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Qualitative Evaluation of Land Suitability for Olive, Potato and Cotton Cultivation in Tarom in Zanjan

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ABSTRACT

The use of soil as one of the main factors in the manufacture of agricultural products for human consumption must be carried out using the right basis and scientific principles. One of the ways to achieve this important goal is to assess land suitability for common crops in the study area. It is also necessary to determine product compatibility based on the soil and climate conditions to reduce the risk of investment because there is no history of the studied plant's cultivation in the region. Therefore, this study aims to evaluate the suitability of land for cotton, potato, and olive crops at the bottom of the valley in Tadarom in Tarom region, Zanjan province to ensure proper use planning. After sampling and performing physical, chemical, and profile tests using the classification key of 2014, the soils were classified into different Aridi Sols categories, namely Typic calcigypsids, haplocambids, and torriortent. The climate, soil, and terrain data of the area were then collected from the relevant agencies. Land suitability assessment for olive, potato, and cotton was also performed using the simple constraint, parametric, FAO system methods. The evaluation results showed that the Tahdareh area with series 1 soils was in the not suitable (N) and subclass (Ns) categories using the history and second root methods, respectively with depth and pebbles as the limiting factors. Meanwhile, soil series 2, 3, 4, and 5 were placed in the critical fit (S_3) and proportionality (S_2) classes by the story and second root methods, respectively, where they were hindered by drainage. Evaluation of these lands for potato crop by story method for series 1, 2 and 3 shows that they were in Ns class, while 4 was in the proportionality (S_3) category with lime as the limiting factor. The non suitable class was obtained using the story method (N) for series 2, 3, 4 and 5 and they were hindered by soil depth, while class S_3 was obtained for all the soils with the texture and gravel as limit factors. The results showed that the studied lands were relatively suitable for olive groves and the conditions can be improved with corrective factors for drainage and the amount of gravel. The storytelling method has very strict output while presenting its results. The study area was considered a land with critical fit (S_3) class for olive cultivation, but it was not very consistent with field observations. Furthermore, the second root method had the greatest compliance with the existing realities in the region and it can be considered the most reliable parametric technique in the qualitative assessment of land suitability.

Keywords: Land evaluation; land use; parametric method; quality proportion

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INTRODUCTION

Over the years, humans have made several efforts to achieve the optimal usage of critical resources around the world. One of the most important natural resources used is soil, which serves as the basis of all agricultural activities. Human and animal life also depends on its level of exploitation, where excessive usage causes degradation. Therefore, soil utilization must be carried out carefully to avoid damage to valuable resources while reaching maximum production (Kilic *et al.,* 2005).

The increase in population and food demand as well as the subsequent degradation of these materials have led to various crises in the modern era (ZaliVargahan *et al.,* 2001; Santana-Cordero *et al.,* 2016; Hanh *et al.,* 2017). The inappropriate use of land is considered one of the most influential destructive factors of natural resources (Lal, 2009; Brevik, 2013). At present, land suitability classification has been considered (Hudson and Birnie, 2000) as a basic solution to certain problems, such as population growth, fertility reduction (Panagos *et al.,* 2015), soil and water pollution (Chartzoulakis and Bertaki, 2015; Sam *et al.,* 2016). Their potential must be evaluated to ensure they are assigned to the most profitable and sustainable operating system.

Land evaluation studies the potential of an area for its intended uses before any application for production. Furthermore, it assesses two important aspects, namely the physical aspects covering soil, topography, climate as well as the socio-economic aspects, such as land size, management level, labor availability and market access. Over time, the physical characteristics of the earth are almost constant, while the socio-economic factors have high variations. The main aim of land suitability assessment is to study the physical, social and economic aspects of land for optimal and sustainable use (Norton, 2003).

The FAO assessment system can fulfill the aforementioned objectives as an applied approach. Furthermore, while providing an optimal cropping pattern, it can also predict the productivity of each crop and provide guidance on the type of management required. One of its advantages is the adherence to a single framework proposed by the World Food Organization in 1976 for global implementation. This system allows the possibility to exchange and utilize the results of studies around the world as well as to collaborate with other countries (Ashraf and Normohammadan, 2011).

Assessing land based on its suitability as well as agricultural and natural resources evaluation helps to reveal its potential and productivity patterns. Evaluation is often carried out to study its characteristics and economic conditions, which helps to achieve the proper use of resources without soil degradation (FAO, 1976, 2007; Niekerk, 2010). One of the ways to optimally use land and prevent destruction is to carry out activities based on its production capacity (Rossiter, 1996; Anaya-Romero *et al.,* 2015).

Land assessment is often performed to evaluate the relationship between the land and its use type. It also helps to determine how the area can be properly utilized as well as to provide an estimate of the required amount of inputs and outputs (Sys *et al.,* 1993). In most developing countries, qualitative suitability assessment is a central focus of land evaluation including suitability studies for potato (Caldiz *et al.,* 2001), tomato (Shepande, 2002), cotton (Kalogirou, 2002) and olive (Wahba *et al.,* 2007).

The sources and capacity of land must be assessed before planning its best usage purpose. Therefore, recognizing the production capacity and allocating them to the best and most profitable type of use as well as paying attention to soil fertility and protection are very important. In evaluation studies, the capacity is often studied and determined based on the type of use. The first step in usage planning is land suitability assessment, where the most important task is understanding the relationship between the natural environment and the types of possible uses.

The problems of land misuse, uncontrolled growth of urban areas and declining area due to cultivation have gained public attention around the world. For policymakers, appropriate and optimal land use methods are very important for planning and effective management of agriculture in the region. The study of soil quality indicators in different areas provides the possibility of better utilization. Therefore, this study aims to evaluate the suitability of lands based on the FAO model using simple and parametric constraints as well as to investigate some soil quality indicators in the valley lands of the Tarom region in Zanjan province for olive, cotton and potato cultivation.

MATERIALS AND METHODS

This study was carried out in Tarom city, Zanjan province, Iran, and the total land used was 570 hectares. Based on the meteorological information of the water synoptic station, the average maximum daily temperature is 36.2°C in August with an average minimum daily temperature of 2.1°C in February. The maximum relative humidity of 70% is often experienced in December and the minimum of 61% in July and February. The absolute maximum and minimum temperatures were 48.5°C in August and -9.5°C in January, respectively. Furthermore, the area had an

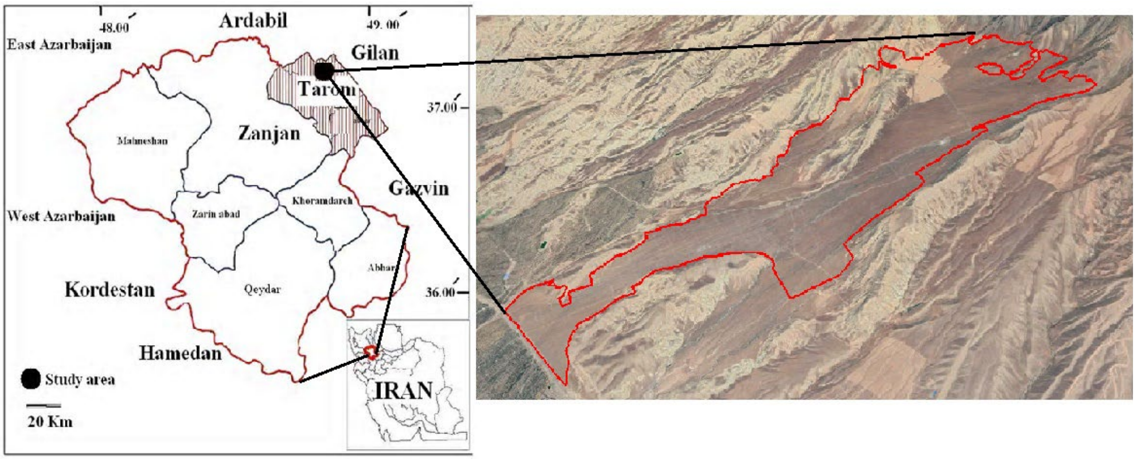

Figure 1- Location of the study area

average annual rainfall of 257.6 mm. The growth period of the region starts on March 18 and ends on June 7th, with a total duration of 83 days. Figure 1 shows the location of the study area.

Before the optimal use of the studied lands was determined, the available resources, such as soil quality were studied to collect comprehensive information on the physical and chemical characteristics as well as the morphological status of the area. Subsequently, their ability to cultivate the three studied crops, namely olives, cotton and potatoes based on the FAO model using simple and parametric constraints was evaluated. After recognizing the production capacity of the land units and allocating them to the best and most profitable type of crop, attention was then paid to soil fertility and protection. The sustainable cultivation with maximum yield was also determined using the following operations.

FIELD OPERATIONS

The profiles of soil in the study area were excavated to characterize and classify them as well as to determine the problems and constraints related to agriculture. In describing the profile factors comprising of surface and sub-terrestrial characteristic horizons as well as the properties of different soil areas, such as thickness, type of horizon, color, structure, pore space, root penetration, density were considered along with the concentration of lime, gypsum and pebbles. Properties, such as slope, topography, water and wind erosion, marsh, flooding, native plants and land use were also recorded. Furthermore, according to the profile description and information obtained from the laboratory analyses as well as the principles of comprehensive classification method, soils with similar management, use, physiographic, morphological, physical and chemical properties were considered as the same series. Each of them can have one or more phases/states/separate units. A total of five series were identified in the study area, where the first consists of five units.

Maps and Reports

The soil map was developed by considering the experimental results, sampling the control profile, synchronization with field observations, determination of different series in terms of their morphological properties as well as adjusting moisture and thermal regimes. Salinity or alkalinity was not considered in the mapping because they had no effect in the studied areas. To map the topography, the slope and microrelief were applied as they were recorded on the soil profile.

Soil Physical and Fertile Properties

A medium texture level was considered for root depth using the appropriate weight coefficient when the soil layers have different textures. In the parametric method, three properties including texture, pebbles percentage and depth were evaluated simultaneously and assigned a grade. Furthermore, each layer was first evaluated and graded, followed by the percentage and amount of pebbles. The value obtained was then multiplied by the degree of soil texture. Depending on the depth, the overall degree of the three factors was determined by applying appropriate weighting coefficients.

Lime affects the physical and chemical properties of the soil, and the finer it is, the greater its effect on the properties. When the amount of lime decreases with depth, it is used up to a depth of 30 cm for evaluation, or it is calculated using weighted coefficients of the average amount to the root penetration depth. Furthermore, the irrigation of calcareous soils causes changes in their physical properties as the irrigated layers harden and soil permeability to the root reduces. The high amount of lime in the soil also causes a reduction in its water storage capacity. It is important to note that low amounts have positive effects on plant nutrition and soil structure improvement.

In the assessment of gypsum status, when its average amount decreases with depth, a value of 30 cm is considered or the evaluation is carried out based on the average value in the root depth and weighting factors. Furthermore, the mean soil pH was calculated for a depth of 25 cm. Using the weighted average coefficients, the average EC was calculated in Decisiemens per meter for olive and potato up to depths of 150 cm and100 cm, respectively.

Method of Classifying Lands

Depending on the extent to which land specifications can meet the needs of the crop, its suitability is expected to vary. Consequently, the value of characteristics for a particular plant is very important in the evaluation process. In this study, two methods were used to determine land class: simple restriction method and parametric method.

Simple restriction method

In this method, the most limited land characteristic for crop growth determines the suitability class. To check the meteorological information and determine the climatic capatibility, the weather data for Abar city station, namely 10 km from the study area was used. The studied climatic parameters include rainfall, temperature, relative humidity and sunlight. The results obtained from the calculation of weather data were compared with the needs of the product, hence, the class depends on each climatic variable. The lowest category obtained was assumed to be the effect of weather. The variables related to geography and soil produced another class, subsequently the lowest was considered the total land class.

Parametric method

In the parametric method, a quantitative rating was assigned to each attribute, and when they are desirable for the target crop, the maximum rating of 100 is used. Meanwhile, when the same attribute is restricted, a lower value was assigned, after which the degrees were then used to calculate the land index. Climate evaluation was also carried out based on variables of temperature, rainfall, radiation and relative humidity. The lowest grade assigned to each group was selected and used by the Storie and Root Secondary Climate Index methods (Equation 1).

$$25 < CI < 92.5 \ CR = 16.67 + 0.9 \text{ x } CI \quad (1)$$

$$\text{CI} < 25 CR = 1.6 \text{ x } CI \quad (2)$$

The land index was calculated using the degrees assigned to each land attribute with the Equation 3.

$$I \text{ x} \left(\frac{C}{100}\right) = A \text{ x} \left(\frac{B}{100}\right) \quad (3)$$

Where I = Storie index and A, B, C, etc. are the degrees.

This method uses the Khidir equation presented in 1986 and known as the second root, which minimizes the interactions between the factors to some extent (Equation 4).

$$I = R_{min} \sqrt{\left(\left(\frac{A}{100}\right) \text{ x} \left(\frac{B}{100}\right) \text{ x} \ldots\right)} \quad (4)$$

Where I = Storie index, Rmin: the lowest degree between the different properties, and A, B and ... other degrees of attributes apart from the lowest.

Using the calculated index, the land suitability class was determined as very good grade (S_1), relatively good (S_2), critical fit (S_3) and not-suitable (N) with value ranges of 100-75, 75-50, 25-25 and 0-25, respectively.

RESULTS AND DISCUSSION

Evaluation of soil properties

The results of soil properties assessment using physical and salinity properties in different series and units were presented for olive plants (Tables 1 and 2), potatoes (Tables 3 and 4) and cotton (Tables 5 and 6). Furthermore, the average soil texture profile in series 1 sandy loam, series 2 sandy loam, series 3 sandy clay loam soil, series 4 clay loam sand and series 5 clay loam were determined based on the mean values of sand, silt and clay as well as the texture triangle. The amount of pebbles in series 1 were 15-35 %, >75 %, >75 %, 15-35 %, 35-75%. Meanwhile, value range of 15-35% was obtained in series 2, 3, 4 with 15-30% in series 5, as shown in Table 1. Based on the results, series 2 and 3 have soil depths of 120 cm, while values of 20 cm, 130 cm and 120 cm were obtained in 1, 4 and 5, as shown in Tables 1, 3 and 5. At these levels, series 1, 2, 3, 4 and 5 have lime content of 14.7, 17.90, 16.16, 7.5 and 27.5, respectively, as shown in Tables 1 and 6. For gypsum, a similar approach was also used, but its content was not reported in the studied profile. Electrical conductivity of soil saturated extract was used to evaluate its salinity. In the study area, a mean value of 0.9 dS m^{-1} was obtained for different soil series under olive, potato and cotton cultivations, as shown in Tables 1, 3 and 5. Salinity values of 0.7, 0.85, 0.9 and 1 dS m^{-1}, were recorded in units 2, 3, 4 and 5 under olive cultivation, respectively, as shown in Table 2.

Final Land Evaluation

The land evaluation value was calculated by combining soil and climate assessment results. Calculation of land index was carried out the methods in Equation 5 and 6.

$$LI = \left(CR \text{ x} \frac{BC}{100} \text{x} \frac{C}{100} \right) \tag{5}$$

$$LI = R_{min} \sqrt{\left(\left(\left(\frac{A}{100} \right) \text{ x } \left(\frac{B}{100} \right) \text{ x } 100 \right) \right)} \tag{6}$$

C and B are related to the soil, while CR is associated with climate. R_{min} is the product of the lowest degree assigned to any soil properties multiplied by the root of the product of the others. The results showed that the lowest climatic index and climatic degree were obtained from olive, while the highest amount of indices were recorded in potato. Table 7 shows the final evaluation of the qualitative suitability of the lands in the Tahdare area using the parametric method, which consists of storie and second root techniques for the cultivation of olive, potato and cotton plants.

Climate characteristics assessment

The climatic characteristic for the target crop were obtained based on the standard tables presented by conveyor Givi (1997) as well as the results of soil analysis and related evaluation experiments. In the parametric method, the lowest degree assigned to each group was selected, and then converted to climate index by using storie and second root methods. Subsequently, the appropriate equations for the climatic degree were obtained. The final result of evaluation for olive using the simple and parametric constraint method revealed that the land was in S_2, while S1, S2 and S1 were obtained for potato with the simple constraint, Storie and second root methods, respectively. Furthermore, the class of S2 was recorded for cotton using the simple constraint, storie and the second root methods, as shown in Figure 7. After determining the degrees in the climate needs, the lowest in each group was then selected. They were then calculated along with the climate index using the storie and second root method, as shown in Table 7.

Qualitative land suitability assessment provides useful information about different crops and the most suitable place to produce them. The results showed that the lowest index and climatic grade were obtained from the olive plant. Furthermore, Mashayekhi (2015) qualitatively and quantitatively evaluated the suitability of land for local crops in the Khodafarin region. The results of climatic evaluation using the simple method and severity showed low suitability S_3 for cotton cultivation in this area. The main limiting factors were high gypsum, pH and unsuitable weather. Rahimi *et al.* (2009) assessed olives on a 2,200ha plot in Roodbar with 6 soil series and phases, where the results showed that soils can be classified into two categories, namely Aridisols and Entosol/Torriorthents. Qualitative evaluation was carried out in the study using the limitation and parametric methods. Olive production was based on regional cultivation management practices in the Roodbar region. The results showed that the climate conditions are very suitable (S_1), but there were important topographic limiting factors, such as large stones, shallow soils, salinity and alkalinity issues. Menjiver *et al.* (2003) conducted a study on land suitability for olive plants in Spain, where 35 research profiles were selected and evaluated using 6 methods. They revealed that according to the FAO method, the most limiting factors in this region were high soil moisture and extreme slope. In the system, all of the studied areas were in the suitable class N_1 and the reduction of any extreme conditions required a lot of expenditure. Similarly, Igue *et al.* (2005) used the same method to evaluate the potential of Azucan lands in West Africa for flax cultivation. Their results showed that soil index for different soils in the area ranged from critical to unsuitable, while the limiting factors were methane production, adverse climatic conditions, physical and chemical properties, soil texture and organic carbon. Al-Mashreki *et al.* (2011) investigated land suitability for rainfed sorghum using GIS and remote sensing technologies in IBI province in southwest Yemen. The results revealed that approximately 5% of the study area was very suitable for sorghum cultivation. Meanwhile, 25%, 31%, 24% and 15% were relatively suitable, critical, inappropriate and temporarily unsuitable, respectively.

Adaptation of climatic, soil and topography needs with parametric method was carried out. Furthermore, Table 7 shows the results of the process including climate index and class, land index as well as final qualitative class. The use of the storie and second root

Table 1. Soil properties evaluation results of different Unit 1 series for olives

Features	series 1/1			series 1/2			series 1/3			series 1/4			series 1/5		
	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value
Slope (%)	96	S_1	5-2	98	S_1	2-0	96	S_1	5-2	96	S_1	5-2	96	S_1	5-2
Flooding	85	S_2	None	100	S_1	None	100	S_1	None	85	S_2	None	85	S_2	None
Drainage	85	S_2	Average	72.5	S_2	Average	72.5	S_2	Average	85	S_2	Average	85	S_2	Average
Texture and structure	100	S_1	SL	100	S_1	SL	100	S_1	SL	100	S_1	SL	100	S_1	SL
Pebbles (vol %)	75	S_1	15-35	0	N_2	>%75	0	N_2	75-35	75	S_1	15-35	0	N_2	35-75
Depth (cm)	0	N_2	20	0	N_2	20	0	N_2	20	0	N_2	20	0	N_2	20
Lime (%)	100	S_1	14.7	100	S_1	14.7	100	S_1	14.7	100	S_1	14.7	100	S_1	14.7
Gypeum (%)	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None
Organic matter (%)	72.5	S_1	1.86	72.5	S_1	1.86	72.5	S_1	1.86	72.5	S_1	1.86	72.5	S_1	1.86
EC (ds m^{-1})	95.96	S_1	0.9	95.56	S_1	0.9	95.56	S_1	0.9	95.56	S_1	0.9	95.56	S_1	0.9

Table 2. Soil properties evaluation results for Units 2 to 5 for olives

Features	Unit 2			Unit 3			Unit 4			Unit 5		
	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value
Slope (%)	98	S_1	2-0	96	S_1	2-5	96	S_1	5-2	96	S_1	5-2
Flooding	100	S_1	None	85	S_2	None	100	S_1	None	85	S_2	None
Drainage	72.5	S_2	Average	85	S_2	Average	72.5	S_2	Average	85	S_2	Average
Texture and structure	100	S_1	SL	98	S_1	LCS	100	S_1	SL	100	S_1	SL
Pebbles (vol %)	75	S_1	15-35	75	S_1	15-35	0	N_2	75-35	75	S_1	15-35
Depth (cm)	85.33	S_1	120	85	S_1	120	0	N_2	20	0	N_2	20
Lime (%)	100	S_1	17.90	100	S_1	16.16	100	S_1	14.7	100	S_1	14.7
Gypeum (%)	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None
Organic matter (%)	85.27	S_1	0.82	100	S_1	2.4	72.5	S_1	1.86	72.5	S_1	1.86
EC (dS m^{-1})	95.47	S_1	0.7	100	S_1	0.85	95.56	S_1	0.9	95.56	S_1	0.9

Table 3. Results of soil properties assessment of different unit 1 for potatoes

Features	series 1/1			series 1/2			series 1/3			series 1/4			series 1/5		
	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value
Flooding	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None
Drainage	85	S_1	Average	85	S_1	Average	85	S_1	Average	85	S_1	Average	85	S_1	Average
Texture and structure	95	S_1	SL	95	S_1	SL	95	S_1	SL	95	S_1	SL	95	S_1	SL
Pebbles (vol%)	72.5	S_2	15-35	50	S_3	35-75	50	S_3	35-75	72.5	S_2	15-35	50	S_3	35-75
Depth (cm)	60	S_3	20	60	S_3	20	60	S_3	20	60	S_3	20	60	S_3	20
Lime (%)	98.4	S_1	14.7	98.4	S_1	14.7	98.4	S_1	14.7	98.4	S_1	14.7	98.4	S_1	14.7
Gypeum (%)	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None
pH	7.9	S_1	7.76	7.9	S_2	7.76	7.9	S_2	7.76	100	S_2	7.76	79	S_2	7.76
EC (dS m^{-1})	99.5	S_2	0.9	99.5	S_1	0.9	99.5	S_1	0.9	85	S_1	0.9	99.5	S_1	0.9

Table 4. Results of soil properties assessment of units 2 to 5 for potatoes

Features	Unit 2			Unit 3			Unit 4			Unit 5		
	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value
Flooding	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None
Drainage	85	S_1	Average	85	S_1	Average	85	S_1	Average	85	S_1	Average
Texture and structure	95	S_1	SL	100	S_1	LCS	100	S_1	LCS	95	S_1	LCS
Pebbles (vol%)	72.5	S_2	15-35	72.5	S_2	15-35	72.5	S_2	15-35	95	S_1	15-35
Depth (cm)	100	S_1	120	100	S_1	120	100	S_1	130	100	S_1	120
Lime (%)	40	N_1	25.25	40	N_1	24.95	97.68	S_1	12.12	72.4	S_2	42.44
Gypeum (%)	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None
pH	82	S_2	7.85	80.5	S_2	7.82	71.5	S_2	7.46	75.75	S_2	7.63
EC (dS m^{-1})	98	S_1	0.94	87.02	S_1	1.40	88.35	S_1	1.67	85.7	S_1	1.14

Table 5. Results of soil properties assessment of different unit series 1 for cotton

Features	series 1/1			series 1/2			series 1/3			series 1/4			series 1/5		
	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value
Slope (%)	98	S_1	2-5	99	S_1	0-2	98	S_1	2-5	98	S_1	2-5	98	S_1	2-5
Flooding	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None
Drainage	100	S_1	Average	100	S_1	Average	100	S_1	Average	100	S_1	Average	100	S_1	Average
Texture and structure	60	S_3	SL	60	S_3	SL	60	S_3	SL	60	S_3	SL	60	S_3	SL
Pebbles (vol %)	95	S_1	15-35	100	S_2	35-75	25	N_2	35-75	72.5	S_2	15-35	25	N_2	35-75
Depth (cm)	0	N_2	20	0	N_2	20	0	N_2	20	0	N_2	20	0	N_2	20
Lime (%)	89.7	S_1	14.7	89.7	S_1	14.7	89.7	S_1	14.7	89.7	S_1	14.7	89.7	S_1	14.7
pH	93.6	S_1	7.76	93.6	S_1	7.76	93.6	S_1	7.76	93.6	S_1	7.76	93.6	S_1	7.76
EC (dS m^{-1})	100	S_1	0.9	100	S_1	0.9	100	S_1	0.9	100	S_1	0.9	100	S_1	0.9

Table 6. Soil evaluation results of units 2 to 5 for cotton

Features	Unit 2			Unit 3			Unit 4			Unit 5		
	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value	Numeric method	Limitation	Value
Slope %	99	S_1	0-2	98	S_1	2-5	99	S_1	2-0	99	S_1	2-0
Flooding	100	S_1	None	100	S_1	None	100	S_1	None	100	S_1	None
Drainage	100	S_1	Average	100	S_1	Average	100	S_1	Average	100	S_1	Average
Texture and structure	60	S_3	SL	85	S_2	SCL	85	S_2	SCL	85	S_2	SCL
Pebbles (vol %)	72.5	S_2	15-35	72.5	S_2	15-35	90	S_1	3-15	72.5	S_2	15-35
Depth (cm)	98	S_1	120	98	S_1	120	98	S_1	120	91	S_1	130
Lime (%)	94.72	S_1	19.72	93.56	S_1	18.56	99.69	S_1	9.38	45.1	S_3	32.55
pH	95	S_2	7.88	87.5	S_2	7.82	89.6	S_1	7.46	89.6	S_1	7.63
EC (dS m^{-1})	100	S_1	0.7	100	S_1	0.85	95.96	S_1	0.9	95.6	S_1	1.0

Table 7. Parametric method for qualitative suitability of cropland for olive, potato, cotton cultivation

Plant	Soil series	Climate index		Climate degree		Land index		Land class	
Olive	1.4	62.5	62.5	72.92	72.92	0	0	N_s	N_s
Olive	1.5	62.5	62.5	72.92	72.92	0	0	N_s	N_s
Olive	2	62.5	62.5	72.92	72.92	26.99	26.44	S_{3w}	S_{3w}
Olive	3	62.5	62.5	72.92	72.92	42.13	42.55	S_{3c}	S_{2c}
Olive	4	62.5	62.5	72.92	72.92	32.79	57.10	S_{3w}	S_{2w}
Olive	5	62.5	62.5	72.92	72.92	36.50	60.24	S_{3w}	S_{2w}
Potato	1.1	72.93	79.1	82.31	87.86	22.36	40.2	N_s	S_{3s}
Potato	1.2	72.93	79.1	82.31	87.86	15.42	30.5	N_s	S_{3s}
Potato	1.3	72.93	79.1	82.31	87.86	15.42	18.5	N_s	N_s
Potato	1.4	72.93	79.1	82.31	87.86	22.36	40.37	N_s	S_{3s}
Potato	1.5	72.93	79.1	82.31	87.86	15.42	30.60	N_s	S_{3s}
Potato	2	72.93	79.1	82.31	87.86	15.48	27.2	N_s	S_{3s}
Potato	3	72.93	79.1	82.31	87.86	14.21	26.28	N_s	S_{3s}
Potato	4	72.93	79.1	82.31	87.86	31.29	52.14	S_{3f}	S_{2f}
Potato	5	72.93	79.1	82.31	87.86	29.67	25.44	S_{3s}	S_{3s}
Cotton	1.1	72	72	81.47	81.47	0	0	N_s	N_s
Cotton	1.2	72	72	81.47	81.47	0	0	N_s	N_s
Cotton	1.3	72	72	81.47	81.47	0	0	N_s	N_s
Cotton	1.4	72	72	81.47	81.47	0	0	N_s	N_s
Cotton	1.5	72	72	81.47	81.47	0	0	N_s	N_s
Cotton	2	72	72	81.47	81.47	30.93	47.4	S_{3s}	S_{3s}
Cotton	3	72	72	81.47	81.47	39.47	58.72	S_{3s}	S_{2s}
Cotton	4	72	72	81.47	81.47	38.60	58.61	S_{3s}	S_{2s}
Cotton	5	72	72	81.47	81.47	26.02	35.89	S_{3s}	S_{3s}

method for different indices gave similar results. The evaluation showed that the Tahdare zone for olive cultivation on series 1 soil was in the not suitable (N) and not subclass (N_s) categories using the storie and second root methods, respectively. The limitation faced in the area was related to soil depth and pebbles. In series 2, 3, 4 and 5, the soil was critically proportional (S_3) and the constraint was drainage except for series 2, which was hindered by climate. Evaluation of these lands on potato crop was based on the storie method for series 1, 2 and 3, which were in the subclass (N_s), and the lime was the limiting factor. For cotton cultivation in soil series 1, the land class was suitable (N), with soil depth as the constraint. Meanwhile, in series 2, 3, 4 and 5, the class of proportion was S_3, with limiting factors of soil texture and pebbles, as shown in Table 7. Elaalem (2013) compares two parametric and fuzzy methods for evaluating olive land suitability in the Jay Farah plain of Libya. The fuzzy method indicated that the majority of the study area was suitable, while the parametric method showed moderate suitability for the plant's production. Mahari and Alebachew (2013) also investigated the ability of some Ethiopian lands using the parametric method. The result showed that the most important limiting factors in the area were slope and soil physical properties, especially texture and depth. Magboul *et al.* (2015) evaluated land suitability for citrus and crop production around the Nile, North Khartoum and Sudan. The results showed that the suitability class was poor and not suitable for the crop. Furthermore, the most important factors limiting factors drainage were soil salinity and erosion. Based on these findings, the storie method often gives more unrealistic as well as strict results and the estimates also show unsuitable class.

CONCLUSION

The evaluation results showed that the Tahdareh area for cultivation of olives and cotton in series 1 soils using the history and second root methods had an unsuitable class, with depth and gravel as the limiting factors. Series 2, 3, 4 and 5 were placed in the critical fit class S_3 with the story method, and it was hindered by drainage. However, in the second root method for the above series, a fit class S_2 was obtained for the olive crop, with soil drainage as the limiting factor. The evaluation of these lands was unsuitable for potato cultivation using the history method on series 1, 2 and 3. Suitability class S_3 was obtained for 4 with high soil lime as the constraint. The results showed that the lands assessed for olive orchards and cotton cultivation were in the critical class S_3, and the removal of the drainage restrictions made it suitable. Most of the areas studied were not suitable for growing potatoes and their cultivation is not recommended.

CONFLICT OF INTEREST

The authors declare that this article is an original study that has not been published in another journal, and there are no conflict of interest

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