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Report on a Visit by the Soil Chemist to Certain Sisal Estates on the Central Railway, Tanganyika 19 May to 3 June 1941

By
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Report on a Visit by the Soil Chemist to certain Sisal Estates on the Central Railway, Tanganyika, 19 May to 3 June, 1941.

(Note: As this Report is being written with very limited time at disposal the style adopted is in places that of the Saving Telegram.)

Journey was planned as a result of letter of enquiry from Jardine Matheson & Co., Dar-es-Salaam, asking questions about soil management on Kiwege Estate and sending soil samples. Soil samples received Amani April and given examination and some analyses but as they were top-soils only and subsoil and other relevant conditions were not indicated it was proposed to visit Kiwege and take opportunity other visits sisal estates. Arrangements made through Sisal Growers' Association and Department of Agriculture, particularly through A.O. Morogoro Mr. J.C. Eyre; to whom and to his Assistant Mr. B. Eccles grateful acknowledgement is made, as well as to managers of estates visited, who gave much time, every facility and personal hospitality.

Estates visited were the following, numbers quoted being those of the T.T. Survey Department's "Sisal Map" :

KINGOLWIRA, no.626 enemy property leased by Central line Estates Ltd.
PANGAWE, no.627, Central Line Estates Ltd.
MAFIGA, no.644, V.M. Nazarali.
RUSEGWA, no.645, " "
KIWEGE, no. 635, Central Line Estates Ltd.
MGUDI, no.637, ditto.
RUVU, no.639, Comprising three estates MARUNDI, RUVU and MPERA, Ruvu Estates Ltd.
KIKONGO, no.630, enemy estates leased by Ruvu Estates Ltd.

Before leaving Morogoro District three days were spent with Mr. A.H. McKinstry, A.O. in charge, at the Kingolowira Settlement Farm and Experiment Station.

Projected visits estates Kilosa District had to be postponed as time available did not permit.

Plan of Report.

Summary of soil conditions seen, and some general observations, will be of interest to all estates and to Dept. of Agriculture. These will be subjects of first part of report for circulation to all concerned through Director of Agriculture. Brief notes on problems of each different estate will follow, also through Director of Agriculture for separate communication to respective managements.

Part I. General Summary of Soil Conditions.

A. Basement Complex Region.

All sisal estates near Morogoro as far east as and including Kiwege lie in geological region of Basement Complex rocks. Parent materials of their soils are therefore ancient gneisses, schists and associated vein rocks and other intrusives, together with detrital deposits derived from these.

Dominant feature of district is northern terminal face of Uluguru Mountains, along immediate foot of which runs, roughly west to east, fertile strip of deep soils of colluvial origin, formed by decomposition of scree and outwash materials accumulated at base of cliffs. Soils of this belt are loam to clay loam, reddish chocolate at surface, reddish orange-brown to rich red-brown in subsoil, showing no change of tint or texture to six feet or more, well drained, moderately acid, not exhaustively weathered and still containing abundant reserves in the form of comparatively fresh particles of feldspars, hornblende, micas, garnet etc. This soil[X] I shall number Type 1. Several short streams tributary to

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[X] Other types will be numbered serially as mentioned. This for the purpose of the present report, pending allocation of names to these soils after correlation with other similar soils already known elsewhere in Tanganyika or in East Africa. A short note on some possible correlations will be included at the end of the report.

Ngerengere River intersect colluvial belt and fill lower parts of some of its valleys with alluvium, on which soils are usually deep, of sandy loam to sandy clay-loam texture, and of colour varying from dark gray-brown to reddish brown. (Type 2). Dept. of Agriculture's Farm at Morogoro exemplifies both the colluvial and the alluvial types. Estates 645, 644 and 627 lie partly within this belt but none of them wholly so.

South-west of Morogoro colluvial belt is constricted where Mindu Hills, north-running minor extension of Uluguru Mts., almost adjoin main mountain mass. Out of angle between flows Ngerengere River, going at first parallel to Uluguru foot at about 5 miles from it, then sweeping to north and east in wide curve before returning south-east to cross Central Railway at Ngerengere Station. For most of its course Ngerengere River has alluvial flats which though never more than a few hundred yards wide in the area being described are an important and significant feature in land-type pattern of district. Ngerengere alluvium is of chocolate-brown colour to considerable depth, of clay-loam texture and tacky consistence, previous and well drained, of high fertility apart from its being subject to annual overflow, and able to carry crops well on into the dry season. (Type 3).

Mindu Hills have own colluvial belt along their base and on this lie Estates 643 and 621, not visited, also (like the Uluguru foot colluvial strip) native lands extensively planted to sorghum.

Main Uluguru wall turns south-east some 12 miles east of Morogoro but a lower ridge continues the frontage of steep slopes some distance further, beyond the Kiroko Pass over which goes a road to Matombo and Kisaki; and the hill-foot belt of colluvial slopes and alluvial bottoms continues also, until cut off by a low saddle joining up with another north-running extension of the hills, a high ridge called Fulwe on the 1:300,000 map, Dindili on the 1:1 million map. Beyond the saddle lie Mikesse and Kinonko native areas with a considerable proportion of alluvial land (type 2) amongst red earths probably classifiable with type 1, in the valley of an east-bound tributary of the Ngerengere. Road to Ngerengere keeps further south on higher-laying broken ground, crossing mostly very shallow gravelly soils (type 4) on quartzose gneiss and quartz-vein rock; this stretch is little cultivated and carries only Brachystegia woodland (miombo). As it approaches the Ngerengere River Valley which is now in its long south-eastward reach, the road route to Ngerengere Station runs out on to

easier slopes where a considerable proportion of deeper soils, as compared with those of the mbombo stretch, has permitted development of sisal estates (635, 636 and 637 part). Western slopes of valley here show last outcrops of the B.C. rocks, the majority gravelly ridges or low knolls with immature shallow soils including type 4 in patches but mostly a somewhat deeperdeveloped sandy or gritty loam over a clay-loam subsoil brownish grey to dull yellow-brown in colour (Type 5). As a special case of these type 5 soils, was noted a turfy very dark brown soil over stiff grey clay, marly below, derived from feldspar rock occuring in quartz-feldspar veins. There are also one or two ridges of reddish-brown loams of good depth and fertility (Type6), which seem to have been derived from water-borne detrital material. Over the whole of this Ngerengere area water-borne deposits complicate the pattern of soil types, and deep light sands sometimes water-bearing and almost of quicksand character (Type 7), and loamy sand over poorly drained sandy clay (Type 8) are extensive in places, whether in hollows, on long slopes or on the flat tops of ridges. In a few places the V - shaped valley-bottoms contain heavy black clay (Type 9), and in a few other places, marked by strong growth of sedge, a black waxy humic soil that might almost be described as a peat (type 10).

The country enclosed in the big northward sweep of the Ngerengere River away from the immediate foot of the Uluguru escarpment consists of a dissected low plateau upon which stand a few residual higher masses, of which the Dindili ridge already mentioned, and Ngumbo Hill on Kingolwira Settlement Farm, are two examples. From the top of Mgumbo the lie of the land was clearly seen and an understanding gained which has assisted considerably in interpreting the soil types. North of the Ngerengere River the same sort of country continues to the divide between that river and the Wami. Sisal estates are nos. 615, 616, 619 and 626; northern parts of 627 and parts of 644 and 645 are included. 620 and 625, which were not visited appear from their position on the map to lie on the border between the "low plateau" and the "colluvial strip" types of country. The whole of the Kingolwira Settlement Area lies in "low plateau" country, including of course the Ngerengere River valley which intersects it.

Apart from the exposed rock of the prominent residual hills, some parts of the nearly flat plateau surface itself carry extensive patches of rubble, on which the shallow soil may be the Type 4 already mentioned, if the rock is mainly quartz, or a chocolate to reddish clay loam (Type 11) if the rock is basic gneiss or greenstone. With the soils depth varying only from nil to a few inches, the fertility of these types is as a whole very low though growth in odd deeper pockets may be very good. Around the base of the rocky hills and where the soil deepens at the margins of areas of types 4 and 11, are grey-brown loams, usually coarse-sandy, over brown somewhat mottled subsoils passing into brashy gneiss rock at 2 ft. depth or so. These immature soils correspond to type 5 already mentioned. The next deeper and more mature stage of soil development from these rocks under present-day climatic conditions is a blackish-brown sandy loam or loam over dulldark reddish-brown to orange-brown clay-loam subsoil of good depth, 5 ft. or so in the pits seen, sometimes calcareous from that depth downwards and passing into decomposed rock which is sometimes so calcareous as to be an impure limestone. (Type 12). All intermediate stages in the maturity-sequence (4, 11)--- (5) --- (12) are to be met with. Collectively they represent the climatic type of the present day under a 25 inch rainfall with 5-6 months' dry season. On Type 12 rainfall would seem to

be the only factor limiting fertility, as it is a soil of very attractive character, though erodible and requiring careful defences against damage from this cause when cultivated in large fields.

Besides these soils of current development there is another group more extensive in area which are in a sense "fossil", in that their development mainly took place in a period long past, almost certainly of wetter climate. These are the reddish chocolate loams on flat or gently sloping tops of broad ridges, which occur, it seems, at two different levels representing peneplain surfaces of different ages from which the present topography of the plateau has been carved. The soils of the older, higher of these two surfaces (Type 13) are very much more mature than the types so far described. The top soil a few inches deep has a well defined "B-horizon" of compact red-brown clay loam just below it, on passing through which there is a bright red very friable subsoil of fine texture but almost no coherence, going without change to six feet or more. Because of prolonged leaching under conditions wetter than now obtain, these soils are acid and impoverished, without lime carbonate at any depth, and with few reserve minerals detectable in the sand-fraction. When cultivated their surface tends to cake into brittle clods, and if sheet-washed the "B-horizon" is exposed as a hard surface into which light rains penetrate with difficulty A typical area of this soil is the experimental field alongside the Cassia avenue at the Kingolwira Settelement Farm. The red-earth plateau surface, at the low level, which must be the remnant of a more recent surface of peneplanation, carry a coil type (14) having some obvious characters in common with 13, viz. the compacted subsurfaces and bright red friable subsoil, but which is less weathered and leached and appears to be more fertile; fields near the Gaol compound, Kingolwira.

Associated with Type 13 and 14 are soils having a horizon of lateritic ironstone at 2-3 ft. depth (Type 15). They occur in zones just below the edges of the broad ridge-tops that carry 13 or 14, and represent the hollows, shallow valley and seepage areas of the old peneplain surfaces. Top soil is a grey-brown sandy-loam, there is a compacted layer just below, then the sub-soil is dull reddish-brown to orange-brown, open and moderately friable, conaining small rusty ferruginous nodules. The ironstone bed comes in sharply at about 2 ft., and consists of a clinker-like rusty-and-black aggregate in a ferruginous-siliceous cement; it may be two feet thick. Below is a mottled red underclay of strongly decomposed rock, which passes finally into brashy schist or gneiss, not calcareous. Where the depth above the ironstone suffices, type 15 should be of as good fertility as, or better than, its corresponding red earth (13 or 14) but shallowness limits it and if truncated by sheet-erosion it may be reduced to more pockets amongst ironstone rubble. Intermediates are found between 13/14, the old red earths, and 15, the ironstone-pan soils; some of the red earths have rudimentary ironstone horizons at 4, 5 or 6ft. depth, consisting of pisolithic gravel rather than of massive clinker.

Two subsidiary types of some importance remain to be described in the basement Complex area: The first (Type 16) is a dull yellow-brown sandy loam over yellow-brown sandy-clay subsoil containing many very small black concretions like small shot. At 3-4 ft. depth the clay becomes very stiff and the concretions larger, and the colour has a pronounced mottling in rust and gray. At 6ft the grey predominates and the clay is soapy and impervious. The soil occurs where a red earth of good drainage passes out, with flattening of

slope, into an area of poor drainage not tapped by any definite stream channel but not totally waterlogged. The conditions may be the present-day equivalent of thosethat gave rise to what are now the ironstone-pan soils (15) of the old peneplains, and the concretions and mottling may be early stages of lateritic-ironstone formation. The type appears to be confined to the more humid parts of the district at the junction of the hill-foot colluvial belt with the undulating low-plateau country. Impeded drainage variants of some of the other types also occur locally, e.g. along margins of minor shallow valleys of the dissected plateau. They are always characterised by grey-rusty subsoil mottling and stiff consistence at depth, evenif the material is sandy. They are infertile for any crop that must have good drainage including sisal, but type 16 appears to carry sorghum well.

The second subsidiary type mentioned (Type 17) is an alluvium older than the present-day Ngerengere alluvium (type 3), and occurs in broader parts of the Ngerengere valley floor or embouchures of tributary valleys, at levels not now reached by floods. An example seen and sampled was a dark-brown loam over dark brown clay-loam subsoil of strong clody character, with inconspicuous black and rusty mottling and somewhat greyer colour at 4-6 ft. Here a gully-system partly stabilised by bushes had begun to re-excavate the old infilling of this part of the valley, and it was evident that caution would be needed in developing land of this type, to avoid the risk so demonstrated; the soil is fertile and attractive.

B. The Sedimentary Rock Region.

East of Ngerengere Station the geological map marks no outcrops of the Basement Complex rocks and there may be none of country rock in place, but a limited area of red loam on Estate 629 might have been derived from transported detritus from these rocks and I understand 628 seen at a distance only, to have larger areas of similar land. Otherwise the soils are derived from sandstones and limestones of several different characters and ages, and from their erosion-products. In continuing the list of soil types into this region I warn that it is a very imperfect rough classification, based on four days' work only, one day at 629 on the eastern slopes of the Ngerengere Valley and three days at 639 in a very large area lying across the Ruvu valley.

Type 18. Dull light brown sandy loam over shallow subsoil with slightly more body and warmer colour, brashy rotten- sandstone gravel at twenty inches, orange-brown calcareous gravelly clay at 2 ft., passing into broken calcareous sandstone or sandy limestone. Boulders of the sandy limestone crop out and the soil depth is very variable. On nearly flat top of high ridge at the break of slope descending into the Ngerengere Valley.

Type 19. Six to eight inches of iron-grey loamy sand lying directly on a stiff mottled grey clay extending to 12 to 18 inches, yellowish-grey calcareous plastic clay below. As its natural vegetation this type carries a short (knee to hip-high) not very dense stand of Themeda grass dotted with scattered low trees including yellow stemmed gall-acacia, a Cassia, a Combretum and an occasional doum palm. In patches the clay comes right to the surface where it has a nearly black colour and the grass is Heteropogon contortus instead of Themeda. Soil is caked hard when dry and boggy when wet. Almost totally infertile for any crop unless it were planted on high matuta after a deep cultivation.

Type 20. Black to dark chocolate friable loam containing small white concretions of lime carbonate in places, and also sharp quartz grit; subsoil a dull light reddish brown (as shown by fresh termite-heaps), depth variable, outcrops or floating boulders of lime stone in places, the limestone of two different types within a few score yards, one a fossiliferous light grey rock the other a very smooth-textured non-fossiliferous light brown rock with conchoidal fracture, weathering yellow externally. Possibly a soil of mixed origin, formed from transported detritus of several geological formations. Fertile. Natural vegetation a grassy woodland of tall Digitaria grass between trees of Acacia pallens, Combretum spp. tall Acacia Seyal and other tree spp.

Type 21. On long gentle slopes dropping from broad ridge carrying type 20; Nearly black rooty loam twelve inches deep, brownish grey clay loam subsoil to 18 inches, slightly calcareous below this and becoming more so, and lighter grey, with increasing depth to 3½ ft. Without grit or gravel, and not mottled. Fertile. Natural vegetation a dense growth of Digitaria grass amongst Combretum, Acacia pallens Dalbergia melanoxylon and other scattered trees forming a light woodland.

Type 22. Dark chocolate clay loam, calcareous greyish brown clay at six inches, grey plastic very calcareous at 1ft. and below; many large anthills and also rock outcrops of similar size and appearance, the rock being a calcareous sandstone or sandy limestone much jointed and weathered. Fertile. grows secondary woody bush luxuriantly including much Acacia Seyal.

The above, types 18 to 22, together with a light grey sand (not seen) under miombo woodland, and the Ngerengere alluvium, here apparently sandier than in the Kingolwira reaches, form what may be called the "Ngerengere East" group of soils. The remaining types to be listed are from the Ruvu area:

Type 23: Orange-brown to pinkish-brown loamy sand deep (6 to 8 ft. or more) bright brick-red to pinkish sandy loam with little perceptible difference from top to bottom of deep section, rare occurrences of rotton rock at depth show it to be derived from a sandstone said to be of Upper Cretaceous age. Flat plateau and ridge-top sites. Is associated with paler-coloured sands on slopes dropping from these plateau areas, and shallow dry or sedgy bottoms of the minor plateau valleys have a buff-coloured or nearly white sand, both these being derived from the main type by wash and effects of higher ground-water in the wet season. Carries a vegetation varying from semi-evergreen tree-thicket to dense semi-thicket parkland with grassy glades. Reasonably fertile according to rainfall but almost certainly poor in plant nutrients and liable to manifest deficiencies under continued cropping.

Type 24. Grey loamy sand to clayey sand, caked at surface, slightly rusty-mottled and compact "B-horizon a few inches down, calcareous sandy clay below. Nearly level topography or long gentle slopes with very localised patches or strips of calcareous black clay at lowest places. Parent material unknown, possibly a marl underlying the sandstone that gives rise to Type 23. Natural vegeation a semi-thicket low forest ("Musa Thicket") of numerous tree spp. and abundant succulent or spiny shrubs and creepers, with open glades. Cleared ground grows dense tall grass (Digitaria sp.) , and fertility seems satisfactory. A variant of this type occurs on a curious heaving topography like an ocean "sea".

Type 25. Deep pale grayish -brown sand, derivation unknown, occupying broad low ridges and long slopes on a part of the plateau area west of Ruvu Valley. Becomes more humic, even slightly peaty in spots, towards base of slopes where there is seepage. Is probably similar, in origin and character to type 7 noted on the western slopes of the Ngerengere Valley near Ngerengere.

Type 26. Grey loam with well marked chicken-wire cracking developed on the exposed face of weathered section; contains abundant water-worn quartz pebbles and grit and also small lime-carbonate concretions. A narrow zone along west slope of Ruvu Valley a little above the valley floor, the remains of a river terrace, upon the old alluvium of which this rather mature soil has developed.

Type 27. Sandy clay coarsely mottled in rusty, yellow, grey and brown, with some black manganese spots, carrying waist high tufts of Digitaria grass with bare ground between appearing hard beaten though there is no trampling (no cattle). Margins of Ruvu valley floor just above flood limit. A colluvium with high water table rather than a true alluvium. Uncultivable.

Type 28. Cracking black clay, not calcareaus at depths tested, a few inches only, in shallowly flooded marginal parts of Ruvu Valley away from the current of the floods and probably now receiving no accretions of alluvia material; carries taller grass growth than 27 and some admixture of other species.

Type 29. Browner and less plastic (less leathery) than 28, clay or clay-loam, flooded by slowly-flowing water; a "living" alluvium receiving annual accretions or disturbance.

Type 30. Level land alongside the main Ruvu River or its principal flood-season side-channels; brown silty loam, not cracking, freely drained but naturally sub-irrigated, fertile and occupied by native gardens, bananas, mango trees etc.

Soils resembling 29 and 30 in most essentials were included under type 3, Ngerengere alluvium.

Type 31. Green-grey silty clay, very plastic, deep, non-calcareous, very slightly mottled in green and grey at depth, is said to be very tacky when wet, floor of broad flat depression which is part of Ruvu Valley but does not carry any channel of the river and is not flooded; vegetation tall grass and widely scattered trees of many undetermined species. Origin and derivation unknown. Not cultivated.

Type 32. Brownish-grey sand over strongly mottled loamy sand (mottling in rusty, bleached grey and black) to 12 or 15 inches, sometimes to 24 or 27 inches, mottled sand clay or clayey sand below (varying bands strata at different depths in different places), with stiff sandy clay strongly mottled with large black manganese spots at 30-36 inches. Low "island" in middle of Ruvu Valley possibly an extensive sandbank in origin, developed to a mature "glay" profile through prolonged leaching and indifferent drainage. A most unatractive soil but not ucultivable.

C. Soil and Sisal.

After compiling a catalogue of soils of such wide diversity as the above it is surprising to have to go on to say that with only three exceptions, namely types 27, 28 and 31 of the Ruvu Valley flood-plain, every soil in the list has been regarded as a sisal soil by some estate manager and he has duly planted it up and waited for leaf. It is true, I found no sisal on top of Mgumbo Hill, where actually it would probably grow,

along with the aloes and sansevieria. Otherwise almost every kind of site and soil that the district affords was found under sisal on one estate or another.

The conclusion is either that sisal is a crop tolerant of a very wide range of soil conditions, --- which within certain clearly- marked limits is perfectly true ---, or that most estate managements have regarded soil as little more than a floor to conduct operations upon. Land has been regarded as sisal land if lining-out was possible upon it, the plants would stay in the ground where put, and a trolley line could be brought near. Whether the land were dry or wet, whether it were rock, sand, loam or clay, whether black, white, red or yellow in colour, whether six inches deep or six feet, does not seem to have mattered, ---- until about the third year after planting, when the prospects of the first cut begin to be calculated. At that stage the soil is discovered to have been of importance and a rough classification begins to take shape in the managers mind. It is largely with a view to bringing to notice the need for an interest in soil at an earlier stage than this that I have listed above in some detail the variety of soils that I saw on this short safari; and I proceed to give, a basis for further throught and observation on each manager's part rather than as an oracular statement, suggestions for a practical classification amongst the many types; the types themselves being easily recognisable on their field characters by any lay observer who takes an interest.

My headings will be:

I Soils too good for sisal.

II Soils that can be developed with confidence by the methods of ordinary good practice and should yield well under continuous sisal for several cycles.

III Soils that can be planted by ordinary methods but must not be expected to yield indefinitely without either fertilising or rotating with some other crop or with a sufficiently long bush fallow (several years).

IV Soils that need some sort of special treatment if reasonable yields are to be looked for; either fertilising, draining, subsoiling, etc., or survey by sufficient numbers of test pits before planting., in order to assess proportion of shallow patches etc.

V Soils which should never be planted.

Group I. Soils too good for sisal. Here I would include the best types of river alluvium, nos. 2, 3, and 30. So valuable are these lands, with their high natural fertility and ability to carry growth in dry weather, that their proper function in the economy of the district would seem to be grow either (a) human food, especially the protective and variety-giving foodstuffs, or (b) cattle food of succulent character for stall-feeding, as part of an intensive system of farming-with-cattle; or(c) some export crop of higher value than sisal.

It is possible that if some turn of the markets gave oportunity under (c), much of type 1, the hill-foot colluvial red earth, would come into this group.

II (Refer back for heading).

Types 1, 6, 12, 14, 17, 20, 26.

No comment required except to note the following point:

Type 12 in its more mature phases, and type 14, have in their natural state developed or begun to develop a compacted "B- horizon" or tight clay-pan at from 6 to 12 inches below that surface. If left long without deep cultivation as when in suckering sisal for several cycles, this clay-pan will tend to re-form, and impede penetration of rain and development of root system. Examples were met with where this seemed to be the case, and seemed to be the only ascertainable cause of complaint against otherwise very good soils. The trouble often accompanies over-crowding due to too many suckers being left. Drastic thinning, and really deep cultivation, to a foot depth, are then desirable.

111. (Refer back for heading).
Types 13, 23, 24.

These are the more sandy, or the more exhaustively weathered, red-earth types. Thye show liability to deficiency diseases, short leaf, etc., if continued under sisal for several successive cycles without rest or return of nutrients to the land. Type 13 is subject, a fortiori, to the "clay-pan" trouble noted above.

IV. (Refer back for heading).

Here come: the extreme light sands, types 7 and 25, which need fertiliser, especially I think nitrogen (sulphate of ammonia). There is scope for simple experimentation in this direction by estate managers. Clean weeding at frequent intervals in an alternative way of economising nitrogen, but I should not like to see it carried out as a policy year after year, -- probably the first two years after planting would be enough; and it should certainly be accompanied by special precautions against sheetwash, which would be insidious and damaging. Tie-riding is suggested.

Next, the sands over clay, types 8 and 32, where a combination of acidity, poor drainage and nitrogen shortage causes short and yellowish leaf. On such land planting sisal on high ridges like sweet pototoes might work better than planting on the flat. If no such measures are thought practicable, land of this type should not be looked upon as disappointing if it does not produce no 1 leaf.

In this group also the peaty sands, type 10, and the moist black-soil hollows, type 9. Drainage by a herringbone system of open ditches would bring some of these soils into excellent condition, as they are not poor in plant nutrients.

Then an unusual soil like 22, chocolate clay-loam over limey clay or limestone, which grows good bush and has grown good sisal, is worth the extra expense of specially deep digging to loosen up the clay and increase soil depth, but may become uneconomic if this is not done.

The shallow immature soils, types 5 and 18, require careful prospecting before development or before expense is incurred in regenerating, as such areas usually include types 4 or 11 (rubble patches), which classify under V, and too high a proportion of these will make a block uneconomic.

Finally a good fruity soil like 21, but rather heavy, should respond to a little help by subsoiling.

V. Soils not worth planting, or any further expense if already planted.

Rubble patches, types 4 and 11, of which surprisingly large areas are in fact under sisal. The labour of a Scottish crofter removing stone might win fair land from such wilderness -- if that were all the land there were.

Shallow sand over stiff clay, type 19; hopeless.

Sandy loam over yellow clay over mottled clay, type 16. It seems a pity to write off such a soil but I can see no prospect of fertilising, draining or subsoiling being effective, or effective for long. Better let such land go back to some function that it can fulfil, such as, I suggest, growing sorghum.

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In conclusion of this general section, I feel that the chief points of good soil management for sisal, apart from detail on particular types, are : soil inspection before planting: planting good material and planting it well: and devotion to the welfare of the young plants in their first two years. Many soil types that are marginal, i.e. that fall into my group III and IV, can produce good leaf if the right measures are supplied during or before the two first critical years of growth. Applied later, when growth is already behindhand, they may be ineffective and in any case will be more difficult. Thus interplanting with maize often shows itself later in backward growth, because there was competition for root-room, nitrogen, phosphate and moisture in the first two growing seasons. Similarly delayed weeding, careless planting or planting at too close a spacing for the soil type to carry, have effects that are too late for remedy in the third year. In such cases it is probably better policy to have the backward sisal out, cut the loss, determine a soil policy, and based on what is known or can be judged about the soil type, and replant with that policy working, than to attempt to impose such a policy on half-grown sisal lacking the vigour to respond to improved soil conditions.

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N.B. The "note on correlations" referred to in footnote on first page of Part 1 has had to be deferred as it would have taken some time to work out properly. There is a general resemblance to soil types in Korogwe-Muhesa- Ngomeni area, and some correlations also with certain Uganda soils; in detail, these comparisons would require caredul considerations and time has not sufficed for it.

Part II. Notes on each estate.

To be communicated only to the estate concerned in each case.

KINGOLWIRA.

Principal problem arises on a 300-hectare block (part of Block F) of 3-year old sisal planted closer than is usual. Experiment on increasing spacing by taking out alternate plants in the row and alternate rows, is on gentle slope of ridge carrying no. 14 soil, red-earth judged to belong to second (lower, younger) (lower, younger) peneplain surface of low plateau. Laboratory examination

of this soil as sampled later by B. Eccles in pit dug near experiment shows moderate acidity (pH 6.2. at surface to 5.9 in subsoil, again 6.2. - 6.4 in 5th and 6th foot) and moderate degree of exhaustion by weathering, residual weatherable minerals (feldspars etc.) not absent though not abundant. But there is a very well marked clay-pan in the 2nd and extending into the 3rd six inches.

Remarks under section C, Group 11 apply, also concluding remarks about cutting losses and replanting after determining soil policy. This soil is not, so far as I can tell without further analyses, a particularly poor one, but its compact clay-pan just below surface has prevented the too-closely planted young sisal from gaining root-vigour. I do not like Pangawe manager's idea of cutting leaf only, and cultivating; I would prefer cutting out entirely, and cultivating deep to break clay-pan. Taking out plants will not by itself restore vigour to those left and will leave a stand of uneconomic density, so Mr. Warren's experiment cannot have direct application in ameliorative measures, though it had been valuable in demonstrating that spacing is too close.

Same block in its southern part has quite different soils, including 4, 11, and possibly a shallow phase of 12. Rocky and shallow-soil parts are not worth continuing with, and a survey could readily delimit such areas for exclusion from any replanting policy.

PANGAWE.

Only problem seemed to be that presented by Group 1 soils, soils too good for sisal. Choice of alternative crop for the Kiroka Valley alluvium whose sisal grows too rank, lies outside field, except to say that judging soil characters as seen in boring, topography, and the indicator plants present, any tropical crop requiring deep rich soil and natural sub-irrigation will not be likely to find itself limited by soil conditions.

KIWEGE.

As extensive notes were taken and a good part of the estate seen a fairly detailed account for these soil can be given later but time does not allow of it with present report, which must remain in the general terms of Part 1. Soils include type 6, the red earths of Block 92/85 and there-abouts, which I think should be surveyed to ascertain their extent with a view to developing them, in preference to regenerating some of the type 5,7 and 8

soils, e.g. of the 1930 block.

The miombo woodland to the south of the 1938 block carries a very sandy and shallow form of type 15, with only a foot depth above the ironstone, and it is certainly not worth clearing.

On the sands, type 7 of the 1938 block, remarks in Part 1, C, Group 1V soils apply.

On the 1929 block there is scope for draining some of the valley-bottoms, to improve conditions on the type 9 and 10 which should then be very productive. Thinning of suckers is badly needed throughout this block. Some deep digging might be useful on the heavy type 5 soil derived from feldspar rock, though it is too mixed up with rubble patches, I should say, for tractor work to this end.

Preliminary laboratory examinations of the samples taken from pits in the type 6 soil (which tails off into 15 and other types) confirms field opinion expressed to Mr. Smith that it is a fairly fertile type of red earth.

MGUDI.

Chief point here, as expressed verbally to Mr. Cooke, is hopeless outlook for the unfortunately fairly large area on type 19 soil, block number not noted, part of the 1937 - 1939 area of the map? No drainage, deep ploughing or fertilising is likely to bring this sisal forward and the area, I think, should be abandoned.

Much more promising are the areas and adjoining the eastern boundary of the estate on soil types 20, 21 and 22, on which see notes in Part I C Group 1V soils.

RUVU.

Notes and data will enable fairly full sketch of the Ruvu Estate soils to be attempted later, but as no particular problems were raised the general account of Part 1 is not here amplified.

RUSEGWA and MAFIGA.

Problem here arises on type 12, a deep and very mature phase, having considerable compaction in immediate subsoil (Mafiga Blocks 2F and 2G). Thinning of suckers, and a deep thorough cultivation, seem all that is necessary, on a vegetation policy, but a better policy might be to cut out, burn, distribute the ash, cultivate as deep as possible and replant. Effect of wood-ash thrown out from labour-lines huts is very marked here and indicates that although the soils are not infertile they might be considerably helped by fertilising.

For type 16, on Rusegwe, see reference in part 1, C, Group V soils. No remedial measure can be suggested here.

Further notes on the Block N area will be furnished after analysis of the sample taken, not now possible for some months; but from field observation it seems that a clay-pan may need to be broken up here also, and that nitrogen-manuring, possibly combined with liming and green-manuring, would be necessary to obtain effective growth. Probably not an economic block on these terms.

Aerodrome site, Block 10 C. on Mafiga, is type 11 soil, shallow but heavy, with much rock-rubble and quartz gravel. Poor growth of sisal seems due entirely to lack of soil depth, rather than to poverty of what soil there is, but again further notes must await analysis of sample. From surface appearances, the site belongs in Group V without much doubt, and I consider should never have been planted.

16th July, 1941.

G.MILNE.