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SERIES I—SOILS

Number 6

THE SOILS OF THE WESTERN PROVINCE OF UGANDA

A Reconnaissance Survey

by

J. F. Harrop, B.Sc. (Leeds).

SURVEY OF AREAS ADJACENT TO BUGAMBE A.E.L. ESTATE FOR THE OMUKAMA'S TEA PLOT.

During a praliminary survey of an area approximately one square mile in extant samples were collected along four transects running at right angles to the N.W. border of the estate. Out of 30 samples collected in this way 13 were found to have pH values close to the upper limit for tea.

Unfortunately it was discovered that the samples had been taken from single holes from situations where the land would not be used for tea i.e. in patches of woodland and on the lower slopes of small wooded valleys. As a check all those sites which showed high pH figures were resampled taking this time composites from or near the original sample locations. The differences in pH between the two samplings is shown in the appended table.

Apropos of the continued high values of D2 and especially C1 certain features of the underlying geology and its effects on soils might be discussed here. Rocks containing calcite and dolomits are known to exist throughout the shales, phyllites and grits of the Bunyoro series but these represent only a small fraction of the rocks as a whole. A calcareous grit for instance was observed along side the river below the tea nursery but since it is of very limited extent it does not affect the tea growing areas.

There are two small ridges of fine and coarse sandstone running across the N.W. border of the estate. Soils on the ridges are very shallow and stony and there is a noticeable change in the grass species and an increase in the number of trees. Transect C for part of its length runs along side one of the ridges and although the rock when tested was not calcareous much of it showed pitting and cavitos on wethered surfaces suggesting that some soluble material had been removed. Four composite soil samples taken from the ridges were found to be definitely acid but in the case of C1 which was sampled in a forested hollow the alkaline reaction of the soil is probsbly due to base rich water draing of the calcareous grit nearby.

Such a condition could not affect the ridge crests where the soils are well leached and on the whole very acid. Even when situated over small areas of calcareous rocks leaching is likely to have proceeded for a sufficient length of time to render the soils acid. In one small area towards the lower part of a slope tea stumps were either growing very slowly or dying off but the soils contrary to expectations were quite acid, pH 5.2 - 5.4 and soil reaction cannot be the cause of restricted growth. Further analysis may reveal some chemical instalance but possibility of soil borne discase should be investigated.

On the attached sketch map an area adjacent to the tea estate is indicated where conditions are suitable for the development of the five to six hundred acres of tea for the Omukama.

The site has the advantage of being close to developed areas of the estate and since there are very few trees scattered throughout the elephant grass clearing should present no problem.

Sample hole No.	pH of 0-6" layer Original sampling.	repeat on composite samples.
Transect A	5.2	5.3
" A1	6.2	5.7
" A2	6.2	
" A3	6.2	
" A4	6.1	
Transect B	5.8	5.7
" B1	6.5	5.9
" B2	5.0	
" B3	6.2	
" B4	5.9	
C	6.2	5.5
C1	7.9	7.2
C2	6.2	5.9
C3	5.1	
C4	6.4	5.9
D	5.8	
D1	5.6	
D2	6.2	6.2
D3	6.2	5.9
D4	6.4	-
E		5.6
E1		5.4
E2		5.2

Soil samples from sandstone ridges.

		pH. 0-6" sample
1st ridge near transect C	outside estate boundary	5-9
" "	inside estate boundary.	5-9
2nd ridge	outside estate boundary.	5-8
	inside estate boundary.	5-5

Soils from area above tea stumps are dying. Composite samples taken at about 10 yd. interval.

No.	pH.
1	5.2
2	5.5
3	5.4
sub-soil at 3 ft.	4.9.

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THE SOILS OF THE WESTERN PROVINCE OF UGANDA

A Reconnaissance Survey

by J. F. Harrop

The Western Province of Uganda is very varied in its scenery and topography with altitudes ranging from the hot low-lying plains near Lake Albert at 2,000 ft. to the ice-capped summits of Ruwenzori which attain their maximum height in Margherita peak (16,794 ft.). Many parts of the Province are hilly or mountainous, notably in West Ankole and Kigezi where the central highlands reach heights of over 8,000 ft. In the extreme south-west of Kigezi district are the extinct volcanoes of Muhavura (13,547 ft.), Mgahinga and Sabinio.

The major part of the Province consists of rolling plains carrying dry, open savanna grassland with the north-east (Ankole) becoming more wooded towards the moister areas in north Toro and Bunyoro. Tropical forests and tall grass communities lie along the western parts of the Province where the maximum rainfall occurs (Langdale-Brown, 1960).

The population and consequently subsistence agriculture is mainly concentrated in the latter areas where most of the second major cash crop, coffee, is also grown. Cotton, the principal cash crop, is grown extensively in the drier parts of Toro and Bunyoro that are not Nature Parks or game sanctuaries. For a fuller account of the Western Province geography see Baker (1958).

This memoir is practically and essentially confined to soils. Details of climate, vegetation, crops and agricultural practices, together with information of a general nature on ethnography, history and communications are recorded in the memoirs on Vegetation and Systems of Agriculture. More emphasis is given here to geology and geomorphology as a background. The plain soil map is drawn on the 1:500,000 scale but coloured maps are being published on the new standard East African grid sheets of 1:250,000. This memoir will form a section of a comprehensive volume on the soils of the Protectorate.

METHODS OF SURVEY

The immediate aims of the survey are to identify the different soils of the Province and record their distribution on a map. Field mapping was conducted on a scale of 1:250,000.

Details of profile morphology and soil distribution were obtained by digging soil inspection pits and augering. Use was also made of any available section that could be examined in road cuttings, murram pits or natural exposures of river channels etc. Information was collected in this manner about conditions of both topsoil and subsoil, and of their relationship to the underlying weathered rock.

The mapping units used in this survey, in most instances, are based on easily recognizable field characteristics and as such do not always correspond to the soil series, associations, etc. which are used in detailed soil surveys in other parts of the world. The map depicts soil units of different kinds, ranging from approximate series to catenas and complexes, but in a wider sense they are all natural land units and can be used as a guide to assessments of soil productivity and land use.

Cartographic Methods

Base maps used for the survey were the 1:250,000 district sheets. After plotting the field data, interpolation was aided by the use of air photographs and print laydowns. Air photographs enabled a much quicker rate of mapping to be achieved and a more accurate delineation of certain boundaries than would have been possible by field

methods alone. In order to produce a map on this scale it has been necessary to ignore the smaller areas of localized soil types and it must be borne in mind that large uniform areas on the map often include minor variations which could only be indicated on a large-scale map. A line drawn on the map to separate two units has in many cases to be chosen rather arbitrarily since in the field the change may merge over an appreciable distance.

Description of Soil Mapping Units

The basis of mapping is the soil profile; this is the sequence of layers or horizons extending down to the parent material from which the soil was formed. The range of soils within a mapping unit may give rise to several profiles which are related to the topography. Where this profile-topography relationship occurs repeatedly the sequence is referred to as a catena. Other variations in the units may arise from changes in parent rock or patchy distribution of laterite and rock outcrops which do not conform to any regular pattern. In such circumstances it is necessary to describe the unit as a complex. On the other hand, a few of the units display sufficient uniformity of profile morphology to be regarded as soil series, this is especially true of soils developed on alluvium. Soil units may show gradual changes which take place over very great distances and the choice of a boundary in such instances is unavoidably subjective.

Laboratory Investigations

Samples were collected from typical profiles of each mapping unit and sent to Kawanda Research Station for routine mechanical and chemical analyses. These consisted of determinations of silt and clay fractions, exchangeable bases and hydrogen, available phosphorus, organic carbon, nitrogen and pH. The results are given in the appendix.

Standard Terms and Definitions

In the following soil descriptions certain terms are used in a technical manner which will be explained and defined here.

Names

Names of soil units are usually those of the village or township near which the soils were first studied. Some of the more extensive units have been given a county or sub-district name.

Colour

To avoid ambiguity of colour description, use has been made of the Munsell soil colour chart.

Texture

Mechanical analysis separates the soil into three constituent fractions: sand, silt and clay. The relative proportions of these fractions are used to define the soil type. Textural names of the United States Soil Survey are used throughout this memoir. The field textures given in profile descriptions will not always tally with the mechanical analysis textures owing to the different clay minerals present. This divergence is most noticeable with tropical soils, for the clay in old red earths has a much lower plasticity than clay in soils of relatively recent weathering, e.g., alluvium and some of the volcanic rocks.

Fertility

This is distinct from productivity and refers to the content of plant nutrients in the soil which in turn are very closely linked with organic matter status.

Structure

Briefly it may be stated that structure is the ability of the soil to form aggregates and retain them under some form of mechanical disturbance such as cultivation operations and impact of rainfall. The size, shape and permanence of these aggregates has an important bearing on soil productivity. There is a scientific classification of the various structural units which need not be fully discussed here since many of the terms used in this report are more or less self-explanatory. Sandy textured soils break down almost to single grains when cultivated and would be described as virtually structureless. Clays tend to crack into hard angular blocks which may be almost indestructible when dry. Soils in the loam class show more varied structure depending on the relative amounts of sand and clay present and also the organic matter content. The latter is of great importance in maintaining structure in the cultivated layer and its depletion due to prolonged cultivation may be one of the most serious causes of loss of productivity. Not only does its destruction mean a loss of plant nutrients but also a reduction in the capacity of the soils to form aggregates, accept and retain rainfall and permit aeration of the upper soil. In subsoils structural units are less easily discernible and those present are usually weak and incoherent, except for the heavier soils. Many tropical loams are almost structureless in their subsoils but the whole mass may be riddled with small but visible pores and termite and/or ant channels. In the dry state these subsoils are easily broken down to very small grains which are probably aggregates made by termites during the construction of their nests.

SOLID GEOLOGY

The underlying rocks of the Province are mainly sedimentary rocks of pre-Cambrian age, their metamorphosed products and later intrusions such as schists, gneisses, granites etc. which underlie the sedimentaries. The sedimentary rocks which comprise argillaceous and arenaceous assemblages were formerly thought to be distinct from the underlying schists, quartzites and gneisses, the latter being assigned to the Archean Basement Complex. The general term "Argillite Series" was applied to all these low-grade or non-metamorphic sediments but this name was abandoned when it was recognized that some of the sedimentary series were of different ages. The shales and phyllites of Kigezi, West Ankole and neighbouring areas of Tanganyika are now collectively grouped in the Karagwe-Ankolean system. To the north a similar group occupying the greater part of Toro and older than the Karagwe-Ankolean is known as the Toro system. The Karagwe-Ankolean is believed to be represented in north Bunyoro by the Masindi Series, while a younger group comprising phyllites and tillites (originally of glacial origin) have been described as the Bunyoro Series.

Combe's (1932) studies of the Karagwe-Ankolean system in southwest Ankole elucidated the relationship between the phyllites and the supposed Archean Complex which underlies them. He was able to show that the highly metamorphosed rocks in the floors of the arenas, so characteristic of the Ankolean landscape were, in fact, partly post-Karagwe-Ankolean granitic intrusions and partly products of a regional metamorphism which affected the Karagwe-Ankolean rocks themselves. Generally speaking the degree of metamorphism increases towards the base of the sediments so that it is mainly in areas where the phyllites are deeply eroded that the more metamorphosed parts are exposed. Thus the higher hills of Ankole consist mainly of shale and phyllite while the lower undulating areas of Nyabishozi are underlain by phyllite and quartz schist. This is also true of the arenas which were at one time now believed to be structural deformations affecting both the phyllites and the intruded granites (King, 1959). Two of the arenas at Chitwe and

Rubanda have been eroded down to the granite and gneiss but the majority, although occasional gneiss outcrops occur, are floored chiefly by metamorphosed products of the sediments and intrusive rocks. The phyllites are folded and flexed along axes which trend between NW/SE and NNW/SSE with occasional cross-folding approximately at right-angles to these directions. Persistent quartzite bands which, although they have greatly facilitated the mapping of stratigraphical zones in the Karagwe-Ankolean beds, constitute only a minor part of the total area of these Karagwe-Ankolean rocks. The highlands of Buhweju are formed of thick beds of quartzite which form the lower parts of the Karagwe-Ankolean system and rest unconformably on schists and quartzites of the Toro System (Igara Series). Northwards the Toro system appears to become progressively more granitized until most of the schist has been replaced, leaving mainly quartzites and granites. The Toro System which has been correlated with the Buganda System shows, generally, a greater degree of metamorphism and greater complexity of structure and composition. Amphibolites are more frequent in both systems being developed extensively in central Toro much as they are near Jinja (King, 1959). Thus the principal rocks underlying the Province are:

Phyllites and shales
Sandstones and quartzites
Granites and gneisses of granitic composition
Amphibolites
Various grades of schists; quartz schists to fine-textured mica schists.

Rift Valley and Associated Geology

Although the present form of the Rift Valley is due to movement during early Pleistocene times the original lines of crustal weakness along which these faults developed were initiated in pre-Cambrian times (Dixey, 1956). The strike of rock grain, schistocity, etc. and subsidiary faulting in the vicinity of the Rift is clearly aligned with this feature. In the immediate vicinity of the fault the rocks are highly sheared and altered by the enormous forces involved in the Rift movement. The upthrust mass of Ruwenzori is the most remarkable product of Rift movements; the block is estimated to have been elevated by as much as 10,000 ft. The structure of Ruwenzori is highly complex. It consists of a Basement Complex, magmatite series of granitic and amphibolitic gneisses and schists with massive quartzites and synorogenic granites (McConnell, 1959; and Dixey, 1946).

Volcanic Activity

Contemporaneous with the latest Rift movements was a phase of volcanic activity which affected a belt of country running along the eastern side of the main Rift fault. The eruptions arose from a large number of explosion craters which are grouped in clusters often so close that many of the vents overlap each other. There are four principal areas; across the escarpment at Kichwamba; south Busongora; Kasenda, east Bunyangabo; and Fort Portal. Very little lava was emitted during the eruptions, the bulk of the material thrown out by the explosions being calcareous ash together with fragments of country rock. The ash was spread over a considerable area but near the vents it became heaped into small cones which now form conspicuous features in the crater areas. Several of the craters are occupied by small lakes. In south Busongora some of the craters are over a mile in diameter and the lake in the twin crater at Katwe is sufficiently saline to yield deposits of crude salt.

The volcanics of south Kigezi differ from the Toro volcanics by the predominance of lava in the erupted material and the greater scale of activity generally. Large quantities of lava were poured out from the main vents Muhavura, Mgahinga and Sabinio into the depression referred to as Bufumbira "bay" (Combe, 1933). The depression is not comparable with the arena structures of Ankole and it is presumed to have been formed by a subsidence as magma was lost from the chamber below. The main lavas formed the plain which slopes gradually down from

the base of the volcanoes occupying in Uganda about 70 square miles. A later phase of vulcanism developed on the plain itself during the course of which a number of scattered eruptions poured out fresh spreads of lava. Many of these later eruptions were explosive, especially those along the eastern margins of the bay. Two small isolated flows occur at Muko and Rubanda. Most of the smaller volcanoes are built of pumice-like ash forming a symmetrical cone, breached on one side by a later lava flow. Several craters in the hills bounding the eastern margins of the bay were explosion vents only, for no lava is to be seen and the surrounding areas are covered by a thin layer of ash.

Pleistocene Deposits

The Rift Valley floor which extends through the western parts of the Province is covered by a thick deposit of unconsolidated detritus derived from the adjacent highlands by the renewed erosional activity which followed the recent Rift movements. There is evidence that much of this material was laid down in a system of lakes which were formerly much more extensive than the present lakes in the valley, reaching their maximum during one of the pluvial periods which affected East Africa. Subsequent adjustments of land level in the Rift Valley, surface warping and lowering of outlets reduced the size of the lakes to their present dimensions. The position of the old lake shoreline is demonstrated in several places along the Fort Portal road, especially as a small wave-cut cliff near Mahokya. On the opposite side of the valley near Dura deposits of well-rounded quartz gravel mark an old terrace which now stands well above the level of Lake George.

The deposits consist of sands, clays and gravels and show a bedded sequence. At Kaiso in the Albert Rift a fossiliferous ferruginized bed occurs in the sediments marking a period of recession during an interpluvial phase when the lake may have completely dried up. A succeeding pluvial restored the lake and with it a further series of deposits. On the basis of these recessions in phases of deposition various stratigraphical horizons have been recognized. In Uganda the oldest are the Kaiso beds followed by the Semliki, and most recently in certain areas, volcanic ash. These divisions of the lake sediments are correlated with lake terraces which occur in the Eastern Rift in Kenya and Tanganyika. Due to a lowering of lake level and the upwarping of the valley floor adjacent to the Rift wall the highest levels of the old sediments stand in some sites as much as a thousand feet above the present lake level. This is true of the oldest deposits at Nyakashuli (N. Kigezi), in the eastern parts of the Murchison Park, and at Wasa south of Lake Albert. Three approximate stages in lake recession or upwarping are discernible in north Kigezi, and at least two, possibly three, at Wasa giving rise to a sequence of ages to the derived soils - see Wasa complex and Semliki, also Nyakashuli, Rwanga and Ishasha soil mapping units.

Later spreads of alluvial material and outwash fans cover the lake deposits in many areas; along the eroding edges of the Rift escarpment but more especially from the high land mass of Ruwenzori. Melt waters from the glaciers brought down large quantities of material from the eastern side of the mountain and distributed it over the flats immediately above Lake George. Gravels and sands appear to be most prevalent, particularly so in the coalescing fans at the exits of the main valleys. Smaller outwash fans occur along the northern limb of the range in Bwamba and Bubandi, Bunyangabo county.

Miscellaneous Alluvia

Along the many drowned water courses throughout the Province there are deposits of sands and clay which in many instances now completely occupy the valley floors. The texture of the drift will depend on the country rock; sands and coarse sands occurring in granite and gneiss areas with predominantly clays from the shales and phyllites. Terrace deposits occur along the main east-west rivers formed before the modifications to surface drainage resulted from the warping caused by Rift movements.

Papyrus swamps fill several of the more deeply drowned valleys in which water was impounded either by the warping or lava dams.

GEOMORPHOLOGY

In the present survey many of the mapping units have been based on the geomorphic features of the landscape and the ultimate classification, so far as it applies to Uganda, on an approximate chronology of these features. This gives a broadly logical arrangement to the soil pattern and while it does not necessarily place the soils in order of age it does offer a more satisfactory grouping for the present scale of mapping. Many of the mapping units are catenas and since these relate entirely to the landscape form, considerable attention must be paid to the processes which have operated to produce the present topography.

Erosion Surfaces

There is much evidence that the land surface of East, Central and South Africa has been subjected to base levelling processes operating over a very long period of time (King, L. C., 1951). Moreover, it is apparent that this peneplanation occurred more than once. During mid-Tertiary times the greater part of the African continent was reduced by sub-aerial denudation to an almost flat plain with little or no relief. This plain it would seem developed near its surface a thick layer of laterite by a process similar to that which operates at the present day in tropical climates. Towards the latter part of the Tertiary era the peneplanation was followed by a gradual uplift of the land surface which by a rejuvenation of the base level of erosion introduced a second phase of erosion and dissection. Owing to different degrees of surface warping it is not possible to correlate widely separated features on heights alone. In fact, even within the limits of Uganda there is no absolute certainty about the relationships between remnants of these ancient levels of erosion. Without entering into any controversy it will be stated here that the surfaces recognized are those described by Wayland (1934) and McConnell (1955). Various authors have recognized several peneplains (or pedeplains) in Africa. The names of these and their authors are given in Table 1.

Table 1

	Wayland (1934)	King (1951)	Dixey (1946)	McConnell (1955)
Upper surface	Buganda (Peneplain II)	Gondwana	Mid-Tertiary	Buganda
Lower surface	Buganda (Peneplain III)	African	End-Tertiary	Tanganyika
				Acholi

In central Buganda there are remnants of a lateritized surface conspicuous as flat crests on many of the hills. This is referred to by Wayland as the Buganda II surface or, implying its approximate age, the mid-Tertiary peneplain, its remnants standing at between 4,300 and 4,400 ft. The new base level initiated by the upwarping is termed the Buganda III surface or the end-Tertiary peneplain (Pallister, 1959) and occurs 400-500 ft. lower than Buganda I. These two surfaces are continued into the Western Province in the lateritized flat summits of the central Bunyoro hills and possibly into Ankole in the lateritized summits of hills in central Nyabushozi. The correlations are difficult to establish owing to the gradual elevation of the land surface towards the west following the latest Rift movements. In Koki, south Ankole and the Rukiga mountains of Kigezi there are high level laterite remnants which, according to McConnell, represent at least two other erosion surfaces.

Wayland accepts the Ankole surface (his Jurassic surface) as a higher, older surface than Buganda II which is continued into Rukiga where it is upwarped from 6,500 ft. to over 8,000 ft., and downwarped in Koki to 5,000 ft. However, there is some suggestion that the Koki surface is an upwarped part of the Buganda surface and that some of the height difference could be accounted for by the more resistant nature of the phyllites to weathering and erosion than adjacent rocks. This might even apply to central Nyabushozi where the height of flat hill crests stand at 4,600 ft. representing a surface cut across schists and gneisses. Considering that the Koki surface is only 100 ft. higher the difference might easily be attributed to differential erosion. The 4,600-foot surface continues westwards into the arena of Mbarara but here the ridges are smoother in outline and they are less intensely lateritized, a condition which could be due to the difference in age of the laterites. If it were supposed that this is the point where the Buganda surface was being cut back below the older Ankole surface it would follow that here must be the youngest parts of the former. The laterite would be relatively immature and would not have developed to the same extent as further east before the next cycle of erosion set in. Thus, as a result of this subsequent dissection, the landscape varies according to the nature or hardness of the laterite cover. In central Nyabushozi the hills are flat crested, while to the west and south-west they are much more bevelled in outline and possess a relatively soft unindurated laterite. In fact, this laterite is very similar to that found in many of the end-Tertiary pediments. Within the arenas themselves the topography is undulating and laterite is seldom encountered. Remnants of the Buganda II surface exist in the flat crests of the hills in central Bunyoro at heights ranging from 4,300 to just over 4,500 ft. The hills lie along the main watershed of the district and are steep sided with broad coalescing pediments. Developed below it is a surface at about 3,700 ft. which with the hill pediments probably represents the end-Tertiary surface. These levels correspond closely with the mid- and end-Tertiary features in Buganda which means, if the correlations are correct, that there has been little, if any, upwarping of the land adjacent to the Rift in this particular area. Further south in Toro there are a few lateritized remnants east of Fort Portal, most likely parts of the Buganda surface, upwarped to over 5,000 ft. which is hardly surprising in the vicinity of disturbances which raised part of the same surface approximately 10,000 ft. in the Ruwenzori massif.

In south Toro and north-west Ankole there is no evidence of lateritized remnants but Combe recognized what he called a two-surface landscape, the higher at 6,500 to 6,300 ft. and a lower one at 5,400 to 5,200 ft. There is some laterite capping the highest hills in Buhwezu which show flattish summits and would appear to represent parts of the Ankole surface. The 5,200 ft. surface is gently undulating and is almost free of any laterite, though there may be incipient development in some subsoils. Erosion bays cut back from the escarpment show a marked hummocky topography and the suggestion of a surface lying irregularly at 4,600 ft. Since the latter areas have been dissected by the rejuvenated drainage cutting back from the Rift they could not be expected to produce a uniform planation.

The early Pleistocene or Acholi surface is probably only represented in some of the swamp valleys along the eastern parts of the Province in Bunyoro and possibly parts of Toro. It is essentially a valley bottom peneplain forming the floor of Lake Kyoga extending outwards along the swamp tracts which finger out from the lake.

Drainage

As with many other surface features, the drainage pattern of the Province has been considerably modified by the latest earth movements involved in the Rift formation. The pre-Pleistocene drainage of Uganda and neighbouring parts of Kenya and Tanganyika found its outlet in the Congo basin and the main watershed lay well outside Uganda area. Swells and depressions which developed in the land surface along with the adjustments in the Rift valleys drastically interrupted the drainage pattern to the extent that rivers were reversed, land drowned and new routes formed.

A brief account of the changes as they affected Uganda will make the peculiarities of the Western Province drainage more easily understood. Originally there were two systems draining the area of Uganda, one along the lines of the present Lake Kyoga and the other in the site of the present Lake Victoria, separated from each other by a low watershed. These systems were initiated on the Buganda surface and persisted until the African peneplanation had almost reached its present stage of development leaving remnants of the Buganda surface, reduced to a small ridge between the two drainage basins. The faulting and upwarping which followed the Rift Valley formation cut off the outlets to the west so that the main drainage routes along the Kafu, Katonga, Ruizi and Kagera were reversed and the combined waters impounded in a depression which became Lake Victoria, and in the north Lake Kyoga. Eventually as the water level rose in Lake Victoria it escaped from the lowest cols in the watershed separating it from Kyoga near the site of Jinja, forming the Sezibwa and Ripon Falls. Thus it drained away via Lake Kyoga into the Nile.

The effect of the Western Province was to produce an approximate watershed running throughout its length, approximately parallel with the Rift Valley. As indicated above, the flow in the main routes to the west was reversed into the Victoria basin but eventually the old routes were rejuvenated as they found a way into the Rift Valley either by capture from new rivers cutting back from the escarpment or rejuvenation of their old channels. Thus the anomaly arises of rivers flowing in two opposite directions. Somewhere in the swamps which now occupy the drowned river channels there is a divide from which point the drainage received from the catchment to the east moves sluggishly into Lake Victoria and to the west into the fast-flowing rivers towards the Rift Valley. The headward reaches of the Victoria drainage are either papyrus swamp, particularly in south Kigezi and West Ankole, or merge into the extensive clay swamps occupying the lower ground among the eastern parts of the Province.

The Ruizi has been completely cut off from its western outlet and a cluster of swamps which mark the valleys of its former tributaries now drain into the Birira and out through the Mitano. Commencing near Mbarara is a short rejuvenated section with a waterfall below which the river has entrenched itself in the sands and clays of the old river terrace. Several miles downstream the river enters the meandering swamp tract which connects the lakes Nakavali, Mburo, Kachira and Kijanebalola and drains out eventually into Lake Victoria at Sango Bay. Since the change in level from the swamp above the falls at Mbarara to that of Lake Nakavali is of the order of 400 ft. it suggests a slight slumping in the area around the lakes somewhere along the line bounding the basin occupied by the lakes in the embayment. South of the Isingiro hills remnants of a lateritized surface appear very similar to that in Nyabushozi but also approximately 400 ft. lower which tends to confirm the possibility of this local warping. The overflow of water impounded in the Nakavali basin into the Orichinga valley could have been halted by a slight change in level causing a lowering of the water level below the col which leads to the Orichinga. The waters would then have found other outlets into Lake Victoria. The fact that the water level in Nakavali is at present rising may be due to choking by papyrus and other vegetation of these other outlets.

Lava dams in addition to back tilting at the Rift are responsible for a series of lakes in south Kigezi. The largest, Bunyoni, occupies a wide strike valley drowned to a depth of about 140 ft. The water is held back by a small lava flow near Muko over which it escapes into the Ruhuhuma swamp thence via a small cross valley into Mutanda which with Muleho is dammed by lavas from Muhavura and Mgahinga. Smaller lakes of Chahafi and Kayumba also owe their origin to lava flows impounding former drainage lines. By the same process of uplift along the Rift Valley many of the valleys of central Toro were drowned and are now occupied by grass or papyrus swamps and their drainage lines partially or wholly reversed. On the eastern side of the main Bunyoro watershed clay swamps fill most of the old valleys.

Along the line of the Rift streams flowing over the edge of the escarpment have received fresh impetus from the uplift and have cut deeply into their own valleys. New consequent streams have arisen and old routes have been extensively rejuvenated. The headward progression in the reversed sections of the main rivers varies according to the nature of the bed rock. The Nile cuts back rapidly through the unconsolidated lake sediments as far as the Murchison Falls where it was partially halted when it reached the old buried escarpment but was, nevertheless, able to cut back almost to Atura, leaving in its wake a series of rapids and cascades. The Muzizi has cut its way back for about 10 miles but the Mpanga has entrenched its valley for approximately 3 miles before reaching a hard dyke rock over which it now spills in a waterfall over 200 ft. in height. Above the falls its reversed section continues for about 8 miles further. The Ruizi no longer contributes any drainage to the west but its old channel into which the Birara drains water from the dendritic system of swamps south of Bushenyi has been entrenched and passes into the deep gorge of the Mitano. The Rift hereabouts has not produced any marked escarpment as to the north but appears to be downwarped towards the fault, thereby helping the river to cut back along its channel.

Near Fort Portal, where the maximum upwarping occurred, a smaller watershed formed separating the drainage which flows out over the escarpment to the north towards the Semliki plains and that which drains into the Lake George basin. This effect of buckling has minimized to some extent the tendencies of the Rift movements to impound the drainage which has only occurred some distance away in Mwenge county where papyrus swamps commence (except for a few instances near Fort Portal where drainage is locally impounded by volcanic ash). The head waters of the Dura and Mpanga drain a wide area extending well east of the escarpment which here has a north-south alignment. Drowning of valleys within this catchment is sufficient to lead to papyrus development although small tracts of phragmites and grass swamps do occur. The water from this catchment area, together with that from a large part of north Ankole and almost the entire east flank of Ruwenzori combine in Lake George. This passes via the Kazinga channel into Lake Edward where drainage from the remainder of the Rift area collects before discharging into the Semliki. The lakes were formerly coextensive but the water level was lowered as it drained away into the Semliki, possibly aided by upwarping in the Lake George basin which led to the separation of Lake George and Lake Edward. Overflows from the former would quickly cut through the sediments to reunite the two lakes and establish a common level. The retreat of the lakes was not a steady, continuous process, for terraces were formed during pauses in the retreat. Lower terrace-like features closer to the Kazinga channel have been shown to be due to faulting and slumping of the Kaiso beds.

The Rift faulting and subsequent modification of the drainage pattern has created a new phase of erosional activity in the areas adjacent to the Rift escarpment. Maximum erosion and landscape dissection occurs as would be expected along the escarpment itself which is deeply incised by the many small streams running over its edge and almost denuded of any soil cover. The catchment areas of the reversed rivers have similarly been subjected to much denudation and are mainly occupied by shallow soils directly overlying recently weathered bed rock. Beyond the reach of the rejuvenation caused by Rift movements the original topography and soil matrix still persists. Thus a transect taken at right-angles to the Rift line would show these features in order. The Rift Valley with its accumulated deposits usually much dissected by upwarping of the rather unstable Rift floor. The escarpment entrenched by new consequent streams and rejuvenated sections of old drainage routes with a catchment area undergoing rapid aggradation. A low watershed will then lead to the mature topography of smooth, gently sloping ridges and swamp-filled valleys. The sequence is modified in Bunyoro where the central watershed consists of hill masses capped by remnants of the Buganda surface which stand some way east of the escarpment. On either side of the hills, pediments lead on to the African surface which, consistent with the trend elsewhere, is drowned to the east and actively dissected to the west (towards the escarpment).

SOIL-FORMING PROCESSES

With the modifications of the land surface described above the processes of erosion and accumulation have given rise to the several soil parent materials which include river and lake alluvia together with ancient and recent weathering products of igneous and metamorphic rocks. These have been subjected to further pedological processes to produce the soils. Some of the processes involved are:-

Biotic Activity

Soil micro-fauna, especially termites, live in the upper part of the solum and are responsible for mixing surface layers. Termites bring up fine material to build their mounds, and the coarser fractions of the weathered rock are left below. The mounds eventually collapse and form a layer of fine material at the ground surface, but new mounds are built so that the process is continuous. This has been in operation for a very long time as termites are among the earliest forms of life; a layer several feet thick of uniform, fine-grained material is built up in which there is no trace of original rock structure, overlying weathered rock. The coarse material which cannot be moved by termites becomes buried below the worked zone as a result of this process, and accumulates in a line of coarse stones between the re-worked soil and the unmoved weathered rock (cf. Anderson, 1957; de Heinzelin, 1955).

Tussocks present in many swamps are due to mounds built up by worms, and may be important in the gradual natural conversion of swamps into dry land (Gunn, 1955).

Leaching, Eluviation and Illuviation

Rainfall passes through the profiles and often carries with it fine clay particles (eluviation) and chemicals in solution (leaching) which tend to be redeposited below (illuviation). The clay content of mature soil horizons almost always increases towards the bottom of the profile. Acid and base radicles which provide the mineral nutrients for plant life tend to be leached into the deep subsoil. This is not shown by the analyses because plants collect and concentrate the bases, which are ultimately returned to the topsoil so that the topsoils usually show the highest concentration of phosphate, bases, etc. Water does not only flow down the profile; it also flows downslope, through the profiles and carries ions in solution and occasionally some clay with it. Lower slopes at swamp edges receive these solutions, and as a consequence tend in some instances to be more fertile than the upper slopes. Swamps are the final depository of such material and have a higher base content than most upland soils.

Lateritization

Laterite (sheet ironstone) and murram (pea or pisolithic ironstone) are chemical deposits consisting largely of iron oxides and kaolin, with smaller amounts of aluminium oxide, all in various states of hydration. Ferruginous waters continually percolate the soil profile but in horizons with high pH values or high available phosphorus the iron may be precipitated. In the dry season soluble iron left behind rapidly becomes insoluble as desiccation proceeds. All these processes may take place in the same profile but the last one is the most important as it is irreversible and eventually may produce thick deposits of ironstone. The first stage is the formation of soft, iron-impregnated kaolinitic pisoliths, more iron is deposited on these in the form of skins which finally become extremely hard murram through the development of films of interlocking crystals of haematite. There is frequently a small hollow in the centre of each pisolith but they do not often show a concentric banding. The murram forms a continuous horizon below the ground surface and parallel to it. Prolonged percolation of ferruginous water may actually cement the murram into sheets leaving the vesicular interstices between the pisoliths. Massive non-pisolithic forms of laterite are produced by the bulk ferruginization of kaolinite in deep

subsoils. The product, now called 'plinthite', is soft to very hard and usually contains discontinuous channels or vesicles within which iron hydroxides are deposited in concentric layers to form rigid tubes. The origin of the cavities is not clear, it may be due to soil micro-fauna, tree roots, shrinkage of volume on weathering, leaching and eluviation effects and, in the case of pisolithic laterite, to voids in the packing of the murram. Ferruginous water may also percolate partially weathered rock before this breaks down to kaolinite. The fabric of the rock is then preserved intact once the iron hydroxides have hardened, forming pseudomorphs from pebble size to large boulders, or even extensive crusts of sheet ironstone on the undisturbed country rock. There are many forms of transition between the murram and the vesicular laterite.

The process of lateritization is enhanced on flat sites, and here thicker and more massive laterite is usually found. Well-preserved remnants of old erosion surfaces often carry thick laterite cover. Erosion in a later part of the cycle may cause the laterite sheet to outcrop at valley sides. When exposed to the air it develops a skin of hydrated iron oxide and becomes much harder than when it is in the subsoil. This is not, however, the true laterite of Buchanan which is dug as a soft clayey mass and sun dried to form hard bricks.

Erosion

On very steep relief there is inevitably a tendency for material to be washed downslope during or after heavy rain. The upper part of a soil profile is slowly removed, but the formation of soil below normally keeps pace, so that there is always a typical profile on the slopes. This is normal geological erosion, not accelerated 'soil erosion' which removes a great deal of material faster than it can be replenished, and often causes irreparable damage by gullying - fortunately rare in Western Province. Excessive sheet erosion affects many of the over-burnt and overgrazed slopes in Ankole and Kigezi.

Pre-weathering

There is considerable evidence from geomorphology, pedology and mineralogy, that some soils are formed on a strongly weathered parent material that had been formed during a previous cycle of weathering. It is difficult to account for variations in soil profiles and their distribution without accepting this theory. Most of the weatherable minerals have been long removed, and the significance of this to a soil study is that bases for plant nutrition cannot be released from the parent material by further weathering. They have all been leached out and no more are available. It is the soils of the red loam type - Buruli, Kigumba, etc. - that are affected by pre-weathering, for which reason they are frequently very low in base content. The evidence for pre-weathering and an account of profile and catenary variations has been given elsewhere (Ollier, 1959; Radwanski and Ollier, 1959).

Examples of the above processes will now be described. Some of the soil mapping units exhibit all of them, others only one or two. No attempt has been made to classify the soils according to mode of formation because sufficient geochemical work has not yet been carried out. Genetic classification systems will be discussed in another memoir. In the four provincial and Karamoja district soil memoirs the mapping units have been arranged for convenience and for easy recognition according to geomorphological levels.

KEY TO THE SOILS OF THE WESTERN PROVINCE OF UGANDA

	MAPPING UNIT	LOCALITY	DOMINANT SOIL TYPES	PARENT ROCK	CASH CROPS	PRODUCTIVITY
			SOILS DERIVED FROM VOLCANIC ROCKS			
1.	Sabinio Complex	South-west Kigezi	Black humose loams	Bufumbira lava	Potatoes	Nil to moderate
2.	Bufumbira Complex	South-west Kigezi	Humose brown loams	Ash and lava	Maize, coffee	Moderate to high
3.	Saka Series	Central west Toro and Ankole	Black loams and sandy loams	Pleistocene volcanic ash	Coffee	High to medium
4.	Kyamutuma Catena	South Toro	Shallow black clay loam and loams	Pleistocene tuff	None	Nil
5.	Chambura Series	North Kigezi and north Ankole	Black sandy clay loams and clay loams	Pleistocene volcanic, tuff and ash	Cotton	High
6.	Nyakatonzi Series	South Toro and north Ankole	Black sandy clay loams	Pleistocene volcanic over old R.V. sediments	Cotton	High to medium
			SOILS DERIVED FROM VOLCANIC AND PRE-CAMBRIAN ROCKS			
7.	Muko Series	South Kigezi	Brown loams/clay loams	Pumice ash/phyllite	Coffee	Moderate to high
8.	Fort Portal Series	Fort Portal and south-west Toro	Black loams/red clay loams	Pleistocene volcanic ash over red clay	Coffee	High to medium
9.	Bubandi Series	West Toro	Loams and sandy loams, non-lateritized	Gneisses, granites and volcanic ash	Coffee	Medium to high
			SOILS DERIVED FROM PRE-CAMBRIAN ROCKS			
	Montane Soils					
10.	Bujuku Complex	Above 10,000 ft. Ruwenzori	Peat over rock or moraine	B.C. granites, gneisses, amphibolites	None	Nil
11.	Kyansabo Series	Between 8,000 ft. and 10,000 ft.	Peaty loam over dark brown loam	B.C. granites, gneisses, amphibolites	Timber	Low
12.	Mulinda Series	5,000 to 8,000 ft.	Brown gritty clay loam and clay loam	B.C. granites, gneisses, amphibolites	Some coffee	Low to medium

MAPPING UNIT	LOCALITY	DOMINANT SOIL TYPES	PARENT ROCK	CASH CROPS	PRODUCTIVITY
Soils Developed on the Ankole Surface and its Remnants					
13. Mafuga Catena	Rukiga highlands and west Ankole	Dark horizon latosols, loams	K.A. phyllite	Timber	Low
14. Buwhezu Series	West Ankole and south Kigezi	Dark horizon latosols, sandy loams	K.A. sandstones, quartzites and granite	Coffee	Low to medium
15. Kabale Catena	South Kigezi	Red and reddish-brown clay loams locally lateritized	K.A. phyllite	Coffee, maize	Medium to high
16. Ntendule Series	West Kigezi	Clay loams and silt clay loams	K.A. phyllite	Timber	Low
17. Koki Catena	Hills in central and south Ankole	Reddish-brown silty clay loams	K.A. phyllite	Coffee	Low to medium
18. Bugamba Catena	South Ankole	Yellowish-red silt clay loams, non-lateritized	K.A. phyllite	Coffee	Medium to low
19. Lubare Series	Lubare ridge	Sandy loams	Quartzite	None	Very low
20. Rugaga Series	South-east Kigezi	Red clay loams	Laterite residues (?)	Coffee	Medium to high
21. Isingiro Catena	South-east Ankole	Black sandy loams	Sandstone and quartzite	Some coffee	Low to medium
Soils Developed on the Buganda Surface and Remnants					
22. Kiamara Series	West central Toro and south Bunyoro	Red clay loams, locally lateritized	Toro schists, phyllites and amphibolites	Coffee, tea	Medium to high
23. Kitonya Catena	Central Bunyoro	Dark red clay loams, occasionally lateritized	K.A. phyllite	Coffee, maize	Medium to high

	MAPPING UNIT	LOCALITY	DOMINANT SOIL TYPES	PARENT ROCK	CASH CROPS	PRODUCTIVITY
Soils Developed on the African Surface and End-Tertiary Pediments						
24.	Mawogola Catena	South-east Ankole	Gritty loams and clay loams	Granites and gneisses	None	Low
25.	Bushenyi Series	West Ankole	Dark horizon latosols loams and clay loams	Schists, phyllites gneisses	Coffee	Medium
26.	Buwekula Catena	East Toro	Gritty loams and gritty clay loams	Granites and gneisses	Some coffee	Medium to low
27.	Ibanda Series	Kigezi and north Ankole	Red clay loam, non-lateritized	Schists and amphibolites	Coffee	Medium to high
28.	Mbarara Catena	Central and south Ankole	Slightly lateritized, loams and sandy loams	Quartz, schists and phyllites	Chiefly cattle, some coffee	Medium to low
29.	Rukiri Complex	Central Kigezi, west Ankole	Reddish-brown quartz clay loams, non-lateritized	Granites, gneisses	Coffee, maize	Low to medium
30.	Bugangari Series	Kigezi, west Bunyoro and Toro	Shallow black sandy loams	Granites and gneisses	Occasional coffee and maize	Low to medium
31.	Nyabushozi Catena	East Ankole	Slightly lateritized loams and sandy loams	Quartz, schists, phyllites and laterite	Chiefly cattle, some coffee	Medium to low
32.	Kazo Series	North Ankole	Shallow stony loams	Granite and quartzite	Only occasionally coffee	Low
33.	Hoima Catena	South and central Bunyoro	Shallow silty clay loams	Bunyoro Series tillites and phyllites	Some coffee	Low to medium
34.	Kigumba Series	North Bunyoro	Red lateritized loams	K.A. phyllite and granite	Maize and some cotton	Medium
35.	Buruli Catena	North Bunyoro	Reddish-brown lateritized loam	K.A. phyllite and granite	Maize and some cotton	Medium to low

	MAPPING UNIT	LOCALITY	DOMINANT SOIL TYPES	PARENT ROCK	CASH CROPS	PRODUCTIVITY
36.	Anaka Complex	North Bunyoro	Brown shallow sandy loams often over laterite	B.C. granite and gneisses	Occasionally cotton	Low
	Soils Developed on the Acholi Surface					
37.	Palabek Complex	North Bunyoro	Shallow brown loams	Alluvium and B.C. gneisses	Occasionally cotton	Low
			SOILS DERIVED FROM RIFT VALLEY SEDIMENTS			
38.	Dura Series	Toro and Kigezi	Black clay loams	Calc-sintor (tufa)	Timber	Moderate to high
39.	Nyakashuli Series	North-west Kigezi	Deep, reddish-brown sands	Kaiso beds	Tobacco and cotton	Low
40.	Rwanga Series	North-west Kigezi	Deep brown sands, occasionally gravelly	Kaiso beds	Tobacco and cotton	Low to medium
41.	Paraa Complex	North Bunyoro	Deep reddish-brown sands, occasionally lateritized	Kaiso beds	None	Low
42.	Ishasha Complex	North Kigezi	Sandy loams and sandy clay loams	R.V. sediments	None	Low
43.	Kasese Series	West Toro	Sands and sandy clays and clays	R.V. sediments	Cotton	Low to medium
44.	Bwamba Complex	West Toro	Deep reddish-brown sandy clay loams, non-lateritized	Old lake deposits and some B.C. granites	Coffee	Medium to high
45.	Wasa Complex	North-west Toro	Sands and sandy clay loams slightly lateritized	R.V. sediments	None	Low

	MAPPING UNIT	LOCALITY	DOMINANT SOIL TYPES	PARENT ROCK	CASH CROPS	PRODUCTIVITY
			ALLUVIAL SOILS			
46.	Papyrus Peat	Kigezi, Ankole	Peaty clays	Papyrus peat	Sweet potatoes	Medium high
47.	Kifu Series	Toro	Grey sands	Granitic hillwash	None	Low
48.	Bukora Series	Bunyoro, Toro, Ankole	Black sandy loams over dark grey clays	River alluvium	None	Low
48A.	Bukora/Mulembo/ Lwampanga Complex	North Bunyoro	Black sands to clays	River alluvium	Sisal	Medium to low
49.	Sebwe Series	Toro	Sandy clay loam	River alluvium	None	Low
50.	Semliki Series	North-west Toro	Dark grey clays	Lake and river alluvium	None	Low
51.	Weiga Complex	North-west Bunyoro	Black clays	Lake and river alluvium	None	Low

B.C. = Basement Complex

K.A. = Karagwe-Ankolean

R.V. = Rift Valley

DESCRIPTIONS OF THE SOILS OF WESTERN PROVINCE

SOILS DERIVED FROM VOLCANIC ROCKS

1. Sabinio Complex

Two units are distinguished for the Kigezi volcanic soils, Bumfumbira for the plain complex and Sabinio for the alpine and semi-alpine areas. Between 7,500 and 8,000 ft. the soils change from the brown colour characteristic of the plains to almost black and in the undisturbed state appear peaty. Cultivation now extends up to 8,000 ft. and few of the soils below this altitude have not been tilled at some time or other. There is certainly some degree of soil zoning according to elevation as on other mountains in East Africa of comparable height, but since the soils on the south Kigezi volcanoes are all dark coloured, increases of organic-matter content are not so apparent in the field. Undoubtedly a maximum is reached in the bamboo zone, especially on flat, non-eroding sites where drainage is likely to be slow as in the saddles between the volcanoes. On the steep slopes soil depth varies according to details of relief, thus profile 1 which was deeper than 24 inches is sited between two small ridges on which rock outcropped frequently. In the alpine zone proper the vegetation and soils are very reminiscent of the upper slopes of Mount Elgon.

Profile 1 (22572-74)

Near saddle on north side of Sabinio mountain, slope 10°, altitude 9,000 ft. Rainfall ca. 75 in. p.a. Bamboo, montane forest.

0 - 9" Very dark brown (10YR,2/2) humose loam, moderately friable, granular when dry. Numerous bamboo roots.

9 - 20" Very dark brown (10YR,2/2) friable humose loam. Very little structure apart from clods held together by roots.

20" + Dark brown sandy loam with some admixed humus from above.

In the higher parts of the cultivated area potatoes and green peas are grown quite extensively and appear to give moderately good yields.

2. Bufumbira Complex

These soils are confined to the lava plains which spread out from the foothills of the volcanoes in the south-west corner of Kigezi. The steep sides of the volcanoes meet this plain at about 7,500 ft. from which height it slopes fairly gradually down to the level of Lake Mutanda at about 5,800 ft. A brief history of the volcanic eruptions is recorded on page 4. The superposition of one lava flow on another has given to the plain a fairly complex mezzo-relief which is of particular significance to the ultimate soil pattern. The individual flows as they halted formed a series of roughly terrace-like features marked in outline by masses of congealed lava boulders. The surfaces of the flows likewise are littered with boulders and fragments. Soil formation on these lava fields is very slow and were it not for the ash emitted during the eruptions which weathers down relatively rapidly the soils in the area would be very shallow and stony. Much of the ash appears to have been thrown out during the later stages of the eruptions and to some extent blankets the lava rubble. These circumstances have given rise to two main series whose distribution is too complex to indicate on the present scale of mapping. The ash soils which are the deepest, yield up to 24 inches on average brown stoneless loam, the depth depending largely on the original ash thickness as well as the soil age. The second type is a shallow rubbly loam with varying amounts of boulders at the surface.

Profile 2 (22479-81)

One mile west of Kisoro, level site. Altitude 6,000 ft. Rainfall 60 to 65 in. p.a. under Exotheca abyssinica with Pennisetum clandestinum in heavily grazed areas.

0 - 9" Very dark brown (10YR,2/2) friable loam, small crumb structure. Occasionally lava fragments. Numerous roots.

9 - 18" Very dark grey-brown (10YR,3/2) friable loam. Weak sub-angular blocky structure. Many lava fragments.

18 - 30" Dark brown (10YR3/3) friable sandy loam, very stony, structureless. Mainly blocks of lava.

30" + Weathered lava, rubble and boulders.

This profile, typical of the shallow rubbly soils developed on lava, shows affinities with the Sabinio unit in the very high organic-carbon figure.

It is difficult to decide to what extent the soils have re-distributed by water action but it would seem that this has affected such sites as Maziba where, without any apparent addition of ash, spreads of moderately deep soils occur adjacent to areas that are almost entirely lava pavements and carrying only shallow pockets of soil.

Profile 3 (12557-64)

Maziba, four miles west of Kisoro, almost level site. Altitude 6,000 ft. Rainfall 55 to 60 in. p.a., under vegetation as for profile 2.

0 - 6" Very dark brown (10YR,2/2) friable loam with small crumb structure. Numerous roots.

6 - 13" As above, fewer roots.

13 - 25" Roddish-brown (5YR,4/4) loam, loose, friable with little structure.

25 - 33" Dark brown (7.5YR,4/4) sandy loam almost structureless.

33 - 46" Brown (10YR,5/3) sandy loam, structureless.

46 - 62" Greyish-brown (10YR,5/2) sandy loam, structureless.

62 - 78" As above but greyer (10YR,5/1).

78 -100" Similar but much more sandy.

Since this profile is so much deeper than the average ash soil it is presumed to be developed on an accumulation of weathered ash deposit as an alluvial fan from higher ground.

Profile 4 (22458-60)

One mile west of Kisoro Rest House, level site, altitude 6,000 ft. Rainfall 55 to 60 in. pa., under vegetation as for profile 2.

0 - 8" Dark brown (7.5YR,3/2) friable loam. Crumb to small sub-angular blocky structure. Numerous roots.

8 - 16" Dark brown (7.5YR,3/2) friable loam. Weak small sub-angular blocky structure.

/continued

16 - 26" Dark brown (10YR,3/3) friable loam, almost structureless.

26" + Weathered pumice-like ash.

Typical of these soils are the high organic carbon figures throughout and the high calcium figures. The available phosphorus content of these soils is very variable and generally much lower than the ash soils in Toro. Frequently, as in this profile it is deficient.

Most of the area is intensively cultivated for subsistence farming with sorghum as the main crop, but coffee is being introduced with success. Planting on cambered beds about 6 feet wide and 2 feet high is practised extensively. Another interesting practice is that of deliberately burning the topsoil in small heaps to increase fertility. This imparts a reddish tint which would otherwise be absent and increases almost 15-fold the available potassium and doubles the available magnesium and calcium.

3. Saka Series

Saka soils are developed directly on the tuff of the Fort Portal volcanic field. Characteristically they are black or very dark brown loams and although the topsoil may be well developed total soil depth is seldom in excess of 3 feet. Usually the soils are much shallower and solid tuff is encountered within 24 inches. Below the topsoil there is a sharp change to a greyish-brown loam which is transitional to a layer of loose greyish-brown decalcified tuff resting directly on slabby tuff rock. The latter may be slightly calcareous in its upper parts but at depth it is markedly so and is cemented into hard rock by calcium carbonate probably in part of secondary origin brought down in solution from above or by ground water.

Profile 5 (18807-11)

Six miles north of Fort Portal, flanking slope of small crater, 20° slope. Altitude 5,100 feet. Rainfall 55 to 60 in. p.a., under Imperata cylindrica.

0 - 10" Black (10YR,2/1) sandy loam friable with a crumb structure. Numerous roots.

10 - 15" Very dark brown (10YR,2/2) sandy loam. Weak sub-angular blocky structure.

15 - 21" Very dark brown (10YR,2/2) sandy loam, almost structureless.

21 - 33" Very dark brown (10YR,2/2) loamy sand. Structureless.

33" + Ash slightly cemented with $CaCO_3$ at depth.

Except in the immediate vicinity of the craters the ash beds near Fort Portal are not of any great thickness and the topography of the volcanic field follows fairly closely that of the pre-volcanic land surface. In the Saka area, for example, soils are mainly shallow on the broad, flat interfluvial ridges becoming deeper down the slopes towards the swamp hollows. Volcanic activity was greater in the crater area to the south of Fort Portal and craters are so numerous that many of them overlap, giving rise to a hummocky and hilly topography.

Black volcanic loams of the Kichwamba crater region are included in this series, although these soils are generally less sandy than those near Fort Portal.

Profile 6 (20931-34)

Three miles north-east of the Kichwamba hotel on a crater rim. Altitude 3,300 ft. Rainfall 50 to 55 in. pa., under Themeda triandra, Imperata cylindrica and occasionally Pennisetum purpureum.

0 - 9" Very dark brown (10YR,2/2) sandy-clay loam, firm granular structure. Numerous grass roots.

9 - 16" Dark grey-brown (10YR,4/2) sandy-clay loam, firm angular blocky structure.

16 - 22" Dark brown (10YR,4/3) sandy-clay loam, sub-angular blocky structure. Occasional fragments of weathered tuff.

22" + Bedded tuff.

Apart from the very shallow sites these soils are much valued for cultivation and are capable of high yields of most food crops, especially plantains. Arabica coffee does well and is the chief cash crop.

4. Kyamutuma Catena

The volcanic area of south Busongora is notably different from the others of Toro and Ankole in the size and form of the explosion craters. Here the craters are unusually wide with relatively low perimeter walls; sometimes the wall is almost non-existent, the crater being a broad circular depression.

No chemical data are available for the associated soils but it is reasonable to suppose that the majority on slopes will be similar to Saka soils at Kichwamba but more calcareous owing to the drier conditions. In the crater hollows which occupy a considerable part of the area, soils will be base rich and occasionally saline, depending on chemical properties of springs and local rock composition.

The vegetation is dominated by Themeda triandra with Acacia xyphocarpa. In many of the craters thicket is regenerating and Euphorbia candelabrum is very conspicuous.

5. Chambura Series

The Chambura Series represents a soil series developed on volcanic ash. It is typically a deep, dark brown clay loam or sandy-clay loam of high base status though seldom calcareous as is usually the case with the closely associated Nyakatonzi soils on the drier plains. An area of these soils was examined in great detail as a proposed site for a sugar estate, the findings being reported by Chenery (1956).

The soils occur on the upwarped or older parts of the ash-covered lake deposits near Lakes George and Edward and on the less compacted ash which forms a higher terrace beyond Katojo. From its greater depth of profile and almost completely decalcified state it presents a more mature stage of development than either the Saka or Nyakatonzi soils with which it is associated. In some sites the entire ash layer is involved in the profile formation so that the dark brown clay loam rests directly on lake sediment. Calcium carbonate concentrations may occur in the lower parts of the soil or even in the sediments. In the deeper ash layers some concretionary material is always present in the weathering ash, several feet below the soil surface.

A profile sampled on deep, uncompacted ash is shown overleaf.

Profile 7 (18879-84)

Three miles north of Katojo, Toro, crest of gentle ridge. Altitude 3,450 ft. Rainfall 40 in. p.a., under moist savanna, Hyparrhenia rufa, Themeda triandra, Imperata cylindrica.

0 - 8" Very dark grey (10YR,3/1) sandy loam, very firm sub-angular to angular blocky structure. Numerous roots.

8 - 18" Very dark grey-brown (10YR,3/3) sandy-clay loam. Firm angular blocky structure.

18 - 36" Very dark grey-brown (10YR,3/2) sandy-clay loam, soil beds slightly prismatic and moderately firm.

36 - 52" As above, structure becoming weaker.

52 - 62" Dark grey brown (10YR,4/2) sandy loam. Structureless. Occasional flecks and concretionary pockets of $CaCO_3$.

62 - 72" As above with more concretions.

The potential fertility of these soils is well demonstrated by the analytical data for this profile. All bases are present in more than adequate amounts; organic carbon maintains a high figure to a depth of three feet and available phosphorus, typical of these ash soils, is very high. Although the soil is decalcified to a depth of almost five feet it is relatively little leached of bases from the exchange complex and probably by no means fully weathered due to the youthful state of these profiles and the rich mineral assemblage of the original ash.

The results of samples collected in the Chambura area during the intensive survey for the proposed sugar estate show essentially the same soil conditions; deep uniform soils of high base status. The tendency of the subsoil to develop warm brown colours is a forerunner of the red ferrisolic stage which has been reached with the older and more mature soils on the Miocene volcanics of Mount Elgon (cf. Ollier and Harrop, 1959).

Soil reaction in the upper parts of the profiles is nearly always acid in spite of the high base content due, most likely, to the presence of illitic and montmorillonitic clay minerals. Few of the soils are saturated within the first three feet.

The fertility of these soils is little exploited, largely because of poor water supplies and proximity to the game park. Some cotton is grown and occasionally small amounts of arabica coffee.

6. Nyakatonzi Series

The flats of Lakes Edward and George are occupied by large areas of black soils often erroneously described as black cotton soils, with which they have some features in common, notably their colour and stickiness when wet. These soils are developed on volcanic ash laid down either on the lake sediments or in the lake itself. Some of the underlying tuff certainly has the neat varved appearance that would be expected of material deposited in water, but this might have resulted from wind-borne fine ash and dust settling on a level surface. Whatever the manner of deposition, the feature which characterizes these soils is the presence of a definite calcareous concretion layer in the profile. On the main terrace, 3,000 to 3,200 feet, it is particularly well developed and is actually worked for road making material. This occurs usually in the form of irregularly shaped, disjointed bodies and although the layer may be a foot or more in thickness it is seldom cemented into a continuous mass. A typical profile appears as follows:-

Profile 8 (8609-12)

Three miles south-east of Katojo, almost level, 1° slope. Altitude 3,400 ft. Rainfall 25 in. p.a. under grass savanna, chiefly Themeda triandra with Imperata cylindrica in depressions.

0 - 6" Black (10YR,2/1) loam, granular to small, sub-angular blocky structure. Numerous grass roots.

6 - 12" Very dark grey (10YR,3/1) loam, firm sub-angular blocky structure.

12 - 24" Dark grey-brown (10YR,4/2) loam, weaker structure than above. Occasional small $CaCO_3$ nodules.

24 - 36" Pale brown (10YR,6/3) sandy loam, structureless, abundant irregular-shaped $CaCO_3$ concretions.

36" + Slabby calcareous volcanic tuff.

It seems doubtful if such a quantity of calcium carbonate could be leached out of a 24-inch layer of soil and most of it must have been derived from some other source. As the lake drained away, the sediments would eventually be exposed as a calcareous swamp. Further drainage aided by evaporation would concentrate the calcium-rich water in the subsoil where due to periodic drying out of the soil most of its calcium would be precipitated. The small amounts of calcium carbonate left in the topsoil would soon be leached out and added to the deposit below. This process would be more effective where a relatively impermeable layer such as bedded tuff existed in the subsoil, since it would hinder drainage downwards and encourage lateral spread of lime-rich ground water. In soils that are free from underlying tuff and rest more or less directly on coarse permeable sediments the concretionary layer is less well developed.

The agriculture carried by these soils is almost exclusively pedigree cotton grown for seed. Yields up to 2,000 lb. per acre are obtained when rainfall is favourable.

SOILS DERIVED FROM VOLCANIC AND PRE-CAMBRIAN ROCKS

7. Muko Series

On many of the hills near the Bufumbira lava field the phyllite soils are covered with a thin layer of volcanic ash and dust. The thicker deposits yield soils which are essentially the same as the ash-derived members of the Bufumbira Complex. Where the ash forms the upper layer of the soils they have been grouped with the Muko Series. The original phyllite paleosols, the B horizons of which are still well preserved, which would be similar to the adjacent members of the Ntendule and Kabala units were probably very acid in reaction and low in bases. The ash contamination has, therefore, raised both the pH and base status of the contaminated soils as shown by profile 9.

Profile 9 (22473-76)

Half-a-mile north of Ndega, steep slope 25°, altitude 6,000 ft. Rainfall 60 to 65 in. p.a., under Exotheca abyssinica, Pennisetum clandestinum and Hyparrhenia pilgeriana and Loudetia kagerensis on shallow soils.

0 - 9" Dark brown (10YR,3/3) sandy-clay loam. Moderately firm, sub-angular blocky structure, many roots.

9 - 18" Dark brown (10YR,4/3) clay. Structure as above.

18 - 28" Dark yellow-brown (10YR,3/4) moderately firm angular blocky structure.

28 - 40" Dark yellow-brown (10YR,4/4) clay.

8. Fort Portal Series

Due to the explosive nature of the volcanic outbursts which affected the western parts of Toro, ash and other volcanic debris was spread over a wide area around the vents. Air currents drifted the finer material even further afield until it finally settled as a thin blanket on the surrounding soil surface. Being in a finely divided state it weathered rapidly and vegetation which was probably quick to establish itself prevented excessive erosion to which the ash layer must have been particularly prone when first laid down. The soils which received this material are now characterized by a very dark or black loamy topsoil which in road cuttings can be seen to rest directly on the old surface of the red loam. The division is usually quite sharp and very little mixing of the two soils has taken place. Close inspection may reveal termite burrows traversing the junction and carrying some red earths upwards but seldom dark material downwards. Where the ash layer exceeds approximately 12 inches there is a conspicuous pale horizon of less weathered material resting on the red soil. This horizon is usually loose, sandy and completely decalcified. Nearer to the vents the red soils are buried under definite slabby layers of tuff-rock so that there is little or no connection between the red and black soils.

Profile 10 (9132-37)

Mabindi estate 3 miles north-east of Fort Portal, mid-slope, altitude 5,000 ft. Rainfall 55 to 60 in. p.a. under *Pennisetum purpureum*.

0 - 2" Black friably sandy loam. Crumb structure. Numerous grass roots.

2 - 6" Very dark brown friable sandy loam, crumb structure. Numerous grass roots.

6 - 12" Dark brown sandy loam, weak sub-angular blocky structure.

12 - 18" Reddish-brown sandy loam almost structureless.

18 - 30" Brownish red sandy loam, very weak sub-angular blocky structure.

30 - 48" Brownish-red gritty sandy-clay loam. Compact and massive with occasional fissures.

During the early stages of weathering the free calcium carbonate and any other easily soluble materials were leached out of the ash and carried down into the underlying soil. Occasionally small calcareous concretions can be seen deep down in the red soil where re-deposition has occurred. Further to the south, in the soils immediately beyond the Ruimi river, a definite concretionary horizon is present at about four feet below the present surface. (This may be lacustrine.)

As far as the top horizon is concerned these soils are essentially similar to the black loams developed on volcanic tuff. Chemically they are identical but may differ in texture, being heavier where the soil is derived from finer wind-sorted volcanic dust.

Also included with this series are soils which have been affected by wind-borne ash in south Busongora around Nyabirongo and Bwera and south of Mahokya. The original profiles in these areas are considerably shallower, less fertile and more gritty, resembling the granite soils of east Toro but the volcanic topsoils have raised their fertility to something approaching that of the soils of this group in Bunyangabo and Burahya.

As with the Saka Series the Fort Portal soils are much used for general cultivation and yield good food crops, especially plantains. Coffee is grown throughout and is the principal cash crop.

9. Bubandi Series

Emerging from some of the larger valleys on the south-eastern side of the main north ridge of Ruwenzori are several outwash fans of sand and gravel which give rise to dark-coloured loams of variable stoniness. Much of the material would appear to be either volcanic ash washed off the hills by erosion or ash laid directly on colluvial material. In the area near Bubandi several spreads of the detritus have coalesced to form a single extensive flat but elsewhere they form relatively small fans near the mouths of the valleys. The soils are, in the main, loams or sandy loams usually moderately stone free until the gravel bed is reached at depths between two and three feet. An example of a deep profile is given below:-

Profile 11 (18757-61)

One mile south of Kazingo, almost level site, 2° slope. Altitude 5,000 ft. Rainfall 60 in. p.a., under Pennisetum purpureum.

0 - 12" Black (10YR,2/1) friable sandy loam, granular to crumb structure. Numerous roots.

12 - 22" Dark brown (10YR,3/3) sandy loam, moderately compact with a weak sub-angular blocky structure.

22 - 32" As above with streaks of humus staining.

32 - 42" Dark brown (7.5YR,4/4) loam with occasional rounded or sub-rounded quartz pebbles and fragments of weathered schist.

42 - 56" Sub-rounded gravel in sandy loam matrix. Slightly paler than above with occasional dark streaks and dark concretionary material.

In the field Bubandi soils appear, as a rule, to be compact and slow draining in their subsoils and locally show definite mottling and dark staining due to the imperfect drainage. Freely drained soils are either more sandy or shallow over the gravel. Base status of these soils is high and the high amounts of available phosphorus present, strongly suggests an admixture of volcanic material throughout the profile.

An area of similar soils immediately south of Lake George has been included in this unit.

In spite of the relatively high fertility of these soils they are not fully used for cultivation. Large areas are left for grazing and good crops are grown on slopes of hillocks scattered near the Ruwenzori foothills.

SOILS DERIVED FROM PRE-CAMBRIAN ROCKS

Montane Soils

10. Bujuku Complex

For the purpose of this survey the mountain soils have been divided into three units based roughly on the vegetation zones which in turn are dependent on altitude. The three broad zones from top to bottom are alpine vegetation, consisting of dense stands of tree heather and tree groundsel with glades of "everlasting" flowers; broad-leaved montane rain forest; and, finally, tall grassland.

At an altitude between 9,000 and 10,000 ft., approximately coincident with the appearance of tree heather, in the vegetation there is a marked change in profile development. The gradual merging of the humose topsoil into the mineral soil below is no longer apparent and an upper peaty layer rests abruptly on grey stony drift which usually shows little sign of weathering. On some of the older moraines, however, some indication of weathering is discernible as a greyish-brown to yellowish-brown horizon, with rusty stains in the morainic material immediately below the peat. The latter is usually well humified, acid and saturated with water. There is no evidence that any of the soils become frozen for long periods in the year owing to an almost continuous cloud cover.

In areas where the moraine is derived from amphibolite rocks, for example near Lake Kitandara, the soils are less acid and higher in exchangeable bases than soils in the forest (Kyansabo unit).

Profile 12 (18840-42)

Half-a-mile east of the lower Kitandara Lake, slightly sloping site, 3°. Altitude 13,500 ft. Rainfall probably about 60 to 65 in. p.a. under Afri-alpine communities including Senecio spp. Lobelia spp., Helichrysum spp., mosses etc. (Hedburg, 1951).

0 - 8" Very dark grey-brown (10YR,3/2) well-humified peat.

8 - 12" As above with a few stones resting abruptly on:

12" + Compact grey moranic consisting largely of amphibolite.

On the granitic, gneiss and mica-schist moraines the peat is very acid and low in bases.

Profile 13 (19011-12)

Busuwagumu (12 miles north of Nyabiringo). Level site. Altitude 11,000 ft. Rainfall 60 to 65 in. p.a., under Helichrysum, Senecio, etc.

0 - 12" Very dark grey-brown peat, almost completely humified.

12 - 20" Pale grey morainic material with some humus staining and rusty blotches.

11. Kyansabo Series

On the whole these forest soils are very acid in reaction and in spite of their high organic-matter content are very deficient in exchangeable bases. The relative fertility of adjacent grassland sites suggests that bases are released from the destruction of their organic matter when forest is cleared for cultivation, but this has not been established as fact.

The following profiles serve to illustrate the low base and high organic-matter content of the Kyansabo soil.

Profile 14 (18875-78)

Six miles south-west of Kisomoro, 10° slope. Altitude 9,000 ft. Rainfall 60 to 65 in. p.a., under moist montane forest and bamboo (Arundinaria alpina).

0 - 10" Black (10YR,2/1) loam with moderately firm amounts of granular structure.

10 - 20" Dark brown (10YR,3/3) loam, small weak sub-angular blocky structure.

/continued

20 - 30" Dark yellowish-brown (10YR,4/4) loam, very weak structure.

30 - 46" As above with occasional fragments of mottled schist.

Profile 15 (18861-63)

Kyansabo, 10° slope, altitude 8,500 ft. Rainfall 60 to 65 in. p.a., under moist montane forest.

0 - 8" Black sandy loam (10YR,2/1) very friable with crumb structure.

8 - 18" Very dark grey-brown (10YR,3/2) sandy loam with weak small crumb structure.

18 - 24" Very dark grey-brown (10YR,3/2) sandy loam almost single grain.

24"+ Weathered gneiss.

12. Mulinda Series

On the steep foothills there is a conspicuous break between the grassland and forest at about 7,000 feet which, although partly an artificial boundary, does in fact also represent a change in soil conditions. Below this line the soils are mapped as Mulinda Series.

Where uncultivated the vegetation is dominated by Pennisetum purpureum and Hyparrhenia cymbaria, a community which is continuous with that of the adjacent lowlands. The division between the upland and lowland soils, however, is not based on topography alone. On the steep slopes the striking red colours of the lowland soils are no longer apparent and colours range from yellowish to greyish-brown. This may be an indication of their immaturity for it is reasonable to suppose that the mountain slope soils are younger than those on the gently undulating lowlands. Erosion effects, perhaps more in the past than at present, have been removing topsoil at a far greater rate from steep slopes and weathering will be retarded by the generally lower temperature of these upland sites. It is also possible that leaching is less severe through the profile on steep slopes and that there is some base enrichment downslope. The following profile is fairly typical.

Profile 16 (18867-69)

Seven miles north-west of Bugoye, 15° slope. Altitude 7,000 ft. Rainfall 60 to 65 in. p.a., under Pennisetum purpureum, Hyparrhenia cymbaria, Setaria spp.

0 - 4" Dark yellowish-brown (10YR,3/4) loam, sub-angular blocky structure. Many roots.

4 - 13" Yellowish-brown (10YR,5/4) loam, weak sub-angular blocky structure.

13 - 34" As above becoming more compact and with weaker structure.

The high base status suggests some enrichment from weathering amphibolite.

To what extent volcanic dust has influenced these soils cannot be satisfactorily assessed at this stage but certainly the presence of ash on the ridge top near the Bwamba Pass at about 8,500 ft. shows that it must be considered. Profile 17 above Bubandi, for example, from its high content of phosphorus and exchangeable bases strongly suggests ash contamination.

Profile 17 (18798-802)

Above Bubandi. Elevation 6,700 ft. Slope 10 to 15°. Under Pennisetum purpureum.

0 - 7" Very dark grey (10YR,4-3/1) loam with good crumb structure.

7 - 17" Dark greyish-brown clay loam. Angular blocky structure, occasional small schist or gneiss fragments present.

17 - 43" Pale brown (10YR,6/3-4) sandy clay loam, blocky structure with vertical fissures.

43 - 53" Yellowish-brown (10YR,5/4) clay, infilling shattered gneiss.

The depths and textures of these soils will naturally vary considerably depending on erosion and weatherability of the underlying rock. Deep soils are not uncommon and on such material as schists profiles may extend down for several feet before bedrock is reached. On the biotite gneiss they tend to be shallower, but on the whole their average depth is adequate for cultivation. Local patches of shallow stony soils derived from quartzites and quartz veins are found, especially on the northern parts of the main ridge. Here the predominance of quartz-rich rocks and low rainfall yield shallow droughty soils which support a dry savanna vegetation. Similar soils occur on the foothills around Duwia and Nkenda between the Ruimi and Nyamwamba rivers.

Soils Developed on the Ankole Surface and its Remnants

13. Mafuga Series

This unit occurs mainly in upland sites and is the most widespread of the dark horizon latosols occupying much of the Rukiga and other highlands of Kigezi. In common with the other dark horizon soils it usually shows a two-layer arrangement in its profiles. The upper of the two, varying in thickness from one-and-a-half to about four feet, is usually stoneless and sharply separated from the underlying layer, consisting mainly of weathered rock rubble with varying amounts of clay loam.

The characterizing dark horizon nearly always occurs in the upper stoneless layer which throughout is weakly structured or structureless and becomes very loose and friable as it dries out. This physical condition renders it very susceptible to erosion when the soils are freshly cultivated on moderate slopes. Since, however, much of the topography consists of slopes between 20 and 30° the risk is considerable and the damage created by rainstorms bears ample testimony to the failure of existing conservation measures. Widespread gully erosion which followed the recent cultivation of slopes just south of Kashambya provides a fairly striking example of the instability of these soils.

Soils of this unit more than any other suggest either a superficial drift deposit or re-sorting of an upper layer to form the present profiles. The two layers differ in texture, colour and structure and would, therefore, seem to be of different origins. Especially is this so with a variant that occurs in the bamboo forests of south-west Kigezi.

Profile 18 (22488-92)

One mile east of Kanaba Gap, Kigezi, mid-slope, 15°. Altitude 7,900 ft. Rainfall 60 in. p.a., under bamboo montane forest.

0 - 8" Very dark brown (7.5YR,2/2) highly organic loam, weakly granular. Bamboo roots very abundant.

8 - 26" Dark brown (7.5YR,3/2) very friable loam, structureless.

/continued

26 - 36" Very dark brown (7.5YR,2/2) structureless loam. Sharp transition to:-

36 - 46" Reddish-brown (5YR,4/4) loam, weak sub-angular blocky structure.

46 - 72" Yellowish-red (5YR,4/8) (with faint diffuse mottling), compact loam containing mainly weathered fragments of phyllite.

In these soils the organic-carbon content is high throughout the upper horizon but the differential accumulation in the lower parts of this layer is sufficient to give rise to a marked dark horizon. The subsoil is reddish in colour and consists of a deep, stony, sandy-clay loam containing occasional fragments of old laterite.

A more normal soil of this unit, typical of the Rukiga highlands, appears below but was not sampled.

Three miles south-east of Lutuza, 10° slope, altitude 8,200 ft. Rainfall 65 to 70 in. p.a.

0 - 10" Very dark brown (10YR,2/2) sandy loam, almost peaty. Loose very friable and structureless. Numerous roots.

10 - 30" Dark brown (10YR,3/4) loam, very little compacted and almost structureless.

30 - 42" Very dark brown (10YR,2/2) highly organic loam with no perceptible structure. Dries out to very small crumbs. Sharp transition to:-

42"+ Dark brown (7.5YR,4/5) sandy loam compact but structureless. Occasional small fragments of phyllite and quartzite.

The profile is developed on mixed detritus derived from phyllite and quartzite which accounts for the sandiness of the subsoil.

The lack of any stable structure is a physical characteristic very typical of these soils. Lower slope and pediment soils usually show a well-marked, relatively stable structure although derived from the same parent rock, i.e. Kabale unit. The transition from one unit to the other is most likely to occur in the upper parts of the slope as shown in the soil map, although the dark horizon phenomenon is not strictly confined to the upland areas. It has been observed occasionally in lower pediment soils but then only as an incipient feature.

The origin of these soils is still very much a matter for conjecture and several hypotheses have been put forward ranging from buried profiles to podsolization. Regarding the latter, there seems to be little evidence of translocation other than a very obvious formation or accumulation of highly organic material as a "dark horizon" at some depth in the profile. This horizon may vary in thickness but is, as a rule, approximately parallel with the soil surface and its depth appears to be little affected by topography. Perhaps the most significant fact favouring a podsolization effect is the presence of genuine podsols where parent rock favours their development within the area of the dark horizon soils. Several such podsols are to be seen on the quartzites at Rugyeyo, Busisa hill near Butale and on the Lubare ridge, Ankole (see Lubare Series). Podsolization does, therefore, definitely take place and the process must have played some part in the formation of associated soils on the phyllites. Semi-alpine vegetation and a thick topsoil with a high content of acid humus which nearly always occurs with these soils would also be expected to produce podsolizing conditions.

The evidence in favour of buried soils is also scant and, in fact, there is much which argues against it (see Bushenyi unit; and Ruhe, 1956). However, since the soils are, by and large, confined to the highest parts of the district this origin could be connected in some way with a former colder climate, when conditions for solifluction obtained. It is certainly true that occasionally contortions of the dark horizon seen in certain sections indicate that some fairly drastic movement has taken place in the upper soil layer.

At lower altitudes the dark horizon does sometimes appear to have been affected by insect activity so that instead of a diffuse layer it shows local concentrations of darker coloured earth in channels together with dark stainings on the faces of the weak structural units.

14. Buwhezu Series

The dark horizon latosols of the Buwhezu unit are distinguished from the Mafuga and Bushenyi (loc cit.) soils primarily on the nature of the parent rock. In the Buwhezu highlands they are derived from sandstone and quartzite but included with them are dark horizon soils on the granites in the Rubanda arena. Originating from quartzose and quartz-rich rocks the soils are usually sandy or gritty and in the case of upland sites laterite gravel from the Ankole surface remnants is frequently included in the profile as, for example, above Butale.

Profile 19 (22724-28)

Two miles north-west of Butale, level site. Altitude 6,500 ft. Rainfall 55 to 60 in. p.a., under Pteridium aquilinium, Melinis spp., etc.

0 - 14" Very dark brown (10YR,2/2) loamy sand, single-grain structure.

14 - 44" Dark brown (7.5YR,4/2) loamy sand, single-grain structure.

44 - 68" Dark brown (7.5YR,3/2) loamy sand, single-grain including occasional fragments of laterite.

68"+ Mainly weathered quartzite and laterite.

Typical of these very acid, free-draining soils, the profile is practically leached of all exchangeable bases.

With soils in the Rubanda arena the dark horizon is usually very pronounced. It occurs at some depth on the flatter sites as, for example, near the R. C. mission church, but usually on slopes and ridges it forms a very dark horizon within two feet of the surface where the subsoils are gritty and compact. Profile 20 represents average conditions.

Profile 20 (22444-47)

Three miles north-west of Rubanda, mid slope 10°. Altitude 6,900 ft. Rainfall 50 to 55 in. p.a.

0 - 8" Very dark grey-brown (10YR,3/2) sandy loam, weak crumb and small sub-angular blocky structure. Many roots.

8 - 30" Dark brown (10YR,4/3) sandy loam, almost single grain.

30 - 48" Dark brown (10YR,3/3) sandy loam, almost single grain.

48"+ Yellowish-brown (10YR,5/4) loamy sand. Chiefly weathered granite, several rounded boulders in situ.

The base status of the soil is remarkably similar to that of the previous profile.

15. Kabale Catena

These soils represent not only the most widespread unit in Kigezi District but the most intensively cultivated areas, particularly around Kabale itself. On the principal ridges and more particularly in saddles of the steep topography there is usually a transition sometimes quite sharp to dark horizon soils of the Mafuga unit. Since this feature is fairly constant the latter have been mapped separately rather than include them as part members of the catenary sequence which occurs over the greater part of central Kigezi.

Within the Kabale catena, as would be expected from the complexity of its topography, there is much local variation, often attributable to changes in parent rock in the form of outcropping bands of quartzite. There is little evidence to suggest that the phyllites themselves from which these soils are derived vary greatly in composition. Being products of a previous weathering cycle they are not likely to yield on weathering the amounts of variety of nutrients that a fresh crystalline rock would. Many of these phyllite soils probably owe their productivity to the more retentive nature of their clay fractions and to rooting depth, for even on some of the steeper slopes, 10 to 20 degrees, the soils are remarkably deep. This, in most cases, is due to clay loam textures which promote a firmer and more stable soil structure. There appears to be no pronounced tendency for severe erosion to occur except on the uppermost slopes where Mafuga soils are found. In fact, hillslope soils in Kigezi do not appear to have been subjected to any man-accelerated erosion in the past and it must be true that soil development has kept pace with the normal geological process of slope retreat. Deepest soils are found on the more mature topography of south Rukiga where hill slopes seldom exceed 15°. Valleys are wider and pediments broader, thereby offering greater scope for cultivation which has led to a density of settlement similar to south Bufumbira. It is in the lower parts of these pediments that contemporary lateritization is taking place, suggesting a high degree of leaching and maturity of profile, for these are probably the oldest soils in the district. The form of laterite is very similar to that in the ridge soils of the Mbarara catena. It appears in the subsoils as a yellow and reddish-brown mottled mass usually fairly soft, hardening only slightly on exposure. Other forms of laterite occur in some of the upland sites but this is a product of an older landscape and the patches of "murram" found on hill crests and shoulders, as at Kabale station hill and around the C.M.S. mission, are relics of the laterite which covered the Jurassic peneplain (Wayland, 1934) or stages in its modification to the present topography.

Since Chenery (1951) made a detailed study of the catena on Kachwekano Farm in which 27 profile pits were examined and 14 sampled for analysis, further sampling was not done during this survey. Five main soil series were found in the farm in catenary associations. Their salient characteristics, using Radwanski's (1960) nomonclature, are:-

1. Kabale "Dark horizon latosols": Brown loams overlying reddish-brown stony loam on what looks like another topsoil ("dark horizon") then brownish-red sandy loam. The whole profile is very acid, pH 4.6-4.3, and the topsoil is abnormally rich in pale-coloured humus. This was the first Dark Horizon Latosol to be described for Uganda. A good example is profile 21:-

Profile 21 (4593-99)

Kachwekano Farm, Kabale. Camp pasture. Low crest of long slope of 5° to south-east; elevation 6,900 ft. under mixed grasses: Exothaca abyssinica, Panicum adenophorum, Digitaria scalarum. Fine roots to base of pit - most abundant in top 12 in.; fairly moist throughout but not wet.

0 - 6" Dark brown (7.5YR,4/2) sandy loam full of grass roots.

6 - 11" As above but with a slight reddish cast (7.5YR,4/4).

11 - 21" Pale brown (10YR,4/2) sandy loam, containing a few very small iron pisoliths slightly redder than above.

21 - 31" Pale reddish-brown (5YR,5/4) full of sub-angular rock fragments and hard or semi-hard murram ("stone line").

31 - 35" Dark brown (7.5YR,3-4/2) loam full of pale reddish-brown to orange-brown semi-hard weathered rock fragments (humose, B horizon).

35 - 48" Yellow-red (5YR,6/6) sandy loam with frequent bright orange-red sandy weathered rock fragments and small quartz pebbles up to ½" diameter.

48 - 66" Chiefly coarse sandy, semi-hard quartzite fragments light reddish-brown (5YR,6-7/4) in colour but infilled with browner material from above. Few small quartz pebbles present - up to ½" in diameter.

2. Kabale "Ferruginous": These are local occurrences, usually at slope breaks of brown to yellowish-brown sandy loam over massive conglomeritic ironstone at 1 to 1½ feet below the surface.

Profile 22 (4614-18)

Kachwekano Farm, paddock; on crest of spur sloping steeply (15°) to south-west; elevation 7,100 ft. mixed grasses chiefly Digitaria velutina, D. scalarum, Exotheca abyssinica, Pennisetum clandestinum and yellow bidens. Roots very abundant to top of iron pan; moisture fair throughout.

0 - 6" Dark brown (7.5YR,3/2) sandy loam with abundant roots.

6 - 12" Similar with a few small iron pisoliths (1/3").

12 - 17" Dark brown (7.5YR,4/2-4), more yellow than above, sandy loam containing a few soft iron concretions (¼").

17 - 30" Massive conglomerate of round and sub-angular crimson ironstone in bright yellow-red (5YR,5/6-8) clayey material - impossible to dig deeper than this.

3. Kabale "Red-Pink": These are brown or reddish-brown humose loams overlying uniform pale brownish-red to pinkish-white loams which may contain murram at any depth. Profile 23 is a good example.

Profile 23 (4608-13)

Kachwekano Farm, Kabale. 900 ft. up the same ridge spur from profile 21, slightly off the crest, sloping 5° to south; old hut site facing the lake, dropping steeply 20 yd. south; elevation 7,100 ft. covered with Erythrina sp. and Bidens pilosa, abundant Borreria sp. and Osbeckia sp. in pasture nearby. Tree roots penetrate to base but are most abundant in top 30 in. Moisture throughout - 2 in. water in bottom.

0 - 6" Reddish-brown (5YR,4/2-3) sandy loam with occasional angular quartz or rock fragments.

6 - 22" Paler brown sandy loam, slight reddish cast, some large ironstones here up to 2" diameter.

22 - 33" Compact, paler, reddish-brown (5YR,6-5/4) loam with dark red ironstone and abundant rock fragments.

33 - 48" Yellow-red (5YR,4/6) clay loam full of ironstone and quartz rock fragments up to 2" diameter.

48 - 66" Similar but more clayey, stony and redder.

4. Kabale "Yellow": These are brown humose loams on yellowish to orange-brown brashy loams which may contain murram. Parent rock often yellow sandstone or weathered quartzite within the top 3 ft. Profile 24 is one of 11 profiles that were examined.

Profile 24 (4619-26)

Kachwekano Farm, just off corner of permanent pasture, old house site; almost flat high terrace; elevation 7200 ft. under thick Polygonum scrub. Thick roots in top 6 in., less at 12 in. and very few below 30 in. Mainly moist to 30 in. Some worm activity but no worms seen.

0 - 6" Friable, dark brown (7.5YR,4/2-4) loam, roots abundant.

6 - 12" Similar, containing worm holes.

12 - 18" Reddish-brown (5YR,4/3) loam, more compact.

18 - 30" Reddish-brown (5YR,4/4) compact loam, containing few roots and a few orange-brown iron concretions.

30 - 42" Very compact, bright reddish-brown (5YR,5/4) loam - clay loam.

42 - 54" Similar to above but with harder concretions.

54 - 66" Similar but somewhat more reddish-yellow (5YR,6/6) in colour.

5. Kabale "Hillwash": Dark brown almost black humose loam to as much as 4 ft. on reddish or yellowish-brown loam. At the fringe of the valleys rock fragments occur in the top 5 ft., in the valley bottoms they are rare.

Five pits were examined, of which profile 25 is typical

Profile 25 (4668-75)

Kachwekano Farm. At head of small perched valley near boundary of the farm under trees 30 ft. high of Maesa lanceolata, Crassocephalum manii; Acanthus arboreus and Lobelia gibberoa also present. Slope 1° to south-east.

0 - 2" Humose mat of leaves and roots, dark brown (7.5YR,3-4/2).

2 - 24" Greyish-brown to brown (10YR,5/2-3) crumby loam.

24 - 48" Similar but darker (10YR,4/2).

48 - 60" Similar with sparse soft orange iron concretions.

60 - 72" Light yellowish-brown (10YR,6/4-6) clay loam, compact and moist; fingers of humose topsoil present.

From this study some interesting relationships emerge between vegetation, land use and kind of soil. These are:

(a) Colonizing forest which occurs usually in the lower slopes of the valleys is more closely connected with depth of humose soil, which determines the range of fluctuation in soil moisture, than nutrient status. Close connections between plant associations and nutrient status are not often established apart from obvious calcifuges and calcicoles. A detailed species population analysis may, however, show such a relationship.

(b) Hut and/or kraal spots are usually characterized by a high pH and nutrient status and this is reflected in the vigorous growth of the trees and shrubs which soon cover the ground after the site has been abandoned. The trees are probably relicts from those planted by the hut owners.

(c) Fringing forest owes its existence to constant ground water supplies with freedom from surface waterlogging.

(d) The valley bottom soils are usually very much less acid than the hills and their nutrient status is higher. This is due to their being formed from the accumulated topsoil of the surrounding hills and to a less extent by enrichment from base-rich ground water.

(e) The pastures are located in the main ridge crest and are very acid and poor in bases but extremely rich in a pale-coloured humus - up to 10 per cent.

(f) The eroded sites have a shallow humose topsoil and are covered by a variety of vegetation types and inferior stands of crops.

(g) The calcifuge Pteridium-Philippia association confined to the eastern slopes of the rocky ridge is on an extremely acid- and base-deficient soil but the humus accumulation is again very high. This acidity combined with the shallowness of soil, steepness of slope and the eastern aspect all tend to create conditions only suitable to semi-xerophytes such as bracken and heather.

The greatest concentration of population occurs on soils of the Kabale Catena and consequently most of the district's sorghum, finger millet and other food crops are grown on them. Vegetables for the Kampala market and fire-cured tobacco are the only cash crops.

16. Ntendule Series

Over a large part of north Bufumbira and the area covered by the Impenetrable Forest the soils are derived from Karagwe-Ankolean phyllites but they differ from those in the western parts of Kigezi, the Kabale unit, by their more pronounced acidity and their generally paler colour. They are in this respect intermediate between soils of the Kabale unit and the Mafuga dark horizon latosols and sometimes a slight dark horizon is discernible in their profiles as, for example, in the following profile:-

Profile 26 (22528-32)

Three miles south-west of Kisizi, mid slope, 20°. Altitude c. 7000 ft. Rainfall 45 to 50 in. p.a., under Pteridium aquilinum and Philippia spp.

0 - 12" Very dark brown (7.5YR,3/2) humose loam, loose and very friable, almost single-grain structure. Numerous roots. Sharp transition to:

12 - 48" Yellowish-red (5YR,4/6) loam. Moderately firm blocky to sub-angular blocky structure. Much vertical fissuring extending below.

48 - 65" Reddish-brown (5YR,4/4) loam, with dark staining on structure units. Angular blocky structure.

65 - 76" Yellowish-red (5YR,4/6) loam. Compact with angular blocky structure.

This profile is uniformly very acid throughout and typical of the Ntendule soils, extremely deficient in bases, Ca and Mg being almost completely leached out. The incipient dark horizon does not show up in

the organic carbon analyses due to it being only a dark coating on the soil aggregates. Usually the surface organic horizon is sharply defined from the soil below.

Continuous cultivation of this surface layer on steep slopes has led to many land slips. Several are to be seen along the road to Musingere near Lake Mutanda.

An extremely acid profile was sampled in the Impenetrable Forest near Luhiza.

Profile 27 (11203-07)

Three miles west of Luhiza, mid slope. Altitude 7,000 ft. Rainfall 70 to 75 in. p.a. Moist montane forest.

0 - 6" Very dark brown (7.5YR,3/2) humose loam with much undecomposed root little. Very little structure, almost single grain. Numerous roots.

6 - 12" Dark brown (7.5YR,4/2) silty loam. Weak sub-angular blocky structure.

12 - 18" Dark brown (7.5YR,4/4) silty loam, very weak structure.

18 - 24" Brown (7.5YR,5/4) stony loam, structureless.

24 - 30" Mainly weathered talc-like phyllite.

The very low pH values are associated with a particularly acid humus and the whole profile is extremely deficient in bases. It is interesting to note that the clay fraction of these soils is composed almost entirely of finely divided mica according to the results of X-ray analysis carried out at Rothamsted.

17. Koki Catena

This catena was first mapped and described in the survey of Masaka District by Radwanski (1960).

Dissected remnants of the phyllite hill masses in south and south-west Ankole and some of the bordering parts of Kigezi give rise to a soil catena which closely resembles the Koki of Masaka and have, therefore, been mapped as the same unit, although there is a possibility that the two areas may be erosion remnants of different surfaces, i.e., Ankole and Koki surfaces respectively.

The bulk of the country occupied by the Ankole surface has been included in the Bugamba catena, primarily on account of its higher rainfall which applies mainly to the central parts of the hills. Towards the outer perimeter and especially to the west, rainfall is less and soil conditions are definitely inferior, due, very often, to human factors (see Bugamba). Detached from the main hill mass are numerous smaller hill groups both to the north-east and south-west and it is these that have been mapped as Koki catena in the Western Province.

The hills are usually smooth and rounded in outline, with steep-fluted slopes. They are almost wholly composed of phyllite with occasional quartzites and intrusive rocks. Their pediments are long and gently inclined, merging into the Mbarara catena. Soil conditions on the steep slopes are very variable but follow closely the topographic pattern:- shallow and often stony on the ridges with deeper accumulations in the intervening gullies usually occupied by trees and bushy vegetation. Fire and overgrazing on most of the slopes has taken its toll of topsoil which is reduced to a thin layer of grey compact stony clay capable of supporting only a very sparse grass cover, usually Themeda triandra.

The pediment soils are generally lighter in texture than their equivalent in Masaka due to the greater degree of metamorphism of the phyllite in Ankole. On the lower parts of the hill slope, soils are derived from quartz schists and are usually loam or sandy loam in texture (cf. Koki, Radwanski, 1960).

On the summits, soils are identical with the Tolero Series of Masaka. They are of practically no agricultural value and being of small and scattered extent are not mapped separately in the Western Province. These soils are skeletal and very shallow, consisting of little more than a few inches of humose loam resting directly on iron-stained phyllite rubble. Occasional fragments of laterite occur as relics of the former lateritic cap which is now almost completely eroded away.

18. Bugamba Catena

The hills which form the upland block of south-central Ankole are a distinct geographical unit with a climate that distinguishes it from the other smaller isolated hills nearby which were formerly part of the same elevated mass. The latter by the normal process of dissection and slope retreat have now become separated by wide, gently undulating tracts which reach their maximum development in the arenas surrounded by remnants of the old upwarped surface. The hills of the Bugamba area are composed almost entirely of phyllite with minor amounts of quartzite and quartz veins and the sediments show strong folding along an approximately NE/SW strike. From their outline it is clear that the hills represent the dissected remnants of a peneplain now standing at approximately 6,000 feet, tilted slightly to the east to 5,500 ft. in the Isingiro hills and up to 8,500 ft. in the Rukiga highlands of Kigezi. This is consistent with the general upwarping of the land surface from the Lake Victoria basin towards the Rift Valley escarpment.

The flat crests of many of these hills carry thick sheets of laterite, relics of the former lateritized peneplain which by its relative hardness has resisted erosion and preserved the flatness of the summit levels. Once the laterite is removed the hills assume a more rounded outline at their crests. The relative rate of summit reduction can be seen at Bugamba itself. The main ridge of Karamrani standing at 6,200 ft. is still capped by a laterite sheet. Extending from it are several subsidiary ridges like fingers which show an approximate concordance of height at about 5,800 ft. These sometimes show laterite remnants but they are less well developed than on the higher ridges. This "two peneplain topography" has been noted in western Ankole (Combe, 1932) and since the difference in the two levels is of the same order, this landscape feature in Bugamba may have a similar origin.

Hill slopes are generally steep, 20 to 24°, with narrow pediments 6 to 10° on which are found the deep yellow-brown or reddish-brown clay loams. Only in the Rwoho valley are they developed to any extent and fringing the outer perimeters of the main hills themselves. To avoid overcomplexity of the map these pediments have been included with the soils of the Mbarara Catena.

The soil pattern is typical of this topography with the shallowest soils on the rounded hill and ridge crests and deepest on the lower slopes and pediments. Many of the steep slope soils were found to be of greater depth than anticipated. Pits sampled along a transect between two ridges in the Forest Department plantation showed an average soil depth of about 24 inches to shattered phyllite with several soils almost twice this depth on slopes of 28°. Profile 28 is an example of a soil of moderate depth.

Profile 28 (20237-39)

One mile east of Bugamba, ridge crest. Altitude 5,800 ft. Rainfall 45 to 50 in. pa. under Themeda triandra and Loudetia kageronsis.

0 - 7" Dark brown (7.5YR,3/2) stony loam. Many fragments of phyllite. Loose crumb structure. Many roots.

7 - 18" Compact but very friable, structureless. Much angular phyllite.

18" + Mainly weathered phyllite in situ with pockets of reddish-brown (2.5YR,4/4) loam.

The shallow hill-crest soils generally show the greatest build-up of organic matter probably because of an inclination to dry out rapidly, thereby retarding the decomposition of plant residues and organic carbon figures show that the humus is more evenly distributed throughout the upper soil horizons. In slope soils, on the other hand, the organic-matter content tends to fall off rapidly with the sharp transition from the surface horizon to mineral soil immediately below. The forest plantation block is part of a reserve which has been more or less closed to settlement for a period of about 10 years and the natural regeneration of vegetation has been allowed to proceed without serious interruption from cultivation and burning. The contrast between this area and nearby sites which have been exploited by native settlers is striking. Even viewed from a distance, it is apparent that where grazing and burning have continued unchecked, the grassland has become very sparse and topsoil erosion has taken place sometimes to the extent of removing the humus layer. This state of affairs is in marked contrast to soil conditions within the reserved area, where not only is there a dense vegetative cover but on average a ten-inch humose surface on all the soils. These conditions have other far-reaching effects, notably in the preservation of water supplies by the protection of the catchment areas. It is significant that streams in the reserve are almost permanent, whereas in other areas water supplies are far less certain. Slope soils on the outer perimeter hills are probably the most affected by over-grazing, burning and erosion. In many instances the topsoil has been removed and the present surface soil is little more than a compact, grey clay carrying an embedded stone mantle. Further modification may have been effected by termite activity which spreads mound material as a compact layer over the surface. Erosion during heavy rains has washed away all loose surface material so that conditions for absorption of water are at a minimum and accelerated run-off at a maximum. Parallel with this development is a serious deterioration of the grass cover which is now in many areas only a very thin sward of drought- and fire-resistant species such as Loudetia kagerensis, L. simplex, Microchloa kunthii and Sporobolus festivus. Bare soil is very noticeable in the early stages of the rains when the burnt remnants of the old vegetation have been washed away and before the new grasses have commenced to grow.

From these observations it must be stated that the soils in the sampled transects represent approximately the best conditions in the area of this catena and that most of the variations represent degradation following land misuse.

Only subsistence cultivation is practised and is mainly confined to either the narrow valley pediments or small patches of deeper soils on the ridge crests. The slope soils are eminently suitable for softwood production and the results of planting in the Bugamba forest reserve are very promising.

19. Lubare Series

Within the zone of the dark horizon latosols, iron podsols have developed on the quartzites. The quartzite ridge of Lubare after which this unit is named is the most extensive area of these soils but they

occur in many other sites, too limited in extent to map on the present scale. One of these has been sampled on Chanka hill between Butale and Lukiri, Buhwezu. In this profile the bleached A_2 horizon was well developed and there seems little doubt that the soils are in every way comparable with iron podsols formed in more temperate regions. It is perhaps remarkable in an area where organic (dark) horizons are so prevalent in the subsoil that there should be little or no humic B_1, although there are scattered flecks of humus staining throughout the B horizon sufficient to raise the organic carbon figure from 1.07 to 2.03. In neither of the sampled sites is it possible to decide the former state of the A_o layer since the soil surface has been disturbed by erosion and burning.

Profile 29 (20989-91)

Chanka hill three miles west of Butale. Altitude 6,000 ft. Rainfall 60 in. p.a., under derived savanna, stunted woody species, e.g., Philippia sp. and Pteridium aquilinium, Melinis spp., Loudetia kagerensis, Protea madiensii.

0 - 12" Black loamy sand, friable and loosely held in rounded clods. Roots numerous.

12 - 22" Grey-brown (10YR,5/2) sand, loose and structureless with numerous angular quartzite stones.

22"+ Yellowish-red (5YR,4/6) sandy loam, moderately compact with little or no structure. Many angular fragments of quartzite.

The Lubare soils are of no agricultural importance.

20. Rugaga Series

These soils could be regarded as a hill-crest member of the Bugamba Catena but since they are from the important agricultural areas in Isingiro they will be described as a separate series. The soils have developed on, though not necessarily from, the laterite remnants of the Ankole surface. They are characterized by their strong red colour and are of loam to clay loam in texture. Their depth is somewhat variable but generally in excess of three feet and occasionally very much deeper. Towards the eroding edge of the flattish crests, laterite may be exposed and locally give rise to a shallow rocky type of this series. Profile 30 is typical of an average depth soil.

Profile 30 (20957-68)

Three miles east of Rugaga; level ridge crest. Altitude 5,200 ft. Rainfall 25 to 30 in. p.a., under Imperata cylindrica, Beckeropsis uniseta, Chloris gayana and Melinis minutiflora.

0 - 8" Dark reddish-brown (5YR,3/4) sandy-clay loam. Friable with a moderately firm subangular blocky structure. Many roots.

8 - 18" Reddish-brown (5YR,4/3) sandy-clay loam, sub-angular blocky structure.

18 - 30" Reddish-brown (2.5YR,4/4) sandy clay loam with a weak sub-angular blocky structure but more compact than horizon above. Occasional laterite fragments.

30 - 42" Reddish-brown (2.5YR,4/4) sandy-clay loam similar to above.

42"+ Disintegrating laterite.

The origin of these soils is not easy to account for; if they were residual and as old or older than the laterite it would demand of

them a degree of stability and resistance to erosion which they most certainly do not possess at the present time. To what extent they are derived from break-down products of the laterite cannot be stated since little is known about the weatherability of laterites and their ability to yield soil material. Most certainly there is evidence of mechanical disintegration of the laterite in the shallower phases but the soils are usually thin gravelly humose loams with very little red clay produced during the present stage of formation.

The analyses of profile 30 show these soils to be reasonably rich in exchangeable bases and far more so than would be expected from an extremely old residual soil. These conditions are similar to those noted in ridge-top soils in the Kibale forest, Toro (see Kiamara soils) where samples taken across hill features showed in every case an increase of bases towards the crests. They differed from the Rugaga soils in their high available phosphorus figures. The area of these soils is much favoured for cultivation and especially for arabica coffee which yields well in spite of a low rainfall of less than 30 inches per annum.

21. Isingiro Catena

With the exception of the Rugaga Series, soils of the Isingiro unit occupy all the hills of that name in the south-east corner of Ankole district. These hills are composed, for the most part, of sandstones metamorphosed to varying extents to hard crystalline quartzites. On the mid and upper slopes the soils are shallow, consisting of a few inches of dark humose sandy loam resting directly on quartzite or sandstone rubble.

Profile 31 (20972-74)

Below the summit of a small knoll, 10° slope. Altitude 5,300 ft. Rainfall 25 to 30 in. p.a., under Themeda triandra with Cymbopogon excavatus, becoming more abundant after cultivation. Loudetia kagerensis dominant on shallowest soils.

0 - 8" Black humose friable loam, containing occasional angular quartz and laterite fragments. Crumb structured. Roots numerous penetrating well into the rubble below.

8 - 28" Mainly laterite rubble and quartz gravel with a dark brown clay loam matrix. Structureless and moderately compact.

28"+ More compact laterite and quartz gravel, no rock seen in situ.

On gentler slopes and in depressions a reddish-brown sandy loam may be present between the dark surface soil and the weathering rock and in these areas termite mounds become more conspicuous. Fertility is generally extremely low, which, together with a low rainfall (less than 30 inches), militates against any extensive cultivation and at best the areas offer only poor grazing.

An area of similar soils occurs in south-west Masaka district also on sandstones and quartzites. As with Isingiro the grassland is sparse, chiefly Themeda triandra and Loudetia kagerensis with occasional Protea madiensis and Gardenia spp. which indicate the impoverished and acid condition of the soils.

The pediments below these hills carry deep red sandy loams, the largest area occupying the eastern half of the Orichinga valley. Here again, owing to the low rainfall and poor moisture capacity of the soils, cultivation is not encouraged. Below the ridge at Murema, however, a small patch of these red soils is intensively cultivated but the site is unique for Isingiro, since here is probably the only permanent spring issuing from the sandstones.

The Bigasha river which drains the greater part of the Isingiro hills is dry for most of the year; its valley is filled with grey alluvial sand and sandy loams.

Possibly owing to their high organic-matter content the soils do seem to contain an unusually high amount of exchangeable bases. The high figures for available phosphorus may arise from a similar source. At Kasumba Gombolola headquarters there is a deeper phase of the series exemplified by profile 32.

Profile 32 (20969-71)

Site characteristics the same as profile 31.

0 - 9" Black (10YR,2/1) sandy loam, weak crumb structure and very friable. Numerous roots.

9 - 18" Very dark brown (10YR,2/2) rubbly loam containing small laterite fragments. Structureless.

18 - 28" Laterite gravel becoming dominant. Structureless Dark brown (7.5YR,3/2) loam matrix.

The area is used mainly for grazing but in the deeper pockets as at Kashumba, plantains and coffee are grown intensively.

Soils Developed on the Buganda Surface and its Remnants

22. Kiamara Series

The deep red loams and clay loams of the Kiamara Series, owing to their fertility, favourable physical conditions and widespread distribution constitute perhaps the most important unit in the whole of the Province. In area they occupy almost a third of Toro district in one single expanse of country and overlie the schist-gneiss complex of the Toro system and its associated amphibolites. The topography is generally undulating, broken chiefly by the quartzite ridges which form a line of outcrops striking south-west/north-east through Nsenze, Butiti, Kyahara, Kikumiro to the Toro border. Numerous other outcrops with a similar strike occur in east Mwenge. Several hills in the Kibale forest area are flat crested and carry a laterite cap which is believed to represent parts of the upwarped Buganda surface. Most of the remnants are now eroded away but boulders and murram found in stonelines of slope soils are derived from the breakdown of the old laterite which formerly covered the peneplained surface. During an intensive survey of the grassland areas in the Kibale forest, carried out to study the soil and vegetation relationships between forest and grassland, several profiles of the typical Kiamara Catena were sampled and described. Transects taken across one of the flat-topped hills down to the swamp showed the following sequence. On the flat crest under tall grass species, Pennisetum purpureum etc., was a red clay loam which towards the edge of the summit became progressively more rubbly due to the proximity of the disintegrating laterite. The upper parts of the slope consist largely of laterite rubble but this gradually gives way downhill to shallow gravelly soils derived from quartzites which often underlie these laterite remnants. Further downslope the angle eases into the hill pediments, occupied by deep red clay or sandy-clay loams extending down to the swamp edge. The swamp soils in this area consist chiefly of coarse quartzose sand.

The texture of the pediment soils of the Kiamara Series is closely related to the underlying rock, especially in the upper parts of the slope, and it is also clear that considerable differences in chemical constitution of these soils arose from changes in parent rock. Profile 33 on the pediment below Nsenze hill (phyllite and schist) is typical of a heavy type.

Profile 33 (16437-42)

North side of Nyamusika hill, Kikali forest, lower pediment, 11° slope. Altitude 5,000 ft. Rainfall 50 to 55 in. p.a., under moist semi-dociduous forest.

0 - 6" Dark reddish-brown (2.5YR,3/4) clay loam. Firm granular to angular blocky structure. Many roots.

6 - 12" Dark red clay (2.5YR,3/6) small firm angular blocky held in large irregular clods.

12 - 24" As above.

24 - 38" Dark red clay (2.5YR,3/6) small angular blocky, larger clods less evident.

38 - 52" As above.

52 - 68" Dark reddish-brown clay (2.5YR,3/4) with occasionally darker streaks.

The unsaturated state of the clay is shown by the pH figures and typical of the forest soils acidity increases with depth. Calcium is perhaps unusually high since two other profiles sampled nearby were deficient in all but the surface 12 inches. Magnesium is low and potassium very deficient, both in keeping with the other profiles. As an illustration of a base-rich version of a similar catena, profile 34 on a pediment slope in Kibale forest is given below.

Profile 34 (16298-303)

Two miles north-east of Kyaninamirama hill, Kibale forest, mid-pediment slope, 8°, altitude 4,900 ft. Rainfall 50 to 55 in.p.a., under moist semi-deciduous forest.

0 - 1" Very dark grey (5YR,3/1) crumbly loam. Numerous roots.

1 - 6" Dark reddish-brown (5YR,3/2) loam, small sub-angular blocky structure.

6 - 14" Dark reddish-brown (5YR,3/3) sandy-clay loam, small sub-angular blocks held in larger, irregular-shaped clods.

14 - 26" Dark reddish-brown (2.5YR,3/4) sandy-clay loam, structure as above.

26 - 38" As above, blocks becoming more angular.

38 - 70" Dark reddish-brown (2.5Y R,3/4) clay loam, firm angular structure. Occasional fragments of quartz.

Bases in this profile are exceptionally high as also are associated soils on the same transect, and however much this may be due to parent rock, it is evident that leaf litter plays no small role. The highly humose surface layer (1 inch) reflects the amount of bases returned by leaf fall. The organic-carbon content of lower horizons shows the usual trend under forest falling off sharply at no great depth (14 inches) then maintaining a steady very low figure. Outside the forest under grassland the soils do not show the same sharp chemical zoning in their profiles and bases, which as well as carbon contents, fall off more gradually with depth and pH values are on the whole higher.

Near Fort Portal under a rainfall of approximately 60 inches these soils can be considered very fertile, especially, as the above example shows, when developed from the more basic members of the underlying rocks. To the east average rainfall figures fall off to 40 inches and species more tolerant of dry conditions become prevalent but the soils remain essentially the same.

Local variations arise from the presence of coarse-grained rocks containing quartz; granites, gneisses and quartzites rendering the soils stony, shallow or both. Pediments below the major quartzite ridges normally carry deep red loams and clay loams much in the way that they do in the areas of the Ibanda unit further south. In fact, soils of the Kiamara and Ibanda units have many features in common and on a larger scale would be grouped together. They are separated in this survey largely on account of the differences in climate and geomorphic origin.

There are many sites especially along road cuttings which demonstrate the tremendous depths attained by the Kiamara soils. It is not unusual to see sections in which 20 or 30 feet of red clay are exposed in which there is little change with depth until weathered rock is reached. Stone lines composed to angular quartz and sometimes laterite fragments may intervene, but the level of these is very irregular and varies considerably in depth over relatively short distances.

The occurrence of incipient dark horizons has been noted in several profiles along the main road from Fort Portal to Butiti and also in the profiles examined in the Kibale forest area (profile 33). These have proved on analysis to consist of a concentration of organic material in a narrow horizon at between depths of 4 to 6 feet. No explanation can be given as to the origin or significance of these layers but it should be remembered that they occur fairly close to an area where this feature is of very widespread occurrence and is probably related to rainfall, altitude and base status.

Near Kyangwali in Bunyoro there is an area of red clay loams which have been included with the Kiamara unit. Profile 35, sampled 1½ miles east of Kyangwali shows the similarity to the main Kiamara type.

Profile 35 (19095-99)

One mile east of Kyangwali, Bunyoro, mid slope. Altitude 3,700 ft. Rainfall 35 to 40 in.p.a., under moist semi-deciduous forest.

0 - 7" Dark brown (7.5YR,3/2) clay loam. Firm sub-angular blocky. Numerous roots.

7 - 14" Dark reddish-brown (2.5YR,3/4) clay loam. Firm sub-angular blocky. Occasional shrub roots.

14 - 40" Yellowish-red (5YR,4/6) clay loam. Small angular blocky structure loosely bound in larger clods.

This profile though quite acid in its subsoil shows an adequacy of all bases throughout. Available phosphorus as usual is very low.

Most of the cultivation in Toro is concentrated on this unit, together with the volcanic soils. In addition to a wide variety of food and cash crops, tea is grown extensively. Large areas in the north and eastern occurrences of the Kiamara Series are still not fully used and offer considerable scope for further development of tea cultivation.

23. Kitonya Catena

Soils of the Kitonya catena are developed on the pediment fans which are spread around the hills of central Bunyoro. These are composed mainly of sedimentary rocks of the Bunyoro and Masindi Series (pre-Cambrian) and are often capped by laterite remnants of the uplifted Buganda surface. Below Kitonya hill itself, as in many other sites, the soils on the pediments are dark red in colour (10R hue). This coloration appears to arise from the finely divided iron oxides present in the parent rock, probably haematite. Local concentrations of iron ores in the sediments have been used by the local inhabitants as a source of iron and fragments of partially smelted ore and laterite can be found scattered about the foothills.

Sheet laterite occurs in many parts of the lower pediment slopes especially where there is seepage from higher ground. Its presence is nearly always detected by the poor tree growth and change in grass community species. Where it is absent soil depth may be considerable and auger borings down to 10 feet have in places failed to reveal any significant change in texture or colour of the soil. On the shallow sites where ironstone occurs within less than 12 inches of the surface and soils are dull in colour and lighter in texture. Their moisture capacity is very low so that they become quickly saturated during the rains but dry out rapidly during the dry season.

Deep pediment soils below Kitonya hill are typical of the dark red members of this catena.

Profile 36 (19075-79)

Half-a-mile north of Kitonya hill, mid-pediment slope. Altitude 4,200 ft. Rainfall 50 to 55 in. p.a., under Panicum maximum and savanna woodland.

0 - 10" Dark reddish-brown (2.5YR,2/4) friable clay loam with small firm sub-angular blocky structure. Many roots.

10 - 22" Dusky red (10R,3/4) friable clay loam moderately firm sub-angular blocky structure. Occasional roots.

22 - 72" As above but weak sub-angular blocky, loose and friable when dry.

Profile 36, in common with many of the other pediment soils, shows a higher base content than expected, which is attributable to the high clay content. The soils near Jinja derived from amphibolite develop a similar colour and are base-rich by virtue of the parent rock composition. So far as could be deduced in the field, no amphibolite is involved in the formation of Kitonya soils, the colour arising from haematite in the phyllite but the source of the bases is not so clear (cf. Radwanski's (1960) Mabira Catena). Pediment soils are not consistently so dark red in colour as profile 36 but they do appear to be of moderate or high base status as, for example, below Rere and Fumbya hills. Soils sampled in these sites showed adequate amounts of bases. Available phosphorus, as would be expected, is very deficient in all soils since the fixation power is likely to be very high. The low plasticity of the subsoil for a clay content greater than 50 per cent suggests a high content of hydrated iron oxides which would fix most of the phosphorus.

Hill slope soils are shallow brashy and compact and usually strongly acid.

Profile 37 (19085-87)

North slope of Kitonya hill, 15° slope. Altitude 4,500 ft. Rainfall 50 to 55 in.p.a.,under Loudetia arundinacea and Combretum gueinzii.

0 - 5" Dark reddish-brown (2.5YR,3/4) friable loam, small crumb structure with occasional phyllite fragments.

5 - 10" Dark red (2.5YR,3/6) friable loam, compact, weak sub-angular blocky structure - more stony than above.

10 - 20" Almost entirely angular fragments of weathered phyllite with a dark red (2.5YR,3/6) clay loam matrix.

20"+ Transitional to parent rock in situ.

It would seem that some of the fine earth brought to the surface by termites is lost by erosion which in time would account for the excessive stoniness of these shallow soils. These shallow steep-slope profiles are all highly leached and contain very small amounts of exchangeable bases which accounts for their acidity. Their base poverty is reflected in the appearance amongst the shrubs of Protea madiensis, Gardenia spp. and Dissotis spp.

The deep members of this catena on the pediments are the most fertile soils of Bunyoro and are intensively cultivated, particularly in such areas as the Waki valley. Plantains and robusta coffee do particularly well.

Soils Developed on the African Surface and End-Tertiary Pediments

24. Mawogola Catena

This unit was first mapped in Masaka District and is fully described with its variants by Radwanski (1960). A large area of similar soils occurs in south Nyabushozi with smaller areas in other parts of Ankole. Its geomorphic history is similar to that of the Mbarara Catena since both are to some extent degraded remnants of the lower surface. With the exception of three small hills Duwoni, Ishura and Warukiri, all traces of the old laterite have been eroded away from the main area and the landscape is characterized by more or less conical-shaped hills usually capped by bare granite or granitic gneiss producing a tor effect. Rock outcrops are a characteristic feature of this catena and form a conspicuous crest to many of the hills. The occasional quartzite hill is recognizable by its smooth rounded outline but dominating the landscape are the granite and granitic gneiss inselbergs. The granites are usually coarse textured and show striking porphyritic development of the feldspars.

The derived soils, in common with other granite areas, contain large amounts of quartz grit and coarse sand. The lower and mid-slope members are red or reddish-brown gritty clay loams with occasionally mottled subsoils in the more mature profiles. Profile 38, sampled one mile west of Rwarurumba, is typical.

Profile 38 (20922-26)

One mile west of Rwarurumba; mid slope, 5°. Altitude 4,300 ft. Rainfall 35 to 40 in. p.a. A mosaic of communities dominated by Cymbopogon afronardus, Themeda triandra associated with Acacia gerrardii.

0 - 4"	Very dark brown (10YR,2/2) sandy loam. Moderately firm small sub-angular blocky structure. Occasional quartz stones and some fine quartz gravel.
4 - 8"	Dark brown (7.5YR,4/2) sandy loam occasionally stained with humus, sub-angular blocky structure.
8 - 18"	Reddish-brown gravelly loam (5YR,4/4) weak sub-angular blocky. Moderately compact.
18 - 30"	Yellowish-red (5YR,4/6) gritty clay loam, compact and structureless.
30 - 42"	Much the same as above with some traces of yellow and red mottling. Very compact.

The surface 8 inches are moderately well supplied with bases but the leached state of the profile is well shown in the lower horizons. The high potassium figures are to be expected from the weathering of orthoclase which is relatively abundant in the parent rock. Near the granite outcrops freshly weathered material is being added to the slope soils which are thereby enriched chemically. In addition to an extra base supply, run-off water from the rocks probably also increases the

ground water supply. Native cultivators are aware of the virtues of these sites and favour them when settling in a new area. Profile 39 is a good example of one of these shallow soils.

Profile 39 (20935-38)

One mile north-west of Rwarurumba, immediately below granite outcrop, 10° slope. Altitude 4,300 ft. Rainfall 35 to 40 in. p.a., under Acacia spp., Cymbopogon afronardus and Sehima nervosum.

0 - 4" Very dark grey(5YR,3/1) sandy loam, sub-angular blocky structure.

4 - 12" Dark reddish-brown (5YR,3/2) gritty loam, compact with a weak sub-angular blocky structure.

12 - 36" Dark brown (7.5YR,4/2) gritty loam, compact and almost structureless.

36"+ Dark brown (7.5YR,4/2) gritty loam, compact and structureless.

The analytical data show an increase in calcium compared with profile 38, but a slightly lower magnesium content.

Both profiles are chemically similar to those on granites in the neighbouring areas of Masaka and all show deficiencies of available phosphorus.

Apart from scattered cultivation, chiefly along the shores of Lake Kachira, the area covered by these soils is used only occasionally for grazing.

25. Bushenyi Series

Over a large part of north Igara county and south Buwhezu in Ankole District there are dark horizon latosols which, differing in some respects from those of the Mafuga unit, have been separated as the Bushenyi unit. The topography is undulating and consists of broad ridge tops which rise to a generally even level of about 5,200 ft. This probably represents the upwarped African surface (Combe, 1939) but carries virtually no laterite.

The soils of this unit are, on the whole, heavier in texture than either Mafuga or Buwhezu units and are derived from fine-grained schists and phyllites. In common with the other dark horizon latosols they display a two-layer arrangement in their profiles with only a few exceptions as around Birere where there is no texture break and the dark horizon occurs in an otherwise deep uniform profile. Usually there is a sharp texture break separating an upper, almost stoneless, layer sometimes as much as 6 feet thick from an underlying heavier, moderately stony layer. The greatest development of these profiles seems to occur on lower and mid-slopes but is by no means poorly represented on the broad flattish ridge crests.

Profile 40 (22621-24 & 22631)

Four miles south of Ishaka, mid slope, 4°. Altitude 5,100 ft. Rainfall 50 to 55 in. p.a., under mixed tree savanna with Pteridium aquilinum, Hyparrhenia cymbaria, occasionally Pennisetum purpureum.

0 - 14" Very dark brown (10YR,2/2) highly organic loam, very loose crumb to single-grain structure when dry. Numerous roots.

14 - 26" Reddish-brown (5YR,4/4) loam, weak sub-angular blocky structure.

/continued

26 - 42" Dark brown (7.5YR,3/2) loam, very weak sub-angular blocky structure.

42 - 62" Reddish-brown (5YR,4/4) loam, moderately firm angular to sub-angular blocky structure.

Sharp transition to:-

62"+ Yellowish-red (5YR,5/6) (compact stony) clay loam with slightly paler coloured mottling. Several sub-rounded quartz stones at the junction with the upper layer.

The depth of the upper solum is typical. Mottling in the stony clay loam suggests an incipient lateritization similar to that which occurs in the subsoils of the Mbarara unit.

In this profile the dark horizon occurs above the stone line marking the junction between the stoneless layer and stony clay loam below but this is not always the case. The depth of the stone line does not in itself appear to control the position of the dark horizon for in shallow soils it can be seen transgressing both the upper and lower layers and cutting across the stone line. Ruhe (1956) describing dark horizon latosols in the Belgian Congo comments on this fact and points out that it precludes a "buried soil" interpretation of the dark horizon.

The soils are very acid but no more so than soils of the Ntendule unit which occur under similar conditions of climate and on the same parent rock but very seldom display any organic horizons in their profiles. As a rule the presence of a dark horizon is associated with a very acid and highly humose topsoil which in the uncultivated state appears as a very dark brown, uncompacted almost peaty layer with a loose, floury consistency in the dry or near dry state. Cultivation tends to destroy it especially on steep slopes where it becomes mixed with mineral soil as the terraces are built up between the bunded strips.

Considering the acidity and generally low base status of these soils it is perhaps remarkable that coffee cultivation is so widespread. Tea, for which conditions are suitable, is being developed immediately east of the Kalinzu forest with successful results (see Chenery, 1960).

26. Buwekula Catena

Soils of this catena are widely distributed over the south eastern parts of Toro district covering most of Kyaka and Kibale counties. The catena extends into Masaka where it was first mapped and described in great detail by Radwanski and Ollier (1959). They are derived from coarse-grained granitic rocks which contain large quantities of quartz; the weathered residue from such rocks yielding a considerable amount of grit which frequently dominates all other mechanical fractions in the upper soil layers.

On the whole the soils are free from laterite and only occasionally do they contain concretionary material. Where fragments of laterite have been observed the source could always be traced to a nearby laterite-capped feature. Downwash of finer material from the weathering laterite increases the redness of the soils below. Soils developed directly from the granite under freely drained conditions fall into the 5YR hue, becoming locally paler or redder with changes of the ferro-magnesian content of the granite. Sudden increases of redness are usually due to the presence of amphibolite.

Owing to the hilly nature of the granite country there is considerable variation in soil conditions. Even in those areas where planation has simplified the topography it is still necessary to recognize a catenary sequence of soil types, and although such details could

not be shown by the present scale of mapping their presence must be understood for a correct interpretation of the soil map. In addition there are other local variations of colour and texture which do not come within the scope of the catena and, therefore, require separate description. The dominant type occurs on the broad, flattish tops of the interfluves and to some extent down the flanking slopes. Further downslope it gives way to a pale yellowish-brown or yellowish-grey soil of similar texture which extends to the fringe of the swamp. Soils in the swamp strip are usually highly organic, black at the surface and coarse grey sand below about 12 inches. Occasionally they become heavier with depth but it would seem that most of the fine material has been washed away leaving only the coarser parts of the sand fraction. Some of the finer material is accumulated in the papyrus swamps which now occupy the main river courses. In the hilly areas the sequence is extended upwards by shallow skeletal soils and rock outcrops. The range of the yellowish soils diminishes with the increase of slope, becoming negligible at slopes over 10°.

The Buwekula Catena is dominated by the excessively drained upslope member and as this also represents the most important cultivable soil it will be described a little more fully.

In a typical profile, such as No. 41, a mottled zone is usually present at a depth of between 3 and 4 feet which in turn is succeeded by weathered parent rock in situ.

Profile 41 (16506-09)

Half-a-mile south of Rwaitengya, Toro. Mid slope 12°. Altitude 4,200 ft. Rainfall 40 to 45 in. p.a., under Cymbopogon afronardus

0 - 9"	Dark grey-brown (10YR,4/2) slightly gritty loam, compact with weak sub-angular blocky structure. Many grass roots.
9 - 20"	Reddish-brown (5YR,5/4) sandy-clay loam. Much quartz grit. Massive with weak angular blocky structure.
20 - 34"	As above.
34 - 72"	Compact, gritty clay loam mottled red (2.5YR,4/8) and yellowish-red (5YR,5/6).
	Weathered parent rock at 8 ft.

Like many granite soils this profile is compact and gritty, deficient in all bases and very acid. The presence of the mottled layer does not appear to depend to any extent on the nature of the parent rock since it also appears in soils of the red loam group and is a true pedological formation (incipient laterite, gleying or differential weathering).

The background colour of reddish-brown is broken by blotches and streaks of grey and yellowish-grey, each of which is surrounded by red staining. This form is suggestive of periodic waterlogging, iron being mobilized at definite centres during times of water saturation and then being redeposited as it diffuses outwards. The deposition of hydrated Fe oxides in the form of tubes points to the localization of these centres along root channels where the necessary organic matter would be present for the activity of the iron-mobilizing bacteria. In addition, it is possible that water entering the soil via channels or cracks would cause a localization of water saturation and that iron diffused outwards in the ferrous state would be oxidized and precipitated in the drier parts of the soil. It is uncertain whether under the present climate, waterlogging of the subsoil occurs for the necessary length of time and the mottling may have been formed under an earlier, wetter climate.

In the uncultivated state the soils are colonized mainly by Cymbopogon afronardus and fire-resistant tree species and on some of the steeper slopes (owing to excessive run-off) it is doubtful if more than a fraction of the rainfall (40-45 inches per annum) is effective in wetting the subsoil layers.

The thickness of the mottled layer varies from one to several feet and its presence appears to be unaffected by topography as is shown by profiles 42 and 43.

Profile 42 (18818-22)

Two miles east of Kyegegwa, swamp fringe. Altitude 4,500 ft. Rainfall 40 to 45 in. p.a., under Cymbopogon afronardus.

0 - 7" Very dark grey-brown (10YR,3/2) coarse loamy sand, almost single grain; loose clods held together by numerous roots.

7 - 15" Dark grey-brown (10YR,4/2) sandy loam, some humus staining from above, single grain.

15 - 24" Dark brown (10YR,5/3) loamy sand, tongues of material from above, single grain.

40 - 50" Brown (10YR,5/3) loamy sand with some rusty brown mottling.

Profile 43 (18833-37)

Two miles east of Kyegegwa, ridge crest. Altitude 4,700 ft. Rainfall 40 to 45 in.p.a., under Cymbopogon afronardus.

0 - 6" Very dark grey-brown (10YR,3/2) coarse sandy loam, sub-angular blocky structure. Many roots.

6 - 15" Reddish-brown (5YR,4/4) coarse sandy loam, sub-angular blocky structure.

15 - 22" Yellowish-red (5YR,4/6) sandy loam, weak sub-angular blocky structure. Much small quartz grit.

22 - 34" As above with weaker structure, almost single grain.

34 - 50" Red (2.5YR,4/6) sandy loam with occasional yellowish-red mottling, single grain.

Immediately below it is the weathered parent rock, in situ with its original structure clearly discernible. White or yellowish pseudomorphs of kaolinized feldspars are embedded in a gritty mass stained by the weathering products of the ferro-magnesian minerals. The whole mass is completely without cohesion when excavated and crumbles to a gritty powder when dry.

Between Bwizi and Nkoma there is a small area of very pale soils developed on aplitic granite. The soils contain large amounts of white mica but due to the scarcity of ferro-magnesian minerals in the parent rock the subsoil colours are unusually pale. Along the same road, generally near village settlements, there is local reddening of soils due to the influence of amphibolite.

Cultivation where not confined to these red soil areas is generally scattered and, although some coffee is grown, cotton is widely grown and is the best quality produced in the country. Tobacco (fire-cured) is a popular cash crop.

27. Ibanda Series

Included in this series are all those soils which are red in colour and occur in lowland areas exposed by the later erosion cycle. They tend to occur, therefore, in gently undulating areas or near the base of many of the main hill masses. On a broader scale they would be grouped with the Kiamara unit of Toro but have been separated partly because of their geographical distribution, i.e., their tendency to occur in small isolated areas rather than in one major area as is the case in Toro district. Several types are recognized within the Ibanda unit but these have not been shown on the soil map and would only be indicated on a scale which allowed greater detail.

The majority of the soils are derived from rocks which contain a moderate proportion of ferro-magnesian minerals, i.e., dolerites, amphibolites and hornblendic granites, but they are also associated with, though not derived from, some of the larger quartzite outcrops, the best example being Ibanda hill itself.

Profile 44 (10322-26)

Half-a-mile east of Ibanda Rest House, mid pediment slope 5°. Altitude 5,000 ft. Rainfall 50 in. p.a., under Pennisetum purpureum.

0 - 6" Dark reddish-brown (5YR,3/3) granular loam. Abundant roots.

6 - 17 Dark reddish-brown (5YR,3/4) loam, granular to crumb structure.

17 - 36" Dark red (2.5YR,3/6) clay loam. Firm sub-angular blocky.

36 - 48" Dark red (2.5YR,3/6) clay loam. Becoming more angular blocky than above.

48 - 72" Dark red (2.5YR,3/6) clay loam. Small angular blocky.

The hill is composed of quartzite and it is on the pediments skirting it that the red soils are most strikingly developed. Other quartzite hills approximately two miles north-west of Ibanda show the same feature and since the quartzite alone could not produce these soils (considering their texture and fertility) it must be supposed that other metamorphic rocks, schists, amphibolites etc. associated with the quartzite are largely responsible. The association of deep red soils and quartzite outcrops is not confined to the Ibanda area, however, for similar circumstances can be quoted for many of the outcrops in Toro, for example in the Kibale forest area and the ridges at Kirahara and Kikumiro.

In the south-east corner of Kigezi considerable areas of a similar red soil occur on the pediments and in the erosion bays below the Kamwezi granite. It is known that this granite is more basic in composition than other granites of south-west Ankole (Combe, 1932), more accurately termed a granodiorite, and may therefore itself be responsible for the red soils.

Similar soils also derived from granite occur north of Rwashamaire and extend towards Ntungamo, but these granites are not known to be more basic than any others in the locality. Amphibolites do occur but they do not appear to be sufficiently widespread to account for the red soil distribution. As with other granite-derived soils, they tend to be gritty but usually less so than the Buwekula and Mawogola soils. The soils of Kamwezi are usually clay loams and sandy-clay loams containing only minor amounts of fine-quartz gravel.

The two areas around Kanungu and Nyakeshenyi are probably very mixed and in several places red soils can be seen to be developed on amphibolite, as for example profile 45.

Profile 45 (22536-39)

One mile north-west of Nyakashenyi, mid slope, 5°. Altitude 5,700 ft. Rainfall 55 to 60 in. p.a., under Pennisetum purpureum and Hyparrhenia cymbaria.

0 - 12" Reddish-brown (5YR,4/3) loam, granular to small sub-angular blocky structure. Many roots.

12 - 26" Dark red (2.5YR,3/6) clay loam. Firm sub-angular to angular blocky structure

26 - 60" Dark red (2.5YR,3/6) clay loam. Small angular blocky structure.

60"+ Outcrops nearby of amphibolite.

The areas of these soils are much favoured for cultivation owing to the generally high level of fertility. Arabica coffee cultivation is concentrated on them but,as in the Ibanda area,there is considerable room for expansion of this cash crop. Luxuriant stands of plantains are quite commonly seen.

28. Mbarara Catena

The catena occupies most of the arenas of Ankole and includes the low-level pediments surrounding phyllite hills which are dissected remnants of the Ankole surface. The topography is gently rolling, smooth in outline with rounded crests to hills and ridges. There does appear to be an approximate concordance of summit heights at about 4,700 feet with several remnants of the original upland block standing above this level. Slopes on the average are gentle, between 5 and 8°, depending to a large extent on the nature of the bedrock; on the fine-grained schists, slopes vary little,from 5 to 6°, merging gradually into clay swamp. Swamps are moderately wide and few of them possess any stream courses. They occur most extensively in the central areas of Nyabushozi. Excavations in these clay swamps for the construction of water tanks has revealed in a number of sites that the alluvial clay is relatively shallow and overlies weathered rock in situ. This suggests that they are not deeply drowned valleys but veneers of alluvium spread over aggraded valleys which have been widened by the normal process of slope retreat (see Bukora unit).

Excluding the valley swamps there is no marked catenary variation over the topographic units. Many of the soils are deep or very deep loams, usually sandy, and the uniformity of their upper horizons is often suggestive of drift material. They are derived mainly from fine-grained siliceous schists and various other metamorphic products of the Karagwe-Ankolean sediments. The schists appear to be dominant in east and central Ankole and the arenas are usually indicated on the geological maps as gneisses and granites. From the textures of the derived soils, however, it is evident that there is often more schist concealed than there is granite exposed and that in spite of granite and gneiss outcrops the majority of the soils arise from finer grained material most likely phyllites etc. altered by the granite intrusions and regional metamorphism effects. This would follow from the observed facts that floors of the arenas often approximate to the contact between the phyllites and the granite intrusions.

Remnants of ancient lateritized peneplains are almost completely absent but widespread contemporary lateritization appears to be taking place and is exposed in many sections close to the Mbarara-Lyantonde road. The laterite is not confined to flat features and may be found in almost any position on the slopes. It is only occasionally rock-hard, being usually moderately friable, sometimes soft and incoherent and in many

respects similar to laterite developing in end-Tertiary pediments elsewhere. It is least conspicuous in the mid-slope positions and, in fact, may be absent altogether or reduced to little more than incipient red and yellow mottling in the subsoil. The relationships between the laterite hardness and iron or aluminium content is not yet known for these soils.

A typical pediment soil below the higher hills of south Ankole was sampled in the Chezo valley.

Profile 46 (10363-68)

Four miles north of Birembo, Ankole, 6° pediment slope. Altitude 4,600 ft. Rainfall 35 in. p.a., under Themeda triandra.

0 - 6" Very dark brown (10YR,2/2) loam, small sub-angular blocky to granular structure. Numerous roots.

6 - 15" Very dark grey-brown (10YR,3/2) loam. Moderately firm sub-angular blocky structure.

15 - 25" Dark brown (7.5YR,4/4) loam.

25 - 48" Yellowish-red (5YR,4/6) loam, weak sub-angular blocky structure.

The tendency for soils in these pediment sites to possess a higher base status is well demonstrated in this profile. In this respect it resembles the Koki "brown" soil of Masaka (Radwanski, 1960).

29. Rukiri Complex

This mapping unit has been introduced to cover those areas which have been affected by post-Rift Valley erosion but which differ in some respects from the Bugangari soils, chiefly in that they show greater profile development and are usually deeper. They probably represent an intermediate stage in development between the immature Bugangari soils and soils on the relatively stable landscapes away from the Rift Valley.

There is considerable variation of soil conditions within the unit and no single profile could be described as typical; individual soils vary according to the nature of the parent rock, usually schists and granites. The topography is nearly always hilly so that the frequently repeated catenary sequence gives considerable complexity to the soil pattern. On the hills, especially those of quartzite and granite, the soils do attain greater depth on the gentle footslopes. The granite soils are often reddish in colour below and well leached.

Profile 47 (10385-88)

One mile north of Rukiri, Buwhezu, hill slope 20°. Altitude 5,000 ft. Rainfall 45 to 50 in.p.a., under Cymbopogon afronardus.

0 - 7" Brown sandy loam (7.5YR,4/2) weakly granular, numerous roots.

7 - 19" Reddish-brown (5YR,4/3) sandy loam, much quartz grit. Weak blocky structure.

19 - 36" Yellowish-red (5YR,4/6) sandy-clay loam with more quartz grit than above. Almost structureless.

36 - 120" Yellowish-red (5YR,4/6) very gritty clay loam. Massive and without structure, occasional fissures.

These soils are genetically related to other granite soils e.g. Buwekula. Profile 47 is well leached, bases are low and horizons are increasingly very acid with depth.

In Bunyoro a broad tract of soils running parallel to the main Rift Valley developed on various members of the Basement Complex and formerly mapped as Bubutu (Eastern Province) are now grouped with the Rukiri unit with which they have more features in common. Like the Rukiri soils to the south in Kigezi these soils here are formed on the degraded remnants of the African Surface where erosion has been rejuvenated by the latest Rift movements. The soils are, on the whole, free from laterite though locally some cementation occurs in the subsoil and ironstone in situ can be seen at several places along the escarpment, notably at Biso 3,400 ft. and Baker's view 3,800 ft. and towards Biseruka. Most of these are laterite residuals from the African surface. Another block of similar soils occurs along the north bank of the Kafu immediately south of Hoima which merges eastwards into the Buruli unit above the Kafu terrace. The soils are usually moderately deep, reddish-brown loams or clay loams, their grit content being very variable and depending on the parent rock, reaching a maximum on the coarse granites and quartzites.

In the Budongo forest a catena of soils developed on gneiss with various amounts of amphibolite and quartzite possesses affinities with both Rukiri and Buruli soils. The characteristics of the former predominate but the patches of laterite and murram that do occur are regarded as relics of the African surface and not products of contemporary processes. At the base of Kasenene hill, for example, blocks of laterite mark the position of old laterite sheet but there are no signs where this has been eroded away, that it is forming again. Small patches of disintegrated laterite, therefore, occupy many of the ridge crests but where this has been removed the soil will be shallow over weathered rock in situ as in profile 48.

Profile 48 (19135-39)

One-and-a-half miles north-east of Busingiro, near crest of ridge. Altitude 3,600 ft. Rainfall 65 to 70 in. p.a., under moist semi-deciduous forest.

0 - 2" Very dark brown (10YR,2/2) loose crumbly loam with numerous roots.

2 - 11" Dark reddish-grey (5YR,4/2) gritty loam. Moderately compact with weak sub-angular blocky structure. Several roots.

11 - 23" Yellowish-red (5YR,4/6) compact gritty clay loam, structureless.

23 - 32" As above with much weathered schist.

32 - 46" Mainly weathered schist in situ.

Typical of forest soils the organic matter shows a marked tendency to accumulate in the surface horizon accompanied by a similar trend in the exchangeable bases producing a near neutral humus. Below the ridges the slopes, of the order of 5 to 8°, carry deep loams such as profile 49.

Profile 49 (19130-34)

Three miles north-east of Busingiro, mid slope 5°. Altitude 3,600 ft. Rainfall 65 to 70 in. p.a., under moist semi-deciduous forest.

0 - 11" Dark brown (7.5YR,3/2) friable loam, weak sub-angular blocky structure with many roots.

11 - 20" Reddish-brown (5YR,4/4) friable loam with humus staining from above. Weak sub-angular blocky structure.

/continued

20 - 28" Yellowish-red (5YR,4/6) compact sandy-clay loam, almost structureless.

28 - 40" As above with very slight pale grey-brown mottling.

40 - 58" As above with slightly more mottling.

Apart from the surface soil this profile is strongly acid and deficient in all bases as well as available phosphorus. A profile sampled less than a mile north-east of No. 49 in a grassland area fringing the forest showed itself to be less acid and more uniformly supplied with calcium and magnesium throughout the profile. Potassium was deficient in all but the surface horizon. In the upper parts of this soil there are occasional stones and boulders of old laterite but at about the two-foot level and below, small rusty flecks and soft concretionary bodies are beginning to appear suggesting that horizons of pisolithic murram may develop once the forest cover is removed.

In the area bordering the Kafu river the soils are relatively shallow and are developed directly on Basement Complex granites and gneisses. Profile 50 is typical of these shallow soils.

Profile 50 (19069-71)

Two miles east of Luhunga hill, mid-slope. Altitude 3,600 ft. Rainfall 45 to 50 in. p.a. Moist, semi-deciduous forest.

0 - 6" Very dark grey-brown friable loam, granular to sub-angular blocky structure. Numerous roots.

6 - 13" Dark brown (7.5YR,4/4) gritty clay loam with a weak sub-angular blocky structure. Occasional quartz fragment.

13 - 21 Dark brown (7.5YR,4/4) clay loam, weak blocky structure. Much angular quartz.

21" + Mainly weathered granite in situ.

The chemical characteristics are normal for soils under forest; moderate base content in the surface horizon falling off sharply below and an accompanying sudden rise in acidity.

Apart from the usual scattered subsistence farming, coffee cultivation is fairly widespread and tea is being introduced at Kayonza with a view to developing an outgrowers' scheme.

30. Bugangari Series

These soils are associated with rejuvenated landscapes in areas affected by Rift Valley faulting. They do not occur exclusively along the fault itself but extend considerable distances beyond in the drainage basins of those rivers which were reversed by the upwarping of the land towards the Rift. Their distribution follows those areas from which all or nearly all the weathered detritus that had accumulated prior to the faulting has been removed by post-Rift Valley geological erosion. The soils, therefore, are of relatively recent origin and are in many cases almost skeletal, their depth depending to a large extent on the present vegetation and land-use. In areas of strong relief especially on the escarpment itself the soils may consist of little more than a stone mantle (quartzite) which is the residue left after constant sheet erosion of finer material unprotected after the grass has been burnt off. A small amount of black loam will be held between the stones but is able to support only a very scant grass cover consisting of poor drought-resisting species. Profile 51 may be regarded as typical.

Profile 51 (19121-23)

Four miles south-east of Butiaba, shelving feature on escarpment, 15° slope. Altitude 3,100 ft. Rainfall 35 to 40 in. p.a. Dry tree savanna, Hyparrhenia filipendula and Acacia spp.

0 - 10" Very dark brown (10YR,3/2) friable humose loam. Small crumb structure. Much angular quartz, numerous roots.

10 - 20" Reddish-brown (5YR,4/3) very stony clay loam with little or no structure. Stones mainly quartz and angular schist fragments.

20"+ Brown (7.5YR,5/4) weathered schist more or less in situ. Very few roots.

On the gently rolling topography the soil is protected to some extent but profiles are still shallow, such as No. 52.

Profile 52 (16494-98)

One mile east of Dura station, Toro, mid-slope 15°. Altitude 3,800 ft. Rainfall 35 to 40 in. p.a. Under dry tree savanna with Themeda triandra, Hyparrhenia filipendula, Cymbopogon afronardus.

0 - 9" Black (10YR,2/1) sandy loam, friable with a crumb structure. Several angular quartz fragments.

9 - 16" Dark grey-brown (10YR,4/2) sandy loam. Much humus staining from above. Abundant small angular quartz. Structureless.

16 - 28" Reddish-brown (5YR,4/4) sandy loam, humus stained, containing less angular quartz than above. Compact and structureless.

28 - 40" Reddish-brown (5YR,5/4) sandy loam. Moderately friable but structureless. Much weathered schist.

40" + Mainly weathered schist and gneiss in situ.

Being shallow sedentary soil the exchangeable-base content will reflect closely the composition of the original rock. Calcium and magnesium are high in No. 52 owing to the local presence of amphibolites, whereas potassium is very deficient. The schist under No. 51, on the other hand, contains more potassium-yielding minerals but is lower in magnesium. Local variation of this nature will affect the Bugangari soils probably more than any other unit.

The underlying rock which is seldom deeper than 3 ft. is slightly weathered but tends to show little gradation in weathering where it can be seen in deep sections. This suggests that it may have been in this state even when it was buried under the accumulated regolith before the rift faulting took place. Only in recent deeply cut gorges can any relatively fresh rock be found. The slightly pre-weathered state of the schists and gneisses associated with country close to the Rift has probably greatly facilitated the rejuvenation of the landscape. In sites further from the Rift Valley the influence of this rejuvenation has been less effective and the soils are deeper and more mature in appearance. They still possess the dark-coloured topsoil but show some reddish-brown or red clay loam below. Eventually they merge into the deep, red clay loams of the Ibanda unit. The junction between these two, therefore, approximates to the limit reached by the post-Rift Valley erosion.

In north Kigezi and adjacent parts of Ankole two zones within this soil unit can be clearly recognized as being related to the vegetation communities. In the drier areas furthest from the Rift Valley is short-grass savanna dominated by Themeda triandra, some Acacia spp.,

Euphorbia candelabrum etc. Close to the Rift there is a conspicuous change in the grass species to Pennisetum purpureum and an associated luxuriance of shrubby species.

Detached from the main soil areas are smaller isolated patches of similar soils on granite and quartzite hills. The black gravelly loams on the granites near Lwentobo, for example, resemble the shallower and skeletal types on the Rift scarp as also do the soils on hills and ridges in western Ankole away from the Rukiga highlands.

As would be expected with relatively young soils, there is a greater content of weatherable minerals but little capacity for the retention of released plant nutrients. The fertility of these soils, therefore, is likely to fall off rapidly with the destruction of the humic topsoil. To what extent the dark coloration denotes high humus content is not known for much of it may be elemental carbon accumulated after grass and bush firing.

Several of the Bugangari soils along the Rift Valley near Fort Portal show high phosphorus contents suggesting that the dark coloration could also arise from volcanic ash contamination.

Cultivation is mainly confined to the elephant grass areas near the escarpment, with grazing on the areas where Themeda triandra is dominant. Sorghum grown in the resettlement plots at Bigodi, however, yielded well, indicating the potential productivity of these soils with favourable rains.

31. Nyabushozi Catena

The geomorphology of Nyabushozi and adjacent areas is dominated by the denuded remnants of an old peneplain which extended over the greater part of east Ankole. The laterite formed during this peneplanation now remains on the flat crests conspicuous on many of the hills in central Nyabushozi. The reason why these flat crests do not persist in the landscape further west is probably due to the relative antiquity of the lateritization on this surface.

The unit is primarily distinguished on account of these laterite remnants which, while exerting no profound influence on the soils generally, do introduce a new member into the catenary sequence, compared with the Mbarara Catena. The Nyabushozi Catena is more or less concentrated on the watershed between the Katonga and Ruizi drainage systems and here, rather contrary to expectation, the clay swamps attain their maximum width. North and south, away from the watershed, the flat-topped features give way to hills rounded in outline and many of more or less conical shape, surmounted by granite or gneiss inselbergs or large blocks of fresh rock. These are all lower than the old peneplain level and possibly represent the exposed parts of the basal weathering surface (Ollier, 1959).

Three small isolated flat-crested hills in south Nyabushozi continue this unit into Isingiro where it reappears in the south-west corner of Ankole. Here the hill summits stand at approximately 4,300 ft. and it is assumed that these represent the same surface downwarped by approximately 300 ft. Other evidence described in the section on geomorphology tends to support this hypothesis. The general topography of this downwarped area closely resembles that of central Nyabushozi and the soils are, therefore, grouped in the same unit.

On the hill crests, soils are usually shallow humose loams and overlie laterite rubble. The summits are seldom sufficiently extensive to preserve deeper soils but occasionally patches of red clay loam persist over the laterite, reminiscent of the soils on the remnants of the Ankole surface in Isingiro. The dark humose loams are, however, more typical and one is described overleaf.

Profile 53 (20911-14)

Four miles north of Kitabo dam; hill crest. Altitude 4,650 ft. Rainfall 35 to 40 in. p.a., under Themeda triandra, Loudetia kagerensis, Ctenium concinnum.

0 - 6" Very dark brown (10YR,2/2) friable sandy loam. Weak crumb structure. Many grass roots.

6 - 14" Dark brown (10YR,3/3) friable sandy loam, weak sub-angular blocky structure. Fewer roots.

14 - 28" Dark brown (7.5YR,4/2) loam, much as above with occasional small fragments of laterite, almost structureless.

28 - 40" Dark brown (7.5YR,4/4) sandy-clay loam with abundant fragments of disintegrating laterite.

Organic carbon figures show a high humus content in the surface soil and moderate amounts below for which reason the bases are much higher than average for other members of the same catena. This tendency for hill-crest soils to be richer in bases and phosphorus has been noted in many sites and no satisfactory explanation can be given that might apply generally, although it seems to be associated with dark humose soils that dry out excessively for greater parts of the year.

Hill slopes are, on the whole, straight and inclined at angles between 6 and 8 degrees with virtually no pediment break in the lower parts. Soils on the slopes are very similar to those of the Mbarara Catena but sometimes appear redder in colour, due to the addition of lateritic material from the hill crests. Average slope soils are reddish-brown loams or sandy-clay loams, often of considerable depth and usually low in exchangeable bases and other plant nutrients. Profile 54 is a typical mid-slope soil.

Profile 54 (20906-10)

Half-a-mile west of Kitabo dam, mid-slope. Altitude 4,500 ft. Rainfall 35 to 40 in. p.a., under Themeda triandra and Cymbopogon afronardus.

0 - 3" Dark brown (10YR,3/3) loamy sand, almost structureless with many grass roots.

3 - 9" Dark brown (10YR,4/3) sandy loam, weak sub-angular blocky structure.

9 - 18" Dark brown (7.5YR,4/4) loam. Compact with weak sub-angular blocky structure.

18 - 34" Strong brown (7.5YR,5/6) loam, compact almost structureless.

34 - 64" As above, very weak blocky structure.

This soil is deficient in all bases, very low in phosphorus and organic matter.

A profile sampled close to the Mizi dam demonstrates the improved base status of the lower-slope soils but even this is marginal and on the deficient side of the accepted minimal requirements. There may be a slight groundwater effect in these lower sites which would account for the increase in bases with depth and the presence of small amounts of sodium in the lowest horizons.

Profile 55 (20938-45)

Mizi dam 4 miles north-east of Sanga, lower slope. Altitude 4,200 ft. Rainfall 35 to 40 in. p.a., under Themeda triandra and Cymbopogon afronardus.

0 - 8" Dark brown (7.5YR,3/4) moderately friable loam. Sub-angular blocky structure. Many grass roots.

8 - 20" Dark brown (7.5YR,4/4) loam. Weak sub-angular blocky structure.

20 - 56" Brown (7.5YR,5/4) loam. Compact with weak blocky structure.

56 - 68" Yellowish-red (5YR,4/8) sandy-clay loam. Some pale yellow mottling and incipient laterite.

68" + Weathered parent rock - many cavities. Whole mass slightly cemented.

Little of the Nyabushozi unit is cultivated, the area being chiefly devoted to grazing. Some development has been initiated by the opening of the Kiruhura-Nakaiita road and several minor roads but settlement is scattered. Little, if any, cash crops are grown.

32. Kazo Series

The main topographic features of the area covered by this unit are smooth, rounded hills with moderately steep slopes, and narrow almost swampless valleys. Slopes are of the order of 10° and tend to be more convex in outline than those in the Nyabushozi and Mbarara Catenas. Pediments are short and constitute only a small part of the total soil area. Conditions on the whole are very poor owing to the loss of topsoil by erosion which in many sites has proceeded to the extent that the surface 12 to 18 inches may consist of little more than quartz gravel. Erosion intensified by steeper slopes has most likely been encouraged by over-grazing and/or over-burning the sparse vegetative cover. The relative abundance of quartzites in the underlying rock would in any case yield stony soils and thicker stone lines. Several of the highest hills including Nyabushozi itself (4,785 ft.) which rise above the level of the old peneplain surface are composed of quartzite which accounts for their rounded outline and thin soil cover. No single profile could be regarded as typical of this series since the unit is intended to convey a preponderance of shallow stony soils over all others, as well as a stronger surface relief differing from the Nyabushozi and Mbarara Catenas. The pediment soils are similar to those of the latter where most of the cultivation is concentrated.

Included with this unit are shallow skeletal soils on quartzite ridges in central Toro and the predominantly rocky parts of Kyaka county. Fertility appears to be very similar to the Mubende unit (Radwanski, 1960) in Buganda. The soils are of little agricultural value being used occasionally for grazing and any cultivation is confined to small valleys and pediments.

33. Hoima Catena

Soils of this unit which cover a large part of south-west Bunyoro are developed on the sedimentary beds of the Bunyoro Geological Series mainly represented by tillites and phyllites with subsidiary amounts of sandstones and conglomerates as basal members. Throughout the area the topography appears as a succession of broad, flat-topped low ridges conforming in height to altitudes between 3,600 and 3,700 ft., most probably part of the dissected African surface.

It would seem that either the parent rock weathers or disintegrates slowly for so little subsoil to accumulate on the hill crests.

Erosion, too, might have been responsible for the paucity of the soil cover on the uplands and it is perhaps significant in this connection that in the forested areas where there has been better soil protection for a considerable period of time soil depths are on average much greater.

Soil conditions vary according to position on this topographic sequence. On the ridge crests which form the greater part of the land surface they are dark coloured, shallow and stony, the following profile being fairly typical:-

Profile 56 (19067-68)

Two miles west of Hoima, flat ridge crest. Altitude 3,600 ft. Rainfall 55 to 60 in. p.a., under Cymbopogon afronardus.

0 - 8" Very dark grey-brown loam (10YR,3/2) moderately firm sub-angular blocky structure. Many grass roots.

8 - 20" Strong brown (7.5YR,5/6) clay loam. Firm blocky structure. Many tillite and quartz stones. Channels and cracks filled with topsoil.

20"+ Mainly shattered tillite more or less in situ.

The soils are usually very acid, poor in bases and available phosphorus and with lower amounts of organic material than their dark colour would suggest.

Apart from the infilled cracks the transition from topsoil to weathered parent rock is usually sharp. Sometimes the rock rubble is packed into a clay loam matrix and locally cemented, giving rise to small patches of moderately hard ironstone, though nowhere does it seem to become as hard as the older surface laterite sheets. Murram pellets and rounded blocks of hard ironstone frequently occur but these are most likely derived from the breakdown of relic laterite eroded from the higher hills in central Bunyoro. On the valley slopes there are deeper accumulations of soil material giving rise to reddish-brown clay loams as for example profile 57.

Profile 57 (18044-49)

One mile north of Naitondo hill, near crest of a ridge. Altitude 3,500 ft. Rainfall 45 in. p.a., under Hyparrhenia rufa, H. variabilis, Panicum maximum, Combretum guienzii and Terminalia glaucescens.

0 - 8" Dark brown (7.5YR,3/2) loam. Firm sub-angular blocky structure. Numerous roots.

8 - 17" Red-brown (5YR,4/3) clay loam. Sub-angular blocky structure. Occasional small, rounded rock fragments (tillite).

17 - 32" Yellowish-red (5YR,4/6) clay loam. Moderately firm blocky structure. Occasional tillite fragments.

32 - 46" As above with weaker structure.

46 - 68" Yellowish-red (5YR,5/8) clay loam mainly weathered tillite.

68" + Weathered tillite in situ.

The base status of these deeper soils appears to be generally superior to the shallow upland phase. In three profiles sampled there was seldom a deficiency of calcium, although magnesium and potassium were rather variable. Soil reaction throughout was very acid which appears to be a fairly constant feature of these phyllite soils even when bases are present in adequate amounts.

The rock is itself the product of at least one previous weathering cycle and, with the exception of coarser fragments included in the tillites, is unlikely to contain more than very small amounts of weatherable material.

Also to the west of Masindi, soils of the Hoima Catena are, on the whole, of better physical conditions, and more fertile which may in part be due to management and the fact that they have been reclaimed from forest within comparatively recent times.

Crop growth is poor on the shallow acid members of this catena and intensive cultivation is confined mainly to the deeper soils on the valley slopes.

34. Kigumba Series

This unit could be correctly regarded as a variant of the Buruli but since it displays on average a greater soil depth and is of higher fertility it has been mapped separately; it also carries more luxuriant vegetation. The soils are developed on a part of the African surface which in Bunyoro cuts across granites and gneisses and metamorphosed sediments of the Masindi Series (believed to be Karagwe-Ankolean in age). The surface around Kigumba stands at about 3,800 ft. and the topography appears as broad flat-topped or very slightly convex ridges separated by wide swamp tracts. As with the Buruli soils, laterite is developed on the ridges outcropping either as eroded pavements or along the edges as steps. Where it lies deep, fresh exposures reveal it as a compact mottled mass with little cementation and only where it outcrops does it become hardened into massive lateritic ironstone. Sheets of pediment ironstone may occur on the slopes flanking the ridges as in the Kitonya Catena which are sometimes exposed as rock-hard ironstone pavements.

Typical soils are reddish-brown loams to clay loams of about two to three feet in depth before concretionary material is reached. A profile sampled at Kigumba farm revealed the sequence through the upper soil layers well into the laterite.

Profile 58 (19149-55)

Immediately north of Kigumba farm buildings, near crest of broad ridge. Altitude 3,800 ft. Rainfall 45 in. p.a., under Panicum maximum, Hyparrhenia rufa with Acacia polyacantha and Albizia zygia.

0 - 5" Dark reddish-brown (5YR,3/2) loam, sub-angular blocky structure. Numerous roots.

5 - 18" Dark reddish-brown (5YR,3/4) sandy-clay loam. Weak sub-angular blocky structure.

18 - 33" Dark red sandy-clay loam (2.5YR,3/4), weak sub-angular blocky structure.

33 - 48" Dark red sandy-clay loam (2.5YR,3/6), weak structure.

48 - 60" Dark red rubbly, sandy-clay loam (2.5YR,3/6), friable and structureless, containing numerous fragments of disintegrating laterite.

60 - 72" As above, laterite fragments more numerous and irregular in outline.

72 - 120" Laterite in situ. Fabric continuous with many cavities and channels. Mottled strong brown (7.5YR,5/6) with dark red (2.5YR,3/6) staining and dark red clay filling some of the cavities.

This profile was unusually deep with only colour and slight structural changes in the surface four feet. The occurrence of a rubble layer interposed between the laterite and the upper soil suggest that the laterite is breaking up at its surface. The sharp transition between the rubble and the loam could be maintained by termite activity. Below the rubble merges from rounded fragments to disintegrating laterite. The upper parts of the laterite show some fragmentation but after the first few inches it is a fairly uniform, vesicular mass riddled with small channels, some of which are lined or filled with red clay, washed down from above. The fabric of the laterite consists of a mixture of angular quartz and kaolin variously impregnated with iron oxides so that the whole appears as a pale-coloured yellowish-red and whitish-yellow mottle. Sometimes there is a slight suggestion of pale margins to the channels which might signify loss of iron from these areas at a time when there was subsoil waterlogging. Blocks of this laterite showed only slight tendency to harden on exposure to the atmosphere. In the freshly exposed profile it was completely dry and, although not particularly easy to dig out, blocks could be broken up by hand. The "murram" horizon is not concretionary but consists of small fragments of laterite variously rounded by weathering. If these are broken the fabric of the laterite can be seen and there is no concentric pattern typical of concretionary bodies. Little, if any, secondary deposition of iron on the "murram" appears to be taking place.

Chemically it differs little from the average Buruli soil. The pH values are fairly steady around 5.0, bases are low, deficient in magnesium and the amounts all fall off with depth. From the appearance of the laterite fabric the soil is derived from granite which being deeply weathered probably contains few weatherable minerals. Similar soils developed on granite occur around Kijunjubwa where the ridge soils show greater depth than the average Buruli soil in Bunyoro.

Profile 59 (19058-63)

One mile south of Kijunjubwa. Altitude 3,600 ft. Rainfall 45 to 50 in. p.a., under savanna woodland.

0 - 7" Dark reddish-brown (5YR,3/3) loam, friable, sub-angular blocky structure.

7 - 15" Yellowish-red (5YR,4/6) loam, friable, weak sub-angular blocky structure.

15 - 24" Red (2.5YR,4/6) loam, friable.

24 - 34" Red (2,5YR,5/6) loam, friable

34 - 60" Red (2.5YR,5/8) sandy-clay loam, friable.

This profile is very comparable with No. 58 with regard to the uniformity of the soil above the laterite but is poorer in bases. As with the Kigumba soil, there was a rubble transition to the laterite in the Kijunjubwa profile.

Towards Atura the African surface cuts across pre-Cambrian metamorphosed sediments and the Kigumba soils become shallower and appear to be less lateritized. Several isolated hills in the area believed to be fault blocks of the same pre-Cambrian rocks give rise to soils of the Kitonya catena on their pediments. On the plain between the pediments the soils show some affinities with this catena. Profile 60 is an example.

Profile 60 (18931-35)

Five miles south-west of Atura, crest of a broad ridge, altitude 3,600 ft. Rainfall 45 to 50 in. p.a., under tree savanna of mixed Acacia and Albizia spp. with Panicum maximum, Hyparrhenia rufa and Chloris gayana.

/continued

0 - 6" Dark reddish-brown (5YR,3/2) loam. Friable with good crumb structure. Numerous roots.

6 - 16" Dark reddish-brown (5YR,3/4) moderately compact loam. Firm sub-angular structure.

16 - 32" Reddish-brown (5YR,4/4) clay loam with sub-angular structure, weaker than above.

32 - 38" Reddish-brown (2.5YR,4/4) structureless and containing a few concretions and cemented fragments of phyllite.

38" + Mainly weathered phyllite in situ with a few cavities and showing slight cementation locally.

In nearby sites the weathered rock was riddled with small channels and cavities lined and strengthened by secondary deposits of iron, the whole having the appearance of vesicular laterite. The near-neutral reaction of this soil and its high base status, especially potassium, indicates its relationship with the pediment soils mentioned above (Kitonya). The high available phosphorus figures in the surface horizons are unusual since these soils are usually deficient in this element.

With the introduction of the resettlement scheme near Kigumba, cultivation on these soils has been increased considerably. Apart from food crops, maize, bananas, etc. the chief cash crop is cotton with much smaller amounts of robusta coffee.

35. Buruli Catena

This unit occurs very extensively in the adjoining parts of Acholi and Mengo and also Teso district (Ollier and Harrop, 1959; Langdale-Brown, 1957). In the Western Province it occurs only in Bunyoro, to the east of the main watershed where the pediments from the central uplands merge into the Mengo plain. The plain has a low relief and is part of the African surface, here represented by low, broad-crested ridges sloping gradually down to wide aggraded, swamp-filled valleys. The swamps are mapped separately (Bukora unit) and consist mainly of clays with often a thin overlay of sand. The remainder of the catena comprises swamp margins, slope soils and ridge-top soils, the last predominating and characterizing the catena. Over the greater part of the area the soils are shallow brown or reddish-brown loams over laterite rubble.

Profile 61 (19144-46)

Mile 18 from Masindi to Kampala, crest of ridge.
Altitude 3,650 ft. Rainfall 45 to 50 in. p.a.

0 - 5" Dark reddish-brown (5YR,3/3) friable loam. Weak sub-angular blocky structure.

5 - 12" Reddish-brown (5YR,4/3) loam almost structureless. Occasional angular quartz fragments.

12 - 30" Reddish-brown (5YR,4/4) gravelly loam. Structureless. Several fragments of laterite.

30"+ The laterite was massive, vesicular but not entirely cemented, consisting in places of concretionary material embedded in yellow-red mottled clay loam.

Along the edges of the ridges are frequent outcrops of hard massive laterite and only in the shallower profiles and eroded phases is it massively cemented. The base status, typical of Buruli soils is low and available phosphorus is deficient. Other Buruli profiles sampled in Bunyoro show similar features but since the sites were not

cultivated the organic-matter contents are on average higher than sampled soils in Mengo and the Eastern Province. Base conditions also are somewhat better than average which may be connected with the denser vegetative cover in Bunyoro.

Profile 62 (19064-66)

Mile 15 from Masindi to Paraa, crest of ridge. Altitude 3,400 ft. Rainfall 50 to 55 in. p.a., under tree savanna and forest patches.

0 - 6" Very dark brown (10YR,2/2) crumbly loam. Many roots.

6 - 12" Dark brown (7.5YR,3/2) loam, moderately firm sub-angular blocky structure.

24 - 36" Dark red (2.5YR,3/6) loam, almost structureless. Several small rounded fragments of laterite.

36" + Compact mass largely composed to laterite rubble. Dark red (2.5YR,3/6) loam matrix, slightly mottled with yellowish-brown (10YR,5/6).

The African surface in the central Uganda plain is cut across deeply weathered Basement Complex gneisses and granites. The soil cover developed on this has little or no reserve of weatherable minerals. In Bunyoro, however, the African surface cutting across less weathered rock may yield slightly greater amounts of bases in the soils.

Large areas occupied by Buruli soils in Bunyoro have only recently been cleared of tsetse fly and so far resettlement has been slow; cultivation is, therefore, scattered and where it occurs is mainly practised at subsistence level. Cotton is the only cash crop.

36. Anaka Complex

Between the area of Palabek soils (vide infra) and the red lateritized loams on the 3,700 to 3,800 feet level (Kigumba) there is a transition zone represented by the Anaka Complex. Since it includes many soil types no single description typifies the complex which ranges from red loam to red and reddish-brown clay loam with variable amounts of laterite (Ollier, 1959).

Soils Developed on the Acholi Surface

37. Palabek Complex

In the eastern parts of the Murchison Park the soils are generally shallow and overlie rock that is only slightly weathered. For this reason and the fact that the rainfall of the area is low (less than 40 inches), they are separated from the Kiamara soils in the central and southern areas of the Bunyoro district although both are derived predominantly from metamorphic rocks of the Basement Complex.

Within the area an old escarpment line of hills running through Igisi up to and beyond Rabongo hill have been mapped out as skeletal soils similar to those on the main escarpment to the west.

At the base of one of the Rabongo hills there are remnants of an old lateritized terrace with an ironstone layer very similar to the one found on the small plateau features near the Paraa-Masindi road to the west. If they were at one tine continuous it must be assumed that the laterite and the veneer of lake sediments and probably some of the underlying weathered rock has been removed from this eastern block by a rejuvenation of the drainage following a slight downwarping to the west and cutting back of watercourses which drain in the direction of Lake Albert. The topography now arises as a series of low convex ridges bounded by narrow incised streams. Patches of lake sediment and laterite may still exist but none were found (see Ollier, 1959).

SOILS DERIVED FROM RIFT VALLEY SEDIMENTS

38. Dura Series

In several localities throughout the Western Province there are small deposits of calcareous tufa arising from springs associated with the Rift Valley faulting. The largest of these occur near the shore of Lake George at Hima, Mahokya and Dura. All are being exploited commercially for lime products. Other smaller ones occur near the hot springs at Rubabu, north of Nyakishenyi, and in the Kaku valley of south Kigezi.

Most of the tufa is relatively hard and weathers slowly to a shallow, almost black soil closely related to a Rendzina. On the more marly deposits soils are deeper and a dark reddish-brown B horizon develops as in the profile below:-

Profile 63 (16480-82)

Two miles west of Dura station, level site. Altitude 3,200 ft. Rainfall 35 to 40 in. p.a., under closed forest.

0 - 14" Black (10YR,2/1) clay loam. Nutty, firm to granular structure. Numerous roots.

14 - 26" Dark reddish-brown (5YR,3/3) clay, firm angular blocky structure.

26" + Soft marly limestone, very porous.

This profile is developing towards a ferrisol with the removal of bases from the surface horizon, judging from the colour and low pH figures.

A nearby profile, however, was still sufficiently saturated with bases to display Rendzina features, alkaline reaction and high bases.

Profile 64 (16483-85)

Site characteristics as for Profile 63.

0 - 10" Black (10YR,2/1) clay loam, nutty structure. Numerous roots.

10 - 16" Dark brown (7.5YR,3/2) clay, angular blocky structure.

16" + Marly limestone with humus staining at junction.

39. Nyakashuli Series

The highest and, therefore, oldest beds of the lake sediments adjacent to the Rift escarpment in north Kigezi yield an area of red sandy loams lying next to the Rift escarpment. Although these soils are comparable with the red sandy loams in Murchison Park and on Kaiso deposits in West Nile they are so widely separated geographically that they have been assigned to a new series. The Nyakashuli soils differ from their northern counterparts in that virtually no laterite is present. Only in a very limited number of sites was ferruginous cementation noted in the subsoil and only then on a very small scale. In addition, occasional small ironstone fragments were found which may have been laterite relics. The topography of the area is also more deeply dissected with moderately steep slopes, very little of the original level of the lake deposit now remains.

The soils are deep and, except for a very dark brown or black sandy loam topsoil, reddish coloured throughout. They are less inclined to be gravelly although gravel stone lines are usually present at depth in the profile. Their red coloration would suggest a more advanced state

of weathering than the Rwanga soils and certainly from a comparison of exchangeable bases the red soils are more thoroughly leached. They appear to be consistently deficient in magnesium, potassium and phosphorus but the exchangeable calcium remains unusually high throughout the sampled profiles. The soils are definitely acid and the pH values deviate only slightly from 6.0. A profile from Nyakashuli is given below:-

Profile 65 (13516-22)

Half-a-mile west of Nyakashuli, flattish ridge crest. Altitude 3,700 ft. Rainfall 50 to 55 in. p.a. under grass savanna, Cymbopogon afronardus and Imperata cylindrica.

0 - 6" Dark reddish-brown (5YR,3/2) sand. Weak sub-angular blocky. Numerous grass roots.

6 - 12" Dark reddish-brown (5YR,3/4) sand, almost structureless.

12 - 18" Reddish-brown (5YR,4/6) sand. Structureless.

18 - 28" Reddish-brown (5YR,5/4) loamy sand.

28 - 96" Reddish-brown (2.5YR,5/4) loamy sand. Structureless.

These soils are being exploited in the Settlement area for food crops and flue-cured tobacco.

40. Rwanga Series

The lacustrine sediments extending southwards from Lake Edward rise gradually from 3,004 feet, the lake level, to slightly over 3,800 feet near the escarpment. The change in level is due to lake terracing as the water receded, aided to some extent by upwarping during later Rift movements. (See Pleistocene deposits in geology section.)

Intermediate between the red sands of the Nyakashuli Series and flats bordering the lake is a belt of complex soils mapped as the Rwanga unit. It consists of sandy loams and sandy clays with varying amounts of gravel. The gravels, with well-rounded quartz stones up to 3 inches in diameter, appear to be interbedded with the finer sediments and tend to outcrop at the eroding edges of valleys or even on the eroded crests of some of the ridges. In section the gravels seem to be of no great thickness and resemble in many instances no more than stone lines which they may well be in fact. Either they represent an old erosion feature when the surface was strewn with water-sorted gravel now buried by finer material brought from below by termite activity and added from above as superficial deposits, or the gravel may have accumulated in the subsoil by termite activity alone.

The soils range from sands to sandy clay loams with varying amounts of water-worn gravel. Topsoils are usually very dark in colour and, probably because of the sandiness, moderately deep often exceeding 12 inches. Subsoils are yellowish-brown or occasionally red sandy or sandy-clay loams freely or excessively drained when gravelly, weakly structured or massive blocky when dry. At Rwanga many of the topsoils are little more than sand and these sandy patches are a definite feature of this unit. Another large area of sand occurs along the road at Kikarara and along the old flood plains of many of the rivers. Profiles sampled at Rwanga and Bukorwe demonstrate that these soils are less acid and less leached than the red Nyakashuli soils.

Profile 66 (13502-08)

Two miles north-west of Rwanga, flat ridge crest. Altitude 3,600 ft. Rainfall 45 to 50 in. p.a., under Themeda triandra, Bothriochloa spp. and forest.

0 - 6" Dark grey-brown sandy loam. Very weak blocky structure. Hard and massive when dry. Many grass roots.

/continued

6 - 24" Brown sand, some humus staining, almost structureless.

24 - 60" Pale brown sand. Structureless.

60 - 78" Orange-brown loamy sand. Structureless. Rounded quartz gravel below 78".

Apart from a deficiency of magnesium they appear to be moderately well supplied with calcium, potassium and phosphorus. The extractable phosphorus figures for the Rwanga profile suggest that there is relatively little fixation of this element when compared with the red soils.

Cultivation in the resettlement areas has produced promising results on freshly opened land for food and cash crops such as coffee, cotton and flue-cured tobacco. But there is a risk on these sandy soils of fertility exhaustion seriously affecting production after a few years.

41. Paraa Complex

Soils of this catenary complex occupy the western block of the Murchison Park. The topography is undulating with broad gently sloping valleys (4°) dipping down to narrow swamp drainage courses. In the mature form the crests of the ridges are smooth and slightly convex but in many places plateau-like features surmount the ridges which are remnants of the former level of the lake sediments. Those examined were all capped by lateritic ironstone, the presence of which maintains the plateau features in their present form. Erosion at the edges dislodges blocks and fragments of the ironstone which, in turn, break down to murram. In those sites where dissolution of the ironstone sheet is complete the soil on the ridge crest consists mainly of a compact but uncemented mass of irregular-shaped ironstone fragments (murram) resting on sands, gravels, etc. of the lake sediments. The ironstone itself is remarkably uniform both in thickness and form and at each site visited it possessed an upper concretionary layer merging downwards into a laminated mass riddled with small iron-coated channels, the whole sheet having a total thickness of between 30 and 36 inches. The lower layer is not so well cemented as the upper parts and is broken fairly easily by hand: the upper layer is usually rock hard. From the presence of isolated trees still remaining in the park grasslands it is evident that the area was once covered by high forest. Several factors have operated to remove this forest including damage by game and the failure of tree species themselves to re-establish because of fires. With the disappearance of the forest it is possible that the modification in the soil-moisture regime caused the laterite to become hardened into its present form. Certainly in other areas, notably on the Kaiso beds at Sindikwa in Toro, several stages in the formation of a similar ironstone (see Wasa Complex) layer can be observed in soils which are developing under conditions comparable with those in the Murchison Park. Common to both soils is a light-textured (sandy loam to loamy sand) topsoil lying directly on a heavy, relatively impermeable subsoil and it is at this junction that concretion formation is initiated. Incipient concretionary horizons are forming in the poorly drained soils lying along the terrace bordering the Nile immediately south of the river and probably elsewhere.

Profile 67 (19026-30)

Half-a-mile south of Paraa ferry. Flat terrace site. Altitude 2,100 ft. Rainfall 40 in. p.a. under Hyparrhenia spp.

0 - 8" Dark grey (10YR,4/1) sandy loam, structureless. Numerous roots.

8 - 18" Dark brown (7.5YR,4/2) sandy loam, very weak blocky structure.

18 - 44" As above with pale grey mottle, sandy-clay loam, some concretionary staining (dark). Blocky structure.

44 - 56" Brown (7.5YR,5/4) sandy-clay loam, massive, occasionally fissured.

This profile shows some slight clay illuviation and a concentration of bases in the lower horizon due, most likely, to the slow drainage in the subsoil. The soils of the complex are generally deep, red, sandy loams or loamy sands and in the usual profile where there has not been disturbance by recent erosion there is a fairly abrupt change at about 15 to 20 inches to a sandy clay.

Profile 68 (19020-25)

Four-and-a-half miles south of Paraa, flattish hill crest. Altitude 2,800 ft. Rainfall 40 in. p.a., under Hyparrhenia dissoluta and H. filipendula and Lonchocarpus laxiflorus.

0 - 6" Dark brown (7.5YR,4/2) loamy sand, structureless. Several grass roots.

6 - 16" Reddish-brown (5YR,4/3) sandy loam almost structureless.

16 - 24" Reddish-brown (5YR,4/6) sandy clay loam. Compact with very weak sub-angular structure.

24 - 66" Reddish-brown (2.5YR,5/4) sandy-clay loam. Compact with very little structure.

The texture break at 16 inches is fairly sharp and appears to be due to a surface re-sorting rather than illuviation of clay. Little movement of bases on clay has taken place in the lower part of the soil and profile conditions are remarkably uniform below 2 feet.

Mottling is usually present at the junction and as mentioned above concretions may also be present especially on the flatter sites. During the rains the topsoil is rapidly saturated and the soil becomes waterlogged, a state of affairs very conducive to surface erosion since soil structure is very poor and the loose soil is easily washed away where there is some slope. This factor may be very important in determining the rate of advance of the erosion gullies and bays so characteristic of the area. In nearly every instance the eroding edges are bordered by strips of bared subsoil which vegetation has little time to colonize before the edges are cut back by the surface draining water. The instability of the topsoil may even promote the action by providing sand etc. as a scouring agent during storm wash-aways.

The erosion areas are associated with a lowered drainage base level and although the erosion may be accelerated by game it is largely a natural process, the rate of its progress being aided by the easily erodible nature of the sediments. It is noteworthy that in some of the broad valleys left in the wake of the erosion where slopes have attained angles of approximately four degrees, a condition of stability seems to have been reached and the ground is largely recolonized and almost completely covered by vegetation.

42. Ishasha Complex

The undulating area of the Rwanga unit merges northwards into the relatively flat or very gently undulating plain bordering Lake Edward. Throughout the plain there are broad, flat tracts of clay swamp especially in the lower parts of the Ishasha, Ntungu and Nchwera rivers. These are seasonally flooded as are many other sites on the plain due to the heavy textured subsoils. The water regime of the soil is, therefore, similar to that in soils on the flats bordering Lake Albert in Toro and Bunyoro; severe waterlogging during the rains and extreme drought for the remaining greater part of the year. The Albert flats are on the whole drier and the soils sufficiently saline locally to be almost solonetzic (see Weiga and Somliki units). Profiles on the undulating areas show a very dark brown or black loam to sandy-clay loam, changing fairly abruptly within the surface 18 inches to a sandy clay or even clay. The subsoil is often mottled but may be reddish-

brown on the better-drained crests of the undulations especially where they are transitional to the Rwanga soils. A dark surface soil sampled near Rwensama appeared as follows:-

Profile 69 (14164-66)

One mile south of Rwensama, level site. Altitude 3,100 ft. Rainfall 35 to 40 in. p.a., under Themeda triandra and Imperata cylindrica and depressions.

0 - 3" Black (10YR,2/1) sandy loam, weak sub-angular blocky structure.

3 - 12" Very dark grey (10YR,3/1) sandy loam, weak sub-angular blocky almost single-grain structure.

The high bases may be due to immaturity or the fact that there is little drainage through the subsoil. Organic carbon figures are low for the very dark soil colours.

43. Kasese Series

In the Rift Valley floor north of Lake George are large spreads of sands, gravels and clays brought down by the rivers draining off Ruwenzori. Large areas of gravel were deposited at the mouths of the principal rivers where they emerge on to the plain; cuttings through these can be seen near the Ruimi bridge and in sections along the course of the Mubuku river. Beyond the gravel fans, sands and finer material were laid down on the plain. Sand and gravel levees and old river courses break the surface of the plain into a series of low ridges and depressions and give rise to a corresponding complexity of the soil pattern. Generally, however, the sandy phases of the alluvium will occur nearer to river mouths and foothills and the heavier textured material towards the lake.

The soils developed on the sands and gravels of these deposits are included in the Kasese Series - the predominant type being a black sandy loam overlying rounded water-worn gravel.

Profile 70 (23771-74):

One and a half miles north-east of Rukoki gombolola headquarters, 2° slope. Altitude 3,200 ft. Rainfall 35 in. p.a., under Themeda triandra, Heteropogon contortus and Balanites aegyptiaca.

0 - 9" Black (10YR,2/1) friable loam, well fissured and with a sub-angular blocky structure, merging into

9 - 19" Very dark brown (10YR,2/2) loam with many dark streaks and staining from above, fissured, with a sub-angular blocky structure.

19 - 39" Dark brown (7.5YR,3/2) loam with darker streaks from above. Weak sub-angular blocky structure.

39 - 54" Dark brown (7.5 YR,4/2) loam. Friable and weakly structured. Roots penetrate well into this horizon.

54" plus. Gravel with some loam matrix, slightly calcareous.

In spite of the fact that these soils are sandy and free draining, they are seldom excessively leached. The high base content may be due to the low rainfall and high evaporation rate for the area. Local variations arise from depth of sandy loam to the gravel and areas of heavier soils as, for example, approximately one mile north of Kasese.

A detailed soil survey of the Lake George flats between the Rukoki and Hima rivers has been carried out to investigate the suitability of the area for irrigation (Harrop, 1961).

Only within recent years have areas of this unit been opened up for cotton cultivation, chiefly due to contract ploughing carried out by the Agricultural Department; yields are high if the plants are sprayed.

44. Bwamba Complex

Soils of this unit are developed on the hill wash pediments skirting the Ruwenzori. They are more extensive on the west side where they merge into the lake sediments. To the east of the mountain there is a relatively small area of soils developed on hill wash material around Bubandi but these are of minor importance when compared with Bwamba.

Studied in detail the Bwamba area is complex and to map even some of the variations would be a very time-consuming operation. In addition to low outcropping ridges of rock the surface is further broken up by deep river and stream valleys which have cut through and brought to the surface underlying sediments of different ages. The dominant member of the Bwamba group is a deep clay loam to sandy-clay loam, yellowish-red (5YR,5/6-4/6) and usually free from laterite. The topsoil is dark in colour, moderately high in organic matter, merges gradually into the subsoil. In texture they are always inclined on the heavy side and usually slightly gritty.

Profile 71 (18894-98)

One mile north-west of Harugali, near crest of ridge. Altitude 3,300 ft. Rainfall 55 to 60 in. p.a., under mixed grasses including Pennisetum purpureum.

0 - 13" Black (10YR,2/1) loam, moderately friable sub-angular blocky structure. Occasional angular quartz, many roots. Merging to:-

13 - 20" Dark brown (7.5YR,4/2) sandy-clay loam, sub-angular blocky structure, occasional quartz.

20 - 33" Yellowish-red (5YR,5/6) gritty clay loam. Compact with a weak blocky structure, roots penetrating cracks and fissures.

33 - 52" As above but becoming more massive.

52" + As above with occasional paler coloured mottling.

The high base and humus status attained by many Bwamba soils is well demonstrated in this profile.

Bordering the main drainage channels there are sands and gravels brought down by torrential floods and these have been cut through by the present rivers. Numerous sections of sands and gravels mixed with various amounts of clay are also exposed in cuttings. In the broader, smoother valleys grey clays, sometimes calcareous, probably belonging to the lake beds are exposed and give rise to heavy grey soils in which profile development is immature.

Profile 72 (18889-93)

One mile south of Bundibugyo, lower slope, 8°. Altitude 3,200 ft. Rainfall 55 to 60 in. p.a., under Pennisetum purpureum.

0 - 10" Very dark grey-brown (10YR,3/2) loam. Moderately firm sub-angular blocky structure. Many roots.

10 - 18" Yellowish-brown (10YR,5/4) humus stained loam containing much small angular quartz. Regular blocky structure and fissured.

18 - 40" Yellowish-brown (10YR,5/4) sandy-clay loam, more massive than above.

48 - 50" Light grey (2.5Y,7/2) with yellowish-brown mottle (10YR,5/4) sandy-clay loam, less angular quartz than above. Large blocky structure.

/continued

58 - 70" Light grey (2.5Y,7/2) with brownish-yellow (10YR,6/6) blotches, sandy-clay loam. Large angular blocky structure.

The slow drainage of these soils is shown by the greyed colours and subsoil mottling. Bases are moderately high and, except for potassium which is deficient, tend to increase in the lower horizons.

The field textures of this soil were heavier than expected from the mechanical analysis figures, probably due to the presence of a 2:1 clay mineral such as montmorillonite.

To the south-west around Bubandi very dark loamy topsoils reminiscent of the volcanic soils become more evident. In the same area many of the soils on the foothills are also very dark. High available phosphorus contents of the topsoils further suggest some volcanic ash contamination.

West of Bundibugyo, bordering the Forest Reserve, the land surface is very deeply dissected and consists almost entirely of a series of very narrow steep-sided ridges. The area is of limited extent and is very clearly defined from the surrounding country. It would be interesting to know if this cutting back of the streams has resulted from, or been intensified by, clearance of the forest. Approximately 1½ miles below Busaru near a dry stream bed a small amount of concretionary ironstone was exposed and although it could not be traced in other sites nearby it is probably part of a formation analogous to the ironstone which occurs in the upper terrace at Wasa and below which there is a similar dissection pattern to that on the forest edge mentioned above.

Because of the general soil fertility and suitable climatic conditions Bwamba is the most important robusta coffee growing area in the Western Province.

45. Wasa Complex

Below the escarpment which extends from the Wasa fault to the south end of Lake Albert is a broad tract of river and lake alluvium laid down as Rift Valley floor deposits. The surface of these deposits grades down to the Semliki alluvium in a series of terrace-like steps, three of which are clearly discernible; a closer examination might reveal more. The whole area is deeply dissected by streams and rivers flowing off the escarpment some of which have become aggraded so that their valleys are fairly broad. During later disturbances following the Rift Valley formation, the lake and its deposits were upwarped towards the escarpment which may have taken place in stages each of which produced a terrace step as the water was forced to retreat. It is fairly evident from the nature of the soils on these terraces that they do represent different stages of emergence from the lake and have in consequence been subjected to different degrees of weathering, soils being more mature on the highest terrace than on the lower succeeding ones. The sequence is interesting in that it shows stages in the development of ironstone characteristic of the older sediments at Murchison and north Kigezi. At Wasa massive ironstone is only found in the upper-exposed sections and occasionally as hard rock pavements where the overlying soil has been washed away.

Profile 73 (18922-27)

Four miles east of milepost 18, Fort Portal to Bundibugyo road, lake sediment, 2° slope. Altitude 3,200 ft. Rainfall 40 to 45 in. p.a., under Themeda triandra, Heteropogon contortus, Hyparrhenia spp.

0 - 8" Black (10YR,2/1) loam, friable with a small sub-angular blocky structure. Numerous roots.

8 - 17" Brown (7.5YR,5/4) loam, containing small amounts of quartz grit. Compact and with little structure.

/continued

17 - 29" Yellowish-red (5YR,5/6) sandy-clay loam, more grit than above. Compact, massive with little structure.

29 - 36" As above with occasional black staining and some concretions.

36 - 50" Colour as above with much dark staining and iron cementation of the grit into irregular-shaped concretions. Sharp transition to:-

50" + Light brownish-grey (2.5Y,6/2) sandy clay with occasional light olive brown blotches (2.5Y,5/4). Massive with occasional vertical fissures.

The concretionary layer is compact but largely uncemented; massive formations seem to arise only from exposure of this material to the atmosphere. The underlying clay appeared to be little weathered, possibly due to its compact nature. Seasonal waterlogging at the junction between the upper parts of the soil and this clay would probably initiate the formation of concretionary material, which in this profile has developed into a layer more than 18 inches in thickness. It may not be a product of lateritization in the classic sense though in the massive state it resembles cemented concretionary laterite. Bases are unusually high for a gritty soil that has probably been well leached.

Profile 74 (18913-20)

Ten miles east of milepost 18, Fort Portal to Bundibugyo road, lake sediments, level. Altitude 3,000 ft. Rainfall 40 to 45 in. p.a., under Themeda triandra etc. as for No. 73.

0 - 6" Dark grey-brown (10YR,4/2) sandy loam. Very weak sub-angular blocky structure, almost massive when dry. Several grass roots.

6 - 14" Brown (10YR,5/3) sandy loam slight pale brown mottling. Weak blocky structure. Compact and massive when dry. Several grass roots.

14 - 24" As above, slightly more pale brown mottling.

24 - 36" Pale brown (10YR,6/3) sandy loam with some rusty streaks.

36 - 43" As above with many irregular-shaped concretionary bodies.

43 - 65" Light brownish-grey (2.5Y,6/2) sandy-clay loam. Compact with angular blocky structure.

65 - 96" Light grey (2.5Y,7/2) sandy-clay loam. Angular blocky structure.

96" + As above with some dark concretions. Slightly calcareous at about 110".

Profile 74 has definite planosolic characteristics typical of soils developed on these old lake alluvia. This need not be a pedogenic feature, however, for it could arise from a re-sorting of surface material or fresh material added by sheet-wash action from higher ground. At the texture junction, impedance of drainage has led to concretion formation but on a much smaller scale than in the older profile above. The clay is decalcified to a depth of 8 feet and is only slightly calcareous at greater depth.

On the lowest terrace before reaching the more recent river (Semliki) alluvium, the youngest soils of the Wasa Complex, are to be found. Profile 75 is probably typical.

Profile 75 (18907-12)

Fourteen miles east of milepost 18, Fort Portal - Bundibugyo road, flat site. Altitude 2,900 ft. Rainfall 40 in. p.a., under Themeda triandra etc. as for profile 73, with occasional Borassus aethiopum.

0 - 9" Very dark grey-brown (10YR,3/2) sandy loam, weak sub-angular blocky structure. Many grass roots.

9 - 21" Dark grey-brown (10YR,4/2) sandy loam. Small weak blocky structure.

21 - 31" As above with some rusty flecks and staining.

31 - 38" Much as above, weak angular blocky structure. Slightly calcareous.

38 - 46" Grey-brown (2.5Y,5/2) sandy loam, blotched with black and brown with occasional small concretionary bodies. Slightly calcareous.

46 - 72" Grey-brown sandy-clay loam (2.5Y,5/2), occasional flecks of $CaCO_3$.

This profile is calcareous at about 20 inches and definite calcium carbonate concretions occur within 3 feet of the surface. No ferruginous concretions appear to be present but occasional small black specks arise with the calcareous concretions which are mainly composed of manganese with some iron oxides. There is only a slight planosolic tendency but horizon for horizon there is a much higher base content than either of the other Wasa profiles.

ALLUVIAL SOILS

46. Papyrus Peat

Because of population pressure the extensive papyrus swamps in Kigezi district have been the subject of such study by officers of the Water Development and Agricultural Departments. A detailed examination of the peat soils by Chenery over the years 1952-53 to ascertain if the swamps when drained would not become sterile is summarized below (ex Chenery, 1954 and 1956). Many of the swamps would have been drained if the experimental area of Nyanza had not gone dead through a build-up of excess acidity derived from sulphur-containing material in the peaty subsoil. This manifests itself by encrustation of sodium and ferric sulphates on the land surface at the sides of drains. Acid sulphate soils are usually associated with recent marine or estaurine clays. Only two instances can be found in the literature of such soils with a different origin, namely, the solfatara muds of Java (Von Faber, 1925), and a lake bed in the Taiga region of Russia (Verigina, 1950). In the following an acid sulphate soil is described that is derived from papyrus peat enriched with sodium sulphate from Pre-Cambrian schists and phyllites. This soil has developed as a result of experimental draining of papyrus swamps in the Kigezi district at about 6,000 feet elevation; similar soils are also beginning to form in the drained papyrus swamps of Buganda at 3,800 feet. This Kigezi acid sulphate soil is quite sterile, as would be expected with topsoil pH values of 2.4 to 2.7. It consists of about an inch of dark brown granular peat encrusted with orange-brown crystals of ferric, sodium and aluminium sulphates; below this occurs dark greyish-brown peat mottled orange with ferric hydroxide. From 9 to 60 inches below the surface is a pale greyish-brown clayey peat full of papyrus culms and roots and bright reddish-brown remains of rotten wood-like material. This reddish-brown colour changes to dark brownish-grey in a few minutes after exposure and to almost black in a few hours. Below 60 inches is a compact pale grey clay very similar to that of the schist soils in the slopes nearby. The smell of H_2S is present in fresh pits but is not strong.

The most interesting features of this soil are the changes that take place when it is dried. In the tables below are presented data

obtained from fresh wet samples and air-dried samples from profiles of a sterile patch and an adjacent site under a healthy stand of papyrus.

Table 2

Depth in.	H_2O % Oven-Dry Soil	Ash % Oven-Dry Soil	Milliequivalents per gram oven-dry soil						
			pH (Glass Electrode)		Water Soluble SO_4		Water Soluble Total Iron as Fe+++		Free* Total Iron as Fe+++
			Wet	Dry	Wet	Dry	Wet	Dry	
Sterile Papyrus Peat									
0-1	133	57	2.8	2.9	.27	.36	.01	.01	2.85
1-3	255	52	2.9	2.8	.26	.26	.02	.02	3.04
3-6	446	34	2.5	2.5	.37	.51	.23	.15	2.30
6-9	665	18	2.7	1.3	.90	1.88	.03	.57	.63
9-12	629	24	3.0	1.2	.18	1.44	.08	.58	.06
12-15	670	25	3.6	1.2	.25	2.80	.10	.68	.07
15-18	625	36	4.3	1.6	.38	2.71	.12	.66	.21
18-24	480	50	5.3	1.7	.45	nd	.03	1.08	.18
24-30	577	49	5.6	1.6	.26	2.32	.02	1.17	.42
30-36	534	44	5.9	1.5	.14	2.60	0	.93	.39
36-48	683	34	6.0	1.2	.14	3.79	0	3.17	.78
48-60	490	40	6.1	2.4	.07	.96	.01	0	.45
Virgin Papyrus Peat									
0-3	686	43	6.4	3.4	tr.	Not determined	.09	Not determined	3.66
3-6	297	72	7.0	4.8	tr.		.03		5.61
6-9	322	68	7.0	4.6	tr.		.02		5.00
9-12	440	25	6.6	3.4	0		.01		5.54
12-18	456	54	6.2	1.9	0		tr.		1.06
18-24	590	34	7.0	2.1	0		.01		.52
24-30	362	72	6.1	1.9	0		0		.49
30-36	715	39	6.1	1.9	0		0		.48
36-48	700	56	6.0	1.8	0		.01		.44
48-60	107	86	6.2	4.0	0		nd		.22

* Allison, L. E. and Scarseth, G. D., 1942.

Although the samples were only dried for a week the increases in acidity, and water-soluble sulphate and iron are remarkably large, and clearly indicate the presence of much free sulphuric acid. The rapidity

with which these increases took place was very much greater than was found by Wiklander et al. (1950) in their sulphate studies on Swedish gyttja soils. They showed that the oxidation of sulphides to free sulphur was quite fast but the further oxidation to sulphate was slow, both in the presence and absence of sulphur bacteria. The amount of sulphate in the Kigezi peat below 9 inches increased 1,000% in 7 days and in the gyttja soil 500% in 89 days. The final sulphate content of the Kigezi peat was 15 times as large as that in the gyttja soil. This may be due to higher initial free sulphur and organic matter contents together with the presence of different sulphur-oxidizing organisms.

The results for the virgin papyrus peat are typical of very many obtained, in that the acidity of the top foot does not increase below pH 3.4 when the samples are dried out separately. Buffer curves have shown that the topsoil is more strongly buffered than the subsoil and a glance at the last column will reveal that this may be connected with the large accumulations of free ferric hydroxide. Further consideration of the table enables the formation of the sterile peat to be visualized as follows: The virgin peat on draining would dry out below the one-foot level to such an extent that the free acid and sulphate contents would be very greatly increased. If the water table were then raised close to the surface an accumulation of sulphates, sulphuric acid and ferric iron would occur there by capillarity and hydrolysis. So long as the water table remained high the topsoil would stay excessively acid.

Profile 76 is typical of papyrus peat soil that will become barren after a few years cultivation.

Profile 76 (6491-502)*

Nyanza Swamp, 12 miles from Kabale on the Kampala Road. Sampled about 24 hours after digging.

0 - 1" Very dark greyish-brown, granular peat containing sporadic orange-brown ferruginous nodules which are probably old root trace material hardened and broken up; quite wet.

1 - 9" Similar to above but mottled and splotched with orange-yellow ferric hydroxide.

9 - 15" Pale greyish-brown rooty peat with bright orange-red organic remains like rotten wood giving the appearance of mottling in cross-section but the redness is not ferruginous.

15 - 18" Dark brownish-grey rooty peaty clay with occasional yellowish-brown splotches of decayed wood. Slight smell of sulphuretted hydrogen at beginning of sampling, not much after a few minutes. Water oozes from 24 inches downwards but the true water table was only 6 to 7 inches from the surface.

18 - 60" After a few hours this material appeared quite black in colour.

The main body of the Kashambya swamp has shown no signs of going dead after at least 10 years from draining. A typical profile from there is given below.

Profile 77 (6514-23)

Kashambya Swamp, near Gombolola Road; eight feet north of survey marking pipe K3, under short grasses and sedges:- Leersia hexandra, Cynodon sp., Kikuyu grass and Killinga sp.; at edge of a large clump of Cyperus latifolius.

0 - 3" Thick sod of living grass roots in dark brown peat.

/continued

* Colours refer to wet soil.

3 - 6" Similar to surface but with granular structure, water table at about 4 inches, one worm was found here.

6 - 9" Reddish-brown rooty peat changing to black in about 60 seconds.

9 - 42" As above and also containing bright reddish-brown wood-like material which gives a fresh cut and mottled appearance. This material appeared uniformly black although the pit was only dug 20 hours previously. A fresh cutting is light brownish-red in colour with a very fibrous structure of old papyrus culms and roots. Colour change to black is complete in 60 seconds. Living grass roots penetrate to 42 inches from surface and are very abundant in the top 12 inches.

42 - 48" Greyer than above and very much more clayey.

48 - 60" Similar but more clayey.

Reclamation of sterile peat

Since the stream running near the sterile patch was base rich, flooding and partial leaching with this water was tried as a remedial measure. Six months' flooding raised the surface reaction to pH 3.6 and promoted vigorous papyrus growth. The soil was still too acid for agriculture but a replicated liming experiment showed that reclamation could be effected quickly by comparatively small dressings of lime (5 tons $Ca(OH)_2$ per acre) plus triple superphosphate (2 cwt. per acre), provided the watertable was kept at about a foot below the surface. Similar results have been obtained by Kivinen (1950) over vast areas of excessively acid sulphate soils in Finland.

Many hundreds of acres of the fringes of Lake Mutanda and the northern half of Kashambya swamp have been reclaimed from papyrus. Good crops of sweet potatoes, sorghum and maize are obtained on cambered beds about 6 feet wide. Useful grazing is obtained from those parts of the swamps in which the watertable is within six inches of the surface.

At lower elevations in Ankole and Toro papyrus peat does occur but it is proportionately thinner as the mean average temperature becomes warmer. In the lower parts of Ankole the peat is just a thin veneer of humose loam over sandy clays. Plots of tea have been tried in the north Kiruruma swamp and at Nyanza. The bushes have done remarkably well where the pH has been above 3.3. Unfortunately, most of the Kiruruma plot had a reaction below this and the tea failed completely.

47. Kifu Series

Swamps in south-east Toro are mainly occupied by coarse grey sands. The soils are base deficient acid and generally similar to swamp fringe soil, profile 42 (see Buwekula), also Radwanski, 1960).

48. Bukora Series

The Bukora Series was first described and mapped in Masaka district (Radwanski, 1960) where it includes most of the alluvial soils in the phyllite country. Associated with it are sandy soils of the Mulembo Series and a yellowish-coloured variant where the drainage has been improved.

The majority of the clay swamps in east and south-west Ankole bordering Masaka are of the Bukora type with variable amounts of sandy overwashes. The loams or sandy loam topsoil is seldom more than a few inches thick and lies abruptly on compact clay. They appear to differ from the Masaka soils in their lower silt content. In none of the swamps

sampled in Ankole did silt exceed or even approach the clay content, as is the case with some of the Masaka soils. In Masaka the high silt figures are probably due to closer associations of the soils with phyllites and shales especially in east Koki where metamorphism of the Karagwe-Ankolean sediments is at a minimum. Most of the swamps of Nyabushozi are derived from schists and strongly metamorphosed sediments.

The similarity is drawn much closer when their chemical properties are considered. In the seasonally waterlogged areas base content of the soils is moderately high and exchangeable sodium is present in almost every profile sampled. Only in the better-drained soils is sodium absent and this is accompanied by a reduction in the other exchangeable bases. The degree of sandiness will naturally vary with the geology of local catchment areas. Over most of the area of Mbarara and Nyabushozi catenas the schists which are inclined to be quartzose yield a moderate amount of light fraction material which is reflected in the relatively low clay content of the Ankole swamp soils when compared with those from south-west Masaka. The swamps do appear to be largely locally derived from hill wash and local drainage which has little or no outlet. Stream flow in the valleys is rarely seen and there is usually little evidence of a stream course. During exceptionally heavy rain-storms, valleys have been known to flood to a depth of several feet and drain away as sheet flows. Usually, however, water accumulates in the flats and is lost by seepage and evaporation.

From the depths of the alluvial cover it would seem that the valleys were formerly widely aggraded and have subsequently been drowned by impounding of the local drainage. The deposits are, therefore, relatively shallow layers of clays and sandy clays with occasional layers of gravel. A profile sampled in the wide valley 1½ miles north of Kitabo dam, Nyabushozi, illustrates the nature of these valleys.

Profile 78 (20915-21)

Six miles north-west of Kitabo, alluvial flat. Altitude 4,400 ft. Rainfall 35 to 40 in. p.a. Themeda triandra, Loudetia kagerensis and Acacia gerrardii.

0 - 3"	Very dark brown (10YR,2/2) friable loam, weak crumb structure. Many grass roots.
3 - 15"	Very dark grey-brown (10YR,3/2) loam, weak sub-angular blocky structure.
15 - 28"	Grey-brown (10YR,5/2) sandy clay. Small angular blocky structure.
28 - 50"	As above but more massive, several vertical fissures.
50 - 64"	As above with sub-rounded quartz gravel.
64 - 78"	Yellowish-brown sandy clay with much rotted schist.
78" +	Weathered quartz mica schist in situ.

The accumulation of calcium and magnesium is typical of these clay swamps but fall off of potassium with depth is rather anomalous when it is considered that the most easily leached base, sodium, is able to accumulate. The humus content is perhaps unusually high for these soils but it is probably due to peat developing in a slight depression.

Evidence from other profile samples indicates that although sodium is almost universally present in these soils other bases, notably magnesium and potassium, are variable. Phosphorus appears to be always deficient.

Most of the Western Province clay swamp soils have been placed in the Bukora unit. The following profile, typical of Bunyoro, illustrates the similarity of the soil.

Profile 79 (19045-49)

One mile south of Kijenjubwa, alluvial flat. Altitude 3,450 ft. Rainfall 50 in. p.a. Themeda triandra, Andropogon dummeri, Imperata cylindrica, Sorghastrum rigidifolium.

0 - 6" Very dark grey (10YR,3/1) loamy sand. Weak crumb structure. Numerous roots.

6 - 13" Very dark grey-brown (10YR,3/2) loamy sand, very weak blocky structure.

13 - 20" Dark grey-brown (10YR,4/2) loam. Blocky structure with many vertical fissures. Fairly sharp transition to:-

20 - 30" Dark grey (10YR,4/1) clay, slight yellow mottling. Hard massive blocky structure - many vertical faces.

30 - 50" Grey clay (10YR,5/1) compact and tenacious, fewer vertical fissures.

The exchangeable bases follow the same trend as profile 78 and the physical conditions of the two profiles are comparable.

48A. Bukora/Mulembo/Lwampanga Complex

On the extensive flats which border the Kafu river in south-west Bunyoro there is a merging of river alluvia and the Lwampanga Series which is the lower catenary component of the Buruli unit. No attempt has been made to separate them during this survey but some of their variants will be described.

The flats below Miramura and Kijenjubwa consist mainly of alluvia brought down by the rivers draining the eastern side of the main Bunyoro watershed together with flood plain alluvium of the Kafu. The soils are grey mottled clays similar to the Bukora Series with overlays of sand. Two trial borings between the rivers Kizi and Kirinjui, south of Kijenjubwa showed 20 inches of dark grey-brown sand over compact clay mottled with yellowish-brown and red. Nearby there were several sand levees parallel with the Kafu river channel.

North of Kibangya the surface of the flats is thrown into slight relief by a series of low mounds on which the soils are moderately well drained dark sandy, or sandy-clay loams. The intervening depressions are occupied by black clays overlying grey mottled clay containing some calcium carbonate at depth. This pattern continues almost to Masindi Port where the surface becomes more even and the soils are almost uniformly well-drained clay loams, e.g., auger borings near the sisal ginnery revealed 0 - 10" dark brown (7.5YR,4/4) compact sandy-clay loam; 10 - 48" strong brown (7.5YR,5/6) friable clay loam very slightly mottled with paler colours at depth.

Immediately east of Kibangya the Kafu terrace gravel occurs near the surface. It is overlain by three inches of rust-stained, very dark grey (10YR,3/1) sandy loam on 9 - 20" dark grey-brown (10YR,4/2) sandy clay. The gravel which follows consists of rounded-quartz pebbles, is cemented into a rock-hard mass by secondary iron deposits. Similar cemented gravels are exposed near the Kafu ferry by Luhunga, south of Hoima.

Between Kibangya and the Nampwere river, islands composed of Lwampanga Series yellowish-brown sandy loams and Buruli merge with the river alluvia.

During the course of a survey carried out to investigate the suitability of the soils on the sisal estate of Bunyoro Enterprises Ltd. for sugar-cane growing this complex was studied in greater detail and profiles were sampled on the two mail soil types.

The principal soil on the estate was a moderately well drained sandy clay loam with a ferruginized concretionary layer in the subsoil. Profile 83 is typical. (Cf. Lwampanga Series (Radwanski, 1960).)

Profile 83 (25991-95)

Two miles west of Masindi Port, old alluvial terrace. Altitude 3,500 ft. Rainfall 44 in. p.a. Hyparrhenia dissoluta, Panicum maximum, Chloris gayana, Albizzia and Acacia spp.

0 - 7" Very dark grey-brown (10YR,3/2) sandy loam, friable and weak sub-angular blocky in structure. Numerous roots.

7 - 18" Dark brown (7.5 YR,4/2) sandy clay loam. Moderately firm sub-angular blocky structure.

18 - 28" Dark brown (7.5 YR,4/4) sandy clay loam. Firm sub-angular blocky structure.

28 - 44" Very much the same as the horizon above with a few dark stainings on the faces of the structural units.

44 - 54" As above with numerous reddish-brown blotches and irregular-shaped iron cemented concretions. Below this horizon the concretionary material tends to be more massive.

Exchangeable bases are unusually high when compared with Lwampanga soils sampled elsewhere but variations of this kind are to be expected where soils come under the influence of drainage from upland areas. Soils in the depressions resemble the Bukora Series as, for example, the following profile.

Profile 84 (25987-90)

Five miles south-west of Masindi Port, low-lying swamp tract. Altitude 3,400 ft. Rainfall and vegetation much as profile 83.

0 - 9" Very dark grey (10YR,3/1) clay loam coarsely granular, friable when moderately dry. Numerous roots.

9 - 22" Very dark grey (10YR,3/1) clay loam with faint brown mottling. Firm sub-angular blocky structure.

22 - 42" Dark grey-brown (2.5Y,4/2) clay with some brown mottle. Blocky with several fissures.

42 - 50" As above but harder and more massive. Only occasional fissures.

In common with the Bukora Series (see profile 78) the content of exchangeable bases is very high and the soil is strongly acid suggesting the presence of 2:1 lattice clays (montmorillonite group).

49. Sebwe Series

The alluvium which occupies the Lake George basin immediately north of the lake consists of silts and clays with smaller amounts of sand brought down by the rivers draining the eastern flanks of the Ruwenzori range. The soils developed on this material, therefore, have certain affinities with the Kasese Series into which they merge as the flat ground begins to rise from the flats towards the foothills. Since the superficial deposits were spread over the plain by fast-flowing rivers there is much re-sorting in the vicinity of the river courses giving rise to patches and levees of sand.

The major soil types, however, are sandy-clay loams, of which profile 80 is fairly typical.

Profile 80 (8807-13)

Four miles north-east of Kasese, flat site. Altitude 3,000 ft. Rainfall 35 in. p.a. under Imperata cylindrica in depressions, Themeda triandra and Heteropogon contortus on better-drained sites.

0 - 12" Black (10YR,2/1) loam, crumb to small sub-angular blocky structure. Numerous grass roots.

12 - 24" Grey-brown (2.5Y,5/2) sandy-clay loam, angular blocky structure. Some humus staining in upper parts of horizon.

24 - 36" As above. Some calcium carbonate flecks.

36 - 72" Light grey-brown (2.5Y,6/2) sandy-clay loam, occasional calcium carbonate nodules.

50. Semliki Series

All the clays on the Semliki flats have been grouped in this series. Minor variations due to small sand levees occur along old meander of the Semliki river but the dominant soils over the area are deep, poorly drained clays. In common with clays on other flats associated with Lake Albert they tend to be saline and frequently contain sufficient sodium to render the soil inimical to many plants. Soil reaction is generally alkaline, though seldom exceeding pH 8.0. One saline soil sampled during the survey carried out by Gunn (1955), however, exceeded pH 9.0 in all horizons down to 4 ft., one horizon (6-12") being as high as pH 10.0 with 29.4 m.e. of sodium, which represented 75 per cent of all exchangeable bases.

The following profile probably represents average conditions:-

Profile 81 (8763-69)

Semliki flats, ten miles east of Rwebishengo, flat site. Altitude 2,300 ft. Rainfall 35 to 40 in. p.a. under Sporobolus pyramidalis and Setaria spp. Hyparrhenia dissoluta, Heteropogon contortus, occasionally Sporobolus molleri in alkaline areas.

0 - 6" Very dark grey (10YR,3/1) clay loam, firm angular blocky structure. Several grass roots.

6 - 12" As above with some humus staining, few roots.

12 - 24" Very dark grey (10YR,3/1) clay, hard angular blocky, many small fissures reaching down to this horizon.

24 - 36" Yellowish-brown (10YR,5/4) fine sandy clay. Angular blocky structure and some fissures.

/continued

36 - 48" Olive grey (5Y,5/2) mottled fine sandy clay.

48 - 60" As above, but heavier textured.

60 - 72" Olive grey (5Y,5/2) mottled clay fairly massive with few fissures.

It is interesting to note the relatively small amounts of exchangeable calcium, a feature which generally applies to the Semliki Series and other saline soils in the Albert flats (see Weiga Complex).

51. Weiga Complex

Between the Weiga river and Butiaba there is a complex of black clay and sandy alluvial soils. The clays are dominant but much variation arises from sandy overwashes and intercalations of sand in the clay which exerts a wide range of effects on the soil drainage.

At Butiaba some of the clays are alkaline and very gypseous, with pH values in excess of 7.0 for the whole profile. The following is a typical example:-

Profile 82 (10402-9)

One mile east of Butiaba, level site. Altitude 2050 ft. Rainfall 30 in. p.a. under Setaria spp., Chloris spp.

0 - 3" Black (10YR,2/1) granular, small sub-angular blocky structure.

3 - 6" Very dark grey (2.5Y,3/0) clay loam, coarsely granular structure.

6 - 57" As above with moderate/firm sub-angular blocky structure.

57 - 105" Grey (2.5Y,6/0) "gravelly" clay packed with gypsum crystals, slightly calcareous.

105" + Mainly gypsum crystals.

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APPENDIX

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 $20 - 2\mu$
Sand $20 - 2000\mu$

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 Kaolinitic 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 PROFILES

Depth Ins.	Mechanical Analysis % Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100 g Soil Ca	Mg	K	Na	Mn	Total	Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
Sabinio															
Profile 1 (22572-74)															
Sabinio Mountain; 9,000 ft.															
9	33	0	4.1	1.3	0.48	0	0.06	5.94	9.9	15.84	37.5	5.2	8.04	11	High C, low P_2O_5, N
20	33	0	2.7	0.6	0.26	0	0	3.56	9.0	12.56	28.3	5.1	9.45	7	
20+	16	7	0.4	0	0	0	0	0.40	6.3	6.70	6.0	5.2	3.39	70	
							N% 0-9"		1.431	C/N 5.6					Low C/N
Bufumbira															
Profile 2 (22479-81)															
Kisoro; 1 mile west of township, 6,000 ft.															
9	11	6	10.8	3.3	0.28	0	0.03	14.41	22.4	36.81	39.1	5.8	11.90	11	High C, low P_2O_5, N
18	12	0	10.0	1.9	0	0	0.01	11.90	20.4	32.30	36.8	6.15	7.01	6	
30	3	10	6.2	0.6	Tr.	0	Tr.	6.20	18.4	24.60	25.2	6.05	3.78	3	
							N% 0-9"		1.142	C/N 10.4					
Profile 3 (12557-64)															
Maziba; 4 miles West of Kisoro, 6,500 ft.															
6	27	0	15.6	2.4	1.12	0	0	19.12	-	-	-	6.58	4.26	155	High bases
13	27	0	19.2	1.2	0.23	0	0	20.63	-	-	-	6.40	3.00	118	High P_2O_5
25	19	8	5.8	1.3	0	0	0	7.1	-	-	-	6.55	1.45	39	N
33	17	14	5.0	0.7	0.59	0	0	6.29	-	-	-	6.60	0.79	34	
46	27	8	3.0	1.3	0.94	0	0	5.24	-	-	-	6.78	0.33	71	
62	31	0	2.1	0.9	0.61	0	0	3.61	-	-	-	6.85	0.11	208	High K
78	15	0	0.8	0.6	0.16	0	0	1.56	-	-	-	6.94	0.07	960	
100	11	0	1.1	0	0.73	0	0	1.83	-	-	-	7.08	0.08	650	
							N% 0-6"		0.561	C/N 7.5					

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e. %	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Profile 4 (22458-60)															
Kisoro, 1 mile W. of rest-house, 6,000 ft.															
8	18	14	8.3	2.5	1.19	0	0.03	12.02	17.9	29.92	40.3	6.0	4.35	12	Low P_2O_5
16	16	18	10.8	2.3	Trace	0	[illegible]01	13.10	16.6	29.70	56.0	6.15	2.13	9	
26	20	6	3.8	0.6	0		0	3.8	8.8	12.60	70.0	6.25	2.17	2	
															High N.
N% 0 - 8" 0.522 C/N 8.3															
- = not enough of sample left for analysis															
Saka **Profile 5** (18807-11)															
Fort Portal, 6 miles north of township, 5,100 ft.															
10	10	24	15.6	4.2	0	0	Trace	19.8	8.2	28.0	70.7	6.0	2.99	2375	Very high
15	10	20	14.8	5.8	0	0	0	20.6	7.3	27.9	73.8	6.2	0.77	3275	P_2O_5, high
21	10	18	13.3	3.5	0	0	Trace	16.8	7.0	23.8	70.6	6.4	1.31	3625	Ca, Mg and
33	12	12	16.8	3.8	0	0	"	20.6	4.0	24.6	83.7	6.5	0.55	5050	low K
Ash	6	0	31.7	4.2	1.12	0	0	37.02	0	37.02	100.0	8.1	0.06	350	
N% 0 - 10" 0.254 C/N 11.8															
Profile 6 (20931-33)															
3 miles N.E. Kichwamba.															
9	18	29	16.6	3.8	1.43	0	0	21.83	4.5	26.33	82.9	6.6	2.79	2350	Very high P_2O_5
16	18	29	16.5	3.3	0.70	0	0	20.50	3.3	23.80	86.1	6.7	1.61	4075	High Ca
22	16	25	24.3	4.2	0.66	0	0	29.16	0.9	30.06	97.0	7.6	1.25	4500	
N% 0 - 9" 0.217 C/N 12.8															

Depth Ins.	Mechanical Analysis % Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
Chambura															
Profile 7. (18879-84)															
Katojo, Toro. 3,450 ft.															
8	18	23	10.1	3.7	0.53	0	0	14.33	7.7	22.03	65.0	5.8	3.02	2475	Very high P_2O_5
18	8	37	13.4	4.7	0.30	0	0	18.40	6.2	24.60	74.8	5.7	2.19	1600	
36	10	37	16.0	5.0	0.39	0	0	21.39	4.8	26.19	81.7	6.1	2.01	2950	
52	12	37	19.1	4.7	0.41	0	0	24.21	3.5	27.71	87.4	6.4	1.92	525	
62	22	27	19.0	5.0	0.47	0	0	24.47	2.8	22.27	90.0	6.7	0.50	420	
76	16	19	29.6	3.5	0.42	0	0	33.52	-	-	-	8.0	0.39	625	Free lime
															Raw humus
N% 0-8" 0.109 C/N 28															
Nyakatonzi															
Profile 8. (8609 - 12)															
Katojo, Toro. 3 miles S.E. of village, 3,400 ft.															
6	20	16	18.6	6.9	1.61	Trace	0.04	27.15	2.1	29.25	92.8	7.09	3.12	3250	Very high P_2O_5
12	13	26	18.0	5.0	0.72	Trace	0.02	23.74	2.0	25.74	92.2	7.01	1.53	5450	
24	11	26	22.3	5.7	0.89	Trace	Trace	28.89	0	28.89	100.0	7.63	0.96	1950	
36	17	20	17.4	7.9	1.69	Trace	Trace	26.99	0	26.99	100.0	8.00	0.51	200	Free lime
N% 0-6" 0.204 C/N 15.3															
Muko															
Profile 9. (22473-76)															
Ndega ½ mile N. of village, 6,000 ft.															
9	12	34	5.9	2.5	0	0	0.18	8.48	8.4	16.88	50.2	5.4	1.74	4	Very low P_2O_5 and K
18	14	42	5.1	2.5	0	0	0.10	7.70	7.7	15.40	50.0	5.6	1.31	2	
28	14	40	4.3	2.3	0	0	0.13	6.73	8.3	15.03	44.8	5.2	1.37	3	
40	10	42	3.4	1.6	0	0	0.04	5.04	4.5	9.54	52.8	5.8	-	2	

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Fort Portal															
Profile 10. (9132-37)															
Fort Portal, 3 miles N.E. of township, 5,000 ft.															
2	14	23	15.6	9.4	1.44	0	0.05	26.49	-	-	-	6.1	6.21	780	High P_2O_5
6	10	23	10.2	3.2	1.00	0	0.03	14.43	-	-	-	5.9	2.46	740	
12	12	19	9.5	2.5	0.50	0	Trace	12.50	-	-	-	5.6	1.91	435	
18	14	19	4.8	2.1	0.30	0	Trace	7.20	-	-	-	5.7	0.45	390	
30	12	27	8.3	2.8	0.35	0	0	11.45	-	-	-	5.7	0.39	370	
48	8	41	5.4	2.8	Trace	0	Trace	8.20	-	-	-	5.8	0.38	70	
Bubandi															
Profile 11. (18757-61)															
Kazingo, 1 mile S. of village, 5,000 ft.															
12	10	24	16.0	4.1	1.11	0	0.05	21.26	7.9	29.16	72.9	5.9	2.76	1950	Very high P_2O_5
22	12	26	9.8	4.9	0.69	0	0.03	15.42	5.1	20.52	75.1	6.0	0.74	2825	High K
32	14	28	10.4	3.8	0.77	0	.02	14.97	5.2	20.17	74.0	5.9	0.50	4625	
42	10	32	7.6	2.7	0.67	0	.02	10.97	4.2	15.17	72.3	5.7	0.26	1300	
56	8	24	5.8	1.8	0.55	0	0	8.15	3.9	12.05	67.6	5.9	0.21	460	
								N% 0-12" 0.281		C/N 9.8					
Bujuku															
Profile 12. (18840-41)															
Kitandara Lakes, ½ mile E. 13,500 ft.															
8	10	0	6.1	1.8	0.42	0	Trace	8.32	15.6	23.92	34.8	5.1	7.79	77	High C. and N due to altitude
12	2	0	2.3	0.6	0.42	0	0.16	2.88	-	-	-	5.2	6.27	72	
								N% 0-8" 0.450		C/N 17.3					

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Profile 13 (1 9011-13)															
Buguwagumu 11,000 ft.															
6	6	5	0.6	0.9	1.50	0	Trace	3.00	33.4	36.40	8.2	3.5	11.30	40	Very high C and N due to altitude
12	6	5	<.3	<0.6	1.08	0	0	1.08	49.2	50.28	2.1	3.2	11.27	28	
20	6	11	<.3	<0.6	0.31	0	0	0.31	20.9	21.21	1.5	3.2	2.75	19	
N% 0-6" 1.335 C/N 8.5															
Kyansabo															
Profile 14 (18875-78)															
Bulapaho, 9,000 ft.															
10	21	0	0.14	2.5	0.11	0	0	2.75	45.4	48.15	5.7	3.8	11.14	112	Very low pH and bases
20	20	11	0.02	T	0.21	0	0	0.24	-	-	-	3.9	1.52	28	
30	12	11	0.02	T	0	0	0	0.02	8.3	8.31	0.12	4.6	1.28	24	
46	18	15	0.06	T	0	0	0	0.06	-	-	-	4.9	1.23	22	
N% 0-10" 1.181 C/N 8.9															
Profile 15 (18861-63)															
Kyansabo, 8,500 ft.															
8	6	0	0.4	0.9	0.48	0	0.36	2.34	8.8	11.14	21.0	4.2	10.17	56	Very low bases, high C.
18	12	0	<.4	0.3	0.23	0	0.20	0.93	8.8	9.73	9.6	4.0	11.59	23	
24	14	0	2.0	<.3	0.17	0	0.12	2.29	-	-	-	4.0	5.72	20	
N% 0-8" 0.770 C/N 13.2															
Mulinda															
Profile 16 (18867-70)															
Bugoye, 7,000 ft. Grassland zone.															
4	20	19	8.1	3.2	0.25	0	0	11.55	6.8	18.35	62.9	5.3	2.90	23	
13	25	27	3.4	3.2	0	0	0.09	6.69	7.2	13.89	48.2	5.0	1.40	30	
22	25	27	3.1	3.1	Trace	0	0.13	6.33	6.1	12.43	50.9	4.9	0.94	10	
34	14	33	2.4	1.9	0.41	0	0.03	4.74	5.5	10.24	46.3	5.0	0.70	24	
N% 0-4" 0.366 C/N 7.9															

Depth Ins.	Mechanical Analysis % Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
Profile 17 (18798-02)															
Bubandi, 6,700 ft. Grassland zone															
7	20	22	12.2	4.8	1.19	0	0.04	18.23	13.4	31.63	57.2	5.6	3.92	350	High P_2O_5
17	18	28	9.9	3.1	0.38	0	0.04	13.42	5.4	18.82	71.9	5.5	1.28	200	
28	14	24	10.2	2.7	0.16	0	Trace	13.06	3.7	16.76	78.2	5.6	0.50	710	
43	18	26	13.7	3.3	0	0	0	17.00	3.2	20.20	84.2	5.7	0.35	3350	
53	20	32	N.D.	N.D.	N.D.	N.D.	N.D.	-	3.4		-	5.8	0.26	775	
N% 0-7" 0.463 C/N 8.5															
Mafuga															
Profile 18 (22488-92)															
Kanaba Gap. (1 mile E.) 7,900 ft.															
8	20	6	3.6	2.0	0.52	0	0.06	6.18	35.2	41.38	15.0	5.0	13.82	28	
26	28	14	0.16	0	0	0	0	0.16	6.2	6.36	2.5	5.1	4.76	5	Very low bases
36	28	14	0.05	0	0	0	0	0.05	29.6	29.65	0.2	5.2	5.00	10	
46	20	22	0.21	0	0	0	0	0.21	5.4	5.61	3.7	5.0	0.67	14	
72	13	34	0.15	0	0	0	0	0.15	6.7	6.85	2.2	5.4	0.46	19	
Buwhezu															
Profile 19. (22724-28)															
Butale, 6,500 ft.															
14	5	18	0.09	0	0	0	0	0.09	8.7	8.79	1.0	4.00	1.02	25	Very low bases and pH
28	5	18	0.06	0	0	0	0	0.06	7.9	7.96	0.8	4.20	0.94	8	
44	7	16	0.06	0	0	0	0	0.06	8.1	8.16	0.7	4.25	0.93	16	
56	7	16	0.03	0	0	0	0	0.03	9.0	9.03	0.3	4.45	0.73	28	
68	5	18	0.03	0	0	0	Trace	0.03	7.8	7.83	0.4	4.35	0.64	23	
N% 0-14" 0.168															

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H. m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Profile 20 (22444-47)															
Rubanda, 6,900 ft.															
8	16	26	0.20	0	0.20	0	<.02	0.40	7.4	7.80	5.1	4.25	3.68	32	Very low bases
30	14	26	0.03	0	0	0	Trace	0.03	6.1	6.13	0.5	4.10	1.08	31	and pH
48	14	16	0.04	0	0	0	0	0.04	8.5	8.54	0.5	4.00	0.96	51	
48+	16	8	<0.8	0	0	0	Trace	<0.8	2.3	-	-	4.30	0.44	23	
			N% 0-8" 0.354 C/N 10.4												
Kabale															
Profile 21 (4593-99)															
Kachwekano Farm, 6,900 ft.															
6	-	-	2.0	<0.6	0.45	0	0.04	2.49	14.0	16.49	14.9	4.8	4.02	-	Very low
11	-	-	0.9	<0.6	0.31	0	0.02	1.23	13.5	14.73	8.4	4.8	3.10	-	bases
21	-	-	-	-	-	-	-	-	-	-	-	4.7	1.55	-	
31	-	-	-	-	-	-	-	-	-	-	-	4.8	2.02	-	
35	8	28	Trace	Trace	Trace	0	Trace	0	7.6	7.6	-	4.9	1.87	-	
48	6	16	<0.8	Trace	Trace	0	Trace	0	-	-	-	4.7	0.89	-	
66	-	-	<0.8	Trace	Trace	0	Trace	0	3.5	3.5	-	4.8	0.34	-	
Profile 22 (4614-18)															
Kachwekano Farm, 7,100 ft.															
6	16	27	28.5	8.4	0.59	0	0.56	38.05	7.4	45.45	83.7	5.9	4.50	-	Former kraal site.
12	18	31	25.1	8.6	0.81	0	0.40	34.91	8.0	42.91	81.4	5.9	4.46	-	
17	12	41	20.7	6.3	0.42	0	0.33	27.75	9.1	36.85	75.3	5.7	3.70	-	
30	10	43	8.3	2.1	0.31	0	0.06	10.77	11.8	22.57	47.7	5.2	2.78	-	

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H. m.e.%	Exch. Capacity m.e. %	% Saturation	pH	Organic Carbon %	P_2O_5 p.p.m.	
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Profile 23. (4608-13)															
Kachwekano Farm, 7,100 ft.															
6	16	26	25.0	11.0	1.07	0	0.21	37.28	6.7	43.98	84.8	6.12	4.65	-	Very high bases, old Kraal site
22	N.D.	N.D.	-	-	-	-	-	-	-	-	-	5.75	4.71	-	
33	N.D.	N.D.	-	-	-	-	-	-	-	-	-	5.34	2.34	-	
48	N.D.	N.D.	6.6	2.4	0.41	0	0.13	9.54	-	-	-	5.05	1.00	-	
66	N.D.	N.D.	-	-	-	-	-	-	-	-	-	4.78	0.58	-	
66+	N.D.	N.D.	3.7	1.9	0.41	0	0.10	6.11	-	-	-	4.80	0.64	-	
			N% 0-6" 0.498 C/N 9.3												
Profile 24. (4619-26)															
Kachwekano Farm, 7,200 ft.															
6	12	37	21.8	13.6	2.78	0	0.34	38.52	6.1	44.62	86.3	5.8	6.91	-	Very high bases, old Kraal site
12	14	41	17.8	10.4	4.21	0	0.43	32.84	6.1	38.94	84.3	6.1	2.56	-	
18	16	36	14.0	8.8	3.51	0	0.11	26.42	5.3	31.72	83.3	6.2	1.43	-	
30	10	44	6.5	5.9	2.15	0	0.02	14.57	9.5	24.07	60.5	5.0	3.88	-	
42	6	48	<.4	1.5	1.81	0	0.02	3.33	10.9	14.23	23.4	4.4	1.15	-	
54	10	52	<.4	1.0	0.87	0	0.02	1.89	10.2	12.09	15.6	4.3	0.93	-	
66	10	57	<.4	<.6	0.53	0	<.02	0.53	9.9	10.43	5.1	4.3	0.81	-	
66+	4	62	<.4	<.6	0.55	0	Tr.	0.55	9.0	9.55	5.8	4.3	0.67	-	
			N% 0-6" 0.456 C/N 15.1												
Profile 25. (4668-75)															
Kachwekano Farm, 7,100 ft.															
2	12	22	V.H.	17.7	1.95	0	0.86	-	8.5	-	-	6.2	13.70	-	Very high bases throughout - old village site
24	20	24	26.7	5.8	0.47	0	0.11	33.08	4.4	37.48	88.3	6.3	3.30	-	
48	18	28	21.6	5.7	0.44	0	0.29	28.03	4.0	32.03	87.5	6.4	2.73	-	
60	22	24	18.7	2.8	0.27	0	0.12	21.89	4.0	25.89	84.6	6.4	2.64	-	
72	4	18	>30	2.9	0.34	0	0.26	-	3.5	-	-	6.6	3.54	-	
	14	22	19.4	1.5	0.27	0	0.11	21.28	2.4	23.68	89.9	6.8	2.80	-	
	2	22	16.8	1.9	0.31	0	0.07	19.08	2.2	21.28	87.7	6.9	2.00	-	
	4	28	11.3	1.4	0.31	0	0.03	13.04	1.0	14.04	92.9	7.0	0.52	-	
			N% 0-2" 0.935 C/N 14.6												

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H. m.e.%	Exch. Capacity m.e. %	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
									Ntendule						
									Profile 26. (22528-32)						
Kisizi, 3 miles W. of village. 7,000 ft.															
12	20	25	0.2	T	T	0	0	0.20	8.0	8.20	2.4	4.2	5.86	17	Very low bases,
32	2	33	0.2	0	0	0	0	0.20	5.8	6.00	3.3	4.2	1.06	12	high acidity
47	4	31	0.2	0	0	0	0	0.20	5.2	7.40	2.7	4.2	0.77	10	low P_2O_5
65	0	31	0.1	0	0	0	0	0	5.0	5.00	0	4.4	0.71	15	
76	6	37	0.1	0	0	0	0	0.1	4.8	4.90	2.0	4.1	0.66	14	
							N% 0-12"	0.374	C/N 15.7						High N and C
							Profile 27. (11203-07)								
Luhiza, 7,000 ft.															
6	17	9	< 0.4	0	0	0	0	-	-	-	-	2.91	14.33	89	Extremely low
12	21	23	0	0	0	0	0	0	9.4	9.4	0	3.32	2.67	17	bases, extremely
18	29	27	0	0	0	0	0	0	7.4	7.4	0	3.91	1.44	17	high acidity,
24	16	25	0	0	0	0	0	0	8.1	8.1	0	4.6	0.87	17	low P_2O_5
30	18	9	0	0	0	0	0	0	5.5	5.5	0	4.4	0.57	14	
							N% 0-6"	0.809	C/N 17.8						High C and N. raw humus.
							Bugamba								
							Profile 28 (20237-39)								
Bugamba, 5,800 ft.															
7	2	25	2.0	3.3	0.91	0	0.06	6.27	8.5	14.77	42.5	5.6	4.13	97	
18	26	26	0.06	0	<.16	0	<.02	0.06	8.8	8.86	0.7	5.0	2.33	7	Very low P_2O_5
18+	40	22	0.03	0	Tr.	0	Tr.	0.03	6.9	6.93	0.4	4.9	0.93	5	and bases. Low C/N
							N%	0.286	C/N 5.0						

Depth Ins.	Mechanical Analysis % Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H. m.e.%	Exch. Capacity m.e. %	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
								Lubare							
								Profile 29 (20989-91)							
Chanka Hill, 6,000 ft.															
12	6	6	1.07	0	Tr.	0	0	1.07	7.8	8.87	12.1	6.5	4.97	-	Low bases
22	8	6	0.32	0	Tr.	0	0	0.32	-	-	-	4.5	1.07	-	
22+	6	8	0.04	0	Tr.	0	0	0.04	8.1	8.14	0.5	5.2	2.03	-	
								Rugaga							
								Profile 30 (20957-60)							
East of Rugaga, 5,200 ft.															
8	11	39	7.8	5.0	0.56	0	Trace	13.36	4.0	17.36	77.0	6.6	2.12	19	Low P_2O_5
18	10	40	9.2	3.9	0.36	0	<0.02	13.46	3.0	16.46	81.8	6.5	1.28	17	
30	12	32	10.3	3.8	0.34	0	<0.02	14.44	2.1	16.54	87.3	7.0	1.30	56	
42	10	34	9.2	3.7	0.38	0	<0.02	13.28	0	13.28	100.0	7.3	0.89	57	
								Isingiro							
								Profile 31 (20972-73)							
Isingiro, 5,300 ft.															
8	7	23	12.6	5.0	2.27	0	0.02	19.89	4.7	24.59	80.9	6.4	3.9	1600	V. High P_2O_5
28	5	41	8.1	1.7	2.67	0	0	12.47	3.9	16.37	76.2	6.6	1.32	370	
								N% 0-8"	0.337	C/N 11.6					

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total	m.e.%	m.e. %					
Profile 32 (20969-71)															
Kasumba, 5,300 ft.															
9	8	15	9.8	1.4	0.16	0	0	11.36	3.0	14.96	75.9	6.5	2.39	425	
18	4	23	6.6	3.1	0.62	0	0	10.32	3.3	13.62	75.8	6.2	0.60	165	
28	6	29	5.5	3.5	0.67	0	0	9.67	4.1	13.77	70.2	6.0	1.46	51	
								N% 0-9" 0.127		C/N 18.8					
Kiamara															
Profile 33 (16437-42)															
Nyamusika Hill, 5,000 ft.															
6	0	54	9.2	2.6	0.20	0	0.10	12.10	6.8	18.90	64.0	5.3	2.25	16	Unsaturated clay
12	0	64	5.9	2.4	0	0	0.09	8.39	5.9	14.29	58.7	5.4	1.43	12	
24	3	66	3.3	1.0	0	0	0.02	4.32	5.3	9.62	44.9	4.9	0.47	26	low K. & P_2O_5
38	6	66	2.6	1.7	0	0	0.12	4.52	6.4	10.92	41.4	5.0	0.32	23	
52	4	64	2.1	1.9	0	0	0.16	4.16	8.1	12.26	33.9	4.6	0.56	28	
68	5	64	2.0	1.2	0	0	0	3.20	5.5	8.70	36.8	4.5	0.71	39	
								N% 0-6" 0.320		C/N 7.0					
Profile 34 (16298-304)															
Kyaninamirama Hill, Kibale Forest, 4,900 ft.															
1	3	16	28.0	6.9	0.87	0	0.08	35.85	-	-	-	7.25	9.87	166	High P_2O_5
6	11	30	18.7	5.2	0.52	0	0	24.42	-	-	-	7.18	3.60	97	C and bases
14	9	36	9.7	2.6	0.48	0	0	12.78	-	-	-	6.30	1.26	64	
26	7	48	7.1	1.6	0.28	0	0	8.98	2.4	11.38	78.9	6.40	0.42	12	
38	9	52	5.4	1.4	0	0	0	6.80	-	-	-	6.00	0.32	19	
50	5	52	4.5	2.2	0	0	0	6.70	-	-	-	5.85	0.39	19	
70	7	54	4.2	3.3	0	0	0	7.50	-	-	-	6.42	0.38	23	

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Profile 35 (19095-99)															
Kyangwali, Bunyoro, 3,700 ft.															
7	10	43	12.3	1.8	1.00	0	0	15.10	3.9	19.00	75.5	6.7	2.59	7	Low P_2O_5
14	10	43	7.3	1.8	1.83	0	0	10.93	3.4	14.33	76.3	6.6	1.25	8	
22	8	55	3.7	2.5	1.97	0	0	8.17	5.4	13.57	60.2	5.0	0.59	9	
30	2	61	3.6	2.5	1.87	0	0	7.97	5.2	13.17	60.5	5.0	0.33	9	
90	8	59	2.7	1.6	2.12	0	0	6.42	5.1	11.52	55.7	5.1	0.24	7	
N% 0-7" 0.259 C/N 10.0															
Kitonya															
Profile 36 (19075-79)															
Kitonya Hill, 4,200 ft.															
10	16	39	11.7	7.1	0.23	0	0.07	19.10	-	-	-	6.1	2.81	13	Very low
22	12	45	2.7	2.4	7	0	0.05	5.15	4.9	10.05	51.2	5.9	0.77	5	P_2O_5
34	8	51	1.3	0.6	0	0	0.13	2.03	4.2	6.23	32.6	5.9	0.24	5	
46	10	53	1.6	0.3	0	0	0.12	2.02	4.4	6.44	31.4	6.0	0.16	7	
72	4	51	1.6	0.3	0	0	0.08	1.98	4.3	6.28	31.5	5.0	0.15	8	
N% 0-10" 0.326 C/N 8.6															
Profile 37. (19085-87)															
Kitonya Hill, 4,500 ft.															
5	16	46	1.6	0.8	0.31	0	0.03	2.74	-	-	-	5.2	2.48	19	
10	12	50	<.02	<.6	Trace	0	0.02	0.02	9.3	9.32	0.2	4.9	1.46	9	Low P_2O_5
2	14	48	<.02	<.6	Trace	0	Trace	0	7.2	7.2	0	4.8	0.49	9	
N% 0-5" 0.242 C/N 10.2															

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
					Mawogola		Profile 38 (20922-26)								
Rwarurumba 4,300 ft.															
4	6	23	3.0	1.4	0.62	0	0	5.02	2.9	7.92	63.4	6.2	1.94	24	
8	12	23	2.0	1.2	0.45	0	0	3.65	3.5	7.15	51.0	5.8	1.12	10	Low P_2O_5 & bases
18	12	33	0.6	0.9	0.45	0	0	1.95	3.8	5.75	33.9	5.4	0.72	3	
30	6	41	0.5	0.9	0.86	0	0	2.26	4.3	6.56	34.5	5.3	0.58	6	
42	10	41	0.3	0.6	1.33	0	0	2.23	4.1	6.33	35.2	5.4	0.41	9	
							N% 0-8" 0.144 C/N 13.5								
							Profile 39 (20935-38)								
Near Rwarurumba, 4,300 ft.															
4	8	25	4.8	0.8	0.36	0	0.05	6.01	5.0	11.01	54.6	5.8	2.32	89	
12	10	31	4.1	1.6	0.33	0	0.02	4.45	2.7	6.15	72.4	6.1	1.22	38	
36	10	31	0.8	0.9	0.75	0	0.03	2.48	1.9	4.38	56.6	6.4	0.92	21	
36+	4	28	1.7	0.8	1.23	0	0.02	3.73	4.1	7.83	47.6	5.4	1.20	8	
							N% 0-4" 0.136 C/N 17.1								
							Bushenyi								
							Profile 40 (22621-24 & 22631)								
Four miles S. of Ishaka, 5,100 ft.															
14	8	26	0.02	0	0	0	0	0	11.1	11.1	0	4.5	3.74	14	Very low bases and P_2O_5
26	4	42	0	0	0	0	0	0	7.0	7.0	0	4.7	1.16	12	
42	2	42	0	0	0	0	0	0	7.6	7.6	0	4.7	1.08	10	
62	0	62	0.05	0	0	0	0	0.05	8.0	8.05	0.6	4.8	0.31	6	

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
								Buwekula							
								Profile 41 (16506-09)							
Rwaitengya, 4,200 ft.															
9	1	22	0.16	0	0.14	0	0.01	0.30	7.8	8.10	3.70	4.4	1.61	13	Very low bases
20	3	34	0.90	0.3	0.23	0	0.10	0.23	7.5	7.73	3.0	4.3	0.60	9	and P_2O_5
34	3	40	-	.0	0	0	0	-	-	-	-	4.4	0.53	10	
34+	0	38	0.02	0	0	0	0	0.02	7.3	7.32	0.3	4.4	0.29	8	
								N% 0-9" 0.144 C/N 11.2							
								Profile 42 (18818-22)							
Two miles E. of Kyegegwa, swamp fringe, 4,500 ft.															
7	8	10	1.6	1.2	1.23	0	0.14	4.17	3.7	7.87	53.0	5.2	1.06	5	Very low P_2O_5
15	7	15	<.8	<.6	0	0	0.02	-	3.8	-	-	4.7	0.45	1	and bases
24	7	17	0.3	0	0	0	0.06	0.36	3.7	1.06	34.0	4.7	0.38	18	low C/N
40	9	9	0.19	0	0	0	0.04	0.23	1.6	1.83	12.6	4.7	0.17	8	
50	9	7	0.12	0	0	0	0.02	0.14	1.8	1.94	7.2	4.6	0.12	3	
								N% 0-7" 0.190 C/N 5.6							
								Profile 43 (18833-37)							
Two miles E. of Kyegegwa.															
6	3	41	2.3	1.6	Tr.	0	0.07	3.97	7.0	10.97	36.2	5.1	2.63	59	Low bases
15	4	46	1.5	0.6	0	0	<.02	2.12	5.2	7.33	28.9	5.1	1.01	6	and N very low
22	7	49	<0.8	<.6	0	0	0.03	1.43	5.2	6.63	21.6	5.1	0.57	7	
34	3	55	0.9	<.6	0	0	0.03	1.53	4.3	5.83	26.3	4.9	0.55	39	
50	5	59	1.1	<.6	0	0	<.02	1.72	3.9	5.62	30.6	5.3	0.26	12	
								N% 0-6" 0.095 C/N 27.7							

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Ibanda															
Profile 44 (10322-26)															
Ibanda, ½ mile from rest house 5,000 ft.															
6	4	24	4.1	1.3	0.7	0	0.02	6.12	4.0	10.12	60.5	5.6	2.19	150	
17	2	32	1.3	1.0	0.7	0	0.05	3.05	4.6	7.65	39.9	5.1	1.20	51	
36	4	38	5.0	1.1	0.5	0	0.03	6.63	3.3	9.93	66.8	5.4	0.44	31	
48	2	38	5.8	1.6	1.0	0	0.04	8.44	3.2	11.64	72.5	5.9	0.36	62	
72	2	36	4.8	0.8	0.8	0	0.01	6.41	2.9	9.31	68.9	6.1	0.35	91	
N% 0-6" 0.209 C/N 10.5															
Profile 45 (22536-39)															
1 mile N.W. of Nyakashenyi, 5,700 ft.															
12	18	45	6.7	2.1	Tr.	0	0.08	8.88	6.0	14.88	59.7	5.9	1.67	11	
26	12	56	1.6	2.5	Tr.	0	0.07	4.17	5.4	9.57	43.6	4.8	0.84	15	
40	12	53	0.9	0.6	Tr.	0	0.06	1.56	5.8	7.36	21.2	4.7	0.62	19	
60	32	45	0	1.1	0	0	0.04	1.14	5.6	6.74	16.9	4.6	0.41	15	
N% 0-12" 0.226 C/N 7.4															
Mbarara															
Profile 46 (10363-67)															
4 miles N. of Birembo, 4,600 ft.															
6	15	21	13.6	7.5	1.3	0	0	22.40	2.6	25.00	89.6	6.4	3.93	143	
15	11	23	5.0	2.8	0.7	0	0.01	8.51	2.6	11.11	76.6	5.3	1.59	113	
25	9	26	2.9	1.6	0.4	0	0.04	4.94	3.4	8.34	59.2	5.2	0.53	39	
36	11	28	3.2	1.0	0.5	0	0.04	4.79	2.7	7.49	64.0	5.1	0.29	27	
48	11	30	2.3	1.3	0.5	0	0.03	4.13	2.7	6.83	60.5	5.5	0.24	13	
N% 0-6" 0.385 C/N 10.2															

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Rukiri Complex															
Profile 47 (10385-88 & 89)															
1 mile N of Rukiri, 5,000 ft.															
7	-	-	2.4	0.8	0.4	0	0.04	3.64	-	N.D.	N.D.	4.6	5.64	37	Low Bases
19	-	-	1.3	.8	0.2	0	0	1.50	-	N.D.	N.D.	4.5	1.52	22	Very acid
36	-	-	.8	0	0.3	0	0	1.1	-	N.D.	N.D.	4.4	0.59	11	
120	-	-	.8	0	0.6	0	0	1.4	-	N.D.	N.D.	4.3	0.48	22	
N% 0-7" 0.2333 C/N 24.2															
Profile 48 (19135-39)															
1½ miles N.E. of Busingiro, 3,600 ft.															
2	10	17	27.0	3.8	0.73	0	0	31.53	3.7	35.23	85.5	6.3	7.35	106	High organic matter & base
11	8	21	7.1	<.6	0.27	0	0	7.37	1.3	7.67	96.1	6.6	1.20	12	Low P_2O_5
23	4	39	2.3	<.6	0.36	0	0	2.66	2.4	5.06	52.6	5.9	0.37	7	Low bases &
32	10	32	1.2	<.6	0	0	0	1.20	3.3	4.50	26.7	5.0	0.35	5	P_2O_5
46	6	37	<.8	<.6	Tr.	0	0	-	3.2	-	-	4.7	0.28	4	
N% 0-2" 0.139 C/N 52.8															
Profile 49 (19130-34)															
3 miles N.E. of Busingiro, 3,600 ft.															
11	4	25	4.9	2.4	2.48	0	0.09	7.87	2.1	9.97	78.9	6.0	1.18	7	Low P_2O_5
20	6	25	0.4	0.8	0.19	0	0.12	1.51	5.7	7.21	21.0	4.7	0.47	6	Low P_2O_5 &
28		33	0.5	0.8	0.12	0	0.12	1.54	5.7	7.24	21.3	4.6	0.41	4	bases, high
40	6	33	0.4	0.7	0.13	0	0.04	1.27	4.8	6.07	20.9	4.7	0.35	1	acidity
58	8	39	0.7	0.6	<0.1	0	0.03	1.33	4.8	6.13	21.7	4.8	0.34	4	
N% 0-11" 0.153 C/N 7.8															

Depth Ins.	Mechanical Analysis % Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
Profile 50 (19069-71)															
2 miles E. of Luhunga hill, 3,600 ft.															
6	1	23	5.8	1.5	0.38	0	0.03	7.71	3.2	10.91	70.6	6.0	1.52	7	Low P_2O_5
16	5	33	0.8	1.1	Tr.	0	0.07	1.97	4.9	6.87	28.7	4.7	0.58	2	
30	4	33	1.1	0.7	0	0	0.10	1.90	5.4	7.30	26.0	4.4	0.47	0	
Bugangari															
Profile 51 (19121-23)															
4 miles S.E. of Butiaba, 3,000 ft.															
10	20	23	8.6	6.0	0.58	0	0.02	15.20	-	-	-	6.2	3.35	40	
20	19	25	7.3	8.8	0.30	0	Tr.	16.40	-	-	-	5.6	1.76	11	
20 + weathered rock															
Profile 52 (16494-98)															
1 mile E. of Dura Station 3,800															
9	7	12	9.4	11.4	0.16	0	0	20.96	4.5	25.45	82.3	5.7	2.26	11	Low P_2O_5 and K^2O_5
16	5	16	5.9	7.9	0	0	0	13.8	4.3	18.1	76.2	5.8	1.37	10	
28	9	12	5.4	10.1	0	0	0	15.5	2.5	18.0	86.0	5.7	0.51	15	
	8	10	6.2	12.6	0.16	0	0	18.96	5.3	24.26	78.0	6.0	0.29	18	

N% 0-9" 0.197 C/N 11.5

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
								Nyabushozi							
								Profile 53 (20911-14)							
4 miles N. of Kitabo dam, 4,650 ft.															
6	8	23	5.7	1.4	0.8	0	0	7.90	5.8	13.70	57.7	6.0	2.77	160	
14	10	29	4.6	1.1	0.92	0	0	6.62	5.1	11.72	56.5	6.0	1.53	175	
28	8	37	4.5	0.9	1.17	0	0	6.57	4.1	10.67	61.6	6.0	1.10	106	
40	4	43	3.2	1.3	1.40	0	0	5.90	3.1	9.00	65.6	6.2	0.46	64	
							N% 0-6"	0.076	C/N 36.5						
								Profile 54 (20906-20910)							
½ mile W. of Kitabo dam, 4,500 ft.															
3	8	17	<.8	0.6	<.16	0	0	1.5	4.7	6.2	24.2	5.3	0.96	18	low base & P_2O_5
9	6	21	<.8	<.6	0.33	0	0.02	1.8	5.8	7.6	23.7	4.7	0.70	10	
18	6	21	<.8	<.6	Tr.	0	0.03	1.4	7.5	8.9	15.7	4.6	0.62	14	
34	8	25	<.8	<.6	0	0	0	1.4	5.3	6.7	20.9	4.6	0.45	12	
64	12	33	1.6	<.6	0	0	0	2.2	4.3	6.5	33.8	5.4	0.35	3	
							N% 0-9"	0.100	C/N 9.6						
								Profile 55 (20938-45)							
Mizi dam, 4 miles N.E. of Sanga, 4,200 ft.															
8	4	25	2.3	0.9	0.31	0	0.04	3.55	5.3	8.85	40.1	5.4	1.20	8	Low P_2O_5
20	6	23	1.2	0.7	0.20	0	0.04	2.14	4.7	6.84	31.3	5.3	0.81	8	
32	2	27	0.8	0.3	<.1	0	0.03	1.13	5.6	6.73	16.8	5.0	0.56	8	
44	8	33	1.4	0.8	0.12	0	0.03	2.35	3.6	5.95	39.5	5.1	0.48	12	
56	4	33	2.8	0.7	0.11	0	0	3.61	3.6	7.21	50.1	5.6	0.36	17	
68	6	37	2.6	1.6	0.25	0.4	0	4.55	2.9	7.45	61.1	6.2	0.33	25	
68+	6	43	5.2	2.5	0.32	0.5	0	8.52	1.7	10.22	83.4	7.8	0.33	32	
							N% 0-8"	0.108	C/N 11.1						

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e. %	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Hoima															
Profile 56 (19067-19068)															
2 miles W. of Hoima, 3,600 ft.															
8	8	35	1.4	1.0	0.16	0	0.11	2.67	8.2	10.87	24.6	4.9	1.46	2	Low P_2O_5 & base
20	5	5	<.8	<.6	Tr.	0	0	1.4	9.7	11.1	14.4	5.1	0.59	2	
			N% 0-8" 0.135 C/N 10.8												
Profile 57 (18944-49)															
1 mile N. of Naitondo Hill 3,500 ft.															
8	10	23	1.8	2.4	0.14	0	0.19	4.53	10.6	15.13	15.1	5.4	2.69	21	
17	20	33	0.8	<.3	0.16	0	VH	0.86	10.0	10.86	7.9	4.8	0.98	12	High Mn & acidity
32	14	39	1.0	<.3	0.14	0	VH	1.14	7.9	9.04	12.6	4.8	0.91	7	with low base &
46	14	43	1.6	<.3	0.15	0	0.13	1.88	9.0	10.88	17.3	4.7	0.41	8	P_2O_5
68	18	35	2.0	Tr.	0	0	0	2.00	7.6	-	-	4.8	0.31	6	low base &
68+	20	23	<.4	<.3	0.13	0	0.02	0.15	5.5	5.65	2.7	4.9	0.05	7	P_2O_5
			N% 0-8" 0.257 C/N 10.5												
Kigumba															
Profile 58 (19149-58)															
Immediately N. of Kigumba farm buildings, 3,800 ft.															
5	6	26	2.7	0.8	1.27	0	0.03	4.80	7.4	12.20	39.4	5.1	2.78	29	Low P_2O_5
18	4	40	0.6	<.3	0.63	0	0.10	1.33	8.3	9.63	13.8	4.8	0.92	2	& bases
33	8	42	1.3	0.3	0	0.3	0.12	2.02	5.6	7.62	26.5	5.0	0.51	5	
48	8	42	1.1	0.4	0	0.5	0.08	2.08	4.3	6.38	32.6	5.3	0.35	7	
60	4	38	1.1	0.3	0	0.5	0.03	1.63	4.2	5.83	28.0	5.0	0.22	7	
72	4	42	1.1	0.7	0.08	1.1	0.02	3.00	4.5	7.50	40.0	4.8	0.20	12	
84	4	32	0.4	<.3	0	1.0	0.01	1.00	5.3	6.30	15.9	4.6	0.32	8	
			N% 0-5" 0.140 C/N 19.8												

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							

Profile 60 (18931-35)

5½ miles S.W. Atura, 3,600 ft.

6	16	23	11.8	3.2	2.34	0	Tr.	17.34	3.6	20.94	83.0	6.8	2.68	200	
16	10	35	7.6	2.1	0.42	0	Tr.	10.12	2.8	12.92	78.0	6.6	1.19	200	
32	6	47	6.3	2.0	0.98	0	Tr.	9.28	2.3	11.58	80.2	6.8	0.85	12	
38	6	25	1.6	0.6	0.42	0	0	2.62	N.D.	N.D.	N.D.	5.8	0.32	8	
38+	8	19	0.8	<.6	0.91	0	0	1.71	N.D.	N.D.	N.D.	6.0	0.20	2	

N% 0-6" 0.227 C/N 11.8

Burili

Profile 61 (19144-46)

18 miles from Masindi on Kampala Rd. 3,650 ft.

5	4	25	2.7	2.1	Tr.	0	Tr.	4.8	3.8	8.6	55.0	6.1	1.64	12	) low P_2O_5
12	4	31	1.1	<.6	Tr.	0	0.03	1.75	5.9	7.6	22.8	5.0	0.56	13	) & bases
20	4	38	<.8	<.6	0.16	0	0.04	1.5	6.7	7.2	20.9	5.0	0.26	19	)

N% 0-5" 0.082 C/N 20.0

Profile 62 (19064-67)

15 miles from Masindi to Paraa. 3,400 ft.

6	12	26	9.8	3.1	0.53	0	0.03	13.46	6.0	19.46	69.2	6.1	2.93	21	
12	12	30	5.3	1.7	Tr.	0	Tr.	7.0	3.5	10.5	66.7	6.0	2.00	32	
24	8	38	1.1	1.4	0.12	0	0.14	3.84	5.3	9.14	42.0	5.6	1.16	5	
36	4	4	1.3	0.9	0.16	0	0.13	2.49	N.D.	10.59	23.5	5.5	0.60	4	

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H. m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon %	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							

Dura

Profile 63 (16480-82)

2 miles W. of Dura Station, 3,200 ft.

14	2	14	5.2	2.5	0.72	0	0	8.42	6.3	14.72	57.3	5.1	4.95	18	
26	6	28	2.9	1.4	0.27	0	0	4.57	8.0	12.57	36.4	5.0	1.32	13	
26+	8	34	29.2	4.2	1.11	0	0	34.51	N.D.	N.D.	N.D.	7.5	0.65	43	

N% 0-14" 0.426 C/N 11.6

Profile 64 (16483-85)

Dura 3,200ft.

10	6	38	>30.0	3.8	1.40	0	0	35.4	2.4	37.8	93.6	7.2	1.22	980	) High Ca
16	8	34	>30.0	6.3	1.78	0	0	38.1	3.4	41.5	91.8	7.3	1.53	550	) & P_2O_5
16+	7	24	19.9	4.2	1.05	0	0	25.15	N.D.	N.D.	N.D.	7.9	0.50	22	

Nyakashuli

Profile 65 (13516-22)

½ mile W. of Nyakashuli, 3,700 ft.

6	5	7	2.6	0.9	0.30	0	0.24	4.04	4.0	8.04	50.2	5.9	1.20	11	) low base
12	4	9	2.2	0.3	0	0	0.29	2.79	4.0	6.79	41.1	5.7	0.72	11	) & P_2O_5
18	4	9	1.6	0.3	0	0	0.16	1.76	3.6	5.36	32.8	5.6	0.60	10	)
28	4	13	1.9	0.3	0	0	0	1.90	N.D.	N.D.	N.D.	5.8	0.29	6	)
48	3	11	1.1	0	0	0	0.03	1.13	2.6	3.73	30.3	6.0	0.12	10	)
72	1	15	1.8	0	0	0	0	1.80	N.D.	N.D.	N.D.	6.0	0.09	11	)
96	3	19	1.2	0	0	0	0.03	1.23	2.8	4.03	30.5	5.7	0.35	22	)

N% 0-6" 0.174 C/N 6.9

Depth Ins.	Mechanical Analysis % Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon	Truog P_2O_5	Remarks
Rwanga															
Profile 66 (13502-08)															
2 miles N.W. of Rwanga, 3,600 ft.															
6	6	19	3.7	0.4	0.40	0	0	4.50	N.D.	N.D.	N.D.	5.9	0.99	177	
12	3	4	3.3	1.0	0.24	0	Tr.	4.54	N.D.	N.D.	N.D.	5.6	0.61	167	
24	5	7	2.6	0.6	0.32	0	Tr.	3.52	N.D.	N.D.	N.D.	5.7	0.47	100	
46	5	7	2.7	0.7	0.38	0	Tr.	3.78	2.2	5.98	63.2	6.1	0.43	82	
60	3	7	3.2	<0.6	0.54	0	Tr.	3.74	N.D.	N.D.	N.D.	6.2	0.47	51	
78	1	11	3.5	0.6	0.69	0	Tr.	4.79	N.D.	N.D.	N.D.	6.3	0.23	4	
							N% 0-6"	0.093		C/N 10.6					
Paraa															
Profile 67 (19026-30)															
½ mile S. of Paraa ferry, 2,100 ft.															
8	8	13	2.1	1.3	0.24	0	0.23	3.87	3.5	7.37	52.5	5.5	0.82	28	
18	12	11	2.0	2.3	0.16	0	0.24	4.70	3.0	7.70	61.0	5.4	0.51	27	
28	6	33	2.7	4.2	0.22	0.6	0.15	7.77	4.0	11.77	66.0	5.0	0.29	3	
44	8	33	2.7	4.9	0.25	0.6	0.08	8.53	4.4	12.93	66.0	5.0	0.23	5	
56	4	31	3.3	4.7	0.30	0.6	0.07	8.97	3.2	12.17	73.7	5.4	0.06	6	
							N% 0-8"	0.100		C/N 8.2					
Profile 68 (19020-25)															
4½ miles S. of Paraa, 2,800 ft.															
6	4	7	2.0	0.6	0.30	0	0.08	2.98	2.2	5.18	57.5	5.8	0.70	58	)
16	2	13	2.8	<0.6	0.25	0	0.07	3.12	2.5	5.62	55.5	5.7	0.15	5	) low P_2O_5
24	4	27	1.0	<0.6	0.23	0	0.09	1.32	3.9	5.22	25.3	4.7	0.19	7	)
34	4	29	1.1	<0.6	Tr.	0	0.11	1.21	3.9	5.11	23.7	4.7	0.23	0	)
46	4	29	1.3	<0.6	Tr.	0	0.10	1.40	3.1	4.50	31.1	5.0	0.20	6	)
66	4	29	1.3	<0.6	Tr.	0	0.03	1.33	2.7	4.03	33.0	5.1	0.12	6	)
							N% 0-6"	0.057		C/N 12.3					

Depth Ins.	Mechanical Analysis % Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon	Truog P_2O_5	Remarks
Ishasha															
Profile 69 (14164-66)															
1 mile S. of Rwensama, 3,100 ft.															
3	6	11	7.7	2.8	0.69	0	0.04	11.23	5.7	16.93	66.3	5.3	1.73	132	
6	7	11	9.5	3.5	0.81	0	0.05	13.86	6.3	20.16	68.8	5.5	1.80	58	
12	10	17	11.0	4.5	0.89	0	0.04	16.43	3.9	20.33	80.8	5.9	1.35	31	
			N% 0-3" 0.140 C/N 12.3												
Kasese															
Profile 70 (23771-74)															
1½ miles N.E. of Rukoki, Toro															
9	16	22	7.3	2.5	0.44	0	0.04	10.28	3.4	13.68	75.1	6.0	1.95	260	
19	20	24	7.5	2.5	0.28	0	Tr.	10.28	2.3	12.58	81.7	6.3	0.95	280	
39	19	28	8.6	3.3	0.39	0	Tr.	12.29	0.7	12.99	97.0	6.9	0.56	325	
54	21	18	6.6	1.3	Tr.	0	0	7.90	0	7.90	100.0	7.8	0.17	199	
Bwamba															
Profile 71 (18894-98)															
1 mile N.W. of Harugali, 3,300 ft.															
13	12	25	10.2	6.6	2.27	0	0	18.07	8.6	26.67	67.8	5.9	4.44	184	
20	12	34	4.2	2.5	0.72	0	0	7.42	7.3	14.72	50.4	5.2	1.18	14	low P_2O_5
33	10	46	5.7	2.3	0	0	0	8.00	4.4	12.40	64.5	5.5	0.53	11	
52	8	54	5.1	2.9	0	0	0	8.00	5.6	13.6	59.0	5.6	0.32	5	
52+	14	50	6.6	5.0	0	0	0	11.60	4.1	15.70	73.9	5.6	0.68	7	
			N% 0-13" 0.378 C/N 11.7												

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							

Profile 72 (18889-93)

1 mile S. of Bundibugyo, 3,200 ft.

10	N.D.	N.D.	10.8	3.2	0.39	0	0.09	14.48	7.1	21.58	67.1	5.3	2.24	16	Low P_2O_5
18	6	24	8.6	3.0	0.20	0	0.05	11.85	3.6	15.45	76.7	5.8	0.78	16	
40	6	23	6.8	2.3	0.16	0	0.02	8.28	2.5	10.78	76.8	5.9	0.17	11	
58	21	37	17.0	5.0	0.18	0	0.03	22.21	2.5	24.71	89.9	6.3	0.17	9	
70	17	25	17.6	6.4	0.17	0	0	24.17	2.0	26.17	92.4	6.5	0.11	11	

N% 0-10" 0.268 C/N 8.4

Wasa

Profile 73 (18922-27)

4 miles E. of milepost 18 Fort Portal-Bundibugyo Rd. 3,200 ft.

8	8	23	8.6	3.1	0.34	0	0.09	12.13	7.1	19.23	63.1	5.6	2.36	33	
17	4	29	5.3	1.4	0.11	0	0.02	6.83	5.2	12.03	56.8	5.4	0.64	5	
29	0	43	3.2	2.7	0	0	0	5.90	3.9	9.80	60.2	5.6	0.64	11	low P_2O_5
36	4	19	3.8	1.3	0	0	0	5.10	3.6	8.70	58.6	6.3	0.25	2	
50	6	21	4.7	1.6	0	0	0	6.30	3.9	10.20	61.8	6.1	0.24	2	
50+	8	41	16.0	5.9	0.19	0	0	22.09	3.0	25.09	88.0	4.7	0.06	7	

N% 0-8" 0.184 C/N 12.8

Profile 74 (18913-20)

10 miles E. of milepost 18, Fort Portal-Bundibugyo Rd. 3,000 ft.

6	6	12	1.8	1.3	Tr.	0	0.22	3.32	3.5	6.82	48.7	5.3	0.64	9	
14	8	19	3.7	1.5	Tr.	0.7	0.14	6.04	2.8	8.84	68.3	5.7	0.38	7	
24	6	19	4.7	1.2	0.21	1.2	0.02	7.33	1.3	8.63	84.9	6.3	0.29	7	low C,N
36	4	19	4.9	1.2	0.16	1.1	0	7.36	0.5	7.86	93.6	7.1	0.15	6	& P_2O_5
43	6	17	5.8	1.4	0.22	1.2	0	8.62	0.3	8.92	96.6	7.0	0.14	1	
65	16	33	14.5	5.3	0.22	2.0	0	20.22	0.7	20.92	96.7	4.7	0.07	11	
96	10	33	13.7	6.7	0.34	2.9	0	23.64	0.3	23.94	98.7	6.9	0.08	12	
108	16	37	8.7	2.8	0.35	0	0	12.33	0.5	12.83	96.4	6.8	0.02	12	

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
									Profile 74 (18913-20)						
									N% 0-6" 0.076 C/N 8.4						
									Profile 75 (18907-12)						
14 miles E. of milepost 18 Fort Portal - Bundibugyo Rd. 2,800 ft.															
9	10	14	2.9	1.5	T	0.55	0.09	4.99	4.1	9.09	54.9	5.1	0.73	15	Low C & N
21	8	22	4.3	1.7	0.22	1.2	0.07	7.49	2.8	10.29	72.8	5.6	0.24	7	
31	18	26	8.8	2.9	0.43	2.3	0.02	14.45	0.5	14.95	96.7	7.2	0.65	0	
38	14	28	11.3	3.0	0.31	2.6	0	17.21	0.1	17.31	99.4	7.7	0.23	17	
46	18	26	15.6	3.4	0.18	2.3	0	21.48	0.5	21.98	97.7	7.8	0.20	52	
72	12	32	11.4	3.7	0.30	2.5	0	17.90	1.1	19.00	94.2	7.6	0.39	14	
									N% 0-9" 0.077 C/N 10.5						
									Papyrus Peat						
									Profile 76						
									Profile 77						
									Bukora						
									Profile 78 (20915-21)						
6 miles N.W. of Kitabo, 4,400 ft.															
3	14	23	5.3	1.80	0.55	0	0.19	7.84	6.5	14.34	54.7	5.0	4.05	16	Low P_2O_5
15	16	29	4.4	1.21	0.27	0.3	0.13	6.31	4.8	11.11	56.8	4.8	2.31	11	
28	8	45	12.9	4.2	0.25	1.1	0.05	18.50	3.7	22.20	83.3	5.1	0.47	11	
50	6	37	13.0	3.5	0.25	0.9	∠.02	17.65	3.3	20.95	84.2	4.8	0.14	42	
64	6	37	13.2	3.6	∠.16	1.2	0	18.00	2.4	20.40	88.2	5.1	0.27	41	
78	16	31	17.6	5.3	∠.16	1.3	0	24.20	2.5	26.70	90.6	4.8	0.25	16	
78+	10	15	5.9	1.9	0	0.3	0	8.10	1.8	9.90	81.8	5.2	0.10	5	

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							

Profile 78 (20915-21)

N/A 0-3" 0.303 C/N 13.4

Profile 79 (19045-49)

1 mile S. of Kijenjubwa, 3,450 ft.

6	14	14	4.8	1.9	0.41	0	0.03	7.14	4.2	11.34	63.0	5.7	3.92	69	
13	14	15	2.6	2.0	0.22	0	Tr.	4.82	3.4	8.22	58.6	5.1	0.68	2	P_2O_5 deficient
20	10	21	4.4	3.0	0.28	0	0	7.68	2.7	10.38	74.0	5.1	0.63	5	
30	8	43	10.4	5.8	0.50	0.9	0	17.60	3.6	21.20	80.5	5.5	0.68	3	
50	2	33	9.1	6.8	0.36	0.8	0	17.06	2.8	19.86	85.9	5.5	0.23	5	

N/A 0-6" 0.168 C/N 22.3

Sebwe

Profile 80 (8807-13)

4 miles N.E. of Kasese 3,000 ft.

6	16	18	2.3	3.0	3.44	Tr.	0.04	8.78	1.7	10.48	83.8	7.0	4.92	1460	
12	8	16	6.3	1.1	1.00	Tr.	0.03	8.43	1.9	10.33	81.6	7.0	1.55	335	Very high
24	20	22	18.9	2.5	0.64	Tr.	0.03	22.07	1.7	23.77	92.8	6.8	0.81	900	P_2O_5
36	2	22	21.9	2.6	0.50	Tr.	0.03	25.03	1.0	26.03	96.2	6.6	0.74	475	
48	18	24	15.9	2.2	0.39	0	0.01	18.40	0.7	19.10	96.3	6.5	0.21	1090	
60	14	22	13.1	2.3	0.21	0	0.04	15.65	0.4	16.05	97.5	6.7	0.15	1030	
72	18	26	18.7	3.0	0.63	0	0.05	22.38	0.4	22.78	98.2	6.8	0.14	1100	

N/A 0-6" 0.427 C/N 11.5

Depth Ins.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H m.e.%	Exch. Capacity m.e.%	% Saturation	pH	Organic Carbon	Truog P_2O_5	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
Semliki															
Profile 81 (8763-8769)															
Semliki flats, 10 miles E. of Rwebishengo, 2,300 ft.															
6	14	26	3.8	8.0	3.22	2.0	Tr.	17.02	7.9	24.92	68.3	6.1	4.62	128	
12	18	34	2.7	8.0	4.87	3.3	0	18.87	1.0	19.87	95.0	6.8	0.89	28	High Na
24	22	40	1.9	7.9	5.94	6.1	0	21.84	0	21.84	100.0	7.4	0.53	38	
36	18	26	1.9	9.3	3.85	6.0	0	21.05	0	21.05	100.0	7.7	0.20	39	
48	19	43	1.4	13.3	5.63	12.5	0	32.83	0	32.83	100.0	7.6	0.20	37	
60	22	40	4.1	6.9	4.92	17.2	Tr.	33.12	0.2	33.32	99.4	7.3	0.20	64	
72	21	53	4.5	10.6	3.63	12.5	Tr.	31.23	0.7	31.93	97.8	7.1	0.18	51	
N% 0-6" 0.373 C/N 12.4															
Woiga															
Profile 82 (10402-10)															
1 mile E. of Butiaba, 2,050 ft.															
3	13	27	2.0	13.1	2.5	.3	0	17.60	0.5	18.10	97.2	7.1	2.10	1040	
6	7	35	5.0	13.1	0.5	4.1	0	22.70	0	22.70	100.0	7.9	1.14	725	High Mg & P_2O_5 & Na.
9	11	34	4.5	16.2	0.5	6.1	0	27.30	0	27.30	100.0	7.9	1.01	605	
24	43	0	15.6	18.1	0.6	14.9	0	39.20	0	39.20	100.0	7.7	0.80	510	
33	43	0	9.7	18.5	0.6	17.1	0	35.90	0	35.90	100.0	7.9	0.63	495	
57	45	5	7.5	15.6	0.7	18.6	0	42.40	0	42.40	100.0	7.8	0.60	637	
81	39	0	6.0	20.8	0.7	21.7	0	43.20	0	43.20	100.0	7.9	0.27	620	
105	10	4	6.0	18.5	0.4	18.6	0	43.50	4.1	47.60	91.4	7.9	0.18	395	
105+	18	0	11.5	1.1	Tr.	0	0	12.60	0	12.60	100.0	7.9	0.09	101	
N% 0-3" 0.245 C/N 8.6															

Depth In.	Mechanical Analysis %		Exchangeable Bases (Cations) Milli-equivalents per 100 g. Soil						Exch. H m.e. %	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															
Profile 83 (25991-95)															
2 miles W. of Masindi Port, 3500 ft.															
7	18	26	7.34	3.2	0.48	0.11	0.14	11.27	4.8	16.07	70.1	5.6	1.67	114	Very acid and low P_2O_5
18	16	38	4.37	2.7	0.17	0.19	0.16	7.59	7.8	15.39	49.3	4.6	1.10	3	
28	10	44	4.37	2.1	0.21	0.10	0.14	6.92	7.4	14.32	48.3	4.5	-	4	
44	10	44	3.91	1.5	0.18	<0.02	0.16	5.77	7.4	13.17	43.8	4.4	-	3	
54	-	-	4.76	1.7	0.22	0.07	0.17	6.92	6.2	13.12	52.8	4.4	-	3	
N% 0-7" 0.170 C/N 9.8															
Bukora															
Profile 84 (25987-90)															
5 miles S.W. of Masindi Port, 3400 ft.															
9	-	-	12.10	8.5	0.90	0.08	0.38	21.96	11.4	33.36	65.7	4.9	2.56	39	High base exc capacity due to presence o montmorilloni clay
22	-	-	12.95	11.0	0.48	0.06	0.71	25.20	8.0	33.20	75.9	4.9	1.57	7	
42	-	-	16.40	12.4	0.48	<0.02	1.37	30.67	5.3	35.97	85.2	5.2	-	3	
50	-	-	23.75	20.2	0.58	0	2.21	46.74	1.2	47.94	97.5	6.8	-	4	
N% 0-9" 0.211 C/N 12.1															