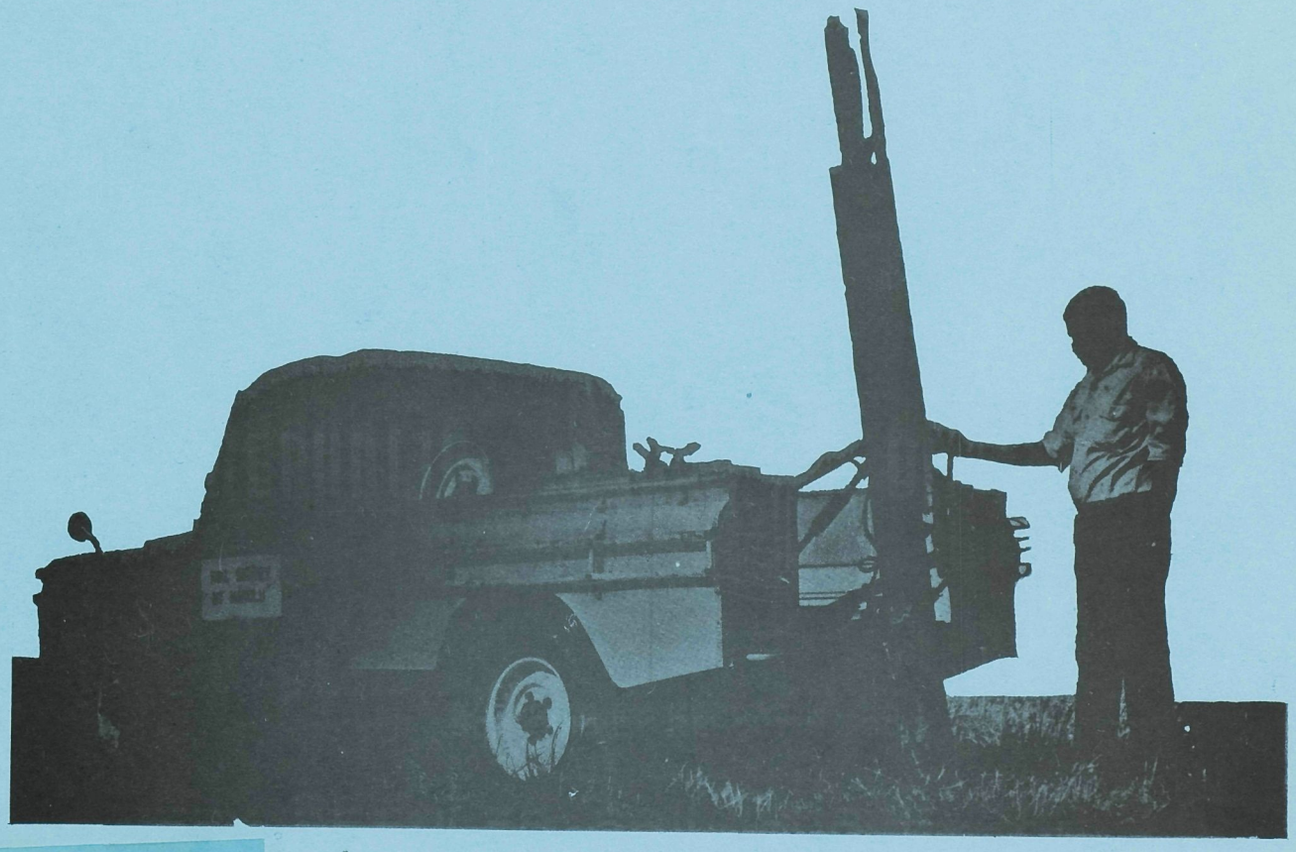
REPUBLIC OF ZAMBIA

SOIL SURVEY REPORT No. 95

VERY DETAILED SOIL SURVEY OF THE CHINSALI FARMER TRAINING CENTRE NORTHERN PROVINCE

BY

L.A. VAN SLEEN



SOIL SURVEY UNIT
LAND USE BRANCH
DEPARTMENT OF AGRICULTURE
1978

REPUBLIC OF ZAMBIA

MINISTRY OF AGRICULTURE AND WATER DEVELOPMENT.

SOIL SURVEY REPORT NO. 95

VERY DETAILED SOIL SURVEY OF THE CHINSALI FARMER TRAINING CENTRE (FTC) NORTHERN PROVINCE

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SUMMARY AND RECOMMENDATIONS.

The soils of the F.T.C. area which were surveyed in very much detail cover an area of approximately 7.56 ha. only, of which only 1.5 ha (or almost 20%) consist of Moderately Good Arable Land (LUS class S_{2s}), while the remaining 6 ha. (or about 80%) are downgraded -due to their coarse texture and 3-5% slope - into Poor Arable Land (5,72 ha.) (LUS class S_{3ts}) or-due to their rockiness-into Unsuitable Land (0,28 ha.) (LUS class Udr).

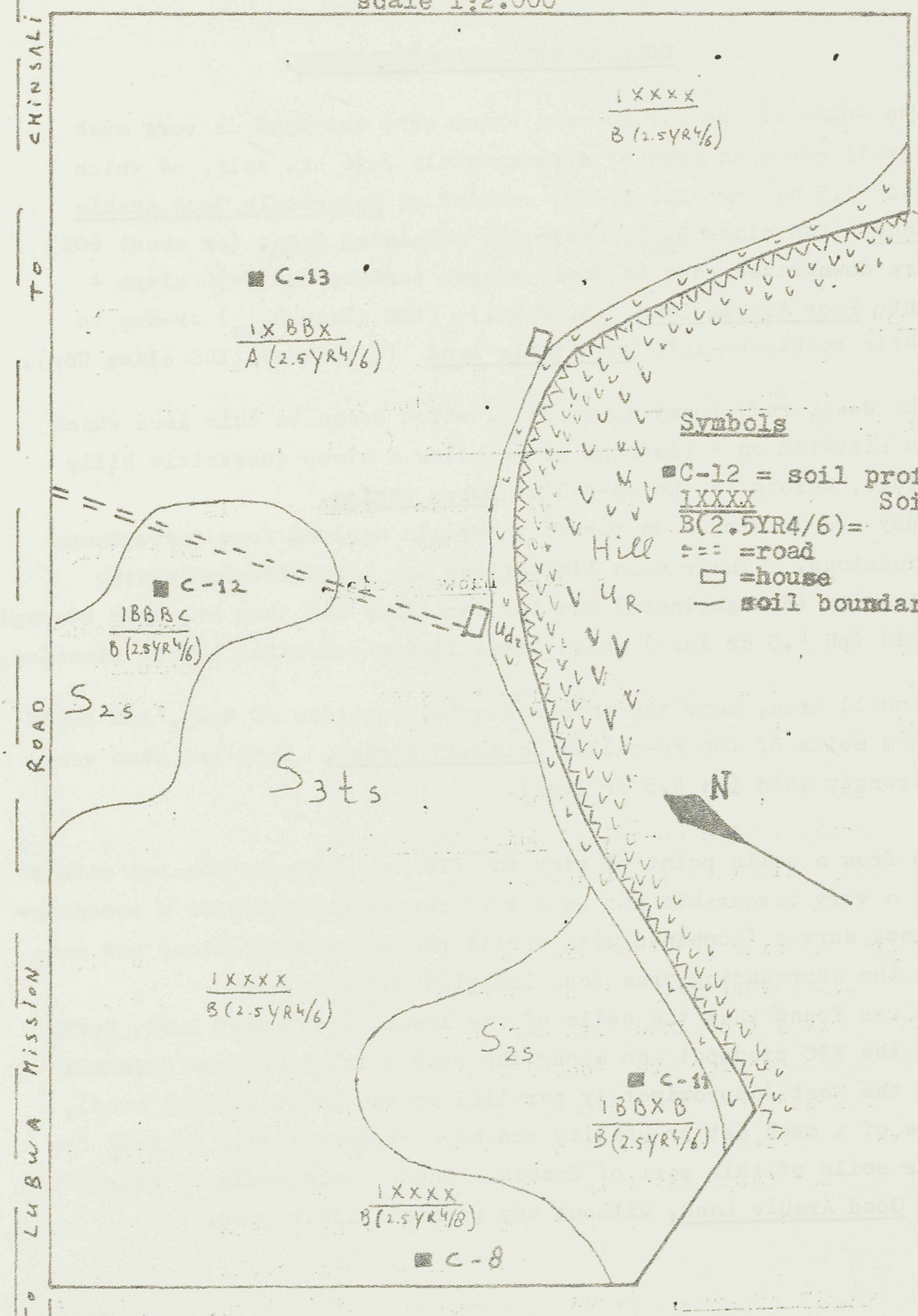
The deep, red, loamy sand soils, which dominate this area which is situated on a piedmont slope below a steep quartzitic hilly ridge, belong to the so-called **Lubwa series.**
They are developed on parent materials derived from ferruginous sandstone. Their main limitations are Low Moisture Holding Capacity (droughtiness) and low fertility and they are very strongly acid (pH 4.5 or less) which makes liming essential before planting.

A small area, near the entrance gate, consists of deep, red sandy loam soils of the so-called Chinsali series. They are also very strongly acid (pH 4.5 or less).

As from a soils point of view the FTC has not been located either on a very favourable nor on a very representative site a reconnassance survey (combined with aerial photo interpretation) was made in the surrounding area (see location map on p.4).
It was found that the soils of the lower plain (unit LoP), North of the FTC piedmont and along the road which runs from Chinsali to the West (approximately parallel to the Lubwa Mission road), are of a much better quality and more representative as well for the soils of this part of Zambia. These soils could be classified as Good Arable Land, without any physical limitation.

LAND CAPABILITY MAP of the Chinsali Farmer Training Centre

scale 1:2.000



Legend

S_{2s} = Moderately Good Arable Land

S_{3ts} = Poor Arable Land

U_{dr} = Unsuitable Rockland

When the soil surveyor together with the planning assistants were sent into the field (in February 1975) in order to survey the Chinsali FTC area, they found that part of the buildings had already been constructed.

Unfortunately it was clear that the sandy piedmont soils on which the area had been located were not very favourable from the agricultural point of view nor could they be considered as being very representative for the soils of this part of Zambia, as these piedmont soils only occur as relatively narrow zones at the foot of feruginous sandstone ridges.

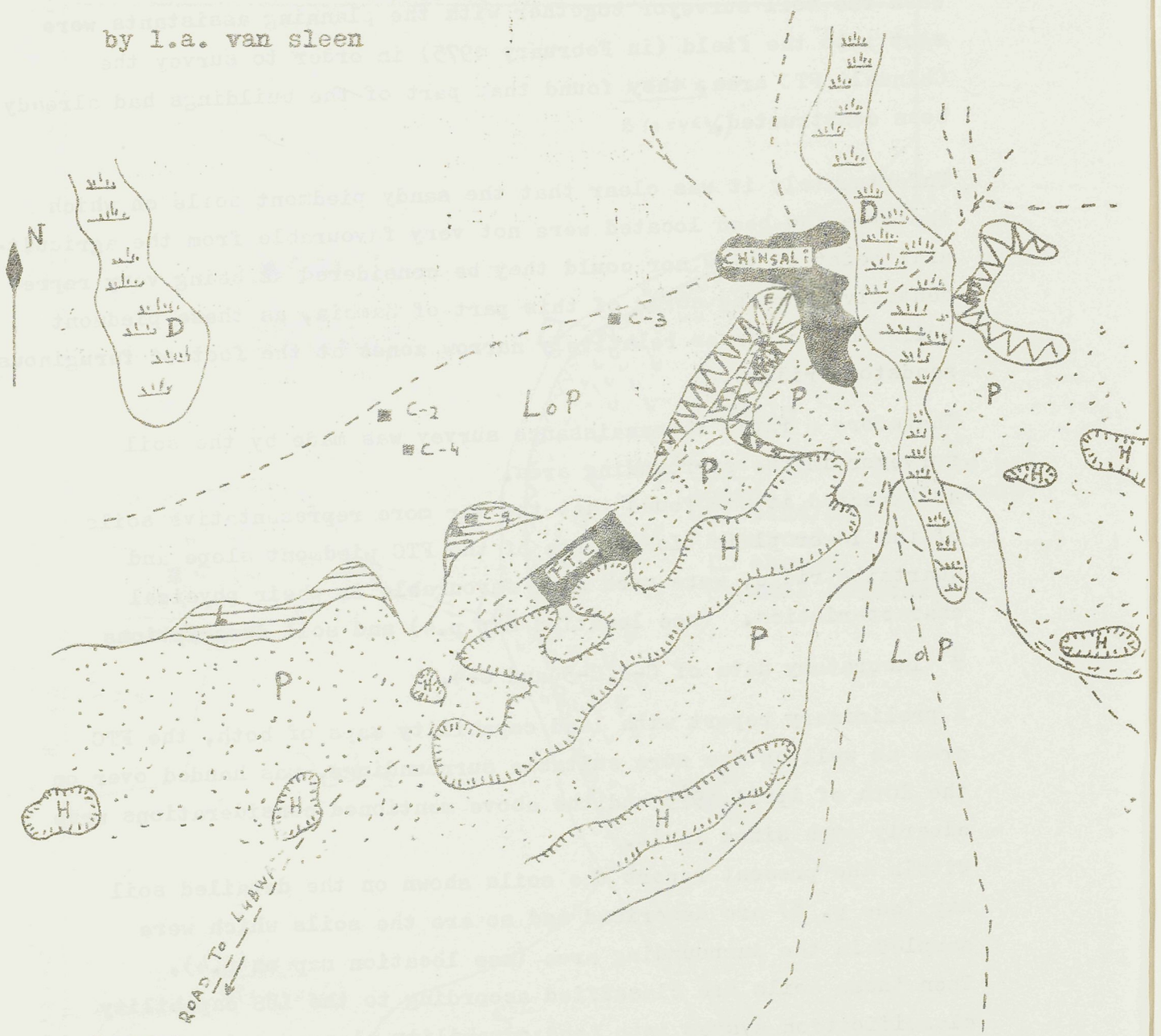
Therefore a rapid reconnaissance survey was made by the soil surveyor in the surrounding area.
As expected it was found that the far more representative soils of the lower plain (LoP) north of the FTC piedmont slope and quartzite ridge, were much more favourable in their physical characteristics. (see location map p.4) and soil descriptions & laboratory data of C-2,C-3 and C-4.

A preliminary report with land capability maps of both, the FTC area as well as the more suitable surroundings, was handed over on the 20th of April 1975 and the above mentioned considerations were clearly emphasized in it.
Within the present report the soils shown on the detailed soil map (see p. 8) are described and so are the soils which were sampled in the surrounding area (see location map on p.4).
Then these soils are classified according to the LUS capability classification system into Land capability classes and subclasses and finally all available information is evaluated in making recommendations for use and management.

LOCATION MAP with main Physiography

scale 1:30.000

by l.a. van sleen



Legend

H= Quartzitic Sandstone Hills

P= Sandy or coarse loamy Piedmont slopes

E= Escarpment, locally with weathered iron ore(probably from a vein).

L= Lateritic gravels

LoP= Lower Plain

D= Dambo or swamp

Symbols

C-2 = profile pit

R-1 = rock sample

---- = road

~~~ = physiogr.boundary
~~~

The ENVIRONMENT.

Location:

The Chinsali FTC area is located in Northern Province, Chinsali District, about 1½ km. S.W. from Chinsali township, along the southern side of the road from Chinsali boma to Lubwa Mission. (see location map p.4)
Its approximate location is 10° 35' South and 32° 03' East of Greenwich. In the south the area is bound by a steep quartzitic sandstone ridge.

Climate:

The meteorological station in Chinsali township is situated at an altitude of 1350 m. and has a mean annual temperature of 20.7 °C. and a mean annual rainfall of 1120 mm.
The climate is strongly seasonal with a wet season from November to April and a dry season from May to October.
The wet season has monthly temperatures of about 21°C. with a mean maximum about 10°C. higher and it has a mean monthly rainfall maximum of about 300 mm. in January.
The dry season has a cool period in June/July with mean monthly temperatures of about 7°C. After June temperatures rise steadily to the October maximum of about 23°C.
Frosts do not occur.

Geology, geomorphology and drainage:

As can be seen on the location map with main phisiography (p.4), the FTC area is located on a piedmont slope below a steep quartizitic ridge (Irumide folding) of the Kibaran System (= Upper Precambrian Basement Complex).
The alluvio-colluvial red sandy or coarse loamy parent materials on which the soils are developed have been derived from these ferruginous sandstones. One rocksample (see R-1 and appendix 4) taken from this ridge contains weathered iron ore, probably from a vein.

The area is - mostly internallt - drained towards the lower plain (LoP) in the North and finally to the Chambeshi swamps, which are to be found north west and west of this area.

Vegetation and land use:

The FTC area does have a sparse tree cover with Brachystegia boehmi, Uapaca kirkiana and Monotes spp. trees. During the time of survey the area was already partly cultivated with Maize.

SOIL SURVEY METHODS

In February-March 1975 a very detailed soil code map (1:500) was made of the FTC area by the planning team and under the supervision of the soil surveyor.

From the Lubwa-Chinsali road , which served as a base line, 8 traverses (each at a distance of 60 m) were made at right angles from it and up to the rocky foot of the sandstone ridge.

Within these traverses soil observations were made every 60m. by the planning assistents.

The soil surveyor traversed the area from 5 till 7 February and had 4 soil profile pits dug in it ,which he examined and sampled completely.

After carefull interpretation of the aerial photographs of the surrounding area 4 more soil profile pits were described and sampled on 18 April outside the FTC area. Detailed descriptions and analyses are to be found in the appendix 1.

The 1:500 soil code map was 4 times reduced and a 1:2.000 soil map (p.8) and Land capability map (p.2) made.

The location map with main physiography of the surrounding area (P.4) was directly made on aerial photographs (scale 1:30.000).

SOIL MAPPING UNITS

Within the FTC area itself (see p.8), which is entirely located on a piedmont slope, only 4 different mapping units have been delineated (H2,P1 and P3). They are discussed first.

Outside this area - on the surrounding lower plateau (LoP) (see p.4) - 4 different soil types have been described and sampled in detail. They are discussed afterwards.

H - Quartzitic Ridge

H1 - rocky hills (ferruginous sandstone). Outside the FTC area.

Cont/..

Mapping Unit H2: Lubwa loamy sand, rocky phase (0.28 ha.)
is a moderately deep to very shallow loamy sand soil with many rock outcrops.
This unit is situated at the foot of the hilly ridge.
Land Capability Unit: U_{dr}

P. - Piedmont Slope

Mapping Unit P1: Lubwa sandy loam (0.94 ha.)
is a deep, somewhat excessively drained, red loamy sand (or sandy loam but with less than 15% clay) subsoil with a sandy loam surface soil.
It occurs on the upper-or mid piedmont slope.

Brief Profile Description

0 - 27 cm. (Dark) reddish brown fine sandy loam
27 - 120cm. Red loamy fine sand

The natural vegetation consists of a rather sparse tree cover.
Soil reaction (pH) is very strongly acid. The soil is moderately suited to most crops due to its gentle slope and coarse texture.
Land Capability Unit : S_{2s}
Typical LUS Code : IBXBX
B(2.5YR4/6)

Mapping Unit P2: Luhwa loamy sand (5.72 ha.)
As above but with a loamy sand texture throughtout the entire soil profile (or coarser).
They occur also on the upper - and mid piedmont slopes.

Brief Profile Description

0 - 43 cm. (Dark) reddish brown loamy sand
43 - 120+cm. Red loamy sand.

Sparse tree cover. Soil reaction (pH) very strongly acid.
This soil is poorly suited to most crops due to its coarse texture and low fertility.
Land Capability Unit: S3ts
Typical LUS Code : IXXXX
B(2.5YR 4/8)

Mapping Unit P3 : Chingali sandy loam (0.56 ha.)
is a deep, well drained, red, sandy loam soil.
It occurs on the mid-and lower piedmont slopes.

Cont/...

Brief Profile Description

0 - 19 cm. Reddish brown sandy loam

19 - 57 cm. Dark red sandy loam

57 - 120+cm. Red sandy loam or sometimes sandy clay loam

The natural vegetation consists of open woodland savannah.
Sooil reaction (pH) is very strongly acid.
This soil is moderately well suited to most crops.
Land Capability Unit: S_{2s}

Typical LUS Code : $\frac{IBBBC}{B(2.5YR4/6)}$

LoP - Lower Plateau

The following soils were described and sampled outside the FTC area (see location map p.4) on the lower plain north of the hilly ridges and piedmont slope.

Profile Pit C-2 : Konkola sandy loam

is a deep , well drained sandy clay to clay soil with a sandy loam surface soil and a sandy clay loam upper subsoil.

Brief Profile Description

0 - 25 cm. dark yellowish red sandy loam

25 - 40 cm. red sandy clay loam

40 - 90 cm. red sandy clay

90 - 160 cm. red clay

The natural vegetation consists of Brachystegia boehmi, B. Longifolia B. utilis, Julbernardia paniculata, Isoberlinia angolensis and I. tomentosa trees. Soil reaction (pH) is very strongly acid in the subsoil and medium acid in the topsoil.
The soil is well suited to most crops.
Land Capability Unit: S_1

Typical LUS Code : $\frac{IBCEE}{A(10R4/6)}$

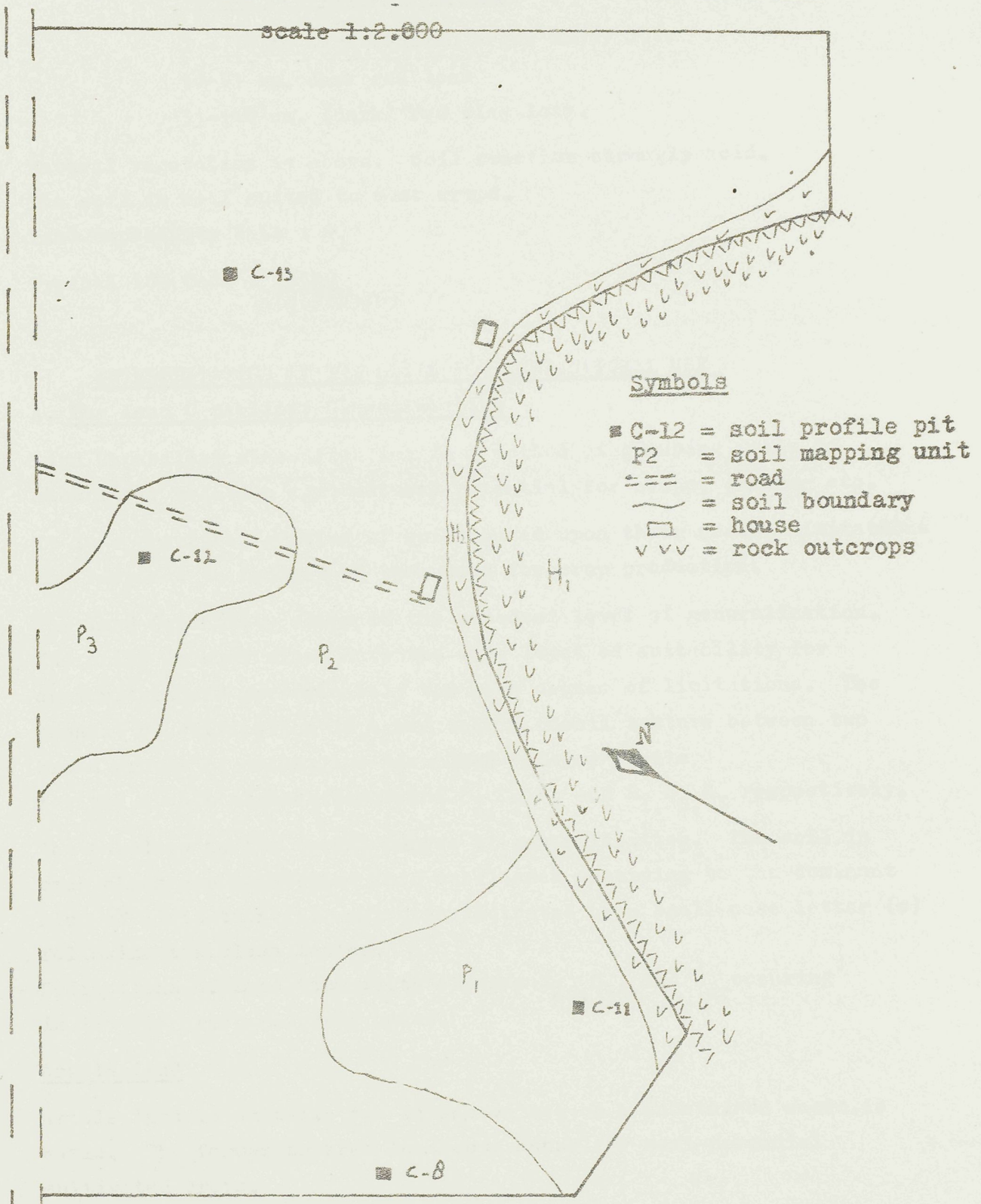
Profile Pit C-4 : Mulanga sandy loam

is a deep, well drained loam to clay loam soil with a sandy loam surface soil. It looks very similar to the previous soil but has a higher silt content (21-30%) and a higher BSP (57-79%).

Cont/....

SOIL MAP of the Chinsali Farmer Training Centre (FTC)

scale 1:2.000



Symbols

- C-12 = soil profile pit
- P2 = soil mapping unit
- = road
- = soil boundary
- = house
- = rock outcrops

Legend

H- Quartzite Ridge
- H1 =Quartzitic Hill
- H2 = Many rock outcrops at foot of Hill

P- Piedmont slope
- P1 =Lubwa sandy loam
- P2 =Lubwa loamy sand
- P3 =Chinsali sandy loam

Brief Profile Description

0 - 18 cm dark reddish brown sandy loam

18-31 cm. dark red loam

31-140+cm. (dark) red clay loam.

Natural vegetation as above. Soil reaction strongly acid.
The soil is well suited to most crops.
Land Capability Unit : S_1

Typical LUS Code : IBDDD / A(2.5YR3/6)

INTERPRETATION OF THE SOILS FOR AGRICULTURAL USE

A, The Land Capability Classification

Land Capability classification is a method of grouping soils to show their relative agricultural potential for crops, grazing etc.

It is a practical grading of soils based upon their needs, limitations and response to management when used for crop production.

The Land Capability class is the broadest level of generalization. The soils in each class have the same level of suitability for agriculture and approximately the same degree of limitations. The present classification is based mainly onsoil texture between two broad groups of soils; the so-called "clayey" soils for the Arable classes indicated C_1, C_2, C_3 and S_1, S_2, S_3 respectively.

The subclass is the second degree of generalization. The soil in each class are subdivided into subclasses according to the dominant kind of limitation (s), which is indicated by a small case letter (s) following the class letter.

Definations of Land Capability classes S_{2s}, S_{3ts} and U_{dr} occuring in the FTC area are given below.

Arable Land

Arable land is suitable for intensive use on a substained econo,ic basis. The farmer is free to choose annual or semi-perennial sultivated crops.

Class S_2 : Moderately Good Arable Land (1.5 ha.)

Land capable of being maintained at a high level of productivity under an intensive cropping system, but requiring special attention to soil conservation or management because of these limatations. Or land capable of being maintained at only a moderate level of productivity. Response to improvement in management is high.

Subclass S_{2s}: Deep, well drained gently s loping.

Cont/...

Marginal Arable Land

Does not su port a long term inte sive use of the Land for arable crops without great risk of poor yields in dry or wet years. Limited freedom of choise of crops or management or high degree of environment control.

Class S_3 : Poor arable land (5.72 ha.)
Land with severe limitations for cultivation which either greatly increases the costs of production or reduce yields to marginal levels, or severely restrict the range of crops that can be grown satisfactorily.
Subclass S_{3ts}: Deep well drained, gently sloping sandy soils.

Unsuitable Land

This class includes land with too severe limitations for arable cropping or grazing.

Subclass U_{dr}: Unsuitable because of too many rock outcrops (0.28 ha.)

B-Crop Suitability ratings

The various kinds of soils have been rated relative to their suitability for production of certain crops. These ratings are called crop suitability classes and range from class 1 for the most suitable to class 4 for the least suitable.

Crop suitability is an evaluation of the land for individual crops , whereas land capability is a grading for overal crop Production. Therefore one soil in Land Capability class C_2 for example may be well suited for maize (eg. Crop Suitability class 1) while another soil in Land Capapbility class S_{3ts} for example may be well suited for Virginia Tobacco (Crop suitability class 1, due to their sandy texture) and only poorly suited for maize.

Before using suitability ratings given in the attached table, the following points should be taken into consideration:

1. An "above average" level of management is assumed, like that of a good farmer, but not like that of an Agric. Research Station.
2. That soil conservation works are installed, where necessary.
3. That, over the long run, the value of the crop yield must be expected to exceed the costs of its production.

Cont/...

4. The soils are graded according to their present field conditions.
5. Ratings are based on present Agric. technology levels.
6. Ratings should not be regarded as infallible.
7. Absence from the list of crops does not indicate a lack of adaptation to local conditions.

Table 1 shows by mapping units the 4 levels of crop suitability, which aredefined as follows:

Suitability class 1 : Well suited the crops grow well and would produce relatively high yields.

Suitability class 2: Moderately suited the crops would produce moderate yields.

Suitability class 3 : Poorly suited the crops would produce poor yields. Response to management is low.

Suitability class 4 : Not suited Little, if any, production would be expected from the crop under consideration.

It should be noted that, for example, a low rating for a given crop does not mean that the crop cannot be produced. It does indicate that some unfavourable characteristics such as low fertility or low permeability would need to be overcome by the addition of extra amounts of fertilizer or other specific treatments for the crop to produce well. The economics of such corrective measures would need to be evaluated carefully.

Cont'/...

Table 1. Suitability ratings by mapping units for the production of specefic crops.

Mapping Units	H2	P1	P2	P3
LUS Land Class	U_{dr}	S_{2s}	S_{3ts}	S_{2s}
Soil Name	rock outcrops	Lubwa SL	Lubwa LS	Chinsali SL
ha.	0.28	0.94	5.72	0.56
Maize	4	2	2	2
Bulrush millet	4	2	2	2
Sorghum	4	2	2	2
Finger millet	4	2	2	2
Groundnuts	4	2	2	2
Soyabeans	4	3	3	2
Beans	4	2	3	2
Sunflower	4	2	3	2
Virginnia Tobacco	4	2	2	2
Potatoes	4	2	3	2
Tomatoes	4	1	2	1
Tomatoes	4	3	3	2
Sugarcane	4	2	3	2
Pine apple	4	2	2	2
Cassava	4	2	2	2
Bananas	4	2	2	2
Citrus	4	3	3	2

C. Evaluation of the soils and Development possibilities

All the soils of the FTC area are chemically poor. They are strongly to very strongly acid. The need for lime is urgent. They have a low Cation Exchange Capability and a low Base Saturation Percentage. The totals of exchangeable Ca, Mg, K is mostly below 1%, which is very poor and they are poorly provided with organic matter (about ½% usually).

Available phosphorus is usually acutely deficient (about 2ppm).

Physically the soils may suffer from droughtiness due to its coarse textures.

Cont/...

Table 2. Tentative Soil Classification of the most important Soil series of the Chinsali FTC Area and its surroundings

Soil Series	USDA - Soil Taxonomy System
Lubwa	Typic (or Oxix) Quartizipsamments
Chinsali	coarse loamy Typic Haplustoxs
Nsato	Psammentic-Lithic Haplustoxs
Konkola	clayey (fine) Typic Haplustoxs
Mulanga	clayey (fine) Typic Eutrustoxs
Misamfu	fine loamy Typic Haplustoxs

U.S.D.A.

Soil Taxonomy

Washington DC.

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APPENDIX 4.

BRIEF PETROGRAPHIC DESCRIPTION

Rock Sample R-I (Chinsali area, see mao p.4)

= Weathered iron ore (probably from a vein)

Subangular grains of quartz, mostly fine grained but some quite large, entirely encased within an opaque cement determined as goethite by X-ray diffraction.

LABORATORY REPORT GEOLOGICAL SURVEY DEPARTMENT OF ZAMBIA
29th October 1976, Minerologist John Tether.