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Land capability and suitability assessment of some soils El-Galaba plain, Aswan, Egypt

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Abstract

The objective of this work aims to study the land capability and suitability under drip and sprinkler irrigation systems of some soils located in El-Galaba plain, west of Edfu city, Aswan governorate, Egypt. The soil texture of the study area was mainly sand, loamy sand and sandy loam with different percentages of gravel content; they are deep soil profiles. Organic matter (OM) content is low and decrease with depth. EC_e values vary widely from 0.3 - 26.7 dS/m indicting that the studied soils are non-saline to moderately saline. Soil reaction (pH) is a strongly alkaline to very strongly alkaline as shown by pH values which ranged from 8.3 to 9.9. Calcium carbonate content ranged between 1 and 12%, while gypsum content ranged between 0.00 and 1.09%. Values of cation exchange capacity (CEC) ranged between 4 to 17 cmol (+)/kg. Most of studied soils are non-sodic, exchangeable sodium percentage (ESP) ranged between 7 and 23%. The land capability using the applied system of land evaluation (ASLE) program by Ismail and Morsi (2001) under drip irrigation system shows the result in the study area are good (C2), poor (C4), very poor (C5), and non-agricultural (C6), while, using ASLE program under sprinkler irrigation system were good (C2), poor (C4), and very poor (C5). Moreover, the microcomputer land evaluation information system (MicroLEIS-Cervatana model) was moderately (S3) and marginally (N1). On the other side, the land suitability using the applied system of land evaluation (ASLE) program under drip and sprinkler irrigation systems were highly suitable, suitable, moderately suitable, marginally suitable, and not suitable (currently suitable N1) for crops; wheat, cotton, sugar beet, maize, soya bean, tomato, cabbage, pepper, onion, alfalfa, date palm, olive, fig and grape. A web-based program the microcomputer land evaluation information system (MicroLEIS-Almagra model), was used to compute the land suitability indicated that the soils of the study area were moderately suitable, marginally suitable, and non-suitable for the selected crops. The major limitations of these soils were soil texture and low soil fertility.

Keywords: El-Galaba plain, land capability, land suitability, ASLE program, microLEIS program.

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1. Introduction

Most areas in Aswan governorate in Upper Egypt are considered as one of the most promising development areas in the governorates of Egypt, as many flat areas can be reclaimed and close to urbanization. By the directives of the state, especially in recent times, for agricultural expansion to meet the continuous population increase, many agricultural areas must be reclaimed to meet the population needs. Land evaluation is part of land use planning process. The aim of land evaluation is to provide information on the constraints and opportunities for the use of land as a basis for making decisions on its use and management (FAO, 1983). As said by NRCS (2008), land evaluation from the agricultural viewpoint concerns the rating of lands and placing them into groups ranging from the most suited to the least suited for specific agricultural use (such as cropland, forestland, or rangeland). A relative value is then determined for each group. Scoring values may be used so that the best group may be assigned a value of 100, while other groups are assigned lower values. Land evaluation is based on data from a national soil survey. Rosa (2005) defined land suitability as the evaluation or foretelling of land quality for specific use. The operation of land suitability is the appraisal and grouping of specific areas of land in terms of their suitability for a defined use. The land capability in some soils of El-Galaba basin, Egypt, was three land capability classes based on microLEIS cervatana model; Good (S2), Moderate (S3) and Marginal (N) according to Saleh *et al*., (2015). In addition, Abdelgalil *et al*., (2016) stated that many modern software such ALES-Arid and ArcGIS 10.1 are used to evaluate land suitability in some soils of Sohag-Red Sea road sides, Sohag, they found that these soils are moderate suitable S2, marginally suitable S3 and not suitable N for selected crops. Fadl and Sayed (2020) evaluate the land capability of some soils of El-Qusiya Area, Assiut, Egypt, belonged two land capability classes according to Storie index; fair (Grade 3) and poor (Grade 4) and the Cervatana model showed that land capability classes of the study area are good (S2), moderate (S3) and marginal (N) with limiting factors of soil (i), erosion risks (r) and bioclimatic deficit (b). The land capability of some soils at North-west of Dashlut, Assiut, Egypt, showed that the soils of the study area were poor (C4), very poor (C5), and non-agricultural (C6) using the ASLE program, while the MicroLEIS (Cervatana model) program pointed that soils was moderately (S3) and marginally (N1) capable grades. Moreover, the land suitability using the ASLE program, the soils of the study area were highly suitable to not suitable for different crops. The land suitability using MicroLEIS (Almagra model) program indicated that the soils of this area were moderately suitable, marginally suitable, and non-suitable for selected crops (Sayed and Khalafalla,

2021. The aim of the study is to evaluate land capability and suitability for some selected crops under drip and sprinkler irrigation systems of these soils.

2. Materials and methods

2.1 Study area

El-Galaba plain is located west of Edfu city and north of Aswan governorate by 60 km. It is located east of Aswan-Cairo highway and south Banban road in the western desert. This area is considered as one of the most promising areas for land reclamation, which is close to urbanization and almost flat. It's bounded by longitude 32° 42′ 03.6″ and 32° 45′ 38.2″ E and latitudes 24° 36′ 47.8″ and 24° 41′ 48.2″ N (Figure 1), covering the study area about 46.52 km^2, (4625 hectares).

2.2 Field and laboratory work

Thirty-six soil profiles were selected to represent the topography and the field observation for surface almost flat of different regions. GPS guidance recorded longitude and latitude directions. Soil profiles were morphologically described according to the guidelines of FAO (2006). The collected soil samples were analyzed in the laboratory according to standard methods by Soil Survey Staff (2014).

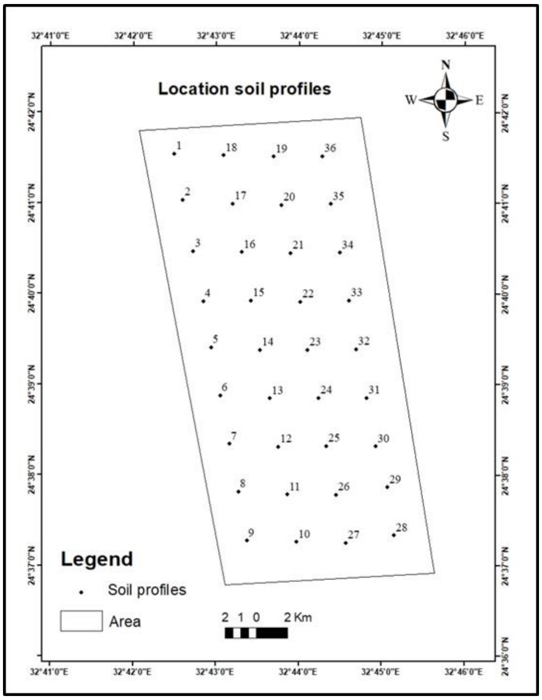

Figure (1): Location map of the study area.

2.3 Land evaluation

2.3.1 Land capability

2.3.1.1 Applied system of land evaluation (ASLE) program

ASLE program for arid and semi-arid regions by Ismail and Morsi (2001) under drip and sprinkler irrigation systems use to classify the soil into capability classes; C1, C2, C3, C4, C5 and C6 (Table 1).

2.3.1.2 The microLEIS (Cervatana model)

The microLEIS internet-based program according to De la Rosa et al. (2004) was divided it into four class., S1, S2, S3, and N which was also used for land capability (Table 1).

Table (1): Capability classes by applied system of land evaluation (ASLE) program and MicroLEIS (Cervatana model).

Applied system of land evaluation (ASLE) program			The microLEIS (Cervatana model)	
Class	%	Description	Class	Description
C1	80-100	Excellent	S1	Excellent
C2	60-80	Good	S2	Good
C3	40-60	Fair	S3	Moderate
C4	20-40	Poor	N	Marginal
C5	10-20	Very poor		
C6	<10	Non-agricultural		

2.3.2 Land suitability

2.3.2.1 The Applied system of land evaluation (ASLE) program

Land suitability classification according to the applied system of land evaluation (ASLE) for arid and semi-arid regions under drip and sprinkler irrigation systems by Ismail and Morsi (2001) was used to recognize suitability classes of some field crops wheat, cotton, sugar beet, maize, soya bean, tomato, cabbage, pepper, onion, alfalfa, date palm, olive, fig and grape crops (Table 2).

Table (2): Suitability classes according to the applied system of land evaluation (ASLE) and microLEIS (Almagra model).

Applied system of land evaluation (ASLE) program (Ismail and Morsi, 2001)			MicroLEIS (Almagra model)					
			Suitability classes		Limitation		Soil factors	
Class	%	Description	Symbol	Definition	Symbol	Definition	Symbol	Definition
S1	> 80	High suitable	S1	High suitable	1	None	a	Sodium saturation
S2	60-80	Suitable	S2	Suitable	2	Slight	c	Carbonate
S3	30-60	Moderately suitable	S3	Moderately suitable	3	Moderate	d	Drainage
S4	20-30	Marginally suitable	S4	Marginally suitable	4	Severe	g	Profile development
NS1	10-20	Currently suitable	S5	Not suitable	5	Very severe	p	Useful depth
NS2	<10	Permanently suitable					s	Salinity
							t	Texture

2.3.2.2 MicroLEIS (Almagra model) program

The microLEIS (Almagra model) program introduced by De la Rosa *et al*. (2004) was based on an analysis of the edaphic characteristics that are directly affected productive development under different agricultural uses for selected crops; cotton, wheat, sugar beet, alfalfa, maize, melon, potatoes, olive, soya bean, sunflower, citrus and peach (Table 2).

2.4 Remote sensing (RS) and geographic information system (GIS) processing

Landsat 8 satellite image for the study area (Path 174, Row 43, date acquired, 2018-02-08) with image resolution of 30 m. Using ENVI 5.1 software was implemented (ITT, 2017). Also, geographic information system (GIS) works including a base map, some soil properties, land Capability, and land suitability, were produced using ArcGIS 10.2.2 software (ESRI, 2014).

3. Results and Discussion

3.1 The physical and chemical of the study area

The analytical data of studied soil profiles (Table 3) show that these soils have mainly gravelly sand to sandy loam texture. The EC_e values vary between 0.3 and 26.7 dS/m, most soil samples are slightly saline (Figure 2). Soil pH range between 8.3 and 9.9 and the weighted mean soil profiles (Figure 3), most of the studied soil samples are very strongly alkaline (pH > 9). Organic matter content is low less than 1% and generally decreases with depth. Gypsum content in the studied soil samples is very low, ranging from zero to 1.09%. Values of $CaCO_3$ for various samples range between 1 to 12% with weighted mean from 1 to 5% (Figure 4). On the whole, the investigation soils areas are non-calcareous. The surface layers of soil samples have relatively higher calcium carbonate than the subsurface ones in most soil profiles. The cation exchange capacity values are from between 4 to 17 cmol (+)/kg soil which is affected mainly by the dominant coarse texture classes. Exchange sodium percentage values are relatively low and different from 7 and 23%. The values of available nitrogen range from 9 and 45 mg/kg of the soil profiles. Available phosphorus for the studied soil samples ranges between 2 and 9 mg/kg. The concentrations of available potassium in the studied soils are 15 to 94 mg/kg. Frequently, the available nitrogen, phosphors and potassium show higher levels in the upper layers and decrease downwards.

Table (3): Some physical and chemical of El-Galaba plain, Aswan, Egypt.

Profile No.	Depth	G.V. (%)	Particle-size distribution			Texture grade	EC_e (dS/m)	pH 1:1	O.M (%)	Gyp. (%)	$CaCO_3$ (%)	CEC (cmol(+)/kg)	ESP (%)	A.nitr. (mg/kg)	A.pho (mg/kg)	A.pot. (mg/kg)
			Clay (%)	Silt (%)	Sand (%)											
1	0 – 20	4	5	6	89	Sand	4.8	9.1	0.07	0.69	9	15	16	38	4	76
	20 - 60	25	1	2	97	Gravelly sand	26.7	9.1	0.26	0.56	1	6	11	44	5	33
	60 - 70	22	1	2	97	Gravelly sand	13.6	9.0	0.40	0.50	1	8	17	35	6	32
	70 - 150	9	1	1	98	Sand	6.4	8.7	0.33	1.09	1	4	15	24	6	24
W. Mean	---	14	1	2	97	Sand	12.1	8.9	0.28	0.86	1	6	14	32	5	34
2	0 – 20	1	1	1	98	Sand	1.6	9.4	0.20	0.02	3	4	11	39	7	53
	20 - 65	31	3	4	93	Gravelly sand	0.3	9.6	0.13	0.03	4	10	13	30	5	38
	65 - 90	25	4	8	88	Gravelly sand	2.7	9.4	0.13	0.00	4	16	9	27	3	36
	90 - 100	29	3	4	93	Gravelly sand	6.2	9.9	0.20	0.04	1	12	14	28	4	30
	100 -150	21	1	3	96	Gravelly sand	3.1	9.9	0.20	0.02	5	14	10	10	3	16
W. Mean	---	22	2	4	94	Gravelly sand	2.2	9.7	0.17	0.02	4	12	11	24	4	32
3	0 – 20	2	1	2	97	Sand	0.7	9.5	0.26	0.01	4	16	12	39	6	30
	20 - 70	23	4	7	90	Gravelly sand	7.9	9.4	0.13	0.15	4	14	11	37	2	55
	70 - 100	12	4	6	90	Sand	3.7	9.2	0.20	0.05	1	13	8	33	3	29
	100 - 150	20	3	4	93	Gravelly sand	10.6	9.4	0.26	0.03	1	11	13	12	5	19
W. Mean	---	17	3	5	92	Gravelly sand	7.0	9.4	0.20	0.07	2	13	11	28	4	34
4	0 – 25	5	3	3	94	Sand	0.8	9.9	0.26	0.01	2	10	13	39	3	41
	25 - 50	26	2	3	95	Gravelly sand	3.0	9.6	0.20	0.11	2	7	14	32	4	32
	50 - 110	8	2	2	96	Sand	16.6	9.1	0.20	0.39	3	8	10	33	5	26
	110 - 120	29	1	2	97	Gravelly sand	2.8	9.3	0.26	0.32	1	9	15	34	6	15
	120 - 150	13	3	3	94	Sand	1.4	9.4	0.26	0.20	5	14	7	9	3	32
W. Mean	---	13	2	3	95	Sand	7.7	9.4	0.23	0.24	3	9	11	29	4	30
5	0 - 35	2	2	2	96	Sand	0.6	9.7	0.26	0.04	2	10	13	39	5	51
	35 - 90	2	2	2	96	Sand	2.5	9.8	0.26	0.06	2	8	12	34	4	35
	90 - 110	32	2	2	95	Gravelly sand	5.9	8.9	0.26	0.50	1	7	9	23	7	20
	110 - 150	17	3	2	95	Gravelly sand	4.5	9.1	0.26	0.47	5	9	10	16	5	20
W. Mean	---	10	2	2	96	Sand	3.0	9.5	0.26	0.22	2	8	11	29	5	33
6	0 - 30	1	2	2	96	Sand	3.4	9.9	0.20	0.05	2	7	16	39	4	33
	30 - 70	3	3	3	94	Sand	2.7	9.3	0.20	0.02	2	11	14	32	4	27
	70 - 100	29	5	4	91	Gravelly sand	4.3	9.0	0.26	0.57	4	10	12	34	6	33
	100 - 150	6	3	2	95	Sand	2.8	9.2	0.13	0.29	1	15	15	19	3	19
W. Mean	---	9	3	3	94	Sand	3.2	9.3	0.19	0.23	2	12	14	29	4	27
7	0 – 25	1	2	2	96	Sand	1.1	9.5	0.27	0.01	6	14	8	37	4	36
	25 - 55	5	3	2	95	Sand	0.7	9.9	0.26	0.04	2	15	17	30	3	29
	55 - 65	23	3	3	94	Gravelly sand	2.4	9.4	0.33	0.21	4	16	10	31	7	22
	65 - 100	12	3	3	94	Sand	0.4	9.3	0.33	0.23	1	14	14	14	5	21
	100 - 150	2	5	1	94	Sand	3.6	9.1	0.26	0.41	4	13	15	19	5	19
W. Mean	---	6	4	2	94	Sand	1.8	9.4	0.28	0.21	3	15	14	24	5	25
8	0 – 25	2	3	0	97	Sand	0.8	9.8	0.20	0.04	2	17	12	34	3	33
	25 - 80	31	6	6	88	Gravelly loamy sand	3.3	9.4	0.27	0.35	2	13	13	32	4	51
	80 - 130	10	3	1	96	Sand	1.4	9.6	0.20	0.03	1	15	8	39	5	20
	130 - 150	8	2	1	97	Sand	0.5	9.6	0.20	0.05	1	14	14	18	2	28
W. Mean	---	16	4	3	93	Gravelly sand	1.9	9.5	0.23	0.15	1	15	11	33	4	35
9	0 - 30	2	4	3	93	Sand	1.6	9.6	0.26	0.18	2	15	11	34	5	51
	30 - 50	21	5	2	93	Gravelly sand	3.3	9.4	0.26	0.19	2	17	9	29	6	32
	50 - 110	12	3	1	96	Sand	5.0	9.1	0.26	0.26	1	14	12	33	4	20
	110 - 150	8	3	0	97	sand	0.7	8.8	0.20	0.02	1	13	10	12	5	23
W. Mean	---	10	4	1	95	Sand	2.9	9.2	0.24	0.17	1	15	11	27	5	29
10	0 – 25	2	5	2	93	Sand	0.6	9.9	0.20	0.05	4	12	8	39	2	56
	25 - 80	3	3	2	95	Sand	4.5	9.2	0.26	0.17	2	14	15	37	5	30
	80 - 110	24	5	2	93	Gravelly sand	5.5	8.9	0.26	0.09	5	15	10	29	6	25
	110 - 150	12	4	1	95	Sand	0.8	9.7	0.26	0.04	6	13	13	13	4	22
W. Mean	---	9	4	1	95	Sand	3.1	9.4	0.25	0.10	4	13	12	29	4	31
11	0 – 25	4	5	4	91	Sand	0.7	9.9	0.17	0.05	1	14	8	39	3	57
	25 - 45	6	6	4	90	Sand	0.6	9.9	0.26	0.04	1	12	16	27	4	46
	45 - 55	27	6	6	88	Gravelly loamy sand	4.6	9.0	0.27	0.14	1	11	19	33	4	62
	55 - 120	18	6	5	89	Gravelly sand	10.5	8.7	0.07	0.43	1	13	12	24	6	42
	120 - 150	25	6	5	89	Gravelly sand	8.0	8.6	0.27	0.17	2	12	10	19	7	22
W. Mean	---	16	6	4	90	Gravelly sand	6.6	9.1	0.16	0.21	1	13	12	25	5	40
12	0 -25	2	3	2	95	Sand	3.0	9.3	0.26	0.37	8	15	7	41	5	44
	25 - 65	2	3	3	94	Sand	3.4	9.4	0.12	0.04	4	14	8	35	4	25
	65 - 95	4	5	1	94	Sand	1.4	9.6	0.22	0.01	4	12	11	34	3	38
	95 - 150	18	5	1	94	Gravelly sand	4.1	8.9	0.17	0.18	5	13	7	10	6	19
W. Mean	---	8	4	2	94	Sand	3.2	9.2	0.18	0.14	5	13	8	27	5	29
13	0 - 35	2	4	2	94	Sand	0.6	9.9	0.17	0.04	3	12	13	34	4	31
	35-70	18	5	4	91	Gravelly sand	1.4	9.7	0.26	0.05	2	11	15	29	5	36
	70-110	18	3	1	96	Gravelly sand	0.9	9.1	0.07	0.03	1	14	9	34	6	26
	110-150	13	3	2	95	Sand	1.0	9.1	0.07	0.03	1	12	10	23	4	28
W. Mean	---	1	4	2	94	Sand	1.0	9.5	0.14	0.04	1	12	12	30	5	30
14	0 – 35	3	4	2	94	Sand	0.7	9.8	0.07	0.06	2	13	15	38	5	45
	35 - 85	21	4	2	94	Gravelly sand	4.3	9.1	0.07	0.25	2	12	9	24	6	23
	85 - 115	15	4	1	95	Gravelly sand	2.5	8.8	0.12	0.10	2	11	12	26	8	15
	115 - 150	13	2	1	97	Sand	1.7	9.3	0.22	0.04	2	6	11	14	4	27
W. Mean	---	14	4	2	94	Sand	2.5	9.2	0.12	0.13	1	11	11	25	6	27
15	0 – 35	3	3	4	93	Sand	4.4	9.1	0.33	0.20	3	9	14	34	6	51
	35 - 70	8	4	4	92	Sand	1.7	9.1	0.07	0.17	3	10	9	37	5	34
	70 - 150	15	4	4	92	Gravelly sand	4.2	8.5	0.12	0.02	4	10	10	15	7	18
W. Mean	---	10	4	4	92	Sand	3.7	8.8	0.16	0.10	3	10	11	25	6	29
16	0 - 25	8	4	6	90	Sand	1.8	9.4	0.12	0.27	6	11	12	32	6	63
	25 - 85	15	4	4	92	Gravelly sand	2.7	9.3	0.20	0.21	2	9	14	28	7	39
	85 - 150	11	4	3	93	Sand	3.8	8.8	0.26	0.09	8	10	13	12	9	15
W. Mean	---	12	4	4	92	Sand	3.0	9.1	0.21	0.17	5	10	13	22	8	33

Table (3): Continued.

Profile No.	Depth	G.V. (%)	Particle-size distribution			Texture grade	EC_e (dS/m)	pH 1:1	O.M (%)	Gyp. (%)	$CaCO_3$ (%)	CEC (cmol(+)/kg)	ESP (%)	A.nitr. (mg/kg)	A.pho (mg/kg)	A.pot. (mg/kg)
			Clay (%)	Silt (%)	Sand (%)											
17	0 - 20	4	2	3	95	Sand	0.8	9.4	0.33	0.01	1	13	11	37	3	55
	20 - 110	16	2	4	94	Gravelly sand	3.7	8.7	0.20	0.37	1	9	10	34	5	79
	110 - 150	11	2	2	96	Sand	3.3	8.7	0.26	0.33	1	5	11	20	3	51
W. Mean	---	13	2	3	95	Sand	3.2	8.8	0.23	0.31	1	9	10	31	4	68
18	0 - 30	3	2	3	95	Sand	1.2	9.2	0.20	0.12	2	8	17	33	5	39
	30 - 60	4	4	3	93	Sand	7.1	8.9	0.26	0.32	2	12	8	30	6	45
	60 - 80	22	7	8	85	Gravelly loamy sand	3.3	9.1	0.26	0.26	1	14	9	34	6	34
	80 - 105	29	4	4	92	Gravelly sand	6.3	8.6	0.20	0.47	1	17	12	23	5	20
	105 - 150	20	4	4	92	Gravelly sand	5.5	8.5	0.20	0.08	1	15	15	19	7	24
W. Mean	---	15	4	4	92	Gravelly sand	4.8	8.8	0.22	0.23	1	13	13	27	6	32
19	0 - 20	1	2	1	97	Sand	1.3	9.1	0.26	0.04	1	6	14	38	3	59
	20 - 40	10	4	6	90	Sand	1.4	9.9	0.20	0.03	1	12	11	31	5	81
	40 - 150	21	9	13	78	Gravelly sandy loam	4.8	9.1	0.26	0.04	1	15	16	18	6	51
W. Mean	---	17	8	11	81	Gravelly loamy sand	3.9	9.2	0.25	0.04	1	14	15	22	5	56
20	0 - 20	1	1	1	98	Sand	0.6	9.2	0.20	0.04	1	5	10	44	4	43
	20 - 45	29	6	8	86	Gravelly loamy sand	3.4	9.4	0.26	0.04	1	12	7	33	3	36
	45 - 150	20	4	2	94	Gravelly sand	5.4	8.7	0.13	0.15	1	10	10	14	7	28
W. Mean	---	19	4	3	93	Gravelly sand	4.4	8.9	0.16	0.12	1	14	10	21	6	31
21	0 - 20	3	3	3	94	Sand	1.0	9.2	0.20	0.08	4	8	14	38	3	32
	20 - 50	15	5	5	90	Gravelly sand	3.7	9.3	0.20	0.31	1	12	11	39	6	70
	50 - 110	18	2	2	96	Gravelly sand	6.3	8.8	0.13	0.41	1	13	8	26	7	32
	110 - 150	8	3	2	95	Sand	2.6	8.9	0.13	0.03	1	9	13	17	4	23
W. Mean	---	13	3	3	94	Sand	4.1	9.0	0.15	0.24	1	11	11	28	5	37
22	0 - 25	1	5	4	91	Sand	2.4	9.6	0.26	0.01	1	13	16	34	5	39
	25 - 65	4	3	3	94	Sand	5.2	8.8	0.22	0.26	1	11	8	30	6	42
	65 - 90	22	5	5	90	Gravelly sand	3.6	8.6	0.13	0.44	1	10	14	23	7	32
	90 - 150	19	5	4	91	Gravelly sand	6.2	8.4	0.13	0.12	1	11	17	20	7	26
W. Mean	---	13	5	4	91	Sand	4.9	8.7	0.16	0.18	1	11	14	24	6	31
23	0 - 35	4	4	4	92	Sand	0.8	9.9	0.13	0.03	2	12	11	40	6	41
	35 - 70	7	3	3	94	Sand	2.5	8.5	0.20	0.03	2	11	9	30	8	37
	70 - 95	25	5	2	93	Gravelly sand	4.2	8.7	0.13	0.56	7	14	10	36	5	20
	95 - 150	2	5	2	94	Sand	4.8	8.6	0.13	0.41	2	12	16	11	4	23
W. Mean	---	8	4	3	93	Sand	3.2	8.9	0.14	0.22	2	12	12	24	5	29
24	0 - 35	2	5	6	89	Sand	5.8	9.6	0.26	0.10	1	11	12	35	4	46
	35 - 70	23	6	5	89	Gravelly sand	7.1	8.6	0.20	0.46	1	13	18	36	5	66
	70 -150	22	5	4	91	Gravelly sand	2.9	9.1	0.20	0.15	2	11	15	29	5	31
W. Mean	---	17	5	5	90	Sand	4.5	9.1	0.21	0.21	1	12	15	32	5	43
25	0 - 40	3	5	4	91	Sand	0.8	9.7	0.26	0.04	4	12	8	35	4	36
	40 - 90	21	5	5	90	Gravelly sand	1.4	9.1	0.13	0.02	1	13	14	22	5	26
	90 - 150	7	4	3	93	Sand	4.1	9.3	0.13	0.04	1	9	12	17	6	24
W. Mean	---	11	4	4	92	Sand	2.3	9.3	0.16	0.03	1	12	12	23	5	28
26	0 - 40	2	2	1	97	Sand	0.9	9.4	0.27	0.03	2	5	9	45	4	57
	40 - 65	9	4	3	93	Sand	1.7	9.2	0.26	0.20	1	10	18	29	2	40
	65 - 90	25	6	5	89	Gravelly sand	0.7	8.7	0.13	0.06	2	12	14	16	5	29
	90 - 150	25	7	4	89	Gravelly sand	4.6	8.7	0.13	0.46	1	14	10	14	4	37
W. Mean	---	16	5	3	92	Gravelly sand	2.5	9.0	0.19	0.24	1	11	12	25	4	42
27	0.20	6	9	10	81	Loamy sand	0.6	9.6	0.27	0.05	11	13	19	26	6	94
	20-55	22	5	9	86	Gravelly loamy sand	18.3	8.5	0.22	0.41	1	10	21	35	7	69
	55-150	21	5	5	90	Gravelly sand	22.7	8.7	0.22	0.69	1	8	23	24	5	58
W. Mean	---	19	5	6	89	Gravelly sand	18.7	8.8	0.23	0.54	2	9	22	27	6	65
28	0-15	4	4	2	94	Sand	0.5	9.3	0.22	0.00	2	7	12	39	4	57
	15-60	3	5	4	91	Sand	0.7	9.8	0.13	0.04	1	9	9	44	3	56
	60-150	15	6	6	88	Gravelly loamy sand	10.2	8.5	0.22	0.35	1	15	11	23	7	34
W. Mean	---	11	5	5	90	Sand	6.4	9.0	0.19	0.22	1	12	11	31	6	43
29	0-15	3	5	4	91	Sand	1.4	9.3	0.17	0.13	4	10	14	37	5	47
	15-70	4	3	3	94	Sand	2.8	8.8	0.27	0.50	1	11	10	36	6	39
	70-150	17	6	6	88	Gravelly sand	5.1	8.5	0.13	0.01	1	13	8	25	5	37
W. Mean	---	11	5	4	91	Sand	3.9	8.7	0.19	0.20	1	12	9	30	5	39
30	0-50	4	5	1	94	Sand	0.9	9.5	0.27	0.01	2	9	13	31	4	73
	50-150	27	6	7	87	Gravelly loamy sand	2.1	8.8	0.12	0.33	2	14	17	30	6	41
W. Mean	---	19	6	5	89	Gravelly sand	1.7	9.0	0.17	0.22	1	13	16	30	5	52
31	0-55	8	5	4	91	Sand	0.9	9.6	0.13	0.01	3	13	12	39	3	50
	55-150	18	5	3	92	Gravelly sand	1.3	8.8	0.27	0.38	1	10	11	34	6	30
W. Mean	---	14	5	3	92	Sand	1.1	9.1	0.22	0.24	1	11	11	36	5	37
32	0-30	4	5	2	93	Sand	0.6	9.6	0.07	0.12	2	11	10	31	5	42
	30-65	24	8	12	80	Gravelly loamy sand	2.3	8.8	0.20	0.24	1	16	15	26	6	61
	65-100	30	7	6	87	Gravelly loamy sand	10.7	8.4	0.13	0.42	1	15	11	19	6	37
	100-150	20	3	2	95	Gravelly sand	3.7	8.5	0.22	0.10	1	12	10	18	5	26
W. Mean	---	14	11	18	71	Sand	3.5	8.8	0.16	0.21	1	10	8	23	5	40
33	0 - 20	10	6	4	90	Sand	4.0	8.9	0.27	0.37	7	12	7	39	6	62
	20 - 80	28	7	9	84	Gravelly loamy sand	6.5	8.4	0.13	0.59	1	14	15	29	5	35
	80 - 150	17	3	1	96	Gravelly sand	6.3	8.3	0.22	0.37	1	3	18	33	9	20
W. Mean	---	21	5	5	90	Gravelly sand	6.0	8.4	0.19	0.46	1	8	15	32	7	32
34	0 - 40	5	3	5	92	Sand	3.4	9.0	0.20	0.36	4	11	9	25	5	49
	40 - 95	20	7	13	80	Gravelly loamy sand	1.8	9.4	0.12	0.02	1	18	12	21	4	59
	95 - 150	30	6	12	82	Gravelly loamy sand	4.1	8.6	0.27	0.43	1	12	11	24	5	35
W. Mean	---	20	6	11	83	Gravelly loamy sand	3.0	9.0	0.20	0.26	1	16	11	23	5	48
35	0 - 15	9	6	9	85	Loamy sand	1.7	9.1	0.13	0.34	10	13	10	33	4	74
	15 - 85	32	4	8	88	Gravelly sand	8.5	8.5	0.17	0.72	2	12	17	29	5	54
	85 -150	18	2	2	96	Gravelly sand	8.7	8.5	0.27	0.35	1	9	19	21	7	31
W. Mean	---	24	3	6	91	Gravelly sand	7.9	8.6	0.21	0.52	1	11	17	26	6	46
36	0 - 25	7	7	10	83	Loamy sand	12.7	8.9	0.22	0.90	12	15	21	34	6	91
	25 - 150	28	2	4	94	Gravelly sand	23.2	8.5	0.27	0.93	1	11	22	22	7	33
W. Mean	---	25	3	5	92	Gravelly sand	21.5	8.6	0.26	0.93	2	12	22	24	7	43

G.V. = gravel by volume. O.M = Organic matter. Gyp. = Gypsum A. nitr. = Available nitrogen. A. pho. = Available phosphorus. A. pot. = Available potassium.

3.2 Land capability assessment

The appropriate systems for land capability classification in arid and semi-arid regions are the Applied System of Land Evaluation Program (ASLE) by Ismail and Morsi (2001) and the microLEIS (Cervatana model) internet-based program according to De la Rosa *et al*. (2004).

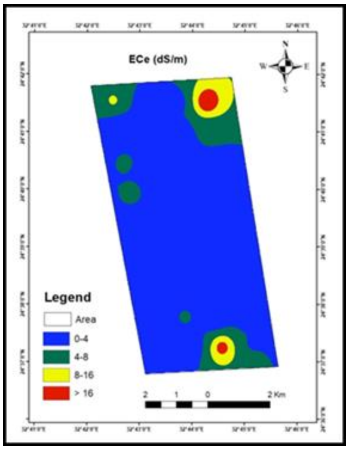

Figure (2): EC_e map of the soil profile weighted mean in the studied area.

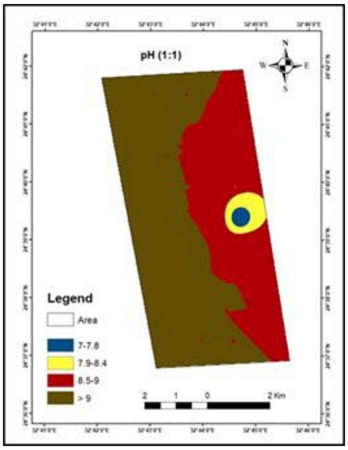

Figure (3): pH map of the soil profile weighted mean in the studied area.

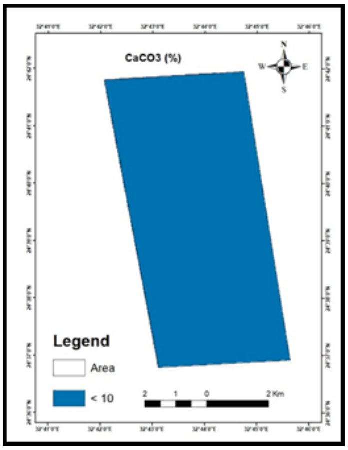

Figure (4): $CaCO_3$ map of the soil profile weighted mean in the studied area.

3.2.1 ASLE program

The land capability is classified by the applied system of land evaluation (ASLE) program by Ismail and Morsi (2001) under two irrigation systems *i.e.*, drip and sprinkler irrigation systems shown in Table (4) and illustrated in Figures (5 and 6). The results of this program indicate that these soils are good, poor, very poor and non-agriculture. With respect to drip irrigation, most of the studied soil profiles are considered very poor (C5). Whereas soil profile 8 is good (C2), as well as soil profiles 1, 12, 15, 22, 24, 27, 29, 33, 34 and 36 are poor (C4). On the other hand, soil profile 18 is non-agricultural. Concerning sprinkler irrigation, most soil profiles in the investigation area are very poor (C5). Whereas soil profile 8 is good (C2), moreover, soil profiles 1, 12, 15, 18, 19, 22, 24, 27, 29, 33, 34 and 36 are poor (C4).

Table (4): Capability classes using ASLE and MicroLIES (Cervatana model) of the studied soil profiles.

Profile No.	ASLE program				MicroLIES (Cervatana model)
	Drip irrigation		Sprinkler irrigation		
	%	Class	%	Class	
1	23	C4	23	C4	NI
2	16	C5	16	C5	S3r
3	14	C5	14	C5	S3r
4	16	C5	16	C5	S3r
5	12	C5	12	C5	S3r
6	16	C5	16	C5	S3r
7	12	C5	12	C5	S3r
8	69	C2	69	C2	S3r
9	18	C5	18	C5	S3r
10	17	C5	18	C5	S3r
11	13	C5	13	C5	S3r
12	21	C4	21	C4	S3r
13	13	C5	13	C5	S3r
14	15	C5	15	C5	S3r
15	24	C4	24	C4	S3r
16	18	C5	18	C5	S3r
17	19	C5	19	C5	S3r
18	9	C6	21	C4	S3r
19	17	C5	22	C4	S3r
20	14	C5	14	C5	S3r
21	19	C5	19	C5	S3r
22	21	C4	21	C4	S3r
23	16	C5	16	C5	S3r
24	32	C4	32	C4	S3r
25	14	C5	14	C5	S3r
26	18	C5	18	C5	S3r
27	21	C4	22	C4	NI
28	11	C5	11	C5	S3r
29	22	C4	21	C4	S3r
30	16	C5	16	C5	S3r
31	14	C5	14	C5	S3r
32	13	C5	13	C5	S3r
33	26	C4	26	C4	S3r
34	24	C4	24	C4	S3r
35	16	C5	17	C5	S3r
36	26	C4	26	C4	NI

ALSE program: C2= good, C4= poor, C5= very poor, C6= non-agriculture. MicroLIES (Cervatana model): S3= moderately, N1= non-agriculture.

3.2.2 The microLEIS (Cervatana model)

Data obtained by the microLEIS (Cervatana model) internet-based program according to De la Rosa *et al*. (2004) is listed in Table (4) and illustrated in Figure (7). The results of this program indicated that the studied soils are suitable and non-agriculture. Most of the studied soil profiles using the microLEIS (Cervatana model) are moderately (S3) but those represented by soil profiles 1, 27 and 36 are non-agriculture (N1). From the above mentioned, it can be concluded that the results of the applied system of land evaluation (ASLE) program are considered very poor (C5). While the microLEIS (Cervatana model) are suitable (S3) in the investigated soil profiles. So, these programs have different predictions for evaluating the soils of the study area point of view of agricultural uses. Major soil limitations of these soils are soil texture and low soil fertility; these soil limitations are nonpermanent and can be improved through applied suited management practices.

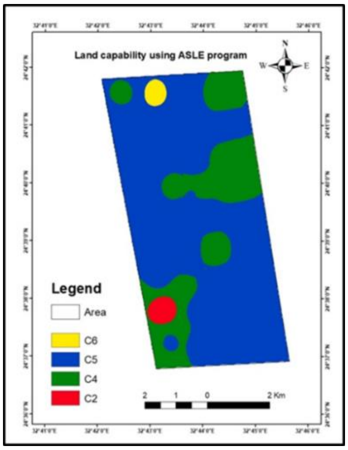

Figure (5): Land capability classes under drip irrigation according to ASLE program.

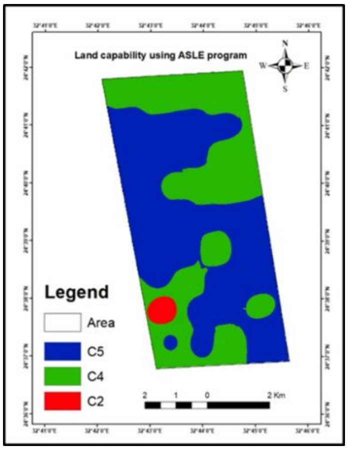

Figure (6): Land capability classes under sprinkler irrigation according to ASLE program.

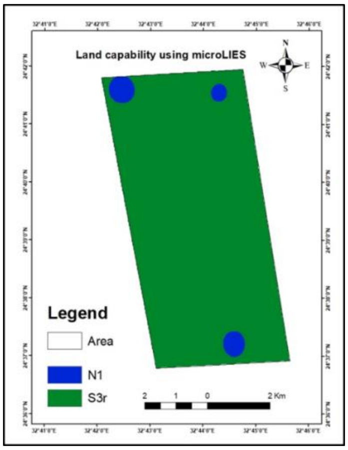

Figure (7): Land capability grades using microLEIS (Cervatana model).

3.3 Land suitability of the studied soils

The current the studied area for land suitability using two programs namely; the applied system of land evaluation (ASLE) program under drip and sprinkler irrigation systems by Ismail and Morsi (2001) and MicroLEIS (Almagra model) by De la Rosa *et al*. (2004).

3.3.1 ASLE program

Data in Table (5) and illustrated in Figure (8) show results of the agricultural soil suitability by using ASLE program under drip and sprinkler irrigation systems for crops; wheat, cotton, sugar beet, maize, soya bean, tomato, cabbage, pepper, onion, alfalfa, date palm, olive, fig and grape. Accordingly, the studied soil profiles have a wide range of suitability namely, highly suitable (S1), suitable (S2), moderately suitable (S3), marginally suitable (S4) and not suitable (currently suitable N1). Most of the investigation soil profiles in the study area under drip and sprinkler irrigation systems are suitable (S2) for these crops. On the other hand, soil profiles 25, 30 and 31 are highly suitable for tomato and date palm. Moreover, soil profiles 32 and 34 are highly suitable for date palm and moderately suitable for soya bean while, Soil profile 33 is highly suitable for date palm and moderately suitable for maize and soya bean. Soil profile 20 is highly suitable for date palm. Soil profiles 2, 3, 4, 5, 11, 17, 18 and 35 are moderately for cotton, maize and soya bean, while soil profiles 6, 7, 8, 9, 14, 15, 16, 21 and 29 are moderately for maize and soya bean, moreover, soil profiles 12 and 23 are moderately for maize, soya bean and tomato.

Table (5): Suitability grade using ASLE under drip irrigation system of the studied soil profiles.

Profile No.	Wheat	Cotton	Sugar- beet	Maize	Soyabean	Tomato	Cabbage	Pepper	Onion	Alfalfa	Date palm	Olive	Fig	Grape
1	S3	S3	S3	NS1	NS1	S2	S3	NS1	NS1	S3	S2	S3	S3	S3
2	S2	S3	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
3	S2	S3	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
4	S2	S3	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
5	S2	S3	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
6	S2	S2	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
7	S2	S2	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
8	S2	S2	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
9	S2	S2	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
10	S2	S2	S2	S2	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
11	S2	S3	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
12	S2	S2	S2	S3	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2
13	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2
14	S2	S2	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
15	S2	S2	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
16	S2	S2	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
17	S2	S3	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
18	S2	S3	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
19	S2	S2	S2	S2	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
20	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S1	S2	S2	S2
21	S2	S2	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
22	S2	S2	S2	S2	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
23	S2	S2	S2	S3	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2
24	S2	S2	S2	S3	NS1	S2	S2	S2	S2	S2	S2	S2	S2	S3
25	S2	S2	S2	S2	S2	S1	S2	S2	S2	S2	S1	S2	S2	S2
26	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2
27	S3	S3	S2	NS1	NS1	S4	NS1	NS1	NS1	S3	S2	S2	S2	NS1
28	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2
29	S2	S2	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
30	S2	S2	S2	S2	S2	S1	S2	S2	S2	S2	S1	S2	S2	S2
31	S2	S2	S2	S2	S2	S1	S2	S2	S2	S2	S1	S2	S2	S2
32	S2	S2	S2	S2	S3	S2	S2	S2	S2	S2	S1	S2	S2	S2
33	S2	S2	S2	S3	S3	S2	S2	S2	S2	S2	S1	S2	S2	S2
34	S2	S2	S2	S2	S3	S2	S2	S2	S2	S2	S1	S2	S2	S2
35	S2	S3	S2	S3	S3	S2	S2	S2	S2	S2	S2	S2	S2	S2
36	S2	S2	S2	NS1	NS1	S2	S4	S4	S4	S3	S2	S2	S2	NS1

S1: highly suitable, S2: suitable, S3: moderately suitable, S4: marginally suitable, N1: currently suitable.

Soil profiles 10, 19 and 22 are moderate for soya bean. Soil profiles 27 are moderately for wheat, cotton and alfalfa, and marginally suitable for tomato and not suitable (currently suitable) for maize, soya bean, pepper, onion and grape. Soil profile 36 is moderately for alfalfa, and marginally suitable for cabbage, pepper and onion and not suitable (currently suitable) for maize, soya bean and grape. Soil profile 24 is moderate for maize and grape and not suitable (currently suitable) for soya bean. Soil profile 1 is moderately for wheat, cotton, sugar beet, cabbage, alfalfa, olive, fig and grape and not suitable (currently suitable) for maize, soya bean, onion and alfalfa. On the other hand, all soil profiles 13, 26 and 28 are suitable for selected crops.

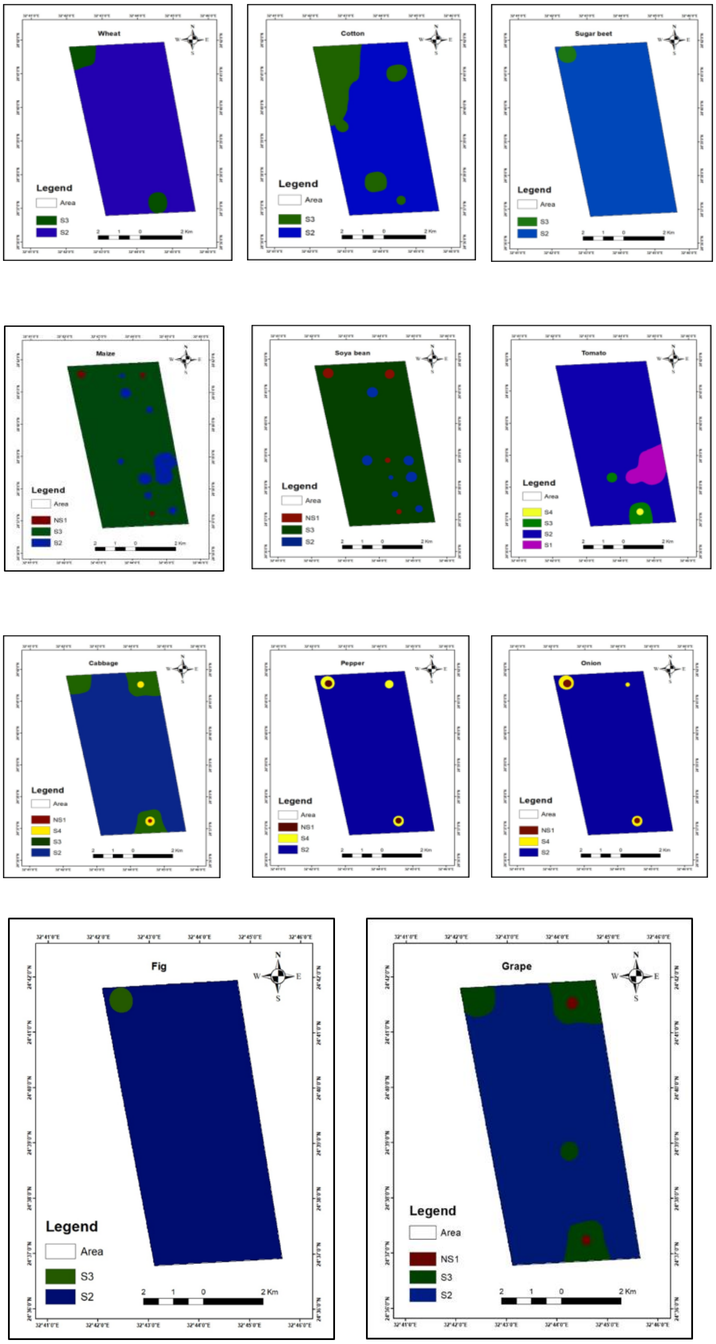

Figure (8): Land suitability maps using ASLE under drip and sprinkler irrigation systems of the study area.

3.3.2 MicroLEIS (Almagra model)

Table (6) and Figure (9) show results of the agricultural soil suitability by using microLEIS (Almagra model). Accordingly, the soil profiles of the study area have a wide range of suitability *i.e.*, moderately suitable (S3), marginally suitable (S4) and not suitable (S5) for the selected crops.

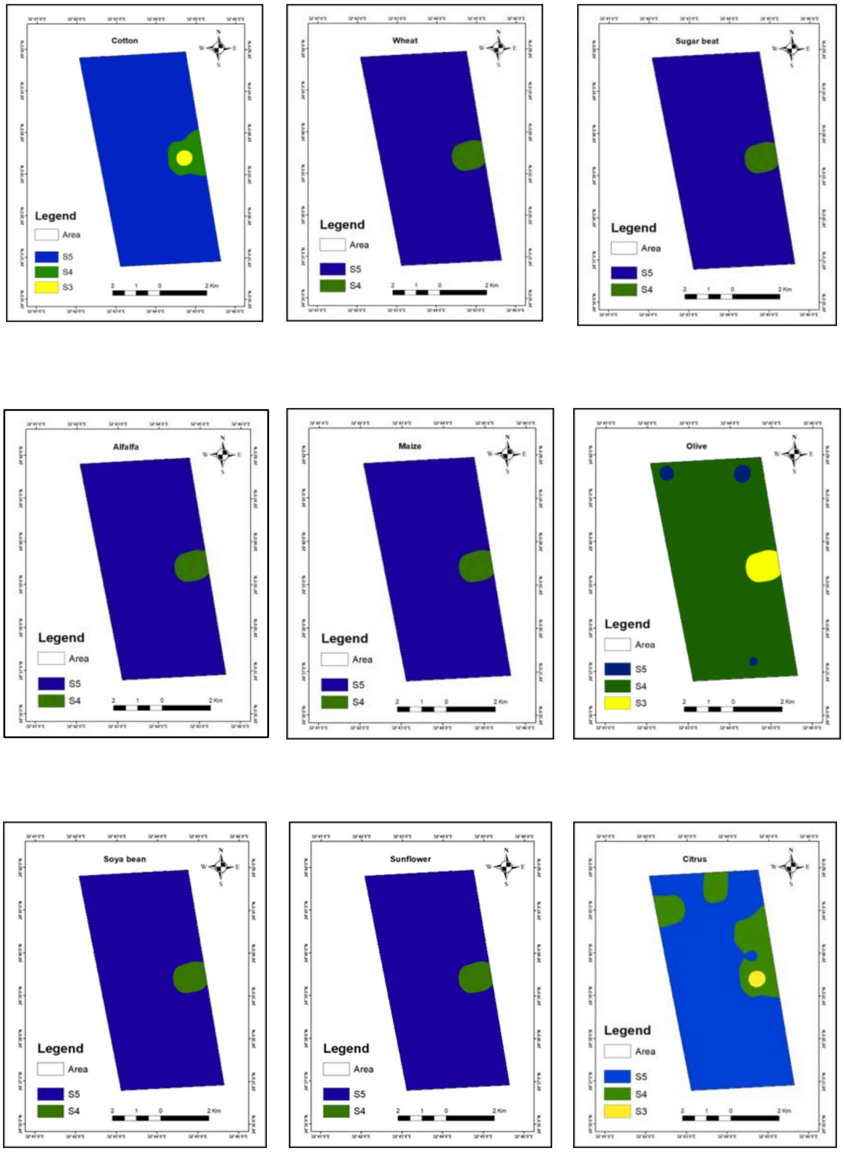

Figure (9): Land suitability class using MicroLIES (Almagra model) program of the study area.

Most of the study area is non-suitable for cotton, wheat, sugar beet, alfalfa, maize, soya bean, sunflower and citrus, are marginally suitable for olive.

Table (6): Suitability class using MicroLIES (Almagra model) program of the studied soil profiles.

Profile No.	Cotton	Wheat	Sugar beat	Alfalfa	Maize	Olive	Soya bean	Sunflower	Citrus
1	S5t	S5ts	S5t	S5t	S5ts	S5s	S5ts	S5ts	S5ts
2	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S4t
3	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
4	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
5	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
6	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
7	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
8	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
9	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
10	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
11	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
12	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
13	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
14	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
15	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
16	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
17	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
18	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
19	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S4t
20	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
21	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
22	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
23	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
24	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
25	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
26	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
27	S5ts	S5ts	S5ts	S5ts	S5tsa	S5s	S5ts	S5ts	S5ts
28	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
29	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
30	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
31	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
32	S3t	S4t	S4t	S4t	S4t	S3tc	S4t	S4t	S3t
33	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
34	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S4t
35	S5t	S5t	S5t	S5t	S5t	S4t	S5t	S5t	S5t
36	S5ts	S5ts	S5ts	S5ts	S5tsa	S5s	S5ts	S5tss	S5ts

S3: moderately suitable, S4: marginally suitable, S5: non-suitable.

On the other hand, soil profile 32 is marginally suitable for wheat, sugar beet, alfalfa, maize, soya bean and sunflower and moderately suitable for cotton, olive and citrus. The soil limitations of these soils are coarse soil texture and very poor nutrient elements.

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