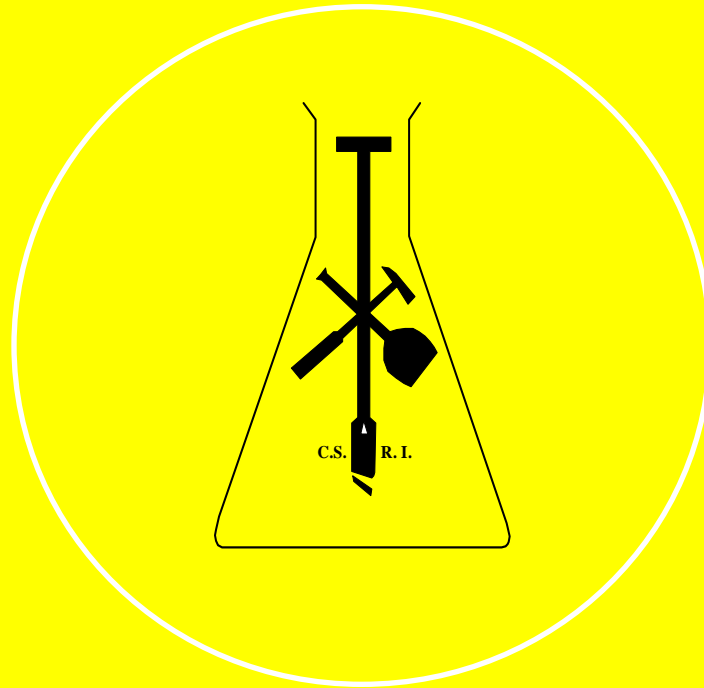


Reference No. **FS/3/2/131**

ZIMBABWE



Chemistry and Soil Research Institute

Soils Draft Report No: A 708

SOILS OF PROPOSED MILSONIA IRRIGATION SCHEMES

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SUMMARY

A detailed soil survey was carried out on approximately 29 ha at Milsonia in Kwekwe District, Midlands Province. The soil survey was 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 7.3. The proportions of Irrigability classes in terms of hactorage are shown in table 1.

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

Category	Approximate area (ha)	Irrigability Class	Limitations/ Remarks	Recommendations
EG1		A	Suitable for irrigation	Most crops such as maize, wheat, sugar beans, tomatoes, cabbage
GE1		D	Very shallow soil depth	Shallow rooted crops such garlic and onions

Soils found in the survey area were derived from an intergrade (mixed geologies) of mafic rock and granite. Since the mafic rock is dominant, most of the resultant soils are dark brown to dark yellowish brown medium sandy clay loams overlying dark brown to reddish brown sandy clays.

Major limitations:

1. Very shallow soil depth
2. Surface stones in some areas.

Most of these (EG1) soils are very good and suitable for irrigation. They have good water holding capacity. The slope being less 2% is very suitable for most irrigation methods.

1.0 INTRODUCTION

A detailed soil survey was carried out at Milsonia proposed irrigation scheme. This was at the request of the International Fund for Agricultural Development (IFAD), under the Smallholder Irrigation Revitalization Programme. A total of 29 ha were surveyed by 1 pedologist over a 2-day period. Ten auger observations were made and 3 pits were dug, fully described and sampled. The proposed irrigation scheme is expected to draw water from Muponesi dam.

A Google Earth Image dated July 2019 was used as base map. Pre-generated auger observations points were marked on base maps based on photo tone and were then studied during survey process. In field points were generated where necessary. Soils of similar morphological properties such as texture, depth 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 the soils for irrigation development.

2.0 GENERAL DESCRIPTION OF AREA

2.1 INTRODUCTION

The proposed Milsonia irrigation scheme is found in Village 6, Ward 1 of Kwekwe District in Midlands Province. To reach the scheme, one drives 12 km from Kwekwe town towards Harare road and turn right into Shamwari road for another 22 km until reaching a sign post written Tavanenhu Primary school and then then turn left. The scheme is located next to the first shopping centre one reaches first. The area lies in Natural Region III at an altitude between 1169 m above sea level with mean annual rainfall of 600-750 mm. The proposed scheme covers 29 ha with potential for expansion into adjacent land.

2.2 GEOLOGY AND LANDFORM

Soils of the proposed scheme are underlain predominantly by a mixture of Mafic (E) and granitic (G) rocks resulting dolerite-granite intergrade (EG) in most of the area with a small part having granite dominating dolerite resulting in (GE). The topography of the area is almost flat with less than 2% slopes.

2.3 SOILS AND SOIL CLASSIFICATION

Based mainly on soil depth and surface stoniness among other parameters, two soil units were observed within the survey area. The soils are dark brown to dark yellowish brown medium sandy clay loams overlying dark brown to reddish brown sandy clays.

3.0 SOIL CATEGORIES

3.1 CATEGORY EG1

This soil unit is found on upper to upper mid slope positions of almost flat 2% topography. The soils are moderately deep (100-150cm) with good permeability and are well drained. Soils are dark brown medium sandy clay loams over brown to yellowish red sandy clays. All the natural vegetation was cleared.

Summary of morphological properties

Depth : moderately deep (100-150 cm)
Texture : medium grained sandy loams over sandy clay
Colour : dark brown (10.5YR 3/3m) over brown (7.5YR3/4m) to yellowish red (5YR4/6m)
Structure : moderately developed medium sub angular blocky
Drainage : well drained
Permeability : good

Summary of subsoil Chemical properties

Cation exchange capacity : 5.9 - 16.8
Base saturation : 84 - 100
pH : 4.3 - 5.1
S/C : 22.8 - 54.6
E/C : 22.8 - 54.8
ESP : 2.7 – 6.6
Typical profiles : 31/AM/19 and 34/AM/19
Approximate Available Water Holding Capacity: 11 – 14 %
Zimbabwe classification : 4GE
Irrigable value : Mainly 1
Irrigability Class : A
FAO classification : Haplic Lixisols (clayic loamic)

Profile Description

PROFILE NUMBER : 31/AM/19 **GOOGLE EARTH IMAGE; 4/07/19**
CO-ORDINATES : 18°46'30.6"S 29°59'23.8"E
AUTHOR : Manyanga M. A DATE: 27-09-19
LOCATION : Milsonia-Kwekwe
ELEVATION : 1169 m
RAINFALL : 600-750mm
LANDSCAPE (SHAPE) : Almost flat
SLOPE (%) : 2
NATURAL REGION : 3
PARENT MATERIAL : Mafic and Granite (EG)
ZIMBABWEAN CLASSIFICATION
GROUP : 8
FAMILY : nEG
DESCRIPTION:



0 - 12cm Dark brown (10YR3/3m); medium sandy clay loam; hard dry; friable moist; plastic and sticky wet consistence; moderately developed medium sub angular blocky structure; good permeability; well drained; fairly numerous very fine roots; common fine and medium tubular pores; diffuse transition to:

12 - 27cm Dark brown (10YR3/3m); medium sandy clay loam; hard dry; friable moist; plastic and sticky wet consistence; moderately developed medium sub angular blocky structure; good permeability; well drained; few very fine roots; pores; common fine and very fine tubular pores; clear smooth transition to:

27- 80cm Dark brown (7.5YR3/4m); medium sandy clay; plastic and sticky wet consistence; good permeability; well drained; occasional very fine roots; few fine tubular pores; clear smooth transition to:

80 - 110cm Yellowish red 5YR4/6m); medium clay; plastic and slightly sticky wet consistence; good permeability; well drained; few coarse angular and sub rounded quartz small stones; clear smooth transition to:

SOIL CHEMICAL DATA: PROFILE 31/AM/19

REFERENCE	S1	S2	S3	S4
DEPTH(cm)	0 -12	12-27	27 -80	80-110
LAB NO	E1920	E1921	E1922	E1923
DM %	100.0	100.0	100.0	100.0
TEXTURE	mSaCL	mSaCL	mSaC	C
CLAY %	22	26	36	45
SILT %	15	11	14	16
FINE SAND %	28	31	27	19
MEDIUM SAND %	22	19	13	11
COARSE SAND %	13	13	10	8
pH (CaCl2)	5.4	4.3	4.4	5.1
EX Ca (me %)	5.6	8.7	5.3	7.9
EX Mg (me %)	3.5	2.7	1.5	5.7
EX Na (me %)	1.35	.48	.39	.46
EX K (me %)	.03	.03	.03	.03
TEB (me %)	10.6	11.8	9	14.1

CEC (me %)	14.4	11.8	5.9	16.8
BASE SAT %	73	100	100	84
E/C	1.8	54.6	22.8	46.9
S/C	23.4	54.6	22.8	39.3
ESP	9.4	4.1	6.6	2.7
EKP	.2	.3	.5	.2

PROFILE NUMBER : 34/AM/19 GOOGLE EARTH IMAGE; 04/07/19
 CO-ORDINATES : 18°46'37.5"S 29°59'29.1"E
 AUTHOR : Manyanga M. A DATE: 17-09-9
 LOCATION : Milsonia-Kwekwe
 ELEVATION : 1169 m
 RAINFALL : 600-750mm
 LANDSCAPE (SHAPE) : Almost flat
 SLOPE (%) : 2
 NATURAL REGION : 3
 PARENT MATERIAL : Mafic and Granite (EG)
 ZIMBABWEAN CLASSIFICATION
 GROUP :
 FAMILY :

DESCRIPTION:



0 - 20cm Dark yellowish brown (10YR3/4m); medium sandy loam; slightly hard dry; very friable moist; plastic and sticky wet consistence; moderately developed medium sub angular blocky structure; good permeability; well drained; fairly numerous very fine and few medium roots; common fine and medium tubular pores; clear smooth transition to:

20 - 42cm Dark brown (7.5YR3/3m); medium sandy clay loam; slightly hard dry; very friable moist; plastic and sticky wet consistence; moderately developed medium sub angular blocky structure; good permeability; well drained; few very fine occasional fine roots; clear smooth transition to:

42 - 72cm Reddish brown (5YR4/4m); medium sandy clay; slightly hard dry; very friable moist; plastic and sticky wet consistence; moderately developed medium sub angular blocky structure; good permeability; well drained; occasional very fine and coarse roots; diffuse transition to:

72 - 100cm Dark reddish brown (5YR3/3m); fine sandy clay; slightly hard dry; very friable moist; plastic and sticky wet consistence; moderately developed medium sub angular blocky structure; good permeability; well drained; occasional very fine, medium and coarse roots; few small sub rounded and angular quartz stones

SOIL CHEMICAL DATA: PROFILE 34/AM/19

REFERENCE	S1	S2	S3
DEPTH(cm)	0 -20	20-42	42-72
LAB NO	E1927	E1928	E1929
DM %	100.0	100.0	100.0
TEXTURE	mSaL	mSaC	mSaC
CLAY %	19	36	41
SILT %	12	12	9
FINE SAND %	28	28	28
MEDIUM SAND %	25	14	12
COARSE SAND %	15	11	10
pH (CaCl ₂)	4.8	4.9	5.1
EX Ca (me %)	5.2	29.9	7.4
EX Mg (me %)	1.8	1.2	1.5
EX Na (me %)	.46	.52	.03
EX K (me %)	.03	.03	.03
TEB (me %)	7.5	31.6	9.0
CEC (me %)	9.0	39.5	37.7
BASE SAT %	83	80	24
E/C	46.3	110.0	92.7
S/C	38.5	88.2	22.0
ESP	5.1	1.3	.1
EKP	.3	.1	.1

3.2 CATEGORY GE1

This category has many surface and sub-surface small and medium quartz stones with very shallow (25-40cm) soil depth. The soils are dark brown (10YR3/3m) medium loamy sand overlying fine sandy loamy. The unit is found on upper slopes positions of 2% slopes.

Summary of morphological properties

Depth	: very shallow (25-40cm)
Texture	: medium sandy loamy overlying fine sand loamy
Colour	: dark brown (10YR3/3m) 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	: 15.4
Base saturation	: 72%
pH	: 4.6

S/C	: 106.2
E/C	: 148.4
ESP	: 3.1
Typical profiles	: 33/AM/19
Approximate Available Water Holding Capacity (AWC)	: 11
Zimbabwe classification	: 8nGE
Irrigable value	: Mainly 3
Irrigability class	: C
FAO classification	: Cambisols

Profile description

PROFILE NUMBER	: 33/AM/19	GOOGLE EARTH IMAGE; 4/07/19
CO-ORDINATES	: 18°46'41.6"S 29°59'36.0"E	
AUTHOR	: Manyanga M. A	DATE: 27-09-19
LOCATION	: Milsonia-Kwekwe	
ELEVATION	: 1169 m	
RAINFALL	: 600-750mm	
LANDSCAPE (SHAPE)	: Almost flat	
SLOPE (%)	: 2	
NATURAL REGION	: 3	
PARENT MATERIAL	: Granite-Maffic (GE)	
ZIMBABWEAN CLASSIFICATION		
GROUP	: 8	
FAMILY	: nGE	

DESCRIPTION:



- 0 - 13cm Dark brown (10YR3/3m); medium loamy sand; slightly hard dry; very friable moist; slightly plastic and slightly sticky wet consistence; moderately developed medium sub angular blocky structure; good permeability; very well drained; fairly numerous very fine roots; few sub rounded and angular quartz small stones; gradual smooth transition to:
- 13 - 28cm Dark brown (7.5YR3/2m); fine 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 broken transition to:
- 28- 60cm Very many coarse gravel and small sub rounded and angular quartz stones; fairly numerous very fine roots; common fine and coarse gravel; clear irregular transition to:

SOIL CHEMICAL DATA: PROFILE 33/AM/19

REFERENCE	S1	S2
DEPTH(cm)	0-13	13-28
LAB NO	E1925	E1926
DM %	100.0	100.0
TEXTURE	mLS	fSaL
CLAY %	6	10
SILT %	11	9
FINE SAND %	47	48
MEDIUM SAND %	26	22
COARSE SAND %	11	10
pH (CaCl ₂)	5.2	4.6
CARBONATES %		
EX Ca (me %)	5.3	6.1
EX Mg (me %)	2.2	4.4
EX Na (me %)	.47	.47
EX K (me %)	.03	.03
TEB (me %)	8.0	11.0
CEC (me %)	8.1	15.4
BASE SAT %	99	72
E/C	137.2	148.4
S/C	135.6	106.2
ESP	5.8	3.1
EKP	.3	.2

4.0 DISCUSSION

Most of the soils are suitable for irrigation with moderately developed structure. Textures are mostly sandy clay loams overlying sandy clays. The soils in unit EG1 are moderately deep hence has higher water storage capacity. Medium to heavier textures coupled with deeper depths means the soils have higher available water holding capacity. The surface and subsurface stones found in unit EG2 may interfere with germination. Soils in categories GE1 are slightly sodic. The soils in categories GE1 and EG2 are acidic and liming is recommended. The water from Gwenhoro dam is suitable for irrigation. Nevertheless, the water has medium calcium/magnesium ratio which has no significant effect.

5.0 RECOMMENDATION

All the surface stones found in unit GE1 must be removed since they may prevent germination by covering crop seed. Liming is recommended as most of the soils are acidic. Liming also helps in correcting soil sodicity. Water efficient irrigation methods such as center pivot and sprinkler are highly recommended.

6.0 BIBLIOGRAPHY

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7.0 APPENDICES

7.1 GWENHORO DAM WATER QUALITY RESULTS

Lab No.	562/GW	
Sample No.	Gwenhoro dam	
	me/l	p.p.m
Calcium (Ca ²⁺)	1.25	25
Magnesium (Mg ²⁺)	2.71	32.5
Sodium (Na ⁺)	0.80	18.47
Carbonate (CO ₃ ²⁻)	ND	ND
Bicarbonate (HCO ₃)	0.9	54.9
Chloride (Cl ⁻)	0.4	14
Sulphate (SO ₄ ²⁻)		
Conductivity (microsiemens/cm)	180	
pH	6.67	
Sodium Adsorption Ratio	0.57	
Residual Sodium Ratio	-3.06	
Ca/Mg/Ratio	0.46	

Code	C ₁ -S ₁ -R ₁ -X ₂	
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The water is of medium salinity and can be used to grow most crop on soils with good drainage.

7.2 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.

7.3 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
L	loam
SiC	silty clay
SiCL	silty clay loam
Si	silt
SaC	sandy clay
SaCL	sandy clay loam
SaL	sandy loam
LS	loamy sand
Sa	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	1K(Deep sands derived from Kalahari deposits

		2.Lithosol Extremely shallow	2E(derived from mafic rocks)
CALCIMOPHIC	Unleached soils generally with large reserves of weatherable minerals: high base saturation.	3. Vertisols Very acidic clay 4.Siallitic Active clay	3B(derived from basalt) 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