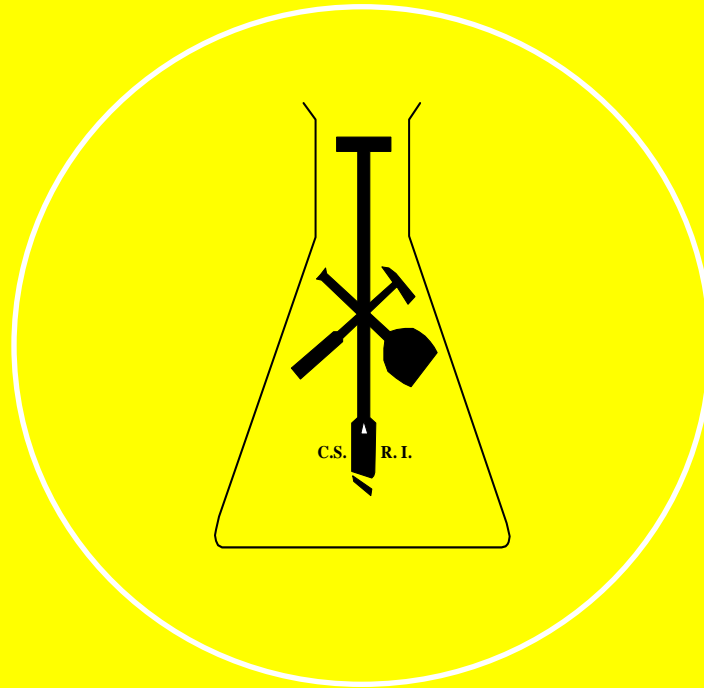


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ZIMBABWE



Chemistry and Soil Research Institute

Soils Report No: A 706

SOILS STATUS OF
MAYORCA IRRIGATION SCHEME

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SUMMARY

At the request of the International Fund for Agricultural Development (IFAD), under the Smallholder Irrigation Revitalization Program (SIRP), a total of 126 ha were surveyed in detail at Mayorca irrigation scheme. Mayorca irrigation scheme is found in village 1; ward 5 of Kwekwe District in Midlands 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 7.3. 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
G1	33.6	C	Light surface textures, rapid permeability in sub horizons	Most crops such as maize, wheat, sugar beans, tomatoes, cabbage
G2	68.3	C	Light surface textures, rapid permeability in sub horizons	Most crops such as maize, wheat, sugar beans, tomatoes, cabbage
G3	14.2	C	Light surface textures, rapid permeability in sub horizons	Most crops such as maize, wheat, sugar beans, tomatoes, cabbage
G4	2.3	D	Light surface textures, rapid permeability in sub horizons surface stones	Shallow rooted crops such garlic and onions

Granite is the major rock underlying the survey area with quartz gravel being prominent in all subsoils. The granite rock resulted in sandy (light textured) top soils overlying sandy loams (medium textured) across the area. Major limitations to irrigation include light surface textures, rapid permeability in sub horizons due to presence of coarse gravel as well as surface stones. Due to gently undulating topography, there should be a minimum to no soil landscaping as this may expose the coarse gravel found in lower horizons. Therefore, sprinkler and center pivot are highly recommended as the best irrigation methods.

1.0 INTRODUCTION

At the request of the International Fund for Agricultural Development (IFAD), under the Smallholder Irrigation Revitalization Program (SIRP), a total 126 ha were surveyed in detail at Mayorca irrigation scheme. Currently the scheme is non-functional but a good sprinkler system with underground pipes is still in place. A water sample was collected from the dam that is earmarked to supply water for irrigation and was analyzed. Main crops previously grown are maize, wheat and sugar beans.

Using a combination of pre-determined and new infield generated observation points, soils of similar morphological properties such as texture, drainage, surface stoniness were demarcated and categorized accordingly. A total of 35 auger observations were made while 4 pits at least one in each category were dug fully described and sampled. All the observation points were marked on Google earth image dated December 2017 which was used as base map. The objective of the survey was to assess the suitability of the soils for irrigation revitalization.

2.0 GENERAL DESCRIPTION OF AREA

2.1 INTRODUCTION

Mayorca irrigation scheme is found in village 31; ward 5 of Kwekwe District, Midlands Province. To go to the area, one travels approximately 29 km from city of Kwekwe along the Kwekwe –Gokwe road and then turn right and travel another 12 km. The scheme is located in natural region III at an altitude between 1130-1140m above sea level with mean annual rainfall of 600-750mm.

2.2 GEOLOGY AND LANDFORM

The soils are underlain by granitic (G) rock with much fine quartz gravel being found throughout the sub soils of survey area. The topography of the area is mainly gently undulating with 2-3% slopes and slopes up to 5% are found in isolated areas.

2.3 SOILS AND SOIL CLASSIFICATION

Three soil units derived from the same geology were identified within the survey area. The units were demarcated based mainly on soil depth. Most of the soils are moderately shallow to shallow mostly brown to dark yellowish medium to coarse loamy sand overlying very pale brown, brown and dark yellowish-brown loamy sand to sandy loam. Across the whole survey area, the fine earth fraction is found up to an average depth of 30-50 cm with fine quartz gravel making greater part of the sub horizons. All the fine

earth soils have good permeability and are well drained with rapid permeability in sub soils due to fine quartz gravel.

3.0 SOIL CATEGORIES

Soil categories were based mainly on texture, soil depth, colour, texture, and sub-surface stoniness.

3.1 CATEGORY G1

Category is found on all slope positions of mainly 2-3% slopes with 5% slopes in isolated areas. The effective depth is moderately deep (up to 120cm). Soils are yellowish brown to light yellowish-brown sands overlying dark brown to dark yellowish-brown sandy loams which in turn overly coarse gravel from 50 cm downwards. These soils are well drained with rapid permeability.

Summary of morphological properties

Depth	: moderately shallow to moderately deep (80-120cm)
Texture	: medium to coarse grained sand over sandy loams
Colour	: yellowish brown (10YR5/4m) to light yellowish brown (10YR6/4m over dark brown (10YR3/3m) to dark yellowish Brown (10YR3/4m)
Structure	: weakly developed fine subangular blocky over moderately developed medium sub-angular blocky
Drainage	: well drained
Permeability	: good in top soils over rapid in sub horizons

Summary of subsoil Chemical properties

Cation exchange capacity	:
Base saturation	:
pH	:
S/C:	
EC:	
Typical profiles	: 21/AM/19
Approximate Available Water Holding Capacity (AWC)/100cm:	
Zimbabwe classification	: 4G
Irrigable value	: 3
Irrigability class	: C
FAO classification	: Regosols

Profile description

PROFILE NUMBER : 21/AM/19 GOOGLE EARTH IMAGE; /11/17
CO-ORDINATES : 18°46.429"S 29°36.126"E
AUTHOR : Manyanga M. A DATE: 21-09-19
LOCATION : Guyu-Chelsa- Gwanda
ELEVATION : 1139 m
RAINFALL : 600-750mm
LANDSCAPE (SHAPE) : Gently undulating
SLOPE (%) : 2-3%
NATURAL REGION : 3
PARENT MATERIAL : Granite-Maffic (GE)
ZIMBABWEAN CLASSIFICATION
GROUP :
FAMILY :

DESCRIPTION:



0 - 12cm Dark yellowish brown (10YR4/4m); medium sand; dry soft; moist loose; non sticky and non-plastic consistence; weakly developed fine sub angular blocky structure; good permeability; well drained, fairly numerous very fine and few medium roots; few sub rounded and angular quartz gravel, diffuse transition to:

12 - 30cm Dark yellowish brown (10YR4/4m); coarse sandy loam; dry slightly hard; moist very friable; slightly sticky and slightly plastic consistence; moderately developed medium sub angular blocky structure; good permeability; well drained; occasional very fine roots; clear smooth transition to:

30- 76cm Dark yellowish brow (10YR4/4m) many subrounded and angular quartz gravel

76- 93 cm C1 Material
93+ C2 Material

SOIL CHEMICAL DATA: PROFILE 21/AM/19

REFERENCE	S1	S2
DEPTH(cm)	0-12	12-30
LAB NO	E1904	E1905
DM %	100	100.0
TEXTURE	cLS	cLS
CLAY %	4	4
SILT %	10	14
FINE SAND %	40	35
MEDIUM SAND %	24	23
COARSE SAND %	22	23
pH (CaCl ₂)	5.3	5.4
EX Ca (me %)	1.3	1.6
EX Mg (me %)	.5	.6
EX Na (me %)	.13	.15
EX K (me %)	.03	.15
TEB (me %)	1.9	2.5
CEC (me %)	5.2	3.0
BASE SAT %	37	83
E/C	128.9	71.3
S/C	48.1	59.0
ESP	2.6	5.1
EKP	.5	5.1

3.2 CATEGORY G2

These are moderately shallow (60-80cm) deep soils found on all slope positions of gently undulating topography. The top soils are brown coarse loamy sands overlying dark yellowish brown to strong brown coarse sandy loams. These soils have coarse gravel from 40 cm downwards.

Summary of morphological properties

Depth	: moderately shallow (60-80cm)
Texture	: coarse grained loamy sand over coarse sandy loams
Colour	: brown (10YR 4/3m) to dark yellowish brown (10YR3/4m) over dark yellowish brown (10YR4/4m)
Structure	: weakly developed fine over medium subangular blocky
Drainage	: well drained
Permeability	: good in top soils over rapid in sub horizons

Summary of subsoil Chemical properties

Cation exchange capacity	: 6.4
Base saturation	: 35
pH	: 5.8
S/C	: 20.8
EC	: 58.9

Typical profiles	: 20/AM/19
Approximate Available Water Holding Capacity (AWC)	: 11%
Zimbabwe classification	: 4G
Irrigable value	: 3
Irrigability class	: C
FAO classification	: Cambisols

Profile description

PROFILE NUMBER : 20/AM/19 GOOGLE EARTH IMAGE; /11/17
CO-ORDINATES : 18°47.193"S 29°345.937"E
AUTHOR : Manyanga M. A DATE: 21-09-19
LOCATION : Mayorca-Kwekwe
ELEVATION : 1140m
RAINFALL : 600-750mm
LANDSCAPE (SHAPE) : Gently undulating
SLOPE (%) : 2-3%
NATURAL REGION : 3
PARENT MATERIAL : Granite (G)
ZIMBABWEAN CLASSIFICATION
GROUP : 4
FAMILY : G

DESCRIPTION:

0 - 21cm Brown (10YR4/3m); coarse loamy sand; soft dry; loose moist; non plastic and non-sticky wet consistence; weakly developed fine sub angular blocky structure; good permeability; well drained; numerous very fine roots; few fine and very fine tubular pores; clear smooth transition to:

21 - 43cm Strong brown (7.5YR4/6m); coarse sandy loam ; slightly hard dry; very friable moist ;slightly plastic and slightly sticky wet consistence; massive structure braking down to moderately developed medium sub angular blocky structure; good permeability; well drained; few very fine roots; few fine and very fine tubular pores, clear smooth transition to:

43- 67cm Many fine rounded and angular quartz gravel. rapid permeability; occasional very fine roots; few fine and very fine tubular pores; discontinuous transition to:

67+ C Material.

SOIL CHEMICAL DATA: PROFILE 20/AM/19

REFERENCE	S1	S2
DEPTH(cm)	0 -21	21-43
LAB NO	E1902	E1903
DM %	100.0	100.0
TEXTURE	cLS	cSaL
CLAY %	9	11
SILT %	5	9
FINE SAND %	39	26
MEDIUM SAND %	24	24

COARSE SAND %	22	30
pH (CaCl ₂)	5.6	5.8
carbonates		
EX Ca (me %)	1.1	1.5
EX Mg (me %)	.6	.6
EX Na (me %)	.15	.13
EX K (me %)	.18	.03
TEB (me %)	2.0	2.2
CEC (me %)	3.0	6.4
BASE SAT %	67	35
E/C	34.8	58.9
S/C	23.5	20.8
ESP	5.1	2.0
EKP	6.1	.5

3.3 CATEGORY G3

These are very shallow to shallow (25-50cm) soils found on mid to upper slope positions of 2-3% slopes. Soil depth is limited by small stones and weathering rock. The soils are dark yellowish brown to brownish yellow loamy sand over dark yellowish brown to strong brown sandy loams.

Summary of Morphological Properties

Depth	: very shallow to shallow (25-50cm) onto soft weathering rock
Texture	: medium loamy sand over coarse sandy loam.
Colour	: dark yellowish brown (10YR4/4m) brownish yellow (10YR6/6m) overlying dark yellowish brown (10YR 4/4m) to strong brown (7.5YR4/6)
Structure	: weakly developed fine sub angular blocky over medium subangular blocky
Drainage	: well drained
Permeability	: good

Summary of subsoil Chemical properties

Cation exchange capacity	: 2.5 – 5.9
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Base saturation : 34 - 66
 pH : 5.6 – 5.7
 S/C : 19.2 - 24
 EC : 28.8 – 71
 ESP : 3.1 – 7.2

Remarks

Typical profiles : 19/AM/19
 Approximate Available Water Holding Capacity (AWC) : 10%

Zimbabwe classification : 4G
 Irrigable value : 3
 Irrigability class : C
 FAO classification : Cambisols

PROFILE NUMBER : 19/AM/19 GOOGLE EARTH IMAGE; /11/17
 CO-ORDINATES : 18°47.170"S 29°35.939"E
 AUTHOR : Manyanga M. A DATE: 21-09-19
 LOCATION : Mayorca-Kwekwe
 ELEVATION : 1131 m
 RAINFALL : 450-600mm
 LANDSCAPE (SHAPE) : Gently undulating
 SLOPE (%) : 2-3%
 NATURAL REGION : 3
 PARENT MATERIAL : Granite (G)
 ZIMBABWEAN CLASSIFICATION
 GROUP : 4
 FAMILY : G
 DESCRIPTION:



0 - 13cm Dark yellowish brown (10YR4/4m); medium loamy sand; soft dry; loose moist; non plastic and non-sticky; weakly developed fine sub angular blocky structure; rapid permeability; well drained; few fine and very fine roots; few fine and very fine tubular pores; clear smooth transition to:

13 - 29cm Strong brown (7.5YR4/6m); medium sandy loam; hard dry; very friable moist; slightly plastic and slightly sticky wet consistence; moderately developed medium sub angular blocky structure; good permeability; well drained; occasional very fine roots; few fine and very fine tubular pores; gradual smooth transition to:

29- 55cm Strong brown (7.5YR5/6m); well drained, rapid permeability; occasional very fine roots; few fine tubular pores; common fine quartz gravel; clear wavy transition to;

55+ Weathering material

SOIL CHEMICAL DATA: PROFILE 19/AM/19

REFERENCE	S1	S2	S3
DEPTH(cm)	0-13	13-29	29-55
LAB NO	E1899	E1900	E1901
DM %	100.0	100.0	100.0
TEXTURE	mLS	cSaL	cLS
CLAY %	7	8	9
SILT %	7	13	5
FINE SAND %	38	39	20
MEDIUM SAND %	27	17	27
COARSE SAND %	21	23	39
pH (CaCl ₂)	5.0	5.7	5.6
CARBONATES %			
EX Ca (me %)	.9	1.2	.9
EX Mg (me %)	.6	.6	.5
EX Na (me %)	.13	.18	.18
EX K (me %)	.05	.03	.15
TEB (me %)	1.7	2.0	1.6
CEC (me %)	7.7	5.9	2.5
BASE SAT %	22	34	66
E/C	114.4	71.0	28.8
S/C	25.3	24.0	19.2
ESP	1.7	3.1	7.2
EKP	.7	.5	6.1

3.4 CATEGORY G4

Soils are extremely shallow (<25 cm) in depth with many surface small stones. These soils are mainly brown coarse loamy sand and are found on upper slope to crestal positions of 3% slopes.

Summary of Morphological Properties

Depth	: extremely shallow (<25cm)
Texture	: coarse loamy sand throughout.
Colour	: brown (10YR4/3m)
Typical Auger	: MY1
Irrigable value	: 4
Irrigability class	: D
Zimbabwe classification	: 2 G
Fao Classification	: Leptosols

4.0 DISCUSSION

Profiles in almost all the area have sandy top soils overlying sandy loam sub soils with average maximum fine earth fraction of about 50 cm. Most of the sub soils are predominantly gravelly meaning they have rapid permeability. Light top soils mean these soils are susceptible to nutrient leaching as well as prone to erosion hence the need to improve nutrient retention capacity through use of organic material and controlling erosion through ensuring ground cover as well as having erosion control structures such as contour ridges in place. The water from the dam is of medium salinity and can be used to grow most crop on these soils since they have good drainage.

5.0 RECOMMENDATIONS

Erosion control measures such as contours should be maintained and or put in place. Both organic and inorganic soil fertility amendments should be used for soil fertility management. It is highly recommended that soil conservation practices such as conservation agriculture be practiced. The three principles of conservation farming namely reduced tillage, crop rotation and reduced tillage can greatly help improve the soil status of Mayorca irrigation schemes. Once operational, farmers are periodically encouraged to send soils for analysis to get crop specific recommendations thereby help managing the soil fertility status.

6.0 BIBLIOGRAPHY

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7.0 APPENDICES

7.2 DAM WATER QUALITY RESULTS

Lab No.	562/GW	
Sample No.	Muponesi dam	
	me/l	p.p.m
Calcium (Ca ²⁺)	4.81	96.25
Magnesium (Mg ²⁺)	5.48	65.75
Sodium (Na ⁺)	1.43	32.80
Carbonate (CO ₃ ²⁻)	ND	
Bicarbonate (HCO ₃)	1.6	97.6
Chloride (Cl ⁻)	0.34	11.9
Sulphate (SO ₄ ²⁻)		
Conductivity (microsiemens/cm)	362	
pH		
Sodium Adsorption Ratio	0.63	
Residual Sodium Ratio	-8.96	
Ca/Mg/Ratio	0.88	
Code	C ₂ -S ₂ -R ₁ -X ₁	

7.3 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.

7.4 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

7.5 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 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	8.Sodic Weakly sodic	8n

	of sodium as the exchangeable ion	Strongly sodic Saline sodic	8N 8h
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