.

48" + As above + frequent $CaCO_3$ concretions.

The presence of calcium carbonate may result from inefficient leaching within the profile due to low rainfall and compactness of the subsoil but it may also indicate that the parent material of this soil has been derived from weathering of rocks containing abundant calcium-bearing minerals. In this case, they may have been volcanic rocks of basic affinity.

Analytical Data. The Wasa Series is an inherently fertile soil with a very high organic-matter content (more than 6 per cent. organic carbon in the topsoil) and base exchange capacity, the latter indicating the presence of a montmorillonitic clay mineral. The available phosphorus is high in all the horizons, a feature quite uncommon in the soils of Buganda, but the carbon/nitrogen ratio reveals a deficiency in nitrogen. The pH trend begins with the acid topsoil (pH below 6) but there is an abrupt change into a slightly alkaline reaction in the horizons containing calcium carbonate.

Agricultural Characteristics. The present productivity of the Wasa Series is extremely low mainly due to the unfavourable climate and moisture deficiency in the soil during the dry season. These soils when irrigated and supplemented with nitrogenous fertilizers would be capable of supporting high-yielding crops such as cotton, tobacco, sugar cane, sisal, etc.

Lake Kyoga Flats

Apart from the Sango and Katera Series, the shore of Lake Kyoga contains scattered expanses of lacustrine clays too small to be shown on the present soil map. The soils developed from these clayey deposits have been named the Kyoga Series. They differ from the Wasa Series in having brown subsoils, being non-calcareous and containing some quartz gravel in the lower horizons.

The rainfall in the area is about 40 in. or less per year but the low-lying plain is subject to seasonal flooding or at least water-logging and this is reflected in the presence of either swampy vegetation or tall-grass savanna with Pennisetum purpureum, Panicum maximum and Sorghum rigidifolium as the dominant species. A description of a better drained associate is given below.

Profile 45 (19638-41): Kyoga Series

Mile 14 from Nakasongola to Erinia; flat plain, altitude 3450 ft.; rainfall 35 to 40 in. p.a.; under elephant grass fallow.

0-3" Dark grey (10YR,4/1) heavily stained with humus, clay. Granular and slightly compact.

3-8" Dark grey (10YR,4/1) stained with humus, clay. Sub-angular blocks. Compact.

8-16" Dark grey (10YR,4/1) stained with humus, clay. Structureless and compact.

16-30" Dark grey-brown (10YR,4/2) slightly stained with humus clay + frequent quartz gravel + occasional quartz stones. Structureless and compact.

Analytical Data. The series is characterized by a near-neutral reaction throughout its profile, extremely high content of available phosphorus (over 1000 p.p.m. in the topsoil) and very high percentages of base saturation (over 90 per cent.) in all the horizons. The content of organic matter as shown by the carbon figures (4.16 per cent.) is high but there may be a shortage of nitrogen.

Agricultural Characteristics. The relatively better-drained associates of the Kyoga Series are often cultivated and support excellent cotton crops. Owing to their seasonal waterlogging, however, they are not suitable for the production of perennial tree crops. Kyoga soils could easily be drained and irrigated and thus rendered highly productive for a wide range of both annual and perennial crops.

Soil Complexes

The Buganda mapping units already described are fairly clearly defined over most of the Province but there are minor zones of overlapping and complicated mixing. These are due to both rapid lithological and tetonic changes as well as irregular mixing of the drift or mantle materials during the various cycles of erosion.

Undifferentiated mixtures of two catenas, major series and another catena or two major series are shown on the soil map as complexes of the respective components, e.g., Buyaga/Kamusene Complex (12/10A).

Mubende/Koki Complex (16/2)

This unit consists of catenas already described which occur in a complicated pattern alternating with each other over distances frequently less than one mile. Although any of these catenas may be dominant over a small area within the unit, none of them is decidedly prevalent over the whole area of the complex.

Mirambi/Buganda Complex (3/5)

In this unit both catenas, or at least some of the components of each catena, may be found on one slope between summit and valley with the Buganda associates in the upper positions and Mirambi components in the middle and lower sections of the pediments. This arrangement reflects the original disposition of the respective parent rocks in which fine-grained metasediments giving rise to Buganda soils are underlain by coarse-grained gneisses of the Basement Complex representing the parent rocks of the Mirambi soils. Progressive dissection and erosion of the pediments causes the removal of the upper formation and the consequent exposure of the underlying Basement Complex gneisses first in the lowest pediment sections and subsequently in the higher sites.

Buwekula/Mirambi Complex (15/5)

There is a similar topographic relationship in this unit with the Buwekula associates occupying hill summits and upper slopes and the Mirambi soils occurring on the lower topographic positions. Buwekula soils may constitute up to 50 per cent. of the uplands.

Buwekula/Kamusene Complex (15/10A)

In this unit the Kamusene Series is dominant over the Buwekula soils which occur only in the immediate vicinity of the rocky outcrops on hill summits. Up to 70 per cent. of the upland area may be occupied by this series.

Mabira/Nakabango Complex (9/10)

The two catenas occupy roughly equal areas of the uplands.

Buyaga/Kamusene Complex (12/10A)

This unit consists of the Buyaga "Red Deep" and the Kamusene Series occurring at locally varying proportions to each other.

Although both a typical Buyaga and a typical Kamusene have been found in this unit, there are also many intergrades between these two series. These intergrades possess transitional profiles displaying some of the features characteristic of both the Buyaga and Kamusene Series. The presence of these intergrades may be explained by the nature of their parent rocks. The Basement Complex gneisses associated with the formation of the Buyaga Series are said to have been intruded by basic dykes while still in a solid, unweathered state. Subsequent weathering and erosion was responsible for a thorough mixing and mutual integration of the weathering products of these two types of rocks from which transitional profiles have eventually developed.

Kabira/Katera Complex (4/21)

In this unit all the uplands, i.e., hill summits and slopes, are occupied by the Kabira Catena but the valley-like depressions and adjoining flat plains are covered mostly by the Katera Series, marking the extent of lake deposition in the past.

Sango/Katera Complex (20/21)

In this unit the Sango Series is dominant over the Katera Series which occurs in small and scattered expanses as shown in Fig. 10.

Sango/Bukora (or Kaku) Complex (20/18 or 18A)

In this unit the clayey deposits normally giving rise to the Bukora or Kaku Series have been partially buried by sandy lake deposits giving rise to the Sango Series. The Sango occurs on the crests of very gentle undulations with the intervening lower lying areas occupied by either the Bukora or Kifu Series.

Alluvial Complexes

In most catenas of the Kingdom the alluvial associates occur in a complex pattern often alternating with each other within the distance of 200 feet or less. The various soil series shown in the valleys on Map 7 represent the most typical but not necessarily the dominant soils associated with the respective catenas. A far more detailed soil survey would be required in order to separate the individual soil series of the river valleys and to estimate their total area.

One of the common examples of such complex alluvial associations is that of the Mulembo and Bukora Series in which the latter forms a low-lying flat base overlain in places by scattered sandy deposits of the former. In a section across the valley the Mulembo Series is characteristically found on the valley slopes where it merges into the Bukora Series on the flat valley floor. However, the Mulembo Series may occur again on the valley floor on slight and irregularly spaced elevations which probably constitute old river levees. The occurrence of these sandy levees on the valley floor is quite irregular and does not seem to follow any pattern.

The Soils and Land-Use of the Sesse Islands

This is a group of islands on Lake Victoria, situated east of Masaka district as shown on Maps 7 and 11. It was not possible in the present reconnaissance survey to conduct detailed soil investigations on these islands and only the major soil types of the biggest island, Bugala, (see Map 11) have been mapped. The other islands such as Kome, Buvuma, Bukasa, etc. have not been visited by the author and their dominant soil types are shown on the soil map (Map 7) in accordance with the data supplied by Dr. E. M. Chenery.

Owing to a very peculiar nature of the Sesse soils, i.e., their extreme acidity and a very high content of phosphorus (Chenery, 1956), no attempt will be made at present to incorporate them in the soil or land classification systems of the mainland soils.

The total area of the islands is about 150 square miles, about half of which is occupied by Bugala, forming a twisted strip of land approximately 40 miles in length and 2 to 4 miles in width.

Topographically, the island consists of a series of long, narrow, flat-topped ridges at 4000 ft. above sea level, surrounded and sometimes intersected by low-lying flat plains situated several feet above the present lake level (3720 ft.). This type of relief is similar to that of the Kabira/Katera Complex (see Map 7). The hill slopes are relatively steep - 8-15-25 per cent - but the gradient of the middle and lower slopes often decreases to form flattish facets, some of which have been identified as ancient lake terraces.

The annual rainfall on the island is much higher than on the mainland and varies from 60 to 80 in. There are two wet seasons, the main one in March, April and May and the minor one in November-December. The intervening drier spells are seldom severe and the total rainfall in any one month is rarely below 2 inches.

The vegetation of Bugala Island was described by Thomas (1942b) who distinguished four major zones:

(a) Aquatic vegetation
(b) Lake-side forest
(c) Grassland
(d) Upper forest.

From the soil point of view, the aquatic vegetation is the least important and it is the three other types that affect the soil evolution and fertility.

Both the lake-side forest and the upper forest consist of a dense and not-easily-penetrable canopy with numerous shrubs in the ground stratum. The two dominant species in both forest types are according to Thomas, Uapaca guineensis and Piptadenia buchananii. The upper forest is further distinguished by the presence of such sub-dominant species as Pseudospondias microcarpa, Pycnanthus kombo, Canarium schweinfurthii, Erythrina abyssinica, and Musanga smithii. The presence of Pycnanthus and Musanga species indicates a secondary forest regrowth.

The dominant species in the grassland, which is mainly a short- to medium-grass savanna, are Loudetia kagarensis, Eragrostis chalcantha, Ctenium concinnum, Andropogon dummeri with taller grasses, i.e., Hyparrhenia diplandra and Loudetia phragmitoides, confined to the vicinity of old cattle kraals.

Neither the forest nor the grassland is confined to any specific soil type and both may alternate with each other within a distance of less than half a mile. There is typically a very sharp boundary between the forest and the savanna with little or no transitional vegetation. It seems, therefore, that the distribution of the forest and grassland is largely, if not entirely, controlled by the past and present farming practices.

Thomas observed forest invasion in some parts of the grassland. This begins from scattered termite mounds which are commonly colonized by

two forest species, Harrungana madagascarensis, a small tree characteristic of secondary forest regrowth and Volkensia duemmeri a small forest shrub. Farther expansion of these forest clumps is checked by seasonal grass fires as well as by the very low content of nutrients in the grassland soils. The termite-made soils appear to be slightly more fertile than the surrounding soils but the difference must be negligible since Harrungana madagascarensis itself is an indicator of very poor, acid soils. In West Africa for instance, Harrungana is one of the first species to colonize badly eroded forest land resulting from open-cast mining (Radwanski, 1956).

The vegetation of the Sesse Islands reflects extreme soil acidity. Chenery (1954a, 1954b) drew attention to the very large expanses of aluminium-accumulating plants, especially the blue-fruited Lasianthus seseensis and Dissotis spp. occurring on the islands. Smaller colonies of the accumulating genera Craterispermum, Psychotria, Gleichenia, Marattia and Polytrichum were also present. According to Chenery these plants are indicative of a good tea soil because the tea bush is also an aluminium accumulator.

Apart from the lake deposits of a variable age, there are two distinct geological formations on Bugala Island; biotite schists and gneisses in the northern part and quartzites, grits and sandstones occupying the remainder of the island. The schists and gneisses in the north are almost entirely overlain by lake deposits. Elsewhere, the upland soils, though possibly derived from quartzites and sandstones, bear little relation to the underlying rocks owing to intense leaching and lateritization of their parent materials frequently associated with severe truncation and exposure of massive laterite.

The soils of Bugala are further characterized by light field texture (sands or loams), very weak structure, loose consistency and weakly developed humose surface horizons.

Eight soil mapping units have been recognized on Bugala Island (see Map 11) but each of these units could be split into two or more soil series in more detailed surveys. The present criteria in separating the units are based primarily on the relative topography affecting the general profile morphology without taking into account the vegetation factor. Each mapping unit, therefore, may occur either under forest or savanna. This arrangement is temporary and was introduced only because it was impossible at the present scale of mapping to distinguish areas under forest as opposed to those under savanna or swamp vegetation.

Using altitude and relief as the primary environmental criteria, two soil groups have been recognized:

The upland soils occurring at 3800 to 4000 ft.

(a) Quartzose, stony soils not shown on the soil map owing to their limited and patchy occurrence.

(b) Sesse "Red" consisting of red sandy loams with murram and boulders.

(c) Sesse "Brown" consisting of brown sandy loams with murram and boulders.

The lowland soils occurring below 3800 ft. and down to the lake level:

These soils are developed from or at least include the remnants of lake deposits. The following units have been recognized:

(a) Bugoma - yellow-brown loamy sands over weathered gneiss or schist.

(b) Bugoma Lateritized - yellow-brown loamy sands over soft laterite with traces of weathered schist or gneiss.

(c) Kikwayu - yellow-brown loamy sands over rounded pebbles.

(d) Kinyu - grey-yellow sands over massive lake laterite.

(e) Sango - grey coarse sands.

23. Sesse Series

These soils occupy most of Bugala, Bukasa and Buvuma Islands. Examples of the two types, Sesse "Red" and Sesse "Brown" are described below.

Profile 46 (22047-50): Sesse "Red"

Mile 6 from Kikwayu to Kalangala; upper slope, altitude 4000 ft.; rainfall 60 in. p.a.; under forest: Uapaca guineensis

0" Very thin layer of partially decomposed leaf litter. A_{oo}.

0-3" Red (2.5YR,4/6) slightly stained with humus, loam. Firm and almost structureless. Occasional weak crumbs. A_1.

3-8" Red (2.5YR,5/8) occasionally streaked with humus, loam. Structureless and firm. Transition to C.

8-24" Red (2.5YR,5/8) loam with occasional semi-indurated earth fragments (pseudo-concretions). Structureless and firm. C.

24-60" Red (2.5YR,5/8) loam + frequent hard murram + occasional fragments of massive laterite. Structureless and firm. C.

The Sesse "Red" is developed from the remnants of the Buganda Surface and is, therefore, similar in this respect to the corresponding associates of the Buganda Catena. However, judging by the profile morphology, this soil is far more lateritized than any of the Buganda soils with the exception of the completely ferruginized associates. In many ways, therefore, the Sesse "Red" may be regarded as being in a far more advanced stage of lateritization than its nearest counterpart in the Buganda Catena, namely, Buganda Clay Loam.

Analytical Data. Although the clay content in the fine-earth fraction of the Sesse "Red" soil is high (40 to 50 per cent.), its influence on the field texture of the soil is considerably reduced owing to its friability and a marked tendency to form minute but stable aggregates. Furthermore, about 50 per cent of the fine-earth fraction is represented by fine sand and there are also varying amounts of coarse sand and fine-quartz gravel in the profile all contributing to the light loamy texture of the soil.

The outstanding and unusual chemical characteristics of the Sesse "Red" soil are the extreme acidity (pH values of less than 4.5 - the lowest encountered in the upland soils of Buganda), a serious deficiency in the exchangeable bases, particularly magnesium, none of

which could be traced with the present method of analysis, and a very high content of available phosphorus (290 to 350 p.p.m.) in all the soil horizons. The acidity and the low percentages of base saturation may be attributed to intense leaching of the soil caused by the high and well-distributed rainfall (the highest in Uganda), but the high content of phosphorus cannot be explained easily though Chenery (1956) suggested that it may be due to the accumulation of guano residues from droppings of fish-eating birds.

Profile 47 (22051-54): Sesse "Brown"

Mile 8½ from Kalangala to Bwendero; middle slops, altitude 3850 ft.; rainfall 60 in. p.a.; under short-grass savanna: Eragrostis chalcantha.

⅛-0" A layer of fine-quartz gravel and sand washed out of the topsoil by the action of rain drops. Degraded. A_1.

0-3" Light brown (7.5YR,6/4) slightly stained with humus, fine-sandy loam. Firm, bound by grass roots. Structureless with occasional weak crumbs. A_1.

3-8" Light brown (7.5YR,6/4) occasionally streaked with humus, fine-sandy loam. Structureless and loose. Transition to C.

8-20" Yellow-red (5YR,4/6) fine-sandy loam with occasional hard murram. Structureless and loose. C.

20-36" Yellow-red (5YR,4/6) fine-sandy loam with frequent murram, frequent fragments of laterite with embedded quartzite. Structureless and loose. C.

Analytical Data. The Sesse "Brown" soil differs from Sesse "Red" in having a lighter texture (18 to 32 per cent. of clay in the fine-earth fraction) and in being even less saturated with exchangeable bases. No exchangeable magnesium or potassium could be traced in any of the soil horizons by the present method of extraction. The content of available phosphorus is lower than in the Sesse "Red" (99 to 180 p.p.m.) but still very high when compared to that of the great majority of soils in Buganda. As shown by the percentage of organic carbon (2.20 in the topsoil as compared with 4.28 in the Sesse "Red"), the content of organic matter is almost twice as low as that of the Sesse "Red". However, the relative proportions of organic matter in Sesse soils show wide variations irrespective of the soil type or even their present vegetal cover. Soils under forest do not necessarily contain more organic matter and may even be inferior to some savanna soils in this respect.

24. Bugoma Series

The soils of the Bugoma Series are found on Bukasa Island of the Sesse group and also on Kome and Buvuma Islands. A typical profile is given below:

Profile 48 (22060-3): Bugoma Series

Mile ¼ from Bugoma to the lake shore; middle slope, altitude 3750 ft.; rainfall 60 in. pa.; under grass fallow.

0-3" Grey-brown (10YR,5/2) slightly stained with humus, sandy loam. Weak crumbs. Firm. A_1.

3-8" Pale brown (10YR,6/3) very slightly stained with humus sandy loam. Weak crumbs. Firm. A_3.

8-24" Light yellow-brown (10YR,6/4) occasionally streaked with humus, sandy loam. Structureless with occasional sub-angular blocks. (B).

24-60" Pink-grey (7.5YR,6/2) mottled white, red, pink and yellow weathered gneiss. Compact. Weathered bedrock.

The low site (only 30 to 50 ft. above the present lake level), the nature and uniformity of the soil material overlying the bedrock of gneiss and the sharp boundary between the two formations indicate that the upper part of the profile has developed from lake deposits which have been formed as a result of the fluctuations of the lake level.

The Bugoma Series shows a progressive lateritization at the junction between the weathered bedrock and the overlying transported material, relisted to the age of the soil as shown by its present altitude above the lake level. In the young soils near the lake level there is very little or no lateritization but in the oldest soils, situated 50 ft. or more above the lake, well-developed lateritic horizons with frequent ferruginous incrustations are found. At the intermediate altitudes incipient lateritization takes the form of yellow, brown and red mottles just above and within the upper part of the weathered bedrock.

Analytical Data. The nutrient status of the Bugoma Series is similar to that of the Sesse Series, previously described, except for a lower acidity (pH 5 or more) and a somewhat higher content of exchangeable calcium and potassium but not magnesium.

25. Kikwayu Series and Kinyu Series

These low-lying soils are found chiefly on Bugala and Buvuma Islands. The following are examples of the two series which are dealt with together because they cannot be separated on the present scale of mapping.

Profile 49 (22043-6): Kikwayu Series

Mile 3 from Kikwayu to Kalangala; old lake terrace, altitude 3750 ft.; rainfall 60 in. p.a.; under forest: Uapaca guineensis.

0" A very thin layer of partially decomposed leaf litter. A_{00}.

0-3" Dark brown (7.5YR,4/4) slightly stained with humus, sandy loam with quartz gravel. Weak crumbs. Firm. A_1.

3-8" Strong brown (7.5YR,5/6) very slightly stained with humus, loamy sand. Almost structureless, occasional weak crumbs. Firm. A_3.

8-24" Strong brown (7.5YR,5/8) loamy sand with quartz gravel. Structureless and loose. C.

24-60" Strong brown (7.5YR,5/8) sandy loam with frequent rounded (water-worn) quartz pebbles. C.

Analytical Data. Kikwayu is more sandy and more gravelly than the Sesse Series and contains rounded quartz pebbles either scattered in the profile or forming a distinct soil horizon.

There is very little difference between this series and the Sesse soils in the content and distribution of the major plant nutrients.

Profile 50 (22064-7): Kinyu Series

Mile 3 from Bugoma to Kikwayu; flat plain, altitude 3730 ft.; rainfall 60 in. p.a.; under short-grass savanna: Loudetia kagarensis and Eragrostis chalcantha.

0" A thin layer of quartz gravel washed out of the humose topsoil by the action of rain drops. Degraded A.

0-3" Dark grey (10YR,4/1) heavily stained with humus, coarse sand. Structureless and loose. A_1.

3-8" Yellow-brown (10YR,5/4) stained with humus, coarse sand. Structureless and loose. A_1.

8-30" Yellow-brown (10YR,5/6) streaked with humus, coarse sand. Structureless and loose. A_3.

30" + Dark brown, mottled yellow-brown, grey and black, massive laterite.

The Kinyu Series occurs in small, unmappable patches in close association with the Sango Series at the lowest topographic levels in the island, representing the relatively recent lake shore plains.

The origin of massive laterite in this series is quite different from that which is now being formed in the Bugoma Series. The former, owing to its low and flat site, has been within reach of the water level of the lake and its development has been largely if not entirely controlled by seasonal waterlogging.

Land-Use

At the end of the last century the population of the Sesse Islands was about 20,000 (Thomas, 1942b) and there were numerous farms with large cattle herds, particularly on Bugala Island. The outbreak of sleeping sickness in 1902 had crippled the agricultural development and became so serious that in 1909 all the inhabitants had to be evacuated to the mainland. By 1920 all the islands were declared safe for human habitation and people began to drift back but even to this day the area is relatively sparsely populated and there are many old farm sites, particularly in the southern part of the island, which remain unused. Although no definite conclusions could be drawn from the brief soil survey, the abandoned farm sites may well be due to accelerated soil erosion in the past resulting from cultivation. The soils in the south of Bugala Island appear to be shallower and there are frequent exposures of massive laterite both on hill tops and hill slopes. Such expanses of soils under short-grass savanna are not uncommon in the north and their irregular distribution throughout the island, together with signs of human habitation, explains their origin as the old farming areas. Most of the grassland soils examined bear signs of disturbance due to cultivation and the short-grass savanna that they support at present may, therefore, be regarded as derived from the original forest vegetation which once destroyed could not re-establish itself, largely due to the inherently low fertility of the soils and, not infrequently, to their advanced stage of erosion induced by the past farming practices.

There are two main types of agriculture on the island adapted to soil conditions; cattle keeping on the savanna soils and food and cash crop production on the forest soils. The latter comprises the growing plantains, cassava, sweet potatoes, beans and a variety of vegetables. Robusta coffee is the main cash crop.

With very few exceptions, such as the areas where the Bugoma Series occurs, the plantains are generally stunted and produce undersized bunches. Robusta coffee grows well around homesteads but, on the whole, trees are unthrifty. They usually display very marked magnesium deficiency symptoms even when young; this results in yields being seldom as high as those of the mainland.

SOIL GENESIS AND CLASSIFICATION

Soil Development

A soil is often defined as a product of the interaction of several factors. None of these factors acts independently and each one is subject to the varied influence of all the others, but for convenience of presentation each will be briefly discussed separately.

Parent Material. In catenas dominated by the deep pediment components, the parent materials usually bear little relation to rocks from which they have been derived by thorough weathering. Examples of rock influence persisting in the soil parent materials are provided by the Buwekula and Nakabango soils. The former contain angular quartz gravel which represents a residuum from the weathering of granite rocks and the latter consist of clays with high contents of exchangeable calcium and magnesium, characteristic of the weathering products of basic rocks.

Climate and Vegetation. The climatic factor and particularly the amount, intensity and seasonal distribution of rainfall have played a major role in the formation of the pediment soils in all the catenas. Its influence is reflected directly in the intensity of weathering, eluviation and leaching, and indirectly through different vegetative covers determining the organic matter status and soil structure. One of the best examples of the climatic effect on morphologically and genetically similar soils is provided by the Kabira, Mirambi and Mawogola Catenas (pp. 44-50).

Biotic Agencies. The deep pediment soils are frequently associated with large termite mounds with termite channels occasionally penetrating the subsoil to a depth of 5 to 6 ft. There is no doubt that termite activities are largely responsible for the maintenance of the present uniformity and thickness of these soils through constant resorting and binding of the soil material and repeated mound building alternating with a collapse of old and abandoned structures.

Time Factor. The age of the pediment soils is extremely difficult to assess, since they typically occur on the old eroded surface associated with the past geologic eras (page 12). It is very likely, therefore, that the parent materials of these soils have been subjected to more than one cycle of weathering, erosion and soil formation and that these cycles were determined by the climatic fluctuations in the past.

Relief and Drainage. The effects of climate, vegetation and parent material are often considerably modified by the position of a soil within a catena and the resulting internal and external drainage. Within a given climatic unit the lower situated components of a catena receive additional supplies of water through internal percolation from higher ground, long after the cessation of rains. Such extra moisture supplies are particularly important in areas of low or badly distributed rainfall and are responsible for the occurrence of forest vegetation on the lower slopes and in depressions between hills covered by plant communities characteristic of a drier climate.

To conclude it may be stated that although no single factor has been able to exercise an unlimited influence, climate (rainfall and temperature) and associated biotic agencies appear to have made the greatest contributions to the formation of the deep, well-drained pediment soils. These soils may, therefore, be regarded as belonging to the zonal group but the concept of zonality would have to be modified to include the climates of the past erosion cycles.

The Soil Profile

Main Genetic Horizons. The horizon development in the upland soils of Buganda has been either checked by a high resistance of the parent rock to weathering, as in the skeletal soils of summits and upper slopes, or obliterated by prolonged weathering and erosive processes, as in the pediment soils. One of the most outstanding morphological characteristics of the upland soils in Buganda is the virtual absence of the intermediate profiles between these two extremes.

All the skeletal soils display a simple two-horizon A-C profile with the C horizon consisting of abundant fragments of partially weathered rock, or massive laterite.

In the pediment soils several stages of the horizon development may be recognized and these appear to be controlled primarily by the type of parent material and particularly by the content and nature of the clay fraction.

Soils with relatively high contents of clay (above 30%) and little gravel in the horizons underlying the topsoil display an A-B-C-type of profile, in which the humose A horizon with its transitional layers is from 6 to 12 inches thick. This is followed by the structural B horizon, 12 to 24 inches thick, which is distinctly more compact than either the A or C and often breaks into sub-angular or angular blocks of varying size and stability. The B horizon is generally of the same colour as the underlying C into which it merges through a few transitional layers, but its clay content is lower than in the C. It follows, therefore, that the maximum clay content does not coincide with the maximum compactness in the field (Kellogg and Davol, 1949). The C horizon differs from the B in being structureless and friable. The type of profile described above is most frequently encountered in the pediment associates of the Buganda, Buyaga, Nakabango and Buwekula Catenas.

Generally, the pediment soils with less than 30 per cent. of clay in the horizons underlying the humose topsoil, or with clay fractions subjected to advanced lateritic alteration, tend to develop the A-C type of profile. The structural B, if present, is extremely weakly developed and can be identified only by its slightly greater compactness. More commonly, the humose A horizon merges through a number of transitional layers with progressively lower humose staining into the loose and friable C, which consists of thoroughly weathered parent material with no traces of rock. Thus, there are at least two distinct types of the C horizon; the first representing partially weathered parent rock in the skeletal soils and the second consisting of thoroughly weathered parent material in the pediment soils (cf. Ollier, 1959).

The morphology of the A horizon appears to be controlled by climatic conditions which determine the type of vegetation and, through it, the amount and nature of the organic matter. Three major divisions have been recognized:

(a) Soils under well-grown forest may possess a thin A_{oo} layer (a fraction of an inch) underlain by a well-mineralized A_1 with little or no transition (A_o) between the two layers, indicating a very rapid and thorough decomposition of plant remains.

(b) Soils under tall- and medium-grass savanna forming a dense vegetal cover contain a well-developed A_1 horizon heavily stained with humus, and a number of the underlying transitional layers (A_3).

(c) Soils under short-grass savanna with a sparse vegetal cover and bare spaces between grass clumps (Buruli Catena), tend to develop a thin film of clean quartz and gravel separated out of the A_1 by the action of rain drops. This horizon has been referred to as a "degraded A". The underlying A_1 horizon is typically thin and weakly stained with humus.

In all the above topsoils the A_1 merges into A_3 or overlies directly either structural B or C. Only in one case, namely in the profile of the Buwekula Shallow (page 69), was the A_2 identified but even here the definition is not used in the commonly accepted sense, since this horizon appears to have developed as a result of lateral removal of the fine soil particles caused by the flow of subsurface water from rock springs.

In the lowland soils consisting of heterogeneous deposits differing in age, texture and relative drainage conditions, the nomenclature of soil horizons is more difficult to establish. Generally, the A horizons may be subdivided by the presence or absence of raw humus or fibrous peat. In more or less permanently waterlogged sites the A horizon overlies directly the gleyed C horizon which is grey or bluish grey in colour, owing to the prevailing reduction and hydration of the iron oxides. With improvement of both external and internal drainage, such as may obtain as a result of down-cutting of a stream to a new base level and the consequent recession of the water table, two stages in the horizon development may be distinguished.

(a) The A horizon underlain by a mottled soil material with a predominance of grey-brown, yellow-brown and grey colours. The mottling indicates better aeration and a certain amount of oxidation and dehydration of iron hydroxides. The mottled material, which may be termed either "mottled B" or "mottled C", merges into the gleyed C as previously defined.

(b) With further improvement in drainage conditions and in the absence of total submergence, at least in the first few feet of the profile, the A horizon is underlain by what may be termed a "colour B horizon", which is of uniform yellow or brown colour indicating better aeration and oxidation. This horizon appears to be replacing the underlying mottled material, which in turn encroaches on to the gleyed C horizon.

An interesting horizon development has been observed in the low-lying and seasonally waterlogged soils which contain light textured surface horizons overlying abruptly a heavy clay stratum (Sango / Bukora and Mulembo / Bukora intergrades). These soils tend to develop a bleached "light grey, structureless layer below the A_1" horizon, resting on the underlying clayey material. Quite frequently such a layer may contain a few semi-hard greyish-brown lumps of probably iron cemented earth. The profiles of this type may possibly be related to the Ground-Water Podzol Group (Thorp and Smith, 1949).

Other Horizons. Among the other horizons frequently encountered in the upland soils of Buganda there are two outstanding, namely, the stonelines and the lateritic horizons. Each deserves a study of its own but as this is beyond the scope of this memoir, only a brief account will be given, describing the nature and main occurrences of these two phenomena.

Several types of stonelines have been described in the preceding paragraphs as associated with different soil profiles. These are summarized below:-

(a) Stonelines in Buganda Loam (page 39), consist of semi-angular quartzite stones and gravel with no apparent genetic relationship to the underlying non-quartzose bedrock. They have, however, strong affinity to the quartzose summits of hills from which they appear to have been derived, then transported by creep and finally sorted out by gravity and biotic activities.

(b) Stonelines, or more appropriately quartzose horizons, in the Kabira, Mirambi or Mawogola soils (pp. 44-50), consist of angular quartzite stones and gravel which have accumulated largely in situ, as a result of weathering and fragmentation of the underlying quartz veins. These veins are often embedded in the lateritic horizons.

(c) Stonelines in the deep associates of the Buyaga Catena often consist of quartzite stones, gravel, occasional relic boulders of massive laterite and occasional stone artifacts.

(d) "Ferruginous stonelines" consist almost entirely of iron concretions and boulders. They are associated with laterite-capped summits and have originated in a manner similar to that of the Buganda Loam stonelines.

(e) "Double stonelines" occur in some pediment profiles of the Buganda Catena. They consist of two sub-horizontal layers of quartzite stones spaced 2 to 4 ft. apart and probably indicate two major cycles of pedimentation, each reflected in a separate deposit of transported material.

(f) "Adventitious stonelines" are found in some profiles of Mawogola soils which have developed from coarse-grained gneisses, but often contain a layer of iron-coated fragments of phyllite characteristic of the Koki soils. These Mawogola profiles have emerged in the lower pediment sections of the Koki Catena, as a result of the removal of the metasediments (phyllites and shales) and the consequent exposure of the underlying Basement Complex gneisses.

(g) Pebble layers occur in old alluvial soils or in so-called "hillwash" soils which are found on the lower slopes of hills. Such layers contain many rounded and obviously water-worn quartz pebbles, probably representing the remnants of old river terraces and water courses.

The effect of lateritization may assume a number of forms in the soil profile. These range from the horizons of red or brown, uniform lateritic clay (sensu Kellogg and Davol, 1949), through brightly mottled and more or less indurated material (lateritic horizons), to massive and completely ferruginized sheets of ironstone. No data on the ratio of silica to sesquioxides in these horizons are available at present and the brief description that follows is confined to accounts of the main occurrences of the lateritic horizons and their evolution in the soil profiles.

Many shallow components of the Buganda, Mirambi, Kabira and Kasolo Catenas occurring on flat summits of hills have developed from massive relic sheets of laterite, the origin of which is associated with the mid-Tertiary peneplain (Buganda Surface). This laterite is the product of a long-completed cycle of lateritization and although it is still well preserved in some localities, it is slowly disintegrating to give rise to the parent rock of immature soils.

The contemporary and sub-recent lateritic horizons occur at various depths in many pediment components of the Buganda, Buyaga, Buruli, Mirambi, Buwekula and Kabira Catenas and their evolution is equally varied.

The lateritic horizons in the pediment components of the Buwekula Catena are never exposed to the surface under undisturbed conditions but follow the slope gradient at the depth of 3 to 4 ft. Their formation, subsequent destruction from above and encroachment on the underlying deeply weathered parent material appears to keep pace with natural soil erosion and to be in equilibrium with the present environment (Radwanski and Ollier, 1959).

Where accelerated erosion has been operative for some time the lateritic horizons may be exposed to the surface as a result of removal of the uniform earth above, particularly in the lower pediment sections of the Buganda, Buyaga, Mirambi, Kabira and Buruli Catenas. The exposed lateritic horizons, when sufficiently impregnated with iron oxides, may harden to form solid and massive benches of laterite. With a limited supply of iron oxides in solution, the lateritic horizons when exposed to the surface do not harden, but begin to disintegrate more or less rapidly to form new soils usually containing a number of ironstone concretions.

The formation of the lateritic horizons described above has been taking place in the upland soils under conditions of more or less free drainage which permitted partial removal of silica and mobility of iron compounds. The later precipitation of the iron oxides results mainly from alternate wetting and drying of the soil profile.

Another type of laterite associated with the vertical movement of the water table must also be mentioned. This laterite is generally dark brown in colour, with dull yellow-brown and dirty grey mottles.

It is found in low-lying and intermittently waterlogged sites (lake shore and river flood plains) and appears to be developing as a result of capillary rise of iron solution from the zone of permanent saturation into the zone of intermittent saturation where it is precipitated, dehydrated and oxidized (Van der Merwe, 1940). The examples of this type of laterite are found in the Lwampanga, Kinyu and Katera Series.

Effect of Leaching. The degree of leaching in the profile is controlled mainly by rainfall and the nature of the parent material. An evenly distributed rainfall with frequent showers is more effective in this respect than heavy downpours of short duration, which are liable to cause sheet erosion. Generally, soil parent materials of light and coarse texture, particularly those containing quartz gravel, are subject to more intensive leaching, even under a relatively low rainfall. The degree of leaching is most conveniently measured by the pH trends and the percentages of base saturation. These show a very wide range in the upland soils of Buganda. In one extreme there are highly leached soils such as the Sesse and Kabira Series, with the pH values of the topsoils generally below 5.0 and with very low percentages of base saturation. In the other extreme represented by the Nakabango soils, the pH values are near-neutral or neutral at the surface and the saturation percentages are approaching 100 (see Table 3).

Eluviation and Illuviation. The mechanical analyses of the fine-earth fractions of the upland soils always show a comparatively low clay content in the surface horizons, increasing steadily with depth. None of the profiles examined shows any significant clay illuviation in the B horizon, as reported by Kellogg and Davol*(1949) in the soils of the Belgian Congo, where they were able to distinguish the textural B horizons. Clay losses in the upland soils of Buganda appear to be effected mainly through lateral eluviation, in a manner similar to that described by Van der Merwe (1940) for the lateritic soils of South Africa.

Physical Properties. The colour of the upland soils varies from red (2.5YR range) to brown and yellow-brown (5YR, 7.5YR and 10YR), with a distinct predominance of the former. The two notable departures from this range are the Koki "Yellow" soils (5Y,9/4) and the Nakabango "Red" soils (10R,3/6).

The texture, as assessed by the content of silt and clay in the fine-earth fraction, varies from the "heavy clay" of the Nakabango Soils, with more than 60 per cent. of clay in the subsoil, to gravelly loam of the Makole Series, in which coarse- and fine-quartz gravel constitute well over 50 per cent. of the soil material.

There are comparatively few types of structural aggregates in the upland soils. The humose A horizons contain crumbs or granules of varying size and stability, largely depending on the content of organic colloids; the structural B horizons, if present, are characterized by sub-angular blocks (angular blocks in the Nakabango "Red" clay). From the point of

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* More precise methods of mechanical analysis would probably reveal the textural B horizons.

internal drainage the absence of stable structural aggregates appears to be compensated by numerous pores and fissures in both the topsoil and the subsoil, which are being continuously made by abundant soil fauna and old root traces.

Organic Matter. The content of organic matter as shown by the percentage of organic carbon in the surface horizons, shows wide variations, depending upon the present climate and the resulting vegetation. The lowest percentages of carbon (below 1 per cent.) are encountered in the soil units supporting dry savannas in the north-east of the Kingdom. These are the Buruli soils and the Lwampanga Series. Most upland soils contain between 1.5 and 3 per cent. of carbon but the members of the Nakabango and Kabira Catenas remaining under forest or forest regrowth may have as much as 4 to 7 per cent. of carbon in the surface horizons.

Chemical Properties. Although these show equally wide variations, certain common features may be enumerated as follows:

(a) The pH values of the topsoils are about 6.0 or less and in some cases below 5.0, as in the Kabira and Sesse soils. The only exceptions are the Nakabango soils which may have a pH at, or just under, 7.0.

(b) The most common deficiency among the major plant nutrients analysed is that of phosphate (below 20 p.p.m. of P_2O_5) and there is also a shortage of nitrogen, particularly in frequent cultivated components of various catenas. In the exchangeable complex the levels of magnesium and potassium are frequently low.

(c) No investigations regarding the availability of minor elements have been carried out on the profiles described in the text but elsewhere in Uganda probable deficiencies and excesses of some of these elements have been discussed by Chenery (1954b).

Soil Classification

As already explained, the grouping of soils into broad physiographic divisions was found to be very convenient in Buganda, where the relief factor plays an important role in soil formation. However, in a system like this the soils are classified by their environmental factors and not by their own properties as expressed in the morphology of their profiles.

There are several other approaches to soil classification which have been applied to African soils. Some of these, following the Russian school of pedology (Dokuchaev, 1898) are mainly genetic, (Charter, 1954; Radwanski, 1956; Brammer, 1956) stressing the importance of the soil-forming factors in soil genesis. Others are concerned with profile morphology as a basis for classification (Van der Merwe, 1940; Kellogg and Davol, 1949); while still others (Aubert, 1958; Sys, 1957) attempt to combine soil morphology and soil genesis into one uniform system.

The soils of Buganda show some affinities to a number of higher categories within each of the above systems but they often differ in some important aspects. More detailed investigations will

be required in order to compare the Buganda soils with these categories and to work out a more certain correlation. The following tables show how Buganda soils may perhaps fit into different systems of classification.

Van der Merwe's System

Soil Sub-Groups	
Laterites	- Sesse "Red" and "Brown"; provided the molecular silica/alumina ratios of the clay fraction are below 1.33.
Lateritic Red Earths	- The deep pediment associates of the Buganda and Buyaga Catenas pending the analysis of the sesquioxides.
Lateritic Yellow Earths	- Koki "Yellow" (?).
Brown to Reddish-Brown Ferruginous Lateritic Soils	- All the shallow, concretionary associates of summits and lower pediment sections, e.g., Buganda "Ferruginized"; Buganda "Brown Ferruginized", etc.
Grey Ferruginous Lateritic Soils	- Kinyu Series; Lwampanga Series (?).
Sub-Tropical Black Clay Soils	- Wasa Series.

Kellogg's System

This system is being thoroughly revised at present and the comparison of Buganda soils will not be made until the revised account is published.

Charter's System

Order:	Climatophytic Earths	
Sub-Order:	Hygropeds	
Great Soil Group Family:	Latosols	
Great Soil Group:	Forest Oxysols	- Sesse "Red" and "Brown"; Kabira "Deep", "Medium" and "Ferruginized".
	Intergrades between Forest Oxysols and Ochrosols	- Buganda Clay Loam; Buganda Loam; Buwekula "Red" and "Brown"; Mirambi "Deep" and "Medium"; Buyaga "Deep" and"Medium".
	Savanna Oxysols	- Buruli "Deep", "Medium" and "Ferruginized".
	Intergrades between Savanna Oxysols and Ochrosols	- Mawogola "Deep", "Medium" and "Ferruginized".
Great Soil Group Family:	Basisols	
Great Soil Group:	Forest Rubrisols	- Nakabango "Red".
	Forest Brunosols	- Nakabango "Medium".
	Intergrades between Forest Rubrisols and Ochrosols	- Kamusene Series.

Order:	Topohydric Earths	
Sub-Order:	Depressiopeds	
Great Soil Group Family:	Calcium Vleisols	
Great Soil Group:	(Savanna) Black Vleisols	- Wasa Series
Order:	Lithochronic Earths	
Sub-Order:	Lithopeds	
Great Soil Group Family:	Not established	
Great Soil Group:	Lithosols	- All the shallow catenary components of summits and upper slopes developed from either fresh rock or massive relic laterite.

Aubert's System

Classe:	Sols à Hydroxydes et Humus Bien Décompose	
Sous-Classe:	Sols Ferrugineux Tropicaux	
Groupe:	S.F.T. non lessivés	
Sous-Groupe:	S.F.T. humifères	- Nakabango "Red" (?)
Sous-Classe:	Sols Ferrallitiques	
Groupe:	S.Faiblement Ferrallitiques	- The pediment associates of the Buganda and Buyaga Catenas.
Groupe:	S.F. Typiques	- The pediment associates of the Buruli Catena.
Groupe:	S.F. Lessivés	- Sesse "Red" and "Brown".
Groupe:	S.F. Indurés	
Sous-Groupe:	S.F. à carapace ou cuirasse d'érosion	Nzia Series and all the shallow catenary associates developed from relic or contemporary laterites.
Classe:	Sols Minéraux Bruts	
Sous-Classe:	S.M.B. Non-Climatiques	
Groupe:	S. bruts d'érosion	
Sous-Groupe:	Lithosols	- All the shallow catenary associates developed from fresh rocks.
Classe:	Rankers et Sols Peu Evolues	
Sous-Classe:	Sols Jeunes Non-Climatiques	
Groupe:	Rankers d'érosion	
Sous-Groupe	R. Lithosoliques	- Buwekula "Shallow" and "Mubende" Series.

Aubert's System (Cont'd)

Classe:	Sols Hydromorphes	
Sous Classe	S. à Hydromorphie Partielle de Surface	
Groupe:	S. à pseudo-gley de Surface	
Sous-Groupe:	avec nodules calcaires	- Wasa Series.

Belgian System (Sys)

Order:	Laterisols	
Sub-Order:	Savanna Laterisols	- The upland components of the Buruli Catena.
Sub-Order:	Forest Laterisols	- Sesse "Red" and "Brown".
Order:	Ferrisols	
Sub-Order:	Savanna Ferrisols	- Kibula Series.
Sub-Order:	Forest Ferrisols	- The upland components of the Nakabango Catena.
	Intergrades between the Savanna and Forest sub-orders	- The upland components of the Buganda, Buyaga and Mirambi Catenas.

LAND-USE AND LAND CLASSIFICATION

Some Economic Features

The agricultural importance of Buganda as one of the four provinces of the Uganda Protectorate is well illustrated by the following table (Uganda Department of Agriculture, Annual Report, 1957) showing the production figures and value of the two main cash crops: robusta coffee in the form of "kiboko", i.e., dried unhulled coffee cherries, and raw cotton.

Table 4

Country	Area in sq. miles excl. open water & reserved forests	Total production of cotton (tons)	Value (£)	Total production of coffee (tons)	Value (£)
Buganda Kingdom	16,597	67,699	4,129,437	100,904	8,663,807
Uganda Protectorate as a whole	74,143	218,962	13,081,119	104,101	9,027,569

Present Land-Use

The distribution of farmland in Buganda follows closely the soil pattern of the catenas. Even in relatively densely populated areas, the shallow and stony soils of summits and upper slopes are not cultivated but are often used for grazing. Similarly, the valley bottom soils are avoided for cultivation except in the most densely populated areas around big towns such as Kampala or Masaka. Large expanses of valley bottom soils are, of course, potentially cultivable but they require drainage or irrigation. Such operations are beyond the present skill and means of the average peasant farmer whose resources are limited to simple hand implements, family labour and little or no reserve capital. It follows, therefore, that under the present conditions in Buganda most of the farms are found on relatively gentle, middle slopes or pediments containing the most productive and the most easily cultivable soils.

The relative density of farming shown on Map 8 normally takes account only of the middle slopes and pediments in each catena unless shallow catenary components constitute more than 50 per cent. of the mapping unit. In addition, the low-lying plains which are sufficiently extensive to be shown on the Generalized Soil Map (Map 6) are considered as a whole, i.e., the density of farming refers to the whole area with no topographic or soil limitations as in the soil catenas.

Farmland is defined as the land supporting any agricultural crops including areas under temporary fallow which represent a part of the crop rotation. In each of the four mapping units shown on Map 8 the area of cultivated land, including fallow, is given as a percentage of the total area of the cultivable land as previously defined.

The mapping units on Map 8 have been established as a result of numerous observations along the roads, tracks and footpaths during the survey and were roughly checked against the aerial photographs. However, owing to the very small scale (1:1,000,000) and the fact that the survey was only a rapid reconnaissance, the present map cannot be regarded as accurate in detail and, in particular, the boundaries between the two middle units are provisional.

The first detailed account of the farming systems in the Uganda Protectorate was published in 1940 (Tothill, et al.) and an up-to-date report on this subject is now in preparation (Parsons, 1960). In the present account the main farming systems practised in Buganda have been distinguished according to five main criteria:

Intensity and type of cultivation

Main food crops

Main cash crops

Extent and type of fallow land

Availability and distribution of grazing land.

Seven generalized mapping units have been established and these are shown on Map 9. Wherever possible the terminology recommended by the World Land-Use Survey Commission (Stamp, 1949) was used in the key to this map. Each of the mapping units is described in the following paragraphs.

Table 5

	System	Food Crops	Cash Crops	Fallow	Grazing
1.	Shifting Cultivation	Millet, Sorghum	None	Short grass	Extensive
2.	Land Rotation	Millet, Sorghum, Cassava	Cotton and/ or Tobacco	Short grass	Extensive
3.	Land Rotation	As above with Sweet Potatoes and some Plantains	Cotton and Tobacco	Short and Medium grass	Confined to Fallow Land and Valleys
4.	Land Rotation	Cassava, Plantains, Sweet Potatoes	Cotton and Coffee	Long grass	Fallow Land, Hill tops, Valleys
5.	Land Rotation	Plantains	Coffee and Cotton	Long grass and forest thicket	Fallow Land and Hill tops
6.	Continuous Cropping	Plantains	Coffee, Plantains, Cotton	None	None
0.	Monocultures	None	Tea or Sugar or Coffee	None	None

1. Shifting Cultivation

This area consists of grassland (mainly short-grass savanna) with only very few scattered settlements. There is very little permanent farming (0 to 20 per cent. as shown on Map 8) and most of the local population consists of pastoral nomadic groups, possessing large cattle herds.

A little shifting cultivation is associated with temporary cattle camps. Small grain crops such as millet or sorghum may be grown for a short period near these camps but the cultivated plots are completely abandoned with the movement of the camp. Seasonal grass fires to provide fresh grazing material for cattle are of regular occurrence and this results in the increase in fire-tolerant woody species in the savanna.

A large area in the south-east of Buganda along the shore of Lake Victoria (see Map 9) may be regarded as a sub-division of this unit; as elsewhere it is devoted to extensive grazing but the land consists of a low-lying, gently undulating plain, subject to seasonal waterlogging in places. This has resulted in an interesting example of adjustment to local conditions in the growing in some localities of the Bambarra groundnuts. The nuts are planted in long beds 1 to 2 ft. above the ground, protected against erosion by either low stone walls or partitions made of brushwood. One or two crops are taken in succession and the land is fallowed for a number of years.

2. Land Rotation (Extensive)

Large expanses of this unit remain uncultivated and are used for extensive grazing but, due to a higher population, settled farming is being gradually established. Farms are of 2 to 5 acres and a land rotation associated with a long fallow under short grass is practised. Food crops are represented by cassava, millet, sorghum, sweet potatoes, beans, groundnuts, pigeon peas and some vegetables. Cotton is the main cash crop and its acreage is gradually expanding. In some areas fire- and air-cured Virginia tobaccos are also grown as the second cash crops.

The actual cropping sequence may vary slightly with different local customs but the one described below is probably typical.

1st year: Grass is burned and dug over with a hoe and cotton is planted between May and June. Sometimes grams (Phaseolus aureus) are broadcast in March and harvested in May before cotton seeds are put in. In areas where tobacco is grown, the seedlings may be transplanted from nurseries in March-April and harvested in June-July (after 90 days). In such cases cotton may be interplanted with tobacco in June or may follow tobacco after harvest.

2nd year: Cotton is harvested in December-January-February and the next crop is usually finger millet which is broadcast either in the standing cotton in December-January or after the harvest. If in the first year cotton was planted late, e.g., in August and harvested in February, finger millet may be replaced by groundnuts as the next crop. This is because finger millet takes about 5 months and groundnuts only 3 months to ripen. After the harvest of finger millet or groundnuts, cotton is usually planted again.

3rd year: Planting may begin with either finger millet or sorghum or groundnuts again and this may be followed by cotton as in the second year but, more commonly, either sweet potatoes or cassava or pigeon peas are put in to complete the rotation. Both cassava and pigeon peas are kept in the ground for 18 to 24 months. The 4- to 5-year

grazing areas are limited to some parts of fallow, uncultivated hill summits and valleys and the remaining land, apart from the fallow, is occupied by both annual and perennial crops. The main food crops are plantains (matoke) with a wide range of subsidiaries such as maize, sweet potatoes, yams, beans, groundnuts and vegetables. Cassava plots are not uncommon but less numerous than in the previous units. Cotton and coffee are of more or less equal importance as cash crops and as much as one third of the total acreage on an average farm is devoted to them.

In more densely populated areas, there are signs of soil exhaustion as a result of continuous cultivation and accelerated sheet erosion of the surface soil. In such cases the land may be abandoned for a number of years and, being unable to support fallow grasses, it remains under a sparse cover of herbaceous weeds.

Unit 4 is also in some ways transitional but into the other extreme, i.e., a forest type of agriculture represented by units 5 and 6. In some parts of unit 4 in the south and north-west of Buganda there is still some land available for the expansion of coffee and plantains but in the north and north-east farming density in the same unit is 100 per cent.

5. Land Rotation (Elephant Grass Fallow)

This unit is similar to the previous one in that plantains are the main food crops. However, the fallow consists of denser and more stable elephant grass and the permanent grazing area is further reduced to hill summits only since most of the valley bottoms are waterlogged and remain unused under swamp vegetation. Coffee is the main cash crop grown in plots often exceeding 2 acres. Small cotton plots are present on every farm and although this crop is subordinate in the farm economy, its total production may exceed that of unit 3 and 4 owing to the fact that unit 5 contains a higher number of farms (100 per cent. density). Probably half of the cultivable land is devoted to the growing of plantains and coffee, the remaining area being under annual food crops, cotton, and grass fallow which, if left undisturbed for some years, gradually reverts into forest thicket.

6. Continuous Cultivation

This unit represents the highest intensity of farming that has been achieved in Buganda under the present level of management in the areas climatically suited to forest regeneration. It has its counterpart in the settled areas of unit 2 where a similar intensity was reached under savanna conditions.

The main food and cash crops are the same as in Unit 5 but their proportions to each other and to the fallow farmland are quite different. Coffee and plantains occupy about 80 per cent. of the cultivable land and are often grown in larger plots, it being quite common for a farmer to have 10 to 15 acres or more under a solid stand of either of these two crops. Some farmers may even specialize in the large-scale production of plantains for bulk sale. The remaining land is devoted to a more or less continual cropping with cotton and annual food crops.

This continuous exploitation of land will eventually lead to soil exhaustion necessitating the same sort of elephant grass fallow as is now used in units 4 and 5. It may even be that in many cases of the latter units the present relatively low level of productivity is the result of such continuous initial cropping as occurs now in Unit 6.

0. Monocultures

The monoculture of tea, coffee and sugar cane is carried out on scattered commercial estates but these represent only a very small fraction of the cultivable land in Buganda. The approximate distribution of these estates is marked with small circles on Map 9.

Land Classification

Factors Controlling Agricultural Productivity

The morphological, chemical, biological and environmental factors controlling the productivity of a soil are mutually dependent on each other but in the following paragraphs an attempt will be made to select and discuss some of the more important ones which are subsequently used in the scheme of land classification presented in Tables 6 and 7.

In the climatic regime prevailing in Buganda, with relatively small variations in temperature and humidity, rainfall, i.e., its amount and seasonal distribution, is by far the most important environmental factor controlling agricultural potential. A comparison between the rainfall map (Map 3) and the land-use maps (Maps 8 and 9) reveals that with some exceptions to be discussed later the areas enjoying the highest and the best distributed rainfall also comprise the areas of highest farming densities where settled agriculture with perennial crops is being practised.

Apart from the moisture supply to plants the main contribution of rainfall to the soil is indirect through vegetation which in turn determines the amount and type of humus in the surface soil. As stated on page 99, soils derived from similar parent materials, with similar morphology and internal drainage, may differ from one another in respect of the humus content in the topsoil. As regards the more important plant nutrients, the supply of phosphorus and sulphur to plants appears to be directly related to the soil organic matter and the exchange capacity of the topsoil, i.e., its ability to receive and hold such nutrients as calcium, magnesium and potassium in readily available form, is largely dependent on the organic colloids.

The effect of rainfall, even if it happens to be high and well distributed, may be seriously limited by soil conditions which control the capacity of a soil to absorb and retain moisture. This, for instance, explains why the Sango and, to a certain extent, the Katera Series (pp. 81 and 84) represent poor crop growing media despite favourable rainfall. These soils are excessively drained and incapable of holding moisture in the dry season.

Conversely, a good water retention capacity may to a large extent offset the effect of a relatively deficient rainfall as is shown in some areas of the Koki Catena (page 33) where Koki "Red Deep" is dominant. Good crops of coffee and cotton are raised on this series by ordinary peasant methods of cultivation with no special precautions to conserve soil moisture under an erratic rainfall of about 35 in. or less per annum. On other soils under the same climatic conditions these crops either fail completely or produce very low yields.

The capacity of a soil to absorb and retain moisture is dependent on a number of characteristics such as depth of the solum, texture, structure of the surface horizons, consistency, type of clay complex, stoniness, presence or absence of indurated horizons to mention the more important ones. These characteristics are closely related to the type of parent material.

The influence of the parent material has an important bearing on two other aspects of the agricultural quality of a soil, namely, the supply of mineral nutrients and liability to erosion. Weathering products of various rocks naturally give rise to a wide range of parent materials differing in their capacity to supply these nutrients. Soils developed from thoroughly weathered and leached parent materials contain little or no weatherable minerals which would supply the nutrient elements to crop plants. Generally, parent material derived from weathering of basic rocks are well supplied with calcium and magnesium. This is one of the main reasons why the Nakabango Series together with some closely related soils (the Kamusene Series) represent the most productive land in the Kingdom. On the other hand, soils derived from weathering of sedimentary rocks such as sandstones and quartzites are the poorest in this respect.

The nature of the parent material also largely determines the erodibility of a soil and the type of erosion that takes place. Thus, weathering products of granite giving rise to the Buwekula Series (page 68) are liable, when deprived of their vegetal cover, to have their clay fraction washed out by rain leaving clean quartz particles in the surface soil. This process is considerably aided by lateral eluviation and, in a more advanced stage, gullies may form in the loose quartzose topsoil, which encroach up the slope.

On soils derived from finer and more clayey parent materials, e.g., the Buganda or Koki Series, sheet erosion appears to be more common causing the removal of the whole surface soil layers over large areas of land. Gullies may also develop subsequently. An example of sheet erosion and its devastating effect on soil truncation in the Koki Catena is illustrated in Figure 4.

Apart from the soil conditions and characteristics mentioned above, the intensity of erosion is also influenced by the type of relief, and particularly the inclination and the length of slope. The actual site of the soil series, i.e., its position on the slope, is also involved. It is an obvious fact that soils on steep slopes are liable to rapid sheet

to gully erosion but on gentle and long slopes erosion may be equally serious. In such cases, the surface run-off, especially at the beginning of the rains when the soil is not capable of absorbing all the water from torrential downpours, causes the formation of gullies on the lower slopes where the run-off, having gained momentum, is very rapid. The gullies, if unchecked, may develop into seasonal water courses extending backslope.

Within a given climatic zone both internal and external drainage are also influenced by the type of relief and the site. Soils situated in the lower topographic positions receive variable amounts of water from higher sites long after the cessation of rains and plants grown on them are often better supplied with moisture in the dry season. This water movement is particularly important in areas with a marginal rainfall and severe dry seasons and partly explains why the lower catenary components of the Buruli Catena such as the Lwampanga Series (page 66) and the "Hill-wash" associates of the Mawogola Catena (page 49) are always more frequently cultivated than the summit and upper slope associates. The value of such contributions of soil moisture also depends on the water-retention capacity of these lower catenary components.

Previous treatment of a soil may also have a profound influence on the present productivity. The so-called lunyu soils or, as they should more appropriately be termed, soils in a lunyu condition, may be found on a wide range of soil types. The lunyu condition appears to be induced by a more or less complete exhaustion of plant nutrients which have been taken up by crops, lost through leaching and/or removed by erosion of the topsoil with a consequent exposure of acid subsoil. In such cases the acidity of a soil may increase to the stage when the concentration of free aluminium and manganese becomes toxic to most plants (Chenery, 1954b). When these conditions are reached the land is abandoned and quite often it is not even capable of supporting elephant grass or other fallow grasses but remains sparsely covered by acid-tolerant weeds. Elephant grass will, however, grow on such soils if planted and will eventually restore their fertility.

Principles of Land Classification

Soils with different morphological characteristics and of different genetic origin may be similar to each other agriculturally; they may be and often are used for the production of the same crops and are subjected to the same system of farming though they may differ in their response to such a treatment. Conversely, soils markedly similar from the pedological point of view may behave in a different way when cultivated.

The purpose of this classification is to group or split, if necessary, the pedological mapping units into classes of soils possessing similar agricultural characteristics. The division into classes is based on the progressively greater number of limitations regarding their agricultural usage as influenced by both the environmental factors and the soil properties. Thus, Class I consists of the best all-round soils in the Province. These soils are or can be used for the growing of the widest range

of crops and can be given the widest range of techniques of management including mechanical tillage. The subsequent land classes acquire more and more limitations as one goes down the scale at the bottom of which there are soils entirely unsuitable for farming. Soils not at present cultivated but potentially cultivable when artificially modified, e.g., by drainage or irrigation, are placed in separate classes.

Table 6

Class	Productivity	
	Annual Crops	Perennial Crops
I.	Very high	Very high
II.	High	High
III.	Moderate	Moderate
IV.	Moderate	Low
V.	Moderate	Very low
VI.	Low	Very low
VII.	Non-productive at present (Requiring drainage)	
VIII.	Non-productive at present (Requiring irrigation)	
IX.	Non-productive at present	
X.	Nil	Nil

No subdivision of the classes into more restricted units will be introduced at this stage since the present classification is provisional and is bound to be modified in future when more precise data obtained from the agricultural experiments become available.

The present assessment of agricultural productivity in each of the ten classes is largely qualitative and derived mainly from field observations on the performance of various crops grown on soil mapping units established in the course of the survey and on the response of these units to cultivation. In the latter case the response of a soil to cultivation is defined in terms of its capacity to hold enough moisture for plant roots, its liability to accelerated erosion, etc.

It is, of course, impossible at this stage to establish detailed quantitative productivity ratings as these can only be obtained through long-term agricultural experiments at different levels of management. Except where otherwise stated, a comparatively low level of management as practised by the peasant farmer in the Province is adopted for this scheme. This consists of manual tillage, mixed food cropping, periodic fallow as the only means of maintenance of soil productivity. The major systems of farming are described on page 107 et seq.

Wherever possible, suggestions are made as regards improvement of the land as, for instance, in the case of some alluvial soils which could be cultivated profitably if drainage or irrigation were established.

As with the land-use maps (Maps 8 and 9), the land classes shown on Map 10 primarily refer to the most typical and most common soil series within each soil mapping unit. These are mostly the middle slope or pediment members of the respective catenas. The summit and upper slope soils as well as the alluvial or plain soils could not be shown separately on

Map 10 owing to the limitations of the scale except in units where they are decidedly dominant, i.e., constitute well over 50 per cent. of the total area.

The boundaries between the land classes cannot be regarded as accurate as they often run along transitional zones. Within each class there are also scattered expanses of soils belonging to other classes and these may represent 20 to 30 per cent. of the area. However, detailed descriptions of soil mapping units and individual soil series are presented on pp. 23-96 of this memoir and these can be used as a means of identifying soil series within the mapping units. Once a soil is identified it can then be referred by its name to a list of soil units belonging to an appropriate land class.

The criteria used in defining the land classes are divided into four main headings:

1. Environmental Factors

   Rainfall
   Vegetation
   Relief

2. Soil properties

   Depth
   Texture
   Structure
   Drainage
   Nutrient status

3. Management

   Crops
   Tillage
   Liability to accelerated erosion

4. Present and potential productivity.

In the fifth heading soil mapping units within which the various land classes are found are enumerated. This, of course, does not mean that the whole area of any soil unit corresponds to one class. As already explained, catenary variations and a number of other causes such as previous treatment of the land, accelerated erosion, etc. are all responsible for the presence of more than one land class in any soil mapping unit.

TABLE 7

LAND CLASS I VERY HIGH PRODUCTIVITY

Productivity

Very high. These soils are capable of supporting agricultural crops for 30 years or more with no apparent drop of their productivity. Crop yields could be increased with the application of higher standards of management involving better cultivation methods, more efficient control of pests and diseases and the use of farm machinery.

Soil Mapping Units

Mabira/Nakabango
Nakabango
Kamusene
Buyaga/Kamusene

Management

Crops: Eminently suitable for all perennial and annual crops with the exception of tea. Also suitable for the growing of cacao.

Tillage: Suitable for mechanical cultivation including tractor ploughing.

Erosion: Very little accelerated erosion under undisturbed conditions. Slight sheet and gully erosion on cultivation, which can be easily prevented by contour ploughing and bunding.

Environmental Factors

Rainfall: 45-55 in. or more per annum. Well distributed throughout the year with relatively mild dry seasons.

Vegetation: Rain forest or secondary plant successions on fallow farmland leading to the re-establishment of forest through the elephant grass stage.

Relief: Rolling hills with summits at 4000-4200 ft. above sea level
Slopes 5-8-10%
Generally $\frac{1}{4}$ mile or less in length.

Soil Properties

Depth: 6 ft. or more of the uniform stoneless subsoil.

Texture: Clay with a variable degree of plasticity.

Structure: Stable crumbs in the topsoil, stable angular blocks in the compact and cracking (when dry) subsoil.

Drainage: Slow absorption of rain water at the beginning of the rainy season due to compactness of the surface horizons. On account of a very high water absorption and fixation capacity of the clay fraction these soils require a relatively high rainfall in order to provide sufficient moisture for plant roots. Once saturated, however, they hold moisture well owing to slow internal drainage.

Nutrient status: Generally very favourable with a high content of humus in the topsoil, high base exchange capacity and relatively high exchangeable bases though in reaction these soils may be acid with the pH of the topsoil at or below 6.0.

Productivity

Originally high but now depending on the treatment of the soil. In very densely populated areas where sheet erosion has not been checked in time there are numerous plots of land which have been abandoned as a result of the complete loss of the humose topsoil and the consequent inducement of lunyu conditions. In some cases, sheet erosion has been responsible for the total removal of the subsoil and exposure of the underlying rock to the surface, in others only the surface horizons have been lost.

Class II soils could be maintained at the originally high level of production but with more intensive farming they will require fertilizer applications to which they are most likely to give economic responses owing to their favourable physical conditions.

Soil mapping Units

Kasolo"Deep"
Koki "Red Deep"
Buganda "Deep"
Mirambi "Deep"
Mabira
Buyaga "Deep"
Mirambi/Buganda
Buwekula/Mirambi

Management

Crops: Suitable for annual and perennial crops including tea but generally excluding cacao unless there was a long period of rest under well-grown forest fallow.

Tillage: Suitable for mechanical cultivation including ploughing.

Erosion: Moderate to severe sheet and gully erosion has been observed frequently on these soils as a consequence of careless cultivation in the absence of conservation measures. In most cases under the present systems of management involving the use of hand tools accelerated erosion can be controlled successfully by grass bunding. With the introduction of more intensive farming systems more effective conservation measures are likely to be required.

Environmental Factors

Rainfall: 40-50 in. or more per year but in some areas (Koki Catena) it is below 40 in.

Vegetation: Elephant grass with a tendency to forest regrowth suppressed by frequent cultivation and grass fires.

Relief: Strongly rolling to rolling hills 4000 to 5000 ft. above sea level. Slopes 5-8-10-16% $\frac{1}{4}$ - $\frac{3}{4}$ mile long.

Soil Properties

Depth: 4 to 6 ft. or more of the uniform subsoil.

Texture: Clays or loams with varying quantities of quartz gravel and stones.

Structure: Crumbs of a variable stability in the topsoil; weak sub-angular blocks in the subsoil merging into unstable and irregular aggregates with depth.

Drainage: Free but not excessive internal drainage. Good moisture-holding capacity.

Nutrient status: Moderate to good depending on the previous cultivation history, length of cropping period and the amount of accelerated erosion in the past. Unlike Class I soils, the mineral nutrient supply in Class II soils is much lower owing to a virtual absence of unweathered but weatherable minerals in the subsoil. The main source of plant nutrients is, therefore, the organic matter and this in turn is controlled by the type of vegetation.

Productivity

After a long and undisturbed fallow these soils, when brought into cultivation, are capable of supporting good crops. However, owing to their generally inferior physical conditions (light texture, presence of stones and gravel, weak structure, shallow subsoil) they deteriorate more rapidly than Class II soils and require a longer fallow period to regain their original productive capacity. The success in farming these soils would depend on the establishment of strict soil conservation measures particularly in the lower sections of the pediments. This may involve the construction of terraces.

Frequent mulching would reduce rain-splash erosion and the loss of organic matter.

Where accelerated erosion has not damaged the profile beyond the possibility of quick reclamation, Class III soils could be made more productive by the application of fertilizers.

Soil Mapping Units

Kabira
Mityana
Buwekula
Buwekula/Mirambi
Mubende
Kyebe

Management

Crops: Suitable for annual and perennial crops except cacao unless the land has remained under forest for a long time. The yields of robusta coffee are lower than those of Class II soils but tea is growing well and appears to be better suited to these soils than either coffee or cotton.

Tillage: Suitable for light mechanical cultivation. Ploughing as a regular operation is to be avoided.

Erosion: Severe rain-splash erosion may take place on cultivated land particularly under annual crops. This results in the loss of organic matter and the accumulation of quartz gravel on the surface. Unchecked sheet and gully erosion may cause the complete removal of the subsoil and the exposure to the surface of either the quartzose layer or the lateritic material, particularly in the lower sections of the pediments.

Environmental Factors

Rainfall: 40-50 in. or more per year. Generally well distributed with mild dry seasons.

Vegetation: Ranging from elephant grass with a tendency to forest regrowth to fire-controlled grass fallow in which elephant grass is partly or entirely replaced by Imperata cylindrica and other grasses.

Relief: Rolling to undulating hills 3800-4600 ft. above sea level.
Slopes 3-5-8-10-16%
$\frac{1}{4}$ - $\frac{3}{4}$ mile long.

Soil Properties

Depth: Less than 6 ft. and typically $2\frac{1}{2}$-4 ft. of uniform subsoil overlying either quartzose horizons $1\frac{1}{2}$-2 ft. thick or compact lateritic material several feet thick.

Texture: Loams or sandy loams with frequent to abundant quartz gravel.

Structure: Crumbs of moderate to low stability in the topsoil. Weak sub-angular blocks merging into structureless material in the subsoil.

Drainage: Generally rapid and often excessive internal drainage. Moderate to low moisture-holding capacity.

Nutrient status: Moderate to low being almost entirely controlled by the contributions of vegetation to the soil organic matter. The topsoils are frequently very acid with pH of 5 or less. Low pH values indicate an advanced stage of leaching and low percentages of base saturation.

Productivity

Moderate for annual crops including cotton and tobacco but low for tree crops and plantains.

Under the present system of management a long fallow period is required to maintain the present productivity of these soils. This can be shortened by the application of fertilizers provided the soils are not in an advanced stage of erosion.

Soil Mapping Units

Kasolo
Kyebe
Bowa
Kibula
Lukaya
Lubumba
Buyaga
Buwekula
Mirambi/Buganda
Katera

Management

Crops: All the common crops, both annual and perennial, are grown on these soils but tree crops, i.e., robusta coffee and plantains, often fail to establish themselves or give low yields. Some improvement in the appearance of robusta is noticeable where shade and mulching is practised but yields are still low.

Tillage: Suitability for mechanical cultivation is even more restricted than in Class III soils owing to unfavourable soil properties.

Erosion: This is similar in nature and intensity to that prevailing in Class III soils.

Environmental Factors

Rainfall: 40 to 50 in. or more per year.

Vegetation: Medium-grass savanna with an unstable elephant grass fallow.

Relief: Gently rolling to undulating hills with summits at 3800 to 4200 ft. above sea level. Slopes 3-5-8-12% ½ to 1 mile or more long.

Soil Properties

Depth: Less than 4 ft. and typically between 1½ to 3 ft. of uniform subsoil overlying either quartzose horizons or compact lateritic material.

Texture: Loams or sandy loams with frequent to abundant quartz gravel throughout the profile or clays with gravel.

Structure: Crumbs of low stability in the topsoil. Irregular and unstable aggregates merging into structureless material in the subsoil.

Drainage: Free to excessive internal drainage. Low moisture-holding capacity with the exception of Kibula.

Nutrient status: Generally lower than in Class III soils, particularly in respect of organic matter but the topsoils are less acid with pH values of about 6.0.

LAND CLASS V MODERATE TO VERY LOW PRODUCTIVITY

Productivity

Moderate for annual crops but very low for perennial crops excluding such semi-perennials as cassava or pigeon peas which thrive well on these soils.
Robusta coffee and plantains are sometimes grown in very small plots round the farm-houses but they are very difficult to establish unless planted under shade and on a mulched ground.
The close proximity of these plots to houses means that they cannot be regarded as indicators of land potential elsewhere within this unit since crops grown on such sites in such small quantities are bound to enjoy the benefit of incidental or, much less frequently, intentional manuring with household refuse or cow dung.

Soil Mapping Units

Mawogola
Lwampanga

Management

Crops: Suitable for annual crops including cotton and tobacco though crop yields under the present system of management are relatively low. Generally unsuitable for tree crops and plantains.

Tillage: Suitable for light mechanical cultivation only.

Erosion: Rain-splash erosion often occurs even under natural conditions after heavy rains owing to a sparse grass coverage. It becomes more pronounced on cultivation. Sheet and gully erosion is more severe in the loamy types since the sandy ones are capable of absorbing rain water more efficiently.

Environmental Factors

Rainfall: 40 in. or less per year with relatively severe dry seasons.

Vegetation: Short-grass savanna with fire-tolerant species of shrubs and trees.

Relief: Gently rolling to undulating hills with summits at 3600 to 4200 ft. above sea level.
Slopes 3-5-8%
½-1 mile or more long.

Soil Properties

Depth: Less than 6 ft. and typically 2 to 4 ft. of uniform subsoil overlying quartzose layers or compact lateritic materials.

Texture: Sandy or gravelly loams or loamy sands.

Structure: Weak crumbs in the topsoil, structureless subsoil.

Drainage: Excessive. Low moisture-holding capacity.

Nutrient status: Inherently low content of organic matter in the topsoil due to sparse grass cover of the ground. Low base-exchange capacities.

LAND CLASS VI LOW TO VERY LOW PRODUCTIVITY

Productivity

Low for annual crops and extremely low for perennial crops.

With better methods of husbandry involving soil conservation, mulching and well-timed tillage to increase porosity of these soils at the beginning of the rainy season, yields of annual crops are likely to be increased. The establishment of tree crops such as robusta and plantains or bananas on a large scale is unlikely to prove an economic proposition.

Soil Mapping Units

Makole
Buruli

Management

Crops: Restricted to annual crops and semi-perennials as cassava and pigeon peas. Large areas of these soils are used for extensive grazing only with seasonal fires as a regular feature.

Tillage: As for Class V. Class VI soils possess a further disadvantage of becoming extremely com - pact when dry.

Erosion: Due to their extreme compactness in the dry season, water derived from the first rains cannot penetrate these soils easily and most of it is lost through surface run-off causing serious erosion of the topsoil.

Environmental Factors

Rainfall: Less than 40 in. per year with a severe dry season.

Vegetation: Short-grass savanna with fire-tolerant species of shrubs and trees.

Relief: Gently rolling to undulating hills with summits at 3600 to 4000 ft. above sea level.
Slopes 1-3-5-8%
½ to 1 mile or more long.

Soil Properties

Depth: Generally less than 6 ft. and typically 2 to 4 ft. of uniform subsoil overlying quartzose layers or indurated lateritic material.

Texture: Sandy or gravelly loams or loamy sands.

Structure: Weak crumbs in the topsoil. Structureless subsoil.

Drainage: Excessive. Low moisture-holding capacity.

Nutrient status: Very low content of organic matter and low base-exchange capacities.

Productivity

Under the present conditions of permanent waterlogging these soils remain unproductive. Successful drainage will depend largely on the profile morphology, i.e., the thickness and distribution of the textural horizons. With very light-textured sandy soils or with those possessing gravelly layers at shallow depths, artificial drainage may cause a rapid loss of water and its shortage in the dry season. Once successfully drained these soils may be used for the growing of a wide range of crops depending on market requirements. In addition they can also provide good grazing for cattle.

Soil Mapping Units

Kifu
Kaku
Liga

Owing to a very small scale these soils could not be shown on Map 10. They represent the lowermost components of a number of soil catenas occurring in areas with an average annual rainfall of 45 in. or more.

Management

Crops: With the exception of some very densely populated areas these soils are not cultivated though they can be brought into cultivation with the establishment of drainage. In some cases relatively shallow ditches due in the valley bottoms would be sufficient, in others more permanent and more efficient drainage systems would be required. On drained sites all the food crops and sometimes plantains and coffee are grown. In addition, sugar cane and rice are likely to succeed.
Tillage: Suitable for mechanical cultivation.
Erosion: Generally there is very little erosion except for that caused by slowly running surface water causing alternate transport and deposition of the surface material. On drained sites containing gravelly soils rainsplash erosion may become severe if the land is left bare in the rainy season.

Environmental Factors

Rainfall: 40-50 in. or more per year with mild dry seasons.

Vegetation: Mainly swamp communities; papyrus, Miscanthidium or swamp forest.

Relief: Flat valley bottoms.

Soil Properties

Depth: Heterogeneous alluvial deposits which have given rise to these soils are several feet in thickness.

Texture: Coarse sands, loamy sands or silty clays with or without the horizon of pebbles.

Structure: Weak to stable crumbs in the topsoil. Structureless subsoil.

Drainage: Permanently impeded with water table just below and rising above the surface in the rainy season.

Nutrient status: High content of organic matter in the topsoil but most of it is raw humus or peat. Generally very acid surface horizons.

Productivity

These soils are at present used for extensive grazing only but when irrigated they would be suitable for large-scale mechanized farming.

Soil Mapping Units

Mulembo
Bukora
Kyoga
Wasa

Management

Crops: There is very little farming on these soils at present and this is due mainly to extreme fluctuations in moisture status and the difficulty in cultivating them with hand implements. However, large areas are suitable for irrigation and for the growing of such crops as sugar cane or rice.

Tillage: Suitable for mechanical tillage including ploughing.

Erosion: Accelerated erosion caused by running surface water may result in the formation of a network of gullies round grass clumps.

Environmental Factors

Rainfall: Generally less than 40 in. per year with a relatively severe dry season.

Vegetation: Medium- and short-grass savanna.

Relief: Gentle valley slopes, flat valley bottoms and old flood plains.

Soil Properties

Depth: As for Class VII.

Texture: Silty clay either throughout the profile or overlain by a layer of fine sand.

Structure: Weak crumbs in the topsoil. Structureless and compact subsoil.

Drainage: Extreme fluctuations in internal drainage ranging from pronounced desiccation of the upper horizons to waterlogging and periodic flooding in the wet season.

Nutrient status: The content of organic matter is much lower than in Class VII soils but the topsoil tends to be less acid.

Productivity

Despite the favourable rainfall, Class IX soils are of extremely low productivity and this is due to their coarse sandy texture, loose consistency and a serious deficiency in major plant nutrients.

At the present time these soils provide rough grazing for a number of cattle herds which appear to be thriving well under these conditions. For a long time to come this would probably be the only way of economic utilization of these soils. A gradual improvement of the stock-carrying capacity of this land may also be attempted.

Soil Mapping Units

Sango.
Truncated associates of Katera.

Management

Crops: With the exception of Bambarra groundnuts grown on raised beds in some localities and some food-crop farming generally confined to the base of scattered hills, these soils are not cultivated. A few attempts in the past to establish commercial estates (e.g. sisal in Sango Bay and coffee near Kyele) have failed completely.

Tillage: Unsuitable for mechanical cultivation.

Erosion: Due to a sparse grass cover both rain-splash and micro-gully erosion often take place even under natural conditions.

Environmental Factors

Rainfall: Ranging from a well-distributed annual average of 45-50 in. to about 40 in.

Vegetation: Short-grass savanna with scattered trees and bushes. Swamp communities in depressions. Scattered patches of rain forest.

Relief: Flat to very gently undulating lake shore plains or extensive river valleys.

Soil Properties

Depth: Sandy horizons are 5-10 ft. thick or more.

Texture: Coarse sand or loamy sand with gravel and pebbles.

Structure: Few or no structural aggregates.

Drainage: Excessive. Extremely low moisture-holding capacity.

Nutrient status: Very low in organic matter and exchangeable bases. The pH value of the topsoil is often below 5.0, indicating an advanced stage of leaching. The only nutrient which is sometimes present in large quantities is phosphorus.

Productivity

From the point of view of farming the present and potential productivity of these soils is extremely low. Even grazing is liable to cause sheet erosion and loss of the humose topsoil. The best and probably the most economic way of utilization would be the establishment, wherever possible, of tree plantations which would provide fire wood and possibly building material. In most cases these plantations would be confined to the highest sites and as such would also serve as windbreaks and water collecting drainage divides.

Soil Mapping Units

All the shallow and rocky associates of the soil catenas, e.g., Nzia
Tolero
Metu
Mubende Shallow
Bowa Shallow, etc.

Management

Crops: There is no permanent farming on these soils but they are frequently used for grazing, particularly in more densely populated areas.

Tillage: Entirely unsuitable for tillage of any kind.

Erosion: Severe sheet erosion takes place as a result of grass fires which leave the land bare at the onset of rains. There is little that could be done to prevent such erosion as the soil is too shallow for the construction of grass bunds or earth terraces. Stone walls are probably the only alternative but the labour and expense involved would not be justified on such poor soils.

Environmental Factors

Rainfall: Ranging from a well-distributed annual average of 45-50 in. to less than 40 in. with a relatively severe dry season.

Vegetation: Short-grass savanna with shrubs or thicket.

Relief: Flat or rounded summits; steep slopes; occasionally more gentle pediments.
Slopes 0-3%, 5-8%, 16-30%.

Soil Properties

Depth: A humose topsoil 2-9 in. thick overlies partially weathered rock.

Texture: Loams or sands with stones and gravel.

Structure: Weak crumbs in the topsoil; structureless, rocky subsoils.

Drainage: Rapid to excessive except on extensive flat summits containing unweathered rock strata which slow down the rate of percolation.

Nutrient status: Generally low though there may be some accumulation of humus on gentle sites.

Significance of the Present Land-Use and Land Classes in the Planning of Land Utilization

Exact figures regarding the increase of population in Buganda in recent years are not available but in the period of 17 years between the 1931 census and that of 1948, the African population increased by nearly 50 per cent. or by 429,416 to 1,302,162 (Baker, 1956).

A comparison of the two land-use maps (Maps 8 and 9) with the land-class map (Map 10) reveals that with very few exceptions most of the good agricultural land already supports a high population which will soon reach the maximum level in relation to the present productive capacity of the land. Even in mapping units with deceptively large areas of uncultivated but cultivable land in the north and west of the Kingdom, the low farming densities under the present systems of management may well be close to the point of saturation. The soils of these units are very inferior agriculturally and, furthermore, a very large proportion of over half a million cattle in the Kingdom is kept in these areas on unimproved grassland with a very low stock carrying capacity.

Since the room for expansion of farming, i.e., the establishment of new farms, particularly in areas containing Class I, II, III and IV land, is either non-existent or very limited, the only other way of increasing agricultural production to cope with the rapidly increasing population is to raise present yields on existing farms. With the present system of farming, which involves the use of fallow as the only means of maintenance of soil fertility, there is little scope for a substantial increase in agricultural production. The disastrous effect of eliminating or even shortening the fallow period is quite apparent in many densely populated areas. It follows, therefore, that new techniques of management and new methods will have to be applied and, while this is a task involving many aspects of research both technical and economic, the following points as regards the development of soil resources will immediately arise.

Increase of the present crop yields will involve, among other things, better standards of farming and the application of artificial fertilizers particularly to cash crops. The land classification in this case will help in assessing the value of such treatments and their applicability to similar soils elsewhere.

Reclamation of badly treated and impoverished soils within the land classes will bring widely different responses according to soil type. Some soils despite an advanced stage of erosion offer scope for quick improvement while others will require a longer period and more expensive measures before they are brought back to cultivation.

Reclamation and utilization of valleys not at present cultivated is an important problem particularly in densely populated areas of Class I, II and III which are associated with Class-VII soils occurring in the river valleys. Most of these soils can be ameliorated by drainage and eventually utilized either for grazing or crop growing though each valley site will have to be considered on its own merits owing to the textural and morphological heterogeneity of the alluvial deposits.

As a standard practice against soil erosion in Buganda, narrow base ridges are commonly built with hand implements along the hill slopes at intervals depending on slope gradient (Masefield, 1942). These ridges, locally known as bunds, are planted with Paspalum notatum Flugge., a quick growing grass with strong roots which prevent the bunds from being washed out in the rainy season. With the introduction of more intensive farming systems and, particularly, mechanical tillage the whole problem of soil conservation will require a thorough revision in order to bring it up to date.

Detailed measurements of soil loss on different soils and under different levels of management will be essential in future, particularly where mechanized farming is to be introduced. The adverse effects of ploughing on some soils, for instance, may not become apparent in the first few years and quite often when these are realized it is often too late to prevent serious damage to the soil.

The intensity of accelerated erosion varies not only with the soil type but also with site characteristics. A very common example of sheet erosion which begins on the slope break in the lower pediment section and encroaches backslope into the higher pediment has been described on page 37 and illustrated in Figure 4. This type of erosion is widespread in Buganda and requires immediate attention, particularly in more densely populated areas.

Land classification brings out the problem of a rational distribution of crops in relation to the soil potential, liability to erosion and all the other relevant morphological and environmental factors. Many soil catenas in Class I, II, III and IV occur under a relief consisting of hill summits and slopes sensu stricto, elongated pediments leading into the valleys through more or less distinct slope breaks. An example of a proper crop distribution in such catenas could be as follows:

Summit - steep upper slope	:	Firewood and/or timber plantations.
Pediments	:	Arable farming, tree crops, plantains.
Slope breaks	:	Strict soil conservation, e.g., permanent grassland.
Valleys	:	Grassland or fodder crops or food crops or special crops, e.g., sugar cane or rice.

Class-IV land represents a transition from the point of view of farming systems in that the area is marginal for the production of tree crops and plantains. The growing of these crops is frequently attempted but the yields are generally low. The problem here would be to find out what special measures can be recommended in order to increase the yields of these crops and what other crops can be introduced. For instance, some citrus trees frequently appear to be thriving better on these soils than either coffee or plantains and the possibility of expanding citrus production is worth considering.

Land classes V and VI would require a different approach since in most cases the soils of these areas are unsuitable in their present

state for economic production of tree crops and plantains. While the experiments with these crops may be conducted on a small scale in carefully selected sites, it is doubtful if they would be applicable to the peasant system of farming since they will involve such expensive measures as irrigation, artificial shade, application of fertilizers, etc.

The more obvious and safer way of utilizing these soils to their best advantage is to concentrate in the production of short-lived annual food and cash crops, on the introduction of other similar crops and on the improvement of the existing grassland in order to raise its stock-carrying capacity. Mechanization of farming is inevitable in such cases and this presents a big problem of research and experimentation since Class-V and, particularly, Class-VI soils are characterized by a very weak structure, low content of organic matter and relatively sparse vegetal cover under natural conditions. These soils are also liable to severe accelerated erosion when cultivated.

Some areas in Class-VIII land offer scope for the introduction of special projects. A good example of this is a flood plain of the Bukora river in the south of the Kingdom (see Class VIII on Map 10) which consists of the Bukora Series described on page 77. This soil has never been cultivated and remains under wooded savanna. Seasonal flooding combined with desiccation in the dry season and the difficulty in cultivating with hand implements are probably the main disadvantages.

Owing to the striking textural uniformity and a very large expanse under a flat to gently undulating relief, the Bukora Series would be suited to mechanized cultivation with sugar cane as the most suitable cash crop. The most convenient trial area is that lying north of the Kakuto-Kibanda road. It comprises more than 40,000 acres of cultivable land which is more than enough to provide the basic acreage for a factory.

The average annual rainfall is probably about 35 in. and, though this is below the requirements for successful production of sugar cane, there are possibilities of introducing flood irrigation at a relatively low cost by damming the river Bukora which has its source in Lake Kijanebalola and flows through the plain towards Lake Victoria. An alternative way of irrigating the land would be to pump water out of the river and distribute it through a network of channels in the cane fields.

If the scheme was considered, small 1 to 2-acre experimental plots of cane would have to be established in the area in order to gain the necessary knowledge as regards the handling of the soil.

The Bukora Series may also be used for improved pasture. Provided the tsetse fly can be controlled, and this should not be an impossible task once the land is cleared for cultivation, cattle keeping on an intensive scale could be built up gradually. The chief problem in the improvement of pasture would be the introduction of leguminous species into the grass mixtures or as fodder crops in order to balance the diet with an adequate amount of protein food.

If the sugar estate with a factory were organized, large amounts of by-products in the form of molasses, etc. could be made available to cattle. Cane tops left in the field after harvest would also provide a good supplementary fodder and the keeping of cattle on such fields periodically would undoubtedly reduce the cost of expensive fertilizers.

The Bukora Series occurs in several neighbouring valleys which may also be utilized for the production of sugar cane combined with cattle keeping on a rotational basis in smaller farm units owned by the local inhabitants. An attempt to extend the acreage of cane in this way would, of course, depend on whether the main estate with a factory could be established.

Considering that most of the upland soils lying west and south of this area are extremely poor (Tolero Series = Class X) a project of this kind would provide a sound basis for the agricultural development of this part of the Kingdom.

Class-IX soils are the least productive agriculturally but they possess two favourable characteristics; high rainfall and a very gentle relief combined with a large expanse. The suitability of these soils for pasture and the fact that they support crops of Bambarra nuts suggest a possible line of development such as extensive cattle ranching rather than intensively grazed leys in combination with the growing of Bambarra nuts as a source of protein food. On the very light sandy soils of Class IX, however, harvesting nuts is an easy task though care should be taken to reduce the disturbance of the topsoil to the minimum, particularly when it is mechanized.

Finally, the economic aspect of farming must be mentioned briefly and one of the main problems facing the farm planner is working out the most economic size of farms for any given area within various land classes at different levels of management. In the initial stage of this investigation it would be necessary to assess the present productivity of various land-classes in terms of cash income per acre particularly for cash crops. It is quite obvious that a farmer with, say, 5 acres of Class-II land may be in a position to maintain himself and his family by devoting a large part of his farm to the growing of profitable tree crops. This would be impossible in Class-V or VI land where cash returns per acre are much lower and even the increase in yields is not likely to provide profits comparable to those of Class-II land. An economic farm unit in these areas would, therefore, be much larger in order to provide sufficient income and thus prevent the creation of both financially and socially lower classes of peasant cultivators. Larger and consolidated farm units would have their own problems of organization and would open the possibilities of establishing large-scale co-operative estates.

The present chaotic distribution of farms and cultivated plots within the farms is one of the chief obstacles to any improvement and progress that could be made in the future. However, this problem is not only economic but also has its social and political aspects which are beyond the scope of this memoir.

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APPENDIX A

ANALYTICAL DATA

Methods

Mechanical Analysis

Silt and clay were determined by the hydrometer method of Bouyoucos (1927) as modified by Tyner (1939) using sodium hexa-meta phosphate as the dispersing agent. The figures in the table are for the International fractions

Clay $< 2\mu$, silt 20 - 2μ
Sand 20 - 2000μ

Exchangeable Bases (Cations)

The exchangeable cations were determined by a rapid method in neutral normal ammonium acetate leachates (Hughes, 1959). The figures in all cases except for sands and sandy loams are about 80% of what is actually present. For sands and sandy loams the more elaborate extraction technique was used and 95%-100% of the exchangeable bases were extracted.

It should be borne in mind that a zero figure for any one cation does not mean that it is entirely absent but that it was not detected by this method.

Exchangeable Hydrogen

This was determined in buffered p-nitrophenol extracts by the method of Schofield (1933).

pH

pH was measured in pastes (about 1:1) by the glass electrode method.

Organic Carbon

The wet combustion method of Walkley and Black (1934) was used but their correction factor of 1.33 was not applied.

Available Phosphate

The well known method of Truog (1930) was used, using buffered N/500 sulphuric acid as the extractant.

Lower Limits of Adequacy for Good Crops

	% Base Exchange Capacity
Calcium	20 for Kaolonitic soils 50 for Montmorillonitic soils
Magnesium	5
Potassium	2
pH	3.5 (tea only) 4.5 (most other crops)
Organic Carbon	1.0%
Nitrogen	0.1%
Truog Phosphate	15 p.p.m.

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ANALYTICAL DATA FOR SOIL SAMPLES

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Kasolo "Red Deep"															
Profile 1 (16762-68)															
3	18	26	7.0	4.2	0.21	0	0.04	11.45	8.1	19.6	58.6	5.7	3.42	10	Low P_2O_5 otherwise normal
8	8	35	6.9	3.2	0.16	0	0.06	10.32	8.1	18.4	56.0	5.5	2.13	5	
18	2	49	3.4	1.2	0	0	0.07	4.67	9.0	13.7	34.2	5.2	1.49	7	
36	0	47	1.6	<.3	0	0	<.02	1.60	8.2	9.8	16.3	5.2	0.71	9	
48	5	48	<.8	0	0	0	0	<.80	9.6	9.6	-	5.2	0.51	8	
48+	2	47	<.8	0	0	0	0	<.80	9.0	9.0	-	5.1	0.56	40	
								N% 0.305 0-3"							
Koki "Red"															
Profile 2 (14560-65)															
3	15	48	2.4	1.9	0.38	0	0.16	4.84	6.6	11.4	42.3	5.7	3.02	43	Low calcium
8	13	48	1.1	0.3	0.11	0	0.08	1.59	7.2	8.8	18.1	5.3	1.12	20	
18	10	55	0.5	<.3	0.08	0	0.05	0.63	6.5	7.1	8.8	5.3	0.63	20	
36	12	53	1.0	<.3	0	0	0.13	1.13	7.1	8.2	13.7	5.2	0.71	20	Very low bases
60	13	57	Tr.	<.3	0	0	0.03	0.03	7.2	7.2	4.2	5.8	0.36	0	
72	10	61	Tr.	<.3	0	0	0.03	0.03	6.9	6.9	4.3	5.6	0.26	7	
								N% 0.253 0-3"							
Koki "Brown"															
Profile 3 (14554-58)															
3	24	37	4.8	1.5	0.39	0	0.04	6.73	4.5	11.2	59.9	5.8	2.29	26	Normal profile apart from high silt content
9	20	41	4.2	1.6	0.23	0	0.06	6.09	6.1	12.2	50.0	5.8	2.13	17	
16	22	41	3.0	1.8	0.23	0	0.09	5.12	6.0	11.7	43.7	5.4	1.67	19	
36	14	41	1.6	0.3	0.08	0	0.04	2.70	5.5	8.3	32.7	5.2	0.66	16	
60	10	47	0.9	0.3	0.12	0	0.02	1.34	6.8	8.1	16.5	5.1	0.46	24	
								N% 0.208 0-3"							

Depth Ins.	Mechanical Analysis Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
									Koki "Yellow"						
									Profile 4 (14567-72)						
4	Nd	Nd	2.8	1.5	0.28	0	0.05	4.63	8.3	12.9	35.8	5.1	2.52	15	Low P_2O_5 and
9	Nd	Nd	1.3	0.8	0.27	0	0.03	2.40	Nd	10.5	Nd	4.8	1.74	9	bases
18	Nd	Nd	<.8	<.6	0.23	0	<.02	0.23	8.2	8.4	2.7	4.8	0.25	6	
36	Nd	Nd	<.8	<.6	0.20	0	0	0.20	7.2	7.4	2.7	4.8	0.66	4	
53	Nd	Nd	<.8	<.6	0.25	0.4	0	0.65	Nd	0.7	Nd	4.8	0.56	4	
60	Nd	Nd	<.8	<.6	0.19	0.7	0	0.89	5.1	6.0	14.9	4.8	0.33	2	
									N% 0.211 0-4"						
									Buganda "Ferruginized"						
									Profile 5 (15242-47)						
2	4	23	6.9	2.5	0.16	0	0	9.06	5.7	15.3	59.4	5.7	2.96	47	
7	4	35	3.4	1.1	0	0	0	4.50	5.8	10.3	43.7	5.5	1.76	11	Low K & P_2O_5
18	4	47	1.3	<0.6	0	0	0	1.30	6.9	8.2	15.8	4.9	0.89	10	Low bases
37	4	47	1.2	<0.6	0	0	0	1.20	6.0	7.2	16.6	5.0	0.47	15	
48	0	55	1.8	0.6	0	0	0	2.40	5.2	7.6	31.5	5.0	0.27	20	
72	0	41	1.8	0.6	0	0	0	1.80	5.3	7.1	25.4	5.0	0.15	18	High N
									N% 0.308 0-2", 0.216 2-7"						
									Buganda Loam						
									Profile 6 (18652-57)						
4	10	23	6.8	4.1	0.14	0	0.03	12.07	4.2	16.3	74.2	6.0	1.93	14	High N
10	8	25	1.2	0.4	0	0	0.12	1.72	6.3	8.0	21.4	4.8	0.81	7	Low P_2O_5 and bases
18	4	43	<.4	<.3	0	0	0.06	0.06	6.0	6.1	1.0	4.8	0.35	7	
36	4	43	1.1	<.3	0	0	0.03	1.13	5.3	6.4	17.6	5.0	0.20	8	
60	5	46	1.3	<.3	0	0	Tr.	1.30	4.8	6.1	21.3	5.0	0.22	12	
72	5	46	1.0	<.3	Tr	0	0.02	1.32	5.0	6.3	20.9	5.0	0.29	14	
									N% 0.284 0-4"						

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Buganda Clay Loam															
Profile 7 (15215-22)															
3	5	32	7.5	3.6	0.14	0	0	11.24	12.7	23.9	47.0	6.0	2.47	15	
7	4	32	5.4	1.9	0.08	0	0	7.38	14.5	21.9	33.7	5.6	1.79	10	
18	2	44	1.6	0.9	Tr.	0	0	2.50	14.7	17.2	14.5	5.3	0.77	5	Low P_2O_5 and bases
30	4	51	1.6	0	0	0	0	1.60	12.6	14.2	11.3	5.4	0.56	5	
42	3	53	2.7	0	0	0	0	2.70	10.5	13.2	20.5	5.5	0.36	9	
54	3	55	2.7	Tr.	0	0	0	2.70	9.5	12.2	22.1	5.6	0.29	14	
66	3	55	2.4	Tr.	0	0	0	2.40	9.1	11.5	20.9	5.9	0.20	20	
78	7	51	2.3	Tr.	0	0	<.02	2.30	8.3	10.6	21.7	5.8	0.20	17	
									N%	0.208	0-3"				
Buganda "Brown Ferruginized"															
Profile 8 (18624-27)															
3	15	40	3.1	1.7	0	0	0.08	4.88	8.3	13.2	37.0	5.5	2.55	25	Low bases
8	14	48	1.6	0.6	0	0	0.02	2.22	8.4	10.6	20.9	5.0	1.63	12	
30	0	60	<.4	<.3	0	0	<.02	-	8.1	8.1	N.D.	4.9	0.88	14	
36	16	34	<.4	<.3	0.23	0	0	0.23	3.8	4.0	5.7	5.4	0.13	16	
									N%	0.257	0-3"				
Kyebe "Red"															
Profile 9 (19806-10)															
3	6	36	6.9	2.0	0.16	0	0.34	9.40	5.3	14.7	63.8	5.9	1.75	14	Low P_2O_5
8	8	34	2.8	1.3	0.17	0	0.21	4.38	5.1	9.5	47.6	5.9	1.74	N.D.	
18	8	54	3.2	1.6	0	0	0.27	5.07	4.3	9.4	54.1	5.9	0.67	10	
36	10	52	2.4	0.4	0	0	0.07	2.87	3.5	6.4	45.1	6.0	0.38	11	
60	2	52	2.0	0.4	0	0	0.05	2.45	3.8	6.3	39.2	5.6	0.23	11	
									N%	0.172	0-3"				

Depth Ins.	Mechanical Analysis Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
Kabira "Medium"															
Profile 10 (14636-41)															
3	6	48	3.7	1.2	0.17	0	0.04	5.11	21.0	26.1	19.6	5.0	2.01	43	High N
9	8	44	1.3	<.3	0.15	0	0.04	1.49	21.3	22.8	6.5	4.6	1.29	22	Low bases
18	6	42	1.1	<.3	0.12	0	0.03	1.25	16.7	18.0	7.0	4.6	0.95	18	
25	6	46	0.6	<.3	0.12	0	0.03	0.75	15.8	16.6	4.5	4.5	0.75	20	
44	6	48	0.7	<.3	0.08	0	0.03	0.81	17.3	18.1	4.5	4.6	0.69	22	
72	4	34	0.4	<.3	0.03	0	<.02	0.43	7.8	8.2	5.2	4.7	0.21	23	
								N%	0.340	0-3"					
Kabira "Ferruginized"															
Profile 11 (18602-06)															
3	8	43	3.6	1.3	0.25	0	0.07	5.22	9.3	14.5	36.0	5.2	2.30	67	Very low bases
7	8	43	2.0	0.8	0.15	0	0.05	3.00	9.2	12.2	24.6	5.0	1.94	22	
18	8	53	0.6	<.3	0	0	0.02	0.62	8.2	8.8	7.0	5.0	1.26	12	
32	8	55	0.6	<.3	0	0	<.02	0.60	8.1	8.7	6.9	5.2	0.89	10	
48	6	27	0.5	<.3	0	0	0	0.50	3.9	4.4	1.1	5.7	0.11	12	
								N%	0.214	0-3"					
Mirambi "Brown Deep"															
Profile 12 (14879-84)															
3	7	15	4.1	2.3	1.00	0	0	7.40	6.1	13.5	54.8	6.3	1.68	72	Normal profile
11	5	23	3.0	1.1	0.78	0	0	4.88	7.2	12.1	40.4	5.8	0.80	5	
22	7	35	2.4	0.5	0.48	0	0.02	3.37	7.1	10.5	32.2	5.3	0.48	20	
34	2	42	2.2	0.9	0.23	0	0.03	3.36	7.2	10.6	31.8	5.3	0.35	45	
54	2	42	1.9	0.9	0.16	0	Tr.	2.96	9.4	12.4	23.9	5.1	0.15	124	
72	2	36	1.0	<.3	0.17	0	0	1.17	9.8	11.0	10.7	4.9	0.23	22	
								N%	0.192	0-3"					

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H.	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
									Mawogola "Medium"						
									Profile 13 (14842-47)						
3	4	23	2.1	1.1	0.20	0	0.05	3.45	7.7	11.2	30.9	5.3	1.41	10	Low bases and P_2O_5
8	8	25	1.6	0.8	0.23	0	0.06	2.69	9.5	12.2	22.1	4.8	1.01	13	
18	6	27	1.0	<.3	0.16	0	0.07	1.23	9.7	10.9	11.3	4.7	0.69	12	
30	4	47	0.4	<.3	0.16	0	0.03	0.59	11.7	12.3	4.8	4.6	0.50	13	
48	6	49	0.5	<.3	0.19	0	0.03	0.72	10.9	11.6	6.2	4.7	0.36	13	
60	4	49	0.3	<.3	0.09	0	<.02	0.59	9.6	10.2	5.8	4.7	0.21	2	
									N% 0.176 0-3"						
									Mawogola "Hillwash"						
									Profile 14 (14974-79)						
5	4	12	2.7	8.8	0.27	0	0	11.77	7.6	19.4	60.8	5.7	1.47	10	Low N
12	1	12	2.0	3.2	0.37	0	0	5.57	8.6	14.2	39.3	5.5	0.95	10	Low P_2O_5
20	3	10	1.5	4.2	0.23	0	0	5.93	6.8	12.7	46.6	5.3	0.47	9	
28	1	8	1.3	3.9	0.16	0	0	5.36	5.0	10.4	51.7	5.3	0.26	7	
36	3	6	1.3	3.0	0.12	0	0	4.42	3.4	7.8	56.5	5.4	0.09	9	
48	3	6	1.2	3.3	0.10	0	0	4.60	3.2	7.8	67.6	5.6	0.06	2	
									N% 0.149 0-5"						
									Makole Series						
									Profile 15 (15011-16)						
3	8	20	2.8	2.8	0.81	0	0	6.41	5.1	11.5	55.7	6.1	1.49	23	
9	6	22	2.1	1.8	0.20	0	0	4.10	8.4	12.5	32.8	5.2	1.13	0	Low P_2O_5
19	4	26	1.6	2.5	0.26	0	0	4.36	8.7	13.1	33.4	5.0	0.96	2	
30	10	32	1.7	1.5	0.34	0	0	3.54	7.6	11.1	31.8	4.9	0.56	5	
48	8	34	2.6	2.1	0.45	0	0	5.15	5.9	11.1	46.6	4.9	0.39	19	
72	6	52	5.9	3.4	0.20	0	0	9.90	4.7	14.6	67.8	5.0	0.20	13	
									N% 0.221 0-3"						

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Mityana "Red"															
Profile 16 (18290-95)															
3	6	38	5.9	3.1	0.41	0	0.02	9.43	4.6	14.0	67.2	5.9	1.89	30	
9	6	36	5.6	0.6	0.13	0	0.08	6.41	4.1	10.5	61.0	5.4	1.44	6	Low bases and P_2O_5
17	10	42	4.5	<.3	0.11	0	0.05	4.66	5.1	9.8	47.7	5.2	0.78	6	
36	2	52	2.1	<.3	Tr.	0	0	2.10	4.2	6.3	33.3	5.3	0.41	12	
54	8	54	2.5	0.6	Tr.	0	0	3.10	3.1	6.2	50.0	5.4	0.21	13	
72	0	50	2.0	<.3	Tr.	0	0	2.00	2.4	4.4	45.5	5.5	0.18	12	
								N%	0.222	0-3"					
Mabira "Red"															
Profile 17 (19794-98)															
3	6	46	30.2	3.4	0.56	0	0.09	34.3	5.7	40.0	85.7	6.1	4.67	43	High nutrients due to organic matter
8	8	48	14.8	2.1	0.38	0	0.07	17.4	2.6	20.0	87.0	6.5	2.18	21	
18	7	64	5.9	1.2	0.23	0	0.02	7.4	2.1	9.5	77.9	5.9	0.90	10	
30	8	64	3.4	1.9	0.18	0	0	5.5	2.3	7.8	70.5	6.2	0.59	22	
60	4	68	1.4	1.8	0.08	0	0.02	3.3	3.0	6.3	52.4	5.8	0.50	12	
								N%	0.476	0-3"					
Mabira "Yellow"															
Profile 18 (19800-05)															
3	6	26	6.8	4.4	0.36	0	0.06	11.6	2.9	14.5	80.0	5.0	1.40	9	Very low P_2O_5
9	6	26	4.1	1.0	0.13	0	0.20	5.4	3.0	8.4	64.2	4.7	0.82	9	
18	10	34	2.4	0.3	0.13	0	0.16	3.0	2.5	5.5	54.5	4.7	0.50	5	
36	12	46	2.1	1.5	0.14	0	0.04	3.8	2.8	6.6	57.6	4.9	0.48	8	
60	0	42	1.0	1.3	0.08	0	0.03	2.4	2.6	6.0	40.0	5.6	0.41	12	Increase in bases due to fresh minerals
72	0	44	1.6	2.3	0.14	0	0.02	4.1	2.7	6.8	60.2	4.5	0.37	12	
								N%	0.159	0-3"					

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g. Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Nakabango "Medium"															
Profile 19 (20617-21)															
3	0	34	33.5	6.6	1.03	0	0.05	41.18	1.8	43.0	95.8	7.2	7.59	143	High N
9	20	42	22.2	6.8	0.67	0	0	29.67	5.9	35.6	83.4	6.0	3.68	21	Very high bases and C
18	10	40	18.7	6.0	0.48	0	Tr.	25.18	6.7	31.9	79.0	5.3	2.44	11	Fire site or fresh
36	4	48	19.7	5.9	0.42	0	Tr.	26.02	3.7	29.7	87.6	6.1	1.31	10	minerals
72	24	14	23.0	8.2	<.16	0	0	31.20	1.9	33.1	94.3	6.3	0.83	5	
								N%	0.756	0-3"					
Nakabango "Red"															
Profile 20 (20627-32)															
3	16	46	20.8	3.4	1.34	0	0.06	25.60	2.4	28.0	91.4	7.2	7.28	190	High bases, N and C
8	18	54	16.9	3.6	0.62	0	0	11.12	2.6	13.7	81.0	6.9	2.37	14	
18	10	66	5.7	2.5	0.53	0	0	8.73	3.6	12.3	70.8	6.3	0.49	9	Low P_2O_5
36	6	72	3.5	1.3	0.61	0	Tr.	5.41	5.9	11.3	47.8	5.0	0.38	8	High clay
58	12	74	4.3	0.9	0.31	0	0	5.51	5.9	11.4	48.3	5.0	0.32	8	
72	16	70	2.0	1.3	0.34	0	Tr.	4.64	5.2	9.8	47.2	5.1	0.32	12	
								N%	0.675	0-3"					
Kamusene Series															
Profile 21 (17154-59)															
3	10	32	8.6	5.0	0.48	0	0.04	14.2	6.7	20.8	67.8	6.0	4.08	15	Low P_2O_5
8	6	35	3.1	1.6	0.12	0	Tr.	4.82	7.7	12.5	38.5	5.3	1.59	9	otherwise normal
16	6	46	2.7	1.1	0	0	0.06	3.86	6.5	10.4	37.3	5.3	1.17	2	
36	8	54	1.7	0.5	Tr.	0	0.03	2.23	4.9	7.1	31.3	5.4	0.54	0	
60	3	59	1.0	<.3	Tr.	0	0	1.00	4.5	5.5	18.2	5.6	0.44	6	
72	3	63	1.1	<.3	<.08	0	0	1.10	4.3	5.4	N.D.	5.8	0.32	0	
								N%	0.297	0-3"					

Depth Ins.	Mechanical Analysis Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
Kibula Series															
Profile 22 (14998-03)															
3	6	40	3.8	4.4	0.42	0	0	8.62	9.0	17.6	48.9	5.8	1.89	10	Low P_2O_5
8	4	42	2.7	3.4	0.21	0	0	5.31	11.7	17.0	31.4	5.4	1.28	6	otherwise normal
18	6	44	1.7	1.1	0.11	0	0	2.91	10.2	13.1	22.2	5.3	0.77	3	
30	3	50	1.8	1.1	0.17	0	0	3.07	9.4	12.5	24.6	5.1	0.51	14	
42	0	56	1.9	1.3	0.16	0	0	3.36	9.4	12.8	26.3	5.0	0.35	6	
60	6	56	2.3	2.4	0.17	0	0	4.87	10.3	15.2	32.1	5.4	0.26	5	
								N%	0.193	0-3"					
Lukaya Series															
Profile 23 (16795-800)															
3	4	27	2.1	1.8	0.39	0	0.09	4.38	6.4	10.8	40.6	5.8	1.71	11	
8	4	31	0.6	<.3	0.16	0	0.06	0.82	7.5	8.3	9.9	4.9	1.11	9	Low bases and P_2O_5
18	6	37	<.4	<.3	0.12	0	0.03	0.15	6.8	6.9	2.0	4.9	0.75	5	
36	4	39	Tr.	<.3	0.08	0	<.02	0.08	6.0	6.1	1.3	5.4	0.50	4	
48	0	42	Tr.	<.3	0.08	0	Tr.	0.08	6.3	6.4	1.3	5.5	0.42	7	
60	0	44	Tr.	<.3	0.14	0	0.02	0.16	6.9	8.1	N.D.	5.3	0.57	5	
								N%	0.150	0-3"					
Buyaga "Red Deep"															
Profile 24 (16904-11)															
3	8	32	6.1	3.4	1.37	0	0.02	10.89	4.3	15.2	71.7	6.2	2.70	28	High N
8	6	38	5.5	1.2	0.50	0	0.04	7.24	5.5	12.7	56.8	6.0	2.18	9	Low P_2O_5
18	2	50	2.6	1.6	0.20	0	0.05	4.45	5.9	10.6	43.0	5.3	1.38	5	
36	10	56	1.3	1.1	0.08	0	0.03	2.51	4.6	7.1	35.3	5.5	0.51	3	
60	12	56	1.3	<.3	Tr.	0	0	1.30	3.6	4.9	26.5	5.9	0.09	9	
80	6	58	1.2	<.3	Tr.	0	0	1.20	3.3	4.5	26.7	6.0	0.14	9	
98	4	48	0.8	<.3	<.08	0	0	0.80	3.3	4.1	19.5	6.2	0.03	0	
123	4	54	1.2	<.3	<.08	0	0	1.20	3.8	5.0	24.0	6.0	0.15	10	
								N%	0.119	0-3"					

Depth Ins.	Mechanical Analysis Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H.	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
Lubumba Series															
Profile 25 (17921-26)															
3	3	27	4.3	3.3	0.44	0	0.02	8.06	5.4	13.5	59.9	6.0	1.89	39	High N
8	1	32	0.4	<.3	<.08	0	0.02	0.42	6.7	7.1	5.9	5.0	0.90	10	Low bases and P_2O_5
18	1	37	<.4	<.3	0	0	0	-	6.4	6.4	N.D.	5.0	0.69	7	
36	3	40	0.7	<.3	0	0	0	0.70	6.3	7.0	10.0	5.4	0.26	9	
52	0	44	0.9	<.3	Tr.	0	0.01	0.91	3.6	4.5	20.2	5.6	0.32	8	
72	3	50	1.0	<.3	Tr.	0	0.01	1.01	3.7	4.7	21.4	5.6	0.33	7	
								N%	0.309	0-3"					
Buruli "Red Deep"															
Profile 26 (19642-47)															
3	6	12	0.7	0.6	<.08	0	0.22	1.52	3.2	4.7	32.2	4.7	0.96	10	Low bases, C and P_2O_5
8	2	22	<.4	<.3	0.19	0	0.05	0.24	3.5	3.7	6.4	4.1	0.56	14	
18	4	30	Tr.	<.3	0.15	0	0.06	0.21	3.7	3.9	5.4	4.1	0.29	11	
36	2	40	0	<.3	0.30	0	0.06	0.36	3.4	3.8	9.6	4.3	0.14	14	
60	6	36	<.4	<.3	0.24	0	0.07	0.31	3.5	3.8	8.1	4.3	0.20	23	
72	2	48	<.4	<.3	0.16	0	0.08	0.24	4.3	4.5	5.3	4.1	0.17	14	
								N%	0.156	0-3"					
Buruli "Ferruginized"															
Profile 27 (19734-39)															
3	2	22	1.8	0.6	0.20	0	0.18	2.78	2.5	5.3	52.7	5.3	0.67	7	Low bases, very low C and P_2O_5
8	6	30	1.0	<.3	0.12	0	0.19	1.31	3.5	4.8	27.2	4.6	0.70	2	
18	10	42	0.5	<.3	<.08	0	0.07	0.57	4.8	5.4	10.6	4.6	0.53	2	
28	2	40	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	
48	6	36	<.4	<.3	0.12	0	0.06	0.18	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	
48+	0	46	<.4	<.3	0.09	0	0.03	0.12	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	
								N%	0.100	0-3"					

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Lwampanga Series															
Profile 28 (19656-61)															
3	6	15	0.7	<.3	0.14	0	0.05	0.89	2.6	3.5	25.5	5.5	0.44	12	Low bases, P_2O_5 and
8	0	22	<.4	<.3	0.14	0	0.05	0.19	3.5	3.7	5.1	4.1	0.36	6	very low N due to
18	4	28	<.4	<.3	<.08	0	0.05	0.05	4.1	4.2	1.2	4.4	0.31	2	sandy topsoil
36	4	36	0	<.3	0.09	0	0.05	0.14	4.5	4.6	3.0	4.4	0.26	7	
60	2	42	Tr.	<.3	0.12	0	0.04	0.16	4.3	4.5	3.6	4.7	0.13	5	
72	2	42	<.4	<.3	0.24	0	0.05	0.29	4.1	4.4	6.6	4.6	0.26	5	
								N%	0.072	0-3"					
Buwekula "Shallow"															
Profile 29 (17689-94)															
3	6	18	3.0	1.8	0.31	0	<.02	5.13	5.8	10.9	46.9	5.8	2.13	12	Low P_2O_5
10	2	16	2.3	1.4	0	0	0	3.70	4.9	8.6	43.0	5.7	2.12	13	Low K
18	1	7	<.8	<.6	0	0	0	1.40	1.9	3.3	42.4	5.7	0.50	5	
36	7	23	<.8	0.6	0	0	0	1.40	3.8	5.2	26.9	4.9	0.36	5	
60	8	45	1.6	1.4	0	0	0	3.00	3.7	6.7	44.8	5.0	0.14	8	
72	5	41	1.1	1.5	0.25	0	0	2.85	4.0	6.9	41.6	4.9	0.08	9	
								N%	0.326	0-3"					
Buwekula "Red"															
Profile 30 (17683-88)															
3	5	29	2.3	1.9	0.66	0	0.02	4.83	5.6	10.5	46.6	5.6	2.01	9	Low P_2O_5
8	4	35	2.2	1.1	0.46	0	0.02	3.73	6.1	9.8	38.0	5.1	1.23	5	
18	2	34	1.4	0.6	0.36	0	Tr.	2.36	6.0	8.4	28.2	4.9	0.72	8	
40	0	47	1.2	1.8	Tr.	0	0	3.00	5.0	8.0	37.5	5.2	0.39	10	
60	4	51	1.2	1.8	Tr.	0	Tr.	3.00	4.4	7.4	40.5	5.4	0.38	14	
72	2	52	1.1	1.5	0	0	0	2.60	4.4	7.0	37.1	5.9	0.15	11	
								N%	0.275	0-3"					

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Buwekula "Brown"															
Profile 31 (17667-72)															
3	8	14	2.0	1.3	0.33	0	0.04	3.67	5.1	8.8	41.9	5.6	1.89		Low bases
8	2	24	<.8	<.6	0.36	0	0.03	1.79	6.8	8.6	20.8	4.9	1.29		
20	4	24	0	0	0	0	0	-	6.8	6.8	N.D.	4.9	0.78		
36	8	42	Tr.	0	0	0	0	-	6.8	6.8	N.D.	5.0	0.33		
60	4	48	1.0	0	0	0	0	1.00	6.0	7.0	14.3	4.9	0.24		
72	6	54	1.4	<.6	0	0	0	2.00	6.6	8.6	23.3	4.9	0.29		
								N%	0.177	0-3"					
Mubende "Deep"															
Profile 32 (17330-34)															
3	7	25	1.2	<.3	0.56	0	0.04	1.80	5.0	6.8	26.5	5.0	1.95	7	Very low bases & P_2O_5
8	9	33	0.7	0	0.16	0	Tr.	0.89	7.0	7.9	11.3	4.7	1.31	5	
22	5	41	Tr.	0	0.13	0	0	0.13	6.2	6.4	2.0	4.8	1.08	3	
44	3	55	Tr.	0	Tr.	0	0	-	5.6	5.6	N.D.	5.2	0.38	1	
72	8	47	Tr.	0	Tr.	0	0	-	4.6	4.6	N.D.	5.3	0.20	0	
								N%	0.200	0-3"					
Mulembo Series															
Profile 33 (14645-51)															
2	0	5	<.4	<.3	0.18	0	0.03	0.21	1.3	1.5	13.9	5.3	1.68	55	Very low bases
8	0	5	<.4	<.3	0.13	0	0.02	0.15	1.4	1.6	9.7	4.8	0.60	41	
19	5	0	0	<.3	0.08	0	0.02	0.10	0.9	1.0	10.0	4.6	0.44	0	
28	1	5	0	Tr.	<.08	0	0	-	1.0	1.0	N.D.	4.6	0.29	2	Very low P_2O_5
34	0	5	0	<.3	<.08	0	0	-	0.6	0.6	N.D.	4.5	0.15	0	
48	8	7	0	Tr.	<.08	0	0	-	0.3	0.3	N.D.	4.9	0.12	4	
60	7	5	0	<.3	<.08	0	0	-	0.1	0.1	N.D.	5.0	0.12	3	
								N%	0.073	0-2"					Very low N

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
								Mulembo "Yellow"							
								Profile 34 (18327-32)							
3	12	12	5.9	3.8	0.34	0	0.03	10.07	3.9	14.0	72.1	6.1	2.09	11	Very low P_2O_5
9	16	12	2.2	3.0	0.12	0	0.06	5.38	4.2	9.6	57.2	5.8	0.93	4	
18	4	10	<.4	0.9	Tr.	0	0.04	0.94	3.4	4.3	21.7	5.2	0.36	5	
36	6	20	0.9	1.0	Tr.	0	0.03	0.93	2.6	3.5	26.3	4.9	0.03	5	
60	0	24	1.0	0.7	0.13	0	0	1.83	3.3	5.1	35.7	4.9	0.08	7	
72	2	32	1.0	1.3	0.10	0	0	2.40	3.4	5.8	41.4	5.0	0.05	7	
								N%	0.227	0-3"					
								Kifu Series							
								Profile 35 (19825-30)							
3	18	22	<.4	<.3	0.69	0	0.04	0.73	18.1	18.8	3.9	4.4	4.70	9	Very low bases & P_2O_5
8	18	24	<.4	<.3	0.30	0	0	0.30	16.0	16.3	1.8	4.4	0.90	7	
14	4	8	0	Tr.	0.10	0	0	0.10	4.9	5.0	2.0	4.6	0.56	9	Extremely acid
36	4	6	0	<.3	0.08	0	0	0.08	0.9	1.0	0.8	4.4	0.11	8	
60	6	10	0	Tr.	0.13	0	0	0.13	0.3	0.2	8.1	4.1	0.14	7	
72	6	14	0	Tr.	0.12	0	0	0.12	0.4	0.5	23.1	4.0	0.12	9	
								N%	0.548	0-3"					High N
								Bukora Series							
								Profile 36 (15257-61)							
3	28	24	3.5	4.0	0.63	Tr.	0	8.13	5.6	13.7	59.2	5.5	2.07	103	
8	28	28	1.6	2.1	0.29	Tr.	0	3.99	6.8	10.8	37.0	4.8	1.56	17	
16	34	42	1.2	1.5	0.19	Tr.	0	2.89	7.0	9.9	29.2	4.7	1.11	18	
28	26	56	1.2	1.1	0.17	0.3	0	2.77	7.8	10.6	26.2	4.8	0.74	21	
40	8	52	1.3	1.1	0.16	0.4	0	2.96	7.3	10.3	28.8	5.0	0.38	16	
								N%	0.183	0-3"					

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H.	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Bukora "Yellow"															
Profile 37 (14493-97)															
4	20	24	1.9	1.8	0.50	Tr.	0.02	4.22	5.0	9.2	45.8	5.3	1.46	32	
9	14	28	1.0	0.6	0.33	0	0.04	1.97	5.5	7.5	26.1	5.0	0.97	35	
24	26	28	0.6	<.3	0.17	0	<.02	0.77	4.9	5.7	13.6	5.1	0.64	10	
44	20	32	<.4	<.3	0.20	0	0	0.20	4.7	4.9	N.D.	5.0	0.38	8	
66	26	36	<.4	<.3	Tr.	0	0	-	4.3	4.3	N.D.	5.2	0.22	8	
								N%	0.121	0-4"					
Kaku Series															
Profile 38 (14872-77)															
5	3	29	38.8	9.4	2.00	0.03	0.22	50.32	9.1	59.4	84.7	5.3	5.61	167	Very high bases indicating montmorillonitic clay mineral
12	9	45	28.4	10.2	1.56	0.40	0.06	40.68	8.2	48.9	83.2	5.3	3.72	20	
22	5	63	30.0	11.6	0.95	0.50	0	43.05	5.5	48.6	88.7	5.0	1.00	9	
34	1	55	18.6	8.1	0.58	0.60	0	27.88	4.0	31.9	87.5	5.0	2.10	5	
48	6	53	16.6	5.0	0.42	0.50	0	22.52	2.8	25.3	88.9	4.9	0.33	4	
54	18	49	11.0	3.8	0.36	0.30	0	15.46	2.3	17.8	87.0	5.0	0.11	2	
								N%	0.384	0-5"					
Liga Series															
Profile 39 (20633-38)															
3	20	31	32.0	6.0	0.78	0.3	0.03	38.81	N.D.	N.D.	N.D.	6.4	8.23	119	High Ca and Mg from basic rocks
8	16	37	21.4	5.4	0.60	0.3	0.04	27.74	9.1	36.8	75.3	5.1	2.45	18	
18	12	49	10.1	4.8	0.39	0.4	0.03	15.72	10.2	25.9	60.6	4.1	0.92	9	
31	14	49	9.5	5.9	0.51	0.6	0.05	16.56	8.6	25.2	65.8	4.1	0.85	3	
45	14	43	10.9	5.5	0.51	0.7	Tr.	17.61	5.8	23.4	75.2	4.5	0.66	3	
72	10	37	8.5	5.5	0.41	0.7	Tr.	15.11	4.3	19.4	77.8	5.2	0.47	8	
								N%	0.736	0-3"					

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Sango Series															
Profile 40 (14353-59)															
5	0	0	<.4	<.3	0.13	Tr.	0.01	0.14	5.2	5.3	6.6	5.2	1.08	121	Extremely deficient in bases but high in P_2O_5 from fish residues
11	0	0	<.4	<.3	0.13	0	Tr.	0.13	3.8	3.9	3.3	5.1	0.83	107	
22	0	0	Tr.	Tr.	0.10	0	0	0.10	2.3	2.4	4.2	5.4	0.44	187	
29	0	0	0	0	0	0	0	-	2.1	2.1	N.D.	5.8	0.14	37	
48	0	0	0	0	0	0	0	-	1.2	1.2	N.D.	6.0	0.09	34	
67	0	0	0	0	0	0	0	-	0.4	0.4	N.D.	6.4	0.05	33	
77	0	0	0	0	0	0	0	-	0.7	0.7	N.D.	6.4	0.11	31	
								N%	0.118	0-5"					
Sango "Shallow"															
Profile 41 (14469-76)															
3	13	0	1.2	0.5	0.31	0.2	0.03	2.24	10.1	12.3	18.2	5.4	1.62	25	Very deficient in bases
7	15	0	0.5	Tr.	0.28	0	0.01	0.79	10.6	11.4	6.9	4.9	1.22	23	
14	9	6	Tr.	0	0.25	0	0	0.25	7.5	7.8	3.2	4.9	0.68	8	
19	13	0	0	0	0.09	0	0	0.09	1.2	1.3	7.0	5.2	0.10	11	
32	9	18	0.8	0	0.17	0.4	0.03	1.40	11.9	13.3	10.5	5.0	0.21	13	
45	5	20	1.6	0.6	0.16	0.7	0.02	3.08	11.5	14.6	21.1	5.2	0.41	13	
49	4	18	2.0	1.0	0.12	0.6	0.03	3.75	11.1	14.9	25.3	5.2	0.52	13	
60	7	26	3.2	1.0	0.16	0.8	0.05	5.21	13.2	18.4	28.3	5.1	0.67	14	
								N%	0.122	0-3"					
Katera Series															
Profile 42 (15329-34)															
3	0	8	<.4	<.3	0.21	0	0	0.21	2.6	2.8	7.5	5.5	0.63	17	Extremely deficient in bases and P_2O_5
8	0	10	<.4	0	0.09	0	0	0.09	2.8	2.9	3.1	5.3	0.53	8	
18	0	12	0	0	0	0	0	-	2.7	2.7	0	5.2	0.32	9	
33	12	16	0.	0	0	0	0	-	2.4	2.4	0	5.4	0.23	4	
48	28	14	0	1.1	0	0	0	1.10	2.3	3.4	32.4	5.4	0.21	9	
60	10	28	1.1	0.8	0.	0	0	1.90	4.0	5.9	32.2	5.4	0.21	5	
								N%	0.085	0-3"					

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Katera "Ferruginized"															
Profile 43 (15599-03)															
3	6	32	2.4	1.5	0.38	0	Tr.	4.28	6.6	10.9	39.3	5.5	1.65	87	
8	4	16	0.7	<.3	0.30	0	0	1.00	8.5	9.5	10.5	5.0	1.80	14	
20	6	36	2.5	0.8	<.08	0	0	3.30	7.8	11.1	29.7	5.0	0.86	73	
50	2	50	0.02	0	0	0	0	0.02	N.D.	N.D.	N.D.	5.1	0.33	32	
60	2	50	0.03	0	0	0	0	0.03	5.0	5.0	6.0	5.0	0.12	25	
								N%	0.111	0-3"					
Wasa Series															
Profile 44 (17106-10)															
4	10	27	18.2	9.4	1.62	0.2	0.09	29.51	7.9	37.41	78.9	5.7	5.97	435	High bases and P_2O_5
12	14	34	25.8	9.4	1.36	0.7	0.06	27.32	8.4	35.7	76.5	5.5	6.54	154	
24	5	42	21.3	4.8	0.85	2.3	0.05	29.30	3.3	32.6	89.9	5.8	1.22	42	
48	7	43	24.2	8.2	0.53	9.3	0.04	42.27	0	42.3	100.0	7.5	0.41	240	
48+	9	50	23.4	10.7	0.75	19.8	0	44.65	0	44.7	100.0	7.4	0.36	210	
								N%	0.260	0-4"					
Kyoga Series															
Profile 45 (19638-41)															
3	12	30	23.2	6.6	3.02	0	0.03	32.8	1.6	34.4	95.3	6.8	4.16	1300	High P_2O_5 due to fish residues
8	6	30	15.2	5.0	2.96	0	0.02	23.2	1.5	24.7	94.1	6.6	2.23	1000	
16	8	42	11.6	4.5	2.62	Tr.	0.01	18.7	1.1	19.8	94.3	6.2	1.02	137	
30	6	42	11.4	4.9	1.24	0.2	0.01	17.7	1.2	18.9	93.8	6.4	0.70	67	
								N%	0.350	0-3"					
Sesse "Red"															
Profile 46 (22047-50)															
3	4	42	3.0	0	<.16	0	0	3.0	11.4	14.4	20.8	4.0	4.28	290	Low bases, extremely acid, high P_2O_5 from bird droppings
8	6	48	1.8	0	<.16	0	0.02	1.8	8.3	10.1	17.8	4.2	2.35	350	
24	6	46	1.9	0	<.16	0	0.03	1.9	10.1	12.0	15.8	4.3	2.82	350	
60	10	52	1.6	0	<.16	0	0.02	1.6	6.0	7.6	21.1	4.4	1.70	320	
								N%	0.325	0-3"					

Depth Ins.	Mechanical Analysis Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mg	Total	Exch. H.	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
									Sesse "Brown"						
									Profile 47 (22051-54)						
3	6	18	1.2	0	0	0	0	1.2	6.0	7.2	16.7	4.9	2.20	104	Highly leached but still high P_2O_5
8	6	18	1.2	0	0	0	0	1.2	5.7	6.9	17.4	5.0	1.34	99	
20	4	22	Tr.	0	0	0	0	0	5.8	5.8	N.D.	5.0	1.01	180	
36	10	32	Tr.	0	0	0	0	0	8.4	8.4	N.D.	5.0	0.67	120	
								N%	0.192	0-3"					
									Bugoma Series						
									Profile 48 (22060-63)						
3	10	24	1.2	0.6	1.00	0	0.02	2.8	5.4	8.2	34.1	5.9	1.14	340	Low bases and high P_2O_5
8	10	24	0.8	<.6	0.81	0	Tr.	1.6	4.8	6.4	2.5	5.8	1.01	175	
24	8	28	19.5	0	0.34	0	Tr.	19.8	6.8	26.6	74.4	5.1	0.81	275	
60	6	18	6.9	0	<.16	0	0	6.9	1.5	8.4	82.1	5.1	0.08	31	
								N%	0.199	0-3"					
									Kikwayu Series						
									Profile 49 (22043-46)						
3	6	22	2.7	0	0.17	0	0	2.9	8.1	11.0	26.4	4.3	1.05	144	Low bases and high P_2O_5
8	4	24	1.2	0	<.16	0	0	1.2	7.8	9.0	13.3	4.4	0.94	146	
24	4	24	1.9	0	0	0	0	1.9	6.6	8.5	22.4	4.7	0.63	125	
60	4	20	2.1	0	0	0	0	2.1	4.6	6.7	31.3	4.9	0.30	126	
								N%	0.115	0-3"					
									Kinyu Series						
									Profile 50 (22064-67)						
3	4	6	Tr.	0	0	0	0	0	7.7	7.7	0	5.1	1.87	17	Extremely low bases, low P_2O_5
8	2	10	Tr	0	0	0	0	0	4.0	4.0	0	5.1	0.46	9	
30	2	10	Tr.	0	0	0	0	0	3.1	3.1	0	5.3	0.27	6	
30+	4	12	0.8	0	0	0	0	0.8	3.3	4.1	19.5	5.3	0.31	8	
								N%	0.187	0-3"					

MAP 4

KINGDOM OF BUGANDA

GENERALIZED GEOLOGICAL MAP.

0 5 10 15 20 25 MILES.

RIVER VICTORIA NILE

NAKASONGOLA

MUBENDE

KAMPALA

MASAKA.

L. WAMALA

DISTRICT BOUNDARY

LAKE ----------L

RIVER ----------R

Key.

L.D	Lake Deposits: sands, silts and clays.
K	Kaiso Beds: sands, silts and clays.
	Areas overlain by Mityana Series: conglomerates, arkoses.
B	Bukoba Series: sandstones.
S	Singo Series: conglomerates, sandstones, rare mudstones.
K.A.	Karagwe-Ankolean System: quartzites, mudstones, phyllite, schists.
T1	Buganda Series (Toro System): quartzites, mudstones, slates, phyllites, schists
T2	Toro System: undifferentiated gneisses and schists.
T3	Toro System: mica schists and metamorphosed sandstones.
B.C.	Basement Complex: undifferentiated acid gneisses and granites

Intrusive Rocks.

M.B.	Mubende Batholith: biotite granite.
S.B.	Singo Batholith: biotite granite.
N.G.	Nkonge tourmaline-muscovite granite.
A	Amphibolites.

Compiled by R. Johnson
Senior Geologist.
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Uganda.

31° 32° 33° 1° 0°

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MAP 6

KINGDOM OF BUGANDA

SOIL MAPPING UNITS.

0 5 10 15 20 25 MILES.

DISTRICT BOUNDARY
RIVER R
LAKE L

MUBENDE
NAKASONGOLA
KAMPALA
ENTEBBE
MASAKA
L. WAMALA
LAKE VICTORIA
R. VICTORIA NILE

1° 0'
0° 0'
31° 0'
32° 0'
33° 0'

Key.

1	Mubende/Koki/Kasolo Complex
1A	Mubende Catena.
1B	Koki Catena.
2	Buganda Catena.
2A	Kyebe Catena
2B	Bowa Catena
3	Mirambi Catena.
3+2	Mirambi/Buganda Complex.
4	Mawogola Catena.
4A	Makole Series.
5	Kabira Catena.
6	Buwekula Catena.
6+3	Buwekula/Mirambi Complex.
7	Mityana Catena.
8+9	Mabira / Nakabango Complex.
9	Nakabango Catena.
6+9A	Buwekula/Kamusene Complex.
10	Lukaya Catena.
11	Buyaga Catena.
11A	Lubumba Series.
11+9A	Buyaga/Kamusene Complex.
12	Buruli Catena.
12A	Lwampanga Series.
13	Lyanda Series.
14	Sango Series.
5+14	Kabira/Sango Complex.
16	Wasa Series.
19	Bukora Series.

Surveyed and compiled by
S. A. Radwanski.
Traced by G.W. Musisi.

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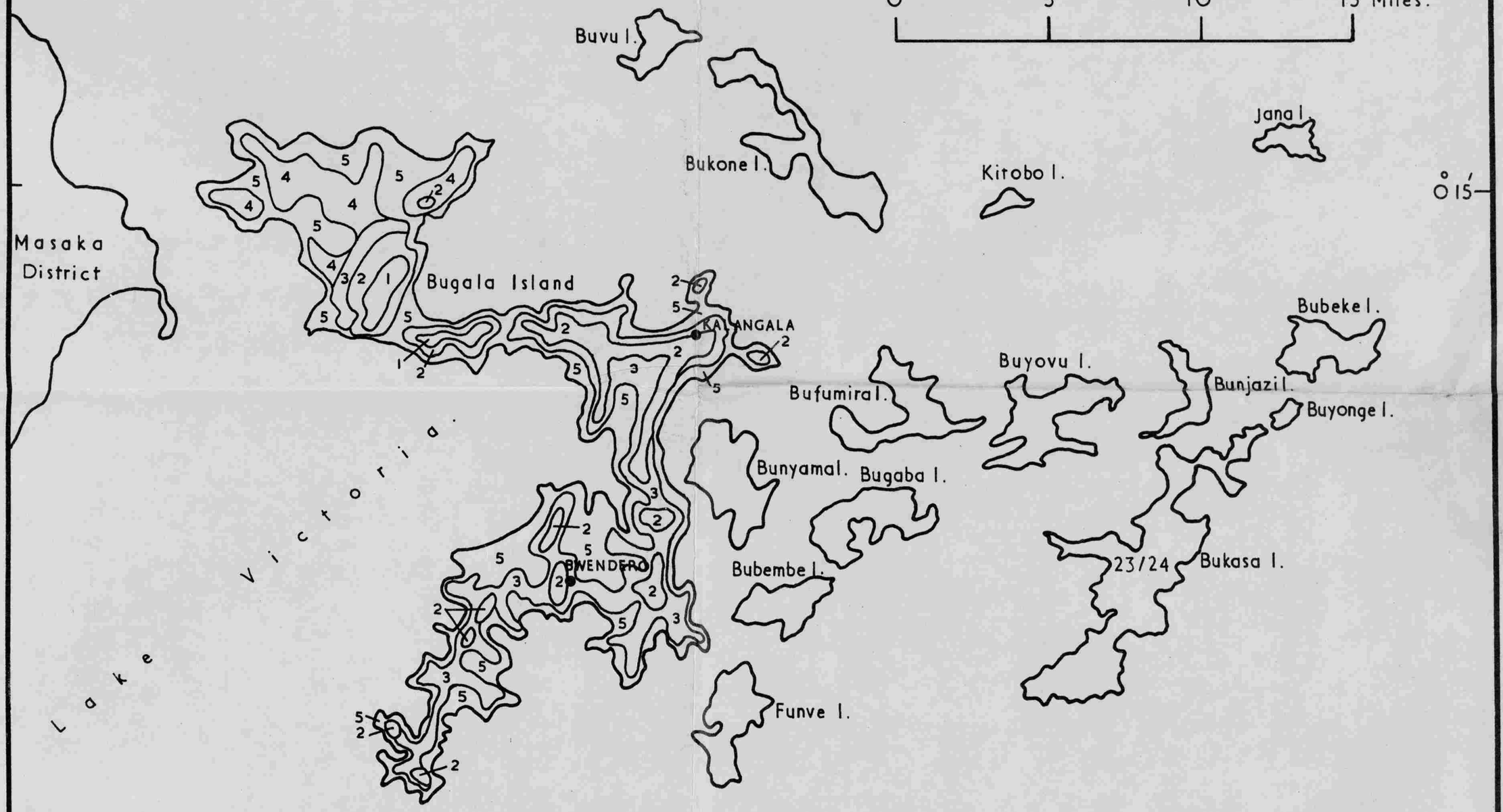
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MAP 11.

KINGDOM OF BUGANDA : SESSE ISLANDS
SOILS.

32 O 32 30'

0 5 10 15 Miles.



Key.

MAPPING UNITS.		DOMINANT SOIL TYPES
1	Sesse Red	Red sandy loams with ironstone concretions and massive laterite
2	Sesse Brown	Brown topohydric varriants of Sesse Red.
3	Kikwayu	Brown loamy sands with rounded quartz pebbles and relic boulders of laterite
4	Bugoma	Yellow-brown loamy sands overlying weathered and partly lateritized bedrock of gneiss.
5	Sango / Kinyu	Sango : Grey, coarse sands. Kinyu : Yellow-brown sands over massive laterite.

O 45'

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FIGURE 2.

KASOLO CATENA.

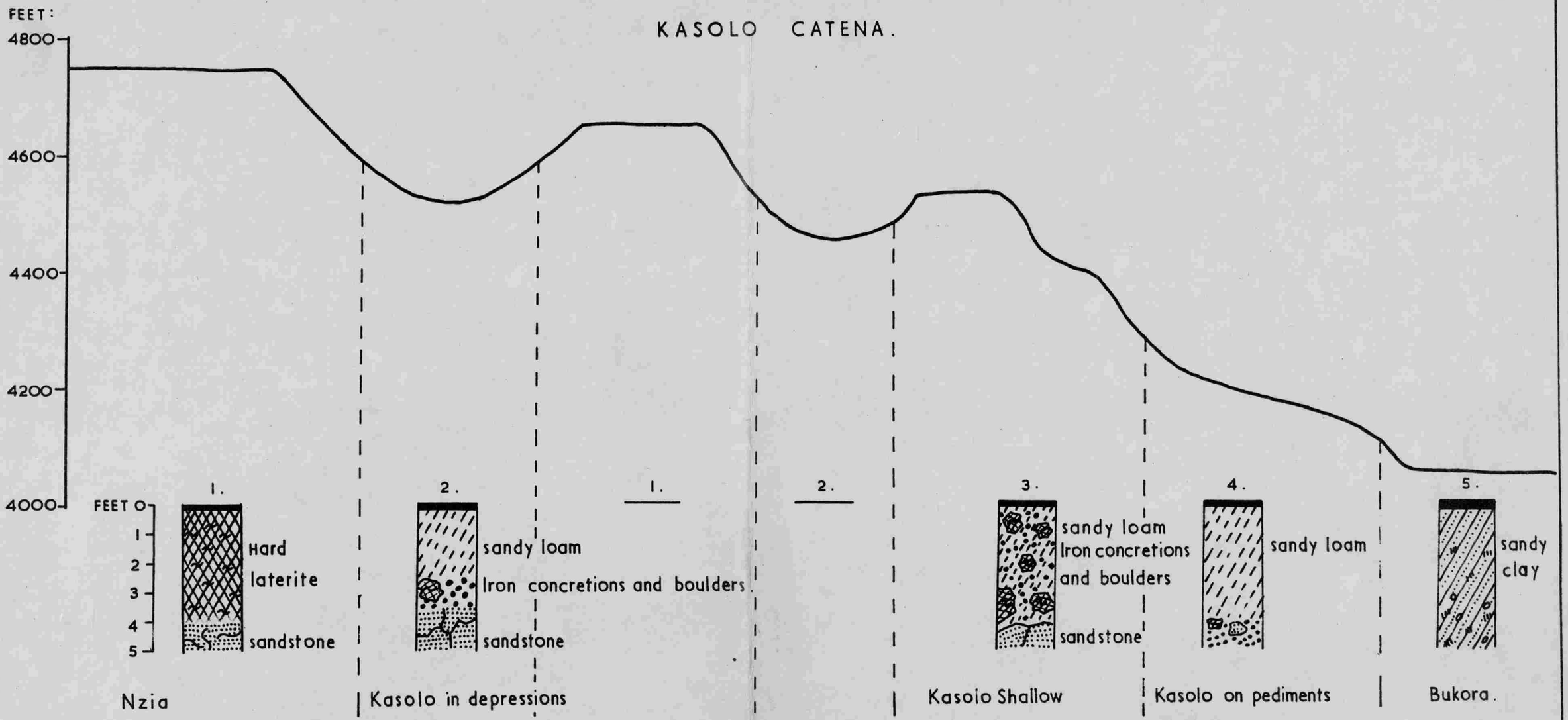


FIGURE 3.

KOKI CATENA.

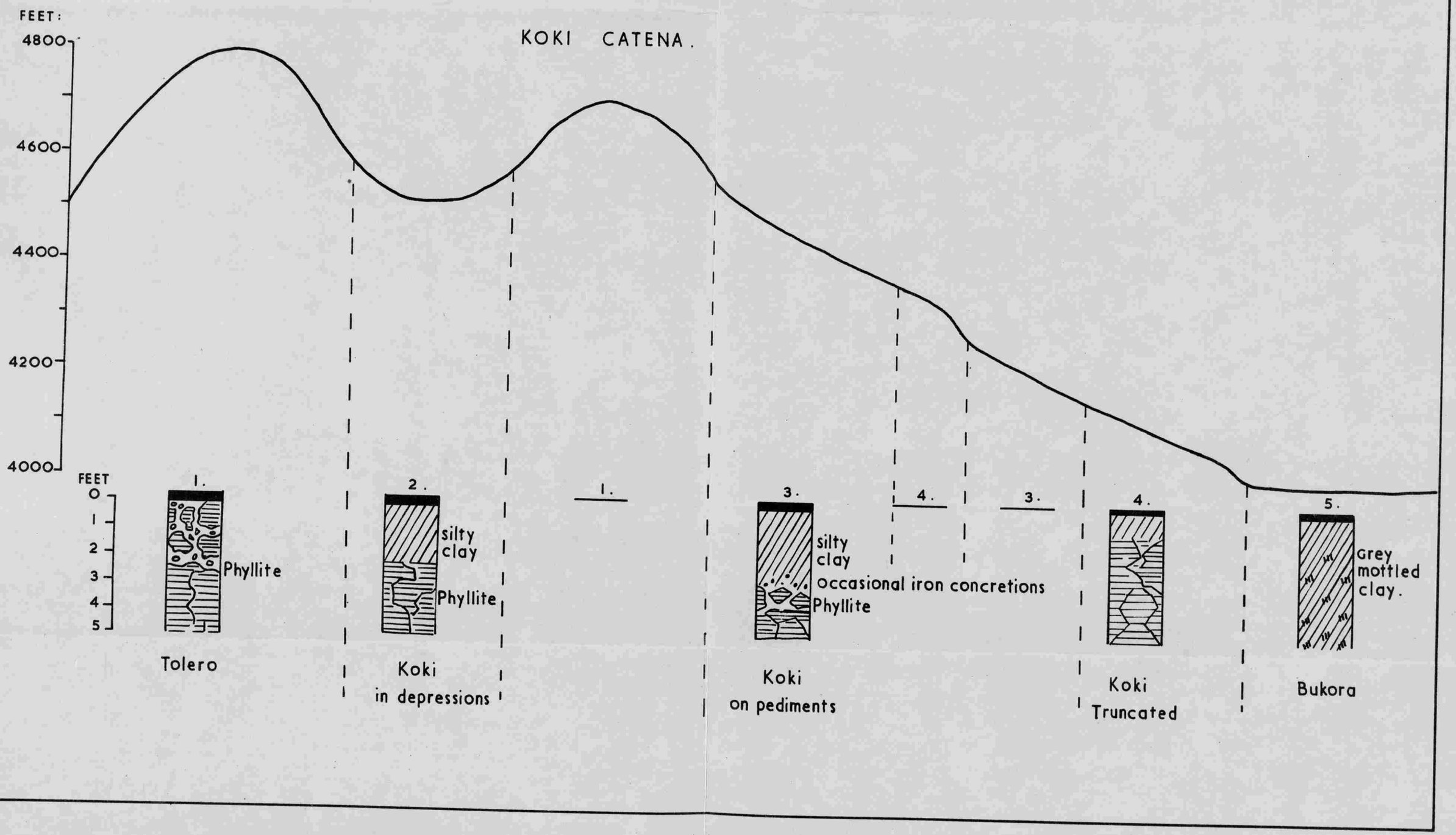


FIGURE 5.

BUGANDA CATENA

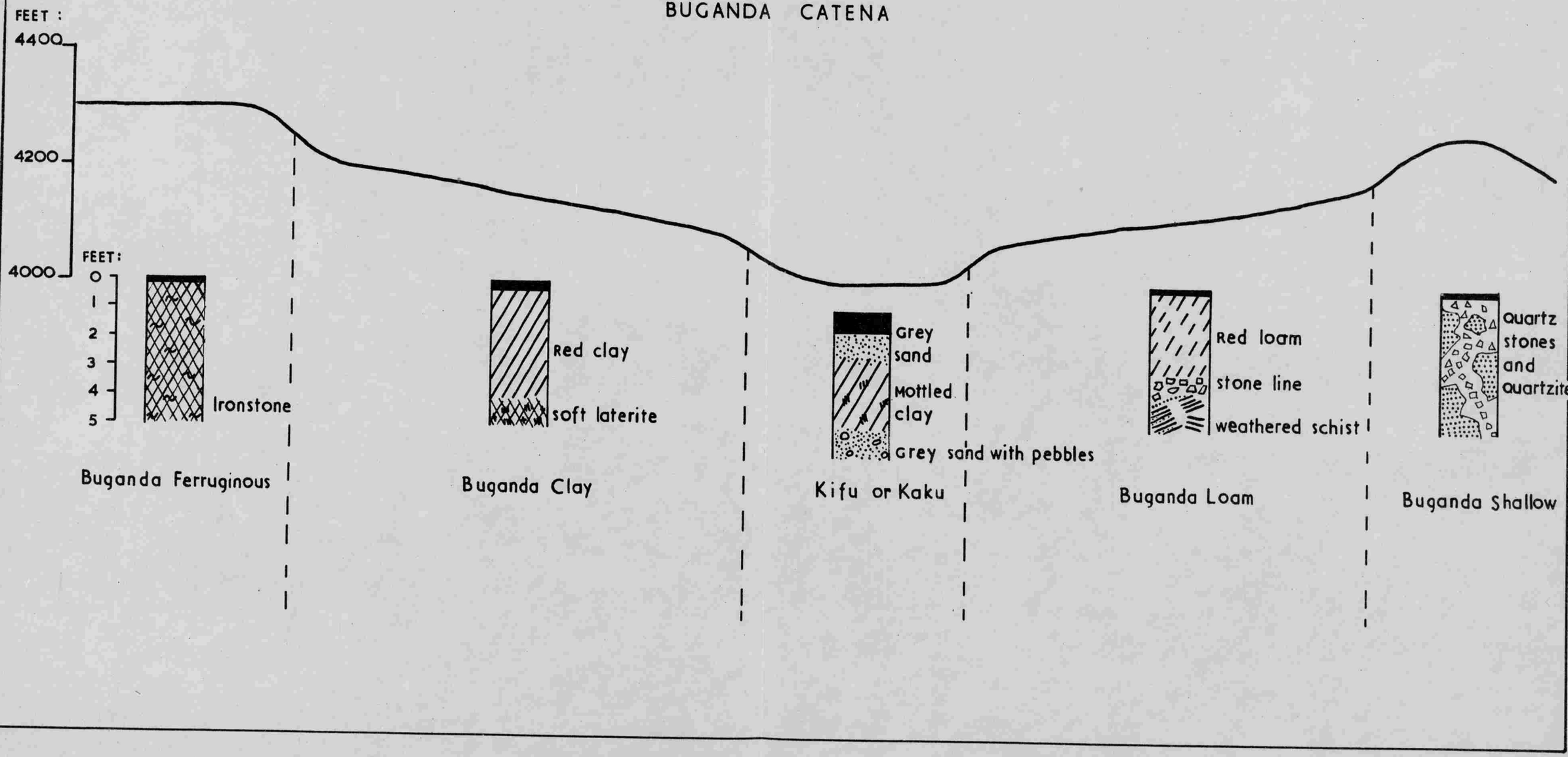


FIGURE 6.

MIRAMBI CATENA.

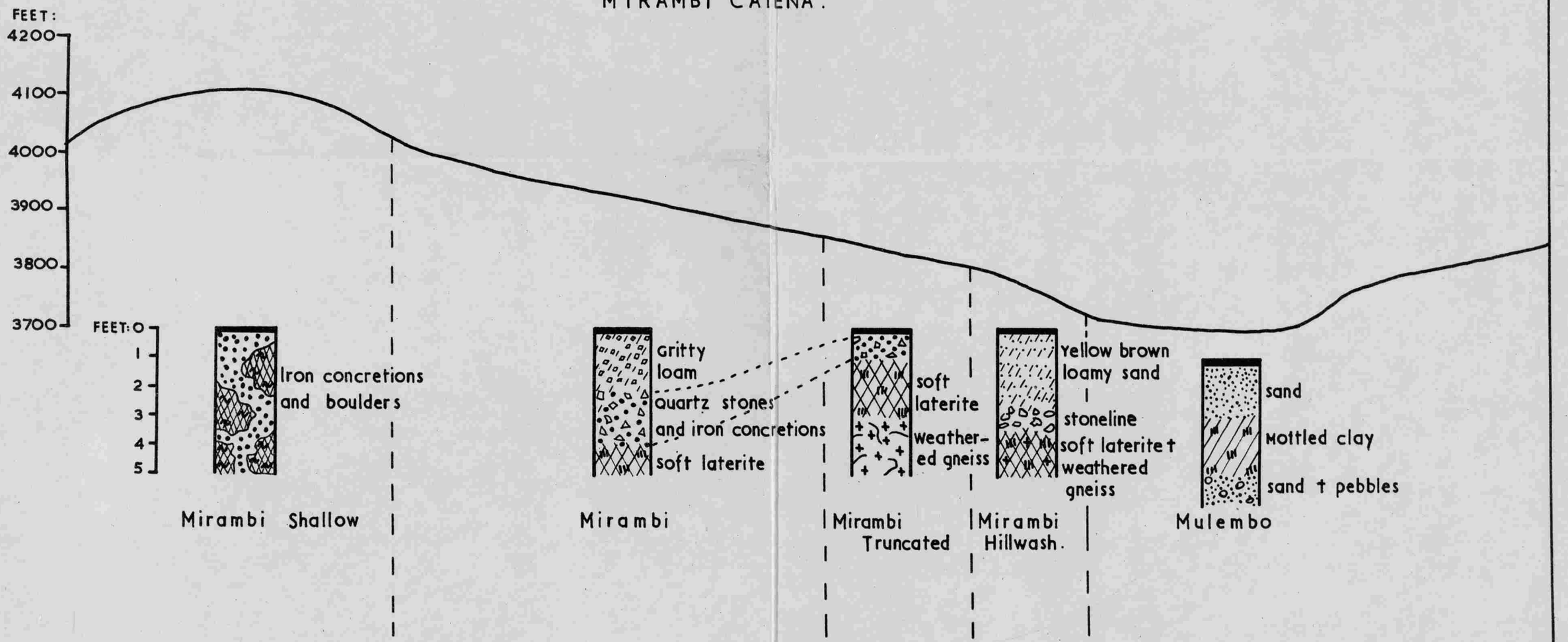


FIGURE 7.

BUYAGA CATENA.

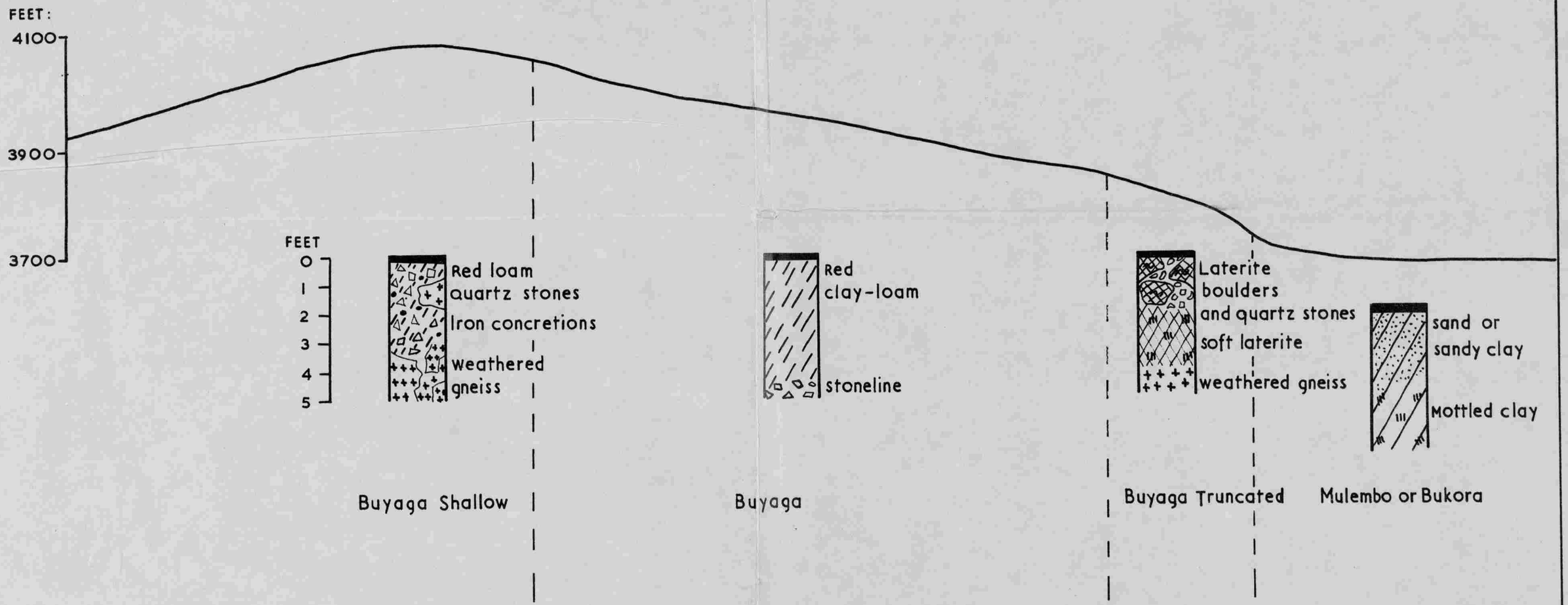


FIGURE 8.

BURULI CATENA AND LWAMPANGA SERIES.

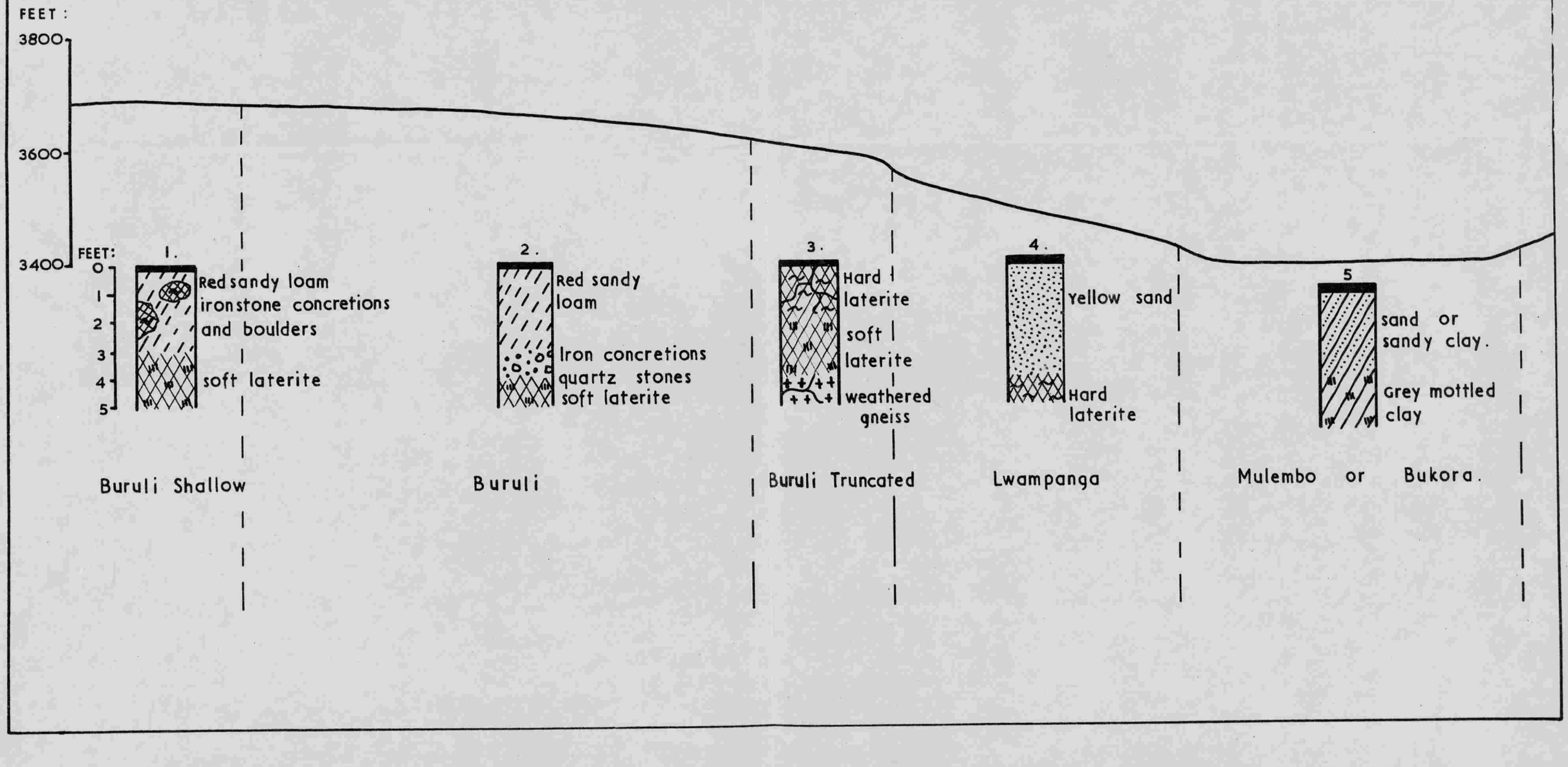


FIGURE 9.

BUWEKULA CATENA AND KAMUSENE SERIES.

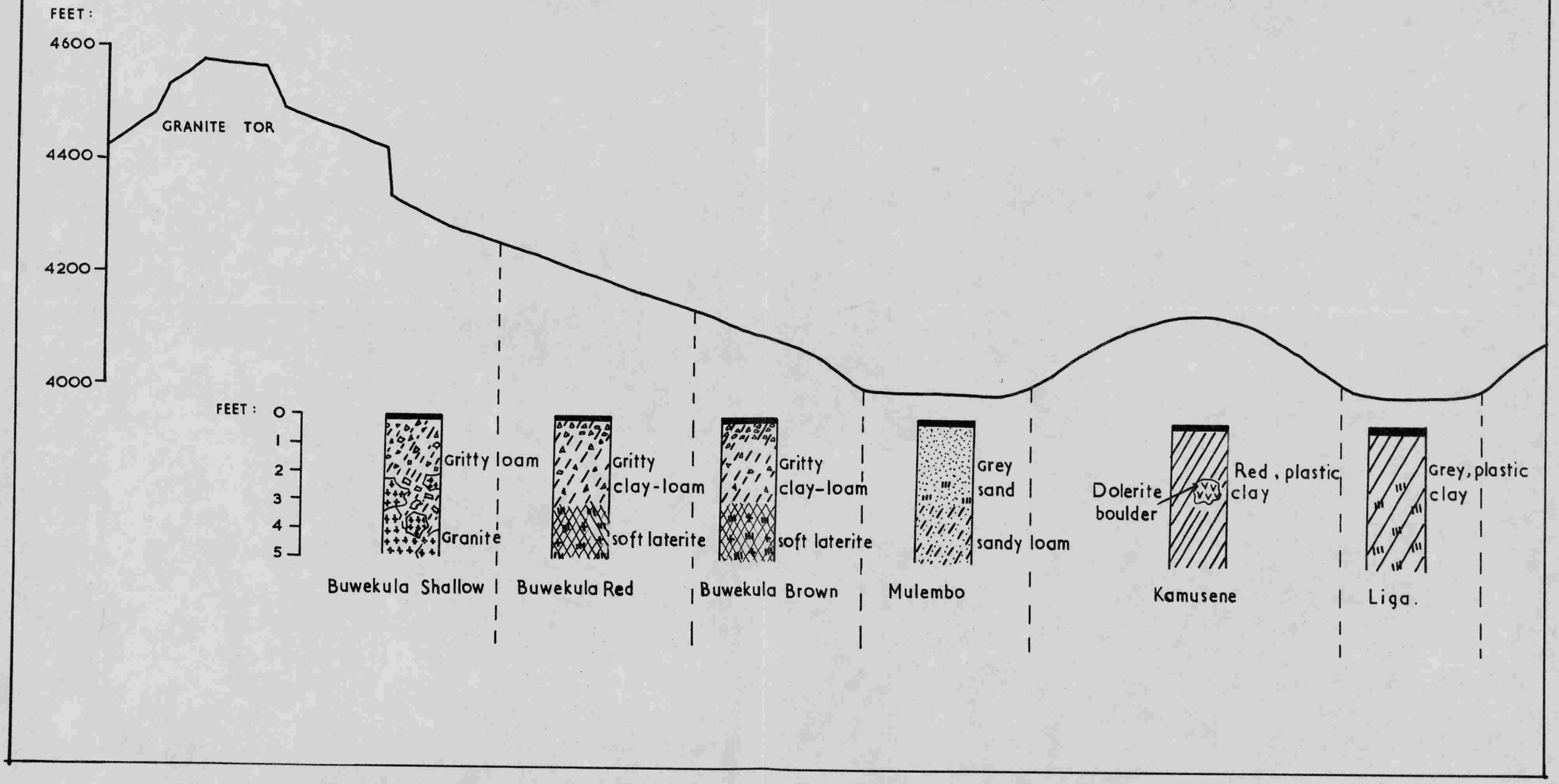


FIGURE 10.

KATERA AND SANGO SERIES.

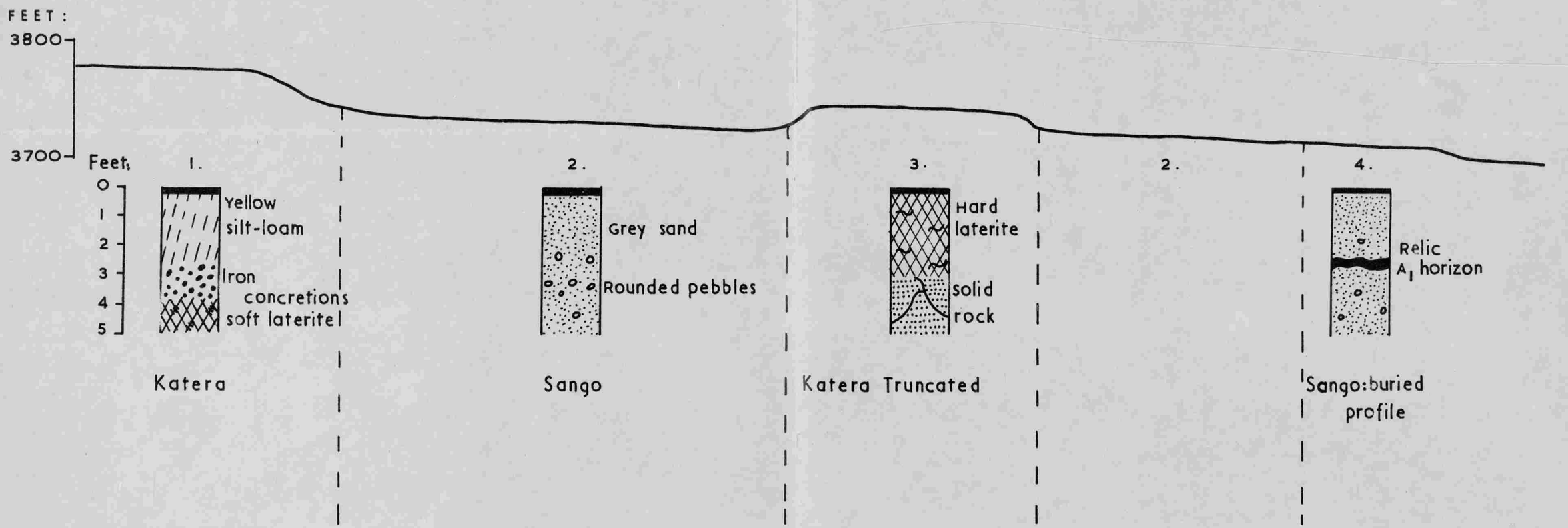


FIGURE 11.

THE BUGALA : SESSE ISLANDS.

Cross-section diagram showing the distribution of soil series in relation to relief.

