SURVEY AND PLAN FOR IRRIGATION DEVELOPMENT IN THE PANGANI AND WAMI RIVER BASINS

UNITED REPUBLIC OF TANZANIA

SOILS

ANNEX I - APPENDIXES

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1969

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Survey and Plan for Irrigation Development in the Pangani and Wami River Basins

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Soils

Annex I - Appendixes

to the

Report prepared for the
Food and Agriculture Organization of the United Nations

by

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FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

Rome, 1968

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A P P E N D I X I

MIWALENI SPRINGS SEMI-DETAILED SURVEY

combined with

KAHE SEMI-DETAILED SURVEY

Site information

a. Soil name: UNIT 1.
b. Higher category classification: Intergrade: Alluvial-Solonetz-Haplorthent (1.53). Revised 7th Approximation (1964).
c. Date of examination: October 1964.
d. Author: G. H. Robinson.
e. Location: ¼ mile south of Miwaleni Springs, Kilimanjaro Region, Tanzania.
f. Elevation: 2345 feet.
g. Land form:
   i. Physiographic position of the site: Alluvial plain.
   ii. Land form of surrounding country: Flat and almost flat.
   iii. Microtopography: Nil.
h. Slope: 0-2% - flat or almost flat.
i. Vegetation and/or land-use: Vegetation is dominated by Acacia thorn-bush with grassy areas and large trees along the river banks. Grazed by cattle and goats.

General soil information

a. Parent material: Recent alluvium.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Moist below 13 inches.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 2 - moderately affected.
h. Human influence: Nil.

Brief description of profile

Very dark grey over dark greyish brown and brown, deep saline and occasionally alkaline, silty clay loam. Highly calcareous throughout with lime nodules in the surface horizon. Structures in the upper profile are granular. Permeable and well drained.

Profile description

A1 0-5" Very dark grey (10 YR 3/1) moist, and (10 YR 4/1) dry, silty clay loam; strong medium granular; often pulverised by cattl trampling; slightly sticky and slightly plastic, very friable moist, hard dry; permeable with common fine and few medium pores; many fine roots; few small lime nodules scattered on the surface; strongly calcareous with high effervescence; gradual smooth boundary; pH 8.4.

A3 5–13" Very dark greyish brown (10 YR 3/2) moist and dark greyish brown (10 YR 4/2) dry, silty clay loam; medium moderate granular; slightly sticky and slightly plastic, friable moist, slightly hard, dry; common fine pores; many fine roots; strongly calcareous; gradual smooth boundary; pH 9.6.

C1 13–26" Dark greyish brown (10 YR 4/2) moist, silty clay loam; moderate medium granular; common fine pores; slighty sticky and plastic; few fine roots; strongly calcareous; pH 9.6.

C2 26–38" Brown (10 YR 5/3) moist, silty clay loam; moderate medium granular; slightly sticky and slightly plastic, friable moist; few fine roots; strongly calcareous; pH 9.6.

C3 38–60" Brown (10 YR 5/3) moist, silty clay loam; massive; strongly calcareous; pH 9.6.

Range of characteristics

Surface colours range from very dark grey to greyish brown. Variation from profile to profile in the reaction to HCl. Subsoil colours are usually dark greyish brown. pH ranges between 8.0 and 9.6.

Similar and associated soils

These soils have some common physical characteristics with Unit 5 which is however not calcareous and is non-saline. Main inclusions are small areas of Unit 31 and 1R.

Land-use and agricultural potential

The unit is not used for agriculture at the present time because of high salt content and some areas with high exchangeable sodium. The soils would need both leaching and in some parts intensive reclamation to produce crops economically. Flood protection will be required.

Site information

a. Soil name: UNIT 4.
b. Higher category classification: Alluvial. Haplorthent (1.53). Revised 7th Approximation (1964).
c. Date of examination: August 1964.
d. Authors: G. H. Robinson and G. R. Suggett.
e. Location: Lower Miwaleni, Kilimanjaro Region, Tanzania. Corner of Kahe Sisal Estate within 100 feet of the Rau River.
f. Elevation: 2335 feet.

g. Land form:
   i. Physiographio position of the site: River terrace.
   ii. Land form of surrounding country: Flat or almost flat.
   iii. Miorotopography: Nil.
h. Slope: Class 1 - flat or almost flat 0-2%.
i. Vegetation and/or land-use: Vegetation is dominantly high riveraine forest. Small farms in olearings and also adjoining the forest produoe a variety of orops, espeoially maize, beans, bananas, sugar oane, oitrus and vegetables.

General soil information

a. Parent material: Reoent alluvium originally derived from the Kilimanjaro Voloanios.
b. Drainage: Class 4 - welldrained.
c. Moisture conditions: Slightly moist throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rookiness: Nil.
f. Evidenoe of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free.
h. Human influenoe: The soil desoribed has not been oultivated for many years. Areas olose by are cultivated and irrigated.

Brief desoription of profile

An alluvial soil with deep, dark reddish brown profile. The upper horizons are quite uniform both in oolour and olay loam texture, but structures are weaker and textures more olayey with depth. The whole profile is friable, porous and permeable and frequently overlies ooarse textured layers or gravels. Very deep profiles with uniform subsoil olay textures to more than six feet are also common.

Profile description

A1 0-10" Dark reddish brown (5 YR 3/2) moist, clay loam; moderate medium granular; stioky and plastio, friable moist, slightly effervesoent; many fine and medium roots holding together the struoture aggregates; olear smooth boundary; pH 7.6.

C1 10-20" Dark reddish brown (5 YR 3/3) moist, clay loam, moderate medium granular; stioky and plastio, friable moist, slightly effervesoent; oommon fine and medium pores; oommon fine roots; olear smooth boundary; pH 7.6.

C2 20-32" Dark reddish brown (5 YR 3/3) moist, olay; weak medium granular; very stioky and plastio; slightly effervesoent; few fine and medium pores; few fine roots; abrupt smooth boundary; pH 7.8.

C3 32–54"+ Dark greyish brown (5 YR 3/3) moist, clay, with thin strata of fine gravel and silt; massive; permeable horizon; pH 7.8.

Range of characteristics

Colours are mainly within the dark reddish brown range, although in heavily forested areas the A1 is higher in organic matter within the dark brown (7.5 YR 3/2) – brown to dark brown (7.5 YR 4/2) range. Surface textures are usually clay loam but may be clay. Always deep and well drained. Some profiles are non-effervescent throughout. pH range 7.4–8.2.

Similar and associated soils

These soils are similar to the alluvial Soil Unit 4R, the main ground for separation is the highly saline-alkaline nature of the latter.

Land-use and agricultural potential

The soils of Unit 4 are excellent agricultural soils and are highly prized by the local population who make their dwellings along the river banks and find employment on the local sisal estates. Fallows are not common and the soils are capable of producing a wide variety of crops. They are highly suitable for irrigation, but the narrowness of the unit along the river, and since adjoining units are often subject to flooding, make it impractical to irrigate. It serves its best use at present for intensive native agriculture with occasional local irrigation.

Site information

a. Soil name: UNIT 5.
b. Higher category classification: Alluvial-Haplorthent (1.53). Revised 7th Approximation (1964).
c. Date of examination: November 1964.
d. Author: G. H. Robinson.
e. Location: Approximately half a mile due west of Miwaleni Springs, Kilimanjaro Region, Tanzania.
f. Elevation: 2360 feet.
g. Land form:
   i. Physiographic position of the site: Old alluvial plain.
   ii. Land form of surrounding country: Flat and almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 – 0–2% flat or almost flat.
i. Vegetation and/or land-use: Mainly cultivated but some areas of Acacia thorn, grassland and old weed covered abandoned fields. The unit is cultivated for a variety of crops including maize, beans, bananas, sugar cane and cotton.

General soil information

a. Parent material: Old alluvium.
b. Drainage: Class 2 - imperfectly drained.
c. Moisture conditions: Moist throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free.
h. Human influence: Occasional drains cross the unit (in the lowest lying parts) especially at field boundaries.

Brief description of profile

Deep, dark greyish brown over dark brown clays. Granular structures are usual down to 40 inches and the profile permeable and friable to depth. pH is less than 8 throughout and the soil only slightly calcareous with no evidence of salinity or alkalinity.

Profile description

A1	0-9"	Dark greyish brown (5 YR 3/2) moist, clay; moderate medium granular; sticky and plastic, friable moist, permeable with common fine pores; numerous fine and medium roots; gradual smooth boundary; pH 7.6.
C1	9-20"	Dark greyish brown (5 YR 3/3) moist, clay; medium granular; sticky and plastic, friable moist; few fine pores; common fine roots; slightly calcareous; gradual smooth boundary; pH 7.7.
C2	20-40"	Some appearance generally as the above horizon, but collected for chemical analysis. pH 7.8.
C3	40-54"+	Dark greyish brown (5 YR 3/3) moist, clay; sticky and plastic, friable moist; slightly calcareous. pH 7.8.

Range of characteristics

Surface colours range between dark greyish brown and dark brown. A clay, or occasionally clay loam surface is always underlain by heavy clays. pH values are always less than 8.4 and the majority throughout the profile less than 8.0.

Similar and associated soils

The soils have many of the characteristics of the more recent alluvial Unit 4, but are dark greyish brown as opposed to dark reddish brown and usually have a higher surface organic matter content.

Land-use and agricultural potential

Situated in the low-lying stream headwater area, these soils are subject to shallow seasonal flooding in the lowest lying areas. The soils are easily worked, permeable and friable, but would nevertheless need protection and good drainage. The latter is important since in fringe areas of the unit some salt encroachment has been noticed following flooding and drying out. A good, extensive agricultural soil, suitable for a wide range of local crops.

Site information

a. Soil name: UNIT 6.
b. Higher category classification: Alluvial-intergrade to Grumusol Vertic Haplorthent (1.53-2). Revised 7th Approximation (1964).
c. Date of examination: November 1964.
d. Author: G. H. Robinson.
e. Location: 500 feet west of the Moshi-Same road along the Soko River, Kilimanjaro Region, Tanzania.
f. Elevation: 2350-2400 feet.
g. Land form:
   i. Physiographic position of the site: Valley bottom.
   ii. Land form of surrounding country: Flat and almost flat.
   iii. Microtopography: Some evidence of gilgai formation.
h. Slope: Class 1 - 0-2% flat or almost flat.
i. Vegetation and/or land-use: Mainly grassy vegetation with some Acacia thorn. Not cultivated but grazed by goats and some cattle.

General soil information

a. Parent material: Alluvium deposited by the Soko River.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry to approximately four feet.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free.
h. Human influence: Nil.

Brief description of profile

A very dark grey over dark reddish brown, deep, moderately well drained clay soil. Clay textures are heavy and subsoil structures prismatic and well developed. Cracking in the dry season to approximately 40 inches. The whole profile is calcareous and occasional lime nodules occur below two feet.

Profile description

A1 0-6" Very dark grey (10 YR 3/1) moist, clay; strong medium granular; very sticky and plastic, friable moist; common fine roots; slightly calcareous; cracks $\frac{1}{2}$ - 3" wide; clear smooth boundary; pH 7.8.

AC 6-22" Very dark grey (5 YR 3/1) moist, clay; strong angular blocky; some dark coloured sands in cracks which pass through the horizon; very sticky and very plastic, firm moist, very hard dry; slightly calcareous; clear smooth boundary; pH 7.8.

C1 22-42" Dark reddish brown (5 YR 3/2) moist, clay; coarse moderate prismatic breaking to coarse angular blocks; very sticky and plastic, firm moist, hard dry; occasional fine lime nodules; calcareous; cracks continue through this horizon; gradual boundary; pH 7.8.

C2 42-63"+ Similar horizon to the above one except that slickensides are evident on the prism faces.

Range of characteristics

The colour of the surface soil may range from dark grey to almost black and may have a very hard granular structure when undisturbed. pH is nearly always less than 8.0.

Land-use and agricultural potential

Unit 6 is not cultivated at the present time. There was no evidence in the field of salinity or alkalinity and it is assumed that seasonal flooding and heavy texture are the main reasons for the lack of cultivation. The soils would require flood protection, but under irrigation would be suitable for such crops as cotton, sugar cane and rice.

Site information

a. Soil name: UNIT 11.
b. Higher category classification: Regosol intergrade to Reddish Brown Entic-Orthid? (4.1-1). Revised 7th Approximation (1964).
c. Date of examination: 23 December, 1964.
d. Authors: N. Mikenberg and G. R. Suggett.
e. Location: Approximately mile 3 on the trail running southwest from Kahe, Kilimanjaro Region, Tanzania.
f. Elevation: Unit extends between 2335 and 2290 feet.

g. Land form:
   i. Physiographic position of the site: Plains below Mount Kilimanjaro.
   ii. Land form of surrounding country: Flat and almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - 0-2%.
i. Vegetation and/or land-use: Natural vegetation, modified by the cutting of selected trees for charcoal burning. Essentially thorn savannah dominated by Acacia with many bare patches.

General soil information

a. Parent material: Old alluvial materials overlying gravels of volcanic origin.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight wind erosion on the bare patches.
g. Salinity or alkalinity: Class 0 - free.
h. Human influence: Nil.

Brief description of profile

Brown to dark brown, deep, clay loam over silt loam soil with very weakly developed structures confined to the upper profile. Porous, friable and deep cracking. The subsoil is highly calcareous below 30 inches - a contrast to the A horizons which are completely non-effervescent. pH is less than 8.2. It is a non-saline non-alkaline, good agricultural soil. Gravels occur in the subsoil and represent about 80% of the horizons below four feet.

Profile description

A11 0-7" Dark brown (7.5 YR 3/2) moist and between brown to dark brown (7.5 YR 4/4) and reddish brown (5 YR 4/4) dry, loam to clay loam; weak, medium sub-angular blocky; sticky and plastic, friable moist, slightly hard dry; porous with many fine and medium pores; common fine roots and few coarse roots; non-effervescent; gradual wavy boundary; pH 7.5.

A12 7-16" Dark reddish brown (5 YR 3/4) moist and reddish brown (5 YR 4/4) dry, clay loam; massive breaking to moderate coarse sub-angular blocky; sticky and plastic, friable moist, slightly hard dry; porous with many fine and medium pores; few fine roots; non-effervescent; vertical cracking through the horizon with ½ inch cracks about one foot apart; clear smooth boundary; pH 7.5

AC 16–30" Dark reddish brown (5 YR 3/3) moist and brown to dark brown (7.5 YR 4/4) dry, silt loam; massive breaking to weak coarse sub-angular blocky; slightly sticky and slightly plastic, slightly firm moist, hard dry; few fine pores; occasional fine roots; effervescent; cracks continue through this horizon; gradual smooth boundary; pH 8.1.

C1 30–51" Dark reddish brown (5 YR 3/3) moist and brown to dark brown (7.5 YR 4/4) dry, silt loam; some white calcareous accumulations along old root channels; massive; slightly sticky and slightly plastic, slightly firm moist, and slightly hard dry; occasional fine roots; strongly calcareous; cracks stop at top of this horizon; abrupt smooth boundary; pH 8.1.

C2 51–60"+ Dark brown (5 YR 3/2) matrix, moist with spots of pinkish grey (7.5 YR 6/2) and dry colour brown (7.5 YR 5/4), gravel with sandy loam inclusions; strongly calcareous; gravels constitute approximately 80% of the horizon; pH 8.2.

Range of characteristics

Surface colours are usually dark brown or brown to dark brown, but a broader range of subsoil colours of dark reddish brown (5 YR 3/3) to dark yellowish brown (10 YR 3/4) has been accepted. Structures are always weak and confined to the A1, the rest of the profile being massive. Surface textures range between sandy loam and clay loam depending to some extent upon the degree of local wind erosion and proximity to gravel outcrops. Subsoil textures are commonly, but not consistently, silt loam with gravels invariably present in the lower subsoil. pH range 6.8–8.2.

Similar and associated soils

This is the deep phase within the unit. Medium and shallow phases occur.

Land-use and agricultural potential

The deep and medium phases of this unit would be suitable for irrigation and capable of producing a wide range of crops. The main limitation to the general utilisation of the soils would be the inclusions of the shallow phase which overlie gravels. Gravels seldom outcrop at the surface, but the shallow soils could be difficult and sometimes impossible to level especially when located at the highest elevations. It is estimated that the shallow soils represent less than 10% of the unit and a good part of them could be brought into produotion using sprinkler irrigation. Research into the geology, water loss and to determine the best irrigation methods will be essential.

Site information

a. Soil Name: UNIT 21.
b. Higher category classification: Grumusol-Andeptic?-Ustert (2.2-3.2). Revised 7th Approximation (1964).
c. Date of examination: 13 January, 1966.
d. Author: G. R. Suggett.
e. Location: Miwaleni Springs irrigation area. 400 yards southeast of Borehole 1 - 9½ miles due southeast of Moshi, Kilimanjaro Region, Tanzania.
f. Elevation: 2380 feet.
g. Land form:
   i. Physiographic position: Gently sloping pediments below Mount Kilimanjaro.
   ii. Surrounding land form: Gently sloping to undulating.
   iii. Microtopography: Nil.
h. Slope: Flat or almost flat to gently sloping 0-6%.
i. Land use: Thorn bush savannah dominated by low Acacia. Coarse grasses common. Cultivated upslope using local furrow irrigation for maize, cotton and beans.

General information on the soil

a. Parent material: Colluvial materials derived from Kilimanjaro Volcanics.
b. Drainage class: Class 4 - well drained.
c. Moisture conditions in profile: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Erosion: Nil.
g. Salinity or alkalinity: Class 0 - free.
h. Human influence: Nil.

Brief description of the profile

A dark reddish brown, deep, well drained, heavy clay soil, with very well developed coarse angular blocky subsoil structure and characteristic deep cracking. Surface structures during the dry season and especially under cultivation break down readily to fine and medium granular, making the soil not too difficult to work under ordinary farming conditions. The soil throughout is very sticky and plastic when wet. Very deep rooting is usual. The unit occupies a distinctive site on the lower pedimentary slopes below Mount Kilimanjaro.

Profile description

All 0-4" Dark reddish brown (5 YR 3/4) moist and dark brown (7.5 YR 3/2) dry, clay; strong fine and medium granular; sticky and plastic; friable moist, loose dry; porous; common fine and medium grass roots, occasionally clumpy; cracks appear at the

surfaoe but are mostly filled by the granular surfaoe struoture; non-effervesoent; gradual irregular boundary; pH 7.0.

A12 4-12" Dark reddish brown (5 YR 3/4) moist and dark brown (7.5 YR 3/2) dry, olay; ooarse moderate angular blooky; very stioky and plastio, friable moist, firm dry; porous with few fine pores; oommon fine grass roots; many oraoks pass through this horizon, being approximately 6" apart and up to ½ inoh wide; non-effervesoent; gradual wavy boundary; pH 7.2.

A13 12-38" Dark reddish brown (5 YR 3/4) moist and dark brown (7.5 YR 3/2) dry, olay; very stioky and plastio, friable moist, very hard dry; few fine grass roots espeoially along ped faoes; one major oraok up to 1½" wide with several minor oraoks approximately 2 feet apart; non-effervesoent; gradual smooth boundary; pH 7.4.

AC 38-60"+ Dark reddish brown (5 YR 3/4) moist and dark reddish brown (5 YR 3/4) dry, olay; strong very ooarse angular blooky; very stioky and plastio, extremely firm moist, extremely hard dry; non-porous; few fine grass roots; clay outans are very oommon on ped faoes; major oraoks oontinue through this layer; non-effervesoent; pH 7.4.

Range of oharaoteristios

This soil is quite uniform over a large area ooinoiding with uniformly deposited voloanio parent materials and elevation. Colours are always dark reddish brown (5 YR 3/4). Struotures are strong coarse angular blooky below the top few inohes and textures always heavy olay.

Similar and assooiated soils

Downslope soils (Unit 31) are similar in struoture and texture but are darker in oolour and have distinotive lime aooumulating horizons.

Land-use and agrioultural potential

These soils are cultivated in some plaoes at the present time by the looal population for orops suoh as maize, ootton and beans, espeoially where water is available for primitive supplementary irrigation. Away from the looal furrows preferenoe for wet season farming is given to less heavy textured soils - but still within the olay range - both upslope and to the west of the area desoribed.

This would be an exoellent soil for irrigation oapable of supporting an almost unlimited variety of orops. The minor problems to irrigation would be the slope of the land whioh sometimes falls within the Class 2 - gently sloping 2-6% oategory, the broad, deep and very deep oraoks which would

involve high initial water intake although they would present no problem after several months of cropping; and the heavy clay textures which might limit heavy mechanised farming during the wet season.

Site information

a. Soil name: UNIT 23.
b. Higher category classification: Intergrade Calcisol-Reddish Brown Calciorthid (4.13). Revised 7th Approximation (1964).
c. Date of examination: January 1965.
d. Authors: N. Mikenberg and G. R. Suggett.
e. Location: 1½ miles southeast of Kahe village on the road to Soko Sisal Estate, Kilimanjaro Region, Tanzania.
f. Elevation: 2380 feet approximately.
g. Land form:
   i. Physiographic position of the site: Plains below Kilimanjaro.
   ii. Land form of surrounding country: Flat and almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - 0-2%.
i. Vegetation and/or land-use: Scattered saltbush and Acacia thorn bush, the former often corresponding to patches of surface salinity. Coarse salt tolerant grasses are common in some parts and there are many bare areas. Not cultivated. Grazed by cattle and goats.

General soil information

a. Parent material: Old alluvial materials overlying volcanic gravels.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Classes 1 and 2 - soils both slightly and moderately affected by salts or alkali.
h. Human influence: Nil.

Brief description of profile

A very dark greyish brown over brown to dark brown and brown deep, sandy loam soil with much gravel in the topsoil which is loose and in contrast to the compaction in the horizon immediately below. Structural development is confined to the surface horizon which is moderately coarse angular blocky. There is a marked increase in pH below 14 inches corresponding to high salt and alkali. This coincides with a IIC lithologic discontinuity.

Profile description

A11 0-5" Very dark greyish brown (10 YR 3/2) moist and greyish brown (10 YR 5/2) dry, sandy loam; moderate, coarse angular blocky; slightly sticky and slightly plastic, friable moist, slightly hard dry; common fine pores; common fine roots; occasional fine rounded gravels; gradual smooth boundary; pH 7.5.

A12 5-14" Very dark greyish brown (10 YR 3/2) moist and greyish brown (10 YR 5/2) dry, gravelly fine sandy loam with common very fine gravels; massive compact horizon; slightly sticky and slightly plastic; very firm moist, very hard dry; calcareous; common fine roots and old root channels with iron staining; abrupt smooth boundary; pH 7.8.

IIC1ca 14-33" Brown to dark brown (7.5 YR 4/4) moist and brown to dark brown (7.5 YR 5/4) dry, gravelly fine sandy loam; massive, non-sticky and slightly plastic, very friable moist; strongly calcareous; occasional very fine roots at top of horizon; not as compacted as above horizon; gradual smooth boundary; pH 9.4+.

IIC2ca 33-58"+ Dark brown (7.5 YR 4/4) moist and dark brown (7.5 YR 4/4) dry, very gravelly sandy loam; massive; strongly calcareous; pH 9.4+.

Note: There are characteristically many salt patches within this unit. The present profile had no salt accumulation at the surface.

Range of characteristics

Colours are not always so grey or dark at the surface and range between very dark greyish brown (10 YR 3/2) and brown to dark brown (7.5 YR 4/4). Subsoil textures are variable in the range sandy loam to gravel. The amount of included gravels varies from profile to profile, and the soils are usually weakly developed. The unit should be regarded as transitional between Unit 11 and the saline-alkaline Unit 32. It contains many inclusions of both.

Land-use and agricultural potential

These soils are not cultivated and because of strong patchy salinity and alkalinity, particularly in the subsoils, reclamation would be essential before they could be used for irrigation.

Site information

a. Soil name: UNIT 24.
b. Higher category classification: Reddish brown.Orthid (4.1). Revised 7th Approximation (1964).
c. Date of examination: January 1965.
d. Authors: N. Mikenberg and G. R. Suggett.
e. Location: Approximately 2 miles southwest of Kahe village on the road to Soko Sisal Estate, Kilimanjaro Region, Tanzania.
f. Elevation: 2290 feet approximately.
g. Land form:
   i. Physiographic position of the site: Plains below Mount Kilimanjaro.
   ii. Land form of surrounding country: Flat and almost flat, but sloping away more steeply eastwards to the Rau River.
   iii. Microtopography: Nil.
h. Slope: Class 1 - 0-2% increasing to Class 2 - 2-6% eastwards.
i. Vegetation and/or land-use: Clump grass with patches of "wild sisal", saltbush and thorn and with some mature Baobab. Cultivated in part, with local irrigation for cotton and maize

General soil information

a. Parent material: Alluvial - colluvial materials originally derived from the Kilimanjaro volcanics.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 1 - slightly affected.
h. Human influence: Nil.

Brief description of profile

A dark reddish brown to reddish brown overlying reddish brown, deep, weakly developed, medium textured soil. Textures fall within the moderately fine range in the subsoil which is strongly calcareous. Lower subsoils are gravelly.

Profile description

A11 0-10" Dark reddish brown to reddish brown (5 YR 3/3 to 5 YR 4/5) both moist and dry; silt loam; weak medium and coarse granular; slightly sticky and slightly plastic, very friable moist, soft dry; common fine roots; common fine pores; gradual smooth boundary; pH 8.0.

A12 10-18" Dark reddish brown to reddish brown (5 YR 3/3 to 5 YR 4/5) both moist and dry, silt loam; weak coarse and medium sub-angular blocky; slightly sticky and slightly plastic, friable moist, slightly hard dry; common fine roots; common fine and few medium pores; gradual smooth boundary; pH 8.1.

C1 18-24" Reddish brown (5 YR 4/5) both moist and dry, silty clay loam; massive; sticky and slightly plastic; few fine roots; effervescent; gradual boundary; pH 8.2.

C2 24-46" Reddish brown (5 YR 4/5) both moist and dry; slightly gravelly clay loam; massive; sticky and slightly plastic, friable moist, slightly hard dry; occasional fine roots in upper horizon; strongly calcareous; gradual boundary; pH 8.2.

C3 46-50"+ Reddish brown (5 YR 4/5) both moist and dry; gravelly clay loam; massive; strongly calcareous; pH 8.2.

Range of characteristics

The colour range in both moist and dry states is dark reddish brown to reddish brown (5 YR 3/3 - 5 YR 4/5). Textures are usually silt loam at the surface becoming more clayey with depth. Subsoils are always strongly calcareous. pH 7.9-8.4.

Similar and associated soils

The soils of this unit have much in common with Unit 11, but they are redder in colour with slightly saline subsoil.

Land-use and agricultural potential

These soils are cultivated by irrigation whenever water is available and could be included within a major irrigation scheme in the area. Sub-soils are usually slightly saline. A variety of crops could be grown under irrigation and responses would be similar to those of Unit 11.

Site information

a. Soil Name: UNIT 25.
b. Higher category classification: Brunizem.Argiustoll (5.63). Revised 7th Approximation (1964).
c. Date of examination: September 1964.
d. Authors: G. H. Robinson and G. R. Suggett.
e. Location: Approximately 1½ miles due southeast of Miwaleni Springs, Kilimanjaro District, Tanzania.

f. Elevation: 2360 feet approximately.
g. Land form:
  i. Physiographic position of the site: Low lying valley bottom flood drainage lines.
  ii. Land form of surrounding country: Flat and almost flat.
  iii. Microtopography: Nil.
h. Slope: Class 1 - 0-2% flat or almost flat.
i. Vegetation and/or land-use: Vegetation is dominantly coarse grasses many of which are water tolerant. Not cultivated at present due to low lying position and susceptibility to wet season flooding. Small salt patches may occur as inclusions.

General soil information

a. Parent material: Old alluvial clays derived originally from Kilimanjaro volcanics.
b. Drainage: Class 2 - imperfeotly drained soils.
c. Moisture conditions: Moist throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free.
h. Human influence: Nil.

Brief desoription of profile

Very dark brown over dark reddish brown, deep, heavy clay or clay loam soils. A firm, stiff clay subsoil is usual and a black organic surface occurs in some of the lowest lying and more frequently flooded profiles.

Profile description

A1 0-6" Very dark brown (10 YR 2/2) moist, clay loam; moderate medium granular; slightly sticky and plastic, friable moist; high organic matter content; many fine and medium roots; gradual smooth boundary; pH 6.8.

B1 6-12" Dark reddish brown (5 YR 3/2) moist, clay; moderate fine granular; sticky and plastic, friable moist; few fine pores; few fine roots; clear smooth boundary; pH 7.2.

B21 12-24" Dark reddish brown (5 YR 3/3) moist, clay; weak medium sub-angular blocky; sticky and very plastic, firm moist; few fine roots; gradual smooth boundary; pH 7.6.

B22 24-36" Dark reddish brown (5 YR 3/3) moist, clay; moderate, medium sub-angular blocky; sticky and plastic, firm moist; few fine black concretions; gradual smooth boundary; pH 7.7.

B23 36-58"+ Dark brown (7.5 YR 3/2) moist, clay; sticky and very plastic, firm moist; few fine black concretions; occasional medium gravels; pH 7.8.

Range of characteristics

Surface colours range from dark brown to very dark greyish brown and subsoil colours from dark reddish brown to dark greyish brown. In the lowest lying areas a thin black organic/clay surface occurs. pH ranges between 6.8 and 8.2 with some profiles slightly calcareous, especially in the subsoil. Subsoils range from firm to very firm and are always heavy clay. Surface textures are clay or clay loam.

Similar and associated soils

In some parts, near the boundaries of the unit in the west, small areas of saline/alkaline soils have been included. These do not form more than 10% of the unit. In some places the soils grade into Unit 4.

Land-use and agricultural potential

The unit is not cultivated at the present time due mainly to flooding. During the survey period, immediately following the heavy rains, much of the unit was under more than a foot of floodwater. These waters originate as overflow from the Rau River and pass slowly southeastward through the area. Unit 25 requires much flood protection and the reclamation of some saline/alkaline spots but could be highly productive for a range of crops under irrigation.

Site information

a. Soil name: UNIT 28.
b. Higher category classification: Natrustoll? (5.66). Revised 7th Approximation (1964).
c. Date of examination: October 1964.
d. Authors: G. H. Robinson and G. R. Suggett.
e. Location: East of the Mue River and 200 yards south of the railway crossing on the Kahe Road, Kilimanjaro Region, Tanzania.
f. Elevation: 2315 feet approximately.
g. Land form:
   i. Physiographic position of the site: Plain.
   ii. Land form of surrounding country: Flat and almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - 0-2%.
i. Vegetation and/or land-use: Coarse grasses with a few palms. Many large bare areas.

General soil information

a. Parent material: Fluvio-colluvial materials of volcanic origin.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 3 - strongly affected.
h. Human influence: Nil.

Brief description of profile

A dark reddish brown, deep, friable, deep cracking, non-saline-alkaline clay soil. Structures are well developed angular blocky in the B horizons. A strongly calcareous profile. The soil dries out to depth in the dry season with coarse cracking to more than 2 feet.

Profile description

A1	0-5"	Dark reddish brown (5 YR 3/2) dry clay; moderate coarse blocky structure breaking to fine and medium angular blocky; sticky and plastic, friable moist, slightly hard dry; strongly calcareous; common fine roots; cracks from one to two inches wide pass through the horizon; clear smooth boundary; pH 9.6.
A12	5-13"	Dark reddish brown (5 YR 3/2) dry, clay; fine strong angular blocky; sticky and plastic, friable moist, hard dry; strongly calcareous; common fine roots; cracks continue through horizon; clear smooth boundary; pH 9.2.
B	13-24"	Reddish brown (2.5 YR 4/4) dry, clay; moderate medium angular blocky; sticky and plastic, friable moist, hard dry; strongly calcareous; few fine roots; cracks, many of which are still one inch or more wide pass through this horizon; gradual boundary; pH 9.2.
C.	24-48"	Dark reddish brown (2.5 YR 2/4) dry, clay; massive; very sticky and plastic, friable moist, hard dry; strongly calcareous; pH 9.0.

Range of characteristics

Surface colours range between dark reddish brown and dark reddish grey. Structures are always well developed and invariably strong fine angular blocky a few inches below the surface. pH ranges between 8.6 and 9.6.

Land-use and agricultural potential

This is a non-agricultural soil at present. Major reclamation would be necessary before it could be used for cultivation. This would be expensive and not easy because of high sodium content and heavy clay texture.

Site information

a. Soil name: UNIT 31.
b. Higher category classification: Reddish Chestnut. Ustoll (5.6). Revised 7th Approximation (1964).
c. Date of examination: August 1964.
d. Authors: G. H. Robinson and G. R. Suggett.
e. Location: 200 yards approximately eastward of Miwaleni Springs, Kilimanjaro Region, Tanzania.
f. Elevation: 2360 feet approximately.
g. Land form:
   i. Physiographic position of the site: Regular pedimentary foot-slopes below Mount Kilimanjaro.
   ii. Land form of surrounding oountry: Flat and almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - 0-2% flat or almost flat.
i. Vegetation and/or land-use: Vegetation consists mainly of coarse grasses with occasional thorn trees and scrub. The unit is limited in extent and quite calcareous, but its closeness to settlements near the Springs has caused it to be cultivated in parts on a shifting agricultural basis, for such crops as maize and cotton.

General soil information

a. Parent material: Colluvial materials derived from the Kilimanjaro volcanics.
b. Drainage: Class 3 - moderately well drained soils.
c. Moisture conditions: Slightly moist in the lower profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 1 - slightly affected.
h. Human influence: Cultivated some years previously but returned to low bush conditions with much weed cover.

Brief description of profile

Brown over very dark greyish brown, deep, lime accumulating slightly saline-non-alkaline clay soils. Structures are always coarse, well developed prismatic, but break readily to coarse angular blocky. Cracking occurs to depth. The most outstanding feature is the accumulation of lime in the upper

mid-profile. This takes the form of flecks and quite large soft irregular nodules - usually greyish or greyish brown in colour.

Profile description

A1 0-6" Brown (7.5 YR 4/2) moist, clay; moderate medium granular; very sticky and very plastic, firm moist; calcareous; common fine and occasional medium roots; clear smooth boundary; pH 8.0.

B21 6-19" Very dark greyish brown (10 YR 3/2) moist, clay; well developed coarse prismatic which breaks readily into angular blocky peds; very sticky and plastic, firm moist; few fine and medium pores; many light grey soft irregular lime nodules and minor flecks of lime are present throughout the horizon; strongly calcareous especially at carbonate accumulation spots; some penetrating of A1 material through minor cracking; gradual smooth boundary; pH 8.4.

B22 19-36" Dark brown (10 YR 3/3) moist, clay; prismatic as above, breaking to coarse angular blocky; very sticky and very plastic, very firm moist; highly calcareous; some penetration of A1 material down cracks; gradual smooth boundary; pH 8.5.

B3 36-64"+ Dark brown (10 YR 3/3) moist, clay; weak prismatic to massive; very sticky and plastic, firm moist; strongly calcareous; pH 8.6.

Range of characteristics

Colours of the surface horizon range from brown to dark greyish brown and the subsoil from very dark greyish brown to brown. Observations during the dry season show the surface to be extremely hard with cracks 1-3" wide penetrating deep into the subsoil. Depth to the lime nodules within the B horizons ranges from 10-20 inches, the number of soft nodules ranging from few to many. pH ranges between 8-8.6 but readings up to 9 have occasionally been recorded in the subsoil.

Similar and associated soils

Unit 31D mapped during the detailed survey between the Rau and Mue rivers is a similar lime accumulating soil, but with a much darker, organic surface, and less well developed structure.

Land-use and agricultural potential

Used at present on a shifting agricultural basis for the cultivation of corn and cotton, these soils would be suitable for a limited range of crops

at the present time. Reclamation would not be too difficult although the heavy clay textures are notconducive to easy drainage or leaching.

Site information

a. Soil name: UNIT 32.
b. Higher category classification: Solonetzic-Reddish Brown. Orthid (4.1). Revised 7th Approximation (1964).
c. Date of examination: November 1964.
d. Authors: G. H. Robinson and G. R. Suggett.
e. Location: Approximately 1000 yards east of the Mue River and 300 yards north of the Kahe-Taveta railway line, Kilimanjaro Region, Tanzania.
f. Elevation: 2320 feet.
g. Land form:
   i. Physiographic position of the site: Alluvial plain between the Rau and Mue Rivers.
   ii. Land form of surrounding country: Flat and almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - 0-2% flat or almost flat.
i. Vegetation and/or land-use: Dominant vegetation is palm with some coarse grass especially in clearings. Occasional thorny Acacia. Many bare areas and surface salt patches. Not cultivated, but frequently rough grazed particularly in the new growth after burning.

General soil information

a. Parent material: Old alluvium originating from the Kilimanjaro volcanics.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Moist below three feet
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 3 - strongly affected.
h. Human influence: Nil.

Brief description of profile

Black, over brown and dark greyish brown, deep, saline-alkaline clay soils. Deep cracking in the dry season. Effervescent subsoils with some lime accumulation as small soft lime nodules in the B2. pH is high throughout, all subsoil horizons being 9.6 or more. Moderate coarse structures are usual in the B horizons and clay skins are present on ped faces in mid profile. Clay throughout.

Profile description

A1 0-4" Black (10 YR 2/1) moist, clay; strong coarse sub-angular blocky breaking to strong medium granular; very sticky and plastic, friable moist; few fine pores; common fine roots; surface cracks from ½ to 2 inches are common; clear smooth boundary; pH 8.8.

B1 4-11" Brown (10 YR 4/3) moist, clay; moderate medium sub-angular blocky; sticky and plastic, friable moist; few fine and few medium pores; calcareous; few fine roots; few fine rounded gravels; cracks continue through this horizon; clear smooth boundary; pH 9.6.

B21 11-19" Brown (10 YR 4/3) moist, clay; moderate medium sub-angular blocky; very sticky and plastic, friable moist, hard dry; highly calcareous; small soft lime nodules are common; few fine roots; some cracking; clear smooth boundary; pH 9.6.

B22 19-36" Dark greyish brown (10 YR 4/2) moist clay; moderate medium to coarse sub-angular blocky; very sticky and plastic, friable moist, hard dry; calcareous; patchy thin clay cutans.

B3 36-54" Dark greyish brown (10 YR 4/2) moist, clay; weak coarse blocky; very sticky and plastic, friable moist; pH 9.6.

Range of characteristics

The colour of the A horizon may range from dark brown to black and in thickness from 4 - 10". Cracks in some profiles extend to 30 inches in the dry season. Subsoil colours range from brown to dark greyish brown. There is variation in pH, especially at the surface. Some subsoils are mottled, usually with pale brown (10 YR 6/3).

Land-use and agricultural potential

These soils are not suitable for cultivation in their present condition due to high salt and exchangeable sodium content. Reclamation would not be easy and would require large amounts of amendments.

Site information

a. Soil name: UNIT 32K.
b. Higher category classification: Alluvial intergrade to Reddish Brown Natrargid (4.23). Revised 7th Approximation (1964).
c. Date of examination: 9th September, 1966.
d. Author: G. R. Suggett.

e. Location: Approximately 5 miles due southwest of Kahe Station, Kilimanjaro Region, Tanzania.
f. Elevation: 2275 feet approximately.
g. Land form:
  i. Physiographic position: Gently sloping plains below Mount Kilimanjaro.
  ii. Surrounding land form: Gently sloping.
  iii. Microtopography: Nil.
h. Slope: Flat or almost flat - 0-2%.
i. Vegetation and/or land-use: Dominant vegetation is saltbush with common salt tolerant succulants, coarse grasses and scrub. No cultivation but grazed by Masai cattle and goats seasonally.

General soil information

a. Parent material: Fluvio-colluvial materials overlying gravels. All originally derived from the Kilimanjaro Volcanics.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight wind erosion.
g. Salinity or alkalinity: Class 3 - highly saline-alkaline. Many large bare patches.
h. Human influence: Nil.

Brief description of profile

Colours grade from a dark brown surface through a dark yellowish brown subsoil to dark greyish brown below 3 feet. Textures vary, with sandy loam and sandy clay loam common in the top soil. Textures are influenced by coarse sands and gravels below. A weakly developed A/C profile still strongly alluvial in character with definite horizonation. The whole profile is highly saline-alkaline with pH values everywhere in excess of 9.6 (La Motte). Highly effervescent throughout.

Profile description

A11 0-2" Dark brown (10 YR 3/3) moist and brown to dark brown (10 YR 5/3) dry, sandy loam; non sticky and slightly plastic, loose moist, loose dry; abrupt smooth boundary; pH 9.6+.

A12 2-12" Dark yellowish brown (10 YR 3/4) and yellowish brown (10 YR 5/4) dry, sandy clay loam; massive, slightly laminated breaking to weak angular blocky; slightly sticky, slightly plastic, friable moist, slightly hard dry; highly effervescent; common fine pores; very frequent fine roots; gradual wavy boundary; pH 9.6+.

C1 12-23" Dark greyish brown (10 YR 4/2) and brown to dark brown (10 YR 5/3) dry, gritty clay loam; massive; slightly sticky, slightly plastic, friable moist, slightly hard dry; highly effervescent; few fine and very fine roots; gradual wavy boundary; pH 9.6+.

C2 23-31" Dark greyish brown (10 YR 4/2) and brown to dark brown (10 YR 5/3) dry, gritty loam with weathered caliche and occasional volcanic gravels; massive; non sticky, non plastic, loose to very friable moist, slightly hard dry; highly effervescent; occasional fine and very fine roots; diffuse wavy boundary; pH 9.6+.

C3 31-38" Dark greyish brown (10 YR 4/2) and brown to dark brown (10 YR 4/3) dry, mixture of fine gravels, grits and loam; massive; non sticky, non plastic, loose moist, extremely hard dry; highly effervescent; gradual smooth boundary; pH 9.6+.

C4 38-56"+ Dark greyish brown (10 YR 4/2) and yellowish brown (10 YR 5/4) dry, coarse, sandy loam; massive; slightly sticky, non plastic, very friable moist, hard dry; highly effervescent; very occasional fine roots; pH 9.6+.

Range of characteristics

Dark greyish brown (10 YR 4/2) subsoil colours are very characteristic of this unit. Surface colours are always dark brown to dark yellowish brown. Textures are very variable, although the surface is always moderately coarse textured and invariably loose. Coarse and fine gravels may be common often forming distinct gravelly layers that may be cemented with calcium carbonate. pH is always very high within the range 8.6 - 9.6+ (La Motte).

Similar and associated soils

In the east this unit grades into Unit 32 which is fine textured with well developed structure. The soils are, however, distinct with only very high salinity and alkalinity in common.

Land-use and agricultural potential

This soil is non-agricultural at present. Reclamation would be very expensive and not an economical proposition bearing in mind available unused lands close by. The saline-alkaline condition of the soil is generally continuous with large areas either completely bare or dominated by saltbush.

Site information

a. Soil name: UNIT 34.
b. Higher category classification: Reddish Chestnut intergrade to Brunizem. Ustoll (5.6). Revised 7th Approximation (1964).
c. Date of examination: November 1964.
d. Authors: G. H. Robinson and G. R. Suggett.
e. Location: Approximately 2½ miles due south of Miwaleni Springs, Kilimanjaro Region, Tanzania.
f. Elevation: 2290 feet.
g. Land form:
   i. Physiographic position of the site: Alluvial plain.
   ii. Land form of surrounding country: Flat and almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - 0-2% flat or almost flat.
i. Vegetation and/or land-use: The natural vegetation is open grassland, but clumps of trees are usually common. In the lowest lying areas patches of swamp grass occur. Near habitations where flooding is not a serious problem the soils are cultivated for a range of crops, but especially corn, cotton and castor.

General soil information

a. Parent material: Old calcareous alluvium with more recent organic accumulations.
b. Drainage: Class 1 - poorly drained.
c. Moisture conditions: Moist throughout profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free with some spots of Class 2 - moderately affected.
h. Human influence: Cultivation only in parts of the unit near Kahe.

Brief description of profile

Very dark grey or black over dark grey and pale brown, deep clay soils with a highly organic surface and highly calcareous subsoil. Textures are uniformly clay throughout and structures moderate. There is always a contrast in effervescence between the topsoil which is seldom calcareous and the highly calcareous subsoil. Poorly drained and susceptible to long period of flooding during the major rainy season.

Profile description

A1 0-5" Very dark grey (5 YR 3/1) moist, clay with a high organic matter content; coarse and medium moderate granular held together by many fine and medium grass roots; sticky and plastic, friable moist; non-calcareous; clear smooth boundary; pH 7.2.

A3 5-12" Very dark brown (10 YR 2/2) moist, clay; moderate coarse and medium granular; sticky and plastic, friable moist; non-calcareous; common to many fine fibrous grass roots; few fine pores; gradual smooth boundary; pH 7.4.

B21 12-32" Combination of dark grey (10 YR 4/1) and very dark greyish brown (10 YR 3/2) clay with oommon white flecks of calcium carbonate; massive; highly calcareous; sticky and plastic; friable moist; clear smooth boundary; pH 8.0.

B22 32-60"+ Pale brown (10 YR 6/3) moist, clay; some lighter pale brown areas suggesting iron segregation; sticky and plastic, friable moist; occasional fine gravels; a very strongly calcareous horizon; pH 8.4.

Range of characteristics

A broad range of characteristics have been accepted although basically the soil consists of highly organic, dark, horizons overlying a highly calcareous subsoil. Surface colours range between very dark grey and black and subsoil colours within the calcareous zone between dark grey and pale brown. pH ranges between 7.2 and 8.6 with great variability from profile to profile. Textures are always clay and structures may be weakly prismatic.

Similar and associated soils

The general form of this soil with a dark non-calcareous topsoil overlying a very highly calcareous subsoil is similar to Unit 43, which is however much better drained, under forest and not susceptible to flooding.

Land-use and agricultural potential

These soils are not much utilised for agriculture except near to Kahe village where flooding is not a problem. Although subsoils are slightly saline, good crops of cotton, maize and castor are obtained. Shallow rooting crops seem to do particularly well. Over the greater area the soils could not be utilised for general agricultural production without large scale drainage and protection works. Floodwaters from the Rau River cross Unit 25 in the north and continue southeastward through the present unit.

Site information

a. Soil name: UNIT 35.
b. Higher category classification: Solonetzic-Reddish Chestnut, Natrustoll (5.66). Revised 7th Approximation (1964).
c. Date of examination: September 1964.
d. Authors: G. H. Robinson and G. R. Suggett.

e. Location: Between the Rivers Mue and Soko, approximately 1½ miles north of the junction, Kilimanjaro Region, Tanzania.
f. Elevation: 2280 feet.
g. Land form:
  i. Physiographic position of the site: Plain.
  ii. Land form of surrounding country: Flat and almost flat.
  iii. Microtopography: Nil.
h. Slope: 0-2% flat or almost flat.
i. Vegetation and/or land-use: Vegetation is dominated by large, mature palms, but bare areas and salt flats are extensive and devoid of vegetation. Coarse grasses are common in some parts and the vegetation is salt tolerant.

General Soil information

a. Parent material: Old alluvial materials of volcanic origin.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Moist throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 3 - strongly affected.
h. Human influence: The thickness of the salt crust varies or may be absent due to trampling and mixing by cattle.

Brief description of profile

Dark reddish brown over dark reddish grey and light brownish grey, deep, saline-alkaline, clay loam over clay soils. Structure is mainly weak coarse blocky. The soils are porous, friable and moderately permeable. Reaction is high with all pH readings 9.6 or more (La Motte). Surface salt accumulation is well marked with ¼" grey-white salt crust which may be seasonal.

Profile description

A1 0-4" Dark reddish brown (5 YR 3/2) moist, clay loam; weak medium sub-angular blocky; slightly sticky and plastic, friable moist; highly effervescent; common fine and medium pores; a dense surface layer of hardened salt is present at the surface; complete absence of vegetation at the sample site; gradual smooth boundary; pH 9.6.

B2 4-16" Dark reddish grey (5 YR 4/2) moist, clay; weak medium blocky; sticky and plastic, friable moist; few fine and medium pores; some fine old dead roots preserved within this horizon and lower part of the above horizon; highly effervescent; gradual smooth boundary; pH 9.6.

BC 16-24" Light brownish grey (10 YR 6/2) moist, clay with some sand grains or stable aggregates that do not readily break down; weak fine and medium sub-angular blocky; sticky and plastic, friable moist; common fine and few medium pores; highly effervescent; gradual smooth boundary; pH 9.6.

C 24-56"+ Light brownish grey (10 YR 6/2) moist, clay, with many stable aggregates of coarse sand size; sticky and plastic, friable moist; pH 9.6.

Range of characteristics

The colour of the A1 horizon ranges between dark brown and dark reddish brown and some clay textures occur. The thickness of the salt crust varies from place to place. It is not continuous but occurs in the shallow pans where vegetation is absent and is probably seasonal. pH is always high and with few exceptions above 9.0.

Similar and associated soils

A soil unit 35H has been mapped which is similar to Unit 35 but is underlain at depths ranging from 10-24" by a hard caliche-like material. It is considered a phase of Unit 35.

Land-use and agricultural potential

Unit 35 is not cultivated due to high salinity and alkalinity and produces almost no pasture, although a few goats are kept, finding their grazing mainly near the Mue and Soko Rivers. It would be expensive to reclaim for irrigation.

Site information

a. Soil name: UNIT 38.
b. Higher category classification: Regosol intergrade to Solonetz. Tropept? (3.5). Revised 7th Approximation (1964).
c. Date of examination: September 1964.
d. Authors: G. H. Robinson and G. R. Suggett.
e. Location: Approximately 2 miles due south of Miwaleni Springs between the Rau and Mue Rivers, Kilimanjaro Region, Tanzania.
f. Elevation: 2330 feet approximately.
g. Land form:
   i. Physiographic position of the site: Low lying ridge on the old alluvial plain between the Rau and Mue Rivers.
   ii. Land form of surrounding country: Undulating.
   iii. Microtopography: Nil.

h. Slope: Class 1 - flat or almost flat 0-2% increasing away from the site to Class 2 - gently sloping 2-6%.
i. Vegetation and/or land-use: Coarse grasses form the dominant vegetation with some thornbush. The unit is never cultivated except where major inclusions of the non-saline non-alkaline Unit 22 occurs near settlements.

General soil information

a. Parent material: Old fluvio-colluvial materials derived from the Kilimanjaro Volcanics.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Slightly moist throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 2 - moderately affected.
h. Human influence: Nil.

Brief description of profile

A dark reddish brown, deep, weakly developed, saline-alkaline clay soil. Weak granular surface structures become massive below 12-18 inches with a corresponding increase in stickiness and plasticity. Salt accumulation occurs at the surface. pH is lower immediately below the surface but rises to 9.6 in the subsoil.

Profile description

A11 0-5" Dark reddish brown (5 YR 3/3) moist, clay; weak medium granular; slick black surface condition due to black alkali; sticky and plastic, friable moist; strongly calcareous; pores; common fine grass roots; clear smooth boundary; pH 9.6.

A12 5-16" Dark reddish brown (5 YR 3/2) moist, clay; weak coarse granular; sticky and plastic, friable moist; calcareous; fine and few medium pores; few fine roots; gradual smooth boundary; pH 8.4.

C1 16-28" Dark reddish brown (5 YR 3/3) moist, clay; massive; sticky and plastic; friable moist; calcareous; few fine roots; gradual smooth boundary; pH 8.4.

C2 28-42" Dark reddish brown (5 YR 3/3) moist, clay; massive; very sticky and plastic; calcareous; occasional fine roots; gradual smooth boundary; pH 9.2.

C3 42-52"+ Dark reddish brown (5 YR 3/3) moist, clay; massive; very sticky and plastic, firm; calcareous; pH 9.6.

Range of characteristics

Within this unit the colour of the surface horizon may range from brown to dark reddish brown and the subsoil from reddish brown to reddish grey. Salt accumulation occurs in patches at the surface often under the grass cover. Surface textures may be clay loam. pH values range between 8.5 - 9.6 without any real gradation and although highest at the surface mid-profile horizons may have the lowest pH. The soils are never well developed structurally.

Similar and associated soils

This soil has much in common with the upland phases within Complex 22 and in most instances appears to represent degenerate areas into which the saline-alkaline conditions have encroached.

Land-use and agricultural potential

Unit 38 is not cultivated due to high salinity and alkalinity, although inclusions of the non-saline - non-alkaline Unit 22 are often used for small farms growing corn and cotton. It supports only a poor quality wild pasture of coarse salt-tolerant grasses. Reclamation would be necessary before these soils could be used and whilst this would not be economical on a large scale at the present time, small inclusions of this unit within a major irrigation scheme, could be recovered without too much difficulty or expense.

Site information

a. Soil name: UNIT 43.
b. Higher category classification: Brunizem-Argiustoll (5.63). Revised 7th Approximation (1964).
c. Date of examination: October 1964.
d. Author: G. R. Suggett.
e. Location: Within the Kahe Forest Reserve on the main road to Soko Sisal Estate from Kahe. Site within $\frac{1}{4}$ mile of the Rau River due southeast of Kahe, Kilimanjaro Region, Tanzania.
f. Elevation: 2290 feet approximately.
g. Land form:
   i. Physiographic position of the site: Old river terrace, not part of the present flood plain.
   ii. Land form of surrounding country: Flat or almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat 0-2%.

i. Vegetation and/or land-use: The vegetation is high continuous forest with thick woody undergrowth. The site described here is not cultivated, but parts of the unit near the Rau River have been cleared and cultivated for a variety of crops, particularly maize and cotton.

General soil information

a. Parent material: Old calcareous alluvium.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Slightly moist throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free.
h. Human influence: Nil.

Brief description of profile

A very dark brown over brown to dark brown, deep, clay loam over clay, moderately well drained, forest soil with high organic matter concentration at the surface. There is a marked contrast between the topsoil which is non-effervescent and the brown to dark brown subsoil which is highly calcareous. A weak crumb structure is common in the top horizon and leaves and other vegetative residue form an undecomposed O1 layer throughout most of the unit. The forest is a dominant influence and the soils could deteriorate rapidly with its removal.

Profile description

O1 1-0" Leaves, twigs and other vegetative residues forming an almost continuous layer.

A1 0-9" Very dark brown (10 YR 2/2) moist, clay loam; fine and medium moderate crumb; nonsticky and nonplastic, very friable moist; non-effervescent; common micro and very fine pores; many fine and common medium living roots; this horizon has an obvious high organic matter content; abrupt smooth boundary; pH 7.8.

B2t 9-22" Very dark brown (10 YR 2/2) moist, clay; moderate medium angular blocky; sticky and slightly plastic, friable moist; few very fine and fine pores and many old root channels filled with materials from the horizon above; many fine and medium fibrous and woody roots; gradual smooth boundary; pH 8.0.

B3ca 22-58"+ Brown to dark brown (7.5 YR 4/2) moist, clay; structure not recorded from auger sample; very sticky and plastic, friable moist; highly effervescent to HCl; few fine pores, fine roots continue through this horizon, but are not common; pH 8.4.

Range of characteristics

The very dark brown subsoil ranges in depth between 4 and 24 inches with variable, though usually high, amounts of organic matter. Towards the edge of the forest to the south surface colours become more greyish brown and the pH is consistently higher bordering the highly saline-alkaline Unit 32. pH range 7.6 - 8.6 but with small alkaline inclusions at the southern boundary.

Land-use and agricultural potential

This would be a very good agricultural soil and suitable for irrigation. It is however located almost entirely within the Kahe forest reserve and is not available at the present time. Small farms in clearings along the Rau River are highly productive during the wet season but due to forest controls the farming is not extensive.

SOIL ANALYSES TABLE I.

MIWALENI SPRINGS AND KAHE. SEMI-DETAILED SURVEY

UNIT No.	Depth Inches	pH in Water 1:1 W/V	pH in Water 1:5 W/V	Conductivity 1:5 W/V millimhos at 25°C	Calcium Carbonate per cent	Organic Carbon per cent	Cations extracted with N ammonium acetate milliequivalent per 100 g. soil Sodium	Cations extracted with N ammonium acetate milliequivalent per 100 g. soil Potassium
4	0-10	7.6	8.6	0.11	2	1.86	0.7	5.0
	10-20	7.8	8.5	0.05	2	0.93	0.9	2.6
	20-32	7.5	8.2	0.05	2	0.50	0.8	2.7
	32-54	7.7	8.2	0.05	2	0.36	1.0	1.7
4R	0-7	7.6	7.6	0.15	2	2.70	3.3	1.8
	7-18	7.7	8.1	0.58	2	1.47	18.7	1.0
	18-29	9.8	9.9	2.50	6	0.73	56.5	1.1
	29-42	10.0	10.1	5.8	16	0.32	66.2	1.4
	42-60	10.1	10.2	2.34	19	0.24	49.6	1.4
5	0-9	6.9	7.2	0.06	2	1.15	0.5	4.3
	9-20	7.8	8.3	0.11	3	0.61	0.6	4.5
	20-40	8.5	8.8	0.14	3	0.40	2.3	5.1
	40-54	9.2	9.4	0.37	4	0.38	7.8	7.2
6	0-6	7.8	8.5	0.10	3	1.03	1.7	1.2
	6-22	7.6	8.0	0.44	4	0.89	6.0	1.2
	22-42	7.7	7.8	1.22	4	0.60	13.9	1.1
	42-63	8.0	8.5	1.05	4	0.34	10.9	1.0
11	0-7	7.4	7.5	0.12	1	1.18	0.1	0.5
	7-16	7.4	7.5	0.05	1	0.48	0.3	0.3
	16-30	8.0	8.4	0.10	2	0.35	0.4	0.1
	30-51	8.1	8.5	0.32	3	0.23	1.2	0.2
	51-60	7.8	8.1	1.20	6	0.10	3.4	0.5
21	0-4	-	6.6	0.07	NIL	1.10	0.1	0.8
	4-12	-	6.8	0.06	NIL	0.98	0.3	0.2
	12-38	-	7.0	0.07	NIL	0.97	1.4	0.4
	38-60	-	7.6	0.15	NIL	0.88	2.4	0.2
22	0-4	7.5	8.3	0.13	3	2.14	0.5	7.2
	4-18	7.1	8.6	0.07	2	0.64	0.7	3.8
	18-24	6.6	8.1	0.15	2	0.44	0.5	3.8
	24-36	6.7	8.0	0.24	2	0.40	0.9	3.6
	36-48	6.9	7.8	0.39	2	0.36	1.1	4.5
23	0-5	6.8	6.6	0.12	1	1.09	2.6	10.3
	5-14	6.8	6.8	0.85	1	0.74	12.8	9.7
	14-33	10.3	10.3	2.40	8	0.19	59.2	15.5
	33-58	10.6	10.7	2.35	18	0.19	57.1	17.3
24	0-10	7.8	8.2	0.14	6	1.63	2.9	11.2
	10-18	8.0	8.1	0.12	6	0.89	3.1	9.0
	18-24	8.0	8.0	0.30	6	0.48	3.3	12.1
	24-46	8.5	8.9	3.40	7	0.35	19.0	13.1
	46-50	8.4	9.0	3.20	8	0.23	25.5	12.2
25	0-6	6.1	7.0	0.07	2	3.59	0.7	2.5
	6-12	6.5	7.1	0.04	2	1.21	0.7	3.0
	12-24	6.8	7.1	0.04	2	0.68	0.7	2.6
	24-36	6.9	7.6	0.09	1	0.42	0.6	2.2
	36-58	7.0	7.7	0.06	2	0.32	0.5	2.6
28	0-5	8.4	9.1	0.20	6	1.09	27.8	3.1
	5-13	8.5	9.4	0.52	8	1.03	31.7	2.7
	13-24	9.4	10.1	2.34	11	0.16	75.6	2.5
	24-48	9.7	10.2	1.47	6	0.02	67.8	1.5
32	0-4	7.7	8.5	0.16	3	1.86	29.6	3.7
	4-11	10.1	10.3	2.26	10	0.16	84.4	3.3
	11-19	10.2	10.3	2.96	14	0.08	82.6	3.1
	19-36	10.2	10.4	2.96	13	0.08	116	2.3
	36-54	10.3	10.4	3.13	11	0.06	124	2.3
32K	0-2	9.3 *	10.0	13.8	9 +	1.79	-	-
	2-12	10.3 *	10.5	5.8	7 +	0.75	-	-
	12-23	10.2 *	10.4	1.88	14 +	0.42	-	-
	23-31	10.2 *	10.4	1.74	16 +	0.35	-	-
	31-38	10.1 *	10.2	1.54	10 +	0.33	-	-
	38-56	10.1 *	10.3	1.70	14 +	0.27	-	-
35	0-4	10.0	10.1	-	21	0.64	71.7	4.4
	4-16	10.4	10.4	1.33	22	0.36	34.8	11.1
	16-24	10.1	10.1	0.69	24	0.16	23.9	5.8
	24-56	9.9	10.0	0.46	25	0.14	8.7	9.0
38	0-5	9.3	9.5	2.83	4	1.51	33.9	3.3
	5-16	8.6	9.1	0.48	2	0.61	14.8	2.6
	16-28	8.9	9.3	0.36	2	0.34	16.5	3.1
	28-42	9.4	9.7	0.33	3	0.32	18.9	3.7
	42-52	9.5	9.9	0.45	4	0.26	21.5	3.8
43	0-9	7.9	8.3	0.18	20	6.6	0.9	7.8
	9-22	8.6	8.9	0.17	23	1.96	0.8	10.7
	22-36	8.8	9.1	0.22	23	0.61	1.6	13.6
	36-58	8.8	9.2	0.26	22	0.46	3.8	13.6

NOTES:

1. Analyses on Units 21 and 32K were determined after July 1965; all other analyses were determined before July 1965.

2. In Unit 32K, pH values marked * were determined on a saturated soil paste and calcium carbonate values (marked +) were determined by means of Collins' calcimeter.

3. All other calcium carbonate values are estimated by acid neutralization.

4. The values for sodium extracted with N ammonium acetate (at pH 7.0) include water soluble sodium. Since water soluble potassium is normally very small the values for potassium are approximate estimates of exchangeable potassium.

5. Calcium carbonate, organic carbon and cations extracted with N ammonium acetate are calculated on air-dry soil.

6. A dash (-) indicates that the analysis was not done or the result was not reliable.

A P P E N D I X II

MIWALENI SPRINGS DETAILED SURVEY

MIWALENI SPRINGS DETAILED SOIL SURVEY

Site information

Because of the smallness of the area one general site description is given with variations and "Soil Information" recorded with the individual profiles.

Date of Survey: November - December 1964.
Location: The detailed soil survey area is situated approximately 1¼ miles south of the Miwaleni Springs between the Rau and the Mue Rivers in the Kilimanjaro Region of Tanzania. Approximately 9½ miles due southeast of Moshi. It extends southward to the Kahe-Taveta railway.
Elevation: Survey area lies between contours 2305 and 2340 feet.
Land form: Old alluvial plain area between the Rau and Mue Rivers.
Slope: Everywhere Class 1 - flat or almost flat 0-2%.
Vegetation: Ranges from open seasonally swampy grasslands to Acacia thorn-bush and palm savannah and thick woody forest. Forest occurs as large areas and also lines the rivers and seasonal drainage channels.
Climate: Interior tropical semi-arid. There are no meteorological stations in or near the area. "Synthetic Rainfall Records" devised by this project hydrologist using data from surrounding stations gives a mean rainfall of 15.34 inches with a maximum of 21.66 and a minimum of 8.40 inches.

Soil profiles

All the profile descriptions given below were made from shallow two foot pits with augering below to 4 - 5 feet in order to complete the survey with full analyses according to a rigid development schedule. The profiles have certain recognised subsoil limitations in consequence and no structures are recorded for those depths sampled by auger.

UNIT 4R

Location: Miwaleni Springs Detailed Survey.
Vegetation: Tall riveraine forest with thick underbush. Not cultivated.

General soil information

a. Parent material: Old alluvial deposits derived originally from the Kilimanjaro Volcano.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Slightly moist to 11 inches and moist below.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.

f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 3 - strongly affected.
h. Human influence: Nil.

Brief description of the profile

A deep, dark brown over dark reddish brown clay loam over clay soil. Structures are granular at the surface and only moderately well developed. Strongly calcareous throughout with pH 8.8 to 8.6. The present profile is saline but alkaline spots are included within the unit.

Profile description

A1 0-5" Dark brown (7.5 YR 3/2) slightly moist, clay loam; moderate and weak medium granular breaking readily to very fine loose weak aggregates; slightly sticky and slightly plastic, very friable moist; porous with common fine pores; common fine fibrous roots which bind together the larger granular aggregates; the horizon becomes slightly lighter in colour with depth; strongly calcareous; gradual smooth boundary; pH 8.8.

C1 5-11" Dark reddish brown (5 YR 3/4) slightly moist; clay; moderate medium granular; sticky and slightly plastic, friable moist; porous with common fine pores; strongly calcareous; few fine roots; gradual smooth boundary; pH 8.8.

C2 11-26" Dark brown (7.5 YR 3/2) moist, clay; moderate medium granular very sticky and plastic, friable; porous with few fine and medium pores; occasional medium distinct old root channels; strongly calcareous; few fine roots; gradual smooth boundary; pH 8.6.

C3 26-58"+ Dark reddish brown (5 YR 3/3) moist; clay; very sticky and plastic, friable moist; strongly calcareous; occasional fine roots in the upper horizon; pH 8.6.

Range of characteristics

Surface colours are always dark brown but after the top few inches which are influenced by the forest vegetation the soil ranges between dark reddish brown and dark brown and alternate colouration from horizon to horizon occurs in what is a typically recent alluvial soil. The soils are mainly saline, but some alkaline spots occur. pH range 8.4 - 9.6.

Similar and associated soils

This soil has much in common with those of Unit 4 of the semi-detailed survey carried out over a larger area although the Unit 4 soils are strictly non-saline non-alkaline and highly productive. Some very small spots of

Unit 4 soils occur on the very edge of the river on some of the larger meanders. These have not been mapable, but produce good crops of bananas.

Land-use and agricultural potential

This is non-agricultural land. It would have to be reclaimed before utilisation and in any case occurs as a thin narrow strip along the river which would be difficult to handle other than in a large well organised scheme.

UNIT 22
(With referance to Unit 22F)

Location: Miwaleni Springs Detailed Survey. Ref. N 5,313,000/W.560,250 (Project topographical survey).
Vegetation: Thick bush vegetation dominated by mature Acacia and palms. Much young Acacia and thin grass cover in less dense areas. No cultivation but a little castor is grown around houses just outside the area. Grazed by goats and cattle.

General soil information

a. Parent material: Old alluvial and probably colluvial materials, since the site occupies a higher position than a lot of the surrounding land.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout the profile to 30 inches. Slightly moist below.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 to 1 - free to slightly affected.
h. Human influence: Nil.

Brief description of the profile

A dark brown over dark reddish brown, deep, well drained loam soil. Surface structures are moderately developed granular within a porous, friable profile. pH increases with depth from 7.0 to 7.5 in the subsoil. Gravels occur in the lowest horizon.

Profile description

A11 0-6" Dark brown (7.5 YR 4/2) dry, clay loam; slightly compacted and breaking to weak fine angular blocks; slightly sticky and slightly plastic, friable moist; slightly hard, dry; common fine pores and distinct old root channels; non-effervescent; common fine living roots; horizon is slightly bleached in the upper part; clear smooth boundary; pH 7.0.

A12 6-16" Dark brown (7.5 YR 4/2) dry, clay loam; moderate medium granular breaking readily to much finer granules; sticky and slightly plastic, friable moist, slightly hard dry; non-effervescent; porous with common fine pores; common fine roots; clear smooth boundary; pH 7.0.

B2 16-30" Dark reddish brown (5 YR 3/3) dry, clay loam; structure indistinct but breaking readily to fine and medium angular blocky; sticky and slightly plastic, friable moist, hard dry; very porous with many fine and few coarse pores; occasional coarse rounded sand grains visible in peds; gradual change; pH 7.5.

C 30-50" Reddish brown (5 YR 4/4) slightly moist, gravelly clay loam with common fine and medium rounded gravels; hard and difficult to auger; pH 8.2.

Range of characteristics

Surface colours are always dark brown (7.5 YR 4/2 or 3/2) and subsoils dark reddish brown (5 YR 3/3 or 3/4). Textures are clay loam at the surface, but may be clay in some subsoils. Gravels occasionally occur in the lowest horizons as in the present profile. Some subsoils are effervescent and also slightly saline. pH is usually 7.0 - 8.2 although in the saline subsoil may range between 8.4 and 8.7.

Similar and associated soils

In the southwest of the area a heavily cultivated and frequently irrigated soil occurs with very similar characteristics and has been mapped as Unit 22F. It is completely non-saline non-alkaline and highly productive in a variety of crops, in forest clearings. Textures tend to be finer and frequently clay at the surface although colour range, porosity, structure and pH are very similar.

Land-use and agricultural potential

These soils are not cultivated within the area, but could be productive under irrigation for a wide variety of crops. It is, however, the second smallest unit, covering less than 2% of the area and is therefore not of any great significance and in no way representative.

UNIT 25F
(With reference to Unit 25S)

Location: Miwaleni Springs Detailed Survey. Ref. N5,310,500/W.563,000.
Vegetation: High dense forest along a seasonal drainage line. Uncultivated.
Local land form: Old depressional drainage line.

General soil information

a. Parent material: Old alluvium.
b. Drainage: Class 2 - imperfectly drained. Seasonally flooded site.
c. Moisture conditions: Slightly moist throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free.
h. Human influence: Nil.

Brief description of the profile

A dark reddish brown over reddish brown, deep, imperfectly drained clay loam over clay soil. Surface structures are moderately developed, but strong coarse columnar peds characterise the subsoil. The clays are very sticky and plastic, and stiff below 16 inches. The soil is slightly calcareous in the subsoil with pH increasing with depth through the range 7.4 - 8.5. A non-saline non-alkaline forested soil with high surface organic matter content.

Profile description

A11	0-6"	Dark reddish brown (5 YR 2/2) slightly moist, clay loam; moderate medium and fine granular; high organic matter content; slightly sticky and slightly plastic, friable; porous with many fine pores; non-effervescent; many fine roots; clear smooth boundary; pH 7.4.
A12	6-16"	Dark reddish brown (5 YR 3/2) slightly moist, clay; strong coarse columnar; occasional small rounded polished gravels; sticky and plastic; hard dry; non-effervescent; few fine roots; gradual smooth change; pH 7.6.
AC	16-36"	Reddish brown (5 YR 4/4) slightly moist, clay; stiff and difficult to auger; very sticky and plastic, firm; slightly effervescent; occasional fine roots in the upper horizon; gradual change; pH 8.4.
C	36-58"	Reddish brown (5 YR 4/4) slightly moist; clay; stiff and difficult to auger; very sticky and very plastic; slightly effervescent; pH 8.5.

Range of characteristics

Surface colours are usually dark reddish brown but the subsoil may range between reddish brown (5 YR 4/4) and dark brown (7.5 YR 3/2). Textures are always heavy clay below the top 6-9 inches. Gravels may occur in the profile at depth. pH is in the broad range 7.0 - 8.5 with the lowest readings at the surface. Surface organic matter content varies but is usually relatively high with many fine roots sometimes in a loose mat.

Similar and associated soils

The present unit occupies the western part of a depressed drainage line which passes through the survey area west to east. The eastern end of the drainage area is occupied by Unit 25S.

Unit 25S may be either dark reddish brown or very dark brown depending upon organic matter accumulation at the surface. Subsoils are strong coarse angular blocky; Textures are consistently clay with pH range 8.5 - 9.4 within a highly alkaline and sometimes saline soil.

Land-use and agricultural potential

The limitations to the use of Unit 25F are seasonal flooding and low depressed site. The soils are fine textured and have slight subsoil alkalinity. They could be included within an irrigation scheme after the provision of flood protection. A forest clearance programme would be necessary, but the unit is very small (32 acres).

Unit 25S by contrast is non-agricultural and is not recommended for development. Expensive reclamation would be involved in bringing the soils into use and this, together with problems related to low-lying position and flooding, would make costs prohibitive.

UNIT 27

Location: Miwaleni Springs Detailed Survey. N.5,309,000/W.561,750.
Vegetation: Mature palms dominate the whole of the unit with some coarse grasses in clearings and occasional thorny Acacia.

General soil information

a. Parent material: Old alluvium.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry to 5 inches and slightly moist below.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.

g. Salinity or alkalinity: Class 2 - moderately affected.
h. Human influence: Nil.

Brief description of the profile

A dark grey over dark brown and brown, deep, moderately welldrained loam over clay loam over clay soil. Very porous in the topsoil corresponding to high organic matter content. The topsoil is non-effervescent, but the profile becomes more calcareous with depth. Rooting is dense in the top foot of the profile. pH increases with depth in the range 7.6 - 9.2+.

Profile description

A11 0-5" Very dark grey (10 YR 3/1) moist and dark grey (10 YR 4/1) dry, loam; weak coarse medium and fine granular, the granules being held together by abundant fine and medium grass roots; slightly sticky and slightly plastic, very friable moist; soft dry; very porous with many fine and medium pores; high organic content with a thin humic surface that is slightly bleached below; gradual smooth boundary; pH 7.6.

A12 5-12" Dark brown (10 YR 4/3) slightly moist, clay loam; moderate medium and fine granular; sticky and slightly plastic, friable moist; slightly effervescent; ccmmon fine and medium roots; gradual smooth boundary; pH 8.0.

B2 12-36" Dark brown (7.5 YR 3/2) moist, clay; sticky and plastic, firm moist; slightly compacted; effervescent; occasional small rounded gravels; gradual boundary; pH 8.8.

C 36-48"+ Brown (10 YR 5/3) moist, clay; with many angular and sub-rounded gravels; strongly calcareous; pH 9.2+.

Note: This is one of the better profiles within this unit. Other profiles range in pH between 8.4 and 8.8 and have the highest pH at the surface within the range 8.6 - 9.4.

Range in characteristics

Topsoil colours are invariably dark grey, but may also be black due to organic accumulation. Subsoil colours range between dark brown and brown, but may also be greyish brown. pH ranges between 7.6 and 9.2+ with considerable variation, highest readings occuring either at the surface or at depth.

Land-use and agricultural potential

Due to high alkalinity and patchy salinity these soils are not cultivated at present. The unit (403 acres) is the largest in the survey area, but would not be suitable for agriculture without reclamation.

UNIT 31D

Location: Miwaleni Springs Detailed Survey. N 5,306,000/W 560,750.
Vegetation: Grass with occasional mature palms and Acacia thorn trees. Not cultivated due to high salinity-alkalinity content.

General soil information

a. Parent material: Old alluvium.
b. Drainage: Class 2 - imperfectly drained. Subject to annual flooding.
c. Moisture conditions: Slightly moist throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness and rockiness: Class 0 - caliche - rocks sometimes outcrop or occur as loose individual stones at the surface.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 3 - strongly affected.
h. Human influence: Nil.

Brief description of the profile

A black and very dark grey, moderately deep clay soil with a highly organic surface which is very heavily rooted. Structures are strong and coarse. The whole profile is strongly calcareous with distinct very pale brown calcium carbonate accumulations below 9 inches. Depth is limited at 40 inches by hard compacted caliche gravels. The soil is alkaline with pH everywhere in excess of 8.5.

Profile description

A1 0-9" Black (10 YR 2/1) slightly moist organic horizon with incorporated clay; strong coarse sub-angular blocky; slightly sticky and slightly plastic; strongly calcareous; abundant fine old roots entering the peds; clear smooth boundary; pH 9.2.

AC 9-16" Very dark grey (10 YR 3/1) slightly moist, clay, with many fine and medium distinct mottles of very pale brown (10 YR 7/3) corresponding to calcium carbonate accumulation. These are really very weak calcareous nodules; sticky and slightly plastic, friable moist; strongly calcareous; few fine roots; gradual smooth boundary; pH 8.6.

C1 16-40" Greyish brown (10 YR 5/2) slightly moist, clay; occasional fine and medium rounded and irregular gravels; sticky and slightly plastic, friable moist; very occasional fine roots; profile ends at 40 inches in hard compacted caliche gravels; highly calcareous; pH 8.7.

Range of characteristics

This is a very small unit (34 acres) and the soils are consistent throughout, being always black surfaced, calcium accumulating and with pH in excess of 8.5 corresponding to high alkalinity (range 8.6 - 9.2).

Similar and associated soils

There are no similar soils to this in the detailed area. Within the semi-detailed area Unit 31 is highly calcareous with calcium carbonate concretions in the subsoil but is much redder, less organic at the surface and developed in bottom-slope colluvial materials.

Land-use and agricultural potential

These soils are not cultivated and would have to be reclaimed. Since the soils are alkaline, reclamation would be expensive. The outcropping caliche-rock is an additional limitation and flood control would have to be established outside the area in order to stop seasonal inundation.

UNIT 32D
(With reference also to Unit 32W)

Location: Miwaleni Springs Detailed Survey. Ref.N.5,307,000/W.558,000.
Vegetation: The dominant vegetation is tall mature palm (Typha augustifolia L.) with coarse grass cover in clearings. Grasses are subject to burning. Not cultivated. Some grazing by goats.

General soil information

a. Parent material: Old alluvium.
b. Drainage: Class 2 - imperfectly drained.
c. Moisture conditions: Slightly moist throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 3 - strongly affected.
h. Human influence: Nil.

Brief description of the profile

A very dark brown over dark greyish brown and greyish brown, deep, saline-alkaline clay soil. Structures are well developed angular blocky. Textures are silty clay over clay and the soil is not very porous. Salt accumulates at the surface and the profile is highly calcareous throughout. pH decreases with depth in the range 9.6 - 8.8.

Profile description

A11 0-8" Very dark brown (10 YR 3/2) slightly moist, silty clay; strong medium and fine angular blocky; slightly sticky and slightly plastic, friable moist; few fine pores; highly effervescent; many fine roots and very fine roots incorporated in the peds; abrupt smooth boundary; pH 9.6.

A12 8-20" Very dark brown (10 YR 2/2) slightly moist silty clay; moderate medium angular blocky; slightly sticky and slightly plastic; only a few fine pores; few distinct old root channels; highly effervescent; common fine roots: clear smooth boundary; pH 9.6.

AC 20-38" Dark greyish brown (10 YR 4/2) slightly moist, silty clay with medium distinct pale brown (10 YR 6/3) mottles; slightly sticky and slightly plastic, friable moist; strongly calcareous; gradual smooth boundary; pH 9.0.

C 38-58"+ Greyish brown (10 YR 5/2) slightly moist, clay; with common fine distinct pale brown (10 YR 6/3) mottles; sticky and plastic; firm; occasional rounded gravels; pH 8.8.

Note: The surface in many places is salt accumulating. Large 10-80 feet salt patches occur from place to place. Salt crusts are thick and fluffy and often disturbed by goats and cattle.

Range of characteristics

Salt accumulations may or may not be present at the surface. Where not present colours are very dark brown (10 YR 3/2 - 10 YR 2/2). Subsoils usually become greyer with depth. Well formed angular blocky surface structures become weaker developed down profile. Textures are always silty clay and clay. pH range 8.4 - 9.6+ with many profiles having all readings above 8.8.

Similar and associated soils

Unit 32W represents a wetter phase of this unit. Like 32D the unit 32W is highly saline and alkaline with similar 10-80 feet salt patches but it occupies a lower lying site, subject to shallow flooding during the wet season. Textures are similar, but clay loam textures have been recorded. Dark surface colours go deeper, but subsoil colours tend in some profiles to be browner. Organic matter accumulation at the surface is higher and surface structures frequently granular. Also a non-agricultural soil.

Land-use and agricultural potential

Neither of these phases of the major unit 32 are cultivated at the present time. The combined area represents the second largest unit within the proposed scheme (373 acres) and cannot be considered for irrigation without large scale investment in reclamation and flood control. Non-agricultural at the present time.

UNIT 34
(With reference also to Unit 34F)

Location: Miwaleni Springs Detailed Survey. N.5,305,000/W.562,000.
Vegetation: Coarse, tall, broad leafed grasslands with clumps of trees. Typical water-tolerant grass vegetation. Not cultivated.
Local land form: Depressional major flood area through which water passes seasonally.

General soil information

a. Parent material: Old alluvium.
b. Drainage: Class 1 - poorly drained.
c. Moisture conditions: Moist throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Subsoil is Class 1 - slightly affected.
h. Human influence: Nil.

Brief description of the profile

A very dark brown over very dark grey and pale brown, deep, poorly drained clay soil with strongly calcareous subsoil. Structures are moderately developed in the fine to medium granular range. The subsoil contrasts with the non-effervescent surface, being strongly calcareous with obvicus calcium carbonate segregation. pH increases with depth to 8.5 corresponding to moderate alkalinity. Individual gravels occur in the lowest horizon.

Profile description

A1 0-5" Very dark brown (5 YR 3/1) moist clay; moderate coarse and medium granular held together by many fine and medium grass roots; sticky and plastic, friable moist; high organic matter content; non effervescent; clear smooth boundary; pH 7.2.

B21 5-12" Very dark brown (10 YR 2/2) moist, clay; moderate coarse and medium granular; sticky and plastic, friable moist; non-effervescent; common fine roots; slightly porous with few fine pores; gradual smooth boundary; pH 7.4.

B22ca 12-32" A combination colour of dark grey (10 YR 4/1) and very dark greyish brown (10 YR 3/2) moist, clay; with common white flecks of segregated calcium carbonate; sticky and plastic, firm moist; calcareous; clear change; pH 8.0.

C 32-60"+ Pale brown (10 YR 6/3) moist, clay; with some pale brown areas and ochreous iron segregation; occasional medium and small angular gravels; strongly calcareous; pH 8.5.

Range of characteristics

Topsoil colours range between very dark brown (5 YR 3/1) and very dark grey (10 YR 3/1). Subsoil colours in the strongly calcareous zone range between pale brown and grey. The change between the two may be almost an unconformity in some profiles. Textures are always clayey. pH ranges between 7.2 and 8.8 with some profiles having reaction throughout in excess of 8.4.

Similar and associated soils

Unit 34F is the forested phase of this soil. It is a very dark grey over dark brown, deep, poorly drained clay soil with a similar strongly calcareous subsoil. Structures are also coarse and well developed, being either columnar or strong angular blocky to the surface. The soil is also moderately alkaline, especially in the subsoil and similarly subjected to flooding or waterlogging in the wet season. pH is usually above 8.4 throughout the profile. Not quite so organic as unit 34.

Land-use and agricultural potential

Units 34 and 34F have the common problems of moderate subsoil alkalinity and poor drainage with seasonal flooding for several weeks during and after the rainy season. Unit 34 is the wettest of the units in the area, although Unit 25 is also water accumulating. The subsoil alkalinity is not continuous throughout the units and would not be a severe problem with good drainage within a well organised scheme. A forest clearance programme would be needed before Unit 34F could be brought into use.

UNIT 38K

Location: N.5,313,000/W 562,000.
Vegetation: Mixture of coarse clump grass, thornbush and palms with large bare patches. Grazed by goats and cattle.

General soil information

a. Parent material: Old alluvium.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 2 - moderately affected..
h. Human influenoe: Nil.

Brief description of the profile

A dark brown over very dark brown, deep, moderately well drained, moderately alkaline soil. Structures at the surface are moderately developed coarse medium and fine angular blocky and overlie a massive subsoil. The profile is strongly effervesoent below the surfaoe. A clay loam surface overlies clays.

Profile description

A11 0-7" Dark brown (7.5 YR 3/2) moist and pale brown (10 YR 6/3) dry, clay loam; weak coarse medium and fine sub-angular blocky; slightly stioky and slightly plastic, very friable moist, soft dry; oommon fine roots; olear smooth boundary; pH 8.0.

A12 7-17" Very dark brown (10 YR 2/2) slightly moist, clay; moderate, medium and fine angular blocky; sticky and plastic, friable moist; common fine pores; strongly effervescent; gradual smooth boundary; pH 8.2.

B21 17-32" Dark brown (7.5 YR 3/2) slightly moist, clay; massive; sticky and plastic, friable moist; few fine and few medium pores; few fine roots; strongly effervesoent; gradual boundary; pH 9.2.

B22 32-56"+ Brown to dark brown (7.5 YR 4/2) slightly moist, clay; sticky and plastic, firm moist; strongly effervescent; pH 8.6.

Note: This profile and samples represents a slightly better than average site within the unit. Other profiles near bare patches give pH readings throughout within the narrow range 8.8 - 9.4 corresponding to high exchangeable sodium content.

Range of characteristics

Surface colours are commonly dark brown (7.5 YR 3/2) but subsoil colours range between very dark brown (10 YR 2/2) and dark reddish brown (5 YR 3/4). Textures are consistently clay loam over clay.

Similar and associated soils

This soil has many characteristics in common with Unit 22 which it adjoins, but has not the granular structure and is heavier textured in the subsoil with higher pH corresponding to high exchangeable sodium content.

Land-use and agricultural potential

This is a patchy alkaline soil and reclamation would be necessary before it could be used for agriculture. It amounts to about 8% of the proposed scheme area. Used only for goat and occasionally cattle grazing. Not suitable for irrigation.

SOIL ANALYSES TABLE II

MIWALENI SPRINGS DETAILED SURVEY

UNIT No.	Depth Inches	pH in Water 1:1 W/V	pH in Water 1:5 W/V	Conductivity 1:5 W/V millimhos at 25° C	Calcium Carbonate per cent	Organic Carbon per cent	Total extracted by N ammonium acetate milliequivalent per 100 g soil Sodium	Total extracted by N ammonium acetate milliequivalent per 100 g soil Potassium
1R	0-5	9.2	9.9	1.52	12	3.96	25.5	10.7
	5-11	10.0	10.3	1.40	15	1.09	27.2	9.2
	11-26	10.0	10.3	1.10	4	0.43	21.7	9.0
	26-58	9.6	10.1	0.48	14	-	22.8	7.2
22	0-6	7.6	7.7	0.05	NIL	1.35	0.5	3.6
	6-16	7.3	7.8	0.05	NIL	0.94	0.8	2.8
	16-30	8.0	8.9	0.10	1	0.46	1.6	2.2
	30-60	7.9	9.0	0.50	10	-	10.6	2.5
25F	0-6	7.1	7.7	0.70	3	8.85	12.8	4.4
	6-16	7.5	8.1	0.34	1	0.92	10.9	3.1
	16-36	8.6	9.2	0.50	2	0.48	14.9	2.8
	36-58	9.4	9.9	0.70	3	-	20.4	3.6
25S	0-8	8.3	9.2	0.55	2	1.89	16.3	3.2
	8-16	9.9	10.2	1.50	12	0.11	31.5	3.6
	16-33	9.8	10.2	1.25	18	0.09	27.2	3.2
	33-56	10.0	10.2	1.50	7	-	36.7	4.1
27	0-5	7.0	7.4	0.87	2	2.67	4.4	3.7
	5-12	8.3	8.7	0.60	2	1.09	7.9	3.6
	12-36	9.4	10.1	1.25	4	0.30	24.5	3.3
	36-48	9.9	10.2	1.45	20	-	22.8	4.0
31	0-9	9.6	9.9	1.20	7	1.15	22.8	4.9
	9-16	9.8	9.9	1.10	12	0.56	23.6	5.0
	16-40	9.3	9.5	1.40	6	-	27.2	5.5
32D	0-8	10.2	10.3	2.60	6	1.93	43.5	5.9
	8-20	10.3	10.3	2.30	10	0.81	29.9	5.5
	20-38	10.1	10.2	1.75	11	0.43	24.5	5.8
	38-58	10.0	10.2	1.40	18	-	20.4	6.4
32W	0-8	10.1	10.4	4.00	5	1.05	58.4	4.4
	8-16	10.2	10.4	4.75	9	0.72	72.0	4.4
	16-26	10.1	10.3	4.85	17	0.33	61.1	4.5
	26-58	10.1	10.3	3.20	22	-	44.8	3.8
34	0-5	7.1	8.3	0.26	3	4.74	3.5	4.0
	5-12	7.8	8.4	0.12	4	1.74	2.2	3.6
	12-32	8.8	9.4	0.36	24	0.59	5.7	5.0
	32-60	9.3	10.1	0.60	9	-	9.8	6.4
34F	0-12	8.3	8.6	0.28	2	3.66	5.4	3.4
	12-30	8.8	9.3	0.30	2	0.74	12.2	4.5
	30-50	9.4	10.1	0.72	3	-	26.6	4.7
	0-7	6.9	7.5	0.60	1	2.03	29.9	3.4
	7-17	7.2	7.8	0.95	2	1.00	13.3	3.6
	17-32	9.6	9.7	1.20	4	0.43	19.0	4.5
	32-56	9.6	9.8	1.20	8	-	23.6	6.0

NOTES:

1. All analyses were determined before July 1965.

2. Calcium carbonate values are estimates by acid neutralization.

3. The values for sodium extracted with N ammonium acetate (at pH 7.0) include water soluble sodium. Since water soluble potassium is normally very small, the values for potassium are approximate estimates of exchangeable potassium.

4. Calcium carbonate, organic carbon and cations extracted with N ammonium acetate are calculated on air-dry soil.

5. A dash (-) indicates that the analysis was not done.

A P P E N D I X III

KAHE DETAILED SURVEY

Site information

a. Soil name: UNIT 11d.
b. Higher category classification: Regosol intergrade to Reddish Brown. Entic-Orthid? (4.1-1). Revised 7th Approximation (1964).
c. Date of examination: 30th June, 1966.
d. Authors: Messrs. Mikenberg, Suggett and Hoekstra.
e. Location: Kahe Irrigation Scheme. Northwest corner of Pilot Area I, which is situated approximately $1\frac{3}{4}$ miles southwest of Kahe village, Kilimanjaro District, Tanzania.
f. Elevation: 2309 feet.
g. Land form:
   i. Physiographic position: Gently sloping plains below Mount Kilimanjaro.
   ii. Surrounding land form: Gently sloping.
   iii. Microtopography: Nil.
h. Slope: Flat or almost flat, 0-2%.
i. Land-use: Vegetation is mainly thornbush dominated by Acacia with much low bush and scrub or grass in clearings. Some goat and cattle grazing. Very occasional sporadic cultivations for maize during the heaviest wet seasons. Charcoal burning.

General information on the soil

a. Parent material: Old fluvio-colluvial materials overlying rounded heavily calcium cemented gravels and occasionally caliche-like materials.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight wind erosion.
g. Salinity or alkalinity: Class 0 - free.
h. Human influence: Nil.

Brief description of the profile

Dark brown over dark yellowish brown, well drained, moderately permeable silt loam soils with occasional heavier textured horizons and sometimes containing individual gravels. Roots penetrate to 60" and often deeper in what are weakly structured friable soils of high to medium porosity. Closely related to and distributed with phases 11m (18-30" overlying gravels and 11s 0-18" overlying gravels), both of which are also weakly developed Regosolic Soils.

Profile description

A11 0-4" Dark brown (10 YR 3/3) moist and brown to dark brown (10 YR 4/3) dry, silt loam; weak fine and medium granular; sticky

and plastic, friable moist, soft dry; non-effervescent; high porosity; common fine and medium roots; clear wavy boundary; pH 7.1.

A12 4-18" Dark yellowish brown (10 YR 3/4) moist and dark yellowish brown (10 YR 4/4) dry, silty clay loam; weak medium granular; sticky and plastic, friable moist, soft dry; non-effervescent; high porosity; oommon fine and medium roots; gradual smooth boundary; pH 7.1.

AC 18-38" Dark yellowish brown (10 YR 3/4) moist and brown to dark brown (10 YR 5/3) dry, silt loam; massive breaking to medium sub-angular blocky; slightly sticky and plastic, friable moist, hard dry; slightly effervescent; medium porosity; common medium roots; gradual smooth boundary; pH 7.6.

C1 38-60" Dark brown (10 YR 3/3) moist and brown to dark brown (10 YR 5/3) dry, silt loam; massive; slightly sticky and slightly plastic, friable moist, soft dry; effervescent; few fine and occasional medium roots; pH 8.0.

Note: Pit ends at the top of a gravel layer. Many rounded calcium carbonate coated gravels form a concentrated slightly compacted layer. This would be a IIC2 horizon.

Range of characteristics

Moist surface colours are usually dark brown (10 YR 3/3 - 7.5 YR 3/2) but subsoil colours have a broader range between dark yellowish brown (10 YR 3/4) and dark reddish brown (5 YR 3/3). Textures are silt loam with some silty clay loam layers. Structures are always weak or very weak. pH ranges between 7.0 and 8.2 with effervescence in most profiles below 18 inches. Gravels are usually very common in the profile below 3-4 feet and are often cemented with calcium carbonate.

Similar and associated soils

Units 11m (medium 18-30" depth above gravels) and 11s (shallow 0-18" depth above gravels) form part of this series.

Land-use and agricultural potential

This soil would be highly suitable for irrigation agriculture and a wide range of crops could be grown.

In preparation of the site for irrigation, care would have to be taken in levelling the two other closely related medium and shallow phases. The present soil and most of the medium units present no levelling problems but levelling of the shallow phase would in some cases be impossible.

Site information

a. Soil name: UNIT 11m.
b. Higher category classification: Regosol.
c. Date of examination: 30th June, 1966.
d. Authors: Messrs. Mikenberg, Suggett and Hoekstra.
e. Location: Kahe Irrigation Scheme. Centrally within Pilot Area I, which is situated approximately $1\frac{3}{4}$ miles southwest of Kahe village, Kilimanjaro District, Tanzania.
f. Elevation: 2307 feet.
g. Land form:
   i. Physiographic position: Gently sloping plains below Mount Kilimanjaro.
   ii. Surrounding land form: Gently sloping.
   iii. Microtopography: Nil.
h. Slope: Flat or almost flat, 0-2%.
i. Land-use: Vegetation is mainly thornbush dominated by Acacia with much low bush and scrub or grass in clearings. Some goat and cattle grazing. Very occasional sporadic cultivations for maize during the heaviest wet seasons. Charcoal burning.

General information on the soil

a. Parent material: Old fluvio-colluvial materials overlying rounded heavily calcium cemented gravels and occasionally caliche-like materials.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight wind erosion.
g. Salinity or alkalinity: Class 0 - free.
h. Human influence: Nil.

Brief description of the profile

Dark brown over dark yellowish brown, moderately deep, well drained, moderately permeable fine sandy loam over silt loam soils. Always unconformably overlying compacted and/or calcium cemented gravels. Roots penetrate throughout the profile. Closely related to and distributed with series Units 11d (more than 30" depth overlying gravels) and 11s (0-18" over gravels) both of which are also weakly developed Regosolic Soils.

Profile description

A1 0-3" Dark brown (10 YR 3/3) moist and yellowish brown (10 YR 5/4) dry, fine sandy loam; massive; slightly sticky, friable moist, slightly hard dry; non-effervescent; few fine and common medium roots; low porosity; slightly compacted with a platy tendency; clear smooth boundary; pH 7.4.

AC 3-14" Dark brown (10 YR 3/3) moist and brown to dark brown (10 YR 5/3) dry, silt loam; massive breaking to fine and medium sub-angular blocky; sticky and plastic, friable moist, hard dry; non-effervescent; medium porosity; few to common medium roots; few fine sub-rounded and rounded gravels; clear wavy boundary; pH 7.2.

IIC1 14-20" Dark brown (10 YR 3/3) moist and yellowish brown matrix (10 YR 5/4) dry with calcium carbonate coated gravels of (10 YR 6/5) pale brown; gravel with silt loam included materials; structureless; highly effervescent; high porosity; common fine, few medium and occasional large roots; fine roots cease after this horizon; abrupt wavy boundary; pH 8.0.

IIC2ca 20-34"+ Dark yellowish brown (10 YR 4/4) moist and pale brown (10 YR 6/3) dry, continuous layer of strongly calcium cemented gravels forming a caliche-like layer; a few medium roots penetrate this horizon; very strongly effervescent; pH 7.8.

Range of characteristics

Loamy textures throughout with either fine sandy loam or silt loam at the surface. Colours are dark brown with dark yellowish brown gravel subsoil. Structures are either very weakly developed or non-existent within a massive profile. pH range 7.0 - 8.2. Gravelly subsoils are usually highly calcareous and may be strongly cemented with calcium carbonate.

Similar and associated soils

A deep (greater than 30") and a shallow phase (0-18") form part of this series.

Land-use and agricultural potential

A moderately good soil for irrigation under which a wide range of crops could be grown. Care would, however, have to be taken during levelling work in order not to remove too much topsoil. Similar responses to deep phase Unit 11d would be expected in the event of satisfactory levelling.

Site information

a. Soil name: UNIT 11s.
b. Higher category classification: Regosol.
c. Date of examination: 30th June, 1966.
d. Authors: Messrs. Mikenberg, Suggett and Hoekstra.
e. Location: Kahe Irrigation Scheme. Southwest corner of Pilot Area I, which is situated approximately $1\frac{3}{4}$ miles southwest of Kahe village, Kilimanjaro Region, Tanzania.

f. Elevation: 2305 feet.
g. Land form:
  i. Physiographic position: Gently sloping plains below Mount Kilimanjaro.
  ii. Surrounding land form: Gently sloping.
  iii. Microtopography: Nil.
h. Slope: Flat or almost flat, 0-2%.
i. Land-use: Vegetation is mainly thornbush dominated by Acacia with much low bush and some scrub or grass in clearings. Bare areas are common. Some goat and cattle grazing.

General information on the soil

a. Parent material: Old volcanic-derived fluvio-colluvial materials overlying rounded heavily calcium cemented gravels.
b. Drainage: Class 4-5 - well to somewhat excessively drained.
c. Moisture conditions: Dry throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight wind erosion.
g. Salinity or alkalinity: Class 0 - free.
h. Human influence: Nil.

Brief description of the profile

Dark brown, well drained, shallow, non saline-non alkaline soils having sandy loam texture overlying gravelly loam and gravels. Very closely related to series 11d but with shallow depth and profile overlying cemented gravels.

Profile description

A1 0-3" Dark brown (10 YR 3/3) moist and yellowish brown; (10 YR 5/4) dry, sandy loam; weak medium blocky; slightly sticky and plastic, friable moist, slightly hard dry; non-effervescent; medium porosity with common fine pores; few fine and medium gravels; gradual wavy boundary; pH 7.0.

C1 3-12/18" Dark brown; (10 YR 3/3) moist and brown to dark brown (10 YR 4.5/3) dry, very gravelly silt loam; massive; sticky and plastic, friable moist, loose dry; non-effervescent; high porosity; few medium and fine roots; rounded medium gravels constitute 80%+ of the horizon; slightly compacted; pH 8.0.

IIC2 12/18-36"+ Brown to dark brown (10 YR 4/3) moist and brown to dark brown (10 YR 5/3) dry, gravel with silt loam materials included; massive; loose dry; highly effervescent; very high porosity; few fine roots; rounded medium gravels constitute 80%+ of the horizon; slightly compacted; pH 8.0.

Range of characteristics

Surface colours are always dark brown (10 YR 3/3) and textures silt loam, although the top 2-3 inches tend to be more sandy due mainly to wind erosion. Gravels always occur within 18 inches of the surface and these are for the most part cemented by calcium carbonate. pH range 6.8 - 8.2.

Similar and associated soils

Phases 11d (deep) and 11m (medium) belong to this series of soils.

Land-use and agricultural potential

The shallowest soils within this phase are non-agricultural due to gravel concentrations at or near the surface, although parts with a deeper topsoil could be cultivated with care under sprinkler irrigation. In the levelling of large areas it may be possible to build up topsoil on these shallow soils for irrigation purposes, but levelling in many parts will be almost impossible where gravels are near the surface at high elevations.

Research into water loss in these shallow gravel areas should be carried out and sprinkler irrigation is strongly recommended for their utilisation. Investigations into the geological strata immediately below these soils will be essential before irrigation.

SOIL ANALYSES TABLE III

KAHE DETAILED SURVEY

UNIT No.	Depth	pH in Water		Conductivity millimhos at 25°C		Calcium Carbonate	Organic Carbon	Total Nitrogen	C/N Ratio	Available Phosphorus ppm
	Inches	Saturated Paste	1:5 W/V	Saturation Extract	1:5 W/V	per cent	per cent	per cent		OLSEN
11d	0-4	6.5	7.3	0.61	0.08	NIL	0.93	0.07	13	3.4
	4-18	6.9	7.5	0.38	0.06	NIL	0.68	0.04	17	1.0
	18-38	7.7	8.4	0.47	0.15	0.6	0.62	0.04	16	0.7
	38-60	7.7	8.5	0.65	0.17	1.9	0.56	0.03	19	0.6
11m	0-3	7.4	8.0	1.13	0.14	NIL	1.12	0.09	12	3.4
	3-14	6.3	7.2	1.09	0.11	NIL	0.50	0.03	17	0.7
	14-20	7.7	8.3	0.55	0.14	5.9	0.51	0.04	13	0.5
	20-34	7.8	8.1	1.13	0.21	17.0	0.31	0.02	16	0.5
11s	0-3	6.9	7.6	0.44	0.05	NIL	0.84	0.06	14	3.3
	3-12/18	6.9	7.7	0.27	0.04	NIL	0.72	0.05	14	1.4
	12/18-36	8.0	8.4	0.35	0.14	3.1	0.51	0.04	13	1.1

UNIT No.	Depth	Particle Size Distribution per cent of mineral fraction				Saturation percentage	Cations extracted with N ammonium acetate milliequivalent per 100 g soil				
	Inches	Coarse Sand	Fine Sand	Silt	Clay		Calcium	Magnesium	Sodium	Potassium	Total
11d	0-4	14	33	36	17	40	15.5	7.5	0.2	5.6	28.8
	4-18	6	32	39	23	67	25.0	6.5	0.2	4.2	35.9
	18-38	4	31	43	22	54	-	6.0	0.2	5.2	-
	38-60	6	34	41	19	53	-	9.5	0.4	5.2	-
11m	0-3	40	37	15	8	30	14.0	4.0	0.1	3.8	21.9
	3-14	48	36	11	5	36	12.0	4.0	0.2	2.7	18.9
	14-20	17	45	25	13	36	-	6.5	0.3	2.2	-
	20-34	18	42	26	14	44	-	7.0	2.0	11.0	-
11s	0-3	30	45	19	6	22	8.5	3.5	0.1	2.6	14.7
	3-12/18	42	39	13	6	30	11.5	3.0	0.1	4.0	18.6
	12/18-36	32	36	17	15	37	-	4.0	0.2	3.8	-

NOTES:

1. All analyses were determined after July 1965.
2. Calcium carbonate was determined by means of Collin's calcimeter.
3. OLSEN available phosphorus was determined by extracting 1 part of soil with 20 parts of 0.5.M. sodium bicarbonate at pH 8.5.
4. The particle size distribution values are percentages of the oven-dry mineral fraction, after removal of calcium carbonate. The size ranges are -

Coarse Sand	2000 - 200 microns
Fine Sand	200 - 20 microns
Silt*	20 - 2 microns
Clay	Less than 2 microns

5. Calcium values have been omitted in the case of calcareous soils, since calcium carbonate is partially soluble in ammonium acetate. The values for total cations extracted by N ammonium acetate are approximate estimates of the cation exchange capacity.
6. Calcium carbonate, organic carbon, total nitrogen, available phosphorus and cations extracted with N ammonium acetate are calculated on air-dry soil.

A P P E N D I X IV

NAURURU SEMI-DETAILED SURVEY

combined with

NGAGE SEMI-DETAILED SURVEY

Site information

a. Soil name: UNIT 114.
b. Higher category classification: Regosol. Quarzipsamment (1.X2). Revised 7th Approximation (1964).
c. Date of examination: 24th March, 1965.
d. Authors: Messrs. N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: In the pediments extending from the Masai Steppe rift formation. Between the rift and the valley flats. Ngage area, 26 miles south of the Nyumba ya Mungu Dam, Tanzania.
f. Elevation: 1800-2100 feet.
g. Land form:
   i. Physiographic position: Pediments from the rift valley edge.
   ii. Surrounding land form: Gently undulating.
   iii. Microtopography: Nil.
h. Slope: Class 2 - gently sloping 2-6% regular slopes. Majority of the slopes around 3%.
i. Vegetation and/or land-use: Continuous medium bush with small grassy clearings and areas of parkland and salt bush. Game and cattle grazing.

General soil information

a. Parent material: Colluvium from Basement Complex rocks.
b. Drainage: Well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some gully erosion.
g. Salinity or alkalinity: Class 0 - soils free of excess salt or alkali.
h. Human influence: Nil.

Brief description of the profile

A dark brown over dark reddish brown, deep, very weakly developed loamy sand over loamy fine sand soil. Increasingly calcareous with depth. Highly porous and deep rooting.

Profile description

AC 0-17" Dark brown (7.5 YR 3/2) moist and brown to dark brown (7.5 YR 4/4) dry, loamy sand; massive, breaking to weak medium granular; non sticky and non plastic; very friable moist, loose dry; many fine vesicular pores; common fine and medium grass roots with few medium and coarse bush roots; pH 8.0; non-effervescent; diffuse gradual boundary to

C1 17-40" Dark reddish brown (5 YR 3/4) moist and dark red (2.5 YR 3/6) dry, loamy fine sand; non sticky and non plastic, very friable

moist, loose dry; few fine roots; pH 8.0, slightly effervescent; many shining quartz particles; diffuse gradual bcundary to

C2 40-60" Same as above except for higher pH and strong effervescence.

Range of characteristics

Colours are consistently dark brown at the surface and dark reddish brown below within a narrow range. The soils are always increasingly more calcareous with depth and strongly calcareous in the subsoil.

Land-use and agricultural potential

This is a deep, well drained soil, potentially suited to a wide range of crops with limitations derived from coarse texture and probable low fertility. Unfortunately, it lies outside the area of effective gravity command. With pump irrigation much of this huge area could be included in a very large irrigation programme.

Site information

a. Soil name: UNIT 115.
b. Higher category classification: Solonetz. Natrargid (4.23). Revised 7th Approximation (1964).
c. Date of examination: 24th March, 1965.
d. Authors: Messrs. N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: Located in the eroded pediment zone at the foot of the Masai Steppe. Ngage area, 26 miles south of the Nyumba ya Mungu Dam, Tanzania.
f. Elevation: 1800-2100 feet.
g. Land form:
   i. Physiographic position: Eroded pedimentary footslopes of the Masai Steppe.
   ii. Surrounding land form: Gently undulating.
   iii. Microtopography: Nil.
h. Slope: Classes 1 to 2. (Mainly 1-3%).
i. Vegetation and/or land-use: Poorer coarse grass with eroded bare patches.

General soil information

a. Parent material: Colluvial well re-distributed sedimentary materials.
b. Drainage: Imperfectly or somewhat poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Eroded throughout the unit.

g. Salinity or alkalinity: Class 3 - soils strongly affected by salt or alkali.
h. Human influence: Nil.

Brief description of the profile

A brown to dark brown deep fine sand and fine sandy loam, imperfectly drained soil with coarse columnar subsoil. pH is consistently 9.6 or higher throughout and the profile has been confirmed by chemical data as being non-saline-alkaline. Very strongly calcareous throughout.

Profile description

A2 0-4" Brown to dark brown (10 YR 4/3) moist and same colour dry, fine sand; structureless; non sticky and non plastic, very friable moist, loose dry; many fine pores; very frequent fine grass roots, both living and dead concentrated within this horizon; pH 9.6; very strongly effervescent; abrupt wavy boundary to

B21 4-12" Olive grey (5 Y 4/2) moist and pale olive (5 Y 6/3) dry with other colours inside the peds, sandy loam; coarse strong columnar; non sticky and slightly plastic, firm moist, hard dry; many small pores; common fine dead roots especially between peds; material from the above horizon has washed down between columnar peds; a highly compacted layer; pH 9.6.; very strongly effervescent; clear irregular boundary to

B22 12-20" Brown to dark brown (7.5 YR 4/2) moist and same colour dry, fine sandy loam; massive breaking to irregular medium blocky; non sticky and slightly plastic, friable moist, hard dry; few fine pores; continuous thick clay cutans along the root channels; few fine dead roots; shining flakes of mica; pH 9.6.; very strongly effervescent.

BC 20-45"+ Brown to dark brown (7.5 YR 4/4) moist and yellowish red (5 YR 4/6) dry, fine sandy loam; massive; slightly sticky and slightly plastic, friable moist, hard dry; pH 9.6.; very strongly effervescent.

Range of characteristics

This is a deep, imperfectly drained soil that is always very highly alkaline. Colours are commonly brown to dark brown. pH ranges between 9.0 and 9.6+.

Land-use and agricultural potential

The soils of this unit are always confined to the lower pedimentary slopes between Unit 114 and the valley flats. They extend as a narrow strip at the

foot of the pediments the length of the Masai Steppe escarpment. These soils are not recommended for irrigation agriculture because of their very high alkalinity. Reclamation would be very expensive.

Site information

a. Soil name: UNIT 120.
b. Higher category classification: Solonetz. Natrargid (4.23). Revised 7th Approximation (1964).
c. Date of examination: March, 1965.
d. Authors: Messrs. N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: Flats below the Masai Steppe, approximately 3 miles west from the Pangani River. Ngage area, 26 miles south of the Nyumba ya Mungu Dam, Tanzania.
f. Elevation: 1800-2100 feet.
g. Land form:
   i. Physiographic position: Valley flats below the pedimentary slopes from the Masai Steppe.
   ii. Surrounding land form: Flat or almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - 0-2% flat or almost flat.
i. Vegetation and/or land-use: Continuous clumpy salt grass vegetation with occasional low bushes. Game grazing.

General soil information

a. Parent material: Alluvial-colluvial materials derived from Basement Complex rocks.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight wind erosion.
g. Salinity or alkalinity: Class 3 - soils strongly affected by salt or alkali.
h. Human influence: Nil.

Brief description of the profile

A deep dark brown over brown to dark brown and dark yellowish brown silt loam over silty clay loam soil. Coarse angular blocky structures overlie a fine angular blocky subsoil. pH increases with depth in the range 8.6 - 9.6. Calcareous at the surface and becoming increasingly more strongly calcareous with depth. Non saline-alkaline.

Profile description

A2 0-2" Dark brown (10 YR 3/3) moist and same colour dry, silt loam; platty; sticky and plastic, friable moist, loose dry; many vesicular pores; frequent fine living roots; pH 8.6.; slightly effervescent; clear wavy boundary to

B21 2-20" Brown to dark brown (7.5 YR 4/2) moist and greyish brown (10 YR 5/2) dry, silty clay loam; coarse sub-angular blocky; breaking to medium sub-angular blocky; sticky and plastic, friable moist, firm dry; many fine and medium pores; common medium and fine grass roots; top soil tends to fill cracks; pH 8.8; strongly effervescent; gradual irregular boundary to

IIB22 20-30" Dark yellowish brown (10 YR 3/3) moist with many dark brown mottling and same colour dry, clay; fine angular blocky; very sticky and very plastic, firm moist, hard dry; few fine pores; thick continuous clay cutans; few fine dead roots; some shells of land snails; cracks stop at the top of this horizon; pH 9.6;. very strongly effervescent; clear wavy boundary to

IIC 30-50"+ Dark reddish brown (5 YR 3/4) moist and same colour dry, clay; fine angular blocky; very sticky and plastic, friable moist, hard dry; few fine pores; thick continuous clay cutans; pH 9.6.; strongly effervescent.

Range of characteristics

A minor soil unit with a consistently uniform range of characteristics not dissimilar from the present profile.

Land-use and agricultural potential

A deep, moderately well drained soil covering a small area in Ngage. Its main limitations derive from its fine texture and high alkalinity. It would require high investment to put into adequate condition for irrigation agriculture. It is not recommended for annual crops and should be left for careful range management or improved pasture.

Site information

a. Soil name: UNIT 125.
b. Higher category classification: Solodized-Solonetz. Alboll (5.2). Revised 7th Approximation (1964).
c. Date of examination: 23rd March, 1965.
d. Authors: Messrs. N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: 3½ miles west of the Pangani River. Ngage area, 26 miles south of the Nyumba ya Mungu Dam, Tanzania.

f. Elevation: 1800-2100 feet.
g. Land form:
  i. Physiographic position: Mainly alluvial plain.
  ii. Surrounding land form: Flat or almost flat.
  iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Open savannah with almost continuous grass cover and with common irregularly scattered low bush. Some bare spots.

General soil information

a. Parent material: Colluvial-alluvial deposits probably re-distributed river deposits.
b. Drainage: Well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight wind erosion.
g. Salinity or alkalinity: Class 2 - soils moderately affected by salt or alkali.
h. Human influence: Nil.

Brief description of the profile

A very dark greyish brown over dark brown and yellowish red silt loam with increasing amount of clay through the A2 and B2 horizons. Coarse platy structures are characteristic of these horizons. There is a narrow range of pH within the profile of 8.2 - 8.4 and the soil is mainly strongly calcareous throughout.

Profile description

A1 0-3" Very dark greyish brown (10 YR 3/3) moist and brown to dark brown (10 YR 4/3) dry, silt loam; structureless; slightly sticky and slightly plastic, very friable moist, loose dry; common fine dead grass roots; surface structure has broken down into a loose condition that is soft under foot; evidence of filled cracks at the surface; pH 8.2; moderately effervescent; abrupt smooth boundary to

A2 3-13" Very dark greyish brown (10 YR 3/2) moist and dark brown (10 YR 3/3) dry with other colours inside the peds; silt loam; coarse columnar breaking to coarse platy; sticky and plastic, very friable moist, slightly hard dry; many fine vesciular pores; few very fine dead grass roots; cracks with filling by loose materials from above; pH 8.4; strongly effervescent clear smooth boundary to

B2 13-35" Dark brown (10 YR 3/3) moist with tongues of yellowish red, very dark greyish brown (10 YR 3/2) dry, silty clay loam; coarse prismatic and internal coarse platy less marked than above; sticky and plastic, friable moist, hard dry; few medium pores; broken thick clay cutans; few fine and medium shrub roots; cracks continue throughout the horizon mainly stopping at the base of this horizon; narrow soil tongues of material similar to the horizon below; pH 8.2; strongly effervescent; abrupt and merging boundary to

C1 35-42" Yellowish red (5 YR 4/8) moist and reddish yellow (7.5 YR 6/8) dry, fine sandy clay loam; massive; sticky and plastic, slightly friable moist, hard dry; many medium and coarse pores; pH 8.2; very strongly effervescent; abrupt smooth boundary to

IIC2 42"+ A horizon of highly effervescent calcium carbonate, impregnated, multi-coloured, red and yellow materials, with some angular and rounded gravels.

Range of characteristics

This unit is considered a minor unit of marginal suitability for irrigation agriculture. The present profile is typical of the soils which have a narrow range of characteristics and are always slightly saline and alkaline.

Land-use and agricultural potential

This is a deep, welldrained soil with limitations of somewhat fine texture ture and alkalinity. Some levelling and reclamation will be needed if ever developed for irrigation. For the time being it is considered suitable for salt-tolerant crops and adapted pasture.

Site information

a. Soil name: UNIT 130.
b. Higher category classification: Alluvial polygenetic. Natrargid (4.23) Revised 7th Approximation (1964).
c. Date of examination: 31st March, 1965.
d. Authors: Messrs. N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: Located on the alkaline bare flats below the Masai Steppe pediments. Ngage area, 26 miles south of the Nyumba ya Mungu Dam, Tanzania.
f. Elevation: 1800-2100 feet.
g. Land form:
    i. Physiographic position: Alluvial-colluvial flats.

ii. Surrounding land form: Flat or almost flat.
iii. Miorotopography: Nil.

h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Salt grass only with very large bare area. Game.

General soil information

a. Parent material: Old river and possibly shallow lake deposits.
b. Drainage: poorly drained.
c. Moisture oonditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rookiness: Nil.
f. Evidenoe of erosion: Nil.
g. Salinity or alkalinity: Class 3 - soils strongly affected by salt or alkali.
h. Human influenoe: Nil.

Brief desoription of the profile

A dark brown over dark reddish brown silt loam over fine sandy loam and clay soil. Reaotion is extremely high and not less than pH 9.6. Strongly calcareous espeoially at the surfaoe. Deep, non-saline - alkaline and slowly permeable. Almost oertainly polygenetic.

Profile description

A1 0-4" Dark brown (10 YR 3/3) moist and light yellowish brown (10 YR 6/4) dry, silt loam; moderate fine platy; non sticky and slightly plastio, friable moist, soft dry; coarse vesicular pores; few very fine dead grass roots; fine organic influenced orusts and minor oracks at the surface to give a playa-like appearanoe; pH 9.6; very strongly effervescent; gradual smooth boundary to

IIC 4-20" Dark brown (10 YR 3/3) moist and same colour dry, fine sandy loam; massive breaking to fine and medium blocky; slightly stioky and plastic, friable moist, hard dry; few pores; few very fine dead roots; pH 9.6; strongly effervescent; clear smooth boundary to

IIIB2b 20-40" Dark reddish brown (5 Y. 3/4) moist and same colour dry, clay; massive, breaking to strong medium blocky; sticky and plastic slightly friable moist, hard dry; few fine pores; patchy clay outans; this seems to be an old B2 horizon buried by more reoent deposits; pH 9.6; very strongly effervescent; clear smooth boundary to

IIIB3b 40"+ As above with inclusions in vein-like strips of olive coloured (5 Y 5/3) materials.

Range of characteristics

The soils do not vary much from the profile quoted.

Land-use and agriculture potential

The soils of this unit have limitations derived from a fine textured subsoil, poor drainage and very high alkalinity. Very high investment will be required to put this soil in a suitable condition for irrigation agriculture.

Site information

a. Soil name: UNIT 132N. For description of 132 see Naururu Detailed Survey Appendix.
b. Higher category classification: Alluvial. Nadurargid (4.24). Revised 7th Approximation (1964).
c. Date of examination: 25th March, 1965.
d. Authors: Messrs. N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: At the foot of Fish Hill near its southern end and approximately 300 yards westward from its base. Ngage area. 26 miles south of Nyumba ya Mungu Dam, Tanzania.
f. Elevation: 1800-2100 feet.
g. Land form:
   i. Physiographic position: Colluvial slope from the "Fish Hill".
   ii. Surrounding land form: Flat or almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Salt bush, salt grass, some shrubs and many bare areas. Game and cattle grazing.

General soil information

a. Parent material: Alluvial and colluvial sediments from the Fish Hill.
b. Drainage: Poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 3 - soils strongly affected by salt or alkali.
h. Human influence: Nil.

Brief description of the profile

This is a poorly drained soil with variable depth to a cemented layer of gravel size material with $CaCO_3$. It is a very dark greyish brown sandy loam soil with a high content in salt and/or alkali. Structures are massive throughout and the subsoil is very compacted. Reaction is in excess of pH 8.7 and increases with depth. Strongly calcareous.

Profile description

A1 0-5" Very dark greyish brown (10 YR 3/2) moist and same colour dry, fine sandy loam; massive; non sticky and slightly plastic, friable moist, loose dry; many fine pores; fine grass roots both alive and dead; pH 8.7; strongly effervescent; gradual diffuse boundary to

C1 5-14" Very dark greyish brown (10 YR 3/2) moist and dark greyish brown (10 YR 4/2) dry, sandy loam; massive breaking to fine granular; slightly sticky and slightly plastic, friable moist, loose dry; many fine pores; few fine roots mainly in the upper part of the horizon; pH 9.4; very strongly effervescent; gradual diffuse boundary to

C2 14-37" Very dark greyish brown (10 YR 3/2) moist and light brownish grey (10 YR 6/2) dry, coarse sandy loam; massive; slightly sticky and slightly plastic, friable moist, loose dry; pH 9.6; very strongly effervescent; this horizon is terminated in a weakly cemented layer of gravel size material similar to this horizon but very compacted.

Range of characteristics

The soils of this unit are poorly to very poorly drained. Depth varies from few inches to 3 feet on a hardened or cemented layer of sandstone with large amounts of calcium carbonate. Colours are variable within the dark greyish brown, brown and pale brown ranges. Vegetation free areas are characteristic. pH is consistently very high throughout the unit in the range 8.7 - 9.6+.

Land-use and agricultural potential

The soils of this unit have limitations derived from their variable depth (usually shallow) poor to very poor drainage and high alkalinity. It would be very expensive to reclaim them and they are best left in their present state with erosion controls.

Site information

a. Soil name: UNIT 133. For description of phases see the Maururu Detailed Survey Appendix.
b. Higher oategory olassifioation: Grumusol. Natraquollio-Mazaquert (2.12-5.35). Revised 7th Approximation (1964).
c. Date of examination: Maroh 1965.
d. Authors: Messrs. N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Looation: Eastern pediments away from Fish Hill towards the Pangani River. Ngage area. 26 miles south of the Nyumba ya Mungu Dam, Tanzania.
f. Elevation: 1800-2100 feet.
g. Land form:
  i. Physiographio position: Very gentle pedimentary slopes away from hill feature.
  ii. Surrounding land form: Flat or almost flat; slightly concave.
  iii. Miorotopography: Gilgai.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Salt grass of a olumpy nature and occasional thorn bushes and small shrubs.

General soil information

a. Parent material: Fine oolluvial-alluvial materials with probable re-sorting of river deposited alluvium.
b. Drainage: Poorly drained.
c. Moisture oonditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rookiness: Nil.
f. Evidenoe of erosion: Nil.
g. Salinity or alkalinity: Class 3 - soils strongly affeoted by salt or alkali.
h. Human influenoe: Nil.

Brief description of the profile

A deep, very dark brown over very dark greyish brown and dark reddish brown, clay soil. Porous, but poorly drained with ooarse angular blooky B2. Strongly oalcareous in the subsoil with pH ranging between 8.6 and 9.3 corresponding to inorease in salinity and alkalinity with depth.

Profile desoription

All 0-5" Very dark brown (10 YR 2/2) moist, clay; strong fine and medium granular; sticky and plastio, friable moist; many pores; abundant fine and medium grass roots oonoentrated as a rough mat within this horizon; the horizon forms a distinct soil-root mass that lifts without breaking; pH 8.6; slightly effervescent; olear wavy boundary to

A12 5-12" Very dark greyish brown (10 YR 3/2) moist and grey (10 YR 5/1) dry; clay; coarse angular blocky with tendency towards prismatic; very sticky and very plastic, firm moist, hard dry; common pores; continuous thick clay cutans; few fine roots; many cracks; pH 8.8; strongly effervescent; clear wavy boundary to

AC 12-32" Dark reddish brown (5 YR 3/2) moist and grey (10 YR 5/1) dry; clay; massive; sticky and plastic, friable moist, hard dry; few fine tubular pores; few fine grass roots; cracks cease at the top of this horizon; pH 9.2; strongly effervescent; clear smooth boundary to

IIC 32-50"+ Brown to dark brown (10 YR 4/3) moist and very pale brown (10 YR 7/3) dry, gravelly sandy clay loam; massive; sticky and plastic, firm moist, hard dry; pH 9.3; moderately effervescent.

Range of characteristics

These soils are very poorly drained. Depth to a petrocalcic layer or unconformed sand layer ranges from 18 inches to more than 30 inches. The colour of the solum is consistent and the topsoil ranges from very dark grey to black. A thin layer of leaves, stems and partly decomposed organic matter covers the undisturbed areas. pH is usually very high within the range 8.6 - 9.6.

Land-use and agricultural potential

At present this land is used for grazing by Masai cattle. Occasionally it is put under cultivation but after one or two years of very poor results due to high salinity and alkalinity it is abandoned. It is strongly recommended not to use this soil for annual crops unless intensive reclamation and drainage improvements are carried out. Recommended for improved pasture.

Site information

a. Soil name: UNIT 134. Includes depth phases: 134Cm, 134Cs and 134CH.
b. Higher category classifioation: Grumusol. Grumaquert (2.11). Revised 7th Approximation (1964).
c. Date of examination: 23rd March, 1965.
d. Authors: Messrs. N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: Approximately 1½ miles from the Pangani River on the right bank. Ngage area. 26 miles south of the Nyumba ya Mungu Dam, Tanzania.
f. Elevation: 1800-2100 feet.
g. Land form:
   i. Physiographic position of the site: Old alluvial plain.

ii. Surrounding land form: Flat or slightly concave with numerous drainage lines.
iii. Microtopography: Gilgai.

h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Mainly swamp grass in open bush country with common thorn clumps and other bushy vegetation. Game area.

General soil information

a. Parent material: Black clay sediments laid down under swampy conditions with an unconformity to a sandy calcium carbonate rich deposit at 3 feet.
b. Drainage: Poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0-1 - soils free or very slightly affected.
h. Human influence: Nil.

Brief description of the profile

A deep, poorly drained, black over very dark grey and dark olive grey, clay soil. Structures are well developed and both blocky and coarse prismatic within the A horizons. Becomes increasingly more calcareous with depth to a very strongly effervescent subsoil. pH is less than 8.3 throughout the profile. Deep cracking, moderately deep rooting, slowly permeable and slightly saline in some parts of the unit.

Profile description

A11 0-3" Black (2.5 Y 2/0) moist and very dark grey (2.5 Y 3/0) dry, clay; medium angular blocky; very sticky and very plastic, firm moist, hard dry; many fine, medium and coarse pores; broken thin clay cutans along old root channels; frequent swamp grass roots with fine ones mainly concentrated in the top few inches; cracks; pH 7.8; very slight effervescence at local points; clear smooth boundary to

A12 3-28" Very dark grey (2.5 Y 3/0) moist with yellowish brown mottling, same colour dry, clay; coarse prismatic breaking to medium and fine prismatic; very sticky and very plastic, very firm moist, hard to very hard dry; few to common pores; continuous thick clay cutans; slickensides; few coarse and medium bush roots and few fine dead roots in the upper part of this horizon; large krotovina inclusions throughout the horizon with occasional gravels; deep crackings; pH 8.2; non effervescent mass with local strongly effervescent spots; clear smooth boundary to

AC 28-38" Dark olive grey (5 Y 3/2) moist and same colour dry, clay; massive breaking to medium angular blocky; sticky and plastic; firm moist, hard dry; few pores; few coarse roots; cracks end near the top of this horizon; pH 8.2; strongly effervescent; abrupt smooth boundary to

IIC 38-48" Yellowish brown (10 YR 5/4) moist and very pale brown (10 YR 7/3) dry, loamy coarse sand; massive; non sticky and non plastic, firm moist, hard dry; pH 8.2; very strongly effervescent.

Range of characteristics

This soil is consistent in colour and clay texture. pH increases with depth and usually ranges from 7.0 to 8.5. Sometimes recent deposits of fine alluvial sediments of lighter colour are to be found on top of the black clay. A petrocalcic layer occurs at depths varying between a few inches and more than 30 inches and on this basis depth phases were established during the Naururu Detailed Soil Survey.

Similar and associated soils

Inclusions of similar soils with high salinity status occur and also occasional soils with sandy layers.

Land-use and agricultural potential

The main limitations for the extensive use of this soil are its fine texture, poor drainage and variable depth to the petrocalcic layer. Its potential for agriculture is good but careful management will be an important consideration.

Site information

a. Soil name: UNIT 139. Includes Units 139w and 139u.
b. Higher category classification: Humic-Gley. Haplaquoll (5.31). Revised 7th Approximation (1964).
c. Date of examination: 30th March, 1965.
d. Authors: G. Robinson and G. R. Suggett.
e. Location: Gitengene Village, Naururu, 25 miles west of Same, Tanzania.
f. Elevation: 2045-2070 feet.
g. Land form:
   i. Physiographic position: Floodplain of the Naururu River.
   ii. Surrounding land form: Flat, slightly concave.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Mainly grassy vegetation with only occasional small clumps of trees on water courses.

General soil information

a. Parent material: Alluvial clays.
b. Drainage: Poorly to very poorly drained.
c. Moisture conditions: Moist throughout most of the year.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 2 - soils moderately affected by salt or alkali. Some of the variants included in this broad soil unit are strongly affected and other variants are salt free. In Ngage some of these soils are cultivated for rice.
h. Human influence: Nil.

Brief description of the profile

A deep black, over dark grey and dark greyish brown clay soil with organic surface horizon. Well developed throughout the profile with angular blocky structures. May be saline and/or alkaline.

Profile description

A1	0-2"	A highly organic clay, heavily rooted horizon with medium and fine angular blocky structure, closely held together by many living and dead grass roots; considerable iron accumulation in the larger root channels; pH 8.2; non effervescent; clear smooth boundary to
B21	2-9"	Black (7.5 YR 2/0) moist, clay; strong medium and coarse angular blocky; very sticky and plastic, friable moist; few pores; continuous thick clay cutans; slickensides; few fine roots mostly dead; pH 8.4; clear smooth boundary to
B22	9-18"	Dark grey (5 Y 4/1) moist, clay; weak fine and medium angular blocky; very sticky and plastic, friable moist; continuous thick clay cutans; pH 8.6; gradual boundary to
C1	18-36"	Dark greyish brown (10 YR 4/2) moist, clay; sticky and plastic, friable moist; few old dead roots with dark greenish grey (5 GY 4/1) accumulations; some polished round sand size particles in the lower part of this horizon; pH 8.6; gradual smooth boundary to
IIC2	36-48"	Dark greyish brown (10 YR 4/2) moist, clay; few pores; some coarse sand size polished particles; pH 9.2.

Range of characteristics

Surface colours are always black or dark grey. All horizons contain variable amounts of organic matter and may be humic. Subsoil colours are

within the range dark grey to very dark greyish brown. Textures are always clay or silty clay. Coarse blocky or columnar structures occur to the surface and surface cracking is generally shallow but common. pH ranges between 8.2 and 9.6.

Similar and associated soils

This is a broad soil unit which includes wet variants and upland ones not subject to flooding.

Land-use and agricultural potential

These soils range from almost alkaline free to very alkaline. They are only cultivated in very small areas in Ngage for rice. Main limitations are seasonal flooding (which is assumed will be under control with the completion of the Nyumba ya Mungu Dam), fine texture, poor to very poor drainage and very alkaline areas. The better soils may do well with rice, and after improvement of the drainage other crops could be experimented with.

Site information

a. Soil name: UNIT 145.
b. Higher category classification: Alluvial. Haplorthent (1.53). Revised 7th Approximation (1964).
c. Date of examination: May 1965.
d. Authors: Messrs. N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Naururu, 100 yards southwest of milestone 6 (topographical map); 25 miles southwest of Same, Tanzania.
f. Elevation: 2045-2070 feet.
g. Land form:
   i. Physiographic position: Alluvial flats.
   ii. Surrounding land form: Flat or slightly concave.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Acacia trees, solanacea, and low thorn bush. Cultivated with maize, banana, cotton and cassava.

General soil information

a. Parent material: River alluvial sediments underlain by a hardened caliche-like layer.
b. Drainage: Well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - soils free of excess salt or alkali.

h. Human influence: Masai cattle grazing. Intensively cultivated under local irrigation without special management practices.

Brief description of the profile

This is a medium to deep soil grading through black, very dark greyish brown, brown and dark brown to a petrocalcic layer. Mainly weakly developed. Non-saline-non-alkaline with pH below 8.5. Silt loam over sandy loam textures.

Profile description

A1	0-8"	Black (10 YR 2/1) moist and dark grey (10 YR 4/1) dry, silt loam; weak granular; slightly sticky and slightly plastic, friable moist, soft dry; many pores; very frequent fine roots and common medium and coarse ones; pH 7.8; non effervescent; gradual wavy boundary to
AC	8-15"	Very dark greyish brown (10 YR 3/2) moist and light brownish grey (10 YR 6/2) dry, gritty sandy loam; fine sub-angular blocky; slightly sticky and slightly plastic, friable moist, slightly hard dry; common pores; few small roots; pH 8.5; very strongly effervescent; gradual wavy boundary to
C1	15-40"	Brown (10 YR 5/3) moist and light grey (10 YR 7/2) dry, gritty sandy loam; massive; slightly sticky and slightly plastic, firm moist, hard dry; pores nil, roots nil; pH 8.5; very strongly effervescent.
C2	40-60"+	Dark brown (10 YR 4/3) moist and pale brown (10 YR 6/3) dry, loamy fine sand; massive; non sticky and non plastic, friable moist, hard dry; pH 8.4; non effervescent.

Range of characteristics

The depth of this soil on top of a petrocalcic layer ranges from few inches to more than 30 inches. The dominant texture is silt loam but some inclusions of silty clay loam and clay loam layers occur. In the vicinity of the petrocalcic layer the dominant textures are gritty sandy loam. Colours do not vary substantially from the profile quoted, pH ranges from 7.0 to 8.5.

Land-use and agricultural potential

This is a very good agricultural soil, extensively used for regular crop production under irrigation. Its main limitation is depth which may vary over short distances. The dominant crops being cultivated are cotton, maize, banana, sugar cane and cassava.

Site information

a. Soil name: UNIT 146, includes variants 146B and 146K and depth phases: 146d, 146m, 146s and 146H.
b. Higher category classification: Rendzina-like. Typic Rendoll (5.110). Revised 7th Approximation (1964).
c. Date of examination: Various dates.
d. Authors: Messrs. N. Mikenberg, G. R. Suggett, F. J. Ijserinkhuijsen and A. Hoekstra.
e. Location: Naururu Pilot Irrigation Scheme; 25 miles southwest of Same, Tanzania. (See Naururu Detailed Survey Appendix for phases).
f. Elevation: 2045-2070 feet.
g. Land form:
   i. Physiographic position: Valley bottom.
   ii. Surrounding land form: Flat with scattered drainage lines.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Big Acacia trees, small shrubs and grass forming a dense parkland vegetation. Cultivated near Naururu under irrigation.

General soil information

a. Parent material: Calcareous alluvial sediments of the Pangani floodplain.
b. Drainage: Well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - soils free of excess salt or alkali.
h. Human influence: Partly cultivated without special management practices.

Brief description of the profile

This is a very broad soil unit which includes depth phases and saline and alkaline variants. Usually silty clay and silty clay loam textures underlain by a petrocalcic horizon. The dominant colours are black and very dark grey and the profile is usually effervescent throughout.

Profile description

For a typical profile description see in the Naururu Detailed Soil Survey Appendix, profile 146m.

Range of characteristics

In the Ngage area variants of this soil unit were mapped. Unit 146B has some evidence of B2 horizon development, with increasing amounts of clay and is slightly saline. Unit 146K has a marked clay accumulation in the B2 horizon

and is very alkaline. Both these variants in more detailed soil studies will have to be separated. In the area surveyed in detail in Naururu phases were mapped on the basis of depth of soil on top of the petrocalcic layer. Deep, medium, shallow and very shallow phases occur.

Land-use and agricultural potential

The average Unit 146 soil is without major limitation for irrigation agriculture. The different depth phases have increasing hazards and adequate management should be provided accordingly. The variant 146B is only suitable for adapted crops with careful management and 146K is not recommended for annual crops unless heavy investment is made to reclaim the soils and improve the drainage.

Site information

a. Soil name: UNITS 147 and 147G.
b. Higher category classification: Intergrade between Humic-Gley and Alluvial. Haplaquoll (5.31). Revised 7th Approximation (1964).
c. Date of examination: 26th March, 1965.
d. Authors: N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: Due west of the tail of Fish Hill, towards the Masai Steppe, approximately 3 miles west of the Pangani River. 26 miles south of the Nyumba ya Mungu Dam, Tanzania.
f. Elevation: 1800-2100 feet.
g. Land form:
   i. Physiographic position: Alluvial swamp lands.
   ii. Surrounding land form: Flat, slightly concave.
   iii. Microtopography: Artificial uneven microtopography with deep holes due to poaching by elephants.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Short coarse swamp grass with occasional thorn trees. Very open parkland.

General soil information

a. Parent material: Alluvial black clay overlying grey caliche-like materials.
b. Drainage:- Poorly to very poorly drained.
c. Moisture conditions: Partly moist.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: 147 Class 0 - soils free of excess salt and alkali. 147G Class 2 - soils moderately affected by salt or alkali.
h. Human influence: Nil.

Brief description of the profile

A deep, clayey, poorly to very poorly drained soil with black over very dark brown horizons underlain by very dark greyish brown and dark brown. In the deep subsoil a caliche-like layer is usually present. Unit 147 is salt free but 147G is affected by salts.

Profile description

A0 +1.5-0" Mainly a root mat of fine roots inoorporated with the mineral soil material, undecomposed leaves.

A11 0-6" Black (10 YR 2/1) moist and same colour dry, clay; coarse blocky to prismatic; very sticky and plastic, extremely firm moist, hard dry; few pores; few fine roots mainly confined to cracks; few fine dead roots; cracked through the horizon; pH 7.5; non effervescent; gradual smooth boundary to

A12 6-14" Very dark brown (10 YR 2/2) moist and same colour dry, with dark brown mottling, clay; coarse prismatic; very sticky and plastic, extremely firm moist, hard dry; few pores; patchy thin clay cutans; very few roots mainly along cracks; largest cracks pass through this horizon; pH 7.6; effervescent only at spots; clear smooth boundary to

A13 14-24" Very dark greyish brown (10 YR 3/2) moist with small, pale brown concretions; clay; coarse angular blocky; sticky and plastic, firm moist, hard dry; few fine pores; patchy moderately thick clay cutans; few very fine dead roots; wide cracks coming from the top go through this horizon; pH 7.6.

AC 20-42" Dark brown (10 YR 3/3) moist with some very dark grey and black streaks; and same colour dry, clay; massive breaking to irregular blocks; sticky and plastic, firm moist, hard dry; gradual wavy boundary to

IIC 42"+ Brown to dark brown (10 YR 4/3) moist and very pale brown (10 YR 7/3) dry, loamy sand to sandy loam; massive; some fine concretions; pH 7.8; strongly effervescent.

Range of characteristics

This is a broad soil unit which includes phases 147 and 147G, both of them clayey soils. There is more evidence of development in 147G (the profile description belongs to a typical 147). Usually these are deep soils, poorly and sometimes very poorly drained, with deep cracks. Cclours range between very dark greyish brown, very dark grey andblack. pH are over 7.0 in the 147 and highly alkaline in the 147G. Drainage lines are common as well as a characteristic artificial microtopography produced by poaching by elephants.

Land-use and agricultural potential

This is a poorly drained fine textured soil. The soil Unit 147G is very alkaline. Heavy investments would be required to reclaim these soils and improve their drainage. They are of marginal suitability for agriculture.

Site information

a. Soil name: UNITS 151 and 152.
b. Higher category classification: Regosol. Quartzipsamment (1.X2). Revised 7th Approximation (1964).
c. Date of examination: 24th March, 1965.
d. Authors: Messrs. N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: Sandy ridges on the alluvial-colluvial plain. Ngage. 26 miles south of the Nyumba ya Mungu Dam, west of the Pangani River, Tanzania.
f. Elevation: 1800-2100 feet.
g. Land form:
   i. Physiographic position: Sandy ridges on the alluvial-colluvial plain.
   ii. Surrounding land form: Undulating convex slopes of sandy ridges (old river levees?).
   iii. Microtopography: Narrow ridges.
h. Slope: Class 2 - gently sloping (0-6%).
i. Vegetation and/or land-use: Salt bush, other various bushes and low trees and some grass, with several bare patches.

General soil information

a. Parent material: Sandy and gravelly river deposits.
b. Drainage: Well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil to slight, mainly accumulation.
g. Salinity or alkalinity: Ranges from Class 0 - soils free of excess salt or alkali to Class 2 - soils moderately affected by salt or alkali.
h. Human influence: Nil.

Brief description of the profile

This is a very irregular mapping unit including a large variety of different soils, which have in common their position on narrow meandering ridges, which are the remnants of old river levees. They are dominantly sand, with variable levels of salinity. The profile described is a deep, sandy, well drained soil from the Ngage area which is slightly saline. The pattern of

its distribution is very intricate and difficult to show at the semi-detailed level of survey.

Profile description

AC 0-14" Very dark greyish brown (10 YR 3/2) moist and brown (7.5 YR 5/4) dry, loamy coarse sand; structureless; non sticky and non plastic, very friable moist, loose dry; many vesicular pores; frequent fine and very fine roots throughout the horizon; pH 8.0; very strongly effervescent; clear smooth boundary to

C 14-30"+ Dry gives mixed colours of variable coarse sands and gravels, fine gravelly coarse sand; structureless; loose dry; common very fine grass roots and few medium woody roots; pH 8.0; very strongly effervescent; stratified water deposited materials.

Range of characteristics

The ridge sites where this soil is always located are variable in size, width and distribution. Some members of this mapping unit are finer textured and highly saline. The soils also range in texture according to their position on the ridge feature, the most sandy members being at the highest elevation. Colours are variable and the common ones are in the range of very dark brown to brown, pale brown and dark brown. Mainly massive or very weak structured.

Land-use and agricultural potential

Notwithstanding that some of these soils could be cropped their variability and irregular distribution make it impossible to develop a special programme for their use. They could be included with neighbouring soils in an irrigation development programme after much levelling.

SOIL ANALYSES TABLE IV

NAURURU AND NGAGE SEMI-DETAILED SURVEY

UNIT No.	Depth Inches	pH in Water 1:1 W/V	pH in Water 1:5 W/V	Conductivity 1:5 W/V millimhos at 25° C	Calcium carbonate per cent	Organic carbon per cent	Total extracted by N ammonium acetate milliequivalent per 100 g soil Sodium	Total extracted by N ammonium acetate milliequivalent per 100 g soil Potassium
114	0-17	7.4	7.6	0.02	1	0.23	0.8	0.8
	17-40	9.0	9.5	0.14	1	0.08	1.5	0.9
115	0-4	9.6	9.8	0.20	2	0.12	2.1	TRACE
	4-12	10.6	10.6	2.60	4	0.11	16.1	0.1
	12-20	10.5	10.6	6.0	8	0.09	30.4	0.1
	20-45	10.2	10.4	2.90	6	-	16.1	0.1
120	0-2	8.6	9.6	0.30	5	0.96	7.4	3.6
	2-20	9.5	10.2	1.00	6	0.46	24.8	2.8
	20-30	10.0	10.4	1.80	7	0.21	28.7	2.6
	30-50	10.2	10.4	3.40	9	-	33.9	1.3
125	0-3	8.3	8.9	0.16	5	0.61	1.7	2.7
	3-13	8.1	9.1	0.18	5	0.55	2.0	2.7
	13-35	8.6	9.6	0.40	5	0.53	7.8	2.6
	35-42	8.3	9.2	0.90	7	-	10.4	3.3
130	0-4	10.0	10.5	1.56	12	0.28	18.3	1.5
	4-20	10.4	10.6	9.0	12	0.25	47.8	2.0
	20-40	10.3	10.4	6.0	12	0.03	35.7	1.8
132N	0-5	10.5	10.6	9.0	9	0.96	71.3	20.5
	5-14	10.4	10.6	4.00	8	0.40	43.5	15.4
	14-47	10.4	10.6	4.00	8	0.16	45.2	14.8
133	0-5	8.0	8.8	0.18	4	1.18	3.9	8.4
	5-12	8.2	9.8	0.12	8	0.61	15.2	9.5
	12-32	9.9	10.4	1.48	6	0.53	33.9	11.6
	32-50	9.6	10.4	1.50	9	-	32.2	8.2
139u	0-4	6.6	7.6	0.65	3	6.45	6.7	3.1
	4-14	9.0	9.9	1.58	8	1.10	23.0	6.4
	14-36	9.4	10.2	2.00	8	0.07	20.4	6.5
	36 +	9.4	10.0	1.10	10	0.19	14.8	4.5
139 w	0-4	8.2	8.8	-	8	3.92	18.3	4.5
	4-14	9.4	10.2	2.40	10	1.73	22.6	6.9
	14-36	9.5	10.3	2.05	10	0.70	23.5	6.0
146B	0-4	7.3	8.4	0.12	3	2.13	10.9	5.0
	4-12	7.4	9.6	0.58	5	1.51	13.0	4.7
	12-20	9.8	10.4	1.35	8	0.36	27.0	5.8
	20-36	9.6	10.4	1.45	5	-	25.6	2.9
146K	0-5	7.2	8.8	0.12	4	3.60	2.0	4.9
	5-15	9.2	10.3	1.40	8	0.85	22.6	6.8
	15-20	9.9	10.4	1.45	12	0.28	38.3	9.6
147	+1.5-0	7.0	7.0	0.40	-	10.9	1.6	4.8
	0-6	7.0	7.6	0.10	3	1.33	1.0	3.3
	6-14	7.7	8.3	0.10	3	0.66	1.0	2.5
	14-24	8.0	8.6	0.12	4	0.70	1.0	2.6
	24-42	7.8	8.6	0.16	6	-	1.1	2.7
	42 +	8.4	9.0	0.17	9	-	1.8	5.0
147G	0-4	8.4	9.2	0.24	5	0.87	-	5.0
	4-11	8.2	9.8	0.58	5	0.60	12.0	4.4
	11-26	9.3	10.0	4.00	7	0.49	39.1	6.0
	26-30	10.0	10.4	4.00	9	-	36.5	3.7

NOTES:

1. All analyses were determined before July 1965.

2. Calcium carbonate values are estimates by acid neutralization.

3. The values for sodium extracted with N ammonium acetate (at pH 7.0) include water soluble sodium. Since water soluble potassium is normally very small, the values for potassium are approximate estimates of exchangeable potassium.

4. Calcium carbonate, organic carbon and cations extracted with N ammonium acetate are calculated on air-dry soil.

5. A dash (-) indicates that the analysis was not done or the result was not reliable.

A P P E N D I X V

NAURURU DETAILED SURVEY

Site information

a. Soil name: UNIT 132.
b. Higher category classification: Solonetz - Mazic Nadurargid (4.24-M) Revised 7th Approximation (1964).
c. Date of examination: 1st September, 1966.
d. Authors: Messrs. N. Mikenberg and A. Hoekstra.
e. Location: Naururu Irrigation Scheme. 20 miles west of Same, Tanzania, 40 yards south of B2250 on the topographical map.
f. Elevation: 2058 feet.
g. Land form:
   i. Physiographic position: Valley bottom.
   ii. Surrounding land form: Flat. Land slopes very gently east to west, towards the river.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat.
i. Land-use: Masai cattle grazing.

General soil information

a. Parent material: Calcareous alluvials of the Pangani floodplain.
b. Drainage: Class 0 - very poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight wind erosion.
g. Salinity or alkalinity: Class 3 - soils strongly affected by salt and/or alkali.
h. Human influence: Nil.

Brief description of the profile

Shallow dark greyish brown sandy loam underlain by a hardened layer of sandstone enriched with calcium carbonate. Very strongly alkaline, weak laminar A2 on top of a columnar B2 with patchy discontinuous organic matter cutans. Inclusions of medium and deep soils. Sparsed shrubs and isolated xerophitic trees in an extensive bare landscape.

Profile description

A2 0-2" Very dark greyish brown (10 YR 3/2) moist and greyish brown (10 YR 5/2) dry, sandy loam, moderate coarse platy; non sticky and non plastic, very friable moist, soft dry; common fine vesciular pores; few quartz particles and fine gravels; very few medium roots; pH 9.4; very strongly effervescent; abrupt, smooth boundary to

B2 2-10" Dark greyish brown (10 YR 4/2) moist and brown to dark brown (10 YR 4/3) dry, gritty fine sandy loam; strong fine columnar;

firm moist, very hard dry; patchy thin organic matter cutans; pH 9.6; very strongly effervescent; very hard compacted peds cemented with calcium carbonate; diffuse irregular boundary to

C 10"+ Yellowish brown (10 YR 5/4) moist and pale brown (10 YR 6/3) dry; massive, compacted, difficult to penetrate by auger, cemented with calcium carbonate; pH 9.4+; very strongly effervescent.

Range of characteristics

The soils of this unit are very poorly drained and very shallow to shallow on a hardened or cemented layer of sandstone with a large amount of calcium carbonate forming a petrocalcic layer. Horizon colours are consistently in the greyish brown (10 YR 5/2) range. Texture is variable and ranges from fine sandy loam to silt loam and in the deep inclusions there may be a layer of loam or clay loam on top of the regular sequence. The platy vesicular top horizon ranges in depth from less than $\frac{1}{2}$ inch to 3-4 inches. The soil occurs in huge flat areas with a characteristic landscape of extensive bare lands with only scattered low shrubs of a xerophitic nature.

Similar and associated soils

The soil units occurring in the vicinity are very easy to distinguish from the 132. The 133 and 134 soils are very heavy clay Grumusols. The other Units (145 and 146) of medium texture are not saline or alkaline.

Land-use and agricultural potential

This is probably one of the worst soils of the whole area. Its very high alkalinity together with its extreme shallowness is reflected in the very poor vegetation. The dry condition of the area together with the lack of cover exposes this soil to wind erosion which is increased by the continuous crossing of large herds of cattle.

This Unit is not recommended for agricultural development. At the best the soils should be protected by allowing the natural vegetation to recover and carrying on a very careful range management programme.

Site information

a. Soil name: UNIT 133.
b. Higher category classification: Grumusol. Natraquollic Mazaquert (2.12-5.35). Revised 7th Approximation (1964).
c. Date of examination: 2nd September, 1966.
d. Authors: Messrs. N. Mikenberg and A. Hoekstra.
e. Location: Naururu Irrigation Scheme. 20 miles west of Same, Tanzania. 40 yards west of D4500 on topographical map.

f. Elevation: 2056 feet.
g. Land form:
  i. Physiographic position: Valley bottom.
  ii. Surrounding land form: Flat, with numerous drainage lines, slightly concave. The land slopes very gently east-west towards the river.
  iii. Microtopography: Gilgai.
h. Slope: Class 1 - flat to almost flat.
i. Land-use: Open parkland. Masai cattle grazing.

General soil information

a. Parent material: Calcareous fine alluvial sediments of the Pangani floodplain.
b. Drainage: Class 0 - very poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 2 - soils moderately affected by salt or alkali.
h. Human influence: Overgrazing; some of the soils of this unit formerly cultivated under irrigation were abandoned after an increase in alkaline conditions.

Brief description of the profile

This is a deep, very poorly drained, dark grey to black heavy clay soil. At depth it may be underlain by a petrocalcic layer or layers of sand from alluvial origin forming a lithological discontinuity. Frequent fine and very fine dead roots are included in the soil peds. In the dry season cracking is common and material from the topsoil can be found in the bottom of the cracks. Most of the roots are concentrated in the top 20 inches.

Profile description

A1 0-5" Very dark grey (10 YR 3/1) moist and dark grey (10 YR 4/1) dry, clay; strong medium sub-angular blocky; very sticky, very plastic, friable moist, hard dry; common fine interstitial pores; fine and medium roots; pH 8.0; very strongly effervescent with HCl; gradual wavy boundary to

AC 5-18" Very dark grey (10 YR 3/1) moist and black (10 YR 2/1) dry, clay; strong coarse prismatic breaking to coarse angular blocky; very sticky, very plastic, firm moist, hard dry; many fine interstitial and common medium tubular pores; thick continuous clay cutans; few medium roots, frequent dead fine roots; slickensides; pH 9.0; strongly effervescent with HCl; abrupt smooth boundary to

C1 18-30" Brown to dark brown (10 YR 4/3) moist and very pale brown (10 YR 7/3) dry, sandy clay loam, massive; sticky and plastic, friable moist, soft dry; few interstitial fine pores; roots nil; cutans nil; some vertical streaks of powdery oalcium carbonate; pH 8.8; strongly effervescent with HCl; diffuse irregular boundary to

IIC2 30-48" Dark grey (10 YR 4/1) moist and grey (10 YR 5/1) dry, loose sand with small gravels; few fine roots; pH 8.2; non effervescent; gradual irregular boundary to

IIIC3 48-60" Increasing amount of gravels of a larger size with coarse sand like old riverbed deposits; pH 7.2; non effervescent.

Range of characteristics

The soils of this unit are very poorly drained. The depth to a petrocalcic layer or unconformed sand layer is more than 30 inches. The colour of the solum is consistent and the topsoil ranges from very dark grey (10 YR 3/1) to black (2.5 Y 2/0). A thin O1 layer of leaves, stems and organic partly decomposed residues covers the undisturbed areas. Reaction ranges from 8.6 to more than9.6 in the A and AC horizons.

Similar and associated soils

This soil unit is very similar to Unit 134 and its depth phases. The main difference is the very high pH of Unit 133. A shallower phase of Unit 133 called Unit 133C has a petrocalcic layer at depths of less than 30 inches. Other soil units of this area like 145, 146 and 132 never reach heavy clay in their range of textures.

Land-use and agricultural potential

At present this soil is only used for grazing. Very occasionally it is put under cultivation, but after one or two years of very poor results due to its high salinity and alkalinity status it is usually abandoned and left in much worse condition. It is strongly reoommended not to use these soils for regular crops under irrigation without improvements. The main limitations are the high salinity and/or alkalinity status and the poor drainage conditions. Both limitations should be overoome before a regular programme with annual cropping is established. For the time being some tolerant crops could be experimented with, as well as a programme for adapted pasture.

Site information

a. Soil name: UNIT 133C.
b. Higher category classification: Grumusol. Natraquollic - Mazaquert (2.12-5.35). Revised 7th Approximation (1964).
c. Date of examination: 2nd September, 1966.
d. Authors: Messrs. N. Mikenberg and A. Hoekstra.
e. Location: Naururu Irrigation Scheme. 20 miles west of Same, Tanzania. 40 yards east of E250 on the topographical map.
f. Elevation: 2059 feet.
g. Land form:
   i. Physiographic position: Valley bottom.
   ii. Surrounding land form: Flat with numerous drainage lines, slightly concave, land slopes very gently east-west towards the river.
   iii. Microtopography: Gilgai.
h. Slope: Class 1 - flat or almost flat.
i. Land-use: Nil.

General soil information

a. Parent material: Calcareous fine alluvial sediments of the Pangani floodplain.
b. Drainage: Class 0 - very poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 2 - soils moderately affected by salt or alkali.
h. Human influence: Nil.

Brief description of the profile

The main difference of this soil and the 133 is the presence of a petro-calcic layer at variable depths ranging from 10 to 30 inches. The dominant depth to such layer is 18 to 30 inches with inclusions of shallower ones.

Profile description

A1 0-6" Black (10 YR 2/1) moist with many medium distinct brown (10 YR 5/3) mottles and very dark grey (10 YR 3/1) dry, clay; strong medium sub-angular blocky; very sticky, very plastic, friable moist, slightly hard dry; many fine interstitial and common fine and medium tubular pores; cutans nil; common fine and medium roots; pH 9.0; very strongly effervescent with HCl; gradual irregular boundary to

AC 6-19" Very dark grey (10 YR 3/1) moist with many coarse prominent mottles dark brown and same colour when dry, clay; strong coarse angular blocky; very sticky, very plastic (slippery), friable moist, moderately hard dry; many fine interstitial and fine tubular pores; common medium roots; moderately thick broken clay cutans; increasing amount of mottles and frequent fine dead roots inside the peds; pH 9.4; very strongly effervescent; abrupt smooth boundary tc

C 19-30" Yellowish brown (10 YR 5/4) moist and very pale brown (10 YR 7/3) dry; massive cemented continuous layer, high calcium carbonate content; some pockets of soft material and tongues of the upper horizon coming through; very few roots reach this layer.

Range of characteristics

Depth to the petrocalcic horizon ranges from 10 to 30 inches. Colour and texture of horizon is consistent and pH ranges from 8.6 to 9.6.

Similar and associated soils

Depth to the caliche-like layer, high alkalinity and fine texture are characteristics of this soil which can easily be differentiated from other soils in this area.

Land-use and agricultural potential

Everything which is being said for soil Unit 133 can be applied to this phase; however, being a shallower soil with limitations for root penetration, the risk of using it under careless management practices is greater.

Site information

a. Soil name: UNIT 134.
b. Higher category classification: Grumusol. Typic Mazaquert - 2.120. Revised 7th Approximation (1964).
c. Date of examination: 31st August, 1966.
d. Authors: Messrs. N. Mikenberg and A. Hoekstra.
e. Location: Naururu Irrigation Scheme. 20 miles west of Same, Tanzania. 80 yards east of D2250 on topographical map.
f. Elevation: 2057 feet.
g. Land form:
   i. Physiographic position: Valley bottom.
   ii. Surrounding land form; Flat with numerous drainage lines, slightly concave, land slopes very gently east-west towards the river.

iii. Microtopography: Gilgai.

h. Slope: Class 1 - flat to almost flat.

i. Land-use: Masai cattle grazing. Large areas of grass land surrounded by irregular islets of parkland.

General soil information

a. Parent material: Calcareous fine alluvial sediments of the Pangani floodplain.

b. Drainage: Class 2 - imperfectly drained.

c. Moisture conditions: Dry throughout.

d. Groundwater depth: Unknown.

e. Stoniness or rockiness: Nil.

f. Evidence of erosion: Nil.

g. Salinity or alkalinity: Class 0-1 - soils free or very slightly affected by salts or alkali.

h. Human influence: Some cattle grazing; further north this soil is cultivated under irrigation.

Brief description of the profile

This is a deep, imperfectly drained, fine textured soil. Black colours grade through very dark grey and brown in the subsoil. Deep cracking occurs during the dry season. A thick grassland vegetation is characteristic with frequent drainage lines which are the remnants of old river meanders filled with fine sediments.

Profile description

A1 0-1" Black (7.5 YR 2/0) moist and very dark grey (10 YR 3/1) dry, loam; weak fine granular; slightly sticky, slightly plastic, friable moist, loose dry; many very fine discontinuous vesicular pores; frequent fine and very fine and few medium roots; partly decomposed organic residum; pH 7.0; effervescence nil; abrupt smooth boundary to

AC 1-14" Black (10 YR 2/1) moist and dark grey (10 YR 4/1) dry, clay; coarse prismatic breaking to medium angular blocky; very sticky, very plastic, firm moist, very hard dry; many fine discontinuous interstitial and common fine continuous tubular pores; continuous moderately thick clay cutans; frequent fine roots; very frequent fine dead roots included in the peds; vertical cracking with material from the top; pH 7.8; non effervescent; clear wavy boundary to

C1 14-30" Very dark grey (10 YR 3/1) moist, with many medium distinct greyish brown mottles and grey (10 YR 5/1) dry, clay; fine sub-angular blocky; sticky and plastic, friable moist, slightly hard dry; cutans nil; few very fine discontinuous

interstitial pores; few fine roots; pH 8.2; strongly effervescent; abrupt smooth boundary to

C2 30-50"+ Brown (10 YR 5/3) moist and very pale brown (10 YR 7/3) dry, massive hard compacted horizon with calcium carbonate; pores inside the peds; pH 8.0; very strongly effervescent.

Range of characteristics

This soil phase is deep and imperfectly drained. Colour and texture of the different horizons is quite consistent with slight changes. pH increases with depth and ranges from 7.0 to 8.5. Sometimes recent deposits of fine alluvial sediments with colours in the vicinity of very dark grey (10 YR 3/1) may be found on top of the black clay. A few inclusions of silty clay with similar ranges of colour were registered.

Similar and associated soils

This is the deep phase of soil Unit 134. The other phases of the same soil unit are classified according to the depth to the petrocalcic layer. The other fine textured soil of the area, the 133, have always pHs higher than 8.6. The remainder of the soils of this area have medium or slightly fine textures.

Land-use and agricultural potential

The main limitation to the extensive use of this soil is its fine texture and imperfect drainage. Further north in the same Naururu area this soil is regularly under cultivation with fair results. It can be used for many adapted crops, namely, rice, cotton, sugar cane, various vegetables, pasture and fruit trees. With adequate control of drainage the range of adapted crops could be much increased.

Site information

a. Soil name: UNIT 134CH.
b. Higher category classification: Alluvial-Grumusol intergrade, Lithic Haplorthent - (1.53-L). Revised 7th Approximation (1964).
c. Date of examination: 31st August, 1966.
d. Authors: Messrs. N. Mikenberg and A. Hoekstra.
e. Location: Naururu Irrigation Scheme. 20 miles west of Same, Tanzania. 80 yards northwest of C750 on topographical map.
f. Elevation: 2059 feet.
g. Land form:
   i. Physiographic position: Valley bottom.
   ii. Surrounding land form: Flat with scattered drainage lines, slightly convex.

iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat.
i. Land-use: Nil.

General soil information

a. Parent material: Calcareous fine alluvial sediments of the Pangani floodplain.
b. Drainage: Class 0 - very poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Some hardened limestone outcrops.
f. Evidence of erosion: Slight sheet erosion.
g. Salinity or alkalinity: Class 0-1 - soils free or slightly affected by salt or alkali.
h. Human influence: Nil.

Brief description of the profile

This is a very shallow soil on top of a hard continuous layer of sandstone cemented with calcium carbonate.

Profile description

A1 0-1/11" Black (7.5 YR 2/0) moist and very dark grey (10 YR 3/1) dry, silty clay loam; weak fine sub-angular blocky; sticky and plastic, friable moist, soft dry; many fine interstitial pores; frequent fine and medium roots; some cemented outcrops can be seen and roots of trees extending horizontally; pH 6.6; non effervescent; abrupt smooth boundary to

AC 1/11-11" Very dark grey (10 YR 3/1) moist and same colour when dry; strong medium angular blocky; sticky and plastic, friable moist and hard dry; patchy moderately thick clay cutans; common fine interstitial and common fine random tubular pores; pH 7.0; non effervescent; abrupt smooth boundary to

C 11"+ Dark greyish brown (10 YR 4/2) moist and greyish brown (10 YR 5/2) dry, massive, hard cemented layer weathered along cracks with earth material and roots between; pH 7.2; very strongly effervescent.

Range of characteristics

Depth of this soil phase varies from 0 to 12 inches. This is the very shallow member of the 134 series. Clay texture is dominant but some inclusions of silty clay were registered. pH ranges from 6.6 to 7.8.

Similar and associated soils

This soil is usually restricted to small areas on a slightly convex position and are associated with the deeper member of the series.

Land-use and agricultural potential

This soil cannot be used for regular crop growing. It is very shallow. Some trees and scattered grasses show that it is probably adaptable to careful range management programme. Most of the area has no vegetation at present. Recommended for permanent buildings within the development scheme.

Site information

a. Soil name: UNIT 134Cm.
b. Higher category classification: Grumusol. Typic Mazaquert (2.120). Revised 7th Approximation (1964).
c. Date of examination: 31st August, 1966.
d. Authors: Messrs. N. Mikenberg and A. Hoekstra.
e. Location: Naururu Irrigation Scheme, 20 miles west of Same, Tanzania. 40 yards west of C750 on topographical map.
f. Elevation: 2058 feet.
g. Land form:
   i. Physiographic position: Valley bottom.
   ii. Surrounding land form: Flat with numerous drainage lines, slightly concave, land slopes gently east-west towards the river.
   iii. Microtopography: Gilgai.
h. Slope: Class 1 - flat or almost flat.
i. Land-use: Masai cattle grazing.

General soil information

a. Parent material: Calcareous fine alluvial sediments of the Pangani floodplain.
b. Drainage: Class 1 - poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight sheet erosion.
g. Salinity or alkalinity: Class 0-1 - soils free or slightly affected by salt or alkali.
h. Human influence: Some cattle grazing; further north this soil is cultivated under irrigation.

Brief description of the profile

This is the medium depth member of the 134 series. Usually at 18 to 30

inches a petrocalcic layer is present. The soils of this series are very uniform and consistent and the main difference between phases is depth caliche-like layer.

Profile description

A1 0-2" Black (7.5 YR 2/0) moist and black (10 YR 2/1) dry, clay; moderate medium sub-angular blocky; very sticky and very plastic, very firm moist, hard dry; few very fine interstitial pores; abundant fine and few medium roots; some white spots of very fine material of unknown origin (neither crystalized nor effervescent); pH 7.2.; gradual wavy boundary to

AC 2-22" Black (7.5 YR 2/0) moist with many coarse prominant sharp light brownish grey mottling and black (10 YR 2/1) dry, clay; strong coarse prismatic; very sticky very plastic, extremely firm moist, very hard dry; common fine random pores, few coarse continuous tubular ones; thick continuous clay outans; common fine and medium and few coarse roots; increasing mottling with depth; vertical random cracking with material from the top; some slickensides; pH 8.2; very strongly effervescent; clear wavy boundary to

C1 22-26" Very dark grey (10 YR 3/1) moist with many medium prominent clear light brownish grey mottling and dark grey (10 YR 4/1) dry, clay; strong fine angular blocky; very sticky very plastic, firm moist, hard dry; few very fine discontinuous pores; few medium roots; pH 8.3; very strongly effervescent; abrupt smooth boundary to

C2 26-35"+ Dark greyish brown (10 YR 4/2) moist and pale brown (10 YR 6/3) dry; gritty clay; massive; sticky and plastic, very firm moist, very hard dry; few very coarse roots; pH 8.4; very strongly effervescent.

Range of characteristics

This poorly drained soil is of medium depth on top of an almost impenetrable petrocalcic layer. Colour is consistent and ranges between very dark grey and black. Texture is always clay with very minor inclusions of silt loam and silty clay loam. pH increases with depth and ranges between 7.0 and 8.5. Some very minor inclusions of pH 8.6 have been accepted.

Similar and associated soils

This is the medium phase of soil Unit 134. It is an intergrade between the deep Unit 134 without caliche-like layer and always clayey and Unit 146 in which the layer is always present and the texture is more coarse.

Land-use and agricultural potential

This soil can be used for regular agricultural production with the limitations derived from fine texture, poor drainage and depth. Able to support most of the cultivated crops adapted to the present ecological conditions. This soil is already under cultivation further north with fair results.

Site information

a. Soil name: UNIT 134Cs.
b. Higher category classification: Grumusol. Typic Mazaquert (2.120). Revised 7th Approximation (1964).
c. Date of examination: 31st August, 1966.
d. Authors: N. Mikenberg and A. Hoekstra.
e. Location: Naururu Irrigation Scheme. 20 miles west of Same, Tanzania. 40 yards west of C750 on topographical map.
f. Elevation: 2058 feet.
g. Land form:
   i. Physiographic position: Valley bottom.
   ii. Surrounding land form: Flat with numerous drainage lines, slightly concave, land slopes gently east-west towards the river.
   iii. Microtopography: Slight gilgai.
h. Slope: Class 1 - flat or almost flat.
i. Land-use: Masai cattle grazing.

General soil information

a. Parent material: Calcareous fine alluvial sediments of the Pangani floodplain.
b. Drainage: Class 0 - very poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight sheet erosion.
g. Salinity or alkalinity: Class 0-1 - soils free or slightly affected by salt or alkali.
h. Human influence: Some cattle grazing.

Brief description of profile

This is the shallow member of the 134 series. A petrocalcic layer is present at 12 to 18 inches. This phase is very uniform in colour and texture.

Profile description

A1 0-1" Blaok (7.5 YR 2/0) moist and very dark grey (10 YR 3/1) dry, loam; very fine orumb; slightly stioky, slightly plastio, friable moist, loose dry; many fine and very fine disoontinuous interstitial pores; oommon fine and medium roots; pH 6.8; non effervesoent; abrupt smooth boundary to

AC 1-12/18" Blaok (10 YR 2/1) moist with dark yellowish brown material in pockets, and very dark grey (10 YR 3/1) dry, olay; strong medium sub-angular blooky; very stioky and very plastio, friable moist, hard dry; patohy moderately thiok olay cutans; oommon fine interstitial and oommon random medium tubular pores; frequent fine dead roots inoluded in the soil peds; some oraokings and pookets of soft materials non effervesoent; pH 7.0; non effervesoent; gradual irregular boundary to

C 12/18"+ Brown to dark brown (10 YR 4/3) moist and light brownish grey (10 YR 6/2) dry; massive oontinuous hard layer oemented with oaloium oarbonate; pH 8.0; very strongly effervesoent.

Range of oharacteristios

Some very minor inolusions with silt loam or olay loam layers were registered. Colour varies very little. pH ranges from 6.8 to 8.4. Effervesoenoe with HCl may ooour throughout or be restrioted to the oaliohe-like layer.

Similar and associated soils

The soils of this phase differ from others of the same series in depth to the petrooalcic layer. Other shallow soils like Units 146 or 132 are never as olayey as this soil.

Land-use and agricultural potential

This soil oan only be used for agrioulture for a limited range of crops with a shallow rooting system. Other limitations are the fine texture and its very poor drainage. It is suited for grazing and forestry.

Site information

a. Soil name: UNIT 145.
b. Higher category classifioation: Alluvial. Haplorthent (1.53). Revised 7th Approximation (1964).
c. Date of examination: 1st September, 1966.
d. Authors: Messrs. N. Mikenberg and A. Hoekstra.
e. Looation: Naururu Irrigation Soheme. 20 miles west of Same, Tanzania. 40 yards west of A1375 on topographioal map.

f. Elevation: 2058 feet.
g. Land form:
  i. Physiographio position: Valley bottom.
  ii. Surrounding land form: Flat, slightly concave.
  iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat.
i. Land-use: Masai oattle grazing.

General soil information

a. Parent material: Calcareous alluvial sediments of the Pangani floodplain.
b. Drainage: Class 4 - well drained.
c. Moisture oonditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rookiness: Nil.
f. Evidenoe of erosion: Nil.
g. Salinity or alkalinity: Class 0 - soils free of excess salt or alkali.
h. Human influenoe: Masai oattle grazing. This soil is largely oultivated under irrigation further north.

Brief desoription of the profile

This is a medium to deep soil of silt loam texture, often underlain by a petrooaloio layer. It only oovers a small area. Larger areas of it extend further north (see semi-detailed soil survey of Naururu) where it is extensively cultivated.

Profile desoription

A 0-5" Very dark brown (10 YR 2/2) moist and grey (10 YR 5/1) dry, silt loam; moderate medium sub-angular blooky; slightly plastio, non stioky, friable moist, slightly hard dry; many very fine interstitial and oommon fine tubular pores; common fine and few medium roots; pH 7.2; non effervesoent; clear wavy boundary to

AC 5-10" Brown to dark brown (10 YR 4/3) moist and light brownish grey (10 YR 6/2) dry, silt loam; weak fine sub-angular blooky; stioky and plastio, friable moist, soft dry; oommon fine interstitial pores; few fine roots; some material from the top comes through root channels like tongues; pH 7.8; very strongly effervesoent; gradual irregular boundary to

C 10-48" Yellowish brown (10 YR 5/4) moist and light grey (10 YR 7/2) dry, gritty sandy loam; massive; slightly stioky, slightly plastio, friable moist, slightly hard dry; few fine tubular pores; very few medium roots; compaotness inoreases with depth; diffioult to penetrate with auger; pookets of soft material; some insect oasts; pH 7.6; very strongly effervesoent.

Range of charaoteristics

The depth of this soil on top of the petrooaloio layer varies from a few inohes to more than 30 inohes. In the area surveyed only medium and deep soils of this unit were registered. The dominant texture is silt loam but some layers of silty olay loam and olay loam may ooour. pH ranges from 7.2 to 8.4. No salinity was observed in this soil. Colour is almost uniform.

Similar and assooiated soils

This soil unit is easy to differentiate from 134 and 133 beoause of their clay texture. The soil series 146 whioh is very similar in texture is always darker in the top soil and the 132 is always very strongly alkaline.

Land-use and agrioultural potential

This is an exoellent soil whioh is extensively used further north for regular orop produotion under irrigation. Its main limitation is its depth whioh varies in short distanoes. It is very olosely related with the 146 of whioh it is suspeoted to be an eroded phase. Crops oultivated in this soil with good produotion levels are ootton, maize, banana, sugar cane and oassava. In undisturbed areas a very dense parkland vegetation exists.

Site information

a. Soil name: UNIT 146H.
b. Higher oategory olassifioation: Intergrade between Rendzina and alluvial; Lithic Haplorthent (1.53-L). Revised 7th Approximation (1964).
c. Date of examination: 1st September, 1966.
d. Authors: Messrs. N. Mikenberg and A. Hoekstra.
e. Looation: Naururu Irrigation Soheme. 20 miles west of Same, Tanzania. 100 yards west of B2750 on topographioal map.
f. Elevation: 2057 feet.
g. Land form:
   i. Physiographio position: Valley bottom.
   ii. Surrounding land form: Flat with soattered drainage lines, slightly oonvex.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat.
i. Land-use: Open parkland. Masai cattle grazing.

General soil information

Parent material: Caloareous alluvial sediments of the Pangani floodplain.
Drainage: Class 1 - poorly drained.
Moisture ooditions: Dry throughout.
Groundwater depth: Unknown.

e. Stoniness or rockiness: Outcrops of hardened caliche-like material.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - soils free of excess salt and alkali.
h. Human influence: Cattle grazing.

Brief description of the profile

This is the very shallow member of the 146 series. A few inches of black to dark grey organic topsoil on a hardened petrocalcic layer are the main features. Texture is usually silt loam or loam. pH ranges from 7.0 to 8.4 and the soil is very strongly effervescent. Its distribution is mainly in pockets or larger areas alternating with shallow and deeper phases of the same unit.

Profile description

A 0-6" Very dark grey (10 YR 3/1) moist and dark greyish brown (10 YR 4/2) dry, silt loam; coarse medium and fine sub-angular blocky; slightly sticky and slightly plastic, friable moist, soft dry; many very fine interstitial and few fine tubular pores; few fine and medium roots; in the lower part of this horizon accumulations of concretionary calcium carbonate, sometimes powdery; pH 8.4; very strongly effervesoent; abrupt smooth boundary to

C 6"+ Brown to dark brown (10 YR 4/3) moist and pale brown (10 YR 6/3) dry, hard concretionary layer cemented with calcium carbonate breaking into irregular blocks; some roots in the crackings, calcium carbonate in veins; pH 7.8; very strongly effervescent.

Range of characteristics

This is a very shallow phase of the 146 series. The depth to the caliche-like layers varies from 0 to 12 inches with frequent outcrops of the cemented layer. Texture ranges from fine sandy loam to silt loam. Rocks are common at the surface. pH varies from 6.8 to 8.4 with inclusions higher than 8.6.

Similar and associated soils

The only other very shallow soils (less than 12 inches) in the area are Unit 134CH of fine texture and Unit 132 strongly alkaline and lacking the dark topsoil.

Land-use and agricultural potential

Due to its very limited depth this soil is not recommended for regular crop production. Well suited for permanent constructions and some adapted grasses. This soil should be left out in any programme of levelling for irrigation purposes.

Site information

a. Soil name: UNIT 146m.
b. Higher category classification: Rendzina-like. Typic Rendoll - (5.110). Revised 7th Approximation (1964).
c. Date of examination: 1st September, 1966.
d. Authors: N. Mikenberg and A. Hoekstra.
e. Location: Naururu Irrigation Scheme. 20 miles west of Same, Tanzania. 100 yards east of C2625 on topographical map.
f. Elevation: 2057 feet.
g. Land form:
   i. Physiographic position: Valley bottom.
   ii. Surrounding land form: Flat with scattered drainage lines.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat.
i. Land-use: Cattle grazing. Intensively cultivated under irrigation further north. Dense parkland vegetation in the undisturbed areas.

General soil information

a. Parent material: Calcareous alluvial sediments of the Pangani floodplain.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - soils free of excess salt and alkali.
h. Human influence: Cattle grazing; intensively cultivated further north.

Brief description of the profile

This is a medium to deep soil of silty clay on silty clay loam texture underlain by a petrocalcic layer. Black colours grade through a very dark grey to the next layer. Non-saline non-alkaline and very strongly effervescent with increasing amount of calcium carbonate. In the semi-detailed soil survey of Naururu the dominant texture in Unit 146 is silt loam to silty clay loam. In the present area this unit is influenced by the fine sediments of the Unit 134.

Profile description

A11 0-5" Black (7.5 YR 2/0) moist with few medium distinct dark greyish brown mottling and very dark grey (10 YR 3/1) dry, silty clay; sticky and plastic, friable moist, soft dry; many fine and very fine interstitial and tubular pores; common fine and medium roots; pH 7.6; very strongly effervescent; gradual irregular boundary to

A12 5-11" Very dark grey to black (10 YR 2.5/1) moist with many medium distinct yellowish brown mottling, and dark grey (10 YR 4/1) dry, silty clay loam; moderate medium gramular; sticky and plastic, friable moist, soft dry; many very fine interstitial and coarse tubular pores; few fine, very fine and medium and few coarse roots; increasing amount of efflorescent calcium carbonate; some insect casts; pH 7.6; strongly effervescent; clear wavy boundary to

AC 11-21" Very dark grey (10 YR 3/1) moist with many prominent yellowish brown mottling, and grey (10 YR 5/1) dry, gritty clay loam; strong medium sub-angular blocky; sticky and plastic, friable moist and slightly hard dry; many fine tubular and interstitial pores; very few roots; increasing amount of calcium carbonate concretions and soft powdery accumulations; pH 8.0; very strongly effervescent; abrupt smooth boundary to

C 21-30"+ Pale brown (10 YR 6/3) moist and very pale brown (10 YR 8/3) dry, medium and coarse angular blocky concretions cemented with calcium carbonate forming a discontinuous layer; pH 7.8; very strongly effervescent.

Range of characteristics

In the area surveyed this soil unit covers only 45 acres and is not representative of the unit as a whole which is mainly of medium texture. This part is influenced by fine alluvial sediments and the soils are in the extreme textural range. The normal range covers loam, silt loam, silty clay loam and silty clay textures. Depths to the caliche-like layer range from 18 to more than 30 inches. pH ranges from 6.8 to 8.4 and the soils are usually very strongly effervescent throughout. Colours of the top soil range from black to very dark grey and are never lighter than very dark grey (10 YR 4/1) which is the breaking line between Units 146 and 145.

Similar and associated soils

This is the medium depth member of the 146 series and includes some deep soils. In the same area other soil units occur such as 145 (lighter than 10 YR 4/1); 132, shallow and veryalkaline, both of them without a dark organic top soil and the 133-134 series which are of fine clay texture.

Land-use and agricultural potential

This is the best soil of the whole Naururu area but only represented in a very small part of this area. It is intensively cultivated further north and the following crops are common: cotton, maize, banana, sugar cane, sweet potatoes, cassava, various vegetables, tropical fruit trees (mango, paw-paw, etc.) and rice on similar soils in Ngage. This soil has no major limitation and the main problem is the inclusion of shallow and very shallow phases. It can be much improved with fertilization and proper water management.

Site information

a. Soil name: UNIT 146s.
b. Higher category classification: Rendzina-like, Typic Rendoll (5.110). Revised 7th Approximation (1964).
c. Date of examination: 1st September, 1966.
d. Authors: Messrs. N. Mikenberg and A. Hoekstra.
e. Location; Naururu Irrigation Scheme. 20 miles west of Same, Tanzania. 80 yards east of Ao on topographical map.
f. Elevation: 2060 feet.
g. Land form:
   i. Physiographic position: Valley bottom.
   ii. Surrounding land form: Flat with scattered drainage lines.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat.
i. Land-use: Nil. Further north there is regular cultivation. Dense parkland.

General soil information

a. Parent material: Calcareous alluvial sediments of the Pangani floodplain.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - soils free of excess salt and alkali.
h. Human influence: Nil. Intensively cultivated further north.

Brief description of the profile

This is the shallow phase of Unit 146. A black loam topsoil grades through a dark grey clay loam to a hardened petrocalcic layer. The depth of this layer varies from 12 to 18 inches. The texture of the top soil is usually loam or silt loam. pH ranges from 7.0 to 8.4 and the soil is very strongly effervescent throughout.

Profile description

A 0-6" Black (10 YR 2/1) moist and very dark greyish brown (10 YR 3/2) dry, loam; weak fine granular; slightly sticky and slightly plastic, very friable moist, soft dry; many fine and very fine interstitial pores; frequent fine and medium roots; pH 7.8; very strongly effervescent; clear wavy boundary to

AC 6-14" Dark grey (10 YR 4/1) moist with many coarse distinct greyish brown mottling, and greyish brown (10 YR 5/2) dry, clay loam; strong medium angular blocky; sticky and plastic, friable moist, slightly hard dry; few fine interstitial and few fine

tubular pores; few medium roots; large amounts of soft powdery oalcium oarbonate; pH 7.6; very strongly effervescent; abrupt smooth boundary to

C 14"+ Pale brown (10 YR 6/3) moist and very pale brown (10 YR 7/3) dry, massive breaking to hard medium irregular blocks cemented with oaloium oarbonate, with few tubular pores; very difficult to penetrate with auger; pH 7.4; very strongly effervescent.

Range of oharaoteristios

This is the shallow phase of the 146 series. Very small areas of it are included in the area surveyed. It is usually patohy or in small irregular spots transitional between the very shallow areas of the same unit and the medium and deep phases. Textures usually range between loam, silt loam and silty clay loam. The oolour of the topsoil is always blaok to dark grey and pH ranges between 6.8 and 8.4. Some small inolusions of the alkaline Unit 132 were registered.

Similar and assooiated soils

The soils ooourring in the vioinity are the fine textured 133 and 134, the medium textured 145 and 132 and other phases of 146.

Land-use and agrioultural potential

This is a good soil but its shallow depth limits the ohoice of crops. Due to the distribution of this soil phase in small patohes no separate management oan be reoommended and in a sound programme of irrigation agriculture it will have to go together with the neighbouring soils.

SOIL ANALYSES TABLE V

NAURURU DETAILED SURVEY

UNIT No.	Depth Inches	pH in Water Saturated Paste	pH in Water 1:5 W/V	Conductivity millimhos at 25°C Saturation extract	Conductivity millimhos at 25°C 1:5 W/V	Calcium Carbonate per cent	Organic Carbon per cent	Total Nitrogen per cent	C/N Ratio	Available Phosphorus ppm OLSEN
132	0-2	9.3	9.9	8.2	1.18	4.4	1.01	-	-	5.8
	2-10	10.1	10.2	> 20	4.00	9.9	0.51	-	-	16.7
	10 +	9.9	9.9	15.9	2.40	25.5	0.39	-	-	16.2
133	0-5	9.0	9.6	4.0	1.22	4.4	2.73	0.19	14	7.5
	5-18	10.0	10.0	9.4	2.80	1.8	0.94	0.05	19	6.6
	18-30	9.6	9.8	7.3	1.14	1.1	0.34	-	-	2.3
	30-48	8.8	9.3	1.39	0.17	0.1	0.24	-	-	0.7
	48-60	8.2	8.3	0.71	0.08	NIL	0.22	-	-	0.6
133C	0-6	8.4	9.1	9.2	1.75	1.6	2.90	0.15	19	10.2
	6-19	9.8	9.9	15.9	3.90	2.1	1.54	0.08	19	11.4
	19-30	9.9	10.0	15.3	2.90	7.6	0.44	-	-	4.0
134	0-1	6.5	6.8	1.06	0.23	NIL	10.5	0.55	19	24
	1-14	7.5	7.8	0.45	0.12	NIL	2.77	0.14	20	6.3
	14-30	8.0	8.5	0.63	0.21	0.8	1.35	-	-	1.2
	30-50	8.3	0.9	0.75	0.31	13.8	0.43	-	-	1.9
134CH	1-1/11	6.8	7.3	0.92	0.17	NIL	6.7	0.41	16	13.4
	1/11-11	7.1	7.3	0.80	0.15	NIL	4.55	0.25	18	4.8
	11 +	7.7	7.9	3.00	0.65	0.9	1.50	-	-	ND
134 Cm	0-2	7.1	7.4	1.90	0.51	1.4	5.9	0.32	18	10.8
	2-22	8.3	8.9	0.80	0.30	2.2	1.79	0.09	20	1.7
	22-26	8.8	9.3	0.80	0.47	6.5	0.79	-	-	TRACE
	26-35	8.7	9.4	0.80	0.59	7.2	0.31	-	-	1.9
134 Cs	0-1	7.0	7.3	0.96	0.18	NIL	7.0	0.34	20	11.9
	1-12/18	7.6	8.2	0.96	0.15	NIL	2.70	0.17	16	2.2
	12/18-18	8.3	9.1	1.43	0.28	5.7	0.34	-	-	1.4
145	0-5	7.3	7.6	0.98	0.15	NIL	6.5	0.40	16	4.8
	5-10	7.7	8.2	0.71	0.23	0.6	4.2	0.21	20	2.4
	10-48	8.0	8.7	1.10	0.26	8.4	0.41	-	-	0.9
146H	0-6	7.9	8.5	0.65	0.23	3.2	1.12	-	-	3.7
	6 +	8.1	8.8	0.84	0.19	2.1	0.58	-	-	1.7
146m	0-5	7.3	7.8	0.73	0.14	NIL	3.55	0.21	17	2.7
	5-11	7.8	8.4	0.65	0.21	2.4	1.68	0.10	17	2.4
	11-21	7.9	8.5	0.51	0.21	3.4	1.37	-	-	1.7
	21-30	8.1	8.8	1.02	0.18	15.2	0.48	-	-	2.9
146s	0-6	8.2	8.9	1.37	0.33	7.2	3.27	0.21	16	1.7
	6-14	8.1	8.7	0.80	0.27	2.8	1.34	0.08	17	3.7
	14 +	8.5	9.5	7.4	1.12	24.8	0.80	-	-	1.7

UNIT	Depth	Particle Size Distribution per cent of mineral fraction				Saturation	Cations extracted with N ammonium acetate milliequivalent 100g soil				
	Inches	Coarse Sand	Fine Sand	Silt	Clay	percentage	Calcium	Magnesium	Sodium	Potassium	Total
132	0-2	22	39	35	4	27	-	-	-	-	-
	2-10	20	36	31	13	37	-	-	-	-	-
	10 +	33	23	32	12	41	-	-	-	-	-
133	0-5	4	22	48	26	86	-	-	-	-	-
	5-18	19	29	16	36	90	-	-	-	-	-
	18-30	22	35	33	10	39	-	-	-	-	-
	30-48	39	59	1	1	25	6.5	2.7	15.2	5.2	29.6
	48-60	55	42	2	1	26	4.2	2.8	6.5	4.1	17.6
133C	0-6	6	24	30	40	103	-	-	-	-	-
	6-19	4	20	37	39	98	-	-	-	-	-
	19-30	46	27	15	12	54	-	-	-	-	-
134	0-1	8	19	54	19	98	36.0	12.0	2.9	7.2	57.2
	1-14	2	17	37	44	80	34.0	18.0	3.2	7.8	63.0
	14-30	16	20	33	31	68	-	-	-	-	-
	30-50	36	22	22	20	62	-	-	-	-	-
134 CH	1-1/11	4	20	52	24	68	38.5	19.5	2.0	9.0	69.0
	1/11-11	2	22	42	34	83	34.5	17.5	2.2	7.5	61.7
	11 +	37	26	23	14	46	-	-	-	-	-
134 Cm	0-2	11	28	35	26	88	-	-	-	-	-
	2-22	12	21	35	32	106	-	-	-	-	-
	22-26	23	23	21	33	91	-	-	-	-	-
	26-35	37	27	22	14	60	-	-	-	-	-
134 Cs	0-1	5	18	52	25	80	38.5	17.5	1.9	8.8	66.7
	1-12/18	6	23	43	28	71	35.5	16.0	3.6	10.8	65.9
	12/18-18	45	21	25	9	50	-	-	-	-	-
145	0-5	7	30	35	28	69	45.0	15.0	5.3	14.0	79.3
	5-10	4	25	53	18	63	-	-	-	-	-
	10-48	7	16	66	11	50	-	-	-	-	-
146 H	0-6	10	36	44	10	56	-	-	-	-	-
	6 +	40	36	20	4	51	-	-	-	-	-
146 m	0-5	9	25	40	26	74	45.0	12.5	4.1	12.5	74.1
	5-11	10	27	34	29	69	-	-	-	-	-
	11-21	12	30	34	24	62	-	-	-	-	-
	21-30	46	23	27	4	59	-	-	-	-	-
146 s	0-6	8	18	56	18	60	-	-	-	-	-
	6-14	6	18	62	14	56	-	-	-	-	-
	14 +	29	27	34	10	49	-	-	-	-	-

NOTES:

1. All analyses were determined after July 1965.

2. Calcium carbonate was determined by means of Collins' calcimeter.

3. OLSEN available phosphorus was determined by extracting 1 part of soil with 20 parts of 0.5.M. sodium bicarbonate at pH 8.5.

4. The particle size distribution values are percentages of the oven-dry mineral fraction, after removal of calcium carbonate. The size ranges are:

Coarse Sand	2 000 - 200 microns
Fine Sand	200 - 20 microns
Silt	20 - 2 microns
Clay	Less than 2 microns

5. Ammonium acetate extraction was only done on non-calcareous soils. The values for total cations in these cases are approximate estimates of the cation exchange capacity.

6. Calcium carbonate, organic carbon, total nitrogen, available phosphorus and cations extracted with N. ammonium acetate are calculated on air-dry soil.

7. A dash (-) indicates that the analysis was not done.

A P P E N D I X VI

HEDARU SEMI-DETAILED SURVEY

Site information

a. Soil name: UNIT 206.
b. Higher category classification: Calcisol-Typic Calcicrthid (4.130). Revised 7th Approximation (1964).
c. Date of examination: 14th January, 1966.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Natural cut in deep gully; 400 yards northeast of existing irrigation scheme, near footpath to Hedaru. Approximately 5 miles south of Hedaru, Tanzania.
f. Elevation: 1875-1925 feet.
g. Land form:
  i. Physiographic position of the site: High terrace.
  ii. Land form of surrounding country: Gently undulating, gullied.
  iii. Microtopography: Nil.
h. Slope: Class 1 - flat to gently sloping.
i. Vegetation and/or land-use: Large open bare spaces with low shrubs. Some game and cattle grazing.

General soil information

a. Parent material: Colluvial deposits covered by fine alluvial sediments.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Gully erosion.
g. Salinity or alkalinity: Class 1 - soils slightly affected by salt or alkali.
h. Human influence: Nil.

Brief description of profile

A deep, well drained, dark reddish brown to dark brown silty clay loam soil. Sub-angular blocky covered by a shallow vesicular fluffy topsoil. Friable, porous and permeable. Effervescent throughout with an horizon of calcium carbonate accumulation in the deep subsoil.

Profile description

A11 0-2" Dark brown (7.5 YR 3/4) moist and brown to dark brown (7.5 YR 4/4) dry, silt loam; weak granular; slightly sticky and slightly plastic, friable moist, soft dry; many vesicular pores; pH 7.8; clear wavy boundary to

A12 2-10" Reddish brown to dark reddish brown (5 YR 3.5/4) moist and reddish brown (5 YR 4/4) dry, silty clay loam; medium and coarse sub-angular blocky; sticky and plastic, friable moist, hard dry; many pores; frequent fine and medium roots; pH 7.7; slightly effervescent; gradual irregular boundary to

C1 10-24" Dark brown (7.5 YR 3/4) moist and brown to dark brown (7.5 YR 4/4) dry, silty clay loam; massive breaking to coarse sub-angular blocky; sticky and plastic, friable moist, hard dry; few pores; frequent medium and coarse roots; pH 7.8; slightly effervescent; gradual irregular boundary to

C2 24-40" Dark brown (7.5 YR 3/4) moist and brown to dark brown (7.5 YR 4/4) dry, silty clay loam; massive breaking to coarse angular blocky; sticky and plastic, slightly friable moist, hard dry; few pores; common medium and coarse roots; pH 7.9; slightly effervescent; gradual wavy boundary to

C3ca 40-50"+ Brown to dark brown (7.5 YR 4/4) moist and brown (7.5 YR 4.5/4) dry; silty clay; massive breaking to coarse angular blocky; sticky and plastic, friable moist, hard dry; few pores; few coarse roots; inclusions of white quartz and powdery calcium carbonate, some concretions and gravels; pH 7.8; very strong effervescence.

Range of characteristics

This soil unit is very complex and cannot be considered as a taxonomic unit. The texture of the top soil includes a large range from sandy loam, sandy clay loam, clay loam and clay with dry colours of greyish brown to light yellowish brown. The lower horizons are more uniform and consistent. It always has a strong effervescence throughout due to either powdery or concretionary calcium carbonate. A fluffy vesicular and easily eroded surface is characteristic. Wind erosion is common and also water erosion which produces spectacular gullies. Some inclusions of shallow soils with stones, gravel and calcium carbonate concretions on the surface were recorded.

Land-use and agricultural potential

A high investment will be required to put this unit in condition for regular agriculture under irrigation. Some salinity was recorded and this limits the range of crops which can be cultivated safely.

Site information

a. Soil name: UNIT 213.
b. Higher category classification: Reddish Chestnut. Mollic Haplargid (4.21-5). Revised 7th Approximation (1964).
c. Date of examination: 18th January, 1966.
d. Authors: N. Mikenberg and J. Kyaruzi.
e. Location: Approximately 3/4 miles west of the Hedaru-Buiko railway line and 1½ mile north of the Pangani River, along cut-line. Approximately 6 miles southeast of Hedaru, Tanzania, following footpath to Irrigation Scheme.

f. Elevation: 1875-1950 feet.
g. Land form:
  i. Physiographic position of the site: High terraoe.
  ii. Land form of surrounding country: Flat or almost flat, some gullies.
  iii. Miorotopography: Slight gilgai; disoontinuous oraoking; sink-holes.
h. Slope: Class 2 - gently sloping.
i. Vegetation and/or land-use: Clump grasses with few oaoias and xerophitio vegetation. Some game and oattle grazing.

General soil information

a. Parent material: Old oolluvial sediments, oovered by reoent colluvials enriohed with gypsum and oaloium oarbonate.
b. Drainage: Class 2 - imperfectly drained.
c. Moisture ooniditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rookiness: Nil.
f. Evidence of erosion: Some wind erosion. Few gullies.
g. Salinity or alkalinity: Class 0 - soil free of exoess salt and alkali.
h. Human influence: Nil.

Brief desoription of profile

This is a deep, imperfeotly drained soil. Brown and dark brown underlain by dark reddish brown, olay loam and olay subsoil with a B2 sub-angular blooky horizon and strong effervescenoe inoreasing with depth. Fluffy orusty surfaoe with oraoking and some soattered gravels. Powdery and orystalized gypsum in veins in the deep subsoil.

Profile description

A1 0-2" Brown (7.5 YR 4.5/4) moist and same oolour dry, silty olay loam; sticky and plastio, friable moist, soft dry; many vesioular and interstitial pores; frequent fine roots and few medium ones; pH 7.1; strong effervesoence; olear and wavy boundary to

B2 2-10" Dark brown (7.5 YR 3/2) moist and brown to dark brown (7.5 YR 4/2) dry, olay loam; strong medium sub-angular blooky; stioky and very plastio, friable moist, moderately hard dry; many pores; few clay outans; some oonoretions; pH 7.7; strong effervescence; gradual wavy boundary to

BC 10-20" Dark reddish brown (5 YR 3/4) moist and same oolour dry, olay; massive; stioky and very plastio, friable moist, hard dry; few pores; few roots; some powdery gypsum in veins; pH 7.9; slightly effervesoent.

C1 20-30" Dark reddish brown (5 YR 3/4) moist and same colour dry, clay; massive; sticky and very plastic, firm moist, very hard dry; few pores; increasing amount of gypsum; pH 7.9; slightly effervescent.

C2 30-36" Dark reddish brown (5 YR 3/4) moist and same colour dry, clay; massive; very sticky and very plastic, firm moist and very hard dry; few pores; gypsum; pH 8.1; moderately effervescent.

Range of characteristics

This is a brown to dark brown soil underlain by reddish brown to dark reddish brown subsoil. The amount of clay increases with depth. The topsoil may vary from sandy loam to sandy clay. An increasing amount of gypsum with depth is characteristic. Towards the south the amount of loose gravel on the surface and the calcium carbonate increases. This soil has a characteristic discontinuous cracking with sink holes. Towards the south near the boundary with MBAL it is heavily gullied.

Land-use and agricultural potential

This is a good soil and its main limitation is its imperfect drainage which could be overcome with adequate water management. Suited to a large range of crops without major limitations.

Site information

a. Soil name: UNIT 214.
b. Higher category classification: Regosol. Typic Naplorthent 1.530. Revised 7th Approximation (1964).
c. Date of examination: 18th January, 1966.
d. Authors: N. Mikenberg and J. Kyaruzi.
e. Location: Approximately 1¼ miles west of railway line Hedaru-Buiko and 2 miles north of the Pangani River; 5½ miles southeast of Hedaru, Tanzania, following footpath to Irrigation Scheme.
f. Elevation: 1875-1925 feet.
g. Land form:
   i. Physiographic position of the site: High terrace.
   ii. Land form of surrounding country: Flat, some gullies.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat.
i. Vegetation and/or land-use: Low shrubs, some scattered xerophitic trees, large bare spaces. Game and some cattle grazing.

General soil information

a. Parent material: Old alluvial sediments covered by recent colluvial sediments enriched with calcium carbonate and gypsum.

b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some wind erosion and few gullies.
g. Salinity or alkalinity: Class 0-soils free of excess salt or alkali.
h. Human influence: Nil.

Brief description of the profile

Deep, well drained, dark brown and brown to dark brown, silt loam on clay loam underlain by silty clay. Weak development with discontinuous cracking at the fluffy surface. Gravels and calcium carbonate concretions on the surface increasing to the south. This is one of the best soils of the area.

Profile description

A1	0-2"	Dark brown (10 YR 3/3) moist and brown (10 YR 5/3) dry, silt loam; weak granular; sticky and plastic; friable moist, soft dry; many vesicular and interstitial pores; frequent fine and some medium roots; pH 7.6; strongly effervescent; clear wavy boundary to
AC	2-8"	Dark brown (7.5 YR 3/2) moist and brown to dark brown (7.5 YR 4/4), clay loam; medium angular blocky; sticky and plastic, friable moist and moderately hard dry; many pores; frequent fine and medium roots; pH 7.7; strongly effervescent; clear irregular boundary to
C1	8-24"	Brown to dark brown (7.5 YR 4/2) moist and brown (7.5 YR 4.5/4) dry, clay loam; massive; sticky and plastic, friable moist and moderately hard dry; common pores; common medium roots; some quartz grains and gypsum in veins; pH 7.8; very strongly effervescent.
C2	24-30"	Brown to dark brown (7.5 YR 4/2) moist and same colour dry, silty clay; sticky and plastic, slightly friable moist and moderately hard dry; common pores; few medium roots; gypsum and calcium carbonate in concretions; pH 8.0; very strongly effervescent.
C3	30-36"	Dark brown (7.5 YR 3/2) moist and brown to dark brown (7.5 YR 4/2) dry, silty clay; massive; sticky and plastic, slightly friable moist, moderately hard dry; common pores; gypsum and calcium carbonate in concretions; pH 8.0; very strongly effervescent.

Range of characteristics

The colour of the topsoil ranges from brown to dark brown to pinkish grey and light brown (dry). The subsoil colour remains uniform. The texture of the upper horizon is usually silt loam, with some inclusions of loam and sandy loam and the subsoil is usually a light clay. Discontinuous cracking at the surface and sink holes are common. Towards the south this soil unit has an increasing amount of gravel and calcium carbonate concretions on the surface.

Land-use and agricultural potential

This is probably the best soil of the whole area surveyed. Well drained, deep, without salinity. Scattered gullies occur but could be easy to level. The fine texture of the subsoil is a limitation.

Site information

a. Soil name: UNIT 214L.
b. Higher category classification: Alluvial. Typic Haplorthent (1.530). Revised 7th Approximation (1964).
c. Date of examination: 14th January, 1966.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Approximately 3 miles south of Hedaru, Tanzania, along foot-path from Hedaru to the Irrigation Scheme.
f. Elevation: 1875-1950 feet.
g. Land form:
   i. Physiographic position of the site: High terrace.
   ii. Land form of surrounding country: Flat with gullies.
   iii. Microtopography: Nil.
h. Slope: Flat.
i. Vegetation and/or land-use: Large bare patches with scattered xerophitic low shrubs. Game with some cattle grazing.

General soil information

a. Parent material: Alluvial sediments mixed with colluvial sediments, enriched with gypsum and underlain by old fluvio-lacustrine materials.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some wind erosion and few gullies.
g. Salinity or alkalinity: Class 0 - soils free of salt or alkali.
h. Human influence: Nil.

Brief description of profile

Deep, dark brown to yellowish brown, moderately well drained soil with sandy clay loam underlain by clay loam and some light clay layers. Friable, with increasing amounts of gypsum and calcium carbonate with depth. Fluffy surface with discontinuous cracking. Closely associated with soil units 234L and 215.

Profile description

A11 0-2" Dark yellowish brown (10 YR 3/4) moist and same colour dry, sandy clay loam; granular; sticky and plastic, friable moist, soft dry; many vesicular and interstitial pores; frequent fine and medium roots; some CaCO3 concretions; pH 7.4; effervescent only in the concretions; clear wavy boundary to

A12 2-12" Dark brown to dark/yellowish brown (10 YR 3/3.5) moist and between brown dark brown and dark yellowish brown (10 YR 4/3.5) dry, clay loam; coarse sub-angular blocky; sticky and plastic, friable moist, moderately hard dry; many pores; frequent fine and medium roots; small quartz grains; pH 7.6; non effervescent; clear wavy boundary to

C1 12-26" Dark brown (10 YR 3/3) moist and same colour dry, clay; massive; very sticky and very plastic, slightly friable moist and hard dry; few pores; few fine and medium roots; few veins with powdery gypsum increasing in amount with depth; pH 7.8; non effervescent.

C2 26-33" Brown to dark brown (7.5 YR 4/2) moist and same colour dry, clay loam; massive; sticky and plastic, friable moist, moderately hard dry; few pores; increasing amount of gypsum; pH 7.8; slightly effervescent.

C3 33-39"+ Dark brown to dark yellowish brown (10 YR 3/3.5) moist and between brown dark brown and dark yellowish brown (10 YR 4/3.5) dry, clay; massive; sticky and plastic, friable moist, moderately hard dry; common pores; large amount of powdery gypsum; pH 7.8.

Range of characteristics

Colours range from brown to dark brown to dark yellowish brown. Infrequently, colours like dark grey or pale brown may occur. The light clay subsoil is somewhat compacted but friable and easy to penetrate with the auger. Small discontinuous cracks and sink holes also occur in this unit. Some gullies occur.

Land-use and agricultural potential

This is a good soil suited for a wide range of crops. Its main limitations are the slightly dissected topography with scattered gullies which should be easy to level and the fine texture and compactness of the subsoil which may limit somewhat the range of adapted crops.

Site information

a. Soil name: UNIT 215.
b. Higher category classification: Intergrade Regosol-Reddish Chestnut. Aridic-Entic Haplustoll (5.62-4.1). Revised 7th Approximation (1964).
c. Date of examination: 14th January, 1966.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Approximately 3½ miles south of Hedaru, Tanzania, along the footpath to the Irrigation Scheme.
f. Elevation: 1875-1950 feet.
g. Land form:
   i. Physiographic position of the site: High terrace.
   ii. Land form of surrounding country: Flat, some gullies.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat.
i. Vegetation and land-use: Large bare areas with scattered low shrubs. Game with cattle grazing.

General soil information

a. Parent material: Old alluvial sediments covered by colluvium and underlain by lacustrine material enriched with gypsum.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some wind erosion, few gullies.
g. Salinity or alkalinity: Class 0 - soils free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

This is a deep, dark reddish brown moderately well drained soil with loam underlain by clay loam and some clay layers in the deep subsoil. Moderately developed structure in the solum and massive compacted subsoil are characteristic with increasing amounts of gypsum with depth.

Profile description

A11 0–2" Reddish brown to dark reddish brown (5 YR 3.5/4) moist and brown to dark brown (7.5 YR 4/4) dry, loam; weak fine granular; slightly stioky and slightly plastio, friable moist, soft dry; many vesioular and interstitial pores; frequent fine roots and medium ones; pH 7.5; non effervesoent; olear wavy boundary to

A12 2–12" Same oolours as above, loam; medium and coarse sub-angular blooky; slightly stioky and slightly plastio, friable moist, moderately hard dry; many pores; oommon medium and fine roots; pH 7.4; non effervesoent; olear wavy boundary to

AC 12–20" Same oolours as above, olay loam; massive; stioky and plastio, friable moist, moderately hard dry; few pores; few medium roots; very fine oonoretions of oaloium oarbonate; pH 7.7; slightly effervesoent.

C1 20–29" Dark brown (7.5 YR 3/2) moist with reddish brown and white mottling and reddish brown to dark reddish brown (7.5 YR 3.5/4) dry, olay loam; massive; stioky and plastio, friable moist, hard dry; few pores; lacustrine sediments with oaloium oarbonate and gypsum; pH 7.8; slightly effervesoent.

C2 29–35"+ Mixed oolours reddish brown to dark reddish brown and very dark grey moist and same oolours when dry, olay; massive; sticky and plastio, friable moist, hard dry; few pores; inoreasing amount of gypsum; pH 7.8; slightly effervesoent.

Range of oharaoteristios

Colours range between dark greyish brown, very dark greyish brown and dark grey and it is often covered by layers of greyish brown and light greyish brown. Deep and moderately welldrained. The soil is consistently olay in the deep subsoil but the solum may range between sandy olay, sandy loam and silt loam. It may be slightly affeoted by salinity. It has a fluffy surfaoe with some disoontinuous oraoks. The number of gullies and the depth of the old laoustrine materials may vary.

Land-use and agrioultural potential

This soil is usually assooiated with Units 214L and 234L and all three of them are similar and diffioult to map separately at this stage. It is suited for a wide range of orops with the fine texture of the subsoil the main limitation. Investment will be neoessary to level this area for irrigation unless sprinkler irrigation is used. Improvement of the drainage may be required. The large amount of gypsum will help to oontrol salinity in the early stages of an irrigation programme.

Site information

a. Soil name: UNIT 215R.
b. Higher category classification: Regosol. Typic Haplorthent (1.530) Revised 7th Approximation (1964).
c. Date of examination: 18th January, 1966.
d. Authors: N. Mikenberg and J. Kyaruzi.
e. Location: East of railway line Hedaru-Buiko, $\frac{1}{2}$ mile north of the Mabilioni village, $\frac{1}{2}$ mile northeast of sharp river bend and railway bend - Hedaru, Tanzania.
f. Elevation: 1900-1950 feet.
g. Land form:
   i. Physiographic position of the site: High terrace.
   ii. Land form of surrounding country: Undulating, many gullies.
   iii. Microtopography: Nil.
h. Slope: Gently sloping.
i. Land-use; Open bare area with scattered xerophitic low shrubs and acacias. Game.

General soil information

a. Parent material: Mixed alluvial and colluvial sediments.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Wind erosion and many deep gullies.
g. Salinity or alkalinity: Class 0 - soils free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

A deep, well drained, reddish brown underlain by dark reddish brown soil; sandy loam texture with sandy clay subsoil. Highly dissected by deep gullies. Some inclusions of shallow soil and gravel on the surface. Areas of sloping and steep lands included.

Profile description

A1 0-2" Reddish brown (5 YR 4/4) moist and yellowish red (5 YR 4/6) dry, very fine sandy loam; weak coarse granular; slightly sticky and plastic, friable moist; soft dry; many pores; few fine and medium roots; pH 7.6; slightly effervescent; clear smooth boundary to

C1 2-10" Reddish brown (5 YR 3/4) moist and yellowish red (5 YR 4/6) dry, sandy loam; medium sub-angular blocky; slightly sticky and plastic, friable moist, hard dry; many pores; frequent fine and medium roots; sand grains in veins and in layers; pH 7.6; strongly effervescent; abrupt smooth boundary to

IIC2 10-24" Dark reddish brown (5 YR 3/3) moist and same colour dry, sandy clay loam; massive; slightly sticky and plastic, friable moist, moderately hard dry; many pores; common fine and medium roots; pH 7.4; strongly effervescent.

IIC3 24-32" Dark reddish brown (5 YR 3/4) moist and reddish brown (5 YR 4.5/2) dry, sandy clay, massive; sticky and very plastic, friable moist, hard dry; few pores; pH 7.3; very strongly effervescent.

IIC4 32-36"+ Dark reddish brown (5 YR 3/3) moist and same colour wet, sandy clay; massive; very sticky and very plastic, friable moist, hard dry; few pores; pH 7.5; very strongly effervescent.

Range of characteristics

Deep and well drained with colours ranging from dusky red to weak red. Inclusions of sandy loam, sand and sandy clay soils.

Land-use and agricultural potential

This is a good soil, well aerated but somewhat heterogeneous, with main limitation due to the presence of deep gullies requiring expensive levelling. Suited for a wide range of crops. More detailed studies will be needed before any irrigation agriculture is started.

Site information

a. Soil name: UNIT 216:
(includes deep, medium, shallow and very shallow phases).
b. Higher category classification: Regosol and Lithosol. Typic Haplorthent (1.53L). Revised 7th Approximation (1964).
c. Date of examination: 20th January, 1966.
d. Author: N. Mikenberg.
e. Location: Approximately 8 miles southwest of Hedaru, Tanzania; ½ mile west of the road Hedaru- Mbuyuni.
f. Elevation: 1950-2000 feet.
g. Land form:
i. Physiographic position of the site: Colluvial slopes.
ii. Land form of surrounding country: Undulating.
iii. Microtopography: Nil.
h. Slope: Class 2 - gently sloping 2-6%.
i. Vegetation and land-use: Mainly thorn bush with some broad leaved bush; many open spaces free of vegetation.

General soil information

a. Parent material: Colluvium underlain by calcium carbonate coated gravels.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Class 1 - rock outcrops.
f. Evidence of erosion: Some wind erosion.
g. Salinity or alkalinity: Class 0 - soils free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

This is an heterogeneous soil unit including deep, medium, shallow and very shallow phases. A well drained, silt loam and gritty sandy loam, with rock outcrops and gravels. Highly calcareous.

Profile description

A11 0-1" Brown to dark brown (10 YR 4/3) moist and yellowish brown (10 YR 5/4) dry, gritty silt loam; structureless; non sticky and slightly plastic, friable moist; soft dry; many vesicular pores; common fine roots; pH 8.2; very strongly effervescent; clear wavy boundary to

A12 1-13" Dark yellowish brown (10 YR 4/4) moist and same colour dry, sandy loam; moderate medium angular blocky; slightly sticky and slightly plastic, friable moist, soft dry; many pores; common to few fine and medium roots; many calcium carbonate concretions; pH 7.9; very strongly effervescent; gradual irregular boundary to

AC 13-24" Dark yellowish brown (10 YR 4/4) moist and yellowish brown (10 YR 5/4) dry, silt loam; moderate medium to coarse sub-angular blocky; slightly sticky and slightly plastic, friable moist, soft dry; many pores; few fine and medium roots; calcium carbonate concretions; pH 7.9; very strongly effervescent; gradual irregular boundary to

C1 24-32" Brown (10 YR 5/3) moist and light yellowish brown (10 YR 6/4) dry; massive; hard, occasional fine roots; cemented caliche-like layers; pH 7.8; very strongly effervescent; abrupt smooth boundary to

C2 32-36" Slightly yellower in colour, calcium carbonate enriched rocky/gravelly layer; slightly sticky and slightly plastic; silt loam; the loose material in between is pH 7.8; very strongly effervescent.

Range of characteristics

This is an heterogeneous soil unit covering a range of depth phases. Rock outcrops, gravels and stones are common. Colours range from strong brown, reddish yellow, dark yellowish brown to light yellowish brown. Textures range from loam and sandy clay loam to sandy clay. A strongly effervescent profile often with concretionary calcium carbonate. Slope varies over short distances.

Land-use and agricultural potential

This soil in its present condition cannot be used for irrigation agriculture. More detailed soil studies are required in order to show the different soil depths and exclude the areas where outcrops, gravel accumulations and very shallow soils are concentrated. In an intensive programme of agricultural development some areas of this soil unit could be used for regular crop production and most of the area could be used for grass and forestry. There are also good prospects for citrus production.

Site information

a. Soil name: UNIT 222.
b. Higher category classification: Reddish Chestnut. Aridic Argiustoll (5.63-4). Revised 7th Approximation (1964).
c. Date of examination: 13th January, 1966.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: 11 miles approximately southwest of Hedaru, Tanzania in the road Hedaru-Mbuyuni 1 mile north of the road.
f. Elevation: 1925 feet.
g. Land form:
   i. Physiographic position of the site: Colluvial plain.
   ii. Land form of surrounding country: Undulating.
   iii. Microtopography: Nil.
h. Slope: Gently sloping.
i. Vegetation and land-use: Isolated low shrubs in clumps, occasional low Acacia and large open spaces. Game and cattle grazing.

General soil information

a. Parent material: Mixed colluvial sediments from the Lasiti hill.
b. Drainage: Class 2 - imperfectly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some wind erosion.
g. Salinity or alkalinity: Class 1 - soils slightly affected by salt or alkali.

h. Human influence: Nil.

Brief description of the profile

Deep, imperfectly drained reddish brown to dark reddish brown, silt loam, underlain by clay loam and olay in the deep subsoil. Large amounts of gypsum and calcium carbonate after a foot and inoreasing in amount with depth. Compacted in the subsoil.

Profile description

A1 0-2" Reddish brown to dark reddish brown (5 YR 3.5/4) moist and brown (7.5 YR 5/4) dry, silt loam; structureless; slightly sticky and plastic, friable moist, soft dry; many vesicular pores; many fine roots; pH 7.9; strong effervescence; gradual wavy boundary to

A3 2-6" Dark red (2.5 YR 3/6) moist with white mottling and reddish brown (5 YR 5/2) dry, silty olay; ooarse angular blooky; stioky and plastio, very friable moist, soft dry; many pores; common fine roots; veins of oaloium oarbonate and gypsum; pH 7.7; strong effervesoence; olear wavy boundary to

B2 6-15" Reddish brown to dark reddish brown (5 YR 3.5/4) moist and brown to dark brown (7.5 YR 4/4) dry; olay loam; coarse subangular blooky; slightly stioky and plastio, friable moist, soft dry; many pores; oommon fine roots; many lenses and veins of oaloium oarbonate and powdery gypsum; pH 7.7; strong effervesoenoe; abrupt smooth boundary to

C1 15-40" Reddish brown to dark reddish brown (5 YR 3.5/4) moist and brown to dark brown (7.5 YR 4/4) dry, olay; massive breaking to fine angular blooky; stioky and plastic, friable moist, hard dry; few pores; very few roots; some quartz grains; pH 8.1; very strong effervesoenoe; diffuse irregular boundary to

IIC2 40-62"+ Mixed material of sand, quartz, oaloium oarbonate, gypsum, gravel and olay; massive; slightly stioky and plastic, friable moist, moderately hard dry; oommon pores; pH 8.0; very strong effervesoenoe.

Range of characteristics

This is a deep, imperfeotly drained, soil. Colours range from olive brown to dark reddish brown to reddish yellow but the colour of the subsoil is more uniform. Texture ranges from sandy loam to olay in the topsoil and sandy clay loam to olay in the subsoil. The subsoil is usually oompacted with large aooumulations of oaloium carbonate, gypsum and some gravels.

Land-use and agricultural potential

This is a fine textured soil with drainage problems. With irrigation it might improve through the dilution of some of the compacting agents. It is suited for a wide range of crops but careful management is required.

Site information

a. Soil name: UNIT 223.
b. Higher category classification: Reddish Prairie. Aridic-Argiustoll (5.63-4). Revised 7th Approximation (1964).
c. Date of examination: 12th January, 1966.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Approximately 3 miles southwest of Hedaru, Tanzania in the road Hedaru-Mbuyuni, and 1 mile north of the road.
f. Elevation: 1925-1950 feet.
g. Land-form:
   i. Physiographic position of the site: Lower pediments of the Pare mountains.
   ii. Land form of surrounding country: Flat, some gullies.
   iii. Microtopography: Slight pseudo-gilgai.
h. Slope: Flat.
i. Vegetation and land-use: Dense Acacia bush; game and cattle grazing.

General soil information

a. Parent material: Colluvial sediments from the Pare mountains.
b. Drainage: Class 2 - imperfectly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some gullies and wind erosion.
g. Salinity or alkalinity: Class 1 - soils slightly affected by salt or alkali.
h. Human influence: Nil.

Brief description of profile

This is a deep, imperfectly drained soil with textures ranging through silt loam and clay loam to a clay B2 horizon. Dark brown, with an horizon of calcium accumulation and gypsum in the lower subsoil.

Profile description

A1 0-4" Dark yellowish brown (10 YR 3.5/4) moist and brown to strong brown (7.5 YR 5/4.5) dry, silt loam; weak granular; slightly sticky and slightly plastic, friable moist, soft dry; many vesicular and interstitial pores; frequent fine and medium

roots; pH 7.4; strong effervescence; clear smooth boundary to

B1 4-11" Dark brown (7.5 YR 3/4) moist and brown to dark brown (7.5 YR 2/4) dry; silty clay loam; medium sub-angular blocky; non sticky and plastic, friable moist, slightly hard dry; many pores; common fine and medium roots; quartz grains; few clay cutans; pH 7.5; strong effervescence; abrupt smooth boundary to

B21t 11-20" Dark brown (7.5 YR 3/4) moist and brown to dark brown (7.5 YR 4/4) dry, clay loam; coarse and medium sub-angular blocky; sticky and plastic, friable moist, hard dry; few pores; common medium and fine roots; common clay cutans; many quartz grains; pH 7.8; strong effervescence; gradual irregular boundary to

B22t 20-30" Dark brown (7.5 YR 3/2) moist and reddish brown to dark reddish brown (5 YR 3.5/3) dry, clay; coarse sub-angular blocky; sticky and very plastic, firm moist, hard dry; few pores; few medium roots; many clay cutans; pH 7.8; very strong effervescence; clear wavy boundary to

B3ca 30-46"+ Dark reddish brown (5 YR 3/2) moist with white and brown mottling, and dark brown (7.5 YR 3/2) dry, clay; massive breaking to medium angular blocky; sticky and plastic, slightly friable moist, hard dry; very few clay cutans; pH 7.9; very strongly effervescent.

Range of characteristics

This is a very minor soil unit. More detailed studies will produce more precise information.

Land-use and agricultural potential

This is a fairly good soil and suited for a wide range of crops. Its main limitation is its slow internal drainage, fine texture and slight salinity. Before any agricultural development is started more intensive studies in this as well as in other soils will be needed.

Site information

a. Soil name: UNIT 224.
b. Higher category classification: Reddish Brown Lateritic. Ustalf (7.4). Revised 7th Approximation (1964).
c. Date of examination: 13th January, 1966.

d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Approximately 3 miles southwest of Hedaru, Tanzania, on the road Hedaru-Mbuyuni, 1½ miles north of the road.
f. Elevation: 1950-1975 feet.
g. Land form:
  i. Physiographic position of the site: Piedmont of the Pare mountains.
  ii. Land form of surrounding country: Flat, few gullies.
  iii. Microtopography: Nil.
h. Slope: Flat.
i. Vegetation and land-use: Scattered low bushes. Game and some cattle grazing.

General soil information

a. Parent material: Colluvial sediments from the Pare mountains.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some wind erosion, few gullies.
g. Salinity or alkalinity: Class 1 - soil slightly affected by salt or alkali.
h. Human influence: Nil.

Brief description of profile

A deep, well drained, dark reddish brown to dark yellowish red, clay loam soil with good open structure. Strongly effervescent throughout. Fluffy surfaoe with discontinuous cracking.

Profile description

A1 0-2" Dark reddish brown (5 YR 3/4) moist and brown to dark brown (7.5 YR 4/4) dry, clay loam; sticky and plastic, friable moist, soft dry; many vesicular and interstitial pores; frequent fine and medium roots; pH 7.7; strongly effervescent; clear wavy boundary to

B2 2-10" Reddish brown to dark brown (5 YR 3.5/4) moist and same colour dry, clay loam; medium and coarse sub-angular blocky; sticky and plastic, friable moist, moderately hard dry; common pores; common fine roots; common clay cutans; pH 7.8; moderately effervescent.

B3 10-30" Dark yellowish red (5 YR 2/6) moist and same colour dry, clay loam; massive breaking to fine and medium angular blocky; sticky and plastic, friable moist, moderately hard dry; few pores; common fine roots; calcium carbonate concretions in veins; pH 7.8; moderately effervescent.

C 30-36"+ Dark brown (5 YR 3/3) moist with white mottling and mixed brown and dark reddish brown dry, silty clay; massive; slightly sticky and plastic, friable moist, slightly hard dry; few pores; calcium carbonate in veins mixed with yellowish material; pH 8.0; strongly effervescent.

Range of characteristics

The full range of characteristics is not well known. From the existing observations this soil is deep and well drained with uniform colours and textures ranging from sandy olay to clay. Some discontinuous cracking at the surface which is crusty and fluffy. Some small gravels occur on the surface. A few gullies may be present.

Land-use and agricultural potential

This is a good soil suitable for a wide range of crops. The wide range of texture may cause internal drainage diffioulties. Salinity hazard from the soils in the vicinity may contaminate this unit if there is not proper management.

Site information

a. Soil name: UNIT 227 (includes depth phases and a fine textured variant).
b. Higher category classification: Reddish Brown Lateritic. Ustalf (7.4). Revised 7th Approximation (1964).
c. Date of examination: 6th, 7th and 11th January, 1966.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Deep phase, 10 miles west of Hedaru on the road Hedaru to Mbuyuni; medium phase 6 miles west of Hedaru; same road, 1½ mile north of road; shallow phase: 6 miles west of Hedaru same road; fine textured phase 227c: 10 miles west of Hedaru on the same road; Hedaru, Tanzania.
f. Elevation: 2000-2050 feet.
g. Land form:
   i. Physiographic position of the site: Low ridge between the Pare mountains and the Lasiti-Surlui hills.
   ii. Land form of surrounding oountry: Flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat.
i. Vegetation and land-use: Low shrubs and sparse low Acacia trees. Almost no grass cover. Game and Masai cattle grazing.

General soil information

a. Parent material: Colluvial sediments from Basement Complex rooks underlain by old alluvial gravels and sediments.
b. Drainage: Class 4 - well drained.

c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Fair rocky outcrops follow a north-south direction. Large areas without outcrops.
f. Evidence of erosion: Some wind erosion.
g. Salinity or alkalinity: Class 0 - soils free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

This is a well drained soil which varies in depth over short distances. Often underlain by a layer of gravel and/or weathered rocks cemented with calcium carbonate which roots can penetrate. Dark red and yellowish red sandy loam, with depth phases to the gravel. Variants are according to the clay content.

Profile description
(The deep phase of Unit 227).

A11 0-1.5" Dark reddish brown (5 YR 3/4) moist and yellowish red (5 YR 4/6) dry, sandy loam; platy breaking to angular blocky; non sticky and non plastic, friable moist, soft dry; many vesicular and interstitial pores; frequent fine roots; pH 7.2; non effervescent; clear smooth boundary to

A12 1.5-10" Dark red (2.5YR 3/4.5) moist and red (2.5 YR 4/6) dry, sandy clay loam; fine sub-angular blocky; non sticky and slightly plastic, friable moist, soft dry; many pores; frequent fine and common medium roots; pH 7.0; gradual irregular boundary to

A13 10-20" Dark red (2.5 YR 3/6) moist and red (2.5 YR 4/6) dry, gritty sandy loam; medium sub-angular blocky; non sticky and non plastic, friable moist, slightly hard dry; many pores; abundant fine roots and few medium and coarse ones; many quartz grains; pH 7.0; non effervescent; gradual irregular boundary to

AC 20-34" Dark red (2.5 YR 3/6) moist and red (2.5 YR 4/6) dry, gravelly sandy loam; medium sub-angular blocky; non sticky and slightly plastic, friable moist, slightly hard dry; many pores; abundant fine roots; 30% gravel highly weathered; pH 7.2; non effervescent; clear wavy boundary to

C1 34-48" Dark red (2.5 YR 3/6) moist and red (2.5 YR 5/6) dry, loamy sand; structureless; many pores; frequent fine roots; increasing amount of gravels; pH 7.3; strong effervescence; clear wavy boundary to

C2 48-55" Red to dark red (2.5 YR 3.5/6) moist and red (2.5 YR 5/6) dry, gravelly sand; massive breaking to sub-angular blocky; non sticky and non plastic, friable moist, hard dry; many pores; abundant fine roots; compacted layer easy to break and roots pass through; pH 7.3; strongly effervescent; abrupt smooth boundary to

IIC3 55-62"+ Mainly platy very weathered rocks of Basement Complex. Strong effervescence.

Range of characteristics

This is a well drained soil. Depth to the dense gravel layer varies from less than 10 inches to more than 30 inches. The fine textured variant (227C) has textures ranging from sandy clay loam to clay loam. Colours are uniform. This area of fine textured soils is located in slightly depressed areas. Discontinuous cracking and sink holes are evident.

Land-use and agricultural potential

A more detailed soil study is required in order to establish the agricultural potential of this unit. The amounts of the different depth phases are not yet known, and such studies would be essential before any irrigation programme is established. From the observed profiles this is a good soil, with good aeration and no drainage problems, but may require fertilizers. Suited to a wide range of crops. The shallow phases oan be devoted to pasture, forestry and some fruit trees like citrus.

Site information

a. Soil name: UNIT 230.
b. Higher category classification: Brunizem, Normargidic Argiustoll (5.63-4.25). Revised 7th Approximation (1964).
c. Date of examination: 12th January, 1966.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Approximately 5 miles west of Hedaru on the road Hedaru-Mbuyuni, 1 mile east of main drainage line, Hedaru, Tanzania.
f. Elevation: 1925-1975 feet.
g. Land form:
   i. Physiographic position of the site: High terrace.
   ii. Land form of surrounding country: Flat to slightly concave.
   iii. Microtopography: Some pseudo-gilgai.
h. Slope: Class 1 - flat or almost flat.
i. Vegetation and land-use: Scattered small shrubs and low Acacias. Game and some cattle grazing.

General soil information

a. Parent material: Old lacustrine sediments containing lime and gypsum and covered with mixed alluvium and colluvium.
b. Drainage: Class 0 - very poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some wind erosion.
g. Salinity or alkalinity: Class 1 - slightly affected with inclusions of Class 3 - strongly affected by salt and alkali.
h. Human influence; Nil.

Brief description of profile

This is a deep, very poorly drained, dark greyish brown, silty clay loam soil with increasing amount of clay with depth. It has a well defined B2 horizon with clay cutans. Some bare areas occur corresponding to high concentrations of salinity, alkalinity and patches of limestone.

Profile description

A1 0-3" Dark brown (10 YR 3.5/3) moist and brown (10 YR 5/3) dry, silt loam; weak granular; non sticky, slightly plastic, friable moist, soft dry; many vesicular and interstitial pores; frequent fine roots; some scattered gravels on surface; pH 7.9; strongly effervescent; clear wavy boundary to

A3 3-7" Dark greyish brown (10 YR 4/2) moist and greyish brown (2.5 YR 5/2) dry, silty clay loam; medium sub-angular blocky; non sticky and plastic, friable moist, soft dry; many pores; frequent fine and medium roots; pH 7.8; strongly effervescent; gradual wavy boundary to

B1 7-14" Dark greyish brown (10 YR 4/2) moist and same colour dry, silty clay loam; coarse sub-angular blocky; non sticky and plastic, slightly friable moist, hard dry; few pores; many fine and medium roots; very few clay cutans; some quartz grains; pH 8.0; very strongly effervescent; clear wavy boundary to

B2 14-24" Same colour as above, silty clay; medium and coarse sub-angular blocky; sticky and plastic, slightly friable moist, hard dry; very few pores; very few medium roots; common clay cutans; some gravels; pH 8.1; very strongly effervescent; diffuse irregular boundary to

B3 24-37" Dark greyish brown (2.5 Y 4/2) moist and greyish brown (2.5 Y 5/2) dry, clay; massive breaking to irregular medium angular blocky; slightly sticky and plastic, slightly friable moist,

hard dry; few clay cutans; pH 8.0; very strongly effervescent; diffuse irregular boundary to

C 37-53"+ Very dark grey (5 Y 3/1) moist with brown mottling and white gypsum, very dark greyish brown (10 YR 3/2) dry, clay; massive; non sticky and plastic, firm moist, very hard dry; pH 8.0; very strongly effervescent.

Range of characteristics

This is a deep, very poorly drained soil that is unusually fine textured. Colours are consistent, with slight changes between dark brown, brown and yellowish brown. Some pseudo-gilgai with discontinuous cracking and sink holes. Spots of solonetz soils.

Similar and associated soils

A most important inclusion is the presence in extensive spots or patches of a highly alkaline soil (Unit 254) which is solonetz-like with typical columnar structure in the B2 and high exchangeable sodium content. This limits the use of the whole area of Unit 230.

Land-use and agricultural potential

The suitability of this soil is limited by its fine texture, very poor drainage and presence of highly alkaline spots of Unit 254. It is not recommended for permanent agriculture without reclamation and improvement of the drainage.

Site information

a. Soil name: UNIT 232.
b. Higher category classification: Brunizem? Mollic-Haplargid (4.21-5). Revised 7th Approximation (1964).
c. Date of examination: 11th January, 1966.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: 10 miles southwest of Hedaru along the road Hedaru-Mbuyuni, 4½ miles north of the road, Hedaru, Tanzania.
f. Elevation: 2025 feet.
g. Land form:
   i. Physiographic position of the site: Large depression in colluvial plain.
   ii. Land form of surrounding country: Flat.
   iii. Microtopography: Pseudo-gilgai.
h. Slope: Class 1 - flat or almost flat to slightly concave.
i. Vegetation and land-use: Low xerophitic vegetation. Game.

General soil information

a. Parent material: Lacustrine clay mixed with fine silty colluvium and alluvium.
b. Drainage: Class 0 - very poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some wind erosion.
g. Salinity or alkalinity: Class 1 - soils slightly affected by salt or alkali.
h. Human influence: Nil.

Brief description of the profile

A deep, very poorly drained soil with alternate layers of dark greyish brown and dark brown. A sequence of increasingly fine textures with depth, namely silt-loam, silty clay loam, silty clay and clay. Deep sink holes and discontinuous crack with a pseudo-gilgai microtopography.

Profile description

A1 0-3" Dark greyish brown (10 YR 4/2) moist and grey to light grey (10 YR 6/1) dry, silt loam; fine irregular sub-angular blocky; slightly sticky and slightly plastic, friable moist, moderately hard dry; many vesicular and interstitial pores; frequent medium roots; some coarse gravels on surface; pH 7.3; strongly effervescent; clear wavy boundary to

B21t 3-10" Dark brown (10 YR 3.5/3) moist with white mottling and brown to dark brown (10 YR 4/3) dry, silty clay loam; non-sticky and plastic, friable moist, slightly hard dry; medium and coarse angular blocky; many pores; frequent medium roots; few clay cutans; few small gravels; pH 7.7; strongly effervescent; gradual boundary to

B22ca 10-24" Dark greyish brown to very dark greyish brown (10 YR 3.5/2) moist and greyish brown (10 YR 5/2) dry, silty clay with increasing amount of gravels and $CaCO_3$ concretions; coarse sub-angular blocky; sticky and plastic, friable moist, slightly hard dry; many pores; frequent medium roots; few clay cutans; pH 7.8; strongly effervescent; gradual irregular boundary to

C1 24-44" Brown to dark brown (10 YR 4/3) moist and grey (10 YR 5/1) dry, clay with small gravels and $CaCO_3$ concretions; massive; sticky and very plastic, friable moist, hard dry; few pores; few medium roots; pH 7.6; strongly effervescent; clear wavy boundary to

IIB2b 44-54" Very dark greyish brown (10 YR 3/2) moist and grey to dark grey (10 YR 4.5/1) dry, clay with some gravels; massive; sticky and plastic, friable moist, hard dry; few pores; old clay cutans; pH 7.8; strongly effervescent.

Range of characteristics

This is a deep, very poorly drained soil, with deep clay inclusions and outcrops of limestone only in the border with the Unit 227. Pseudo-gilgai and continuous cracking at the surface. Some gravels. Colours are uniform and consistent unless influenced by limestone accumulation or in the vicinities of the red soils of Unit 227. Soil Unit 255 is a very shallow inclusion of cemented calcium carbonate soil occurring at the edge of the present soil unit described above. It covers minor areas mainly in spots or irregular patches.

Land-use and agricultural potential

This is a deep soil with limitations due to fine texture and very poor drainage. Salinity hazards would be severe without good management. The range of crops is very limited.

Site information

a. Soil name: UNIT 233.
b. Higher category classification: Intergrade Brunizem-Reddish Chestnut; Aridic-Argiustoll (5.63-4). Revised 7th Approximation (1964).
c. Date of examination: 12th January, 1966.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: 4½ miles southwest of Hedaru along the Hedaru-Mbuyuni road and 1½ miles north of road; 2 miles east of main drainage line; Hedaru, Tanzania.
f. Elevation: 1925-1950 feet.
g. Land form:
   i. Physiographic position of the site: Piedmont of the Pare mountains.
   ii. Land form of surrounding country: Flat to slightly concave with some mounds of limestone.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat.
i. Vegetation and land-use: Clumps of very low shrubs with some bush and low trees. Some Acacias. Game with some Masai cattle grazing.

General soil information

a. Parent material: Colluvial sediments underlain by silty clays enriched with calcium carbonate.

b. Drainage: Class 1 - poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some wind erosion.
g. Salinity or alkalinity: Class 2 - soils moderately affected by salt or alkali.
h. Human influence: Nil.

Brief description of profile

This is a deep, poorly drained, brown to dark brown over dark yellowish brown, silty clay loam soil with horizons of silty clay. Affected by salinity and alkalinity, with a B2 horizon of clay accumulation and another horizon of calcium carbonate accumulation. A gilgai-like microtopography is characteristic and some cemented calcium carbonate mounds occur.

Profile description

A1 0-3" Brown to dark brown (7.5 YR 4/4) moist and pale brown (10 YR 6/3) dry, silt loam; fine sub-angular blocky; non sticky and slightly plastic, friable moist, soft dry; many pores; frequent fine and medium roots; pH 7.7; strongly effervescent; clear wavy boundary to

A3 3-8" Brown to dark brown (7.5 YR 4/4) moist and brown (7.5 YR 5/4) dry, silty clay loam; medium sub-angular blocky; non sticky and slightly plastic, friable moist, soft dry; many pores; frequent fine and medium roots; few small concretions of calcium carbonate and gravels; pH 7.8; strongly effervescent; gradual wavy boundary to

B21t 8-16" Same colour as above, silty clay; medium and coarse angular blocky; tendency to coarse prismatic structure; slightly sticky and plastic, firm moist, hard dry; common pores; few fine roots; common clay cutans; small quartz-like grains; pH 8.0; strongly effervescent; clear, smooth boundary to

B22t 16-27" Dark yellowish brown (10 YR 4/4) moist and yellowish brown (10 YR 5/4) dry, silty clay loam; medium angular blocky; slightly sticky and plastic, slightly friable moist, moderately hard dry; common pores; few medium fine roots; common clay cutans; some quartz grains; pH 8.5; very strongly effervescent; abrupt smooth boundary to

B3ca 27-38" Brown to dark brown to dark yellowish brown (10 YR 4/3.5) moist and brown (10 YR 5/3) dry, silty clay; massive breaking to fine and medium angular blocky; non sticky and plastic, slightly friable moist, hard dry; few pores; pH 8.6; very strongly effervescent; clear smooth boundary to

IIC1 38-58" Brown to dark brown (10 YR 4/3) moist and light brownish grey to greyish brown (2.5 YR 5.5/2) dry, silty clay loam; massive; non sticky and plastic, friable moist, moderately hard dry; mixed materials; pH 8.5; strongly effervescent.

Range of characteristics

This is a deep, poorly drained soil, with gilgai-like microtopography, discontinuous cracking and sink holes. The colour of the topsoil ranges from dark yellowish brown to pale brown (dry) and the subsoil from very dark greyish brown to very pale brown. Textures range from sandy loam to clay. It is a heterogeneous unit with many inclusions of sandy and clayey soils and outcrops of cemented limestone. Gravels occur on the surface and spots of highly alkaline soils are common.

Land-use and agricultural potential

Moderately suited for irrigation for a narrow range of crops with limitations due to fine texture, poor drainage and highly alkaline spots. Some areas of almost pure limestone. Tolerant crops could be considered as well as adapted pasture and forestry.

Site information

a. Soil name: UNIT 234.
b. Higher category classification: Reddish Chestnut. Ustoll (5.6). Revised 7th Approximation (1964).
c. Date of examination: 11th January, 1966.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: 4.5 miles southwest of Hedaru along the road Hedaru-Mbuyuni, and 2 miles north of the road, along cut-line, 2 miles east of main drainage line; Hedaru, Tanzania.
f. Elevation: 1925-1950 feet.
g. Land form:
   i. Physiographic position of the site: Footslopes of the Pare mountains.
   ii. Land form of surrounding country: Flat to slightly convex.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat.
i. Vegetation and land-use: Few Acacia and almost no ground cover. Game and some Masai cattle grazing.

General soil information

a. Parent material: Highly caloareous colluvial sediments.
b. Drainage: Class 2 - imperfectly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.

e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some wind erosion.
g. Salinity or alkalinity: Class 1 - soils slightly affected by salt or alkali.
h. Human influence: Nil.

Brief description of profile

This is a deep, imperfectly drained soil. Brown to dark brown underlain by dark greyish brown, silty clay loam with silty clay subsoil. Few spots of salinity. Horizons of clay and calcium carbonate accumulation and some calcium carbonate concretions and gravels at the surface.

Profile description

A1 0-3" Brown to dark brown (10 YR 4/3) moist and pale brown (10 YR 6/3) dry, silt loam; weak fine granular; slightly sticky and slightly plastic, very friable moist, soft dry; many vesicular and interstitial pores; abundant fine and few medium and coarse roots; pH 8.1; very strongly effervescent; clear wavy boundary to

B1 3-10" Dark brown (10 YR 3/3) moist and brown to dark brown (10 YR 4/3) dry, silty clay loam; fine sub-angular blocky; slightly sticky and slightly plastic, friable moist, slightly hard dry; many pores; common fine medium roots; pH 8.1; very strongly effervescent; gradual wavy boundary to

B2 10-21" Dark brown (10 YR 3.5/3) moist and brown to dark brown to dark greyish brown (10 YR 4/2.5) dry, silty clay; medium sub-angular blocky; non sticky and plastic, friable moist, slightly hard dry; many pores; common medium roots; few clay cutans; pH 8.0; strongly effervescent; gradual irregular boundary to

C1ca 21-50"+ Dark greyish brown (10 YR 4/2) moist and greyish brown (10 YR 5/2) dry with white mottling, silty clay; massive; slightly sticky and plastic, friable moist, slightly hard dry; calcium carbonate concretions; few pores; pH 8.4; very strongly effervescent.

Range of characteristics

The top soil may vary from a few inches to 2-3 feet in irregular patterns. Some scattered gravel and calcium carbonate concretions occur. Some saline and alkaline spots. The colour of the topsoil ranges between dark greyish brown and light grey and the subsoil between dark brown and pale brown. Textures vary from sandy loam to sandy clay and clay loam.

Land-use and agricultural potential

Main limitations derive from the somewhat fine texture, imperfect drainage, and presence of saline and alkaline spots in irregular distribution. Well suited for grasses and forestry as well as fruit trees.

Site information

a. Soil name: UNIT 234L.
b. Higher category classification: Reddish Chestnut. Ustoll (5.6). Revised 7th Approximation (1964).
c. Date of examination: 19th January, 1966.
d. Authors: N. Mikenberg and J. Kyaruzi.
e. Location:: 3 miles southwest of Hedaru along the Hedaru-Mbuyuni road $\frac{3}{4}$ mile north of the road, Hedaru, Tanzania.
f. Elevation: 1875-1950 feet.
g. Land form:
   i. Physiographic position of the site: High terrace.
   ii. Land form of surrounding country: Flat.
   iii. Microtopography: Nil. Some pseudo-gilgai.
h. Slope: Class 1 - flat or almost flat.
i. Vegetation and land-use: Low bush in clumps and large open spaces without ground cover. Game and some Masai cattle grazing.

General soil information

a. Parent material: Colluvial sediments underlain by old lacustrine deposits enriched with gypsum and calcium carbonate.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some wind erosion.
g. Salinity or alkalinity: Class 1 - soils slightly affected by salt or alkali.
h. Human influence: Nil.

Brief description of profile

This is deep, moderately welldrained soil, with alternate horizons of dark brown and dark greyish brown, silty clay loam underlain by silty clay and clay in the subsoil. A good developed structure with some discontinuous cracking at the surface. Calcium carbonate and gypsum increases in amount with depth.

Profile description

A11 0-1.5" Dark grey to dark greyish brown (10 YR 4.5/2) moist and dark greyish brown (10 YR 4/2) dry, fine sandy loam; weak granular to structureless; non sticky and plastic, friable moist, soft dry; many vesicular and interstitial pores; frequent fine and medium roots; pH 7.5; strongly effervescent; clear wavy boundary to

A12 1.5-8" Dark brown (10 YR 3/3) moist and same colour dry, silty clay loam; coarse blocky; slightly sticky and plastic, friable moist, moderately hard dry; many pores; common fine and medium roots; some veins of gypsum and calcium carbonate; pH 7.7; very strongly effervescent; gradual irregular boundary to

B2 8-15" Dark brown (10 YR 3/3) moist and dark greyish brown (10 YR 4/2) dry, silty clay; medium sub-angular blocky; sticky and very plastic, friable moist, moderately hard dry; few pores; few medium roots; few clay cutans; some quartz grains; pH 7.9; very strongly effervescent; gradual irregular boundary to

BC 15-26" Dark greyish brown (10 YR 4/2) moist and dark grey (10 YR 4/1) dry, clay; massive; sticky and very plastic, friable moist, hard dry; few pores; few roots; some gypsum in veins; pH 8.0; very strongly effervescent.

C1 26-33" Dark greyish brown (10 YR 4/2) moist and dark brown to dark greyish brown (10 YR 4.5/2) dry; clay; massive; sticky and very plastic, friable moist, hard dry; few pores; few roots; increasing amount of gypsum; pH 8.0; very strongly effervescent.

C2 33-41"+ Dark grey to very dark grey (10 YR 3.5/1) moist and very dark grey (10 YR 3/1) dry with white specks, clay; massive; sticky and very plastic, friable moist, hard dry; few pores; large amount of gypsum; pH 8.0; very strongly effervescent.

Range of characteristics

This is a deep, moderately well drained soil, with discontinuous cracking on surface, sink holes, fluffy surface, and gypsum and calcium carbonate in the subsoil. It is consistently somewhat fine textured with some inclusions of clay. The colour of the topsoil ranges between dark brown and light brownish grey and the colour of the subsoil between very dark grey to dark yellowish brown (dry).

Land-use and agricultural potential

This is a good soil but with limitations due to fine textured inclusions and slow water intake. Suited to a wide range of crops.

SOIL ANALYSES TABLE VI

HEDARU SEMI-DETAILED SURVEY

A. MAIN DATA - ALL PROFILES

UNIT No.	Depth Inches	pH in Water			Conductivity millimhos at 25°C		Calcium Carbonate	Saturation percentage
		Saturated Paste	1:5 W/V	1:10 W/V	Saturation Extract	1:5 W/V	per cent	
206	0-2	7.9	8.1	-	0.45	0.12	-	63
	2-10	7.8	8.3	-	0.85	0.22	-	62
	10-24	7.4	8.0	-	12.4	2.3	-	56
	24-40	7.8	8.2	-	1.47	0.28	-	61
	40-50	7.7	8.2	-	9.6	1.50	-	61
213	0-2	7.8	8.1	-	0.49	0.13	10	57
	2-10	7.7	7.7	-	2.8	2.2	10	68
	10-20	7.7	7.8	-	3.4	2.6	9	71
	20-30	7.7	7.8	-	8.8	3.9	7	71
	30-36	7.8	8.0	-	13.9	5.4	7	86
214	0-2	7.9	8.2	-	0.39	0.16	12	71
	2-8	7.9	8.2	-	0.64	0.19	12	72
	8-24	7.7	7.9	-	4.1	1.32	12	77
	24-30	7.8	7.9	-	8.8	3.9	9	82
	30-36	7.9	8.0	-	11.3	4.5	10	89
214L	0-2	7.7	7.7	-	0.49	0.09	NIL	54
	2-12	7.9	8.1	-	1.03	0.15	NIL	53
	12-26	7.9	8.4	-	1.07	0.23	NIL	56
	26-33	7.7	7.7	-	9.0	3.2	NIL	61
	33-39	7.7	7.9	-	9.8	3.2	NIL	63
215	0-2	7.5	8.0	-	0.60	0.15	NIL	56
	2-12	7.4	8.2	-	0.83	0.12	NIL	62
	12-20	7.9	8.8	9.3	0.90	0.19	NIL	55
	20-29	7.8	8.4	-	6.0	1.13	NIL	64
	29-35	7.7	7.9	-	8.1	2.8	NIL	69
215R	0-2	8.0	8.5	-	0.40	0.11	5	41
	2-10	7.8	8.3	-	1.22	0.16	1	30
	10-24	7.7	8.3	-	1.77	0.25	6	44
	24-32	7.6	8.1	-	6.6	0.68	9	45
	32-36	7.6	8.2	-	9.7	1.08	9	48
216	0-1	8.0	8.8	8.9	0.53	0.13	11	25
	1-13	8.0	8.8	8.9	0.54	0.12	15	41
	13-24	8.0	8.6	8.8	0.46	0.13	32	42
	24-32	8.2	8.8	9.0	0.32	0.13	48	43
	32-36	8.3	8.8	8.9	0.37	0.13	39	38
222	0-2	7.7	7.8	-	2.8	2.4	8	59
	2-6	7.7	7.7	-	2.6	2.4	7	66
	6-15	7.5	7.6	-	10.5	3.9	8	76
	15-40	8.0	8.0	-	>20	5.9	9	81
	40-62	7.9	7.9	-	>20	6.6	17	92
223	0-4	8.0	8.3	8.6	0.79	0.11	7	38
	4-11	8.0	8.4	8.9	1.54	0.19	11	48
	11-20	8.3	8.9	9.5	1.62	0.38	7	64
	20-30	8.3	8.9	9.5	6.1	1.07	8	72
	30-46	8.0	8.2	8.1	13.2	4.5	8	74
224	0-2	8.2	8.3	8.6	0.43	0.12	-	57
	2-10	8.3	8.6	9.1	1.28	0.31	-	64
	10-30	8.1	8.6	9.2	7.0	1.22	-	75
	30-36	7.9	8.0	8.2	12.4	4.4	8	68
227A	0-2	6.9	7.0	-	0.47	0.07	NIL	24
	2-27	7.7	8.1	-	0.50	0.08	NIL	34
	27-43	7.9	8.1	-	1.56	0.24	7	43
	43-60	7.8	8.1	-	2.9	0.46	10	54
227C	0-8	7.8	8.1	-	0.92	0.14	-	48
	8-29	7.8	8.0	-	0.45	0.13	-	54
	29-36	7.8	8.3	-	0.46	0.14	-	58
	36-45	7.9	8.1	-	0.50	0.15	-	60

SOIL ANALYSES TABLE VI

HEDARU - SEMI-DETAILED SURVEY

A. MAIN DATA - ALL PROFILES

227d	0-1.5	6.4	7.1	-	0.55	0.03	NIL	20
	1.5-10	6.9	7.3	-	0.37	0.05	NIL	24
	10-20	6.3	6.9	-	0.45	0.05	NIL	28
	20-34	6.5	6.7	-	0.38	0.06	NIL	32
	34-48	7.5	8.0	-	0.84	0.14	3	34
	48-55	7.8	7.8	-	3.5	2.5	9	35
	55-62	7.8	7.8	-	5.6	3.0	16	34
227m	0-2	6.4	7.0	-	0.39	0.05	NIL	20
	2-19	6.5	7.1	-	0.36	0.05	NIL	27
	19-24	7.7	8.3	-	0.58	0.13	-	32
	24-28	7.8	8.2	-	0.51	0.12	-	34
	28-36	-	8.0	-	-	0.70	-	-
	36-48	8.0	8.4	-	1.06	0.20	20	32
227s	0-3	7.9	8.4	-	0.31	0.07	2	19
	3-11	7.4	7.7	-	0.38	0.08	1	26
	11-22	7.9	8.3	-	1.33	0.22	8	35
	22-46	7.9	8.3	-	1.11	0.20	19	39
	46-66	8.2	8.8	9.0	1.48	0.25	24	37
230	0-3	8.2	8.5	8.7	0.83	0.16	9	48
	3-7	8.3	8.5	9.0	0.73	0.19	9	53
	7-14	8.2	8.6	9.1	3.0	0.39	8	51
	14-24	8.1	8.6	9.2	8.6	1.07	9	59
	24-37	8.2	8.8	9.3	11.6	1.88	9	72
	37-53	8.2	8.4	8.5	15.8	6.1	8	75
232	0-3	8.0	8.1	-	0.54	0.14	10	56
	3-10	7.9	8.2	-	0.58	0.18	11	59
	10-24	8.0	8.1	-	0.68	0.19	9	62
	24-44	8.1	8.4	-	0.73	0.24	9	66
	44-54	8.0	8.1	-	4.5	1.51	9	67
233	0-3	8.1	8.4	8.5	0.47	0.15	17	49
	3-8	8.2	8.4	8.9	0.54	0.17	19	55
	8-16	8.3	8.8	9.2	0.81	0.25	16	57
	16-27	8.5	9.0	9.5	1.77	0.32	17	64
	27-38	8.7	9.5	9.6	4.2	0.62	19	72
	38-58	8.6	9.3	9.7	4.4	0.94	22	86
234	0-3	8.1	8.2	8.7	0.86	0.18	16	40
	3-10	8.4	8.5	9.0	1.48	0.27	15	54
	10-21	8.3	8.6	9.1	12.0	2.00	16	56
	21-50	8.2	8.3	8.5	15.0	4.8	16	72
234L	0-1.5	8.0	8.6	8.8	0.47	0.13	8	55
	1.5-8	8.1	8.8	9.2	1.11	2.22	10	59
	8-15	8.1	9.2	9.4	0.79	0.25	9	60
	15-26	8.2	9.3	9.5	0.77	0.29	9	68
	26-33	8.2	9.3	9.6	1.26	0.37	9	72
	33-41	7.9	8.0	8.2	8.5	3.8	11	80
254	0-2	8.5	9.1	9.2	0.90	0.18	7	22
	2-9	8.4	9.6	10.0	6.7	1.09	17	52
	9-16	9.0	9.7	10.0	12.8	2.6	14	73
	16-43	9.3	9.8	9.9	17.6	3.2	15	78
256	0-1	8.2	8.2	8.6	0.41	0.16	17	47
	1-12/24	8.4	8.6	8.8	0.43	0.13	31	49
	12/24-36	8.5	9.0	9.4	2.7	0.41	39	53

NOTES:
1. All analyses were determined after July 1965.
2. Calcium carbonate values are estimated by acid neutralization; they are calculated on air-dry soil.
3. A dash (-) indicates that the analysis was not done.

SOIL ANALYSES TABLE VI.

HEDARU SEMI-DETAILED SURVEY

B. WATER SOLUBLE CATIONS AND ANIONS ON SALINE SOILS

UNIT No.	Depth Inches	Water Soluble Cations milliequivalent per 100g soil					Water Soluble Anoins milliequivalent per 100g soil				
		Calcium	Magnesium	Sodium	Potassium	Total	Chloride	Sulphate	Bicarbonate	Carbonate	Total
206	10-24	6.0	1.1	4.4	T	11.5	6.0	4.6	1.7	NIL	12.3
	40-50	1.8	0.6	4.1	T	6.5	4.9	1.4	0.8	NIL	7.1
213	2-10	49	3	<1	T	52	0.2	50	-	NIL	-
	10-20	70	5	2	T	77	0.5	75	-	NIL	-
	20-30	64	7	10	T	81	2.8	80	-	NIL	-
	30-36	82	11	19	T	112	6.2	105	-	NIL	-
214	8-24	6.6	1.4	4.0	T	12.0	0.2	10.6	1.2	NIL	12.0
	24-30	33.4	6.8	13.6	0.1	53.9	1.8	48.8	1.4	NIL	52.0
	30-36	30.4	8.2	12.3	0.1	51.0	3.4	49.6	1.2	NIL	54.2
214L	26-33	10.6	4.3	8.2	T	23.1	2.4	20.3	1.3	NIL	24.0
	33-39	10.5	4.3	8.4	T	23.2	2.8	20.2	1.2	NIL	24.2
215	20-29	0.9	0.4	5.6	T	6.9	1.6	4.7	1.7	NIL	8.0
	29-35	9.8	3.4	7.7	T	20.9	1.8	18.4	1.7	NIL	21.9
215R	24-32	1.3	0.2	1.8	T	3.3	2.2	0.6	0.8	NIL	3.6
	32-36	1.3	0.4	3.4	T	5.1	3.6	0.6	1.0	NIL	5.2
222	0-2	87	2	<1	1	90	0.4	90	-	NIL	-
	2-6	270	3	<1	<1	274	0.4	270	-	NIL	-
	6-15	253	6	9	T	268	4.0	260	-	NIL	-
	15-40	239	9	22	T	270	8.0	260	-	NIL	-
	40-62	203	7	24	T	234	12.0	220	-	NIL	-
223	20-30	0.2	0.1	4.6	T	4.9	2.2	-	1.3	NIL	-
	30-46	43	6	17	T	66	3.6	60	-	NIL	-
224	10-30	0.2	0.1	5.2	T	5.5	3.1	1.4	1.2	NIL	5.7
	30-36	15.2	3.6	18.0	0.1	36.9	3.6	31.1	2.2	NIL	36.9
227d	48-55	156	.2	1	T	159	0.2	160	-	NIL	-
	55-62	65	4	2	T	71	0.4	70	-	NIL	-
230	14-24	0.3	0.4	4.0	T	4.7	3.5	-	1.1	NIL	-
	24-37	0.6	0.4	8.0	T	9.0	5.0	-	1.2	NIL	-
	37-53	34	7	30	T	71	4.4	65	-	NIL	-
232	44-54	9.2	2.9	3.0	0.2	15.3	0.4	13.5	1.2	NIL	15.1
233	38-58	0.2	0.2	4.6	T	5.0	1.4	-	2.2	NIL	-
234	10-21	0.5	0.4	7.8	T	8.7	3.8	4.2	1.0	NIL	9.0
	21-50	22.6	7.2	24.0	0.2	54.0	2.7	48.1	1.8	NIL	52.6
234L	33-41	14.7	4.4	8.8	0 1	28.0	2.0	25.8	1.0	NIL	28.8
254	9-16	0.2	0.1	11.8	T	12.1	4.7	4.5	3.6	0.4	13.2
	16-43	0.2	0.1	14.1	T	14.4	5.6	6.7	3.1	0.7	16.1

SOIL ANALYSES TABLE VI

HEDARU. SEMI-DETAILED SURVEY

C. SUPPLEMENTARY DATA ON SELECTED SOILS

UNIT No.	Depth Inches	Particle Size Distribution per cent of mineral fraction				Cations extracted with N ammonium acetate milliequivalent per 100g soil					Available Phosphorus ppm
		Coarse Sand	Fine Sand	Silt	Clay	Calcium	Magnesium	Sodium	Potassium	Total	OLSEN
206	0-2	8	24	33	35	44.5	11.5	0.4	4.1	60.5	11.7
	2-10	4	29	30	37	48.0	13.5	0.8	3.2	65.5	7.7
	10-24	4	29	26	41	-	15.5	4.0	2.4	-	5.6
	24-40	11	33	21	35	44.0	12.5	1.4	2.7	60.6	5.6
	40-50	20	36	8	36	-	9.5	5.0	2.0	-	3.7
214	0-2	14	48	7	31	-	-	0.8	11.0	-	7.7
	2-8	4	32	19	45	-	-	1.7	4.6	-	3.0
	8-24	7	37	30	33	-	-	3.5	3.4	-	2.0
	24-30	15	24	24	37	-	-	12.5	3.4	-	2.0
	30-36	8	20	32	40	-	-	17.5	3.1	-	4.7
215	0-2	37	22	12	29	30.0	11.0	0.7	4.5	46.2	33
	2-12	16	36	23	25	29.0	11.5	1.5	2.9	44.9	3.0
	12-20	22	28	21	29	28.5	11.5	2.5	2.7	45.2	2.0
	20-29	14	45	10	31	45.0	6.0	8.0	2.4	-	9.7
	29-35	8	33	13	46	55.5	15.5	8.5	2.0	-	5.6
227d	0-1.5	66	24	5	5	6.0	1.0	0.5	1.8	9.3	27
	1.5-10	48	31	13	8	9.5	2.0	0.7	3.4	15.6	3.7
	10-20	51	27	11	11	8.0	3.5	0.5	2.0	14.0	1.3
	20-34	44	40	12	4	12.5	1.5	0.6	1.8	16.4	0.7
	34-48	45	40	12	3	-	4.0	1.2	1.6	-	0.7
	48-55	46	24	15	15	-	-	1.3	1.5	-	1.3
	55-62	66	23	7	4	-	-	3.0	1.1	-	1.3
232	0-3	21	20	37	22	-	7.0	0.2	15.0	-	12.0
	3-10	22	26	21	31	-	7.0	0.4	4.6	-	5.5
	10-24	27	32	14	27	-	9.0	0.4	4.5	-	4.5
	24-44	36	21	19	24	-	11.0	1.2	4.7	-	5.5
	44-54	30	19	17	34	-	13.0	1.5	4.6	-	6.0

NOTES:

1. All analyses were determined after July 1965.

2. The particle size distribution values are percentages of the oven-dry mineral fraction, after removal of calcium carbonate. The size ranges are -

Coarse Sand	2000 - 200 microns
Fine Sand	200 - 20 microns
Silt	20 - 2 microns
Clay	Less than 2 microns

3. Calcium (and sometimes magnesium) values have been omitted in the case of calcareous soils, since calcium carbonate is partially soluable in ammonium acetate. The values for total cations extracted by N ammonium acetate are approximately estimates of the cation exchange capacity.

4. OLSEN available phosphorus were determined by extracting 1 part of soil with 20 parts of 0.5.M. sodium bicarbonate at pH 8.5.

5. Cations extracted with N ammonium acetate and available phosphorus are calculated on air-dry soil.

NOTES:

1. All analyses were determined after July, 1965.

2. For these determinations, all saline soils (36) were extracted initially at a ratio of 5 parts of water to 1 part of soil. 27 soils giving more than 1 milli-equivalent percent of calcium (in the soil) were extracted at a ratio of 10 parts of water to 1 part of soil; and then 25 of these were extracted at a ratio of 20 parts of water to 1 part of soil. Finally, soils still giving extracts saturated or nearly saturated with calcium sulphate (Units 213, 222 and 227d) were extracted at a ratio of 100 parts of water to 1 part of soil, when all gypsum was dissolved.

3. Results are calculated on air-day soil and are recorded to the nearest 0.1 milliequivalent percent, except for units 213, 222 and 227d, although here it was still possible to record chloride to the nearest 0.1.

4. T = trace, usually less than 0.04 milliequivalent percent.

5. A dash (-) indicates that the analysis could not be done or was unreliable.

A P P E N D I X VII

RECONNAISSANCE SURVEY

of the

WAMI COASTAL PLAIN

Site information

a. Soil name: UNIT 301.
b. Higher category classification: Alluvial. Typic Haplorthent (1.530). Revised 7th Approximation (1964).
c. Date of examination: 19th August, 1965.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: 1 mile east of railway; halfway between escarpment and Wami River, Wami alluvial flats, Tanzania.
f. Elevation: 20-50 feet above sea level.
g. Land form:
   i. Physiographic position of the site: Valley bottom.
   ii. Land form of surrounding country: Flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat, less than 1%.
i. Vegetation and/or land-use: Tall grasses, Acacias and low shrubs. Game grazing.

General soil information

a. Parent material: River alluvium.
b. Drainage: Class 1 - poorly drained.
c. Moisture conditions: Dry throughout the profile.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

Alternating very dark brown and very dark greyish brown clay layers with many roots concentrated in the top few inches. Strong angular blocky surface with massive subsoil. Wide deep cracking in the dry season. Some gilgai microtopography but without evidence of churning in the profile. pH range 6.5 to 6.8 increasing down profile.

Profile description

A1 0-4" Very dark brown (10 YR 2/2) moist and very dark grey to dark grey (10 YR 3.5/1) dry, clay; strong medium angular blocky; sticky and plastic, extremely firm moist, hard dry; many interstitial and tubular pores; very abundant living roots forming mats, frequent dead roots; pH 6.5; non effervescent; clear wavy boundary to

C1 4-20" Very dark greyish brown (10 YR 3/2) moist and very dark grey (5 YR 3/1) dry, clay; massive breaking to coarse angular blocky; very sticky and very plastic, extremely firm moist, hard dry; few pores; patchy moderately thick clay cutans;

few medium and fine roots; pH 6.6; non effervescent; diffuse irregular boundary to

C2 20-56"+ Very dark brown (10 YR 2/2) moist and very dark greyish brown (10 YR 3/2) dry, clay; massive; sticky and plastic, firm moist, hard dry; few pores; few slickensides, very few roots; pH 6.8; effervescence only in small specks of segregated calcium carbonate.

Range of characteristics

This is a deep, poorly drained soil that is clay textured throughout. Colours range between very dark brown to dark greyish brown with occasional mottling. Well developed angular blocky structures are characteristic. It is confined to the flat bottomlands of the floodplain and the unit 303 is a variant of it. Further more detailed soil studies will show if both units should be considered separate series.

Land-use and agricultural potential

This soil is not utilised for regular crop production. Occasional extensions of agriculture from the riverside soil Unit 302 may include some of the 301 series. The main limitations are fine texture and poor drainage with susceptibility to flooding. It is a good soil for crops such as rice and sugar cane.

Site information

a. Soil name: UNIT 302.
b. Higher category classification: Alluvial. Typic Haplorthent (1.530). Revised 7th Approximation (1964).
c. Date of examination: 19th August, 1965.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: 200 yards south of the Ferry on the Wami River. Wami alluvial flat, 30 miles north of Bagamoyo, Tanzania.
f. Elevation: 25 feet.
g. Land form:
   i. Physiographic position of the site: Valley bottom.
   ii. Land form of surrounding country: Flat or almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Cultivated for different crops especially mango, banana, coconut, maize, sugar cane, and cassava.

General soil information

a. Parent material: River alluvium.
b. Drainage: Class 4 - well drained.

c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

A deep, well drained soil with alternating layers of very dark grey, dark grey, dark yellowish brown and dark greyish brown colours and clay loam, silt loam, loam and clay loam textures. Sub-angular blocky structures overlie a massive subsoil. pH ranges between 5.7 and 6.2 increasing with depth. Porous and deep rooting with an open structure. Non effervescent except for scattered flakes of calcium carbonate below 4 feet.

Profile description

A1 0-6" Very dark grey to very dark greyish brown (10 YR 3/1.5) moist and dark greyish brown (10 YR 4/2) dry, loam; coarse sub-angular blocky; slightly sticky and slightly plastic, friable moist, slightly hard dry; many interstitial and tubular pores; abundant fine, medium and coarse roots; non effervescent; clear irregular boundary to

C1 6-15" Very dark grey matrix (10 YR 3/1) moist with dark brown mottling and dark greyish brown (10 YR 3/1) moist with dark brown mottling and dark greyish brown (10 YR 4/2) dry, clay loam; medium sub-angular blocky; sticky and plastic, friable moist, slightly hard dry; many pores; patchy thick clay cutans; frequent fine and very coarse roots; pH 5.7; non effervescent; abrupt smooth boundary to

IIC2 15-23" Brown matrix (10 YR 5/3) with streaks of dark grey mottling and brown to dark brown (10 YR 4/3) dry, silt loam; massive; non sticky and slightly plastic, very friable moist, soft dry; many pores; few fine, medium and coarse roots; common streaks or organic matter cutans; pH 5.6; abrupt smooth boundary to

IIIC31 23-39" Very dark greyish brown (10 YR 3/2) moist with streaks of dark yellowish brown and dark greyish brown (10 YR 4/2) dry, loam; weak fine blocky; non sticky and slightly plastic, friable moist, soft dry; many pores; frequent medium and coarse roots; pH 6.0; non effervescent; diffuse irregular boundary to

IIIC32 39-51" Very dark greyish brown (10 YR 3/2) moist with dark brown mottling and yellowish brown (10 YR 5/4) dry, clay loam; weak fine angular blocky; slightly sticky and slightly plastic, friable moist, soft dry; common pores; patchy thick clay cutans; few

coarse roots; pH 6.3; non effervescent; abrupt wavy boundary to

IVC4 51-58" Brown to dark brown (10 YR 4/3) moist with mottlings and very dark grey (10 YR 3/1) dry, very fine sandy loam; structureless; non sticky and slightly plastic, very friable moist, soft dry; common pores; pH 6.2; very slightly effervescent in scattered flakes of segregated calcium carbonate.

Range of characteristics

This is a deep, mainly well drained, heterogeneous soil unit of the present riverbanks. It occurs as narrow but often continuous areas along the river, being especially broad at the bends. Alternating layers of varying texture and colour. Usually medium textures, with strongly developed structure. pH is always below 7.0.

Land-use and agricultural potential

This is a very good soil with minor limitations due to a somewhat irregular topography. It would require some levelling. Restricted to small areas since the unit never occurs as large uniform blocks of land. Suited for a wide range of crops. Very intensively cultivated at the present time.

Site information

a. Soil name: UNIT 303.
b. Higher category classification: Intergrade Grumusol-Low Humic gley. Haplaquoll (5.31). Revised 7th Approximation (1964).
c. Date of examination: 26th September, 1965.
d. Authors: N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: Southern Wami alluvial flat. Near to the railway bridge on the right bank of the Wami River. Approximately 200 yards from the bridge.
f. Elevation: 25 feet.
g. Land form:
   i. Physiographic position of the site: Flocdplain of the Wami river.
   ii. Land form cf surrcunding country: Flat or almost flat.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Open bush with abundant tall grasses and small Acacia. Small areas are cultivated for maize, bananas and other food crops.

General soil information

a. Parent material: Alluvial clays.
b. Drainage: Class 1 - poorly drained.
c. Moisture conditions: Moist throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free of excess salt or alkali.
h. Humaninfluence: Nil.

Brief description of profile

This is a deep, poorly drained soil occurring in the flat regularly flooded areas of the Wami floodplain. Black, very dark grey and very dark greyish brown in colour with clay texture, moderate angular blocky structure. Deep cracking in the dry season. pH ranges between 5.8 and 6.2 increasing with depth. Non effervescent throughout.

Profile description

A11 0-2.5" Very dark grey (10 YR 3/1) moist and very dark greyish brown (10 YR 3/2) dry, clay; moderate fine angular blocky; sticky and plastic, slightly friable moist, hard dry; many pores; abundant fine and medium roots and dead ones inside the peds; pH 5.8; non effervescent; clear wavy boundary to

A12 2.5-9" Black (10 YR 2/1) moist with abundant strong brown rusty mottling along the old root channels and same colour dry; clay; medium angular and sub-angular blocky; very sticky and very plastic, very firm moist, hard dry; common pores; patchy thick clay cutans; frequent fine and common medium roots; pH 5.9; non effervescent; gradual irregular boundary to

B2 9-26" Very dark grey (10 YR 3/1) moist with dark yellowish brown mottling and same colour dry, clay; very coarse angular blocky; sticky and plastic, very firm moist, hard dry; common pores; clay cutans limited to old root channels; common fine roots; slickensides; pH 6.0; non effervescent; gradual irregular boundary to

IIBC 26-40" Very dark grey (10 YR 3/1) moist and same colour dry; clay; coarse irregular angular blocky; sticky and plastic, slightly friable moist, moderately hard dry; common pores; continuous thick clay cutans; common fine dead roots inside the peds; slickensides; pH 5.8; non effervescent; peds seem to be slightly tilted from the vertical position; gradual irregular boundary to

IIC1 40-62" Very dark greyish brown (10 YR 3/2) moist and same colour dry; clay to clay loam; massive; stioky and plastic, slightly firm moist, slightly hard dry; common pores; pH 6.2; non effervescent; small white crystals throughout this horizon.

Range of characteristics

This is a deep, poorly drained soil very similar to the 301 of which it is considered as a variant. The main difference with Unit 301 is the large amount of rusty fine mottling in the solum, which gives the soils a much browner colouration and the presence of a B2 horizon.

Land-use and agricultural potential

This soil is not cultivated. The main limitations are its fine texture, slow internal drainage and annual flooding. With adequate control this soil would be suited for a fairly wide range of crops, particularly rice, sugar cane, maize and vegetables.

Site information

a. Soil name: UNIT 306.
b. Higher category classification: Alluvial, polygenetic with upper profile development. Tropept (3.5). Revised 7th Approximation (1964).
c. Date of examination: 25th September, 1965.
d. Authors: N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: Southern Wami Coastal Plain. Approximately 3 miles from the Wami ferry on the road to Bagamoyo, Tanzania.
f. Elevation: 25 feet.
g. Land form:
   i. Physiographic position of the site: Valley bottom.
   ii. Land form of surrounding country: Flat with old river channels.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Almost continuous forest and bush along old channels thatare aotive drainage lines in the wet season.

General soil information

a. Parent material: Old alluvial materials of different ages up to the present time.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free of exoess salt or alkali.
h. Human influence: Nil.

Brief description of profile

A broad soil unit including deep, moderately well drained to somewhat poorly drained soils, with polygenetic profiles. Alternate horizons of variable colour and textures are characteristic. For the time being this is considered a soil complex and further more detailed studies will be necessary.

Profile description

A1 0-7" Very dark greyish brown (10 YR 3/2) moist and very dark grey (10 YR 3/1) dry, clay loam; medium and coarse angular blocky; sticky and plastic, firm moist, very hard dry; common pores; common fine roots; pH 6.0; non effervescent; irregular broken boundary to

B2 7-22" Dark yellowish brown (10 YR 4/4) moist with many fine, clear, brown to dark brown rusty mottling and brown to dark brown (10 YR 4/3) dry; clay loam; medium angular and sub-angular blocky; sticky and plastic, firm moist, very hard dry; few fine and medium pores; continuous thick clay cutans along ped faces and old root channels; few fine and medium roots, very fine dead roots inside the peds; pH 6.1; non effervescent; gradual wavy boundary to

BC 22-36" Dark yellowish brown (10 YR 4/4) moist with common brown to dark brown mottling and yellowish brown (10 YR 5/4) dry, silty clay loam; medium angular blocky; slightly sticky and slightly plastic, slightly firm moist, hard dry; many fine and medium vesicular pores; broken thick clay cutans mainly along the old root channels; few fine and medium roots; pH 6.2; non effervescent; abrupt smooth boundary to

IIC1 36-52" Brown to dark brown (7.5 YR 4/4) moist with very distinct white spots and strong brown (7.5 YR 5/6) dry, very fine loamy sand; massive; non sticky and non plastic, friable moist, slightly hard dry; many pores; pH 5.9; fine and medium calcium carbonate soft concretions; clear and slightly wavy boundary to

IIIC2 52-56"+ Dark yellowish brown (10 YR 4/4) moist with many fine and medium mottling and same colour when dry, silty clay loam; massive breaking to fine irregular angular blocky; slightly sticky and slightly plastic, friable moist, slightly hard dry; few to common coarse and medium pores; pH 6.7; highly effervescent in spots.

Range of characteristics

A broad soil unit inoluding soils with a wide range in texture and colour. They have topographical position in common and occur along old river channels. They are commonly medium to fine textured and are moderately well to somewhat poorly drained. Downstream a similar unit, 306A, is mostly fine textured in the large grass-land area near the coast.

Land-use and agricultural potential

Parts of this unit are well suited for many crops and some sugar cane, rice, cotton, maize and vegetables are grown. The main limitations of the soils are a slow internal drainage and the fine texture in some horizons. The unit has the major limitation of irregularity of land form since it is dissected by old major drainage channels and much levelling would be necessary as well as drainage and flood control.

Site information

a. Soil name: UNIT 316.
b. Higher category classification: Reddish Chestnut. Haplustoll (5.62) Revised 7th Approximation (1964).
c. Date of examination: 17th August, 1965.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: 5 miles north of the ferry on the Wami river on the road to Sadani; 3 miles west from the road; approximately 1 mile east of railway; Wami, Tanzania.
f. Elevation: 75-175 feet.
g. Land form:
   i. Physiographic position of the site: Colluvial plain.
   ii. Land form of surrounding country: Flat or almost flat, dissected by drainage lines and streams.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Palm trees, Acacias and grass. Game grazing. Some maize cultivated alongside the railway.

Brief description of profile

A deep, well drained, very dark grey and dark brown over dark greyish brown soil, with loamy sand over sandy clay loam and sandy loam textures. It has a sub-angular blocky structure over a mainly massive subsoil that is sometimes compacted. Non effervescent throughout with pH consistently around 5.8.

Profile description

A11 0-4" Very dark grey (10 YR 3/1) moist and grey to light grey (10 YR 6/1) dry, loamy sand; weak sub-angular blocky; non sticky and non plastic, friable moist, slightly hard dry; many vesicular pores; abundant roots in clumps; pH 5.9; non effervescent; clear wavy boundary to

A12 4-10" Dark brown (10 YR 3/3) moist with dark yellowish brown mottling and grey to light grey (10 YR 6/1) dry, loamy sand; massive breaking to weak sub-angular blocky; non sticky and non plastic, friable moist, slightly hard dry; many vesicular pores; very few roots; pH 5.6; non effervescent; abrupt smooth boundary to

B21 10-20" Dark greyish brown (2.5 Y 4/2) moist and dark grey (10 YR 4/1) dry, sandy clay loam; strong medium sub-angular blocky; slightly sticky and non plastic, extremely firm moist, hard dry; common pores; continuous thick clay cutans; few coarse roots; frequent fine dead ones inside the peds; very compacted when dry; pH 5.8; non effervescent; clear smooth boundary to

B22 20-42" Dark greyish brown (10 YR 4/2) moist with very dark grey streaks and dark greyish brown (10 YR 4/2) dry, sandy loam; massive breaking to irregular blocky; slightly sticky and slightly plastic, friable moist, hard dry; many pores; pH 5.7; non effervescent; streaks of darker material; gradual irregular boundary to

B3 42-56"+ Black (10 YR 2/1) moist with dark greyish brown streaks and light grey lenses, same colour dry, sandy clay loam; massive; slightly sticky and slightly plastic, friable moist, soft dry; common pores; pH 5.8; lenses of sandy material and quartz.

Range of characteristics

Topsoil colours range between grey, grey brown and dark greyish brown (dry) and the subsoil is in the grey brown range with some yellowish brown or light yellowish brown layers. Texture is usually in the sandy loam to sandy clay loam range. pH is slightly acid and some transitional forms with calcium carbonate may occur.

Land-use and agricultural potential

This is the most extensive soil in the northern part of the Coastal Wami area. It is a good soil without major limitations and is suited to a wide range of crops.

Site information

a. Soil name: UNIT 317.
b. Higher category classification: Regosol. Quartzipsamment (1.X2). Revised 7th Approximation (1964).
c. Date of examination: 24th September, 1965.
d. Authors: N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: Southern Wami Coastal Plain. Approximately 6 miles from the ferry on the road to Bagamoyo.
f. Elevation: 50 feet.
g. Land form:
   i. Physiographic position of the site: Higher parts of the gentle swells and low hills on the gently sloping shelf area.
   ii. Land form of surrounding country: Gently undulating.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Open bush with isolated clumps and occasional baobab. Occasionally cultivated, mainly for cassava and maize.

General soil information

a. Parent material: Marine sands, probably re-deposited in places.
b. Drainage: Class 4 - well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight and very local wind erosion.
g. Salinity or alkalinity: Class 0 - free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

This is a deep, well drained soil with sandy textures throughout. Colours are very dark greyish brown over dark greyish brown and brown to dark brown. Subsoil layers are highly compacted. An extremely weakly developed soil with most horizons structureless or massive. Friable, very porous and deep drying in the dry season. Always non effervescent.

Profile description

A11 0-1" Very dark greyish brown (10 YR 3/2) moist and greyish brown (10 YR 5/2) dry, fine sand; structureless; non sticky and non plastic, very friable moist, soft dry; many vesicular pores; frequent roots concentrated in the vicinities of clump grass vegetation; common pellet-like aggregates formed by topsoil micro-fauna (unknown); pH 6.1; non effervescent; clear and smooth boundary to

A12 1-10" Very dark greyish brown (10 YR 3/2) moist and greyish brown (2.5 Y 5/2) dry, fine sand; weak medium and fine granular; non stioky and non plastic, very friable moist, soft dry; many vesicular pores; frequent fine roots less concentrated than above; some pellets of the above type confined to holes and hollows in the soil; pH 6.1; non effervescent; clear smooth boundary to

AC 10-20" Dark greyish brown (10 YR 4/2) moist and light brownish grey (10 YR 6/2) dry, sand; massive; non stioky and non plastic, very friable moist, slightly hard dry; many pores; few fine roots; pH 5.8; non effervescent; clear smooth boundary to

IIC1 20-36" Brown to dark brown (10 YR 4/3) moist with many strong brown distinct mottling and fine greyish brown (10 YR 5/2) dry, coarse sandy loam; massive; slightly stioky and slightly plastic, very friable moist, very hard dry; few distinct dark organic matter stains along the old root channels; many pores; few coarse roots; pH 5.6; non effervescent; gradual smooth boundary to

IIC2 36-52"+ Brown to dark brown (10 YR 4/3) moist and pale brown (10 YR 6/3) dry, loamy sand; massive; very slightly stioky and slightly plastic, very firm moist, very hard dry; few to common pores; very compacted layer; pH 6.6; non effervescent.

Range of characteristics

Always deep, well drained and coarse textured. The full range of characteristics is not well known because of difficulties in surveying the very dense bush. The profile quoted is, however, very typical.

Similar and associated soils

This Unit is intimately associated with Unit 367 which is underlain by fine marine sediments. In some areas it is very difficult to map them separately because of the intricacy of the pattern.

Land-use and agricultural potential

This is a fairly good soil suited to a wide range of crops with limitations derived from coarse texture and probably low fertility level. Investments in clearing the dense bush areas and in levelling may be relatively high. With adequate soil and water management good responses can be expected from this soil under irrigation agriculture.

Site information

a. Soil name: UNIT 318.
b. Higher category classification: Reddish Chestnut. Haplustalf (7.46). Revised 7th Approximation (1964).
c. Date of examination: 14th August, 1965.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Northern Wami Coastal Plain, 30miles north of Bagamoyo, Tanzania; 2 miles south of Sadani on the road to Bagamoyo, $\frac{1}{4}$ mile east of the road.
f. Elevation: 10-25 feet.
g. Land form:
   i. Physiographic position of the site: Coastal plain.
   ii. Land form of surrounding country: Gently undulating plain with ridges and depressions.
   iii. Microtopography: Some small mounds around grass clumps.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Low palm trees, clumps of Acacia and grass; large grassy areas.

General soil information

a. Parent material: Colluvial sediments underlain by mixed river and marine alluvium.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some sheet erosion and slight wind erosion.
g. Salinity or alkalinity: Class 0 - free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

A grey over dark to very dark grey, sand over sandy loam profile with compact massive subsoil layers. A very strong calcareous horizon of calcium carbonate accumulation is present between 23 and 35 inches. Structural development is confined to the top 14 inches. Structures are coarse angular blocky. Reaction ranges between pH 5.8 and 7.0, the highest readings corresponding to the calcareous horizon.

Profile description

A1 0-6" Very dark greyish brown (10 YR 3/2) moist and grey (10 YR 5/1) mixed with dark yellowish brown (10 YR 4/4) dry, sand; weak fine granular; non sticky and non plastic, very friable moist, slightly hard dry; many vesicular pores; abundant roots forming mats, outstanding in the ground; pH 5.8; non effervescent; clear wavy boundary to

B21 6-14" Dark grey (5Y 4/1) moist with very dark brown mottling and grey (10 YR 5/1) dry, with a different internal colour of the peds, sandy loam; very coarse angular blocky breaking to medium angular blocky; non sticky and non plastic, firm moist, hard dry; common pores; patchy thick clay cutans; common medium and coarse roots; abundant dead roots; pH 6.7; non effervescent, with cracks, gradual irregular boundary to

B22 14-23" Very dark grey (5Y 3/1) moist and dark grey (5 Y 4/1) dry, sandy clay loam; massive breaking to fine angular blocky; non sticky and non plastic, extremely firm moist, very hard dry; few pores; frequent fine dead roots, few coarse ones; pH 6.9; slightly effervescent in small spots, clear very irregular boundary to

B3ca 23-35" Black (10 YR 2/1) moist with grey to dark grey mottling and very dark grey (5 Y 3/1) dry; sandy clay loam; massive breaking to fine angular blocky; slightly sticky and slightly plastic, friable moist, hard dry; common pores; few dead roots; pH 7.0; very strongly effervescent; lenses of segregated calcium carbonate and some quartz accumulations; gradual irregular boundary to

C 35-54"+ Very dark grey (5Y 3/1) moist with olive grey mottling in veins and dark grey (5Y 4/1) dry, sandy loam; massive, slightly sticky and slightly plastic, friable moist, moderately hard dry; few pores; pH 6.5; veins of fine quartz through this horizon.

Range of characteristics

This is a small unit, tentatively established for a fairly good soil located near Sadani. It occurs between streams and drainage lines, under a mixed vegetation of low Palms, Acacias in clumps and grass. Its importance and full range of characteristics are unknown at this level of the survey. Some outstanding facts are the presence of a B3ca horizon with segregated calcium carbonate in nodules and accumulated in small lenses. pH ranges between 5.8 and 7.0. The colour of the deep subsoil may come into the olive greys and coarse sandy layers may occur at varying depths.

Land-use and agricultural potential

This is a good soil for most of the crops adapted to the local conditions. No major limitations were observed. The slightly undulating topography dissected by streams and drainage lines which will need some levelling and the behaviour of the massive, very compacted subsoil layers should be investigated. These are very similar to a fragipan but with large amounts of soluble materials and cracking which will help to improve drainage. Infiltration tests should be carried out in any detailed irrigation investigation programme.

Site information

a. Soil name: UNIT 319.
b. Higher category classification: Regosol. Typic Quartzipsamment (1.X20). Revised 7th Approximation (1964).
c. Date of examination: 18th August, 1965.
d. Authors: N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: Wami Coastal Plain, 30 miles north of Bagamoyo, Tanzania. 200 yards east of railway, ¾ mile north of the right angle turn in the road, Wami Sisal Estate.
f. Elevation: 75 to 150 feet.
g. Land form:
   i. Physiographic position of the site: Colluvial plain.
   ii. Land form of surrounding country: Flat but dissected by drainage lines.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Trees with some grassy areas. Some small farms occur near the railway line with maize, peas, beans. Yearly burning ofgrasses.

General soil information

a. Parent material: Colluvial sands from the western uplands.
b. Drainage: Class 4 to Class 5 - well drained to somewhat excessively drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight wind erosion.
g. Salinity or alkalinity: Class 0 - free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

This is a deep, well to somewhat excessively drained, brown to dark brown over brown and reddish brown sand. Extremely weakly developed with structures confined to a thin A1 horizon. A mainly loose, porous, acid soil with rapid permeability.

Profile description

AC 0-8" Brown to dark brown (10 YR 4/3) moist and brown (10 YR 5/3) dry, sand; weak fine granular; non sticky and non plastic, friable moist, soft dry; many vesicular pores; very occasional worm casts; pH less than 5.0; non effervescent; gradual smooth boundary to

C1 8-32" Brown (7.5 YR 4/4) moist with dark brown mottling and light brown to brown (7.5 YR 5/4) dry, sand; massive; non sticky and non plastic, friable moist, slightly hard dry; common pores; coarse and medium roots; pH less than 5.0; non effervescent; gradual irregular boundary to

C2 32-57"+ Reddish brown (5 YR 4/4) moist and dark brown (7.5 YR 4/4) dry, loamy sand; massive; non sticky and slightly plastic, friable moist, slightly hard dry; speckled quartz grains; common pores; pH less than 5.0; non effervescent.

Range of characteristics

This is always a very sandy soil. Colours range between dark grey and pale brown (dry) and pH between less than 5.0 and 6.6.

Land-use and agricultural potential

A good soil suited for a wide range of crops with limitations derived from coarse texture and probably low fertility status. It needs levelling. It is already under cultivation where drinking water is available or can be transported.

Site information

a. Soil name: UNIT 360.
b. Higher category classification: Grumusol. Typic Mazaquart (2.120). Revised 7th Approximation (1964).
c. Date of examination: 11th August, 1965.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Northern Wami Coastal Plain, 30 miles north of Bagamoyo, Tanzania - 1¾ mile north of crossroads (Wami Station, Wami Sisal Estate and Sadani to Bagamoyo), 1½ mile west of road.
f. Elevation: 25 to 30 feet.
g. Land form:
   i. Physiographic position of the site: Plain.
   ii. Land form of surrounding country: Gently undulating valley between flattened ridges.
   iii. Microtopography: Gilgai.
h. Slope: Class 1 - flat or almost flat (0-2%). Slightly concave.
i. Vegetation and/or land-use: Tall, dense, grass cover with some scattered small Acacia trees. Game.

General soil information

a. Parent material: Marine clay covered by fine lacustrine sediments.
b. Drainage: Class 1 - poorly drained.
c. Moisture conditions: Dry throughout.

d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight sheet erosion.
g. Salinity or alkalinity: Class 0 -- free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

A deep, poorly drained, heavy clay soil. It is consistently black in colour with deep continuous cracks in the dry season and a gilgai microtopography. Structures are dominantly coarse angular blocky with well developed slickensides. A typical acid Grumusol.

Profile description

A11 0-2" Black (7.5 YR 2/0) moist and black (10 YR 2/1) dry, clay; granular and fine angular blocky; sticky and plastic, friable moist, slightly hard dry; common pores; patchy thick clay cutans; abundant very fine living and dead roots; many cracks; pH 5.8; non effervescent; abrupt and wavy boundary to

A12 2-8" Black (2.5 Y 2/0) moist and same colour dry, heavy clay; strong coarse angular blocky; sticky and plastic, firm moist, hard dry; few to common pores; continuous thick clay cutans; abundant fine and very fine roots; few coarse ones; many cracks; pH 5.6; non effervescent; gradual irregular boundary to

A13 8-17" Black (2.5 YR 2/0) moist and same colour dry, heavy clay; very coarse angular blocky easily breaking to fine angular blocks; very sticky and very plastic, extremely firm moist, very hard dry; few pores; continuous thick clay cutans; slickensides; abundant dead fine roots; many cracks; pH 5.5; non effervescent; diffuse irregular boundary to

AC 17-36" Black (5 Y 2/1) moist and same colour dry, heavy clay; massive breaking to coarse angular blocky tilted from vertical axe; very sticky and very plastic, extremely firm moist, very hard dry; patchy thick clay cutans; slickensides; fine dead roots; pH 6.6; non effervescent; diffuse smooth boundary to

C1 36-53"+ Black (5 Y 2/1) moist and same colour dry; silty clay; massive; sticky and plastic, friable moist, slightly hard dry; few pores; few slickensides; pH 6.4; slightly effervescent.

Range of characteristics

This is always a deep, poorly drained soil, with colours ranging between black and dark grey. pH ranges between 6.0 and 6.8 but in certain extreme

cases is as low as 5.4 and as high as 7.0. Inclusions of Units 361 and 365 occur as well as some sandy ridges.

Land-use and agrioultural potential

The main limitations of this soil are fine texture and slow internal drainage. It could be suitable for crops like rice and with careful water management and much improved drainage, to a wide range of crops such as ootton, maize, sugar cane and vegetables.

Site information

a. Soil name: UNIT 361.
b. Higher category classification: Humic-gley. Argiaquoll (5.32). Revised 7th Approximation (1964).
c. Date of examination: 12th August, 1965.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Wami Northern Coastal Plain, 30 miles north of Bagamoyo, Tanzania, 2½ miles north of cross-roads (Wami Station to Wami Sisal Estate and Sadani to Bagamoyo), ½ mile west of road.
f. Elevation: 20 to 50 feet.
g. Land form:
   i. Physiographic position of the site: Dissected plain.
   ii. Land form of surrounding country: Flat or almost flat.
   iii. Microtopography: Some gilgai.
h. Slope: Flat or almost flat, slightly concave.
i. Vegetation and/or land-use: Grass and Acacia trees. Game grazing and some sisal.

General soil information

a. Parent material: Marine sediments covered with lacustrine clay.
b. Drainage: Class 1 - poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

A deep, poorly drained soil with clay texture covered with a variable layer of sandy clay loam. Colours are black over very dark grey, dark grey and olive grey. It has a B2 horizon and an horizon of calcium accumulation. Structures are coarse angular blocky and very well developed. pH range 5.7 - 6.6 increasing with depth.

Profile description

A1 0-4" Black (10 YR 2/1) moist with light grey veins and black (7.5 YR 2/0) dry, sandy clay loam; granular and medium sub-angular blocky; non sticky and slightly plastic, firm moist, slightly hard dry; many pores; abundant roots in mats; cracks with loose sand falling through them; pH 5.7; non effervescent; clear wavy boundary to

B21 4-13" Black (2.5 Y 2/0) moist and black (7.5 YR 2/0) dry, clay; strong medium and coarse angular blocky; very sticky and very plastic, firm moist, very hard dry; many pores; continuous thick clay cutans; slickensides; abundant living and dead roots; cracks with loose sand falling through them; pH 5.6; non effervescent; gradual irregular boundary to

B22 13-22" Very dark grey (2.5 Y 3/0) moist and same colour dry, clay; very coarse angular blocky; very sticky and very plastic, extremely firm moist, very hard dry; few pores; continuous thick clay cutans; slickensides; common roots; calcium carbonate segregated starting in the lower part of this horizon; some quartz from the topsoil falling through the cracks; pH 6.0; gradual irregular boundary to

B3ca 22-32" Very dark grey (2.5 Y 3/0) moist with very pale brown to light yellowish brown mottling and white concretions, dark grey (2.5 Y 4/0) dry, clay; massive breaking to coarse angular blocky; very sticky and very plastic, firm moist, hard dry; patchy thick clay cutans; slickensides; very few roots; cracks; pH 6.2; highly effervescent only in the calcium carbonate concretions; clear irregular boundary to

C1 32-45"+ Olive grey (5 Y 5/2) moist with dark grey mottling and light grey concretions, pale olive (5 Y 6/3) dry, clay; massive breaking to irregular angular blocky; very sticky and very plastic, firm moist, hard dry; few slickensides; very few dead roots; pH 6.6; effervescence only in the few $CaCO_3$ concretions.

Range of characteristics

Topsoil colours range between very dark grey, light grey and grey (dry) and the subsoil from very dark grey to light olive brown and olive (dry). Under cultivation (sisal) topsoil colours change to greyish brown.

Land-use and agricultural potential

The main limitations of this soil are fine texture and poor drainage. It would, however, be suited to a wide range of crops within an organised scheme

following improved drainage. Suited for rice and with improved drainage suitable for sugar cane, maize, cotton and vegetables as well as improved pasture and forestry.

Site information

a. Soil name: UNIT 365.
b. Higher category classification: Low-Humic Gley. Duraquoll (5.34). Revised 7th Approximation (1964).
c. Date of examination: 13th August, 1965.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Wami Northern Coastal Plain, 30 miles north of Bagamoyo, Tanzania, 1¼ mile north of crossroad of Wami Station-Wami Sisal Estate and Sadani-Bagamoyo roads; ¼ mile east of road.
f. Elevation: 25 to 40 feet.
g. Land form:
   i. Physiographic position of the site: Plain.
   ii. Land form of surrounding country: Flat or almost flat and dissected.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Grass, Acacia trees and some shrubs. Cultivated for sisal.

General soil information

a. Parent material: Marine sediments covered by fine lacustrine sediments.
b. Drainage: Class 1 - poorly drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Some sheet erosion.
g. Salinity or alkalinity: Class 0 - free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

Very dark brown and black horizons underlain by olive grey with increasing amount of calcium carbonate in the subsoil. Textures are fine sandy clay over sandy clay and clay with some gravels in the subsoil. There is a massive hardened fragipan-like layer in the subsoil. Concretions of calcium carbonate and manganese dioxide frequently occur. Platy and columnar structures occur within the A horizons. pH 5.8 - 6.8 increasing with depth.

Profile description

A11 0-1" Very dark brown (10 YR 2/2) moist and grey (10 YR 5/1) dry, fine sandy loam; weak granular slightly platty; non sticky

and non plastic, friable (brittle) moist, slightly hard dry; many vesicular pores; abundant roots; this horizon occurs in small mounds with clumpy grass; pH 5.8; non effervescent; gradual wavy boundary to

A12 1-9" Black (10 YR 2/1) moist and grey (10 YR 5/1) dry with different internal colour (very dark brown), sandy clay; coarse coumnar breaking to medium angular blocky; sticky and slightly plastic, extremely firm moist, hard dry; common pores; broken thick clay cutans; cracks; pH 6.4; non effervescent; abrupt smooth boundary to

B2 9-22" Black (5 Y 2/1) moist with dark yellowish brown mottling and black (2.5 Y 2/0) dry, sandy, clay; massive breaking to medium angular blocky; sticky and plastic, extremely firm moist, hard dry; few pores; few dead roots; cracks; pH 6.7; effervescent only in some occasional calcium carbonate concretions; manganese concretions; few gravels; gradual irregular boundary to

C1 22-34" Olive grey (5 Y 5/2) moist with light grey concretions and same colour dry, clay; massive; very sticky and slightly plastic, firm moist, hard dry; few pores and clay cutans; pH 6.8; strong effervescence in the calcium carbonate concretions; frequent gravels; diffuse irregular boundary to

C2 34-45"+ Pale olive (5 Y 6/4) moist with pale yellow concretions and greyish brown (2.5 Y 5/2) dry, gravelly sandy clay; massive; sticky and slightly plastic, firm moist, hard dry; pH 6.8; strongly effervescent.

Range of characteristics

This is a deep, poorly drained soil. Colours range between dark grey, grey and dark greyish brown in the topsoil and olive with some grey and brown hues in the deep subsoil. Texture is usually sandy clay and ranges to sandy clay loam with coarse sand layers at different depths. Gravels, $CaCO_3$ concretions, and manganese concretions occur and usually increase with depth. pH ranges mainly between 6.0 and 6.8 and can be as low as 5.6 and as high as 7.4.

Land-use and agricultural potential

This is a good soil with limitations derived from poor drainage, its heterogeneity and a slightly irregular topography. The massive subsoil layer should be investigated carefully regarding its behaviour under irrigation. It is suited for a wide range of crops, namely rice, cotton, sugar cane, maize and vegetables.

Site information

a. Soil name: UNIT 366.
b. Higher category classification: Reddish Chestnut. Ustalf (7.4). Revised 7th Approximation (1964).
c. Date of examination: 16th August, 1965.
d. Authors: N. Mikenberg and F. J. Ijserinkhuijsen.
e. Location: Wami Northern Coastal Plain, 30 miles north of Bagamoyo, Tanzania. 2 miles south of Sadani on the road to Bagamoyo and $1\frac{1}{4}$ miles north of the trail to the salt works; $\frac{1}{4}$ mile west of the main road.
f. Elevation: 25 to 50 feet.
g. Land form:
   i. Physiographic position of the site: Dissected plain.
   ii. Land form of surrounding country: Flat or almost flat and dissected.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Grasses, Acacia trees and shrubs in islands. Game grazing area.

General soil information

a. Parent material: Marine and fluvial sediments, some colluvium.
b. Drainage: Class 3 - moderately well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Nil.
g. Salinity or alkalinity: Class 0 - free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

Very dark grey and very dark brown horizons overlying a dark grey and olive grey subsoil. Textures are sandy loam and sandy clay loam underlain by sandy clay. Coarse sub-angular blocky structures occur in the A and B2 horizons with massive subsoils below. A deep cracking, porous, moderately well drained soil. pH increases with depth in the range 6.2 - 7.2.

Profile description

All 0-4" Very dark grey (10 YR 3/1) moist and grey (10 YR 5/1) dry, sandy loam; coarse columnar breaking to medium sub-angular blocky; slightly sticky and slightly plastic, friable moist, hard dry; many vesicular pores; abundant fine and medium roots, few coarse ones; small mounds around grass clumps; cracks; pH 6.2; non effervescent; clear wavy boundary to

A12 4-10/15" Very dark brown (10 YR 2/2) moist and very dark greyish brown (10 YR 3/2) dry, sandy clay loam; coarse sub-angular blocky; slightly sticky and slightly plastic, slightly firm moist, hard dry; many pores; common medium and coarse roots; few dead ones mainly fine; very compacted material when dry with cracks; pH 6.3; non effervescent; clear irregular boundary to

B2 10/15"-16/21" Very dark grey (5 Y 3/1) moist and same colour dry, sandy clay with small gravels; coarse angular blocky; sticky and plastic, firm moist, very hard dry; few pores; continuous thick clay cutans; frequent fine dead roots; few medium living ones; wide cracks; pH 6.4; effervescent only in the lower part of this horizon where some calcium carbonate concretions occur; gradual irregular boundary to

B3ca 16/21-42" Dark grey (5 Y 4/1) moist and same colour dry, with white concretions and few gravels; massive; slightly sticky and slightly plastic, extremely firm moist, hard dry; few pores; patchy thick clay cutans; few dead roots; few cracks; pH 6.6; highly effervescent in the CaCO3 concretions; gradual wavy boundary to

C1 42-46" Dark grey (5 Y 4/1) moist with same colour dry, sandy clay loam with gravels and concretions increasing in amount and size with depth; massive; sticky and slightly plastic, friable moist, slightly hard dry; few pores; pH 6.9; strongly effervescent; diffuse irregular boundary to

C2 46"+ Olive grey (5 Y 4/2) moist with light grey concretions and same colour dry, sandy clay loam with many gravels increasing in size and amount with depth; massive; sticky and plastic, friable moist, slightly hard dry; pH 7.2; strongly effervescent.

Range of characteristics

A deep, moderately well drained soil, with colours ranging between very dark grey to light grey in the solum and light olive to olive grey in the deep subsoil. Concretions and gravels increase with depth as well as the amount of CaCO3. Textures range between sandy clay loam and sandy clay. A hard massive layer usually occurs in the deep solum and layers of coarse sand may occur.

Land-use and agricultural potential

This is a good soil with minor limitations mainly derived from the somewhat undulating topography which is dissected by drainage lines and streams. The behaviour of the hard massive A12 layer under irrigation should be investigated. Suited to a wide range of crops.

Site information

a. Soil name: UNIT 367.
b. Higher category classification: Reddish-Chestnut. Ustalf (7.4). Revised 7th Approximation (1964).
c. Date of examination: 23rd September, 1965.
d. Authors; N. Mikenberg, G. R. Suggett and F. J. Ijserinkhuijsen.
e. Location: Southern Wami Coastal Plain. Approximately 5 miles from the Wami Ferry on the road to Bagamoyo.
f. Elevation: 50-75 feet.
g. Land form:
   i. Physiographic position of the site: Gentle colluvial slope seawards.
   ii. Land form of surrounding country: Gently undulating with some steeper rised and flatter areas.
   iii. Microtopography: Nil.
h. Slope: Class 1 - flat or almost flat (0-2%).
i. Vegetation and/or land-use: Open bush with many clumps. Clump grass in continuous cover. Some game. Small sandy areas are sometimes cultivated.

General soil information

a. Parent material: Colluvial materials, over buried old colluvial over a marine deposit high in calcium carbonate.
b. Drainage: Well drained.
c. Moisture conditions: Dry throughout.
d. Groundwater depth: Unknown.
e. Stoniness or rockiness: Nil.
f. Evidence of erosion: Slight wind erosion.
g. Salinity or alkalinity: Class 0 - free of excess salt or alkali.
h. Human influence: Nil.

Brief description of profile

A deep, well drained very dark greyish brown over greyish brown and light olive brown sandy soil with a sandy clay B2 and an horizon of calcium carbonate accumulation. This is not a uniform soil and has inclusions of sandier areas as well as depressions with heavy clay accumulation sometimes mapped separately as Unit 367A. More detailed soil studies are needed.

Profile description

A11 0-2" Very dark greyish brown (10 YR 3/2) moist and dark greyish brown (10 YR 4/2) dry, sand; weak fine and medium granular; non sticky and non plastic, friable moist, soft dry; many vesicular pores; roots of clump grass vegetation with concentrated areas of fine roots; pH 6.2; non effervescent; clear smooth boundary to

A12 2-6" Very dark greyish brown (10 YR 3/2) moist and dark greyish brown (10 YR 4/2) dry, sand; massive breaking to coarse sub-angular blocky; non sticky and non plastic, friable moist, hard dry; many vesicular pores; common to frequent fine roots mainly concentrated below clumps; pH 6.2; non effervescent; clear wavy boundary to

IIB2b 6-25" Very dark grey (10 YR 3/1) moist with brown to dark brown mottling and very dark greyish brown (10 YR 3/2) dry with a different internal colour in peds; sandy clay; strong coarse angular blocky; slightly sticky and slightly plastic, firm (brittle) moist, very hard dry; continuous moderately thick clay cutans; frequent old fine dead roots; rusty mottling along old root channels; pH 6.5; non effervescent; gradual and slightly wavy boundary to

IIIC1ca 25-54"+ Light olive brown (2.5 Y 5/4) moist with white mottling, network of old root channels stained very dark (beetroot colour not available in Munsell notation), same colour dry, sandy loam; massive breaking to irregular angular coarse blocky; non sticky and very slightly plastic, firm moist, hard dry; common pores; very few fine dead roots near the upper boundary of this horizon; pH 7.6; very strongly effervescent in distinct calcium carbonate accumulations confined to this horizon.

Range of characteristics

This is an heterogeneous soil unit. The soils are usually deep and well drained but its full range of characteristics is not well known. The area is slightly irregular and includes sandy patches and heavy clay depressions, in a somewhat undulating topography. More detailed studies will be needed in a follow-up stage to clarify the different components of this mapping unit.

Land-use and agricultural potential

These are good soils but require a good deal of dense bush clearing and levelling. Further intensive soil studies will be needed in order to segregate the different members of this tentative broad soil unit. It seems suited to a wide range of crops but moderately high investments will be needed in order to put it in adequate condition for irrigation agriculture.

SOIL ANALYSES TABLE VII

WAMI COASTAL PLAIN. RECONNAISSANCE SURVEY

A - MAIN DATA

UNIT No.	Depth Inches	pH in Water		Conductivity millimhos at 25° C		Organic Carbon
		Saturated Paste	1:5 W/V	Saturation Extract	1:5 W/V	per cent
301	0-4	5.6	6.4	-	0.06	3.58
	4-20	6.2	7.2	-	0.06	1.08
	20-56	7.2	7.9	-	0.70	0.97
302	0-6	6.4	7.1	-	0.06	2.00
	6-15	5.8	6.8	-	0.05	0.91
	15-23	5.8	6.8	-	0.03	0.34 *
	23-39	6.2	7.0	-	0.05	0.70 *
	39-51	7.0	7.5	-	0.03	0.78 *
	51-58	7.4	7.9	-	0.03	0.23
303	0-2.5	5.6	6.4	-	0.17	5.76
	2.5-9	5.3	6.3	-	0.06	2.86
	9-26	5.9	6.7	-	0.21	1.12
	26-40	5.5	6.0	7.1	1.46	0.95
	40-62	5.9	6.1	12.1	3.8	0.76
306	0-7	5.7	6.2	-	0.07	2.28
	7-22	6.1	6.8	-	0.07	1.00
	22-36	6.6	7.0	-	0.06	0.66
	36-52	6.6	7.1	-	0.05	0.23 *
	52-58	7.7	8.2	-	0.13	0.50 *
316	0-4	5.8	6.4	-	0.02	0.84
	4-10	5.1	6.2	-	0.01	0.48 *
	10-21	5.2	6.1	-	0.27	0.66 *
	21-42	5.0	5.9	5.5	0.90	0.40
	42-56	5.2	5.5	9.4	3.8	0.33
317	0-1	7.1	7.6	-	0.07	0.62
	1-10	6.2	7.0	-	0.04	0.53
	10-20	5.5	6.4	-	0.04	0.32
	20-36	5.5	6.7	-	0.05	0.30
	36-52	6.5	7.4	-	0.07	0.20
318	0-6	5.6	6.4	-	0.05	0.59 *
	6-14	6.2	7.2	-	0.04	0.75
	14-23	7.2	7.9	2.2	0.27	0.76 *
	23-35	7.7	8.0	10.0	3.8	0.31
	35-54	6.8	7.5	5.3	0.60	0.20
319	0-8	4.6	5.6	-	0.01	0.66
	8-32	4.4	5.6	-	0.01	0.35
	32-57	4.2	5.2	-	0.01	0.29
360	0-2	5.7	6.7	-	0.07	2.72
	2-8	5.2	6.2	-	0.08	2.53
	8-17	5.7	6.5	1.7	0.24	1.84
	17-36	6.5	6.8	5.5	1.09	1.46
	36-53	7.3	7.7	12.4	2.8	0.48
361	0-4	5.8	7.0	-	0.03	0.72
	4-13	6.0	7.0	-	0.05	1.04
	13-22	7.3	8.0	1.1	0.24	0.80
	22-32	7.7	8.3	5.4	0.94	0.57
	32-45	7.6	8.3	10.5	1.72	0.40
365	0-1	6.2	6.9	-	0.04	1.18
	1-9	5.7	6.9	-	0.05	1.14
	9-22	7.4	8.0	3.1	0.39	0.60
	22-34	7.6	8.3	10.7	1.57	0.26
	34-45	7.7	8.6	12.0	1.80	0.21
366	0-4	5.8	6.7	-	0.05	1.40
	4-10/15	5.5	6.7	-	0.04	1.04
	10/15-16/21	7.3	8.0	-	0.06	0.64
	16/21-42	8.3	9.3	-	0.06	0.42
	42-46	7.9	8.8	7.1	0.86	0.20
	46 +	8.0	8.8	7.5	1.05	0.16
367	0-2	5.9	6.8	-	0.04	1.00
	2-6	5.5	6.5	-	0.05	0.71
	6-25	6.3	7.4	-	0.22	0.52
	25-54	7.8	8.8	7.7	0.94	0.22

NOTES: 1. All analyses were determined after July 1965
2. Organic carbon is calculated on air-dry soil. Analyses marked * have been checked

SOIL ANALYSES TABLE VII

WAMI COASTAL PLAIN - RECONNAISSANCE SURVEY

B. SUPPLEMENTARY DATA ON SELECTED SOILS

UNIT No.	Depth Inches	Particle Size Distribution per cent of mineral fraction				Cations extracted with N ammonium acetate milliequivalent per 100g soil					Available Phosphorus ppm P	
		Coarse Sand	Fine Sand	Silt	Clay	Calcium	Magnesium	Sodium	Potassium	Total (corrected)	OLSEN	TRUOG
301	0-4	2	33	16	49	25.0	10.5	0.6	4.5	40.3	39	60
	4-20	8	25	33	34	35.5	5.0	1.6	1.4	43.2	2	1
	20-56	9	26	20	45	33.0	8.0	6.0	1.0	44.5	5	9
302	0-6	8	21	15	56	24.5	1.0	0.5	5.0	30.7	92	88
	6-15	3	24	14	59	20.0	3.5	0.3	5.4	29.0	124	125
	15-23	6	55	12	27	10.0	2.5	0.4	2.4	15.1	46	68
	23-39	6	30	32	32	20.5	5.0	0.4	2.7	28.4	32	72
	39-51	6	36	20	38	27.0	4.5	0.5	2.7	34.5	40	68
	51-58	5	63	14	18	13.0	5.5	0.2	1.0	19.5	18	72
303	0-2.5	4	26	30	40	35.0	12.0	1.1	7.5	54.8	160	137
	2.5-9	6	24	24	46	37.0	6.0	1.2	2.7	46.6	110	56
	9-26	2	19	19	60	24.5	17.5	2.5	1.1	44.6	32	17
	26-40	3	26	38	33	20.5	19.0	11.0	1.1	44.3	61	64
	40-62	2	19	22	57	39.0	16.5	16.5	1.1	55.1	32	60
306	0-7	5	37	27	31	21.0	2.5	0.6	4.2	27.9	52	76
	7-22	9	43	12	36	22.0	2.0	0.6	1.5	25.7	5	22
	22-36	2	27	31	40	19.0	5.0	0.7	0.8	25.2	4	12
	36-52	4	76	5	15	7.5	3.0	0.3	0.5	11.1	8	31
	52-58	4	41	33	22	27.0	6.5	0.8	0.8	34.5	2	17

		Water Soluble Chloride me per 100g soil
316	42-56	2.6
318	23-35	3.0
360	17-36	4.2
	36-53	11.6
361	22-32	3.2
	32-45	6.7
365	22-34	5.5
	34-45	6.7
366	42-46	3.0
	46 +	3.5

NOTES:

1. All analyses were determined after July 1965.

2. The particle size distribution values are percentages of the oven-dry mineral fraction. The size ranges are -

Coarse Sand	2000 - 200 microns
Fine Sand	200 - 20 microns
Silt	20 - 2 microns
Clay	Less than 2 microns

3. The total of the cations extracted with N ammonium acetate (at pH 7.0) has been corrected for water soluble salts, estimated from the conductivity of the 1:5 extract by the approximate relation.
Conductivity (millimhos) x 5 = me salts per 100 g soil. The result is an estimate of the cation exchange capacity.

4. OLSEN available phosphorus was determined by extracting 1 part of soil with 20 parts of 0.5.M. sodium bicarbonate at pH 8.5.

5. TRUOG available phosphorus was determined by extracting 1 part of soil with 200 parts of 0.002 N sulphuric acid at pH 3.0.

6. Cations extracted with N ammonium acetate, available phosphorus and water soluble chloride are calculated on air-dry soil.