REPUBLIC OF KENYA

MINISTRY OF AGRICULTURE—NATIONAL AGRICULTURAL LABORATORIES

KENYA SOIL SURVEY

The soils of Norther Provin-
ce

by

C.D.Ollier 1959

THE SOILS OF NORTHERN PROVINCE

(excluding Karamoja District)

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UGANDA PROTECTORATE

DEPARTMENT OF AGRICULTURE

MEMOIRS OF THE RESEARCH DIVISION

SERIES I: SOILS

Number 3

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A Reconnaissance Survey

by

C. D. Ollier, M.Sc. (Brist.), F.G.S. Soil Survey Officer

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Kawanda Research Station 9th April, 1959.

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(EXCLUDING KARAMOJA DISTRICT)

A Reconnaissance Survey

by C.D. Ollier, M.Sc., F.G.S.
Soil Survey Officer, Department of Agriculture

GENERAL.

Information regarding Northern Province (excluding Karamoja) on extent, climate, ethnography, history, communications, vegetation, crops and farming systems will be recorded in the memoirs on vegetation and farming systems. It is more relevant here to concentrate on geology and geomorphology as a background to the soils of the area. Field, cartographic and laboratory methods used in this survey are the same as those described in the memoir on Eastern Province soils. Similarly, the definitions of terms apply here. The uncoloured map accompanying this memoir is drawn on the 1:500,000 scale. The final editions of both the map and memoir will be printed in the format of the publications of the Soil Survey of the United Kingdom; the coloured maps being on the new standard 1:250,000 grid sheets.

GEOLOGY AND GEOMORPHOLOGY.

With the exception of the Rift Valley deposits, of probable Pleistocene age, the whole of Northern Province is underlain by granitic and metamorphic rocks of the Basement Complex (Pre-Cambrian). A wide range of rock types is represented, including quartzites, schists, amphibolites, charnockites, phyllites, mylonites and others. Rock type is of considerable importance in some areas - in detailed soil mapping it is often of prime importance - but in reconnaissance mapping the influence of petrology often has to be overlooked. However, some mapping units, such as Zeu, are largely correlated with rock type.

Over wide areas of Northern Province the original rocks have been very deeply pre-weathered (Ollier, 1959) and it is the regolith - not fresh rock - which is the parent material of soils. In many areas, therefore, a straightforward geological map would give little indication of soil type.

Most of the Rift Valley sediments occur in West Nile District where they are represented by red coarse sands and very subordinate amounts of clay, gravel and diatomite. Similar sediments occur in Acholi, but gravel and clay are more common.

The natural features of Northern Province are best seen by a journey from east Acholi to the west of West Nile. The first part of such a journey is very monotonous for Acholi is a vast plain, with only occasional hills rising abruptly from it. At the Nile the first of the Rift Valley faults is seen, but although it has a throw of probably several thousand feet, the resulting topography is not very spectacular. Rift Valley deposits occur mostly in West Nile and there is only a very narrow strip in Acholi, except for the south west part of the Murchison Game Park. In West Nile they are backed by a series of fault scarps arranged *en echelon* which separate the Rift Valley plain from the Madi plain. This plain is, in turn, stopped by another large scarp to the west, above which is the West Nile Plateau. These physiographic forms are depicted on the geomorphology map. This succession of plains is largely due to rift valley movement acting on one, or in places possibly two erosion surfaces.

The Acholi plain is part of the African or end-Tertiary surface, and there are no certain traces of the older Gondwana surface in Northern Province. A very small area at Lendu near Zeu is possibly a remnant of the Gondwana surface. The relationship between

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The natural features of Northern Province are best seen in a journey from east Acholi to the west of West Nile. The first part of such a journey is very monotonous for Acholi is a vast plain, with only occasional hills rising abruptly from it. At the Nile the escarpment of the Rift Valley fault is seen, but although it has a throw of probably several thousand feet, the resulting topography is not very spectacular. Rift Valley deposits occur mostly in West Nile and there is only a very narrow strip in Acholi, except for the south west part of the Murchison Game Park. In West Nile there are a number of a series of fault scarps arranged en echelon which separate the Rift Valley plain from the Madi plain. This plain is, in turn, succeeded by another large escarp to the west, above which is the West Nile Plateau. These physiographic forms are depicted on the geomorphological map. This succession of plains is largely due to rift valley movement acting on one, or in places possibly two erosion surfaces.

The Acholi plain is part of the African or end-Tertiary surface, and there are no certain traces of the older Gondwana surface in Northern Province. A very small area at Londe near Adu is possibly a remnant of the Gondwana surface. The relationship between the two principal erosion surfaces of Uganda has been established by a study of the topographic features in Eastern Province and Mengo. The lower of these, the African surface, has been found, in the present survey, to be continuous with the main surface of Northern Province.

As mentioned above, the African surface is largely cut across rotted or pre-weathered rock, and such areas are shown on the geomorphic map. The so-called "Acholi" surface (McConnell, 1955) is cut across fresh rock. The two surfaces are not separated by any fundamental change in base level, and there is no erosion scarp between them, and it is probable that they are parts of one and the same erosion surface; the Acholi being part of the African surface where all the regolith has been stripped off by erosion. As the presence or absence of a regolith is of fundamental importance to soil formation the term Acholi surface has been retained as a useful name for the lowest parts of the African surface.

The West Nile escarpment has been mapped by Hepworth (1955) as a warp, rather than a true fault, which has been emphasized by later erosion. But the Rift Valley escarpments are all true fault scarps. They are highest in the south, and smaller "hinge zone" faults appear in the northern part according to Macdonald (1958). An ancient Acholi fault is responsible for the remarkably straight course of the Aswa river, although it does not produce any outstanding features of relief.

These opinions on the ages and correlations of erosion surfaces and faulting are in agreement with Ruhe's findings in the Belgian Congo and are supported by Hepworth's findings in West Nile District. They are, however, opposed to the ideas of many other writers, such as Lepersonne (1956), Dixey (1956) and McConnell (1955). Perhaps it is because Ruhe partly based his correlations of surfaces on soil studies, and not simply on altitudes and attitudes, that his results are similar to those of the present survey.

Most of the hills in the Province are of inselberg type, and rise abruptly from the plains as steep, bare masses of fresh, solid rock, usually with no soil cover at all. Their formation has been described by Ollier (1960). The Madi hills of West Nile appear to be remnants of a dissected, uptilted fault block, with a fault scarp parallel to the Nile near Dufile. The Agoro Hills in Acholi are also possibly the result of faulting. There is an undulating plateau on the top of the hills, but the south facing scarp separating this from the lower Acholi plain is very steep, and valleys carrying water from the high surface "hang" above the lower surface - that is they are not graded to the lower surface.

In Eastern Province there is evidence to show the existence of a former great lake on the site of present Lake Kyoga but very much more extensive. This extended into Northern Province, but here it was really a system of wide, shallow rivers rather than a true lake. A veneer of alluvium was deposited which is now the parent material of some soils. This part of the African surface might be regarded as a "panplain" rather than a pediplain. Earth movement also controlled the form of river valleys; some are small and "normal" but others, as in Lango, are wide and swamp filled. The area of swamps around Pakelle may also be due to earth tilting, possibly associated with faulting near Dufile and the Madi Hills.

All major valleys are aggraded, but alluvial and swamp deposits have not been extensively studied. In some places, such as over the Pager mapping unit, alluvial soil profiles are fairly well differentiated, indicating maturity, and therefore a considerable age to the alluvium. In most places, however, the layers in alluvial or swamp profiles are due to original alluvial deposition and not to soil forming processes, indicating immaturity and therefore a comparative recent origin of the sediments. The aggradation has an origin which is partly geomorphic, but is also associated with the dense growth of papyrus and other plants which blocks streams and causes deposition of

3.

KEY TO NORTHERN PROVINCE SOILS

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(excluding Karamoja District)

MAPPING UNIT	LOCALITY	DOMINANT SOIL TYPES	PARENT ROCK	CASH CROPS	PRODUCTIVITY
		Soils of the Upwarped African Surface			
1. Zeu Catenas	S.W. West Nile	Reddish brown to red clay loams. Sometimes lateritised.	B.C. Amphibolite and Gneiss	Arabica Coffee	High to medium
2. War Catenas	S.W. West Nile	Reddish brown clay loams developed on gneiss. Sometimes lateritised.	B.C. Gneiss	Arabica Coffee	High to medium
3. Arua Series	West central West Nile	Deep grey sandy topsoils over brown heavier subsoils on laterite.	(Pre-weathered) B.C. Gneiss and Granite	Tobacco	High to low
4. Koboko Catena	N.W. West Nile	Shallow grey sands with murram on weathered rock.	B.C. Schist, Gneiss, quartzite	Cotton	Medium to low
5. Yumbe Catena	Madi Plateau, West Nile	Shallow dark sandy soils over laterite.	B.C. Schist, gneiss, quartzite	Cotton	
6. Parombo Series	Madi Plateau, West Nile	Red brown clay loams formed in pre-weathered rock	B.C. Schist, gneiss and granite	Cotton	Medium to low
		Soils of the African Surface			
7. Buruli Catena	Lango and South Acholi	Reddish brown sandy clay loams over laterite - usually several feet deep.	B.C. Schist, gneiss, and granite	Cotton	Medium to low
8. Pajule Series	Northern Acholi	Grey to grey brown sandy loams over red clay on laterite - usually shallow	(Pre-weathered) B.C. Schist, gneiss and granite	Cotton	Low
9. Kiten Catena	North East Acholi	Brown loams on rotted rock, laterite may be present.	B.C. Schist, gneiss and granite	Cotton	Low
		Soils of the Degraded African Surface			
10. Anaka Complex	Acholi	Brown shallow sandy soils often over laterite.	B.C. Gneiss and granite	Cotton	Low

Soils of Ancient Lake Deposits on the African Surface

Soils of Ancient Lake Deposits on the African Surface					
11. Amuria Series	Lango and south Acholi	Grey brown sand over brown sandy loam on laterite	Old Lake Deposits	Cotton	Low
12. Dokolo Series	Lango District	Deep, sandy, grey brown topsoils over thick reddish brown clay loam subsoils. sometimes lateritised.	Old Lake Deposit	Cotton	High to medium
Soils of the Acholi Surface					
13. Okollo Complex	Madi Plateau, West Nile	Grey brown sands over weathered rock.	B.C. Gneiss and quartzite	Shea butternuts	Low
14. Palabek Complex	Northern and western Acholi	Shallow, brown loams developed on old alluvium	B.C. Gneiss and alluvium	Cotton	Low
Soils of old Rift Valley Sediments					
15. Rogem Type	Along the Nile in West Nile	Deep, red sands	Kaiso Red Sand	Cotton	Low
16. Paraa Series	South West Acholi (and Bunyoro)	Deep, reddish brown on grey sands.	Kaiso sand on clay	Big game	Low
Alluvial Soils					
17. Pager Series	N. Lango & Acholi	Grey clays mottled brown	Recent alluvium	Cotton	Low to medium
18. Pakelle Complex	The Pakelle area of Acholi	Brown sandy clay swamp soils and sandy loams	Swamp, alluvium and rock	Cotton	Low
19. Ora Series	Major valley in eastern West Nile	Dark grey calcareous clays	Recent alluvial clay	Cotton	Medium
20. Panyimur Series	S.E. West Nile	Dark grey on brown sand	Recent alluvial sand	Cotton	High
21. Laropi Series	Along banks of River Nile	Grey brown sandy loams and sands	Recent alluvial sand	Cotton	Medium
22. Undifferentiated alluvium	South Lango	Clays	Alluvial clay	Cattle	Low
Rocky Soils					
23. Aswa Complex	Along River Aswa and tributaries, Acholi	Bare rock, with patches of coarse sand and alluvium	Alluvium and rock	Cotton	Low
24. Metu Complex	All steep slopes throughout Province	Brown sands on steep rocky slopes.	B.C. Rock	Shea butternuts	Low

sediments. Aggradation may also result from fairly recent soil erosion. Sheet erosion is common in most areas, and gully erosion is becoming more serious in one or two places.

THE SOILS

Twenty four mapping units are distinguished in Northern Province (except Karamoja district) and of these only three occur in other provinces. The mapping units are, in the main, delineated by geomorphic or landscape features but ten, at least, conform to the accepted definition of a soil series and one to that of soil type. In the descriptions that follow, only brief mention is made of land-use and agricultural potential because these subjects will be dealt with in the vegetation and farming systems memoirs. A table is given below of the salient points of the respective soil units arranged in natural physiographic groups with emphasis on erosion surface. At this stage no pedological classification is offered as this is being intentionally deferred until the whole Protectorate has been surveyed.

SOIL DESCRIPTIONS

Soils of the Upwarped African Surface

1. Zeu Complex of Catenas

This mapping unit, which is a complex of catenas, is restricted to the south-west part of West Nile District, on the upper plateau. The altitude is from 4,000 to 6,000 feet. The parent rocks are Basement Complex metamorphics containing a good deal of amphibolite. The slopes in the Zeu area are not simple, but have been shown by Hep-worth to consist of a great may minor facets. This pattern of topography is probably a useful feature of the area, for it will naturally help to prevent erosion. The valleys are narrow and incised, arranged in a close drainage system. Along the floor of each is a strip of deep, humose alluvium. Quartz bands are fairly common and the larger ones give rise to ridges or hills. Other rock outcrops are rarely seen. The rocks appear to have undergone intensive pre-weathering and rotted rock of various kinds is the parent material of the soils. Resorting of the upper layers gives rise to the topsoils, and stone line profiles are not infrequent. Laterite and murram have a patchy distribution and are not extensive. Around Lendu Hill there is a very peculiar, slag-like laterite possibly a remnant of the Gondwana erosion surface. The soils are deep and merge imperceptibly into rotted rock in situ. Drainage is free, and structure is generally weak or absent except for very weak crumbs. The actual profile described below has better structure than most, probably because it is from a forest site. The area has a high rainfall and a good vegetative cover, so there is a reasonable depth of topsoil rich in organic matter. These amphibolite soils are among the best in Northern Province, and are comparable in profile morphology, if not in nutrient status, with the Nakabango soils of Eastern Province.

Profile 1 is typical for soils developed on amphibolite.

Profile 1. (18374-79)

Lendu Forest, West Nile.

0 - 2" Dark reddish brown (5YR: 3/4), sandy clay loam; fine subangular blocky to cloddy.
0 - 5" Similar, merging to
5 - 12" Slightly paler reddish brown (2.5YR: 3/4)
12 - 22" Similar but with crumb structure
22 - 44" Redder (10R: 3/4) crumb structure
44 - 72" Similar.

Gneiss in the Zeu area gives rise to red soils of roughly the same type as those on amphibolite, but these are not so red, they are gritty with quartz fragments, and are less fertile.

Drainage is free, and structure is generally weak, especially under crops rather than forest. Profile 2 is an example.

Profile 2. (18369-73)

Lendu Forest, West Nile.

0 - 6"	Dark reddish brown (5YR:3/2), sandy loam, subangular blocky structure
6 - 14"	Reddish brown (5YR:4/3), sandy clay loam, weak subangul blocky structure
14 - 24"	Reddish brown (5YR:4/4), sandy clay, fine subangular blocky/crumb structured
24 - 44"	Reddish brown (2.5YR:4/4), sandy clay, crumb structured
44 - 50"	Sandy clay loam. Rotted rock with many stones.

Soils in the incised valleys are usually little altered alluvium. The valley bottoms have gentle slopes and it is an eas matter to arrange simple irrigation systems, and the soil is then very productive, though it is of rather limited extent. It is id for seed beds or for growing crops which are not wanted in large quantities.

To the north the Zeu complex gives way to the War mappin unit which is roughly similar but does not contain any amphiboliti soils. To the east is the West Nile escarpment, and in the zone close to the escarpment the soils tend to be thinner than inland. In areas of the Belgian Congo, bordering the Zeu soil unit, there very deep soils with humose topsoils of great thickness, far bette soils than those in Uganda. This is probably due, in part, to original differences in soil formation, but a lot of the comparati poverty of the soils on the Uganda side of the border must be put to poor management and the effects of widespread sheet erosion.

Analytical data are presented in the appendix. Mechani analysis shows that soils on both amphibolite and gneiss are fine sandy clay loams, merging down into sandy clay. Organic matter i high on account of the altitude. The soils are acid, but the ver marked acidity of profile 1 may be due to its situation in the for It is noteworthy that in this profile the acidity decreases with depth. All bases are very low, and so is the phosphate content. The profile developed on gneiss was not under forest and is conseq rather richer in bases.

2. War Complex of Catenas.

The War mapping unit is a complex of catenas, occupying the southern part of the West Nile Plateau, excluding the Zeu area in the south west, at an altitude of about 4,000 feet.

The underlying rocks are mostly metamorphic gneisses, schists and quartzites, which have been very deeply weathered. Weathered rock is the parent material of the soils, which are usua resorted at the surface, and stoneline types are frequent. Major rivers, such as the Ora, occupy fairly deep valleys so that there a high surface relief. Soils change fairly rapidly with the natu

of the underlying weathered rock, but various kinds of red loam constitute the dominant types.

A soil on a quartz-gneiss outcrop showed a few inches of grey brown (10YR:5/3) loamy sand over rock rubble and stones. More commonly, even when rubble is within a foot of the surface the soil is reddish brown (5YR:4/3) sandy loam. Deep cuttings on lower slopes frequently show well developed subsoils, and it is often difficult to determine how much of this is rotted rock in situ. Such a profile near War showed

0 - 6"	Reddish brown (5YR:4/4) fine sandy clay loam
6 - 72"	Reddish brown (2.5YR:4/4) clay loam.

A more typical profile is described below.

Profile 3.

Paidha rest house. Altitude 4,800 ft., flat site.

0 - 6"	Dark reddish brown (5YR:3/2), sandy clay loam
6 - 12"	Reddish brown (5YR:4/4), fine sandy clay loam
12 - 18"	Yellowish red (5YR:4/6), clay
18 - 24"	Yellowish red (5YR:4/6), clay
24 - 36"	Red (2.5YR:4/6), clay

Laterite is not common, but there are occasional patches. Quartzite ridges and hills are present and usually carry poor soils. On the steeper hills there is a marked catenary distribution of soils in which tongues of fairly deep and sorted drift are separated by strips of skeletal soil on bare, fresh rock. Trees seem to grow equally well on both types (most of the large hills are forest reserves.)

The War area has a fairly high rainfall (0.55), good vegetative cover and a comparatively intensive agriculture. Humose topsoils, however, are generally shallow, which may be due to some extent to sheet erosion, for many slopes are steep, and there are one or two places where gully erosion is active, notably in the area west of Kango. The valleys are incised, and there are narrow strips of deep, humose alluvial soils, as in the Zeu area to the south. Towards the scarp in the east thin dark soils appear. At Use forest reserve for instance a profile shows

0 - 12" dark grey (10YR:4/1) loam sand

Stoneline

Gritty orange coloured rotted rock.

To the north the War soils are replaced by the Arua mapping unit. To the west is the watershed region, and soils there tend to be shallower than usual.

Analytical data for War soils are very like those obtained from Zeu soils. Mechanical analysis shows the dominant texture is

fine sandy clay loam, with sometimes a lighter textured topsoil or heavier textured subsoil. Organic matter is less high, and base content is low. Phosphate is often low, though in the example given in the appendix it is quite high. Soils are acid, usually with a pH between 5 and 6.

3. Arua Series.

The Arua mapping unit approximates to a single soil series and occupies the central part of the West Nile plateau at an altitude of about 4,000 feet, in an area of good rainfall. It is underlain by metamorphics of the Basement Complex, but the profiles do not appear to be directly derived from the underlying rock. Much of the rock is deeply pre-weathered, but there are several outcrops of fresh rock, as at Arua hill itself.

A complete profile is shown below.

Profile 4. (81394-7)

Mbaraka

0 - 6"	Greyish brown (10YR:5/2) sandy clay loam
6 - 30"	Brown (10YR:5/3), sandy clay loam
30 - 48"	Pale brown (10YR:6/6), loam
48 - 60"	Strong brown (7.5YR:5/8), sandy clay loam

The most notable feature of the Arua soils is the deep sandy layer at the surface which merges into heavier textures below. In many places (Arua golf course, for example) the soil on all parts of the slopes appears to be grey sand, though pits show that it grades down into reddish brown subsoils of heavier texture and eventually into rotted rock. The origin of the sands is not yet known. Many valleys are narrow and there is little alluvium. Upper reaches of valleys often display soil profiles similar to those of the slopes.

The profiles show some variations, mainly in the depth and thickness of the horizons. The grey sandy topsoils are thickest in the vicinity of Arua itself, and become thinner in all directions away from Arua. Stonelines may be present. The laterite layer is often thick, but is usually at some depth; on the Congo border, however, it is very thick indeed and occurs either close to or at the actual surface. Laterite is frequently absent altogether, as is shown in profile 5.

Profile 5. (18416-8)

4 mls S. Arua

0 - 10"	Dark brown (10YR:4/1)	sand, single grain - small crumb structured
10 - 24"	Dark brown (10YR:4/1)	gravel, single grain - small crumb structured
24 - 72"	Rotted rock.	

Most of the soils are very freely drained and there is rarely a deep accumulation of humose topsoil. Considering the sandy nature of the soils they are quite rich in bases and have no marked deficiencies. It is notable that this soil supports the densest population in West Nile, but this may be due to factors other than soil type. It also supports a flourishing flue-cured tobacco industry. To the east, towards the escarpment, soils become very thin and laterite has only a patchy distribution, though it is fairly continuous in most of the rest of the area. To the north the deep sandy upper part of the soil profile gradually disappears, and the Arua series gives way to shallow, sedentary profiles of the Koboko unit. The junction with the War unit to the south is comparatively abrupt.

Mechanical analysis of soils of Arua series shows that they possess loamy sand texture in topsoils, and sandy clay loam textures below. Organic matter is usually high, but the available base and phosphate content is satisfactory for a sandy soil.

4. Koboko Catena.

Soils of the Koboko mapping unit are a catena occupying the northernmost part of the West Nile plateau, at an altitude of a little over 4,000 feet.

The parent rocks are again metamorphics of the Basement Complex, consisting largely of schist and gneisses, with some quartzites and small areas of granite. The rocks are often deeply pre-weathered. On valleysides the basal surface of weathering is reached and both fresh and rotted rock outcrop to form the parent materials of the soils. Shallow, sedentary soils are usual, due to re-sorting of the weathered rock at the surface.

A typical Koboko profile is shown below.

Profile 6. (18398-9)

Near Oraba

0 - 6"	Greyish brown (10YR:5/2), sand to sandy loam
6 - 12"	Brown (7.5YR:5/3) sandy clay loam
12 - 24"	Murram
24" +	Rotted rock (schist)

Slopes are often steep and there is definite evidence of colluviation afforded by the presence of derived murram in the stonelines on lower slopes. Some stonelines contain fragments of unweathered rock other than quartzite, and there may also be some original laterite. There is much skeletal soil on both fresh and pre-weathered rock which has not even reached the stoneline stage of development. Quartzite gives rise to ridges and granite forms small hills, and these are often virtually soil-less. Laterite

has a very patchy distribution, depending on very local conditions of drainage.

The better patches of soil are used for agriculture, and food crops do reasonably well. The Koboko soils are regarded favourably by peasant farmers, but their potential is considerably less than those of Zeu, War or Arua.

To the east the soils thin out towards the escarpment, which is not such a marked topographic feature here as in the south of West Nile, and skeletal soils on rotted rock are frequent. On plateau remnants in the southern part of the Koboko unit, soils may be two to three feet deep, where they merge into the Arua series. To the west is the watershed between the Nile and Congo drainage systems and soils again tend to be thin. There is more laterite here than elsewhere with local patches of very massive sheet laterite.

The Koboko soils differ from the Arua soils in being shallower and more leached. They are acid with a pH of between 5 and 6, and contents of available bases and phosphate are low.

5. Yumbe Catena.

The Yumbe mapping unit which approximates to a catena, occurs on the Madi plateau at about 3,200 feet, especially in the northern part of the district, where relief is fairly low. The area is underlain by rocks of the Basement Complex, but they do not have much effect on soil type.

The soils were probably once like those of the Arua series, and may have been their equivalent at a lower level. Now, however, due to surface erosion they are considerably truncated. A typical profile is shown below.

Profile 7.

Otrem.

0 - 6"	Dark brown (7.5YR:3/2), fine sandy loam
6 - 18"	Brown (7.5YR:4/2), fine sandy clay loam
18" +	Laterite

The main distinguishing features of the profile are the ubiquity of laterite and a topsoil of shallow sand or sandy loam, usually of a grey brown colour. The topsoil can be thicker but is seldom more than about 12". The laterite is usually massive and vesicular, but only about 12" in thickness. Much thicker laterite is sometimes present, however, and there may be pisolitic murram instead of massive laterite. Below the laterite is rock which may or may not be rotted. This is frequently exposed on valley sides. Due to rapid drainage the soils are well leached and they are frequently very poor in nutrients. Deeper phases of the Yumbe soils are found just below the escarpment, where the sandy topsoil may be up to three or

four feet thick. A profile from this area is shown below.

Profile 8. (7516-9)

Omugo. Mid slope.

0 - 6"	Black (10YR:4/1) clay loam, weak crumb structure
6 - 24"	Very dark grey (7.5YR:3/0) clay loam, slightly mottled strong brown, cloddy dry, massive wet.
24 - 80"	Brown (7.5YR:4/4) gritty clay with mica and murram

These soils are probably enriched by solutions draining from higher ground which enhances their fertility. For this reason they are highly regarded for tobacco cultivation.

The depth of the soil is very variable and even within one small pit it may change from 6" to 36" around the sides. In the Wolo area the soils are very shallow on massive laterite, with usually only a few inches of very dark grey brown (10YR:3/2) gritty loamy sand topsoil. Many valleys in the area have wide expanses of thin sandy alluvium over rock, or sometimes laterite, and the soils are very like those of the Yumbe unit elsewhere. Deep, humose alluvial sand is sometimes present, as in the valley north of Yumbe itself, and these are usually the most fertile soils in the area.

The Yumbe unit eventually gives rise to the Okollo after more extensive erosion. Where the underlying rock is highly weathered, erosion of the topsoil and laterite will give rise to deep Parombo red loam. This being so, the southern part of the Madi plain has apparently suffered more erosion than the northern, where the Yumbe soils still exist. Towards the scarps of the rift valley the Yumbe soils become thin and finally disappear, giving way to Angal soils.

Apart from sandy bottom lands the heavier types of upland Yumbe soils seem to be the most fertile. The Omugo profile shown in the appendix is a sandy clay loam, fairly rich in organic matter and base content. In the other profiles organic matter is not high and the base content is lower. Phosphate is deficient in most Yumbe soils. The soils are acid, with a pH usually below 6.

6. Parombo Series

The Parombo mapping unit, which approximates to a soil series, occupies irregular patches on the Madi Plain at an altitude of about 3,200 feet.

The soils are developed on deeply weathered metamorphic and granitic rocks of the Basement Complex most of the rocks are schists, which are easily weatherable. The areas of Parombo soils have abrupt junctions with the Okollo unit where there are skeletal four feet thick. A profile from this area is shown below:

<u>Profile 8.</u> (7316-9)

Omugo. Mid slope.

0 - 6" Black (10YR:2/1) clay loam, weak crumb structure

6 - 24" Very dark grey (7.5YR:3/0) clay loam, slightly mottled strong brown, cloddy dry, massive wet.

24 - 80" Brown (7.5YR:4/4) gritty clay with mica and murrum.

These soils are probably enriched by solutions draining from higher ground which enhances their fertility. For this reason they are highly regarded for tobacco cultivation.

The depth of the soil is very variable and even within one small pit it may change from 6" to 36" around the sides. In the Wolo area the soils are very shallow on massive laterite, with usually only a few inches of very dark grey brown (10YR:3/2) gritty loamy sand topsoil. Many valleys in the area have wide exposures of thin sandy alluvium over rock, or sometimes laterite, and the soils are very like those of the Yumbe unit elsewhere. Deep, humose alluvial sand is sometimes present, as in the valley north of Yumbe itself, and these are usually the most fertile soils in the area.

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The soils are developed on deeply weathered metamorphic and granitic rocks of the Basement Complex. Most of the rocks are schists, which are easily weatherable. The areas of Parombo soils have abrupt junctions with the Okollo unit where there are exclosed soils formed on fresh rock.

The profiles themselves are mostly of the red loam type, and very similar in many ways to the soils of the War unit on the West Nile Plateau. A typical profile is cited below.

Profile 9. (18421-3)

Uleppi.

0 - 6"	Dark reddish brown (5YR:3/3), gritty fine sandy clay, crumb structure
6 - 12"	Yellow red (5YR:5/6), gritty fine sandy clay, subangular blocky structure
12 - 72"	Yellow red (5YR:5/6), fine sandy rotted rock with quartzite basis

Despite the similarity of soils between Parombo and War units, the climate above and below the escarpment is very different, which profoundly affects the utilisation of the land in the two localities. For example coffee, one of the main crops on the plateau, is not grown in the Parombo area.

Laterite is not frequent on the Parombo soils, but does occur, as at Parombo itself, where rotted rock is lateritised in situ, and there are also large fragments of derived laterite often measuring up to one foot in diameter. At Bondo there are deeper red colours which suggest the presence of amphibolitic rocks, but the area also contains many stony soils derived from gneiss. Here the unit is a soil complex which appears to be a lowland equivalent of the Zeu unit above the scarp. Rock outcrops, especially of quartzite, are common. Valleys are mostly fairly wide and shallow, and the soils on valley sides are much the same as those on the upper slopes and ridge crests. Relief is generally moderate.

At the foot of the escarpment, there is frequently a wedge of detritus which gives rise to fertile red loams. This kind of soil has not been mapped separately because of the small size of the units, and the general similarity, for practical purposes, to the Parombo soils. A particularly good example of this soil is seen at the scarp-foot behind Nebbi, on the site of the cotton variety trial centre.

The soils of this unit display many differences in their chemical and physical constitution. The wide range is due to variations of site, drainage and parent material.

Soils at sites near the foot of the scarp are usually the most fertile. They contain drift or hillwash from the scarp, incorporated in the parent material, which includes an abundance of weatherable minerals. They also receive the run-off from the scarp, which besides improving their moisture content results in a certain amount of base enrichment by downslope illuviation. In these sites vegetation grows well, and the organic matter content is therefore soils formed on fresh rock.

The profiles themselves are mostly of the red loam type, and very similar in many ways to the soils of the Bar unit on the Zebo Nile Plateau. A typical profile is cited below.

Profile 9. (S4421-3)

Ulappi.

0 - 6" Dark reddish brown (5YR:3/3), gritty fine sandy clay, crumb structure

6 - 12" Yellow red (5YR:5/6), gritty fine sandy clay, subangular blocky structure

12 - 72" Yellow red (5YR:5/6), fine sandy rotted rock with quartzite bands

Despite the similarity of soils between Parombo and Bar units, the climate above and below the escarpment is very different, which profoundly affects the utilisation of the land in the two localities. For example coffee, one of the main crops on the plateau, is not grown in the Parombo area.

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Away from the escarpment there is no additional supply of bases or water, and the soils are highly leached red loams, similar in many ways to Buruli soils but not usually lateritised. These poorer soils show some variation among themselves depending on the nature of the underlying rock. The better ones are derived from amphibolite or mica schists, and the rest from more quartzose gneisses and similar rocks.

Soils of the African Surface

7. Buruli Catena.

The Buruli mapping unit consists mainly of the lateritic red loams associated with remnants of the African erosion surface. It is the same unit, virtually a catena, that occurs widely in many other parts of Uganda, but there are minor differences when compared with other Provinces. From south to north there is a gradual deterioration of the red loams, and generally the Buruli soils of Northern Province are poorer than those of Eastern Province or Buganda, but there is no clear boundary. The red loams of northern Acholi have been mapped under a separate name, the Pajule unit, because here the differences are fairly well marked.

Typical profiles of Buruli soil are shown below.

Profile 10. (17220-4)

Minakulu.

0 - 7"	Dark brown (7.5YR:3/2), sandy loam
7 - 18"	Reddish brown (5YR:4/4), fine sandy clay loam
18 - 30"	Yellowish red (5YR:4/6), fine sandy clay loam
30 - 44"	Red (2.5YR:4/6), clay loam
44 - 68"	Red (2.5YR:4/6), clay loam
68" +	Murram

Profile 11. (15937-41)

Aduku.

0 - 6"	Dark brown (7.5YR:3/2), fine sandy clay loam
6 - 14"	Dark reddish brown (5YR:3/4), fine sandy clay loam
14 - 22"	Reddish brown (5YR:4/3), clay loam
22 - 33"	Yellowish red (5YR:4/6), clay loam
33 - 40"	Yellowish red (5YR:4/6), clay loam
40" +	Murram

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Typical profiles of Buruli soil are shown below.

Profile 10. (17290-4)

Minakulu.

0 - 7"	Dark brown (7.5YR:3/2), sandy loam
7 - 18"	Reddish brown (5YR:4/4), fine sandy clay loam
18 - 30"	Yellowish red (5YR:4/6), fine sandy clay loam
30 - 44"	Red (2.5YR:4/6), clay loam
44 - 58"	Red (2.5YR:4/6), clay loam
58" -	Murram

Profile 11. (15937-4E)

Aduku.

0 - 6"	Dark brown (7.5YR:3/2), fine sandy clay loam
6 - 14"	Dark reddish brown (5YR:3/4), fine sandy clay loam
14 - 22"	Reddish brown (5YR:4/3), clay loam
22 - 33"	Yellowish red (5YR:4/6), clay loam
33 - 40"	Yellowish red (5YR:4/6), clay loam
40" +	Murram

Profile 12. (13461-6)

Labora Farm, Gulu.

0 - 3"	Dark brown (7.5YR:3/2), fine sandy clay loam, weak subangular blocky structure
3 - 9"	Reddish brown (5YR:4/3), fine sandy clay loam, crumb structure
9 - 22"	Reddish brown (5YR:4/4), fine sandy clay loam, crumb structure
22 - 30"	Reddish brown (5YR:4/3), fine sandy clay loam, weak crumb structure
30 - 38"	Reddish brown (5YR:4/3), fine sandy clay loam, weak crumb structure
38 - 60"+	Red (2.5YR:4/8), fine sandy clay loam, weak crumb structure.

Variations in the profile can arise as follows:-
The humose topsoil may or may not be present, but there is usually a small thickness. Complete absence of a humose topsoil indicates a truncated profile, and this is not uncommon. In the Maruzi area of Lango, for instance, there are many areas of very shallow, bright red soils over laterite where the vegetation cover is thicket, and there is a lot of bare soil exposed to sheet erosion.

The best soils of the Buruli unit occur along the Soroti - Lira - Gulu ridge. Laterite is almost always present, below which is rotted rock. Stone lines may or may not be present. These soils are probably the most productive in Acholi, but in Lango they are often rather poor.

The analytical data in the appendix are of typical Buruli soils. Most textures on analysis, show a good deal of sand, and most samples fall into the fine sandy clay loam type. In the field the soils give the impression of being heavier and often feel like loams or clay loams. The increase in sand on analysis may be due to aggregation of smaller particles by iron oxides. It is usual for the clay content to increase down the profile, but the amount of silt shows no regular variations.

The content of organic carbon depends on several factors, chief of which are the climate, vegetation cover and history of land use. In wetter areas, such as the Gulu area, which usually have the best vegetative cover, the carbon tends to be fairly high, and is low in drier areas with sparse vegetation, such as the Minakulu area. Heavy cultivation or grazing tends to reduce the organic matter content. Such soils are merging into the Pajule series, which might be regarded as degraded Buruli. Phosphate content is generally low, and a topsoil figure of 20 or more is considered high for these soils. The soils are always acid; figures over pH6 are found in the better soils and are associated with wetter areas and high organic matter content. In drier areas and those with little organic matter the

pH is lowest but Buruli soils rarely fall below 5.0 in any horizon. Acidity usually increases with depth. Bases are generally low, and there may well be deficiencies of major elements. The same trends are shown as before, and the soils which are poorest in phosphorus and organic matter will also tend to have low base status.

Mineralogical analysis of Buruli soils indicates a high degree of weathering and most of the soils appear to be formed on pre-weathered parent material. Dominating the heavy minerals are ilmenite and secondary limonite, with a total of about 10% of zircon, tourmaline and rutile. Other minerals such as kyanite, staurolite, and hornblende are present as occasional grains. The light minerals are nearly all quartz. Thus there are few primary minerals present which might release nutrient bases to the soil on weathering.

8. Pajule Series.

Soils of the Pajule mapping unit are similar to the Buruli soils in many ways, but occur in dryer areas. In parent material and original mode of formation the two are the same, and the Pajule may be regarded as a truncated Buruli soil. They have much shallower topsoils, and the reddish brown (5YR) hues always appear within 6" of the surface. Eroded profiles which have been stripped of topsoil are common. In this state the surface tends to become baked hard in dry weather which increases their erodibility. Sheet erosion is also encouraged by the sparseness vegetative cover, which is due in part to poor surface conditions and severity of droughts and high rainfall intensity. At their best the Pajule resemble the Buruli soils of the Gulu area; at their worst they present a laterite pavement with a thin veneer of baked red clay loam. The latter supports mainly stands of bamboo (*Oxytenathera abyssinica*).

Typical profiles are shown below.

Profile 13. (10433-8)

North West of Patiko. Top catena.

0 - 6"	Dark grey brown (10YR:4/2), sandy loam
6 - 18"	Dark reddish brown (5YR:3/2), sandy clay
18 - 30"	Dark red (2.5YR:3/6), clay
30 - 42"	" " " "
42 - 54"	" " " "
54 - 70"	" " " "

Profile 14. (10427-32)

North West of Patiko. Mid catena.

0 - 6"	Dark grey (10YR:4/1), fine sandy loam	
6 - 18"	Dark reddish brown (5YR:3/2), sandy clay	
18 - 30"	Yellowish red (5YR:4/6), with grey mottles, sandy clay	
30 - 42"	" " " " "	
42 - 54"	" " " " "	
54 - 66"	" " " " "	

Pajule red loams often occur around large inselbergs, which act as water collecting areas and the soils around their bases may be enriched by illuviation. An unusually red version occurs in the Adilang area. Topsoils are 5YR dark reddish browns, of almost any texture, and subsoils are 5 to 2.5 YR reddish brown clay loams and laterite occurs at various depths. These soils are very similar to soils in the Wiawer area of Karamoja.

The examples for which analytical data are given in the appendix are of the best in the Pajule unit, and it can be seen that they are very like Buruli soils in chemical characteristics. At Patiko they are very rich in phosphate, but this is not a usual feature. Many other profiles are both phosphate and base deficient.

9. Kiten Catena.

The Kiten mapping unit is a catenary association of north-east Acholi consisting of red loam soils and alluvial black calcareous soil. They occupy the headwater areas of the River Moruto and its tributaries.

The area is extremely arid (30-35" rain p.a.) and the soils differ from similar soils elsewhere in characters which are probably associated with the aridity of their location. The soils are derived from rotted rock, but there is little profile development, other than a small amount of resorting of the upper layers. A typical profile is shown below.

Profile 15. (19446-9)

Madi Opei.

0 - 6"	Dark grey brown (10YR:4/2) loamy sand
6 - 15"	Brown (10YR:4/3) sandy loam
15 - 28"	Brown (10YR:4/3) sandy clay loam
28 - 38"	Brown (7.5YR:4/3) sandy clay + murram
38" +	Laterite

It will be seen that the soil colours are brown and not so red as those of wetter areas. Calcareous concretions sometimes occur in what are obviously profiles of weathered rock in situ. Close to hills, on upper pediments, the soils are darker and heavier, and seem to have illuviated clay, together with some base enrichment.

Laterite occasionally occurs, and small patches of murram gravel, especially to the east of Kiten itself.

A typical profile is shown below.

Profile 16. (18439-43)

North of Madi Opei

0 - 5"	Brown (10YR:5/3) loamy sand
5 - 18"	Grey brown (10YR:4/2) gritty clay loam
18 - 25"	" " "
25 - 36"	" " "
36" +	" " "

At first sight this is rather like an alluvial profile, but gravel and quartz grit through the profile show that it is much modified rotted rock in situ.

The alluvial soils, when seen in the dry season, are grey cracking calcareous clays similar to those of other areas, and the complete drying that they undergo in the long dry season has no obvious effect on the soil profiles, other than self mulching.

The chemical data in the appendix show several unusual features. In the first the sodium, phosphate and to some extent the other bases increase down the profile. This soil was taken from a site where illuviation was possible from higher ground nearby. In the topsoil, bases and phosphate are deficient. This peculiar trend occurs in Karamoja (Chenery 1955, Wilson 1960) and indicates the beginnings of semi-desert conditions of soil formation. The organic carbon figures are higher than would be expected from the general appearance of the soils. The second profile shows a normal profile distribution of bases and phosphate.

Soils of the Degraded African Surface

10. Anaka Complex

The Anaka soil unit is one of the most complex and ill defined of the Province. It comprises a number of different soil associations which display such complicated inter-relationships that they could not be mapped separately. The simplest way of regarding these soils is that they mark a transitional zone between the Buruli red loams and the largely skeletal soils of the Palabek unit. They generally show a topsoil of sandy loam, dark grey brown in colour (7.5YR, or more rarely 10YR.) This frequently, but not invariably, overlies laterite, one to three feet below. On slopes especially, the sandy loam topsoil may extend down without laterite, to a dark subsoil of brown (5YR) colours. Such profiles are comparable with the Dokolo profiles in morphology, but they are less fertile. At the other extreme the Anaka soils can approach those of the Palabek, and there the profiles consist of grey brown sandy topsoil overlying

Laterite occasionally occurs, and small patches of murram gravel, especially to the east of Kitgum itself.

A typical profile is shown below.

Profile 14. (15/59-41)

North of Wadi Oped

0 - 5"	Brown (10YR.5/3) loamy sand	
5 - 18"	Grey brown (10YR.4/2) gritty clay loam	
18 - 25"	"	"
25 - 36"	"	"
36" +	"	"

At first sight this is rather like an alluvial profile, but gravel and quartz grit through the profile show that it is much modified rotted rock *in situ*.

The alluvial soils, when seen in the dry season, are grey cracking calcareous clays similar to those of other areas, and the complete drying that they undergo in the long dry season has no obvious effect on the soil profiles, other than self mulching.

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Two of the Anaka profiles are given below as examples of the range that can occur, often within a very restricted area.

Profile 17. (17207-11).

Karlo. Mid slope, nr. Lamogi.

0 - 3"	Dark grey (10YR:4/1), fine sandy clay loam, weak crumb structure
3 - 9"	Dark greyish brown (10YR:4/2), fine sandy clay loam, weak crumb structure
9 - 18"	Dark brown (10YR:4/3), fine sandy clay loam, weak crumb structure
18 - 33"	Yellowish brown (10YR:5/4), fine sandy clay, subangular blocky structure
33 - 48"	Paler yellowish brown (10YR:5/6), mottled strong brown, (7.5YR:5/6) fine sandy clay.

Profile 18. (17216-9)

Paicho, Gombololo H.Q. Plateau.

0 - 3"	Dark brown (7.5YR:4/2), fine sandy clay loam, clods
3 - 9"	Paler dark brown (10YR:4/3) fine sandy clay loam, small clods
9 - 19"	Brown (7.5YR:5/4), fine sandy clay loam, small clods
19 - 33"+	Yellow red (5YR:5/6), fine sandy clay loam, subangular blocky structure.

The combinations of soil types do not occur in any particular topographic order, consequently there is no typical catena.

Generally the Anaka soils are deeper when they adjoin Buruli soils and become more skeletal and shallow towards the Palabek soil area. Lower and mid slopes are usually the best for agricultural purposes. Analytical data from two fairly good soils are given in the appendix. It is seen that in the topsoils, the base and organic matter contents are quite satisfactory, but the phosphate content is deficient. Many Anaka soils are poorer than these examples.

Soils of Ancient Lake Deposits on the African Surface

11. Amuria Series

As was explained in the section on geomorphology, there was formerly a lake extending beyond the present Lake Kyoga, which laid down sandy loam sediments, and it is on these that the Amuria soil type is formed. These soils are continuous with the present valley slope soils, but cover ridges and hill tops as well as lower slopes. For practical purposes this unit may be regarded as a soil series. Sandy loam textures are the rule, and the commonest colours are in the brown (7.5YR) range, although reddish brown (5YR) colours are sometimes present in the subsoil. They are generally shallower than the Amuria soils of Eastern Province, especially in the vicinity

of the Lango - Acholi border, where soils are often less than 12" deep over laterite. In the better soils, laterite is absent or at a great depths.

The Amuria soils have no very abrupt boundary with the Buruli soils, but merge through a transition zone with topsoil characteristics like the Amuria and subsoils like the Buruli. They are well delineated from the swamps but this is an elaborate and convoluted form line, consequently the line drawn on the map has been smoothed out in parts.

Two typical profiles are given below.

Profile 19. (17232-5)

Omoro. Plateau.

0 - 6"	Dark brown (10YR:4/2), sand
6 - 18"	Brown (10YR:4/3), sand
18 - 48"	Brown (7.5YR:5/5), loamy sand
48 - 72"	Brown (7.5YR:5/4), fine sandy loam

Profile 20. (17228-31)

Apigikwe. Plateau.

0 - 5"	Very dark grey brown (10YR:3/2), sand
5 - 12"	Brown (7.5YR:4/2), loamy sand
12 - 20"	Brown (7.5YR:4/2), sandy loam
20 - 48"	Brown (7.5YR:5/4), sandy loam with murram pellets
48" +	Laterite

Analytical data for several soil types of the Amuria unit are given in the appendix. The Omoro profile may be regarded as typical of the shallow soils of the Lango - Acholi border area. They are acid and the base contents are very low in spite of a moderate organic matter content. This may be due to a grass cover for a long time, as the sample is from an uncultivated site. Typical of the soil generally, phosphate is very deficient.

The Patonga profile is much deeper, and is rather like a Dokolo soil. The pH is exceptionally high for Amuria soils and the base content better than average. The phosphate figure is very high but organic matter content is moderate. This soil is as good as Amuria soils can be, but such soils occur in very small and widely scattered areas.

The Apigikwe profile is from a fairly average Amuria soil, though the absence of all bases but calcium (which is itself very low) represents a worse state of affairs than is usual.

12. Dokolo Series.

This soil series occurs only in Lango and they are regarded as the best soils in the district. From their general appearance of the Lango - Acholi border, where soils are often less than 12" deep over laterite. In the better soils, laterite is absent or at a great depth.

The Amuria soils have no very abrupt boundary with the Burulli soils, but merge through a transition zone with topsoil characteristics like the Amuria and subsoils like the Burulli. They are well delineated from the swamps but this is an elaborate and convoluted form line, consequently the line drawn on the map has been smoothed out in parts.

The typical profiles are given below.

Profile 19. (17232-5)

Omoro.	Plateau.
0 - 6"	Dark brown (10YR:4/2), sand
6 - 18"	Brown (10YR:4/3), sand
18 - 48"	Brown (7.5YR:5/3), loamy sand
48 - 72"	Brown (7.5YR:5/4), fine sandy loam

Profile 20. (17228-31)

Apigikwo.	Plateau.
0 - 5"	Very dark grey brown (10YR:3/2), sand
5 - 12"	Brown (7.5YR:4/2), loamy sand
12 - 20"	Brown (7.5YR:4/2), sandy loam
20 - 48"	Brown (7.5YR:5/4), sandy loam with murram pellets
48" +	Laterite

Analytical data for several soil types of the Amuria unit are given in the Appendix. The Omoro profile may be regarded as typical of the shallow soils of the Lango - Acholi border zone. They are acid and the base contents are very low in spite of a moderate organic matter content. This may be due to a grass cover for a long time, as the sample is from an uncultivated site. Typical of the soil generally, phosphate is very deficient.

The Patongo profile is much deeper, and is rather like a Dokolo soil. The pH is exceptionally high for Amuria soils and the base content better than average. The phosphate figure is very high but organic matter content is moderate. This soil is as good as Amuria soils can be, but such soils occur in very small and widely scattered areas.

The Apigikwo profile is from a fairly average Amuria soil, though the absence of all bases but calcium (which is itself very low) represents a worse state of affairs than is usual.

12. Dokolo Series.

This soil series occurs only in Lango and they are regarded as the best soils in the district. From their general appearance they seem to represent an Amuria topsoil, often quite thick, over a Buruli subsoil.

Three typical profiles are shown below.

Profile 21. (19284-90)

4 ml. E. Lira.

0 - 6"	Dark grey (10YR:4/1), loamy sand, crumb structure
6 - 12"	" " " " " "
12 - 24"	Dark brown (7.5YR:3/2), sandy loam, cloddy structure
24 - 40"	Brown (7.5YR:4/4), fine sandy clay loam, weak crumb structure
40 - 64"	Yellowish red (5YR:4/6), fine sandy clay loam, structureless
64 - 88"	Yellowish red (5YR:5/6), clay loam, structureless
88 - 120"	" " " " " "

Profile 22. (15968-73)

Dokolo, Prison Farm. Lower slope.

0 - 4"	Very dark brown (10YR:2/2), sandy loam
4 - 14"	Dark brown (7.5YR:3/2), sandy loam
14 - 28"	" " " fine sandy clay loam
28 - 36"	Brown (7.5YR:5/3), fine sandy clay loam
36 - 52"	Yellowish red (5YR:5/6), clay loam
52 - 72"+	" " " " "

Profile 23. (15962-7)

Dokolo Gombolola. Flat site.

0 - 2½"	Dark brown (7.5YR:3/2), fine sandy clay loam
2½ - 5"	" " " " " " "
5 - 10"	Dark reddish brown (5YR:3/3), fine sandy clay loam
10 - 18"	" " " " " " " "
18 - 25"	" " " " " " " "
25 - 36"	Reddish brown (5YR:4/4), clay loam
36" +	Murram

Characteristic of these soils are their deep humose topsoils which extend down to two feet in some cases. The organic matter content though not high is higher than average for Northern Province soils and appears to be present in sufficient amount to produce a moderately stable crumb structure and improved water holding capacity. Colours are dark brown (7.5YR:4/3) and the commonest texture is fine sandy clay loam. The subsoils are in the 5YR hue and the textures heavier, usually clay loam. Laterite may or may not be present.

The soils occur largely in Dokolo county, hence the name, but also extend as far as Lira where some of the best examples are found. They merge into Buruli unit by the thinning out or they seem to represent an early topsoil, often quite thick, over a Buruli subsoil.

Three typical profiles are shown below.

<u>Profile 21</u>. (19264-90)

4 mi. E. Lira.

0 - 6"	Pink grey (10YR:6/3), loamy sand, crumb structure
6 - 12"	" " " " " " "
12 - 24"	Dark brown (7.5YR:3/2), sandy loam, cloddy structure
24 - 40"	Brown (7.5YR:4/2), fine sandy clay loam, weak crumb structure
40 - 64"	Yellowish red (5YR:4/6), fine sandy clay loam, structureless
64 - 88"	Yellowish red (5YR:5/6), clay loam, structureless
88 - 100"	" " " " " "

<u>Profile 22</u>. (19662-73)

Dokolo, Prison Farm. Lower slope.

0 - 4"	Very dark brown (10YR:2/2), sandy loam
4 - 14"	Dark brown (7.5YR:3/2), sandy loam
14 - 28"	" " " fine sandy clay loam
28 - 36"	Brown (7.5YR:5/3), fine sandy clay loam
36 - 52"	Yellowish red (5YR:5/6), clay loam
52 - 72"	" " " " "

<u>Profile 23</u>. (19969-75)

Dokolo Gombolola. Flat site.

0 - 2½"	Dark brown (7.5YR:3/2), fine sandy clay loam
2½ - 5"	" " " " " "
5 - 10"	Dark reddish brown (5YR:3/3), fine sandy clay loam
10 - 18"	" " " " " " "
18 - 25"	" " " " " " "
25 - 36"	Reddish brown (5YR:4/4), clay loam
36" +	Murram

Characteristic of these soils are their deep humose topsoils which extend down to two feet in some cases. The organic matter content though not high is higher than average for Northern Province soils and appears to be present in sufficient amount to produce a moderately stable crumb structure and improved water holding capacity. Colours are dark brown (7.5YR:3/3) and the commonest texture is fine sandy clay loam. The subsoils are in the 5YR hue and the textures heavier, usually clay loam. Laterite may or may not be present.

The soils occur largely in Dokolo county, hence the name, but also extend as far as Lira where some of the best examples are found. They merge into Buruli unit by the thinning out of disappearance of the thick topsoil, and they merge into Amuria when the red subsoil disappears and the whole profile becomes shallower. The Dokolo series can be found on any part of the plateau or slope and there seems to be little influence of the topography on the soil pattern within the mapped areas.

Analytical data from several profiles are given in the appendix, and in general bear out the field impression that these soils are amongst the most fertile of the Province. There is, however, a clear deficiency of phosphate, and the potassium content too, is very deficient. It is rather surprising that of the two samples from Dokolo itself the plateau site is more fertile than the lower slope, for this is the reverse of the usual arrangement in most soils of Northern Province. It is not known whether this is a regular feature of Dokolo soils or not.

Soils of the Acholi Surface

13. Okollo Complex

The Okollo soil complex occupies considerable areas on the Madi plateau, at about 3,200 feet, in West Nile. Much of the Madi Plain is part of the Acholi erosion surface cut across fresh, solid rock, and this is the parent material of the soils on it. These soils are in marked contrast to those formed on pre-weathered rock, and are generally very shallow.

Some of the shallowest of all are seen close to the top of the Rift Valley escarpment above Panyimur. Here amphibolites, gneisses and quartzites outcrop as extensive rock pavements which are partially covered by gravel. Even here there is a sparse vegetation cover, mostly of thorn bushes and some grass. There are several patches of massive laterite near the escarpment, especially east of Angal.

Elsewhere there is some slight accumulation of weathered rock formed in the present cycle of weathering, but these yield only shallow, skeletal soils. In some places, as at Okollo, the farmers remove the large stones from the plots they are cultivating and thus improve the depth of the soil. A typical soil profile shows only 6 inches of grey brown (10YR 5/2) sand, with many small stones. There are, fortunately, small patches of weathered rock (originally micaceous) scattered throughout the Okollo soil unit, and these produce soils of the series. They are quite suitable for cultivation and settlements make use of such patches wherever possible but they cannot be mapped on the present scale. Narrow strips of alluvial soil are also used for cultivation wherever possible.

The boundaries of the Okollo complex vary as follows. To the west is the West Nile escarpment, which carries skeletal soils, but at the base there is frequently a wedge of detritus which forms disappearance of the thick topsoil, and they merge into Amuria when the red subsoil disappears and the whole profile becomes shallower. The Bokolo series can be found on any part of the plateau or slope and there seems to be little influence of the topography on the soil pattern within the mapped areas.

Analytical data from several profiles are given in the appendix, and in general bear out the field impression that these soils are amongst the most fertile of the Province. There is, however, a clear deficiency of phosphate, and the potassium content too, is very deficient. It is rather surprising that of the two samples from Bokolo itself the plateau site is more fertile than the lower slope, for this is the reverse of the usual arrangement in most soils of Northern Province. It is not known whether this is a regular feature of Bokolo soils or not.

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Some of the shallowest of all are seen close to the top of the Nile Valley escarpment above Pamujuru. Here amphibolites, gneisses and quartzites outcrop as extensive rock pavements which are partially covered by gravel. Even here there is a sparse vegetation cover, mostly of thorn bushes and some grass. There are several patches of massive laterite near the escarpment, especially east of Angal.

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The boundaries of the Okollo complex vary as follows. To the west is the West Nile escarpment, which carries skeletal soils, but at the base there is frequently a wedge of detritus which forms soils of moderately good depth. The Parombo soils have an irregular distribution within the Angal complex, but become more widespread to the west. The junction between the two is often remarkably sharp, following a rock junction, but the boundary as mapped is necessarily somewhat generalised because many of the patches of Parombo soil are too small to be indicated as individual areas. The junction of the Okollo with the Yumbe unit is less well defined but the presence of fairly large spreads of laterite in the latter has been used to fix the boundary. Typical soils of the Okollo are laterite-free but small scattered patches of laterite do occur in the mapped areas which are too small to separate out on the present scale. To the east the Okollo area is bounded by the many scarps of widely different sizes which separate it from Rogem sand.

The analytical results obtained from a number of soils of Okollo type are given in the appendix. It must be remembered that it is not always possible, within the Okollo mapping unit, to find even a six inch depth of soil. There is low phosphate content, and a very small amount of organic matter. The figures for base content are low, indicating a general deficiency, though it must be admitted that they are no worse than many soils which are deeper and possess better physical conditions. Presumably there are weatherable minerals available which, on decomposition, are able to provide some bases.

14. Palabek Complex.

In north and west Acholi a new erosion surface has been formed at 3,000 feet, known as the Acholi surface, largely cut across fresh rock - not across the pre-weathered and rotted rock of the African surface. On the Acholi surface fresh rock is the soil parent material and it appears that very little soil formation has occurred in the present cycle. Not all pre-weathered rock has been removed, however, and there are patches of red soils scattered throughout the Palabek soil unit which is thus a soil complex. The situation is comparable to that in West Nile where patches of Parombo soil are scattered within the Okollo mapping unit. The differences correspond to changes in the underlying rock type. There are also outcrops of laterite, always on ridge tops or plateaux, which are remnants of the lateritised African surface on these are small patches of Anaka or Buruli soil, but they are of such limited extent that they cannot be mapped separately. On low sites alluvial deposits are spread over the rocks, and these probably represent the better soils in the area.

Examples of Palabek profiles are given below.

Profile 24.

Near Ogibi. (Palabek Atiak track)

0 - 6"	Dark brown (7.5YR:3/2), loam
6 - 12"	Brown (7.5YR:4/2), sandy clay loam
12 - 18"	Brown (7.5YR:4/3), clay loam

This merges into a layer with the same material and rock fragments.

Profile 25.

Lolim.

0 - 6"	Very dark grey brown (10YR:3/2), loamy sand
6 - 12"	Dark brown (10YR:3/3), sandy loam
12 - 18"	Dark yellowish brown (10YR:3/4), sandy loam
18 - 24"	Brown (7.5YR:4/4), sandy clay loam

Profile 26. (18556-8)

Ridge north of River Anaka

0 - 4"	Greyish brown (10YR:5/2), fine sandy clay loam crumb
4 - 9"	Brown (10YR:5/3), fine sandy clay loam, weak crumb
9 - 24"	Yellowish brown (10YR:5/4), sandy clay cloddy

These are some of the better soils types, but it must be remembered that there are also large areas of very shallow and poor soils, and even bare rock. The chemical data in the appendix are from such soils. They show the usual low contents of organic matter, available bases and phosphate but these tend to increase with depth as a result of severe dry seasons, like the Kiten soils.

Soils of Old Rift Valley Sediments

15. Rogem Type.

The most extensive of the soil types formed on rift valley deposits is Rogem sand in West Nile.

This is a deep, sandy, red soil which often shows little variation over many square miles; it is one of the few mappable soil types (soil type used in its defined sense) in the Protectorate. Topographically it occurs on a plateau varying in height from a few feet to about two hundred feet above the River Nile, which is dissected by several very broad valleys which cross the plateau to enter Lake Albert or the Nile. The parent material is a Pleistocene lacustrine deposit known as the Kaiso beds (although probably younger than those of the type locality, Kaiso, in Bunyoro). There are occasional bands of diatomite, and clay but the soils are almost always sandy.

A typical profile is shown below.

Profile 27.

Pakwach.	Terrace.
0 - 3"	Grey brown (7.5YR:4/2), coarse sand
3 - 15"	Reddish brown (5YR:5/6), "
15 - 36"	" " (5YR:4/4), "
36 - 48"	" " " Loamy coarse sand

These soils are considered rather poor, and are used mostly for cassava growing, although one cotton crop can be taken when the land is freshly opened. On the lower slopes, just above the swamps, narrow strips of what is a transition between Ora clay and Rogem sand, are found. It is dark, sandy clay or similar texture, and yet does not suffer flooding in the wet season. Here various food crops other than cassava are grown.

Some unusual soils at Pakwach may be described here as they do not cover sufficient area to warrant a separate mapping unit but are located adjacent to the Rogem sand. A spit of shingle and shells has been built out from the shore at Pakwach, and within this are lake-laid sands which are very saline. In fact, in former days this soil was used as a source of salt. The spit at Pakwach is the only one along the Nile, though there are others in Bunyoro along the banks of the Lake Albert.

These deep sands have a low inherent fertility, falling off rapidly from the topsoil downwards. Two typical topsoils are given in the appendix and it is seen that even topsoils have low organic matter and very low base contents. The phosphate content is quite good in these samples, but is usually deficient. The pH is over six, not indicating the presence of bases but approaching the sterility of pure sand. This is due to the very low clay and organic matter contents. Lower slopes near scarp margins, as was explained above, are better than the upper slopes, and an example from Inde is given. This has ample phosphate, and the base content is not too bad, though calcium is deficient.

16. Paraa Series.

These soils are formed on Kaiso sediments in Acholi, like the Rogem sand of West Nile, but there are several differences in character. Generally the soils are of a browner colour than the Rogem which are very red. Whereas the Rogem soils are almost all coarse sands, the Paraa, although usually sandy, do show a greater variety of textures. Some of the profiles rapidly become sandy clays with depth, and in the neighbourhood of Paraa itself there are large pebble beds.

Two typical profiles are shown below.

Profile 28.

Te Okoto (M. 33)

0 - 6"	Dark greyish brown (10YR:4/2), sand
6 - 12"	Brown (7.5YR:4/4), sandy loam
12 - 18"	Reddish brown (5YR:4/4), sandy clay loam
18 - 36"	Dark red (2.5YR:3/6), sandy loam

Profile 29.

Pak ba

0 - 6"	Brown (7.5YR:4/3), sand
6 - 12"	" (7.5YR:4/4), sand
12 - 18"	Yellowish red (5YR:5/6), loamy sand
18 - 36"	" " (5YR:5/6), sandy loam

Most of the valleys in the area are narrow and there is no eqivalent to Ora clay of West Nile, and consequently there are no swamp edge soils equivalent to the most fertile soils of the rift valley lowlands. All the rivers have short courses and the area is more efficiently drained than the West Nile areas, and the problem of water supply would make agriculture difficult. Fortunately the entire area is in the National Game Park, which is perhaps the best use to which it could be put. There are several expanses of severe gully erosion, especially around Paraa, which are due to overgrazing by the very large numbers of animals, especially hippo.

Analyses of Paraa soils show them to be very sandy, acid, and with a low content of bases. Phosphate, in some samples, is remarkably high possibly from the manure of the natural fauna.

Alluvial Soils

17. Pager Series

Although the lower valley of the Aswa river consists largely of bare rock, the upper valley (the river is called the Moroto in Lango) and its branches, have deposits of alluvium along their courses. The soils developed on this alluvium occur in broad spreads several miles across, and despite the ground being very flat, the soils are not usually swampy. The soils appear to have attained some degree of maturity as indicated by the textural profile which shows an increasing heaviness with depth, and not the random variation that occurs in recent alluvial soils; they may thus be regarded as a mappable soil series.

Most profiles have dark coloured top soils, generally in the 10YR hue, dark grey or dark brown being the commonest colours. Some soils in the Pader Palwo area are exceptionally yellow. Although the textural profile is graded and topsoils are lighter than subsoils,

the majority of profiles are clays but occasionally sandy profiles do occur, as in the Kitgum area.

In many sites murram is present at between one and three feet from the surface, indicating a shallow fluctuating water table within the alluvium. The shallowest soils are little used for cultivation, which may be due to their poverty, or simply to the preference on the part of the local people to use them for grazing.

Two typical Pager profiles are shown below.

<u>Profile 30.</u> (10709-15)

Agago River

0 - 2"	Dark grey (10YR:4/1), clay loam, weakly granular
2 - 9"	Dark brown (10YR:4/3), sandy clay, " "
9 - 15"	" " " sandy clay loam, angular blocky structure
15 - 24"	Grey brown (10YR:5/2), sandy clay loam, " " structure
24 - 36"	Dark grey brown (2.5Y:4/2) (with paler slight mottling) sandy clay loam, angular blocky structure
36 - 48"	" " " " (with paler slight mottling) sandy clay loam, angular blocky structure
48 - 60"	" " " " (with paler slight mottling) sandy clay loam, angular blocky structure

<u>Profile 31.</u> (10445-51)

Pager River

0 - 6"	Very dark grey (10YR:3/1), clay, granular structure
6 - 12"	" " " " " angular blocky structure
12 - 24"	" " " " " " " "
24 - 36"	" " " " " " " "
36 - 48"	Dark grey (10YR:4/1) " " " "
48 - 56"	" " " " " " "
56 - 65"	Very dark grey (10YR:3/1) " " " "

Pager soils merge into the wide expanses of Sebei clay along the Karamoja - Lango border. Elsewhere they merge into the dark sandy soils of the Amuria and Anaka units, but in the north they have fairly abrupt boundaries with adjacent soil units. Genuine swamp soils occur close to the rivers, but these are not usually extensive, and have not been mapped separately.

Analytical data for two typical Pager profiles are given in the appendix. They seem reasonably fertile, but the phosphate content is low in the profile from Pager and sodium is high in the subsoils of the Agago site.

18. Pakelle Complex.

The Pakelle soil complex occupies a roughly triangular patch in the northern part of East Madi, inside an area of Palabek soils.

This mapping unit is really a geomorphic rather than a soil unit, and delimits an area where minor earth movements have caused back-damming of rivers and the creation of swamps. The swamp soils are black clays, but they are better for agricultural purposes than much of the surrounding country. This is especially true of the swamp edges. The area has a fairly high rainfall despite its usual arid appearance, and is quite productive of cotton. Hot springs indicative of soil salinity, occur a few miles south of Pakelle, but generally the soils are not saline. The different soil types have a patchy distribution within the area mapped as Pakelle, and between the swamps there are areas of skeletal soil over fresh rock and some smaller patches of red loam. The mapping unit can be regarded as a complex mixture of swamp (Ora) soils and upland soils of the Palabek unit.

The profile below is a typical sandy soil from a swamp edge.

Profile 32. (5444-8)

0 - 6"	Greyish brown (2.5Y:5/2), loamy sand
6 - 14"	" " " sandy loam
14 - 24"	Yellowish brown (10YR:5/4), sandy clay loam
24 - 36"	Pale yellowish brown (10YR:6/4), sandy clay
36 - 48"	Brownish yellow (10YR:6/6), sandy clay

As the soil types are very diverse the chemical data is very variable. The analytical data in the appendix are from a swamp edge soil.

Ora Series.

The Ora soil series occurs in wide seasonally flooded valleys in the rift valley lowlands of West Nile. The soils are heavy black clays commonly referred to as black cotton soils, with occasional carbonate concretions. A typical profile is shown below.

Profile 33. (10855-61)

R. Koichi, old flood plain

0 - 6"	Very dark grey (10YR:3/1), clay, angular blocky structure
6 - 12"	" " " " " " " "
12 - 24"	" " " " " " " "
24 - 36"	" " " " " " " "
36 - 48"	" " " " " " " "
48 - 60"	" " " " " " " "
60 - 72"	" " " " " " " "

Sandy layers are sometimes found in various parts of the profile. These are the result of original sedimentary banding and

not of pedological formation. Such a profile is shown below.

Profile 34. (10754-7)

River Ora, Flood plain, 3,000 ft.

0 - 6"	Very dark grey (10YR:3/2), sandy clay loam, weakly granular
6 - 12"	" " " " sandy clay, weak angular blocky structure
12 - 24"	Dark brown (10YR:3/3), loamy sand, structureless
24 - 30"	" " " sandy loam, weak angular blocky structure

In the Obongi-Kali area there is a peculiar arrangement of soil types which is not at present clearly understood. Here the black clays are not confined to valleys but extend up the slopes and even to the summits of low mounds. Occasionally the Ora soils are saline, (E.G. profile 35), and therefore not utilised. The local people claim to be able to recognise saline soils by the taste. Water conditions control the use of the Ora clays; cotton is the usual crop, and food crops are generally grown on the margins of the swamps, where the soils are the most productive in the area.

Profile 35. (10804-10)

River Acha, swamp.

0 - 6"	Very dark grey (10YR:3/1), clay, angular blocky structure
6 - 12"	" " " " sandy clay, " " "
12 - 24"	" " " " " " " " "
24 - 36"	" " " " " " " " "
36 - 48"	" " " " " " " " "
48 - 60"	Dark grey (10YR:4/1), sandy clay loam, angular blocky structure
60 - 72"	Grey Brown (10YR:5/2), " " " " " "

Mechanical analyses, shown in the appendix, indicate irrational changes in the texture profile, suggesting that the variation is due to sedimentation and not to soil forming processes. Most textures are heavy and clays throughout form the commonest profile, such as that from the River Koichi. Organic carbon and phosphate figures are usually high, as are most bases. Sodium is sometimes present, as in profile 33, and it may be excessive. Topsoils are acid, to below pH5, although calcium carbonate may be present in discrete concretions.

20. Panyimur Series.

Panyimur series occurs along the shores of Lake Albert (2030 ft.) in the south of West Nile district. Its soils are probably derived largely from old lakeside deposits, plus a certain amount of detritus derived from the escarpment. The soils are dark in colour, but remarkably sandy in texture, though subsoils can be as heavy as clay loam. They have fairly loose single-grain structure

and are very easy to work. Towards the escarpment the slope of the ground increases, but the soils are very much the same and rarely become stony. The actual lake margin soils are not used for cultivation, presumably because of excess water conditions.

A typical profile is shown below.

Profile 36. (13953-5)

Panyimur. Terrace.

0 - 6"	Very dark grey (10YR:3/1), sand
6 - 15"	Grey (2.5Y:5/0), sand
15 - 40"	Very dark greyish brown (10YR:3/2), loamy sand

Analytical data indicates that the soils are loamy sand to sands with a moderate organic matter content. The phosphate content is high, and seems to increase towards the lake shore. Base contents are fairly high, and sodium is absent, so these soils are satisfactory in all respects, in fact, they are the best soils in the Rift Valley.

21. Laropi Series.

The Laropi soil series extends along the banks of the Nile in the Northern part of the province; it consists of deep sands, originally laid down by the River Nile. Minor rivers cross the areas mapped as Laropi and form narrow tracts of heavy black clays of the Ora type, but these have not all been shown on the map. Deep grey brown sands form the whole of the soil profile in most instances, but there are sometimes horizons of different colour or texture. These are original sedimentary horizons and not soil horizons.

Profile 37. (10930-4)

Dufile

0 - 6"	Black to dark grey (10YR:4/1), loamy sand, angular blocky structure
6 - 24"	Very dark grey (10YR:3/1), sandy clay loam, angular blocky structure
24 - 36"	Very dark grey brown (10YR:3/2), sandy clay loam, angular blocky structure
36 - 51"	Dark grey brown (10YR:4/2), loamy sand, weak angular blocky structure
51 - 72"	Pale brown (10YR:6/3), sand, structureless

Some of the Laropi soils are too saline for cultivation, but generally they are the best soil in the regions where they occur - better than the average Ora, Rogem or Metu soils and are particularly favoured for settlement.

Maruzi county in the south of Lango district is bordered along the Nile by a number of river terraces, which give rise to a soil which may be classed with the Laropi series. It is sandy, and

grey to grey brown in colour, and although it has little appearance of high productivity it is claimed locally to be very good land, being much used for cotton (in preference to the Buruli soils of the area). There are some patches of coarse gravels on the terraces, unused for cultivation, and these support dense thorny thickets.

Laropi profiles are very variable. Mechanical analysis shows that subsoil textures are erratic, due to sedimentary banding and not to soil forming processes. The organic matter content is usually satisfactory, but in the very sandy areas, as in Lango, a low organic matter figure is normal. Phosphate content is generally high in West Nile representatives of this series, but the very sandy soils of Lango are deficient. Base contents follow the same pattern, the West Nile area being the best, though there is occasionally excess sodium.

22. Undifferentiated Alluvium.

Along the southern boundary of Lango district small rivers feed into Lakes Kyogo and Kwania and these are terminated by swamp alluvium. The alluvial deposits are almost invariably dark grey clays with very infrequent thin lenses of fine sand. Seasonal flooding is a regular feature of these soils and this is reflected in their yellowish brown mottled subsoils. They differ from the Ora clays on this account and also in that calcium carbonate concretions are absent. These soils support swards of perennial grasses, chiefly *Echinochloa pyramidalis* with Phoenix palms on anthills. Profile 38 is typical of the Lango swamps.

Profile 38. (11126-31)

Abalang Swamp near Kangai-Ochero road crossing.

0 - 6"	Dark grey (10YR:4/1), clay, angular blocky structure
6 - 12"	" " " mottled yellowish brown, angular blocky structure
12 - 24"	Grey (7.5YR:5/0), mottled yellowish brown, angular blocky structure
24 - 60"	Grey (7.5YR:5/0), " " " " blocky structure

The analytical data show that these clays are fairly acid, pH 5-6, despite a high base content, indicating the presence of montmorillonitic clay mineral. Available sodium approaches the danger level in some profiles. Topsoils are notably low in organic matter despite their dark colours which may be ascribed to the clay mineral and free carbon from grass fires.

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Iteropi profiles are very variable. Mechanical analysis shows that subsoil textures are erratic, due to sedimentary banding and not to soil forming processes. The organic matter content is usually satisfactory, but in the very sandy areas, as in Lango, a low organic matter figure is normal. Phosphate content is generally high in West Nile representatives of this series, but the very sandy soils of Lango are deficient. Base contents follow the same pattern, the West Nile area being the best, though there is occasionally excess sodium.

22. Undifferentiated Alluvium.

Along the southern boundary of Lango district small rivers feed into Lakes Kyoga and Kwania and these are terminated by swamp alluvium. The alluvial deposits are almost invariably dark grey clays with very infrequent thin lenses of fine sand. Seasonal flooding is a regular feature of these soils and this is reflected in their yellowish brown mottled subsoils. They differ from the Ora clays on this account and also in that calcium carbonate concretions are absent. These soils support swards of perennial grasses, chiefly Echinochloa pyramidalis with Phoenix palms on anthills. Profile 18 is typical of the Lango swamps.

Profile 18. (1112G-11)

Abalang Swamp near Kangai-Ochero road crossing.

0 - 6"	Dark grey (10YR.4/1), clay, angular blocky structure
6 - 12"	" " " mottled yellowish brown, angular blocky structure
12 - 24"	Grey (7.5YR.5/0), mottled yellowish brown, angular blocky structure
24 - 60"	Grey (7.5YR.5/0), " " " " blocky structure

The analytical data show that these clays are fairly acid, pH 5-6, despite a high base content, indicating the presence of montmorillonitic clay minerals. Available calcium approaches the danger level in some profiles. Topsoils are notably low in organic matter despite their dark colours which may be ascribed to the clay mineral and fine carbon from grass fires.

scarps are highest in the south and fade off to the north, but there the Madi Hills may represent further faulting on a large scale. Above the escarpments are usually Okollo soils, and below them, apart from small areas of colluvium derived from the scarp, there are soils of the Rogem and Ora units. On the scarps themselves there is only skeletal soil, pale grey, sandy and stony. Due to the slopes there is little retention of water and vegetation is represented only by drought and fire resistant species. Such land has no agricultural value. The work of Macdonald (3) indicates that the faulting on the West Nile sides of the rift, in the Obongi area, is a complex hinge zone, which results in many minor fault blocks instead of the large clean cuts as occur on the Acholi side and south West Nile. The effect of this is to break the soil distribution into smaller areas, (not mapped on the present scale) which would in turn cause very scattered and patchy agriculture if they should ever be utilised.

The West Nile escarpment as distinct from the Rift Valley is a north-south feature, parallel to the western boundary of the district. There is no evidence for faulting in the area, but Hepworth's (2) work suggests it is a warp which has been emphasised by later erosion. The scarp is highest and most marked in the south, (behind Parombo), and can be followed to Koboko where it is a fairly minor feature of the landscape. In front of the escarpment proper there is a zone of hills - erosional remnants of the front part of the zone, and these are steep sided and have similar soil to the escarpment proper. The Metu mapping unit covers the whole zone of escarpment and hills. The soils are grey, sandy skeletal soils, and like those of the rift valley faults are excessively drained in many places.

The Madi hills have not been geologically surveyed, but appear to be an uptilted fault block, mainly of quartzites, the dissection of which has given rise to the present rugged topography. The junction between the hills and the alluvium near Dufile appears to be a fault scarp, but in the west the hills merge into the Madi plain. In the hills proper there are the usual grey to yellowish brown, sandy, stony skeletal soils, but the topography is much more uneven than on the fault scarps but there are occasional flat sites where reasonable depths of soil accumulates. This is still sandy, but in suitable sites, or on the more micaceous rocks loamy soils can occur. In some profiles there is even laterite. Examples of two profiles in the Madi hills are shown below.

<u>Profile 41</u>. (7524-8)

Metu

0 - 5"	Dark greyish brown (10YR:4/2), loamy sand
5 - 10"	" " " " sandy loam
10 - 16"	Dark brown (7.5YR:4/2), sandy clay loam
16 - 24"	Brown (10YR:5/3), sandy clay loam
24 - 48"	Dark brown (7.5YR:4/4), sandy loam

Rocky Soils

23. Aswa Complex.

The river Aswa in Acholi follows for most of its course a thick milonite band, which marks the line of a very ancient fault. The water-course has minor deviations, but it must be one of the longest straight stretches of river in the world. The milonite must have proved fairly easily erodible to control the direction of the river to such an extent, and this is also shown by the amount of freshly exposed rock. This bare rock is the basis of the Aswa mapping unit.

In contrast to the Moroto reaches of the river, the Aswa valley is not covered by a thick sheet of alluvium, but is mostly bare rock, and although there are many patches of alluvial soils on minor meanders and backwaters they are of such small size and of such irregular distribution that they are not used for crops. They are also liable to flooding. The main Aswa valley and the portions of tributary valleys of the same type, such as the Aguga, can be regarded as virtually useless, and soil-less.

On slightly higher ground, where a reasonable depth of soil replaces the more usual shallow stony soils, there is some cultivation, and the profiles given below are of these atypical and better soils.

Profile 39.

Aswa River on Atiak - Palabek track.

0 - 6"	Very dark grey brown (10YR:3/2), sand
6 - 12"	Dark grey brown (10YR:4/2), sand
	Rock

Profile 40. (17188-91)

Higher ground, near above. Palulu.

0 - 4"	Very dark grey (10YR:3/1), loamy sand
4 - 14"	Very dark grey brown (10YR:3/2), loamy coarse sand
14 - 24"	Dark grey brown (10YR:4/2), sandy clay loam
24 - 36"	Dark grey brown (10YR:4/2), sandy clay loam
	Merging into broken rock

The example from which the analytical data is given is from an area recently cleared by the Tsetse department and not yet settled (1958). Most bases are present in reasonable quantities, but the complete absence of phosphate is highly deleterious. This is a fairly light soil and possibly the heavier soils are somewhat better.

24. Metu Complex.

This name, taken from a village in the Madi Hills, has been given to those areas on the soil map where there is very little soil, but steep rocky scarp slopes. Some of these areas may be characterised further.

The rift valley escarpment consists of several fault scarps arranged en echelon, roughly parallel with the Albert Nile. The

Profile 42. (18475-7)

Agoro

0 - 8" Dark grey (10YR:4/1), loamy sand
8 - 16" Dark greyish brown (10YR:4/2), loamy sand
16 - 24" Dark brown (10YR:4/3), gritty loamy sand

The Agoro hills are made of granitic rocks and rise abruptly from the north Acholi plains by an escarpment of about 1,000 feet. The escarpment, as would be expected, is covered by skeletal soils with much bare rock. Above the escarpment is a dissected plateau with undulating landscape, which rises gently to the peaks of the Imatong mountains. The upper slopes too, have generally shallow and sandy soils of fairly poor quality, and they are not used for cultivation. From the natural vegetation it seems that the area receives quite a high rainfall, and there are some permanent rivers. These have cut very steep gorges where they cross the edge of the escarpment. At Agoro water from the river has been used from time immemorial for irrigation during the dry season. At present the hills harbour much game and are used more as a hunting area than anything else. Lack of easy access is likely to prevent any development.

The Maruzi (Mahaluzi) Hills of south Lango are composed of Karagwe-Ankolean rocks, mainly quartzites. These have a skeletal soil and are comparable with the Bugondo hills of Teso in Eastern Province. There are some patches of highly sheared phyllitic rocks such as occur at Serere in Eastern Province, and there may be some small areas of Serere soil series, though none were discovered during the survey. The Maruzi area seems to be drier than the Serere-Bugondo area, and soils are not so well developed, and suffer considerable sheet erosion.

The Acholi hills range from small tors to huge inselbergs like Rom. All are composed mainly of granitic or gneissic rock and all have bare rock surfaces or, at best, only skeletal soils. Many inselbergs rise from plains of pre-weathered rock but there is little of this material left near the inselbergs and even their pediments are on fresh rock. Around some hills (e.g. Paimol) there is an apron of detritus derived from the hill, spread all around it, so that the surrounding profiles have a topsoil derived from the fresh rock, and containing unweathered minerals, which overlies very weathered rock. Certain hills assume a fantastic shape, of which Amiel is probably the most striking example. Although the soils of the hills themselves are virtually useless they are often the foci of settlements. This is due to the fact that they concentrate rainfall as runoff in the pediment at their bases, producing springs and wells.

Analytical data does not mean much in the case of these soils, which are so patchy and reflect only the nature of the underlying rock and its degree of weathering. The Nebbi samples quoted

in the appendix are such shallow soils but the differences give some idea of the variation that can take place within a short distance. The Agoro hills profile from Lotutura is deeper. Here the pH and most bases are low, but organic matter is high, probably because they are not cultivated. The Metu profile is even deeper but can hardly be regarded as typical. Nevertheless such pockets do occur among the poorer and more skeletal soils. The high potassium figure and deficiency of other bases must indicate relationship with underlying rock and lack of maturity of the profile. In considering the potential value of such small areas of soil within the Metu unit each must be considered separately, for it is not possible to generalise about the chemical data because local variation is too great.

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3. Macdonald, R., (1958). Verbal communications

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 - 2μ
Sand 20 - 2000μ

Exchangeable Bases (Cations)

The exchangeable cations were determined by a rapid method in neutral normal ammonium acetate leachates (Hughes, 1959). The figures in all cases except for sands and sandy loams are about 80% of what is actually present. For sands and sandy loams the more elaborate extraction technique was used and 95%-100% of the exchangeable bases were extracted.

It should be borne in mind that a zero figure for any one cation does not mean that it is entirely absent but that it was not detected by this method.

Exchangeable Hydrogen

This was determined in buffered p-nitrophenol extracts by the method of Schofield (1933).

pH

pH was measured in pastes (about 1:1) by the glass electrode method.

Organic Carbon

The wet combustion method of Walkley and Black (1934) was used but their correction factor of 1.33 was not applied.

Available Phosphate

The well known method of Truog (1930) was used, using buffered N/500 sulphuric acid as the extractant.

Lower Limits of Adequacy for Good Crops

	% Base Exchange Capacity
Calcium	20 for 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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APPENDIX

ANALYTICAL DATA FOR SOIL PROFILES

APPENDIX

ANALYTICAL DATA FOR SOIL PROFILES

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
									ZEU Profile 1 (18374-9)						
Lendu Forest, West Nile.															
2	6	27	1.0	0.6	0.17	tr.	0.19	1.96	14.2	16.16	12.1	4.85	2.7	12	Very deficient in all nutrients
5	4	33	<0.4	<0.3	<0.08	tr.	0.14	0.14	13.7	14.84	0.9	4.80	2.2	9	
12	6	37	<0.4	<0.3	<0.08	0	0.12	0.12	11.6	11.72	10.0	4.85	1.6	3	
22	10	43	tr.	<0.3	<0.08	0	0.17	0.17	8.5	8.67	2.0	5.10	0.9	6	
44	8	47	tr.	<0.3	tr.	0	0.15	0.15	6.7	6.85	2.2	5.45	0.4	8	
72	4	53	<0.4	<0.3	<0.08	0	0.04	0.04	7.6	7.64	0.5	5.10	0.8	15	
									N% 0.189 0-2", 0.154 2-5"						
									Profile 2 (18369-73)						
Lendu Forest, West Nile.															
6	8	27	4.2	1.5	0.66	0	0.22	6.58	9.5	16.08	40.9	5.30	3.0	25	Bases derived from organic matter.
14	10	33	1.3	0.7	0.34	0	0.13	2.37	8.7	11.07	21.4	5.00	1.6	7	
24	4	43	<0.4	<0.3	0.13	0	0.10	0.23	6.5	6.73	3.4	4.90	1.0	9	Very deficient
44	10	43	<0.4	<0.3	0.49	0	0.05	0.54	4.6	5.14	10.5	5.15	0.3	2	
50	6	39	<0.4	<0.3	0.68	0	0.03	0.71	3.7	4.41	16.1	5.30	0.4	2	
									N% 0.270 0-6"						
									WAR Profile 3 (18380-2)						
Atyak Rest House, West Nile.															
5	10	23	6.3	2.2	0.82	0	0.14	9.46	6.4	16.06	58.9	5.8	3.24	102	
18	12	25	1.7	<0.3	<0.08	0	0.11	1.81	6.7	8.51	21.3	5.2	1.23	18	Rooting zone
24+	6	43	1.6	0.7	<0.08	0	0.02	2.32	3.2	5.52	42.0	5.6	0.27	20	
									N% 0.248 0-5"						

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							

Depth Ins.	Mechanical Analysis Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
									ARUA						
									Profile 4 (18394-7)						
Mbaraka, West Nile.															
6	0	13	2.8	1.8	tr.	0	0.02	4.62	N.D.	-	-	6.4	1.43	18	
30	2	32	1.5	0.7	0.22	0	0.02	2.44	3.5	5.94	41.2	6.25	0.71	5	Normal base distribution
48	0	27	1.0	<.3	0.17	0	0.03	1.20	3.6	4.80	25.1	5.00	0.63	2	Low phosphate
60	8	35	0.9	<.3	0.16	0	tr.	1.06	2.6	3.66	28.9	5.25	0.20	0	
									N% N.D.						
									Profile 5 (18416-8)						
Arua, West Nile.															
10	10	20	6.3	2.2	0.39	0	0.13	9.02	4.0	13.02	68.8	5.75	1.64	60	Better soil than
24	10	32	4.8	1.0	0.38	0	0.15	6.33	5.0	11.33	55.7	5.50	1.14	11	Profile 4
72	4	32	1.8	0.9	0.27	0	0	2.97	3.2	6.17	48.0	5.05	0.27	14	
									N% 0.150 0-10"						
									KOBOKO						
									Profile 6 (18398-9)						
Oraba, West Nile.															
6	6	38	2.2	0.9	0.27	0	0.03	3.40	3.1	6.50	52.3	5.3	0.15	3	Very low phosphate
12	6	18	2.7	0.7	0.46	0	0.08	3.94	4.9	8.84	44.6	5.2	1.02	9	Fresh minerals here
12+	Weathered rock														
									N% 0.022 0-6"						
									YUMBE						
									Profile 8 (7516-9)						
Omugo, West Nile.															
6	6	21	7.3	2.5	0.66	tr.	0.11	10.57	N.D.	-	-	5.4	2.10	N.D.	Fairly high base content
12	10	21	6.2	1.5	0.39	tr.	0.12	8.21	N.D.	-	-	5.6	1.62	N.D.	throughout profile
24	11	21	6.7	1.5	0.25	tr.	0.06	8.51	N.D.	-	-	5.5	1.11	N.D.	
36	7	35	7.0	3.3	0.28	tr.	<0.01	10.58	N.D.	-	-	5.5	0.54	N.D.	
									N% 0.175 0-6"						

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Satur-ation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							

Depth Ins.	Mechanical Analysis Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
									FAROMBO Profile 9 (18421-3)						
Uleppi, West Nile.															
6	8	24	6.2	2.0	1.34	0	0.06	9.60	2.1	11.70	82.1	6.30	1.59	8	Normal profile
12	8	46	3.2	1.0	0.34	0	0.15	4.69	5.2	9.89	47.4	5.10	0.69	9	
72	4	40	3.2	2.3	0.45	0	0.10	6.05	2.4	8.45	71.6	5.80	0.78	6	
									N% 0.122 0-6"						
									BURULI Profile 10 (17220-4)						
Minakula, Lango.															
7	10	44	4.4	1.2	0.52	0	0.16	6.28	3.5	9.78	64.2	5.85	0.53	15	Low N, C, P_2O_5
18	2	42	1.4	0.6	0.39	0	0.10	2.49	5.0	7.49	33.2	5.30	0.74	5	
30	12	45	1.2	<0.3	0.42	0	0.14	1.76	4.6	6.36	27.7	5.25	N.D.	5	Low Ca and Mg
44	6	48	1.4	<0.3	0.35	0	0.07	1.82	3.6	5.42	33.6	5.60	0.48	9	
68	8	46	1.4	<0.3	<0.08	0	0.05	1.45	3.1	4.55	31.8	5.60	0.63	5	
									N% 0.078 0-7"						
									Profile 11 (15937-41)						
Aduku, Lango.															
6	6	26	5.6	2.0	0.46	0	0.15	8.21	4.0	12.21	67.3	6.05	1.62	11	Normal profile
14	1	42	3.0	0.8	<0.08	0	0.14	4.02	5.9	9.92	40.4	5.4	1.08	6	
22	1	42	2.4	0.7	0.11	0	0.16	3.37	6.1	9.47	35.7	5.3	0.98	6	
33	3	42	2.2	0.5	0.08	0	0.21	2.99	5.4	8.39	35.8	5.3	0.63	5	
40	5	42	1.7	0.4	<0.08	0	0.16	2.34	5.3	7.64	30.6	5.3	1.22	6	
									N% 0.165 0-6", 0.101 6-14"						
									Profile 12 (13461-6)						
Labora Farm, Gulu, Acholi.															
3	7	17	3.2	0.8	0.23	0	0.06	4.29	3.4	7.69	55.8	5.6	1.1	14	Low N and P_2O_5
9	9	25	1.9	0.5	<0.08	0	0.02	2.50	3.3	5.80	43.2	5.7	0.85	14	
22	5	23	3.9	0.3	<0.08	0	0.01	4.21	2.6	6.81	61.9	5.9	0.64	3	
30	3	23	5.4	1.0	0.12	0	0.01	5.53	1.9	7.43	74.2	6.15	0.47	5	Abnormal increases in bases
38	7	27	15.6	0.3	0.14	0	0	<15.77	0	<15.77	100.0	7.7	0.39	13	here may be due to except-
60	5	28	15.6	0.3	0.08	0	0	<15.90	0	<15.9	100.0	7.7	0.23	4	ionally dry site
									N% 0.085 0-3", 0.0909 3-9"						

Depth Ins.	Mechanical Analysis Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
									PAJULE						
									Profile 13 (10433-8)						
Patiko, Acholi.												Top of Catena			
6	6	22	2.8	1.4	0.43	0	V.H	4.63	4.5	9.13	50.7	5.51	2.07	57	Fairly high base content throughout profile, increase with depth due to dry site.
18	4	28	4.0	2.0	0.42	0	0.27	6.69	5.7	12.39	54.0	4.90	1.17	41	
30	4	44	4.1	2.3	0.45	0	V.H	6.85	4.7	11.55	59.3	5.10	0.62	6	
42	7	45	4.6	3.0	0.40	0	V.H	7.00	4.0	11.00	63.5	5.40	0.41	19	
54	7	47	5.4	2.7	0.46	0	0.28	8.84	3.9	12.74	69.4	5.45	0.36	16	
70	0	50	5.3	2.6	0.39	0	0.14	8.43	3.8	12.23	63.7	5.40	0.32	20	
									N% 0.144 0-6"						
									Profile 14 (10427-32)						
Patiko, Acholi.												Mid Catena			
6	10	16	5.7	3.0	0.34	0	0.11	9.15	5.3	14.45	63.3	5.87	1.47	265	As for profile 13.
18	2	24	2.6	0.7	0.24	0	0.18	3.72	5.6	9.32	39.9	5.15	0.86	22	
30	4	34	3.8	1.2	0.22	0	0.26	5.48	4.2	9.68	56.6	5.16	0.54	18	
42	8	39	4.6	1.6	0.31	0	0.28	6.79	3.6	10.39	65.4	5.12	0.44	8	
54	6	43	4.6	2.6	0.33	0	0.15	7.68	3.3	10.98	69.9	5.32	0.32	9	
66	4	46	5.1	1.7	0.42	0	0.10	7.32	3.5	10.82	67.7	5.30	0.36	13	
									N% 0.138 0-6"						
									KITEN						
									Profile 16 (18439-43)						
North of Madi Opei, Acholi.															
5	4	41	0.6	<0.3	0.28	0	0.31	1.19	5.2	6.39	18.6	5.3	1.04	8	Very low N and P. Increase in base content with depth due to dry climate.
18	12	45	9.8	4.7	0.49	3.0	0.03	18.02	4.2	22.22	81.0	5.5	0.67	7	
25	8	43	10.2	3.0	0.49	3.2	0.02	16.91	1.5	18.41	91.9	6.5	1.01	7	
36	10	45	14.5	4.2	0.74	4.7	0	20.14	0.5	20.64	98.5	7.4	0.71	18	
36+	8	39	13.8	3.2	0.75	4.9	0	21.65	0.6	22.25	97.3	7.4	0.60	33	
									N% 0.057 0-5"						

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Satur- ation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							

Depth Ins.	Mechanical Analysis Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H	Exch. Capacity m.e.	% Satur-ation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
									Profile 15 (18446-9)						
Madi Opei, Acholi.															
6	6	19	4.4	1.6	0.61	0	0.06	6.67	2.9	9.57	69.7	6.0	1.76	25	Better soil than Profile 16
15	10	27	4.2	1.7	0.31	0	0.07	6.28	4.3	10.58	59.4	5.4	1.36	14	but still reflects dry
28	4	39	4.9	1.7	0.23	0	0.06	6.89	4.5	11.39	60.5	5.3	1.21	13	climate
38	8	43	5.2	2.2	0.24	0	0.04	7.68	2.8	10.48	73.3	5.25	1.05	7	
									N% 0.128 0-6"						
									ANAKA						
									Profile 17 (17207-11)			Mid Slope			
Karlo, Near Lamogi.															
3	8	25	4.3	2.6	0.33	0	0.05	7.28	7.4	14.68	49.6	5.1	1.85	11	Low P_2O_5 throughout,
9	10	29	2.4	1.3	0.23	0	0.18	4.01	7.7	11.71	34.2	4.9	1.25	8	otherwise normal.
18	8	35	2.5	1.0	0.17	0	0.16	3.83	6.6	10.43	36.7	5.0	0.93	9	Increase in bases due
33	6	45	3.5	1.7	0.17	0	0.04	5.41	4.5	9.91	54.6	5.45	0.54	9	to fresh minerals.
48+	5	54	3.6	2.0	0.17	0	0.02	5.79	4.3	10.09	57.4	5.7	0.59	9	
									N% 0.147 0-3", 0.117 3-9"						
									Profile 18 (17216-9)			Plateau			
Paicho, Acholi.															
3	6	17	2.9	0.8	0.46	0	0.08	4.24	4.0	8.24	51.5	6.2	1.13	11	Normal profile with
9	10	31	1.5	<0.3	0.30	0	0.08	1.88	3.7	5.58	33.7	5.5	0.8	5	very low P_2O_5
19	12	31	1.2	0.3	0.11	0	0.09	1.70	4.2	5.90	28.8	5.4	0.30	8	
33+	11	35	0.9	<0.3	<0.08	0	0.09	0.99	4.8	5.79	17.1	5.25	0.72	8	
									N% 0.118 0-3", 0.07 3-9"						
									AMURIA						
									Profile 19 (17232-5)			Plateau			
Omoro, Acholi															
6	4	17	1.6	0.8	0.38	0	0.11	2.89	2.4	5.29	54.6	5.6	0.74	12	Low N and P_2O_5
18	4	23	1.4	0.6	0.21	0	0.05	2.26	N.D.	-	-	5.4	0.71	7	
48	0	33	1.2	<0.3	0.55	0	0.06	1.81	3.7	5.51	32.8	5.2	0.38	3	Bases accumulate due to
72	6	35	1.3	0.6	0.16	0	0.05	2.11	3.3	5.41	39.0	5.0	0.38	5	ironstone pan
									N% 0.074 0-6"						

N% 0.074 0-6"

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
									Profile 20 (17228-31)						
Apigikwe, Lango.												Plateau			
5	6	17	2.4	<0.3	0.18	0.4	0.22	3.20	3.1	6.30	50.8	5.2	0.84	21	Low N and P_2O_5
12	2	23	2.3	0.7	0.10	tr.	0.05	3.15	3.7	6.85	46.0	5.5	1.41	7	
20	4	29	1.9	<0.3	0.17	1.4	0.08	3.55	4.2	7.75	45.8	4.9	0.54	9	
48	0	31	1.8	<0.3	0.11	tr.	0.07	1.98	4.0	5.98	33.1	5.2	0.62	11	
									N% .085	0-5",	0.089	5-12"			
									DOKOLO						
									Profile 21 (19284-90)						
4 ml. E. of Lira, Lango.												Plateau top			
6	6	28	6.1	1.0	0.44	tr.	0.11	7.65	5.5	13.15	58.2	5.75	1.61	7	Normal profile apart from very low P_2O_5
12	2	33	4.7	0.7	0.31	0	0.05	5.76	4.3	10.06	57.3	5.8	1.18	4	
24	6	37	2.8	1.2	0.15	0	0.10	4.25	7.2	11.45	37.1	5.1	1.15	3	
40	6	37	1.9	0.7	0.10	0	0.06	2.76	5.3	8.06	34.2	5.1	0.56	3	
64	0	43	1.9	0.5	0.11	0	0.05	2.66	3.7	6.37	41.8	5.4	0.35	9	
88	4	45	2.2	1.0	0.22	0	0.02	3.44	2.2	5.84	58.9	6.05	0.19	4	
120	2	51	1.9	0.8	0.22	0	0.02	2.94	2.6	5.54	53.1	6.0	0.16	0	
									N% 0.155	0-6"					
									Profile 22 (15968-73)						
Dokolo Gombolola, Lango.												Lower slope			
4	2	36	6.0	2.6	0.86	0	0.08	9.54	4.1	13.64	69.9	5.9	1.68	10	Normal profile apart from low P_2O_5
14	4	29	4.4	1.4	0.38	0	0.12	6.30	6.1	12.40	50.8	5.5	1.39	22	
28	2	32	4.4	1.9	0.39	0	0.16	6.85	5.4	12.25	55.9	5.2	1.40	8	
36	10	38	2.7	0.3	0.21	0	0.10	3.31	4.2	7.51	44.1	5.45	0.62	9	
52	0	42	2.6	0.7	0.23	0	0.06	3.59	3.0	6.59	54.5	5.8	0.47	10	
72+	0	46	2.9	1.0	0.28	0	0.02	4.20	2.9	7.10	59.2	6.1	0.30	10	
									N% 0.143	0-4"					

Depth Ins.	Mechanical Analysis	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil	Exch. H	Exch. Capacity	% Satur-	pH	Organic Carbon	Truog P_2O_5	Remarks

Depth Ins.	Mechanical Analysis Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
Profile 23 (15962-7)															
Dokolo Gombolola, Lango.												Flat plateau top			
2½	1	22	6.8	2.9	0.45	0.3	0.08	10.53	4.6	15.13	69.6	6.05	1.89	8	Low P_2O_5 throughout.
5	1	24	3.9	2.4	0.22	0.3	0.18	7.00	6.5	13.50	51.9	5.50	1.01	6	
10	3	28	3.1	1.8	0.16	0	V.H	5.06	N.D.	-	-	5.3	1.17	8	
18	1	32	2.8	1.4	0.15	0	0.19	4.54	7.6	12.14	37.4	5.3	1.02	6	
25	5	32	2.8	1.0	1.18	0	0.12	4.11	6.8	10.91	37.7	5.4	0.81	8	
36	6	38	3.3	1.2	0.15	0	0.09	4.64	5.1	9.74	47.6	5.4			
36+	Murram														
									N% 0.171 0-2½"						
OKOLLO (18403)															
Parombo, West Nile.															
6	8	14	3.0	2.3	0.77	0	0	6.07	1.4	7.47	81.3	6.4	0.66	11	Low N and P_2O_5
									N% 0.091						
(18406)															
Ofaka, West Nile															
6	4	40	2.6	1.8	0.36	0	0.03	4.79	5.2	9.99	47.9	5.60	0.60	2	
									N% 0.103						
PALABEK Profile 26 (18556-8)															
Ridge north of River Anaka, Acholi.															
4	4	14	1.5	1.0	0.24	0	0.08	2.82	5.8	6.62	42.6	5.7	0.77	16	Fresh minerals present
9	6	18	1.2	0.7	0.11	0	0.10	2.11	3.6	5.71	37.0	5.1	0.71	3	
24	2	22	1.5	0.8	0.66	0	0.20	3.16	2.6	5.76	54.9	5.1	0.43	24	
									N% 0.065 0-4", 0.067 4-9"						
ROGEM (18409)															
Mutir, West Nile.															
6	0	5	1.0	0.5	0.16	0	0.06	1.72	0.9	2.62	65.6	6.2	0.29	34	Low bases

Depth Ins.	Mechanical Analysis Silt	Clay	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil Ca	Mg	K	Na	Mn	Total	Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
										(18408)					
Biliba, West Nile.															
6	8	0	0.9	<0.3	0.16	0	0.06	1.12	0.8	1.92	58.3	6.40	0.30	23	Low bases
									N% 0.163						
										(18410)					
Inde, West Nile.											Near swamp margin				
6	0	7	2.9	0.9	0.31	0	0.10	4.21	1.2	5.41	77.8	6.60	0.68	144	High P_2O_5
									N% 0.131						
										PARAA (17299)					
Paraa, Acholi															
6	0	9	1.3	1.2	0.21	0	0.23	2.94	2.1	4.04	72.8	5.95	0.51	4	Low N, P and bases.
									N% 0.0755						
										(17297)					
Ognen, Acholi															
6	5	5	2.4	<0.6	0.28	0	0.05	2.73	1.3	3.03	90.1	6.65		156	High P - fish residues
									N% 0.081	(17298)					
Te 'okoto, Acholi															
6	0	9	2.9	0.6	0.20	0	0.08	3.78	2.4	6.18	61.0	6.25	0.87	58	Game droppings.
									N% 0.109						

Depth Ins.	Mechanical Analysis	Exchangeable Bases (Cations) Milli-equivalents per 100g Soil	Exch. H	Exch. Capacity	% Satur-	pH	Organic Carbon	Truog P_2O_5	Remarks

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
									PAGER						
									Profile 30 (10709-15)						
Agago River, Acholi.															
2	18	39	7.0	3.5	0.7	tr.	0.18	11.38	11.5	22.88	49.7	5.4	2.97	146	High bases
9	14	39	7.8	2.2	0.4	tr.	0.14	10.54	9.4	19.94	52.9	5.1	1.32	21	
15	12	35	7.7	2.2	0.3	1.1	0.13	11.13	6.8	17.93	62.1	5.2	0.72	15	
24	9	35	7.4	5.0	0.3	2.7	tr.	15.40	3.0	18.40	83.7	6.6	0.54	5	Accumulation due to very sovere dry season and no through leaching.
36	7	39	7.8	4.4	0.2	3.7	0	16.10	0.4	16.50	97.6	6.6	0.32	1	
48	11	38	9.4	8.8	0.2	5.0	0	23.40	1.4	24.80	94.4	7.3	0.15	8	
60	11	32	8.1	6.6	0.3	4.0	0	20.00	0	20.00	100.0	7.0	0.11	3	
									N% 0.193 0-2", 0.105 2-9"						
									Profile 31 (10445-51)						
Pager River, Acholi.															
6	11	52	13.3	9.4	0.8	0	tr.	23.5	3.9	27.4	85.8	5.65	1.82	17	As above but lower P_2O_5
12	8	62	15.6	10.6	0.5	0.3	tr.	27.0	4.6	31.6	84.4	5.74	1.07	2	
24	8	62	17.6	11.2	0.6	0.9	tr.	20.3	3.1	23.4	86.8	6.1	0.93	3	
36	11	59	16.4	10.0	0.8	1.5	tr.	28.7	2.5	31.2	92.0	6.3	0.99	4	
48	9	53	20.4	9.4	0.7	1.2	tr.	31.7	2.8	33.5	94.6	6.0	0.63	8	
56	10	53	21.9	8.8	0.8	1.1	0.03	32.6	2.3	34.9	93.5	5.8	0.41	28	
65	4	60	20.4	8.8	0.8	1.7	0	31.7	2.5	34.2	92.7	5.8	0.48	10	
									N% 0.158 0-6"						
									PAKELLE						
									Profile 32 (5444-8)						
Pakelle, East Madi.															
6	4	11	1.5	0.6	0.28	0	0.04	2.42	1.5	3.92	61.7	6.4	0.51	14	Low N and P_2O_5, sandy topsoil
14	4	16	1.3	0.6	0.22	0	0.04	2.16	2.2	4.36	49.5	5.7	0.31	5	
24	4	36	2.0	1.0	0.22	0	0.02	3.24	3.8	7.04	46.0	5.2	0.30	5	
36	4	42	2.4	1.0	0.23	0	0.02	5.65	3.1	8.75	64.6	5.7	0.24	11	
48	6	41	2.2	0.8	0.20	0	0.03	3.23	2.0	5.23	61.8	5.1	0.23	8	
									N% 0.068 0-6"						

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
									ORA						
									Profile 33 (10855-61)						
River Koichi, West Nile.												Old flood plain			
6	11	51	12.7	7.2	0.3	0	0.09	20.29	8.6	28.89	70.2	4.90	3.42	390	High P_2O_5
12	34	40	17.0	10.0	0.3	0	0.05	27.35	7.1	34.45	79.4	5.05	1.29	156	High bases due to lack of
24	14	52	21.4	12.5	0.8	<.7	0.06	34.76	6.7	41.46	83.8	5.15	1.20	265	through leaching and severe
36	10	62	21.11	11.3	0.3	1.0	0.04	33.74	7.2	40.94	82.4	4.95	1.17	500	dry season.
48	10	52	17.5	10.0	0.5	<.3	0.03	18.03	7.0	25.03	72.0	4.80	0.83	143	
60	7	56	20.6	11.4	0.5	1.3	0.03	33.83	6.4	40.23	88.3	4.60	0.44	50	
72	8	62	21.4	10.3	0.5	0.8	0.03	33.03	5.3	38.33	86.2	4.60	0.42	52	
									N% 0.219 0-6"						
									Profile 34 (10754-7)						
River Ora, West Nile.												Old flood plain			
6	12	29	11.6	3.4	1.4	0	tr.	16.40	3.3	19.70	83.2	6.2	1.68	500	High P_2O_5
12	14	39	16.6	4.5	1.2	0	0.05	18.15	2.4	20.55	88.3	6.1	1.29	150	High bases but some
24	3	17	8.0	4.2	0.4	0	0	12.60	1.4	14.00	90.0	6.39	0.74	183	through leaching due to
30	7	23	9.1	3.2	0.3	0	0	10.60	2.0	12.60	84.1	6.2	0.80	480	light texture
									N% 0.169 0-6"						
									Profile 35 (10804-10)						
River Acha, West Nile												Swamp			
6	11	48	11.7	2.4	1.1	0	0.06	15.26	4.6	19.86	76.8	5.9	1.98	585	High P_2O_5
12	6	47	4.8	8.8	0.8	0	tr	14.40	3.3	17.70	81.4	6.0	0.90	125	High bases, some through
24	6	46	4.8	7.6	0.6	0	0	13.00	2.6	15.60	83.3	6.2	0.78	117	leaching
36	9	44	15.8	6.2	0.4	0	0	22.40	2.1	24.50	91.4	6.05	0.57	122	
48	8	38	14.8	4.1	0.3	0	0	19.20	3.3	22.50	85.3	6.10	0.44	90	
60	10	30	11.6	2.4	0.2	0	0	14.20	1.1	15.30	92.8	6.4	0.32	62	
72	8	29	10.0	1.6	0.2	0	0	11.80	0.6	12.40	95.2	6.0	0.18	64	
									N% 0.146 0-6"						

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil	Exch. H	Exch. Capacity	% Satur-	pH	Organic Carbon	Truog P_2O_5	Remarks
	Silt	Clay								

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Satur-ation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
									PANYIMUR						
									Profile 36 (13953-5)			Terrace			
Panyimur, West Nile.															
6	9	0	6.8	3.0	1.09	0	0.06	11.95	1.6	13.55	88.2	6.7	1.19	350	High P_2O_5 due to fish residues
15	5	0	4.1	1.3	0.31	0	0.06	5.77	0.8	6.57	87.8	6.9	0.47	620	
40	5	10	8.0	3.9	0.23	0	0.04	11.17	2.2	13.37	88.5	6.3	0.91	330	
							N% 0.114 0-6", 0.0717 6-15", 0.0932 15-40"								
									LAROPI						
									Profile 37 (10930-4)						
Dufile, West Nile.															
6	8	12	5.9	3.9	0.8	0	0.07	10.67	2.7	13.37	79.8	6.8	1.04	500	High P_2O_5 due to fish residues
24	11	30	3.0	3.7	0.3	4.7	0.02	11.72	0.9	12.62	92.9	7.1	0.93	455	
36	7	24	7.0	2.9	0.3	6.2	0	16.40	0	16.40	100.0	7.7	0.32	290	
51	4	13	5.4	2.6	0	4.5	0	12.50	0	12.50	100.0	7.8	0.15	310	
72	all sand		3.5	3.4	0	0	0	6.90	0	6.90	100.0	8.4	0.02	122	
									N% 0.104 0-6"						
									UNDIFFERENTIATED ALLUVIUM						
									Profile 38 (11126-31)						
Abalang Swamp near Kangai-Ochero road crossing															
6	11	50	9.9	3.7	0.6	0.5	0.25	14.95	6.1	21.1	70.8	5.2	1.14	56	High bases increasing with depth due to severe desiccation
12	3	50	9.4	4.9	0.4	0.6	0.07	15.37	4.6	20.0	76.9	5.2	0.45	7	
24	7	46	10.2	3.7	0.3	0.4	0.02	14.62	3.5	18.1	80.8	5.6	0.34	22	
36	6	55	10.4	4.7	0.2	0.6	Tr.	15.9	2.2	18.1	87.9	5.9	0.27	20	
48	4	63	14.9	5.4	0.2	1.0	Tr.	21.5	1.8	23.3	92.4	6.0	0.21	9	
60	3	52	18.7	5.9	0.3	1.3	Tr.	25.2	1.6	26.8	95.3	6.1	0.17	25	
									N% 0.146 0-6", 0.075 6-12"						

Depth Ins.	Mechanical Analysis		Exchangeable Bases (Cations) Milli-equivalents per 100g Soil						Exch. H	Exch. Capacity m.e.	% Saturation	pH	Organic Carbon %	Truog P_2O_5 p.p.m.	Remarks
	Silt	Clay	Ca	Mg	K	Na	Mn	Total							
										ASWA					
										Profile 40 (17188-91)					
Palulu															
4	9	16	7.0	3.3	0.54	0	0.02	10.86	1.5	12.4	87.6	6.2	1.19	28	High bases, increasing with depth.
14	8	17	6.1	2.8	0.26	0	0.11	9.27	1.3	11.6	79.8	6.0	0.81	15	
24	6	29	8.0	3.6	0.41	0	0.06	12.07	1.8	13.9	86.7	5.8	0.47	4	Low P_2O_5
36	6	31	9.0	4.4	0.49	0	0.05	13.94	1.8	15.7	88.8	5.7	0.44	4	Low N
								N% 0.113	0- 4",	0.083	4-14"				
										METU					
										Profile 41 (7524-8)					
Metu															
5	10	11	5.0	1.4	0.55	0	0.11	7.06	0.6	7.7	91.7	6.45	0.51	136	
10	6	17	3.4	0.7	0.29	0	0.05	4.44	1.6	6.0	74.0	5.94	0.54	11	Low C, N and P_2O_5
16	4	25	4.0	0.9	0.43	0	0.02	5.35	1.9	7.3	73.2	5.90	0.51	10	
24	8	35	4.3	0.8	0.48	0	0.02	5.60	2.5	7.1	78.9	5.50	0.47	13	
48	6	17	3.9	0.8	0.44	0	0.04	5.18	2.5	7.7	67.4	5.60	0.29	8	
								N% 0.076	0-5",	0.075	5-10"				
										Profile 42 (18475-7)					
Lotutura, Agoro Hills															
8	14	28	7.6	0.8	0.18	0	0.12	8.70	5.8	14.5	60.0	5.40	1.73	5	Low Mg and K
16	16	28	7.0	0.4	0.15	0	0.16	7.71	6.0	13.7	56.3	5.20	1.56	1	Very low P_2O_5
24	10	26	7.9	0.4	0.17	0	0.15	8.64	4.3	12.9	66.9	5.45	1.17	12	
								N%	0.119	0-8"					
										(18387)					
S.W. of Nebbi															
6	2	6	1.3	0.7	0.29	0	0.04	2.33	1.0	3.33	70.2	5.35	0.45	15	All nutrients low
								N%	0.052						

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