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Land Capability and Suitability Evaluation of Faculty of Agriculture Farm, Sohag, Egypt

Ali R. A. Moursy* and Fatma N. Thabit

Soil and Water Department, Faculty of Agriculture, Sohag University, Sohag, 82524, Egypt

Fourteen soil profiles were collected to represent an area about 40 feddans of faculty of agriculture farm, Sohag University to evaluate land capability and crop suitability of soils. Morphological, physical, chemical, fertility characteristics of examined soils were recognized using standard methods of soil testing. All soil attributes were input in different models of suitability and capability evaluation. The salient findings of this study revealed that, the study area was near to optimal (G1) and good capable (G2) except few sites were very poor (G4). Soil suitability evaluation was done for Wheat, Maize, Alfalfa and Poato crops using parametric and MicroLEIS (ALMAGRA) models. The area under investigation has been generally divided into highly to marginally suitable (S1 and S2 in parametric method and S3 in MicroLEIS-ALMAGRA model) for cultivating these crops except few sites were not suitable (S5 in MicroLEIS model) for this purpose. Soil limitations were observed in the study area such as low organic matter, coarse soil texture, alkalinity, and salinity. Storie index and parametric methods were strongly recommended to be used for land capability and suitability assessment in the investigated area, respectively. These findings are useful for decision makers to be used in better planning and management of agricultural lands.

Keywords: Capability, Suitability, Land evaluation, MicroLEIS-Almagra model, Storie index, Sohag.

1. Introduction

Egypt area is around a million km^2 where about 8.5 million feddans (6% of Egypt area) are arable lands. Moreover, about 5.7 million feddans belong to old soils of Nile valley and delta, while more than 2.5 million feddans are newly reclaimed soils (Mohamed et al., 2019). Unfortunately, Egyptian old agricultural soils are decreasing due to urban sprawl and degradation (Enar et al., 2021). Soil is the medium which provides plants with necessary nutrients needed for growth (El-Ramady et al., 2020). The real treasure for agriculture, human and environment is found in soil. The integrated management of soil is necessary to prevent soil degradation and a decline in crops yield (El-Ghannam et al., 2019). Soil is a complex system with a matrix varied in nature which very hardly to be comprehended (Rossel et al., 2006). The production of food, fibre, and energy depends seriously on the soil, which also sustains and controls life on Earth. Soil controls water flow, filter metals and nutrients from the environment, and potentially store carbon to reduce global warming (Tesfahunegn, 2014; El-Ramady et al., 2019; Abuzaid et al., 2021). Soil quality is influenced by its structure, composition, physico-chemical properties, and biological characteristics. (Bünemann et al., 2018). The identification of soil attributes is necessary for optimizing productivity (Hicks et al., 2015); environmental management (Lin et al., 2006); and precision farming (Angela et al., 2012); soil quality

*Corresponding author e-mail: ali.refaat@agr.sohag.edu.eg
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(Elbasiouny et al., 2017) under the climate change conditions. Recently, many studies targeted soil and crops quality to understand the soil productivity limitations such as pollution, degradation, desertification and urban sprawl on the fertile soils (Saeed and Bedair, 2021). Furthermore, the continuous climatic changes causing a change in the conditions of agricultural production in those areas, it was necessary to discuss the issue of continuous agricultural land evaluation. Globally, about 50% of the cultivated lands are moderately and highly degraded, whereas global crop yield decreased by about 13%. Salinization and poor management policies of irrigation are main reasons for losing over 1.5 million ha annually (Mohamed et al., 2013). Especially at the present time, good planning is mandatory to achieve the optimal utilization of all environmental resources. Decision-makers must have a sufficient knowledge about land evaluation used techniques whereas many factors should be included in the applied criteria. Land evaluation is considered as a tool for systematic and strategic land-use planning for a specific purpose. Evaluation of land is an interpretation of the soil attributes, cropping cover, climatic conditions and other data layers related to the specific purpose of land-use to characterize and diagnose the optimal land-use among these alternatives (Sayed, 2006). Elnaggar (2017) defined land suitability as how the land is fitted with the requirements of a specific target of the land-use either in actual land-use or after improvement as estimated potential suitability. Moreover, it is a matching between land attributes and crop requirements to estimate land quality for a specific land use (Mustafa et al. 2011). Not only soil attributes are used, but also climate data as well as socio-economic factors should be included in the criteria of land evaluation (Atoyebi et al., 2017). According to Abdellatif et al. (2020), agricultural land evaluation includes two major types (capability and suitability evaluation). Land capability and suitability evaluation are done using traditional or program methods. Storie index as well as Sys and Verhye index are used as manual conventional methods of land capability evaluation (Sayed et al., 2016). On the other hand, land capability and suitability evaluation can be automatically done by the use of different models such as agricultural land evaluation system (ALES), and MicroLEIS (Yousif, 2019). Land capability and suitability classification mean dividing a piece of land to different classes of capability and suitability. These classes can be subdivided into sub-classes based on limitations or conservation required (Moursy et al., 2020). Manikandan et al. (2013) explained that these subclasses present limitations of the land under evaluation (such as erosion hazards, stones, shallowness, salinity, low fertility, excess water, and climatic limitations). El-Sayed et al. (2020) Studied the soils of Wadi Tag El-Wabar, West of Sohag area and they found that these soils are good (G2), Fair (G3), poor (G4) and non-agricultural (G5) that represents 4.13, 30.07, 34.92 and 30.88%, respectively, of total area for the agricultural use by applying modified storie index rating (O’Geen et al., 2008). As described by Sys and Verhye (1975), land capability could be includes in four classes (excellent, good, moderate, and not capable). There are many studies were carried out regarding agricultural land evaluation either for capability or suitability evaluation in Egypt. For Example in El-Dakhla Oasis, Ibrahim et al. (2013) assessed the capability and suitability of different 16 crops in their investigated area. A part of this area was having a good capability while other parts were under fair capability condition. They also found that the study area was moderately suitable for cultivating Alfalfa, Olive, Mango, groundnut, potato, wheat, and Sorghum while highly suitable for Barley. Abosafia et al. (2022) utilized the ASLE model to evaluate the land capability and soil suitability of Kafr El-Sheikh soils. Their results indicated that, the land varied between very poor and fair capability. They also found that the land was under the S1 class for wheat, barley and date palm, S2 for growing Maize, and not suitable for Onion and Citrus. Fayed (2003) applied the capability index for assessing the soil in a part of West Nile Delta (El-Bostan region), and classified it to moderate and marginal capability classes. They pointed out that, the main factors that limit soil capability in the studied soils were soil texture, $CaCO_3$, salinity, as well as ESP. Abd El-Khalek (2004) applied the soil capability index to Wadi El-Rayan soils and matched between the soil properties and rating of Storie index, he found that a half of investigated lands were non-agricultural, while the other half is varied between poor and excellent soils. Some soils of Wadi El-Natrun area was evaluated using procedure of FAO framework by Abd Al-Hamid et al. (2010), they pointed out that the study area was classified for capability to be under three classes (moderately suitable, whereas topography, soil texture and salinity were the limiting factors;

temporary not suitable and permanently not suitable). They also estimated the potential capability of the land and their finding revealed that the limitations could be removed by enhancing some soil properties and the land could be cultivated with five main crops (wheat, barley, grapes, alfalfa and fodder beet). Mahmoud et al. (2009) used agricultural land evaluation system (ALES) for evaluating land capability in some Egyptian soils and found that the capability of the area ranged between high and moderate capability classes. After enhancement of soil parameters, soil could be moderately suitable for cultivating maize, olive, figs, wheat, sorghum and barley. Land capability and soil suitability of Tushka area using ASLE and modified Storie index programs were achieved by Abd El-Aziz (2018).The results revealed that the capability of soils according to ASLE program was good (C2) and fair suitable (C3). Furthermore, these soils are good, fair and poor by using modified Storie index. Most of the selected crops were found to be the best in soils of the S2 and S3 suitability classes by ASLE program. Moursy et al. (2020) evaluated land capability and suitability of an eastern desert part of Sohag using traditional and automated methods. Based on Storie index, they could classify the capability of the soils in the investigated area which varied between poor to fair capability. By using Sys and Verheye index, the capability of the studied site ranged from very poor to fair. The ALSE model was used for suitability classification in the same site, whereas soils ranged from N1 to S2 for cultivating, mango, olives, tomato, alfalfa, maize, and wheat. Using the parametric method of suitability assessment, area varied between S3 and S2 for the evaluated crops. They also pointed out that some soil properties such as soil texture, salinity, and soil organic matter were the major limitations.

This study aimed to (i) evaluate land capability of faculty of Agriculture farm, Sohag University; and (ii) evaluate and classify the land suitability for different crops.

2. Experimental

2.1. Study area

The studied area represents a part with an area about 40 feddans of the newly reclaimed farm of Agriculture Faculty, University of Sohag, El-Kawamel region, Sohag, Egypt. It lies between 26° 28'17.76" to 26° 27'54.75" N and 31° 40'13.11" to 31°40'24.28" E, in the western part of Sohag Governorate (Figure 1). This area is characterized by dry climate along the year. The temperature varies from 8°C to 39°C and rarely be below 5°C or above 43°C. There is non-significant seasonal variation in the rainfall frequency. The average of wind speeds is about 8.5 k knots with a maximum of 10.0 k knots. The climatic condition of 2021 year of the study area is demonstrated in Table 1 and Figure 2. As mentioned in Thabit (2012), in 2000, the reclamation processes in the study area started by sprinkler and drip irrigation systems establishing and amending the soil by addition about 30 cm of dredged clay materials obtained from the irrigation canals to the soil surface for improving of soil physical properties and the availability of the essential nutrients for plant growth. Then the cultivation and agricultural practices were continued in the study area to present. Wheat and alfalfa are annually cultivated in the major of the study area with application of organic amendments (farmyard manure) and mineral fertilization; the other part of the study area was cultivated with grape. The irrigation water source in the farm depends on the near canal (Nile water) with water salinity not exceeding 0.5 dS m^{-1} over the year.

2.2. Soil sampling

In 2021, 14 soil profiles were chosen to represent the study area as shown in figure 1. Profiles No 1, 2, 3, 5, 6, 7, 12 and 13 were collected from areas under sprinkler irrigation and cultivated with wheat, while the profiles No 8, 9 and 11 were sampled from areas cultivated with alfalfa and irrigated with sprinkler irrigation also. Furthermore, the profile No 10 was sampled from a grape-growing area with drip irrigation, however the profiles No 4 and 14 were sampled from uncultivated area to illustrate the status of study area's soil prior the reclamation steps and cultivation. GPS "Garmin–eTrix" used to define the geo-coordinates of each soil profile under the WGS84 coordinate system. Atotal number of 56 different soil samples were carefully collected from the fourteen selected soil profiles at four depths (0-25, 25-50, 50-75 and 75-100cm). The pedo-morphological description of all collected soil profiles was recorded *in situ* as described by FAO (2006). The studied soil profiles were previously used in Moursy and Thabit (2022) in order to characterizing and assessing land productivity of the study area. To complete the plan of land evaluation, this study was carried out to estimate the capability and suitability of this area.

2.3. Soil analysis

The collected soil samples were prepared to be analyzed whereas air-dried, crushed, and 2mm sieved. After that soil were analyzed against their physical and chemical properties. Soil texture was determined using the international pipette method (Gavlak et al., 2005). Soil reaction (pH) was measured in 1:1 suspension (soil:water) as described by (Jackson, 1973). Electrical conductivity (EC_e) was determined in soil paste extract using Beckman Conductivity Bridage at 25°C according to Bashour and Sayegh (2007). Total calcium carbonate ($CaCO_3$) was estimated using Scheibler's calcimeter (Nelson, 1982). Gypsum content was determined in the soil samples using the precipitation with acetone according to Nelson (1982) and Hesse (1998). Walkely and Black method was used for determining soil organic matter content, which the dichromate oxidation was applied as described by (Bashour and Sayegh, 2007). Soil cation exchange capacity (CEC) was estimated using sodium acetate pH=8.5 as a saturation solution and ammonium acetate (pH=7.0) as a replacement solution as described in Bashour and Sayegh (2007). The ESP was calculated as a ratio of exchangeable sodium to the CEC of soil. Total nitrogen was measured using the micro-kjeldahl method (Jackson, 1973). The 0.5M $NaHCO_3$ (pH=8.5) solution was used to extract the soil available Phosphorus (Olsen et al., 1954) and measured colorimetrically using chloro stannous phosphomolibdic acid method and Spectrophotometer.

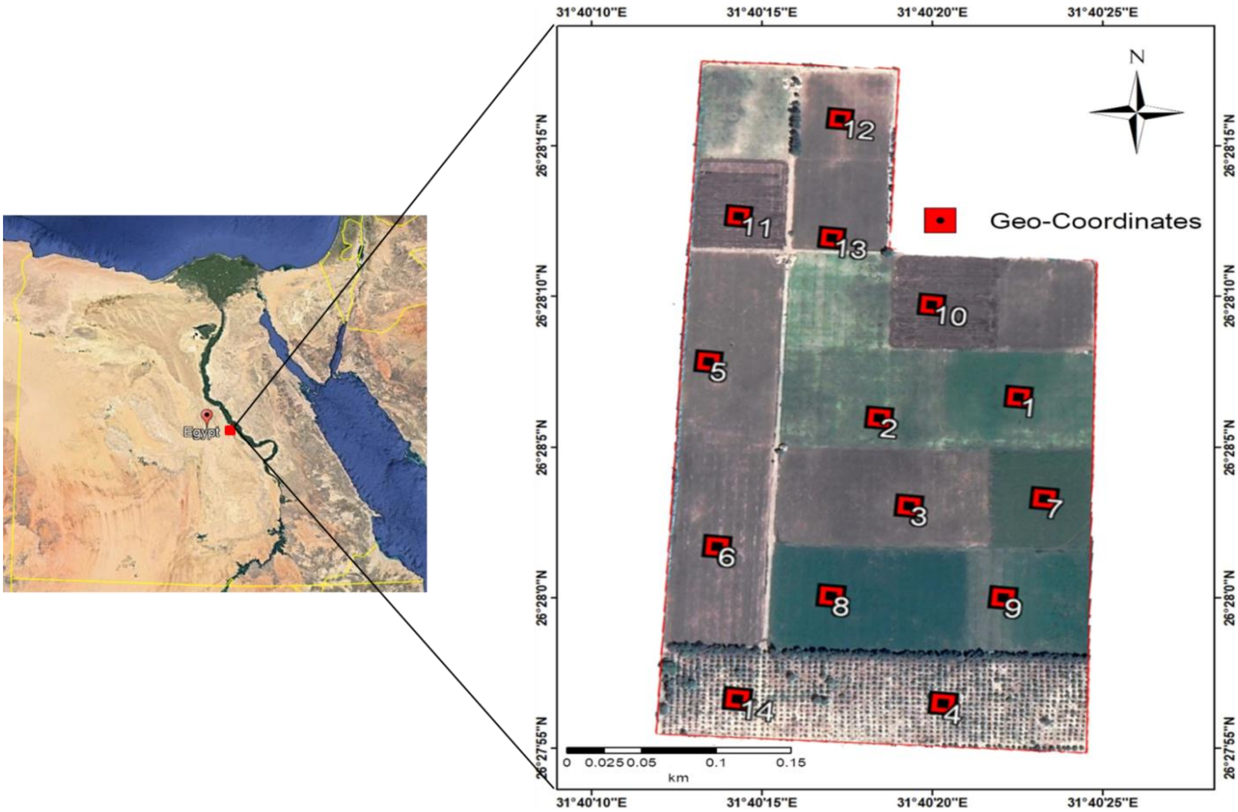

Fig. 1. The location map and soil profiles distribution of the investigated area.

Table 1. The average climatic data of the study area in 2021 (https://weatherspark.com/).

Average	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Temperature	14.0	16.0	20.0	25.0	30.0	32.0	33.0	32.0	30.0	26.0	20.0	16.0
Wind Speed	7.0	7.4	8.0	8.4	9.1	10.0	9.5	9.4	9.3	8.0	7.2	7.0
Precipitation	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0

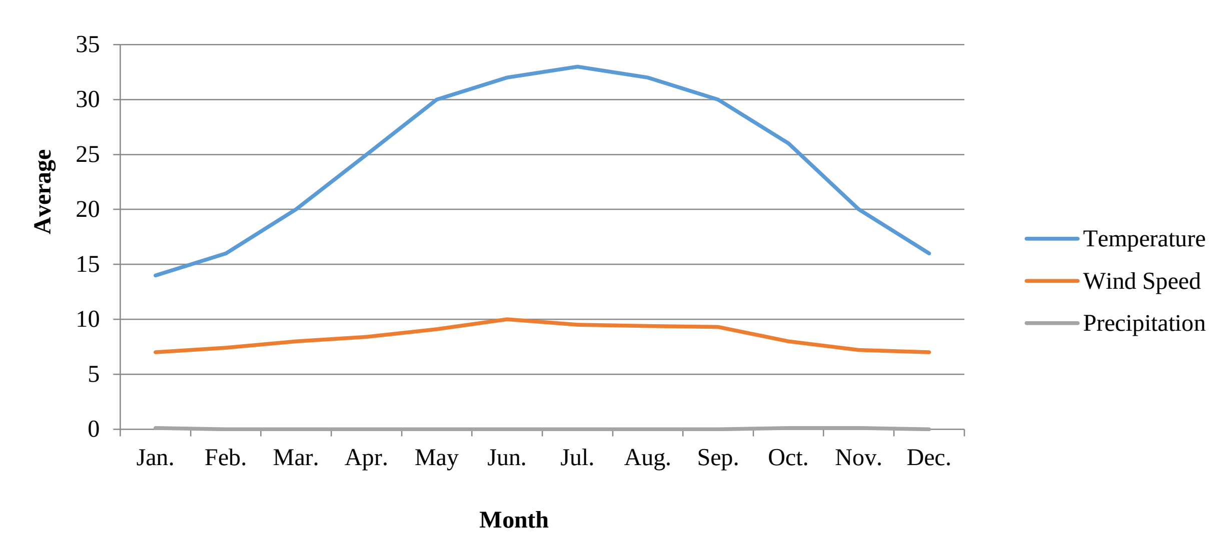

Fig. 2. The average values of climatic conditions of the study area in 2021.

Soil available Potassium was extracted with ammonium acetate (pH=7.0) (Carson, 1980) and determined using flamephotometer. Soil available micronutrients (iron, manganese, zinc, and copper) were extracted using DTPA solution (Lindsay and Norvell, 1978), and then measured using atomic absorption spectrophotometer. SPAW software package was utilized for estimating soil bulk density as well as soil-water parameters (Saxton and Rawls 2006).

The result data of each soil profile were presented in the weighted mean form. The weighted mean value for each soil parameter (V) of the soil profile was estimated as expressed in Equation 1.

$$V = \sum_{i=1}^{n} \frac{(vi \times ti)}{T} \qquad \text{(Eq. 1)}$$

Where, (vi) is value of each soil parameter; (ti) is the thickness of each horizon; and (T) is the soil profile depth.

2.4. Land capability evaluation

(i) **Storie Index**

It is expressed in equation (2), based on different soil factors which as soil profile development ‘A’; surface soil texture ‘B’; various land factors ‘C’ such as slope, drainage, and alkalinity; and factor ‘X’ which include other related soil parameters (e.g. nutrients, salinity, erosion, and micro-relief) according to Storie (1954). For calculating this index, each soil factor was scored in (%) form, multiplied as in a decimal from, and then the final capability index was expressed as (%) form. Based on the final index, Storie classified the capability of land into six grades as given in table 2 (Sys and Verheye 1975).

(ii) **Sys and Verheye Index**

Soil capability index (Ci) is written as equation (3) depends on 9 soil parameters which affect crop yield. These parameters are such as texture ‘A’; $CaCO_3$ content ‘B’; gypsum content ‘C’; EC_e ‘D’; Na saturation ‘E’; drainage ‘F’; soil profile depth ‘G’; weathering stage ‘H’; and soil profile development ‘I’. Similarly to Storie Index, each soil factor was scored in a percentage form, multiplied as in a decimal from and then the final capability index expressed as (%) form. Based on the Ci index, land capability was classified into five grades with corresponding limitations (Table 2).

2.5. Land suitability evaluation and classification

(i) The parametric method

This method depend on considering climatic data; soil morphological characteristics (erosion level, slope, drainage, and soil profile depth); soil physical characteristics (soil texture and Stoniness); and chemical characteristics (calcium carbonate, nutrients, soil CEC, base saturation, soil organic matter, gypsum content, soil EC_e, pH and ESP) according to Sys et al. (1991). Table 2 demonstrated the different suitability classes and corresponding limitations of soils.

(ii) **MicroLEIS (Almagra) model**

The studied soils were evaluated using MicroLEIS (De la Rosa et al., 2004), Internet-based program. Almagra model for agricultural soil suitability. Table 2 showed the suitability classes as well as their limitations. Figure 3 illustrated the utilized methodology of land suitability evaluation for different crops.

3. Results and discussion

3.1. Soil characterization

Morphologically, soil profiles of the study area were more than one meter depth and the elevation of the studied site was around 70 m.a.s.l. The studied site was almost levelled where the slope was not exceeding 1%, and all studied soil profiles were well-drained. Table 3 shows the weighted mean of soil physico-chemical characteristics as well as fertility status and soil-water characteristics of all studied soil profiles. The obtained data showed that soils were having coarse texture of sand, loamy sand and moderately coarse texture of sandy loam according to Sys (1979). The soil profiles No. (1, 2, 3, 5, and 7) were sandy-loam (SL); while loamy-sand (LS) texture grade was recorded for profiles (6, 8, 9, 10, 11, 12, and 13) and sand (S) texture was in profiles (4 and 14). Soil bulk density was 1.44 Mg m^{-3} as an average, and available water, field capacity, and wilting point water contents were found to be very low. According to chemical properties, soils were ranged from slightly-alkaline to moderately alkaline (Cooke, 1967) and varied between slightly-saline and moderately-saline, according to (Richards, 1954). The soil content of organic matter was low whereas ranged from 0.27 to 0.92% which referred to low CEC and soil fertility. The total calcium carbonate and gypsum content averages were 7.28 and 4.79%, respectively. The soil cation exchange capacity was low which ranged between 4.70 and 15.70 $cmol^{+}$ kg^{-1}. The soil base saturation was above 75%, while the exchangeable sodium percentage was low (below 15) in all soil profiles except profile No. 14, whereas ESP value was 16.23 %. In regard to the weighted mean of nutrients in soil profiles, Total N was low, available P and K ranged from low to moderate. The available Fe, Mn, Zn and Cu in all studied soil profiles ranged from deficient to adequate for crop production.

3.2. Land capability evaluation

(i) Storie Index

Storie index obtained results for the evaluation of land capability were showed in Table 4. The studied soils were classified into three grades G2, G3 and G4. The soils of profiles (1, 2, 3, 5 and 7) were under grade 2 (G2np) whereas the capability index value was 61.37%. These soils are suitable for the majority of crops, and give good to excellent yields with minor limitations (low nutrients 'n' and alkalinity 'p'). Soil profiles (6, 8, 9, 10, 11, 12, and 13) were under grade 3 (G3tn) with a value of 51.68% for the capability score; whereas these soil quality can be categorized to be fairly good with few limitations (coarse soil texture 't' and low nutrient content 'n'). Regarding profiles 4 and 14, soils were under G4 grade (capability index = 38.76%) which having a narrow range for their agricultural possibilities, whereas these soils may perform well for some crops and unsuitable for other kinds of crops. The G4 soils (G4tnp) were having limitations of coarse soil texture 't', alkalinity 'p' and low nutrient content 'n'.

(ii) Sys and Verheye Index

The obtained data of assessing the land capability using Sys and Verheye index was presented in Table 5. The evaluated soils were categorized into three grades (G1, G2 and G4) whereas considered as near to optimal, moderate and very poor for capability. Soil profiles (1, 2, 3, 5 and 7) are under grade 1 (capability index = 76.71% and 72.88%); whereas near to optimal capability with no or very slight limitations affect productivity for not more than 20%. Soil profiles (6, 8, 9, 10, 11, 12 and 13) are under grade 2 (G2ac) with 57.37% capability index, whereas soils having moderate quality and moderate limitations (coarse soil texture 'a' and calcium carbonates 'c') which affect crop production, with continuous economic yield and benefits. Very poor soil quality (grade 4; G4ace; capability score = 29.07% and 25.65%) was obtained for soil profiles (4 and 14). These soil profiles (4 and 14) have severe limitations such as coarse soil texture 'a', calcium carbonates 'c' and salinity 'e', which mean that the soil is unsuitable for any land uses.

Table 2. Land capability and suitability evaluation methods.

Grade	Land quality	Soil rating (%)	Limitations	Description
		Land Capability evaluation		
		Storie Index (Storie, 1954); $I = A \times B \times C \times X$ (Eq. 2)		
1	Excellent	>80 to 100	---	Suitable for almost all kinds of crops.
2	Good	>60 to 79	---	Suitable for the majority of crops with good to excellent yields.
3	Fairly good	>40 to 59	---	Fair quality, less wide suitability range and give reasonable yields with
4	Poor	>20 to 39	---	Probably give good yield in some crops and not-suitable for other kinds of
5	Very poor	>10 to 19	---	Marginally utilized except for grazing purposes.
6	Non-agricultural	Less than 10	---	Not-suitable for all land uses.
		Sys and Verheye Index (Sys and Verheye 1975); $Ci = A \times B \times C \times D \times E \times F \times G \times H \times I$ (Eq. 3)		
0	Optimal	More than 80	No	Suitable for whole agricultural activities.
1	Near to optimal	60 to 80	Slight	Productivity is affected (not more than 20%).
2	Moderate	45 to 60	Moderate	Crop yield is influenced but may remain economical.
3	Poor	30 to 45	Severe	Reduction in the yield and inhibit soil utilization.
4	Very poor	Less than 30	Very severe	Not-suitable for all land uses.
		Evaluation of land suitability		
		Parametric method (Sys et al., 1991)		
S1	Highly-suitable	More than or equal 85	No	---
S2	Moderately-suitable	≥ 60 & < 85	Slight	---
S3	Marginally-suitable	≥ 40 & < 60	moderate	---
N	Not-suitable	<40	Severe	---
		MicroLEIS -almagra model (De la Rosa et al., 2004)		
S1	Highly-suitable	---	No	---
S2	Suitable	---	Slight	---
S3	Moderately-suitable	---	Moderate	---
S4	Marginally-suitable	---	Severe	---
S5	Not-suitable	---	Very severe	---

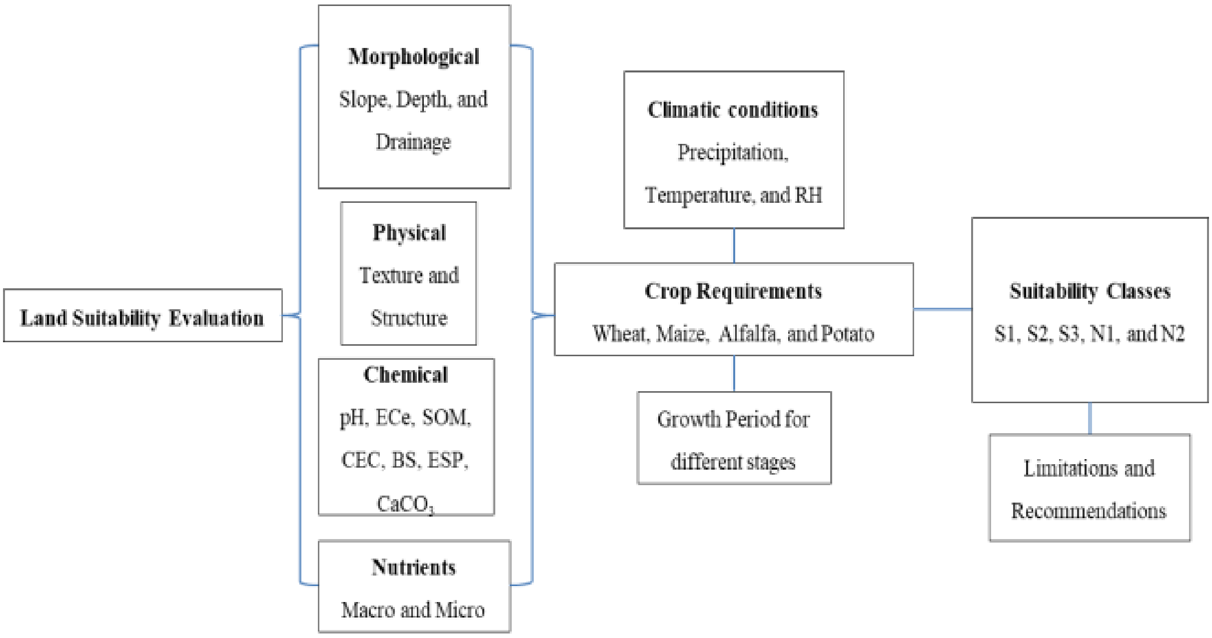

Fig. 3. The methodology of evaluating land suitability for different crops by MicroLEIS model.

3.3. Land suitability evaluation

Land suitability evaluation was applied for various crops such as potato, alfalfa, wheat, and maize. Table 6 showed the obtained data of land suitability evaluation used methods (parametric method and microLEIS-almagra model). The findings gained from parametric method revealed that all studied soil profiles were classified as moderately-suitable (S2) for all investigated crops (Sys et al., 1993). The suitability index ranged from 65 to 84.55%, whereas soil profiles (4 and 14) were having the lowest values. Crop-wisely, all soil profiles were moderately suitable for cultivating maize with S2ot and S2at sub-class and the main limitations in the studied soil profiles are organic matter ‘o’, alkalinity ‘a’ and texture ‘t’. Concerning Wheat crop, similar results are recorded for soil profiles, whereas two suitability sub-classes (S2ot and S2oat) were presented. Soil profiles (1, 2, 3, 5, 6, 7, 8, 9 and 11) were highly suitable for cultivating Alfalfa (suitability score is above 80%). Meanwhile soil profiles (4, 10, 12, 13 and 14) were moderately suitable for Alfalfa cultivation in the study area whereas three sub-classes (S2oc, S2ot and S2oat) were obtained from the classification. Four main limitations viz organic matter ‘o’, calcium carbonates ‘c’, alkalinity ‘a’ and texture ‘t’ were in the studied soils. Potatoes can be cultivated in the study area where soils are moderately suitable (S2ot, S2oc, S2pc and S2otsp). Soil limitations are organic matter ‘o’, calcium carbonates ‘c’, alkalinity ‘a’, texture ‘t’, salinity ‘s’ and alkalinity ‘p’. In regard to the obtained results of the MicroLEIS model (Table 7), all soil profiles are found to be moderate suitable (S3t) for all crops (potato, alfalfa, wheat, and maize), except soil profiles No. 4 and 14 which not suitable (S5a). Soil limitations of the investigated site are soil texture ‘t’ and alkalinity ‘a’.

3.4. Comparison between used methods of evaluation

Storie as well as Sys and Verhye methods were utilized for land capability evaluation in the farm of faculty of Agriculture, Sohag University. In Storie index outputs, three categories of capability were obtained whereas some soil profiles were having good capability, while other soil profiles were varied between fair and poor capability. On the other hand, Sys and Verhye index’s results showed better performance of these lands in their capability. However, soils ranged between very poor and near to optimal capable. In this situation, it is better to select the minimum results of capability which belonged to Storie index because the main goal of the land management is to enhance the capability.

To improve the capability of these soils, some technical practices should be applied against the limitations appeared in the evaluation. Coarse soil texture, low nutrients’ content, calcium carbonates’ content, salinity and soil alkalinity are considered as the most limiting factors in the investigated area. Therefore, leaching the soil with low EC water is preferable, and the application more amounts of organic matter, dredged clay materials and soil conditioners are strongly recommended in these soils to enhance their capability.

Table 3. Some soil characterization and the weighted mean (W) of soil physico-chemical properties of the studied soil profiles.

Soil parameter	Soil profile No.													
	P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**P12**	**P13**	**P14**
Latitudes (N)	26°.4683	26°.4681	26°.4673	26°.4656	26°.4687	26°.4670	26°.4674	26°.4665	26°.4665	26°.4692	26°.4701	26°.4710	26°.4698	26°.4656
Longitudes (E)	31°.6729	31°.6718	31°.6721	31°.6723	31°.6704	31°.6705	31°.6731	31°.6714	31°.6728	31°.6722	31°.6706	31°.6715	31°.6714	31°.6707
Soil profile depth (cm)	100^+	100^+	100^+	100^+	100^+	100^+	100^+	100^+	100^+	100^+	100^+	100^+	100^+	100^+
Elevation (m.a.s.l)	69.5	69.4	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.4	69.5	69.5	69.4	69.5
Slope (%)	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
Drainage	Well	Well	Well	Well	Well	Well	Well	Well	Well	Well	Well	Well	Well	Well
Sand (%)	68.98	75.93	74.86	90.82	78.54	78.29	72.63	84.51	82.48	78.84	85.73	81.02	86.86	92.31
Silt (%)	21.22	14.79	15.79	4.86	12.50	15.15	16.23	7.85	9.05	12.39	8.50	10.93	6.36	3.54
Clay (%)	9.80	9.28	9.36	4.33	8.96	6.56	11.14	7.64	8.47	8.77	5.77	8.05	6.78	4.16
Texture grade	SL	SL	SL	S	SL	LS	SL	LS	LS	LS	LS	LS	LS	S
D_b (Mg m^{-3})	1.46	1.45	1.46	1.41	1.57	1.56	1.58	1.56	1.56	1.57	1.54	1.56	1.55	1.52
Wilting point (v/v %)	8.10	7.40	7.40	4.40	5.60	4.40	7.20	5.20	5.30	5.90	4.00	5.30	4.50	2.80
Field capacity (v/v %)	17.00	15.00	15.20	9.30	11.80	10.90	14.20	10.00	10.60	11.80	8.60	10.80	8.60	6.30
Available water (v/v %)	9.00	8.20	8.10	5.00	6.20	6.10	7.10	4.80	5.30	5.90	4.60	5.50	4.10	3.50
pH (1:1)	8.15	8.11	8.09	8.37	8.19	8.07	8.21	8.13	8.06	8.27	8.19	8.23	8.25	8.22
EC_e (dS m^{-1})	1.53	1.62	1.74	4.76	1.56	1.51	1.42	1.66	1.16	1.88	1.63	1.25	1.32	7.00
SOM (%)	0.81	0.60	0.51	0.34	0.70	0.52	0.67	0.92	0.75	0.65	0.72	0.55	0.70	0.27
$CaCO_3$ (%)	4.96	6.45	7.19	10.16	7.03	5.51	6.99	7.25	7.09	7.71	6.40	8.00	6.15	11.05
Gypsum (%)	2.70	4.50	3.20	4.60	5.50	4.50	6.80	3.40	4.00	7.40	5.10	3.70	4.90	6.80
CEC $cmol^+ kg^{-1}$	15.70	12.43	13.67	5.50	11.23	12.43	14.58	9.00	11.07	11.24	8.89	9.49	8.26	4.70
Base saturation (%)	>75	>75	>75	>75	>75	>75	>75	>75	>75	>75	>75	>75	>75	>75
ESP	4.99	6.44	6.84	13.09	7.39	5.98	4.73	7.98	6.50	10.66	9.67	5.72	8.14	16.23
Total N (mg Kg^{-1})	437.50	393.75	332.50	183.75	428.75	315.00	385.00	533.75	406.88	341.25	310.63	328.13	411.25	161.88
Available P (mg Kg^{-1})	6.13	4.82	7.10	3.21	7.53	8.12	5.63	6.56	7.16	5.14	4.96	6.02	7.10	3.45
Available K (mg Kg^{-1})	195.05	157.98	175.68	136.68	167.68	156.75	182.28	163.28	146.30	183.55	150.55	175.05	166.18	127.05
DTPA- ex. Fe (mg Kg^{-1})	12.12	6.89	10.38	5.03	7.62	8.55	11.36	9.85	9.68	10.10	8.21	7.10	8.38	3.95
DTPA- ex. Mn (mg Kg^{-1})	5.60	5.29	6.78	1.63	4.35	5.84	9.13	8.12	5.93	6.35	5.76	6.22	4.98	1.52
DTPA- ex. Zn (mg Kg^{-1})	1.02	0.95	1.05	0.57	0.69	0.88	1.80	1.18	1.32	1.64	0.82	0.84	0.79	0.40
DTPA- ex. Cu (mg Kg^{-1})	2.62	2.09	2.08	1.07	2.24	2.19	4.18	3.48	2.76	5.40	2.20	2.36	3.36	0.81

Table 4. Land capability evaluation using the Storie index.

Soil parameter	Factor	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14
Soil profile development	**A**	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Texture	**B**	95	95	95	60	95	80	95	80	80	80	80	80	80	60
Slope (%)	**C and X**	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Drainage		100	100	100	100	100	100	100	100	100	100	100	100	100	100
Nutrients status		80	80	80	80	80	80	80	80	80	80	80	80	80	80
Alkali status		95	95	95	95	95	95	95	95	95	95	95	95	95	95
pH-level		85	85	85	85	85	85	85	85	85	85	85	85	85	85
Erosion		100	100	100	100	100	100	100	100	100	100	100	100	100	100
Micro-relief		100	100	100	100	100	100	100	100	100	100	100	100	100	100
Storie Index score (%)		61.37	61.37	61.37	38.76	61.37	51.68	61.37	51.68	51.68	51.68	51.68	51.68	51.68	38.76
Land capability Grade		G2np	G2np	G2np	G4tnp	G2np	G3tn	G2np	G3tn	G3tn	G3tn	G3tn	G3tn	G3tn	G4tnp

G2: good capability class; G3: fair; G4: poor; n: nutrients; p: pH-level; t: soil texture.

Table 5. Land capability evaluation using Sys and Verheye index.

Soil parameter	Soil profile No													
	P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**P12**	**P13**	**P14**
Soil Texture (A)	85	85	85	60	85	75	85	75	75	75	75	75	75	60
Soil Depth (B)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Calcium Carbonates (C)	95	95	95	60	95	85	95	85	85	85	85	85	85	60
Gypsum (D)	100	95	95	95	95	95	95	95	95	95	95	95	95	95
Alkalinity and Salinity level (E)	95	95	95	85	95	90	95	90	90	90	90	90	90	75
Drainage (F)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Slope (G)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Land Capability index score	76.71	72.88	72.88	29.07	72.88	57.37	72.88	54.51	54.51	54.51	54.51	54.51	54.51	25.65
Capability class	G1	G1	G1	G4ace	G1	G2ac	G1	G2ac	G2ac	G2ac	G2ac	G2ac	G2ac	G4ace

G1: near to optimal; G2: moderate; G3: poor; G4: very poor; a: soil texture; c: calcium carbonates; e: alkalinity and salinity.

Table 6. Land suitability evaluation using the parametric method.

Crop suitability	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14
Wheat	84.55	84.55	84.55	77.27	84.55	84.55	82.73	84.55	84.55	82.73	84.55	82.73	82.73	75.45
	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2oat
Maize	80.00	78.18	78.18	72.73	78.18	80.00	76.36	78.18	78.18	74.55	76.36	76.36	74.55	67.27
	S2ot	S2ot	S2ot	S2at	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2ot	S2at
Potato	80.45	80.45	80.45	71.82	80.45	78.64	79.09	78.64	78.64	76.36	78.64	77.27	77.27	70.00
	S2oc	S2oc	S2oc	S2to	S2oc	S2oc	S2pc	S2ot	S2ot	S2pc	S2ot	S2oc	S2oc	S2tosp
Alfalfa	84.09	83.18	83.18	75.91	83.18	82.27	81.36	81.36	81.36	78.64	80.45	79.55	79.09	73.64
	S1	S1	S1	S2ot	S1	S1	S1	S1	S1	S2oc	S1	S2oc	S2oc	S2oat

S2: moderately suitable; o: organic matter; t: texture; a: ESP; s: salinity; p: pH.

Table 7. Land suitability evaluation using MicroLEIS-Almagra model application.

Crop suitability	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14
Wheat	S3t	S3t	S3t	S5a	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S5a
Maize	S3t	S3t	S3t	S5a	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S5a
Potato	S3t	S3t	S3t	S5a	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S5a
Alfalfa	S3t	S3t	S3t	S5a	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S3t	S5a

S3: moderately suitable; S5: not suitable; t: soil texture; a: alkalinity and salinity.

According to land suitability evaluation, two methods were used viz parametric method of Sys et al. (1993) and MicroLEIS model as a web-tool. In both of the used method, similar categories of soil suitability for cultivating various crops were obtained. In parametric method, all studied soil profiles gave the same performance as moderately suitable for all investigated crops. There were some limitations in the study area's soils such as soil pH, EC, texture and organic matter content. By using MicroLEIS model of suitability evaluation, similar grade of land suitability (moderately suitable) was recorded for all soil profiles except profiles No. 4 and 14 whereas categorized to be as not suitable for cultivating all examined crops in the study area. However, same soil limitations were observed from the MicroLEIS obtained results. The main difference between two used models of suitability is that, the parametric method is considered as a quantitative method whereas suitability index is calculated as a percentage of land suitability for each crop. This certainly helps in land management regarding enhancing the suitability. Vice-versa situation in MicroLEIS tool of evaluation, whereas qualitative description only can be obtained but the ease of use still the main advantage.

4. CONCLUSION

The study area was described as levelled, deep, well-drained, slightly saline and alkaline except few sites. Soil content of organic matter, available macro and micro nutrients varied between low and moderate, while cation exchange capacity was low due to the lack of clay content and the dominancy of coarse texture. Storie index showed a better performance than Sys and Verheye index in evaluating land capability in Faculty of Agriculture Farm, Sohag University. Soils ranged between good and very poor for their capability. Soil limitations were coarse soil texture, low nutrients' content, calcium carbonates' content, salinity and soil alkalinity. Regarding suitability evaluation, the parametric method was preferable to be used than MicroLEIS-Almagra model. Its outputs were in detailed format as useful information in better land management. As in capability evaluation, same soil limitations were observed in the used models. The obtained data of this study can be used as a guide for decision makers to reach optimal use of land and also to reach higher agricultural productivity.

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