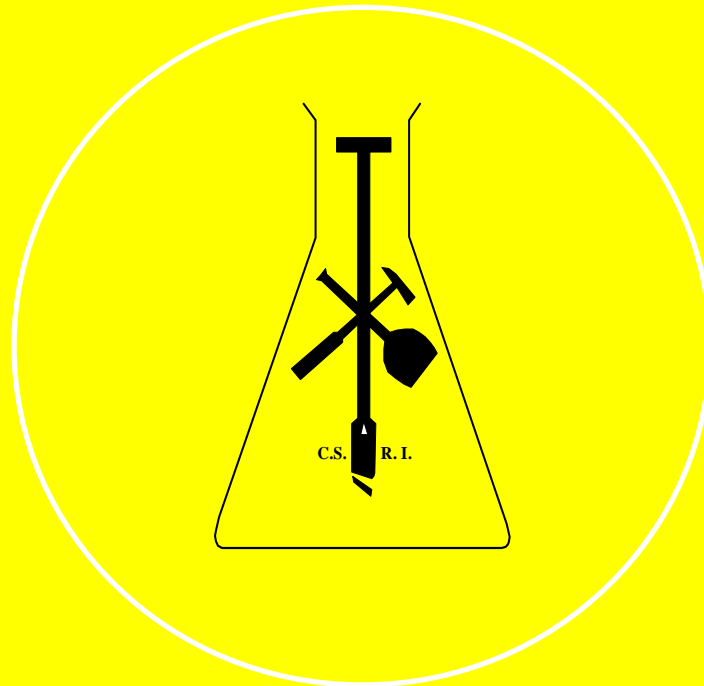


Reference No. **FS/3/8/53**

ZIMBABWE



*Chemistry and Soil Research Institute*

Soils Report No: A 705

**SOILS OF  
GUYU-CHELESA IRRIGATION SCHEME  
AND THE PROPOSED EXTENSION**

M.A. Manyanga  
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## SUMMARY

A detailed soil survey was carried out on approximately 76 ha (36 ha within the existing scheme and 40 ha on the proposed extension site). The survey area is found in Gwanda District, Matabeleland South Province. The soil survey is part of feasibility studies for Smallholder Irrigation Revitalization Programme (SIRP) funded by International Fund for Agricultural Development (IFAD). Irrigability classes were assigned as outlined in Appendix 7.2. The proportions of Irrigability classes in terms of hactorage are shown in Table 1.

Table 1: Different soil categories: Irrigability classes and sizes.

Category	Irrigability class	Approximate area (ha)	Limitations/Remarks	Recommendations
GE1	B	18.9	Shallow depth	Most crops including cereals and horticultural
GE2	C	10.8	Very shallow depth	Most crops including cereals and horticultural
G1	C	28.8	Light texture	Most crops including cereals and horticultural
G2	D	8.3	Light textures and extremely shallow soil depth	Shallow rooted crops such garlic and onions

Soils found in the survey area were derived from mixed geologies (intergrade) of granite and mafic rocks as well as granite rock. The intergrade resulted in medium textured soils while granite resulted in light sandy soils.

### Major limitations to irrigation include:

1. Very shallow to shallow soil depth
2. Surface stones
3. Light textures

Within the existing scheme, there should be minimal to no landscaping since the soils are very shallow to shallow. This is because any soil movement may result in weathering material being exposed as top soil is removed. The proposed extension site has light textured soils with poor structure, low water and nutrient holding capacity. Use of organic material can help improve all these parameters. Inorganic fertilizer should be applied based on crop nutrient requirements. Water use efficient irrigation methods such as sprinkler or center pivot are highly recommended. Due to shortage of electricity use of renewable energy such as solar for pumping is also recommended.

## **1.0 INTRODUCTION**

At the request of the International Fund for Agricultural Development (IFAD), a detailed soil survey was carried out on approximately 76 ha (36 ha within the existing scheme and 40 ha on the proposed extension site) by 1 pedologist over a 5-day period. A total of 43 auger observations were made, 3 pits were dug, fully described and sampled. Currently the existing scheme is non-functional, abandoned pipes and sprinklers are found all over the area. The irrigation scheme used to draw water from Tuli River through sand abstraction method. Main crops previously grown are maize, wheat and sugar beans.

A Google Earth Image dated September 2006 was used as base map. During the survey process, auger observations were done on pre-generated and field generated points. Soils of similar morphological properties such as texture, drainage and surface stoniness were demarcated and categorized accordingly. In each category at least a pit was opened, fully described and soil samples collected for laboratory analysis. The objective of the survey was to assess the suitability and the current status of the soils for irrigation revitalization at the proposed extension site and the schemes.

## **2.0 GENERAL DESCRIPTION OF AREA**

### **2.1 INTRODUCTION**

Guyu-Chelesa irrigation scheme is found in Matebeleland South Province, 50km south west of Gwanda town and 2 km north of Tuli Business centre along the Gwanda Fort Tuli road. The area lies in natural region IV at an altitude between 780-785 m above sea level with mean annual rainfall of 450-600mm.

### **2.2 GEOLOGY AND LANDFORM**

Soils of the existing scheme are underlain predominantly by granitic (G) rock with some dolerite intrusion resulting in soils derived from granite-dolerite intergrade (GE). However, the entire proposed extension site has soils derived from granite rock. The topography of the area is mainly gently undulating with 2-3% slopes.

### **2.3 NATURAL VEGETATION**

Within the southern part of the existing scheme and greater part of the proposed extension area, *Acacia* species are dominant. *Colophospermum mopane* is found in isolated areas within the proposed extension site.

### **2.4 SOILS AND SOIL CLASSIFICATION**

Four main soil units were identified within the survey area. Most of the soils of the existing scheme are mostly brown medium to coarse grained loamy sand overlying dark brown sandy loam. The other side of the scheme and the entire proposed extension site has dark brown to dark yellowish brown coarse sand to coarse loamy sand.

### 3.0 SOIL CATEGORIES

Soil categories were based on texture, soil depth, soil drainage, permeability and surface features, like stones.

### 3.1 CATEGORY GE1

This soil unit forms greater part of the existing scheme and its soils are mostly moderately shallow (50-80 cm). The soils are brown medium to coarse grained loamy sandy to over dark brown sandy loam. The soils have good permeability and are well drained. This unit is found on all slope positions of gently undulating topography of 2-3%.

#### Summary of morphological properties

Depth : moderately shallow (50-80cm)  
Texture : coarse grained loamy sandy overlying coarse sandy loam  
Colour : brown (7.5YR 4/4m) over dark brown (7.5YR3/3m)  
Structure : moderately developed medium sub angular blocky  
Drainage : well drained  
Permeability : good

#### Summary of subsoil Chemical properties

Cation exchange capacity : 11- 25  
Base saturation : 100%  
pH : 6.7 -6.8  
S/C : 78-92  
EC : 78-198  
Typical profiles : 16/AM/19  
Approximate Available Water Holding Capacity (AWC): 10.9%  
Zimbabwe classification : 4GE  
Irrigable value : 2  
Irrigability class : B  
FAO classification : Haplic Lixisols (Loamic)

PROFILE NUMBER : 16/AM/19 GOOGLE EARTH IMAGE; 26/10/06  
CO-ORDINATES : 20°23'46.65"S 32°18'45.63"E  
AUTHOR : Manyanga M. A DATE: 17-09-19  
LOCATION : Guyu-Chelsa -Gwanda  
ELEVATION : 782 m  
RAINFALL : 450-600mm  
LANDSCAPE (SHAPE) : Gently undulating  
SLOPE (%) : 2-3%  
NATURAL REGION : 4  
PARENT MATERIAL : Granite-Maffic (GE)  
ZIMBABWEAN CLASSIFICATION  
GROUP : 4  
FAMILY : GE

DESCRIPTION:



0 - 20cm Dark brown (7.5YR3/4 m); coarse loamy sand; slightly hard dry; friable moist; plastic and sticky wet consistence; moderately developed medium sub angular blocky structure; good permeability; well drained; numerous very fine roots; few fine and very fine tubular pores; clear smooth transition to:

20 - 42cm Dark brown (7.5YR3/2m); coarse sandy loam; slightly hard dry; friable moist; plastic and sticky wet consistence; moderately developed medium sub angular blocky structure; good permeability; well drained; few very fine roots; few fine tubular pores, clear smooth transition to:

42- 57cm Dark brown (7.5YR3/2m); coarse sandy loam; slightly hard dry; friable moist; sticky and plastic wet consistence; moderately developed sub angular blocky structure; well drained, good permeability; occasional very fine roots; common fine and coarse gravel; clear irregular transition to:

57+ C Material.

## SOIL CHEMICAL ANALYSIS: PROFILE 16/AM/19

REFERENCE	S1	S2	S3
DEPTH(cm)	0 -20	20 -42	42 -57
LAB NO	E1888	E1889	E1890
DM %	100.0	100.0	100.0
TEXTURE	cLS	cSaL	cSaL
CLAY %	7	13	14
SILT %	8	10	14
FINE SAND %	34	31	29
MEDIUM SAND %	26	21	22
COARSE SAND %	24	25	20
pH (CaCl <sub>2</sub> )	6.4	6.7	6.8
EX Ca (me %)	8.4	6.7	11.9
EX Mg (me %)	8.1	4.2	7.8
EX Na (me %)	.77	.71	.84
EX K (me %)	.35	.24	.06
TEB (me %)	17.6	11.9	11.3
CEC (me %)	22.7	25.9	11.3
BASE SAT %	78	46	100
E/C	321.3	197.9	78.5
S/C	249.7	91.3	78.5
ESP	3.4	2.8	7.4
EKP	1.5	.9	.5

### 3.2 CATEGORY GE2

In some parts of this category, there are surface stones scattered around as well as gravel. These soils are very shallow (25-40cm). They are brown medium to coarse grained sandy loams to sandy clay loams over dark brown sandy clay loams. The slopes are 2-3% and this category is also part of the existing scheme.

#### Summary of morphological properties

Depth	: very shallow (25-40cm)
Texture	: medium grained loamy sand overlying coarse grained sandy loam.
Colour	: brown (7.5YR 4/4m) over dark brown (7.5YR3/3m)
Structure	: moderately developed medium sub angular blocky
Drainage	: well drained
Permeability	: good

#### Summary of subsoil Chemical properties

Cation exchange capacity	: 14-18
Base saturation	: 20-44

pH : 6.4-6.6  
S/C : 40-73  
EC : 167 -202

Typical profiles : 17/AM/19  
Approximate Available Water Holding Capacity (AWC) : 9.93 %  
Zimbabwe classification : 4GE  
Irrigable value : 3  
Irrigability class : C  
FAO classification : Dystric Cambisols

PROFILE NUMBER : 17/AM/19 GOOGLE EARTH IMAGE; 26/10/06  
CO-ORDINATES : 21°22'12.5"S 28°58'38.75"E  
AUTHOR : Manyanga M. A DATE: 17-09-19  
LOCATION : Guyu-Chelsa- Gwanda  
ELEVATION : 780 m  
RAINFALL : 450-600mm  
LANDSCAPE (SHAPE) : Gently undulating  
SLOPE (%) : 2-3%  
NATURAL REGION : 4  
PARENT MATERIAL : Granite-Maffic (GE)  
ZIMBABWEAN CLASSIFICATION  
GROUP : 4  
FAMILY : GE

DESCRIPTION:

0 - 14cm Dark yellowish brown (10YR4/4m); medium loamy sand; slightly hard dry; very friable moist; sticky and slightly-plastic wet consistence; moderately developed medium sub angular blocky structure; good permeability; well drained, few very fine and fine roots; few fine interstitial pores, clear smooth transition to:

14 - 33cm Yellowish brown (7.5YR5/4m); coarse sandy loam; very friable moist; non-sticky and slightly plastic wet consistence; moderately developed small sub angular blocky structure; good permeability; well drained; numerous very fine roots; clear iregular transition to:

34- 61cm C1 Material -advanced weathered rock  
61- 88 cm C2 Material-slightly weathered rock



## SOIL CHEMICAL ANALYSIS: PROFILE 17/AM/19

REFERENCE	S1	S2	C1
DEPTH(cm)	0 -14	14 -33	33 -50
LAB NO	E1891	E1892	E1893
DM %	100.0	100.0	100.0
TEXTURE	mLS	cSaL	mLS
CLAY %	7	9	9
SILT %	7	7	4
FINE SAND %	39	33	38
MEDIUM SAND %	27	28	28
COARSE SAND %	19	24	22
pH (CaCl <sub>2</sub> )	5.5	6.4	6.6
EX Ca (me %)	2.9	4.1	1.6
EX Mg (me %)	2.8	1.5	1.3
EX Na (me %)	.51	.68	.49
EX K (me %)	.15	.06	.18
TEB (me %)	6.4	6.3	3.6
CEC (me %)	10.1	14.4	17.8
BASE SAT %	63	44	20
E/C	137.0	166.7	201.4
S/C	86.9	72.6	40.3
ESP	5.1	4.7	2.8
EKP	1.5	.4	1.0

### 3.3 CATEGORY G1

Soils in this unit cover a greater part of the proposed extension area. *Accacia sp* are the dominant vegetation type with scattered *Dctrostachy cinerii* and *combretum sp* in the area. Topography is gently undulation with 2-3 % slopes. The soils are moderately shallow with a depth of 50-100 cm, dark yellowish brown to brown overlying dark brown (10YR 3/3) coarse loamy sands. The top soils are weakly sodic. Permeability is good and drainage is rapid.

#### Summary of Morphological Properties

Depth	: moderately shallow (50-100cm) onto soft weathering rock
Texture	: coarse loamy sand throughout.
Colour	: dark yellowish brown (10YR4/4m) to brown (10YR4/3m) overlying dark brown (10YR 3/3m)
Structure	: weakly developed fine sub angular blocky
Drainage	: well drained
Permeability	: rapid

## Summary of subsoil Chemical properties

Cation exchange capacity	: 9-13
Base saturation	: 42 -74
pH	: 6.3-6.7
S/C	: 58-138
EC	: 138-185

Typical profiles	: 15/AM/19
Approximate Available Water Holding Capacity (AWC)	: 9%
Zimbabwe classification	: 4G
Irrigable value	:3
Irrigability class	:C
FAO classification	:Eutric Arenosols

## PROFILE DESCRIPTION

PROFILE NUMBER	: 15/AM/19	GOOGLE EARTH IMAGE; 26/10/06
CO-ORDINATES	: 20°23'46.65"S	32°18'45.63"E
AUTHOR	: Manyanga M. A	DATE: 17-09-19
LOCATION	: Guyu-Chelesa-Gwanda	
ELEVATION	: 785 m	
RAINFALL	: 450-600mm	
LANDSCAPE (SHAPE)	: Gently undulating	
SLOPE (%)	: 2-3%	
NATURAL REGION	: 4	
PARENT MATERIAL	:Granite (G)	
ZIMBABWEAN CLASSIFICATION		
GROUP	: 4	
FAMILY	: G	

### DESCRIPTION:



0 - 20cm Dark yellowish brown (10YR3/4m); coarse grained loamy sand; soft dry; very friable moist; non plastic and slightly soft sticky wet consistence; weakly developed fine sub angular blocky structure; rapid permeability; well drained; fairly numerous fine and very fine roots; diffuse transition to:

20 - 39cm Dark brown (10YR3/3m); coarse grained loamy sand; soft dry; very friable moist; soft; non plastic and slightly sticky wet consistence; weakly developed fine sub angular blocky structure; rapid permeability; well drained; fairly numerous very fine roots; clear smooth transition to:

39- 50cm Brown (7.5YR4/3m); coarse loamy sand; soft dry; very friable moist; non plastic and slightly sticky wet consistence; weakly developed fine to medium sub angular blocky structure; well drained, rapid permeability; few very fine roots; clear irregular transition to;

50+ Weathering material

## SOIL CHEMICAL ANALYSIS: PROFILE 15/AM/19

REFERENCE	S1	S2	S3
DEPTH(cm)	0 -20	20 -39	39 -50
LAB NO	E1885	E1886	E1887
DM %	100.0	100.0	100.0
TEXTURE	cLS	cLS	cLS
CLAY %	6	5	9
SILT %	7	5	4
FINE SAND %	32	36	28
MEDIUM SAND %	28	26	29
COARSE SAND %	27	28	31
pH (CaCl <sub>2</sub> )	5.7	6.3	6.7
EX Ca (me %)	1.9	3.5	1.9
EX Mg (me %)	2.2	2.5	2.3
EX Na (me %)	.52	.60	.50
EX K (me %)	.22	.29	.53
TEB (me %)	4.8	6.9	5.2
CEC (me %)	5.3	9.3	12.3
BASE SAT %	90	74	42
E/C	92.3	185.0	138.5
S/C	83.5	137.4	58.6
ESP	9.7	6.5	4.1
EKP	4.1	3.1	4.3

### 3.4 CATEGORY G2

Soils in this category are found on the southernmost part of the existing scheme with a very shallow depth of 25-40cm. *Accacia sp* secondary vegetation is common in this area. Surface small stones are very prominent. These soils are mainly dark yellowish brown over dark brown coarse sands which have rapid permeability and are well drained.

#### Summary of Morphological Properties

Depth	: very shallow (25-40cm)
Texture	: sand to loamy sand throughout.
Colour	: dark yellowish brown (10YR3/4m) overlying dark brown (10YR 3/3)
Typical Auger	: GY13
Zimbabwe classification	: 2G
FAO classification	: Leptosols

## **4.0 DISCUSSION**

Soils of Guyu-Chelesa irrigation scheme and proposed extension site are very shallow to shallow in depth which significantly reduces the available water storage capacity. Most of the soils on existing scheme are sandy loam to loamy sand which have appreciable water holding capacity (approximately 9 % - 10.9 %). Shallow depths reduce their water storage capacity. In some parts of the existing scheme (unit G2) and the entire proposed extension site (unit G1), the soils are moderately shallow and very shallow respectively. Top soils in unit G1 are weakly sodic as shown by exchangeable sodium percentage 0-9% hence they have potential for sodicity developing especially if poor quality irrigation water is used. The soils are loamy sands with low water and nutrient retention capacity. These soils are also prone to erosion. In some parts of categories GE2 and G2, small and large stones are found which significantly interfere with machinery especially during land preparation and can affect seed germination. At about 20cm depth, soils in the existing scheme especially in soil unit GE2 have a plough pan which needs to be broken through ripping.

## **5.0 RECOMMENDATIONS**

Landscaping should be avoided due to the gently undulation topography of 2-3% slopes coupled with shallow soil depths as it reduces the plough layer. All movable and loose stones should be taken out of the cropping area. Use of organic material such as cattle manure is strongly recommended especially for soil units G1 and G2 which have light textures. Manure will help improve water holding capacity as well as nutrient supply. Continued use of sprinklers is advised however, more water use efficient methods such as drip and center pivot irrigation are recommended. Farmers can continue growing maize, wheat and sugar beans; nevertheless, they can also introduce horticultural crops such as garlic, onions, cabbage and tomatoes among other crops to boost their income. A reliable source of energy such as solar for pumping water is highly recommended for continuity.

## **6.0 BIBLIOGRAPHY**

Bennet, J.G. (1985). A Field Guide to Soil and Site description in Zimbabwe. Zimbabwe Agricultural Journal, Technical Handbook No. 6.

Munsell Soil Colour Charts (1990). Revised edition.

Nyamapfene, K. (1991). Soils of Zimbabwe. Nehanda Publishers.

Thompson, J.G. and Purves, W.D. (1978). A Guide to the Soils of Rhodesia. Zimbabwe Agricultural Journal, Technical Handbook No. 3

## 7.0 APPENDICES

### 7.1 LAND SUITABILITY CLASSIFICATION FOR IRRIGATION

The irrigability classes assigned to mapping units have been based on factors related to land characteristics, such as slope and soil properties, such as water holding capacity, permeability and levels of exchange sodium percentage.

The irrigability classes are defined as follows.

**Class A:** Suitable for irrigation without special precautions or practices and capable of sustained productivity.

**Class B:** Suitable for irrigation with special precautions or practices. Sustained productivity is attainable with good management and maximum efficiency in the use of irrigation water, but risks are greater than with class A owing to moderate soil and/or topographic limitations and special care is necessary. Corrective measures may be recommended according to the nature of limitations.

**Class C:** Of very restricted suitability for irrigation; confined to specific types of crops and practices owing to severe soil and/or topographic limitations.

**Class D:** Unsuitable for normal irrigation.

**Class S:** Excessively pervious sands of restricted suitability owing to inadequate water holding capacity, unavoidable high-water losses and low inherent fertility.

**N.B.** It should be noted that these Irrigability Classes and the criteria used to assess the suitability of soils are intended for normal full-scale irrigation i.e. all-the-year- round irrigation for rotation of intensively grown crops as distinct from supplementary irrigation of summer crops grown mainly under normal rainfall. It also assumed that the water used for irrigation is of good quality.

### 7.2 GLOSSARY OF TECHNICAL TERMS

#### Soil Depth

Extremely shallow	<25cm
Very shallow	25-40cm
Shallow	40-50cm
Moderately shallow	50-100cm
Moderately deep	100-150cm
Deep	>150cm

#### Soil Texture class

C	clay
CL	clay loam

<b>L</b>	loam
<b>SiC</b>	silty clay
<b>SiCL</b>	silty clay loam
<b>Si</b>	silt
<b>SaC</b>	sandy clay
<b>SaCL</b>	sandy clay loam
<b>SaL</b>	sandy loam
<b>LS</b>	loamy sand
<b>Sa</b>	sand

**Texture classification-coarse(c), medium (m) and fine (f).**

Express each sand fraction as a % of the total sand fraction in the sample.

- If the coarse sand is  $\geq 25\%$  the texture will be prefixed with a 'c'.
- If the fine sand is  $\geq 60\%$  the texture will be prefixed with 'f'.
- If the coarse sand,  $< 25\%$  and the fine sand is  $< 60\%$  the texture will be prefixed with 'm'.
- If the total sand fraction is  $< 45$  there is no prefix.

**Particle size grades**

Coarse sand	2, 0mm (2000um)-0.5mm (500um)
Medium sand	0,5mm (500um) - 0,2mm (200um)
Fine sand	0, 2mm (200um)-0, 02(20um)
Silt	0, 02(20um) - 0,002(2um)
Clay	$< 0,002(2um)$

**Other Abbreviations**

**d**-Dry **m**-Moist **K**-Potassium **Ca**-Calcium **Mg**-Magnesium **Fe**-Iron

**CEC**-Cation Exchange Capacity **TEB**-Total Exchangeable Bases

**me%**-Milli-equivalents percent or per 100grams of soil.

**Base Saturation%**- $100 * \text{TEB} (\text{cmol}_c \text{kg}^{-1}) / \text{CEC} (\text{cmol}_c \text{kg}^{-1})$

**ESP**-Exchangeable sodium percentage **EKP**-Exchangeable potassium percentage

**7.4 A SIMPLIFIED OUTLINE OF THE SOIL CLASSIFICATION SYSTEM OF ZIMBABWE**

ORDER	DESCRIPTION	GROUP	TYPICAL SOIL FAMILIES
1.AMORMIC	Little or no horizon development	1.Regosol Deep sands  2.Lithosol Extremely shallow	1K(Deep sands derived from Kalahari deposits 2E(derived from mafic rocks)
CALCIMOPHIC	Unleached soils generally with large	3. Vertisols Very acidic clay	3B(derived from basalt)

	reserves of weatherable minerals: high base saturation.	4.Siallitic Active clay	4PE(derived from mafic gneiss)
KAOLINITIC	Moderately to strongly leached soils; appreciable amounts of free sesquioxides of iron and aluminum.	5.Fersiallitic mixed clay 6.Paraferallitic Inert clay 7.Orthoferallitic	5G(coarse grained sandy soils derived from granite) 6G 7G
NATRIC	Dominated by appreciable amounts of sodium as the exchangeable ion	8.Sodic Weakly sodic Strongly sodic Saline sodic	8n 8N 8h