Ndola, Zambia

Detailed Reconnaissance Soil Survey of Kafubu Farm

Soils Incorporated Pvt Ltd
P.O. Box MP 360
Mount Pleasant
Harare, Zimbabwe
Tel: +263 4 882737 email: al.hungwe@soilsinc.com

March 2013

1. Introduction

At the request of Goldenlay Pvt Ltd, a detailed reconnaissance soil survey of Kafubu farm was carried out over the period 22 – 25 December 2012. The purpose of the soil survey was to delineate and map all soils that are suitable for crop production under both rainfed and irrigated farming. Kafubu farm, some 3000ha in extent, is located some 15km to the south west of the city of Ndola.

The background to the soil examination is that Goldenlay, a large chicken and egg production company, owns a farm about 25km to the west of Ndola where they produce an average of 300 000 eggs per day. This operation consumes large quantities of feed, which the company is currently sourcing from various producers in Zambia. As part of their future business plans, Goldenlay has decided to produce some of its feed. To that end, the company has acquired Kafubu farm, which is located about 10km from their current operation for the purpose of growing crops, mainly maize and soya bean for chicken feed. The farm is located on an interfluve between two rivers and there is an opportunity for the establishment of some irrigation.

A potential dam site has been identified and is indicated on the soil map. Details of the amount of water that can be stored in this dam and the potential yield are being determined.

The soil surveys conducted and reported here were carried out at the detailed reconnaissance scale for the purpose of establishing how much arable land occurs on the farm and to characterize these soils. It must be pointed out that this was not a detailed soil survey to support final irrigation design.

2. Assessment Methodology

Prior to the field visit to site, satellite imagery of the farm was obtained and examined to gain a preliminary overview of the soils that were likely to occur in the area as well as to determine if there are any major fatal flaw limitations to arable farming or irrigation such as rugged topography or the existence of extensive areas of wetland.

Concurrent with the study of satellite imagery, background information on the geology of the area as well as information from previous soil surveys in the province was obtained from various sources and studied.

In the field, the soils were examined along all available access routes. There have been little farm activity on Kafubu farm in the past decade and as a result, there has been little farm track maintenance. In addition, the soil examination was carried out in the middle of the rainy season. Thus, unfortunately, vehicle access was not extensive over the farm and some foot traverses had to be made. Along these traverses, soils were examined by auger borings to a depth of 120cm unless stopped by rock or impenetrable gravels. The succession of horizons in each auger was studied and used to assess the suitability of the soils for arable farming and irrigation.

In addition to the augers, nine pits were dug in representative locations to characterize the different soil types occurring on the farm and these pits were subjected to detailed descriptions. Soil samples were collected for laboratory analysis from these 9 soil pits and submitted to the laboratories of the Chemistry and Soil Research Institute, Harare, Zimbabwe, for analysis for a variety of soil textural and chemical characterization parameters.

3. Soil Survey Findings

3.1 General Decription of the Soils of the Project Site

The project site is located in an area of intermediate to mafic metamorphosed sedimentary geology geology. These metamorphic rocks give rise to red, well drained soils throughout the landscape, except in low lying wetland locations. In upland and midslope positions, the soils are generally deep, red and orange sandy loams and sandy clay loams in the surface, overlying similar red coarse grained sandy clays and clays. Soil depth generally exceeds 100 cm. In some locations however, the soil profile has a layer of laterite gravels in the subsoil even though the soil depth still exceeds 100cm.

Surface outctrops of laterite were encountered on the farm but these were found to generally be in the form of narrow dykes that are not expected to amount to a significantly large areas of the land. However, the exact extent of these laterite outcrops and areas where the laterite significantly limits soil depth, rendering the soil unsuitable for irrigation or arable farming can only be determined through detailed soil surveys.

3.2 Soil Types Identified and Mapped

Five soil types were identified and mapped in this reconnaissance soil survey. Summary descriptions of these are given below as well as an assessment of their suitability for irrigated sugarcane.

3.2.1 Soil Type 1 – Deep red Sandy Clay Loams and Sandy Clays over Red Clays

These are the most common soils on the project site and they consist of deep, over 150cm, red coarse grained sandy loams and sometimes sandy clay loams in the surface, which in turn overlie similar red sandy clay loams to clays to a depth exceeding 150cm. They are formed from a mafic gneissic rock and are well drained throughout the profile.

Their good texture and resultant high water holding capacity, as well as their excellent drainage properties render them highly suitable for irrigated sugarcane. The location of these soil blocks is shown on the soil map below. In the field some occasional narrow banks of laterite were found occurring in these soils. However, these bands of laterite were narrow, less than 20 metres wide and therefore unlikely to detract heavily from the suitability of these soils for arable farming.

Soil pits 2 and 9 whose profile descriptions and laboratory analysis data are presented in Appendix 1 are representative of these soils. The analysis shows that these soils are highly leached and thus of low pH, with pH values of around 4 on the calcium chloride scale. The rest of the analysis data is consistent with high leaching rendering the soils of low base saturation, low exchangeable bases. The soils are non sodic. Under crop production, these soils will require applications or lime to correct acidity before any applications of fertiliser.

With regard to irrigation systems, these soils can be irrigated by both surface and overhead method, although overhead would be more appropriate and provide a better opportunity for more economical and even water application.

Under good management, and barring any chemical deformity (which is not expected to be the case), good yields of maize, soya bean and any other common field crops should be achievable on these soils.

3.2.2 Soil Type 2 – Moderately Deep to deep yellowish red to orange Sandy Loams and Sandy Clay Loams over Sandy Clay Loams and Clays

These soils are similar to type 1 soils, occurring in midslope and crest of interfluve positions in the landscape. They may have been formed from a less mafic type of parent rock, hence their less red colour. The soils consist of moderately deep to deep, dark brown sandy loams in the surface, overlying yellowish red and orange brown sandy clay loams in the subsoil. These soils are well drained and do not exhibit any signs of impeded drainage.

Soil pits 1 and 3, that are described in Appendix 1 are representative of these soils. The analysis data for these soils shows that, similarly to soil type 1, these soils are leached, of low pH and low bases. They will similarly require applications of lime to correct the low pH before any commercial crop production can be contemplated. Because of their leached status, they are low in potash and most essential nutrients, especially phosphate.

With regard to irrigation, these soils are suitable but are best irrigated by overhead method to take account of their light surface texture and the possible need for short irrigation cycles. The soils are suitable for the rainfed production of any common field crop, including maize and soya bean. They are the most common soils on the farm.

3.2.3 Soil Type 2a – Soil Type 2 soils but occurring in association with some laterite oucrops and shallow soils over laterite.

These are areas of soil type 2a soils but where it was that the type 2 soils were occurring in association with outcrops of laterite. As a result, some of these areas may not be suitable for arable farming or irrigation.

It was not possible in the detailed reconnaissance soil survey to fully delineate and separate shallow laterite areas from the deep type 2 soils. However the amount of shallow soils is deemed to be small. It can, however, only be established through a detailed soil survey.

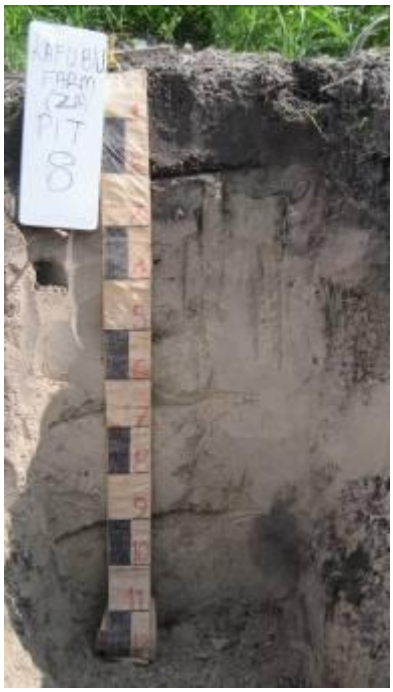
3.2.4 Soil Type 3 – Deep pale yellow loamy sands over yellow sandy

Type 3 soils are appear to be derived from a granitic gneiss or some sandstone in lower midslope positions towards the local drainage lines. These soils consist of deep dark brown to black sandy loams in the surface, overlying yellow sandy loams and sandy clay loams in the subsoil. They are well drained, exhibiting no signs of layers of impeded drainage in the subsoil.

Soil pits 4, 5, and 6 that whose soil profile descriptions and laboratory analysis data are presented in appendix 1 are typical of these soils. Vegetation on them and crops that were observed growing on them by local settlers with limited or no fertiliser indicated that they may be limited in their natural fertility. The soil analysis data shows that, as expected, they are heavily leached, of low pH, and low exchangeable base status. Thus, large amounts of lime and fertiliser will be needed for successful crop growth on these soils.

On account of their good texture, good water holding capacity, good drainage and good depth, these soils are highly suited to crop production. With regard to irrigation, they can only be irrigated buy centre pivot, on account of their tendency to be light textured in the surface, thereby requiring short irrigation cycles

3.2.5 Soil Type 4 – Wetland Margin Sandy Soils



These soils are found on the margins of the wetlands of the farm. They consist of moderately shallow to deep black loamy sands in the surface over white sands to depths of about 80cm. Below that depth the soils become white sandy loams and sandy clay loams.

The white sandy horizon that extends from 20cm to about 80cm is very distinctive and sought by locals for use as pit sand for construction. Thus large trenches left behind by previous mining of this sand are evident on the edges of the wetlands on the farm.

These soils are not suitable for arable farming, nor are they suitable for irrigation on account of their sandy texture and their occurrence on the edge of wetlands. Pit 8 which is described in appendix 1 is representative of these soils

3.2.6 Soil Type 5 - Wetland Areas

Type 5 refers to all areas of wetlands on the farm. Thus, it is not, strictly, a soil type but a reference to all areas that are permanently wet. They are not suitable for any arable farming or for irrigation. They are best left natural

4. The Soil Map

A soil map of Kafubu map is presented below, showing the general distribution of the different soils that were identified and mapped. Also indicated on the map are the hectarages of the different soil blocks to facilitate planning of cropping programme.

5. Areas of Irrigable Soils

The table below presents the hectarages of the soils that were identified and mapped.

Summary Tables of Areas of Soil Types

Suitability for Arable Farming	Suitable		Not Suitable		Total
	Hectarage	% of farm	Hectarage	% of farm	
Soil Type 1	333	11.3			333
Soil Type 2	1675	56.6			1675
Soil Type 2a	84	2.8			84
Soil Type 3	546	18.5			546
Soil Type 4			181	6.1	181
Soil Type 5			138	4.7	138
Totals	**2638ha**	**89.2%**	**319**	**10.8%**	**2957ha**

It will be seen that at reconnaissance scale, nearly 90% of the farm is arable.

6. Conclusion

Kafubu farm has good potential for arable farming and for irrigated crop production. Most of the farm is underlain by deep well drained sandy loams in the surface overlying sandy clay loams and clays in the subsoil.

Soil types 1, 2 and 3 can all be irrigated under centre pivot and but cannot be surface irrigated on account of their tendency to be sandy in the surface.

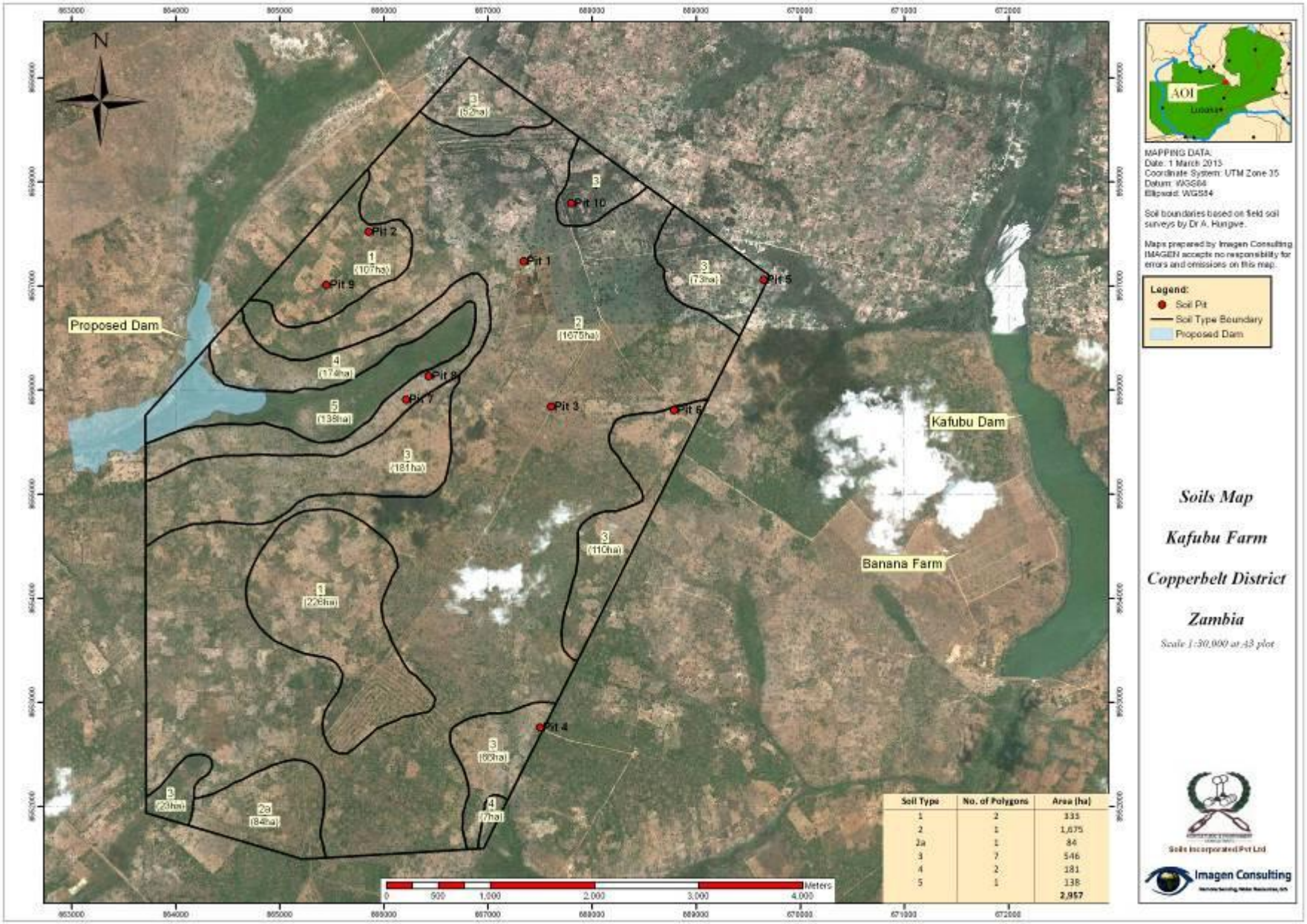


Figure 1: Detailed Reconnaissance Soil Map of the Kafubu Farm.

APPENDIX 1

Soil Profile Descriptions and Soil Sample Analysis Data

Soil Type 1 :- Pit 9

UTM Coords Zone 36KL: 0665444/8557010

Site: Crest of interfluve
Vegetation: Edge of maize land, myombo woodland with *Brachystegia boehemii* and *specitoi, eupaka spp*
Parent Material: intermediate metamorphic rock
Slope: <1%
Soil Profile Description

0 – 23cm: Dark reddish brown (5YR 3/2m) medium grained loamy sand; moist friable consistence; weak medium sub angular blocky structure; good permeability and numerous roots. Clear transition to:

23 – 42cm: Reddish brown(5YR 3/6m) medium grained sandy loam; moist friable consistence; moderate medium sub angular blocky structure; good permeability and fairly numerous roots. Gradual transition to:

42 – 84cm: Dark reddish brown (2.5YR 3/6m) medium grained sandy clay loam; moist friable consistence; medium sub angular blocky structure; good permeability and common tree roots. Diffuse transition to:

84 – 140^{+}cm: Dark reddish brown (2.5YR 3/6m) medium grained sandy clay; dry hard consistence; medium sub angular blocky structure; good permeability and few tree roots.

Remarks
First horizon has is organic and has good micro structure

Analysis Data

Ref	PIT9S1	PIT9S2
Depth	0-20	23-42
Lab No.	X94	X95
Texture	mLS	mSaL
Clay %	9	19
Silt %	4	6
Fine Sand %	41	35
Medium Sand %	34	31
Coarse Sand %	12	9
pH	4.1	4.7
ExCa (me%)	0.8	0.6
ExMg (me%)	1.1	1
ExNa (me%)	0.31	0.09
ExK (me%)	1.51	0.11
TEB (me%)	3.7	1.8
CEC(me%)	6.2	2.3
Base Sat %	60	78
E/C	68.2	11.8
S/C	41.3	9.2
ESP	5	4
EKP	24.5	5

Soil Type 1 :- Pit 2

UTM Coords Zone 36L: 0665851/8557522

Site: Upper midslope position in landsacape
Vegetation: Old Arable land, surrounded by tall *brachystegia spp, albizia spp, and ficus spp trees*
Parent Material: Metamorhic rock, schists
Slope: <1%
Soil Profile Description

0 – 13cm: Dark brown (7.5YR 3/3) medium grained loamy sand; weakly developed fine to medium subangular blocky structure with well developed microstructure; moist friable consistence; numerous fine roots and good permeability. Clear transition to:

13 – 37cm: Bright brown (5YR 5/6) medium grained sandy clay loam; moderately developed medium subangular blocky structure; moist friable consistence; numerous fine roots and good permeability. Diffuse transition to:

37 – 113cm: Orange (5YR 6/6) medium grained sandy clay loam; moderately developed medium subangular blocky structure; few fine roots and good permeability. Clear transition to:

113 – 130^{+}cm: A horizon of densely packed small to medium subangular quartz stones and laterite gravels with good to slightly restricted permeability.

Analysis Data

Ref	PIT2S1	PIT2S2	PIT2S3
Depth	0-13	15-30	70-90
Lab No.	X71	X72	X73
Texture	mLS	mSaCL	mSaCL
Clay %	9	27	31
Silt %	3	3	5
Fine Sand %	44	36	33
Medium Sand %	34	26	19
Coarse Sand %	10	8	12
pH	5.3	3.9	4.5
ExCa (me%)	0.5	0.5	0.5
ExMg (me%)	1.1	1.2	1.5
ExNa (me%)	0.24	0.19	0.16
ExK (me%)	0.26	0.16	0.19
TEB (me%)	2.1	2.1	2.3
CEC (me%)	4.4	5.5	6.3
Base Sat %	48	38	37
E/C	47.4	20.3	20.3
S/C	22.8	7.6	7.5
ESP	5.5	3.5	2.5
EKP	6	3	3

Soil Type 2:- Pit 1

UTM Coords Zone 36L: 0667341/8557240

Site: Upper midslope position
Vegetation: old arable land remnant *albizia spp, brachystegia spp.*
Parent Material: matamophic schists/ sandstone
Slope: <1%
Soil Profile Description

0 – 12cm: Brownish black (10YR 3/2) medium grained sandy loam; massive structure; moist friable consistence; fairly numerous fine roots and good permeability. Gradual transition to:

12 – 30cm: Dull yellowish brown (10YR 4/3) medium grained sandy clay loam; weakly developed fine subangular blocky structure; moist friable consistence; fairly numerous fine roots and good permeability. Gradual transition to:

30 – 50cm: Yellowish brown (10YR 5/6) medium grained sandy clay loam; weakly developed fine subangular blocky structure; moist friable consistence; few roots and good permeability. Diffuse transition to:

50 – 96cm: Bright yellowish brown (10YR 6/6) medium grained sandy clay loam; weakly developed fine subangular blocky structure; moist friable consistence; few roots and good permeability. Diffuse transition to;

96 - 160^{+}cm: Bright yellowish brown (10YR 6/6) medium grained sandy clay; weakly expressed fine subangular blocky structure; moist friable; occasional roots and good permeability.

Analysis Data

Ref	PIT1S1	PIT1S2	PIT1S3	PIT1S4	PIT1S5
Depth	0-12	12-30	25-45	60-80	120-140
Lab No.	x66	X67	X68	X69	X70
Texture	mSaL	mSaCL	mSaCL	mSaCL	mSaC
Clay %	12	24	25	32	36
Silt %	10	5	7	9	7
Fine Sand %	35	35	36	33	33
Medium Sand %	32	29	25	20	18
Coarse Sand %	11	7	7	6	6
pH	4.8	4	3.4	3.6	3.9
ExCa (me%)	1.3	0.5	0.6	0.8	0.6
ExMg (me%)	1.9	1	1.6	1.8	1.8
ExNa (me%)	0.19	0.35	0.37	0.24	0.21
ExK (me%)	0.47	0.35	0.31	0.34	0.35
TEB (me%)	3.9	2.2	2.9	3.2	2.9
CEC (me%)	12.5	6.5	6.1	10.2	7
Base Sat %	31	33	48	32	42
E/C	108	27.6	24.3	31.4	19.3
S/C	33.5	9.2	111.5	10	8
ESP	1.5	5.3	6	2.3	3
EKP	3.8	5.3	5	3.3	5

Soil Type 2 :- Pit 3

UTM Coords Zone 36L: 0667603/8555843

Site: Crest of interfluve
Vegetation: Fallow arable land with *Albizia*, *Strychonos* and *Brachystegia* regrowth
Parent Material: metamorphic rock with a strong sandstone influence
Slope: <1%
Soil Profile Description

0 – 13cm: Dark brown (7.5YR 3/2m) medium grained loamy sand; moist friable consistence; incipient weak fine sub angular blocky structure; good permeability; and numerous grass roots. Clear transition to:

13 – 38cm: Reddish brown 5YR 4/6m) medium grained sandy clay loam; moist friable consistence; incipient moderate medium sub angular blocky structure; good permeability; and fairly numerous grass roots. Gradual transition to:

38 – 84cm: Orange (7.5YR 6/8m) medium grained sandy clay; moist friable consistence; incipient moderate medium sub angular blocky structure; good permeability; and common roots. Diffuse transition to:

84 – 135^{+}cm: Bright brown (7.5YR 5/6m) medium grained sandy clay; moist friable consistence; incipient moderate medium sub angular blocky structure; good permeability; and few roots.

Analysis Data

Ref	PIT3S1	PIT3S2	PIT3 S3	PIT3S4
Depth	0-13	15-30	50-70	95-115
Lab No.	X74	X75	X76	X77
Texture	mLS	mSaCL	mSaC	mSaC
Clay %	8	27	38	38
Silt %	5	5	5	7
Fine Sand %	36	28	26	28
Medium Sand %	39	29	21	20
Coarse Sand %	12	11	9	8
pH	4.4	4.1	4.8	4.5
ExCa (me%)	1	1.3	0.9	0.9
ExMg (me%)	1.4	1.3	1.4	1.3
ExNa (me%)	0.14	0.22	0.37	0.62
ExK (me%)	0.26	0.3	2.8	3
TEB (me%)	2.7	3.1	5.7	5.4
CEC(me%)	7	5.4	50	55
Base Sat %	39	57	14.9	14.2
E/C	87.3	20	7.4	7.8
S/C	34.3	11.5	3.5	4
ESP	2	4	6.5	11.5
EKP	3.7	5.5		

Soil Type 3:- Pit 4

UTM Coords Zone 36L: 0667497/8552760

Site: Lower midslope topographic position
Vegetation: Arable land, last crop maize and cassava with *Brachystegia bohemii*, bamboo and *Albizia spp*
Parent Material: sandystone
Slope: 1 – 2%
Soil Profile Description

0 – 16cm: Brownish black (10YR 3/2m) medium grained sandy loam; moist friable consistence; weak fine sub angular blocky structure; good permeability; and common roots. Clear transition to:

16 – 45cm: Brown (10YR 4/6m) medium grained sandy clay loam; moist friable consistence; incipient moderate medium sub angular blocky structure; good permeability and few roots. Diffuse transition to:

45 – 84cm: Yellowish brown (10YR 5/6m) medium grained sandy clay loam; moist friable consistence; incipient moderate medium sub angular blocky structure; good permeability and few roots. Diffuse transition to:

84 – 133cm: Bright yellowish brown (10YR 6/6m) medium grained sandy clay loam; moist very friable consistence; incipient moderate medium sub angular blocky structure; good permeability and occasional roots. Gradual transition to:

133 – 150+cm: Horizon of densely packed laterite gravels; slightly restricted permeability and occasional roots.

Remarks
Fourth horizon has few laterite gravels near the base

Analysis Data

Ref	PIT4S1	PIT4S2	PIT4S3	PIT4 S4
Depth	0-13	20-40	55-75	100-120
Lab No.	X78	79	X80	X81
Texture	mSaL	mSaCL	mSaCL	mSaCL
Clay %	8	27	30	28
Silt %	9	3	6	8
Fine Sand %	47	38	38	34
Medium Sand %	30	27	21	20
Coarse Sand %	6	4	4	9
pH	4.1	3.9	4.6	5.1
ExCa (me%)	1	0.8	0.8	0.8
ExMg (me%)	1.6	1.2	1.5	1.5
ExNa (me%)	0.68	0.15	0.18	0.2
ExK (me%)	3.1	2.2	2.6	0.23
TEB (me%)	3.1	6.4	5	.2.8
CEC (me%)	7.9	8.8	8.1	5.1
Base Sat %	39.7	72	61	54
E/C	39.7	7.9	8.6	18
S/C	6	1	2.5	9.7
ESP	22	2.3	3.5	4
EKP				4.5

Soil Type 3 :- Pit 5

UTM Coords Zone 36L: 0669645/8557061

Site: Lower slope position near edge of dambo
Vegetation: Arable land, last crop maize with *Albizia, B. bohemii* regrowth
Parent Material: metamorphic, possibly sandtone
Slope: <2%
Soil Profile Description

0 – 14cm: Brownish black (10Yr 3/2m) medium loamy sand; moist friable consistence; weak fine sub angular blocky structure; good permeability and numerous fine roots. Clear transition to:

14 – 29cm: Grayish yellowish brown (10YR 5/2m) fine grained sandy clay loam; moist friable consistence; weak fine sub angular blocky structure; good permeability and fairly numerous fine roots. Gradual transition to:

29 – 70cm: Dull yellowish brown (10YR 5/4m) medium grained sandy clay; moist friable consistence; moderate medium sub angular blocky structure; good permeability and few roots. Diffuse transition to:

70 – 109cm: Dull yellowish orange (10YR 6/4m) medium grained sandy clay loam; moist friable consistence; moderate medium sub angular blocky structure; good permeability and occasional roots. Gradual transition to:

109 - 140+cm: Dull yellow (2.5Y 6/3m) gravelly sandy clay loam with bright reddish brown (5YR 3/6m) mottles and few concretions; moist friable consistence; moderate medium sub angular blocky structure; good permeability and occasional roots.

Remarks
Last horizon has few laterite gravels

Analysis Data

Ref	PIT5S1	PIT5S2	PIT5S3	PIT5S4
Depth	0-14	14-29	40-60	80-100
Lab No.	X82	X83	X84	X85
Texture	mLS	fSaCL	mSaC	mSaCL
Clay %	9	28	39	34
Silt %	5	3	6	8
Fine Sand %	45	44	31	32
Medium Sand %	33	21	17	16
Coarse Sand %	7	4	7	10
pH	4.9	4.9	3.7	3.8
ExCa (me%)	1	0.7	0.9	0.7
ExMg (me%)	1.3	1	1.5	1.1
ExNa (me%)	0.26	0.11	0.16	0.12
ExK (me%)	0.28	0.17	0.26	0.25
TEB (me%)	2.9	2	2.8	2.2
CEC (me%)	5.7	6.5	6.5	2.5
Base Sat %	51	31	43	91
E/C	62.9	23.7	16.6	7.2
S/C	31.7	7.3	7	6.5
ESP	4.5	1.7	2.5	5
EKP	5	2.7	4	10

Soil Type 3 :- Pit 6

UTM Coords Zone 36L: 0668785/8555809

Site: Upper midslope topographic position on interfluve
Vegetation: Arable land, current crop maize with remnant of big m*yombo woodland, Albizia*
Parent Material: metamorphic rock, possibly sandstone
Slope: 1 – 2%
Soil Profile Description

0 – 9cm: Brownish black (10YR 3/1m) medium loamy sand; moist very friable consistence; no structure; good permeability and fairly numerous roots. Clear transition to:

9 – 35cm: Dull yellowish brown (10YR 5/3m) medium grained loamy sand; moist friable consistence; weak fine coarse angular blocky structure; good permeability and fairly numerous roots. Gradual transition to:

35 – 74cm: Dull yellowish brown (10YR 5/4m) coarse grained sandy loam; moist friable consistence; moderate fine sub angular blocky structure; good permeability and few roots. Diffuse transition to:

74 – 129^{+}cm: Dull yellow orange (10YR 6/4m) medium grained sandy loam; moist friable consistence; fine to moderate fine sub angular blocky structure; good permeability and occasional roots. Diffuse transition to:

129 - 178+cm: Dull yellow orange(10YR 6/4m) medium grained sandy loam with few Brown (5YR 4/6m) mottles; moist friable consistence; fine to moderate fine sub angular blocky structure; good permeability and occasional roots.

Analysis Data

Ref	PIT6S1	PIT6S2	PIT6S3	PIT6S4
Depth	0-9	15-30	45-65	90-110
Lab No.	X86	X87	X87	X89
Texture	mLS	mLS	cSaL	mSaL
Clay %	11	10	18	11
Silt %	2	4	8	3
Fine Sand %	30	31	17	31
Medium Sand %	41	39	32	39
Coarse Sand %	16	16	26	16
pH	4.2	4.3	3.4	4
ExCa (me%)	1.3	0.6	0.7	0.5
ExMg (me%)	1.1	0.8	1.1	1
ExNa (me%)	0.19	0.06	0.15	0.11
ExK (me%)	0.41	0.12	0.2	0.19
TEB (me%)	3	1.6	2.1	1.9
CEC(me%)	4.8	2	4.4	5.7
Base Sat %	62	79	49	33
E/C	45.3	19.3	24.7	52.8
S/C	28.1	15.3	12	17.2
ESP	4	3	3.5	2
EKP	8.5	6	4.5	3.3

Soil Type 3 :- Pit 7

UTM Coords Zone 36L: 00000

Site: Lower midslope topographic position on interfluve
Vegetation: Old arable land one year fallow with *Albizia, B. bohemii, eupaca kirkiana* regrowth
Parent Material: metamorphic rock, possibly sandstone
Slope: <1%
Soil Profile Description

0 – 9cm: brownish black (10YR 3/2m) medium to coarse grained sandy loam; good permeability and very numerous roots. Clear transition to:
9 – 48cm: Dull yellowish brown (7.5YR+ 5/4m) medium grained sandy clay loam; good permeability and numerous roots. Abrupt and wavy transition to:
48+cm: Horizon of hard bench laterite.

Remarks: 5m away soil deeper than 80cm; As Pit 6 but shallow to laterite

Soil Type 4 :- Pit 8

UTM Coords Zone 36L: 0666428/85556134

Site: Lowland, edge of dambo
Vegetation: Syzygium, wetland grasses, sedges, sycamore
Parent Material: sandtone
Slope: nearly flat<1%

Soil Profile Description

0 – 21cm: Brownish black (10YR 3/1m) medium grained sand; moist friable consistence; massive structure; good permeability and numerous roots. Clear transition to:

21 – 65cm: Grayish yellow (2.5Y 7/2m) medium grained sand; moist friable consistence; massive structure; good permeability and fairly numerous roots. Gradual transition to:

65 – 93cm: Grayish yellow (2.5Y 7/2m) medium grained sandy clay with yellowish gray (10YR 5/8m) few mottles; moist friable consistence; massive structure; good permeability and occasional roots. Gradual transition to:

93 – 1150^{+}cm: Grayish yellow (2.5Y 7/2m) medium grained sandy clay loam with common yellowish brown (10YR 5/8m) mottles; moist friable consistence; good permeability and no roots.

Remarks

The last horizon was too wet for structure determination

Analysis Data

Ref	PIT8S1	PIT8S2	PIT8S3	PIT8S4
Depth	0-20	30-50	70-90	95-115
Lab No.	X90	X91	X92	X93
Texture	mS	mS	cSaC	mSaCL
Clay %	5	5	35	20
Silt %	2	4	4	2
Fine Sand %	43	36	17	35
Medium Sand %	39	45	28	28
Coarse Sand %	10	11	16	15
pH	4.4	4	4	4.1
ExCa (me%)	1	0.7	1	1
ExMg (me%)	1.2	1.1	1.4	1.3
ExNa (me%)	0.23	0.14	0.08	0.13
ExK (me%)	0.18	0.07	0.11	0.1
TEB (me%)	2.6	1.9	2.5	2.5
CEC (me%)	4.5	2.3	5.5	3.2
Base Sat %	57	86	46	77
E/C	82.2	45.2	15.7	15.8
S/C	46.9	38.9	7.2	12.2
ESP	5	6	1.5	4
EKP	4	3	2	3

APPENDIX 2

Glossary of Soil Science Terms and Parameters used in Reporting in Soil Laboratory Analysis

GLOSSARY OF TERMS AND ABBREVIATIONS USED IN REPORTING SOIL ANALYTICAL DATA AND SOIL PROFILE DESCRIPTIONS

Texture: The relative proportions of sand silt and clay in the <2mm material of a soil. The United States Department of Agriculture (USDA) soil textural triangle is used for determining soil textural classes. The symbols used for the classes are as follows:

S or Sa	-	Sand	LSa	-	Loamy Sand
SaL	-	Sandy Loam	SaCL	-	Sandy Clay Loam
SaC	-	Sandy Clay	C	-	Clay
CL	-	Clay Loam	SiL	-	Silty Loam
SiCL	-	Silty Clay Loam			

The small letter prefix in the soil texture refers to the dominant grain size in the sand fraction as:

f	-	fine grained (2.0 - 0.5mm diameter)
m	-	medium grained (0.5 - 0.2mm diameter)
c	-	coarse grained (0.2 - 0.02mm diameter)

Thus mSaCL, fSiL and cSaC represent medium grained sandy clay loam, fine grained silty loam and coarse grained sandy clay respectively.

pH ($CaCl_2$) - the pH of a 1:5 suspension of soil in 0.01M $CaCl_2$ solution
pH (KCl) - the pH of a 1:5 suspension of soil in 0.01M potassium chloride solution
pH (Water) - the pH of a 1:5 suspension of soil in distilled water. Please note that pH in water is 1.0 pH unit higher than value in calcium and potassium chloride.

Exchangeable Cations:- The amounts of cations in the soil solution that are electrostatically held on the negatively charged sites of the soil constituents, mainly on clays and organic matter. Measured in units of milliequivalents of positive charge on the respective cations per 100g of oven dry soil (meq%), which is equivalent to centimoles of positive charge on the respective cation per kg of soil (cmoles(+)/kg).
Ex Ca, Ex Mg, Ex Na and Ex K represent exchangeable calcium, magnesium, sodium, and potassium respectively.

TEB (me %): - total exchangeable bases in milliequivalents per 100g of oven dry soil or centimoles of positive charge per kg of soil (cmoles(+)/kg) where:
TEB (me %) = (Ex Ca + Ex Mg + Ex Na + Ex K) me %(cmoles(+)/kg)

The maximum value of the TEB is the CEC since the soil exchange complex can only adsorb using its exchange capacity.

CEC (me%): - Cation Exchange Capacity: - the total amount of excess negative charge in the soil, onto which exchangeable cations in the soil solution are electrostatically attracted. Measured in units of milliequivalents per 100g of soil.

Base Sat %: - Base Saturation percentage: - the proposition of the CEC that is satisfied by the exchangeable bases, calculated as:

Base Sat % = $\frac{\text{TEB}}{\text{CEC}} \times 100\ \%$

The maximum value of Base saturation percentage is 100%. Low base saturations of less than 60% are associated with highly weathered or highly leached soils of low pH where the soil pH is usually lower than 5 on the calcium or potassium chloride scale.

E/C: - E/C value is the CEC per 100g of clay, calculated as:

E/C Value = (CEC/CLAY %) x100 me per 100g clay
This is a measure of the amount of negative charge per unit amount of clay, hence an indication of the type and activity of the clay fraction. Soil consisting mainly of montmorillonite clays will have higher E/C values (generally >32) while soils consisting mainly of kaolinite have values

generally less than 11. High CEC and E/C values can also arise from high organic matter contents.

S/C: - S/C value is the TEB per 100g of clay, calculated as:

S/C value = $\frac{\text{TEB}}{\text{Clay \%}}$ x 100 me per 100g clay

This parameter, like the E/C value is also an indicator of type and activity of clay fraction.

ESP: - Exchangeable Sodium Percentage, calculated as:

ESP = $\frac{\text{Ex Na}}{\text{CEC}}$ x 100 %

ESP is the proportion of the CEC accounted for by exchangeable Na cations - a measure of the sodicity of a soil. In Zimbabwe, soils are considered sodic when the ESP exceeds 9%. The internationally accepted threshold for sodicity is 15%.

EKP: - Exchangeable potassium percentage is similar to ESP and is defined as:

EKP = $\frac{\text{Ex K}}{\text{CEC}}$ x 100 %

Soil Depth: - The depth of soil from the surface to a horizon limiting root growth:

> 150cm: - deep
100 - 150cm: - moderately deep
50 - 100cm: - moderately shallow
40 - 50cm: - shallow
25 - 40cm: - very shallow
<25: - extremely shallow

Soil Colour: The soil colours reported are according to the Munsell soil colour charts. The colour code such as 10YR 4/6 is a compound of three parameters, which are the hue (10YR), the value (4) and the chroma (6). The hue represents the dominant spectral colour of the soil and is related to the dominant wavelength of light reflected by the soil.

Value is reported on a scale of 1 to 10 and refers to the brightness of the soil colour and is a function of the total amount of light reflected by the soil.

Chroma, also reported on a scale of 1 to 10, refers to the relative purity of the dominant spectral colour. The "d" and "m" after the colour code refers to the dry and moist colours respectively. Because the natural field soils moisture status is variable, moist colours are used in reporting the colour of a soil.

Soil Nitrogen: The mineral nitrogen content of a soil is a dynamic parameter which changes considerably during the crop growing season via continuous additions and losses. Additions arise from nitrification and release from organic matter while losses are mainly from leaching with a small amount being lost via denitrification. Thus the amount of nitrogen that is measured in a soil at the beginning of the crop growing season is not a good indication of the amount of nitrogen that the soil will release to the crop during the season. However, the soil N content is useful in determining the amount of fertiliser to apply at the time of analysis to meet crop requirements. As a guide the mineral nitrogen levels in a soil can be assessed for adequacy as follows:

- Less than 5 ppm is very low
- 5 – 7.5 ppm is low
- 7.5 – 10 medium or slightly adequate
- > 10 ppm high nitrogen content

Soil Phosphate: This species is measured as P_2O_5 by the Bray extraction method where a suspension of soil and Bray solution is shaken and the phosphate so extracted into solution is measured by colorimetry. Adequacy levels in the soil are assessed as follows:

- Less than 7ppm is acutely deficient;
- 7 – 15 ppm is deficient
- 15 – 30 ppm is marginally adequate
- 30 – 50 ppm is adequate
- Over 50 ppm is rich

Since phosphate is a relatively immobile nutrient that is not subject to leaching, levels that are recorded for samples collected from arable lands may be elevated by previous phosphate applications on the land.