Qualitative Evaluation of Land Suitability for Principal Crops in the West Shoush Region, Khuzestan Province, Southwest Iran

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ABSTRACT:Today's excessive use of croplands and the resulting damages along with the ever-increasing demand for further crop productions have necessitated the best land management practices more than ever. Due to the current lack of any proper land management practices for West Shoush region in Khuzestan Province, southwest Iran, a land suitability evaluation study for key productions of the region, including wheat, alfalfa, maize, and barley, covering an area of 41958 ha was carried out in the region. Using the findings of the semi-detailed soil studies for this area, 4 soil families and 32 soil series in 2 physiographic units were identified. Physiologic requirements of each crop were also determined and rated based upon the proposed method of Sys et al. (1991) and the tables provided by the Iranian Soil and Water Research Institute (Givi. J., 1997). Qualitative evaluation was carried out by means of simple limitation and parametric methods (Storie and Root Square Method) and comparing land and climate characteristics with crop needs. The indexes obtained for alfalfa, barley and wheat were higher in comparison to that developed for maize. Limiting factors in different crop yield in the region along with climatic variables included soil physical properties, especially its texture and carbonate contents and slope. From the two methods used i. e, simple limitation and parametric methods (Storie and Square Root Methods), the latter(Square Root Methods)produced more realistic results in respect to the existing conditions of the region.

Introduction

Considering the rapid growth of the world populations, which is in its turn a limiting factor to the arable lands around the world, the dire need for effective and efficient application of the croplands have been felt more than ever. Sustainable agriculture would be achieved if lands be categorized and utilized based upon their different uses (FAO.1983). Qualitative evaluation of the land suitability consists of determination of the land use for particular applications regardless of yield fulfillment and socio-economic issues (FAO.1976 and 1983). In this view, FAO (Food and Agriculture Organization) took a stride in its Soils Bulletins No. 32, 42, 48, 52 and 55 by introducing various methodologies based upon the above framework.

Calderon *et al.* (2005) performed a land evaluation project for Shouyang County in Shanxi Province, China, in which maize, soybean, potato; sunflower, wheat as well as tree crops were studied. For this purpose, land suitability classification was carried out using parametric method and the consequent land suitability maps were prepared for crops under traditional and mechanized cultivations.

Liu *et al.* (2006) investigated the land suitability for agricultural crops in Danling County - Sichuan province, China-using the Sys's parametric evaluation system. The final aim of this evaluation is to facilitate farmers in choosing the best crop to be cultivated (for small areas)and decision makers in planning the rural development (for large areas).Several crops were analyzed; in particular, the suitability for rice was compared to the one for other summer crops like sweet potato and maize. A comparison between wheat and rape was carried out since these are the more common crops to be rotated with rice. The more widespread tree crops, like orange and loquat, were also included in the analysis as well as mulberry tree which is becoming more widespread due to the growth of the silk market. The evaluation of some cash crops that do not currently grow in the agricultural landscape of *Danling* County was carried out too in order to gain an indication about future productivity of the area.

The main objective of this research is to evaluate and compare land suitability for principal crops based on the simple limitation and parametric evaluation systems for West Shoush Plain, Khuzestan Province, Iran.

Materials and Methods

The study area was West Shoush Plain with an area of 41958 ha. in the Khuzestan Province at a distance of 5 km of west and north west Shoush between 31º 38´ and 31º 49´ N and 48º 57´ and 49º 07´ E. This area has an arid climate with a mean annual rainfall of 295 mm and minimum and maximum relative humidity of 32% and 67%, respectively. The mean annual temperature is 24.4 Cº. The warmest month of the year is Tir (June-July) with a maximum temperature of 46.3Cº while the coldest month of the year is Dey (late October to early January) when the minimum temperature is as low as 7.2 Cº. The annual evapo-transpiration has been measured as 2250 mm (KWPA, 2005).

In the present study almost totally 32 soil series were categorized and climatic, topography and soil properties were prepared and ranked based upon Sys *et al* .(1991) tables and proposed tables of the Iranian soil and water research institute (Givi. J., 1997) and the Manual of land classification for irrigation (Mahler, P.J., 1979),. Climate data and those related to different stages of plant growth were taken from Khuzestan soil and water research institute and physiological requirements of each plant were extracted from tables prepared specifically for Iran (Givi. J., 1997). In evaluating of the qualitative land suitability, land properties were compared with the corresponding plant requirements. In this stage, in order to classify the lands the simple limitation and parametric methods (i. e, Story and Square Root Methods) were used. Simple limitation method compares the plant requirements with its corresponding qualitative land and climatic characteristics and the most limiting characteristics defines land suitability class while in parametric method land and climate characteristics are defined using different ratings. The measurement of theses characteristics can be done using the followings:

1. Storie Method:

$$I = A \times \frac{B}{100} \times \frac{C}{100} \times \frac{D}{100} \times \frac{E}{100} \times \frac{F}{100}$$

where I is the specified index and A, B, C, …., are different ratings given for each property.

2 Square Root Method:

$$I = R\min \sqrt{\frac{A}{100} \times \frac{B}{100} \times ...}$$

in which R_{min} is the minimum rank.

By determining the specific land index and using the guidelines given by Sys *et al*. (1991), the qualitative land suitability classes and the limiting factors of the plant growth in different soil series for each plant were determined.

Results and Discussion

Thirty two soil series and seventy nine series phases were derived from the semi-detailed soil study of the area. The soils of the area are of Inceptisols and Entisols orders. Also, the soil moisture regime is Ustic while the soil temperature regime is Hyperthermic (KWPA, 2006).

The results of the physical evaluation showed a close correlation between the simple limitation method and parametric method (square root method); however, due to the interaction of many-sided impacts of the land properties, using Storie method in determining of the land index will lead to underestimation of the land classes obtained compared to what gained through simple limitation and square root methods.

Regarding the accuracy and several advantages of the parametric method (square root method) the results obtained by this method in the present study will be reviewed briefly.

The comparison of the land indexes for wheat, barley, alfalfa and maize, Table (1) and (2) indicated that in land series 9,10,11,12,14,17,18,19,20,21,22,23,24,25,27,30 and 32 with an area of 23073 ha (54.99%) growing wheat, barley and alfalfa was the most suitable than maize. In land series coded 15 and 16 with an area of 3839 ha (9.15%) growing barley and alfalfa was the most suitable compared with wheat and maize. Only in land series 13 with an area of 829 ha (1.97%) growing wheat and barley was the most suitable than alfalfa and maize. In land series 1,2,3,4,5,6,7,8,26 and 29 with an area of 11958 ha (28.50%) growing alfalfa was the most suitable than other crops. and finally, in land series coded 28 and 31 with an area of 2259 ha (5.38%) growing barley was the most suitable compared with other productions. Figure 1 shows the most suitable map for Principal Crops in the West Shoush Region, by notation to land index (Li). As seen from this map, nearly all of this plain was suitable for alfalfa and the largest portion of this plain was suitable for wheat and barley. also, there was not founded area that was suitable for maize.

Generally, the most important limiting factors in wheat and barley productions in the region under study included physical properties of the soil especially soil texture and slope. Briza *et al.* (2001) also suggested that the most limiting factors of the land suitability in the Province of Ben Slimane, Morocco, in wheat and barley productions included physical characteristics such as soil texture, soil depth and slope.

The major limiting factors in maize production are low relative humidity and high n/N ratio during the plant growth, lime content and soil texture among the soil physical properties and slope. Limiting factors in producing alfalfa also include slope and soil texture among the soil physical properties.

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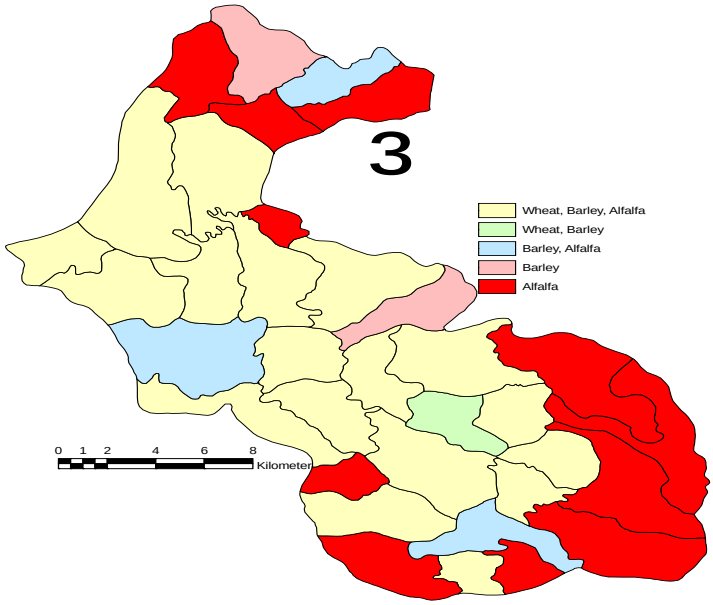

Fig 1: The most suitable map for Principal Crops.

Table (1): Results of the Qualitative Suitability Evaluation of Different Land Series for Crops under Study Using Parametric Method (Square Root)

Land series	Wheat		Maize		Barley		Alfalfa	
	Land index	Suitability Classes	Land index	Suitability Classes	Land index	Suitability Classes	Land index	Suitability Classes
1	42.51	S_3s	33.87	S_3sc	45.11	S_3s	63.86	S_2s
2	42.89	S_3s	33.80	S_3sc	45.41	S_3s	64.88	S_2s
3	56.48	S_2ts	39.45	S_3tsc	58.13	S_2ts	70.33	S_2ts
4	62.91	S_2s	44.78	S_3sc	63.03	S_2s	82.08	S_1
5	38.17	S_3ts	28.59	S_3tsc	39.21	S_3ts	57.04	S_2ts
6	55.21	S_2ts	37.32	S_3tsc	57.86	S_2ts	68.67	S_2ts
7	56.94	S_2ts	39.87	S_3tsc	58.45	S_2ts	70.38	S_2ts
8	54.01	S_2ts	36.72	S_3tsc	55.49	S_2ts	63.24	S_2ts
9	57.81	S_2ts	38.97	S_3tsc	60.48	S_2ts	61.34	S_2ts
10	57.40	S_2ts	40.33	S_3tsc	60.96	S_2ts	62.19	S_2ts
11	77.10	S_1	52.14	S_2c	81.84	S_1	85.19	S_1
12	66.01	S_2t	46.61	S_3sc	69.32	S_2t	70.29	S_2s
13	65.33	S_2tn	26.63	S_3tsnc	67.36	S_2t	55.09	S_2sn
14	78.71	S_1	49.62	S_3nc	82.38	S_1	83.96	S_1
15	72.06	S_2ts	43.69	S_3tsnc	75.67	S_1	75.86	S_1
16	72.94	S_2ts	48.18	S_3tsc	77.39	S_1	77.78	S_1
17	62.43	S_2ts	36.92	S_3tsnc	67.31	S_2ts	65.37	S_2tsn
18	64.24	S_2ts	43.31	S_3tsc	67.12	S_2ts	67.78	S_2ts
19	63.09	S_2ts	41.06	S_3tsc	66.45	S_2ts	66.98	S_2ts
20	63.74	S_2ts	44.07	S_3tsc	68.25	S_2ts	69.60	S_2ts
21	75.05	S_1	50.48	S_2sc	78.39	S_1	78.58	S_1
22	64.09	S_2ts	39.45	S_3tsnc	65.18	S_2ts	65.77	S_2ts
23	65.72	S_2ts	43.90	S_3tsc	66.39	S_2ts	68.07	S_2ts
24	63.89	S_2ts	41.51	S_3tsc	66.26	S_2ts	67.36	S_2ts
25	65.04	S_2ts	42.96	S_3tsc	67.36	S_2ts	67.59	S_2ts
26	55.21	S_2ts	35.59	S_3tsc	57.17	S_2ts	67.36	S_2ts
27	64.89	S_2ts	43.61	S_3tsc	67.69	S_2ts	68.91	S_2ts
28	45.39	S_3tsn	17.60	N_1tsnc	52.58	S_2ts	46.44	S_3tsn
29	52.38	S_2ts	35.17	S_3tsc	54.97	S_2ts	61.38	S_2ts
30	79.68	S_1	52.78	S_2c	83.02	S_1	83.16	S_1
31	70.14	S_2n	31.16	S_3nc	80.19	S_1	61.52	S_2n
32	66.74	S_2t	43.48	S_3tnc	70.24	S_2t	67.45	S_2t

Table (2): Results of the Qualitative Suitability Evaluation of Different Land Series for Crops under Study Using Parametric Method (Storie)

Land series	Wheat		Maize		Barley		Alfalfa	
	Land index	Suitability Classes	Land index	Suitability Classes	Land index	Suitability Classes	Land index	Suitability Classes
1	36.15	S_3s	19.37	N_1sc	40.70	S_3s	55.79	S_2s
2	36.89	S_3s	19.27	N_1sc	41.29	S_3s	57.63	S_2s
3	44.03	S_3ts	21.52	N_1tsc	46.63	S_3ts	61.35	S_2ts
4	54.64	S_2s	27.74	S_3sc	54.82	S_2s	75.47	S_1
5	29.19	S_3ts	13.78	N_1tsc	30.79	S_3ts	44.55	S_3ts
6	42.08	S_3ts	19.26	N_1tsc	46.22	S_3ts	58.52	S_2ts
7	44.74	S_3ts	22	N_1tsc	47.18	S_3ts	61.39	S_2ts
8	40.28	S_3ts	18.66	N_1tsc	42.51	S_3ts	54.75	S_2ts
9	46.17	S_3ts	21.02	N_1tsc	50.49	S_2ts	51.49	S_2ts
10	45.51	S_3ts	22.51	N_1tsc	51.31	S_2ts	52.91	S_2ts
11	66.11	S_2ts	37.63	S_3c	74.50	S_2ts	76.85	S_1
12	54.51	S_2t	30.08	S_3sc	60.10	S_2t	61.23	S_2s
13	33.41	S_3tn	10.88	N_2tsnc	56.73	S_2t	39.80	S_3sn
14	68.87	S_2ts	34.05	S_3nc	75.49	S_1	76.02	S_1
15	60.79	S_2ts	26.41	S_3tsnc	67	S_2ts	66.77	S_2s
16	61.37	S_2ts	32.13	S_3tsc	69.06	S_2ts	69.17	S_2s
17	48.75	S_3ts	18.88	N_1tsnc	56.70	S_2ts	49.50	S_3tsn
18	51.62	S_2ts	25.97	S_3tsc	56.39	S_2ts	56.95	S_2ts
19	49.81	S_3ts	23.31	N_1tsc	55.27	S_2ts	55.62	S_2ts
20	50.81	S_2ts	26.87	S_3tsc	58.24	S_2ts	60.08	S_2ts
21	64.07	S_2ts	35.23	S_3sc	69.88	S_2s	69.60	S_2s
22	51.40	S_2ts	21.53	N_1tsnc	53.16	S_2ts	35.72	S_3ts
23	54.06	S_2ts	26.69	S_3tsc	54.98	S_2ts	54.78	S_2ts
24	51.11	S_2ts	23.84	N_1tsc	54.97	S_2ts	56.26	S_2ts
25	52.93	S_2ts	25.53	S_3tsc	56.74	S_2ts	56.69	S_2ts
26	42.09	S_3ts	17.53	N_1tsc	45.14	S_3ts	56.24	S_2ts
27	52.70	S_2ts	26.33	S_3tsc	57.29	S_2ts	58.85	S_2ts
28	28.46	S_3tsn	5.23	N_2tsnc	38.14	S_3ts	30.16	S_3tsn
29	37.90	S_3ts	17.13	N_1tsc	41.71	S_3ts	51.54	S_2ts
30	70.63	S_2ts	38.55	S_3c	76.63	S_1	76	S_1
31	58.12	S_2n	14.89	N_1nc	71.51	S_2ts	50.85	S_2n
32	55.73	S_2t	26.17	S_3tnc	61.68	S_2t	56.45	S_2t