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Land suitability evaluation of Bilverdy research station for wheat, barely, alfalfa, maize and safflower

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Abstract In the present study and research work land suitability evaluation (qualitative classification) has been determined for wheat, barely, alfalfa, maize and safflower in Bilverdy research station of Islamic Azad University in East Azarbaijan by using Simple Limitation Method (SLM), Limitation Method regarding Number and Intensity (LMNI) and Parametric Method (PM) such as square root and storie methods. Landscape qualities, climate and soil and their characteristics, which most influence crop suitability have been combined by the adopted methodology. Also economic factors are excluded and moderate management is assumed. Results of different methods showed that the most important limitation factors are climate, pH, OC, gravel, salinity and sodicity alone, or with together, while in safflower CEC can be added to these factors.

Evaluation by SLM and LMNI show similar suitability classes, which confirms the previous findings for crops by other researchers. But in many cases the use of parametric methods especially the square root method revealed to be more realistic in showing the distinguished suitability classes.

Therefore this study not only compares different methods results, but also evaluates the capabilities of the study area for above named crops. According to the obtained results of square root method cultivation of wheat, barely, alfalfa and safflower cultivation with marginally suitable class and 40 - 65 % of optimal production are recommended respectively.

Key words: climate, pH, gravel, OM, CEC, salinity, sodicity

Introduction

Relatively scarce commodity of land for agriculture, food security of world population and suitability assessment of an area for crop production requires considerable land use accuracy. Therefore in order to help developers and agricultures, and to match the land optimum use, land suitability evaluation plays very important role, because land suitability is assessed a part of rational cropping system (FAO 1976) and a land piece use optimizing for a specified use (Sys et al 1991a). Wheat, barely, alfalfa, maize and safflower are important and commercially produced in the majority parts of Iran and also East & West Azerbaijan province, which their production depends very much on climate, soil, topography and water availability that are the most important categories of environmental information required for judging land suitability. Also in different parts of Iran land suitability evaluation has done for some of this crops by Movahhedi Naeni (1993), Ghasemi Dehkordi (1994), Sarvari and Mahmoudi (2001), Jafarzadeh and Atabakazar (2004), Jafarzadeh et al. (2004, 2005a, b, 2006), and Shahbazi and Jafarzadeh (2004).

The results confirm some obtained results of previous researchers about the different methods, but also present the land suitability based upon SLM, LMNI and PM methods and evaluate the capabilities of the study area for the above named crops.

Matrials and methods

Bilverdy research station lies between 46º 08′ to 46º 40′ East latitudes and 35º 08′ to 35º 12′ North longitudes, which are about 106 ha and altitude of the region is 1550m above sea level. In order to have confident soil data, the soil reports have been studied and 9 soil profiles selected for more detail soil survey. Profile descriptions were made using standard terminology (USDA, 2003) and also after preparation and analyzing of samples (Table 1), soil were classified by USDA classification system (USDA, 2006) in Aridisols order and suborders of Sodic Haplocambids, Typic Haplocambids by Saedi and Jafarzadeh (2005) (Table 2, Figure 1). The most important climate characteristics necessary for suitability determination (temperature, rainfall, relative humidity…) were collected from Ahar Meteorological Station (Table 3), where average total rainfall is about 302.8 mm, mean temperature is 40.48ºC and also the calculated soil temperature and moisture regimes revealed mesic and aridic regime, respectively. Based on obtained information about topography, soil, climate and suitability evaluation methods (Sys et al., 1991b), simple limitation method, limitation method regarding number and intensity and parametric methods (storie and square root method) were selected and the land suitability class for crops was determined.

Table 1 Analytical characterization of the representative soils in the study area

Profile	Horizon	Depth	C (%)	Si (%)	S (%)	Text. class	pH	OM (%)	$CaCO_3$ (%)	ECe (dS/m)	CEC (mol/kg)	Gravel (%)
1	A	0-25	3.36	22.7	41	SL	8.76	0.2	23.5	27.9	18.55	0.11
	C_1	25-55	9.33	27.8	39.3	SL	8.32	0.23	23.8	13.04	16.91	-
	C_2	55-120	43.1	15.9	41	C	8.46	0.25	20.5	0.61	23.05	-
	C_3	>120	45	16	39	C	8.39	0.2	22.1	0.3	22.9	-
2	A	0-28	22.6	33	4.44	L	8.25	0.22	23.8	6.2	11.74	0.02
	BK	28-55	32	27	41	CL	8.46	0.23	23.9	5.72	16.46	0.05
	C_1	55-120	2.8	54.4	43.8	SL	8.85	0.24	21.5	5.48	1.88	0.15
	C_2	>120	4	55	41	SL	7.98	0.25	22.7	5.6	2.5	0.2
3	A	0-25	16.4	25.5	58.1	SL	7.98	0.25	23.8	8.84	8.7	-
	B_1	25-55	13	37.4	49.6	L	8.14	0.19	24.9	1.95	6.88	0.02
	B_2	55-120	24.9	32.3	42.8	L	9.88	0.25	24.8	4.2	12.95	-
	C	>120	33	27	40	CL	9.01	0.22	24.8	3.08	16.94	-
4	A	0-25	13	34	53	SL	8.11	0.25	24.9	8.9	7	2.86
	B	25-50	9.6	31.2	59.2	SL	8.14	0.23	24.7	5.25	5.26	0.22
	C	50-80	4.2	40	55.8	SL	9.2	0.18	24.4	5.7	2.46	32.35
	2AB	80-120	17.1	30.5	52.4	SL	10.03	0.26	24.8	5.5	90.07	0.19
	3C	>120	14	28	58	SL	9.6	0.22	24.6	5.2	7.44	0.2
5	A	0-30	28.3	24.4	47.3	SCL	8.03	0.35	24.8	6.65	14.85	3.33
	B_1	30-60	21.5	26.1	52.4	SCL	8.82	0.22	24.8	6.7	11.19	0.9
	B_2	60-105	25.5	40.3	34.2	L	9.16	0.19	24.9	3.91	13.13	0
	C	>105	5.1	52.2	42.7	SiL	9.33	0.2	23	1.9	2.95	0.79
6	A	0-35	30.6	31.8	37.6	SiCL	8.8	0.27	24.8	20.16	15.84	0
	B_1	35-80	25.5	42.5	42.5	L	10.07	0.2	24.9	4.42	13.15	0.12
	B_2	80-120	23.8	34	34	L	9.9	0.26	24.8	1.42	12.42	0.16
	C	>120	24	35	35	L	9.98	0.23	24.8	2.92	12.46	0.14
7	A	0-9	33.4	28.9	38.7	CL	9.64	0.25	24.8	3.97	16.7	0.5
	B_1	9-22	31	32	37	CL	9.14	0.26	24.9	0.054	16.02	3.16
	B_2	22-64	18.2	2.3	79.5	LS	8.54	0.13	24.5	11.15	9.36	0.75
	C_1	64-120	34	27	39	CL	9.58	0.27	24.7	0.94	17.54	60.83
	C_2	>120	32	25	43	CL	9.06	0.26	24.7	0.5	16.52	60.5
8	A	0-35	35	29	43	CL	8.45	0.26	24.9	14.53	18.02	0.6
	B_1	35-75	22.7	34.1	43.2	L	9.1	0.21	24.8	4.83	11.77	0.14
	B_2	75-120	30.5	40.5	29	CL	9.55	0.22	24.8	4.56	15.69	0.16
	C	>120	17.9	29.9	52.2	L	10	0.24	24.9	3.41	9.43	0.15
9	A	0-15	35.3	43	21.7	LC	8.74	0.3	24.7	5.31	18.25	1.9
	B_1	15-35	31.6	45	23.4	LC	8.98	0.24	24.9	3.98	16.28	2.03
	B_2	35-75	19.8	22.1	58.1	LS	8.85	0.16	24.8	2.9	10.22	0.37
	C_1	75-120	30.3	44	35.7	LC	9.45	0.23	23.8	1.42	15.61	30.81
	C_2	>120	34.4	30	35.6	LC	9.15	0.22	24.32	0.9	17.64	30.45

Abbreviations: C (clay), L (loam), SL (sandy loam) CL (clay loam), LS (loamy sand), LC (loamy clay), SiL (silt loam), SCL (sandy clay loam), SiCL (silt clay loam) estimated by the hydrometer method.

Table 2 Families of the representative soils in the study area

Profile number	Soil families (ST)
1	Fine mixed, superactive, mesic Sodic aplocambids
2	Loamy mixed, active, mesic, Typic Haplocalcids
3	Loamy mixed, active, mesic, Sodic Haplocambids
4	Coarse loamy mixed, active, mesic, Sodic Haplocambids
5	Loamy mixed, active, mesic, Sodic Haplocambids
6	Loamy mixed, active, mesic, Sodic Haplocambids
7	Coarse loamy, mixed, active, mesic, Sodic Haplocambids
8	Loamy, mixed, active, mesic, Sodic Haplocambids
9	Coarse loamy mixed, active mesic Sodic Haplocambids

Table 3 Climatic characteristics of the Ahar Meteological Station.

Temperature (°C):	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max. mean t°	2.6	3	8.8	16.3	20.9	25.5	17.7	27.1	24.6	17.8	11.5	5.5
Min. mean t°	-5.5	-5	-0.8	2.3	8	11.8	15.2	14.9	10.8	6.3	1.6	-2.3
Absol. max t°	15.6	17.4	21	26.5	30.2	34.2	36.4	36.4	35	29	22.5	17
Absol. min t°	-19	-20.5	-17.5	-11	-4	6	8	7.4	4	-2.5	-16.6	-19
Mean month°	-1.5	-0.6	4	10.3	14.5	18.7	21.5	21	17.7	12	6.6	1.6
Rainfall (mm)	18.44	19.2	38.9	42.7	14.4	29.4	5.3	9.1	9	33	31.1	22.2
Relative humidity (%)	68.7	69.7	67.4	60.7	59.8	56.3	51.4	55.8	56.1	62.1	61.5	67.5
Sunshine (hr)	4.74	5.15	5.13	6.29	7.57	9.1	9.59	8.82	8.08	6.16	5.36	4.36
Etp (mm)	26.7	35.6	55.8	95.6	131	171.8	191.4	179.6	138.2	85.6	50.6	34.3
1/2 calculated Etp (mm)	13.35	17.8	27.9	47.8	65.5	85.9	95.7	89.8	69.1	42.8	25.3	17.15

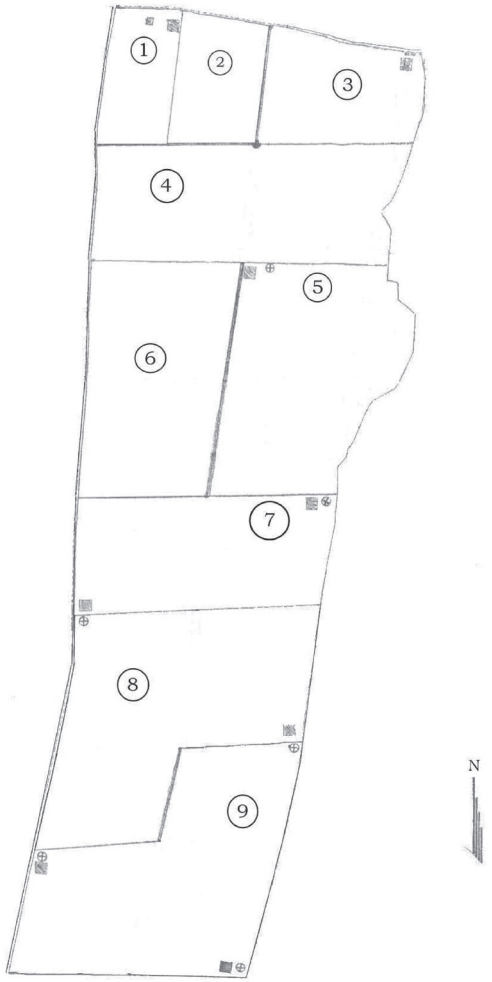

Figure 1 Representative soil profiles of the study area

Results and discussion

According to Vink (1960) report suitability is largely a matter of producing yield with relatively low inputs and also the crop need or influence of soil and site characteristics and identifying and delineation of land with the desirable attributes are two important stages in finding land suitability for specific crop. In this study specified requirements for wheat, barely, alfalfa, maize and safflower by Sys et al. (1993a) were used. In the region based on square root method an optimal climatic condition for irrigated barely and safflower makes high suitable classes, while climatic data during the growing cycle cause moderately and marginally suitable condition for wheat, alfalfa and maize respectively. Therefore the most important limiting factors are climate, pH, OC, CEC, gravel, salinity and sodicity, which their effects can appear alone or in combination. Simple limitation method, limitation method regarding number and intensity, and parametric methods (storie and square root method) were employed and classes of land suitability were determined. Evaluation by SLM and LMNI show similar suitability classes, while the accuracy of obtained results by the square root method is high and revealed to be more realistic in comparing with other methods result. Therefore soil attributes data such as pH, OC, gravel, salinity and sodicity had influence on the land suitability for barley, wheat, alfalfa, maize and safflower and resulted in:

1) mainly marginally (S3) to non suitable (N2) land classes by using the limitation methods , which there is some similarity to the obtained land suitability classes of barley, wheat, alfalfa and safflower by using the square root method, and

2) no suitable (N1-N2) classes by using the storie method (Tables 4.1 and 4.2). Also in the all part of the study area above named limiting factors cause non suitable (N1-N2) classes for maize by using the square method. Therefore According to the results of square root method cultivation of wheat, barely, alfalfa and safflower cultivation with marginally suitable class and 40–65% of optimal production are recommended respectively.

Table 4.1 Land suitability classes of the study area for barely, wheat, alfalfa based on different methods

Profiles	Barley				Wheat				Alfalfa			
	SLM	LMNI	Storie	Square root	SLM	LMNI	Storie	Square root	SLM	LMNI	Storie	Square root
1	N_{2fn}	N_{2fn}	N_2	N_2	N_{2fn}	N_{2fn}	N_2	N_2	N_{2fn}	N_{2fn}	N_2	N_2
2	S_{3sf}	S_{3sf}	N_1	S_3	S_{3s}	S_{3s}	N_1	S_3	S_{3sf}	S_{3cf}	N_2	N_1
3	S_{3sf}	S_{3sf}	N_1	S_3	S_{3s}	S_{3s}	N_1	S_3	S_{3sf}	S_{3sf}	N_2	N_1
4	S_{3f}	S_{3f}	N_1	S_3	S_{3s}	S_{3s}	N_1	S_3	S_{3f}	S_{3f}	N_1	S_3
5	S_{3f}	S_{3f}	S_3	S_3	S_{2cf}	S_{2cf}	S	S	S_{3f}	S_{3f}	N_2	S_3
6	N_{2fn}	N_{2fn}	N_2	N_2	N_{2fn}	N_{2fn}	N_2	N_2	S_{3fn}	S_{3fn}	N	N
7	N_{2f}	N_{2f}	N_2	N_2	N_{2f}	N_{2f}	N_1	N_1	N_{2fn}	N_{2fn}	N_2	N_2
8	S_{3sfn}	S_{3sfn}	N_2	N_1	S_{3sfn}	S_{3sfn}	N_2	N_2	S_{3sfn}	S_{3sfn}	N	N
9	N_{2f}	N_{2f}	N_2	N_1	N_{2f}	N_{2f}	N_2	N_1	N_{2f}	N_{2f}	N	N

Abbreviations: f (fertility limitation), n (salinity & sodicity limitations), s (soil limitation), c (climate limitation)

Table 4.2 Land suitability classes of the study area for maize, safflower based on different methods

Profiles	Maize				Safflower			
	SLM	LMNI	Storie	Square root	SLM	LMNI	storie	Square root
1	N_{2fn}	N_{2fn}	N_2	N_2	N_{2fn}	N_{2fn}	N_2	N_2
2	S_{3csf}	S_{3cf}	N_2	N_2	S_{3f}	S_{3f}	N_1	S_3
3	S_{3csfn}	S_{3cfn}	N_2	N_2	S_{3f}	S_{3f}	N_2	N_2
4	S_{3csfn}	S_{3cfn}	N_2	N_1	S_{3f}	S_{3f}	N_2	N_1
5	S_{3cfn}	S_{3cfn}	N_2	N_1	S_{3f}	S_{3f}	N_1	S_3
6	N_{2fn}	N_{2fn}	N_2	N_2	N_{2fn}	N_{2n}	N	N
7	N_{2fn}	N_{2fn}	N_2	N_2	N_{2f}	N_{2f}	N	N
8	N_{2n}	N_{2n}	N_2	N_2	N_{2f}	N_{2f}	N	N
9	N_{2fn}	N_{2fn}	N_2	N_2	N_{2f}	N_{2f}	N_2	N

Abbreviations: f (fertility limitation), n (salinity & sodicity limitations), S (soil limitation), c (climate limitation)

References

[1] FAO, 1976. A framework for land evaluation. Bulletin, 32, FAO, Rome, 72 pp.

[2] Gasemi Dehkordi, V. R., 1994. Soil study and land suitability evaluation Barkhar region of Isfahan. MSc. Thesis, Faculty of Agriculture, Soil Science Department. Tehran University.

[3] Jafarzadeh, A. A., Atabakazar, M. R., 2004. Land suitability evaluation of shakaryazi region for wheat, barely, alfalfa, sugar beet and safflower. Int. Conference of CIGR, Beiging, China. Session IV, part 5, no. 7, pp. 1-5.

[4] Jafarzadeh, A. A., Khoshzaman, T, Neyshabouri, M. R., Shahbazi, F., 2005a. Qualitative land suitability in Yakhfarvazan region of Ahar for wheat, barley, safflower, bean, soybean and potato. In: Int.Conference of ICEM, Hyderabad, India, pp. 342-348.

[5] Jafarzadeh, A.A, Momtaz,H.R., Neyshabouri, M.R., 2005b. Qualitative evalution of land in karkaj research station of Tabriz University for wheat, potato, maize, tomato, bean and alfalfa. In: Int.Conference of ICEM, Hyderabad, India, pp. 95-102.

[6] Jafarzadeh, A. A., Abbasi, G., 2006. Qualitative land suitability evaluation for the growth of onion, potato, maize, and alfalfa on soils of the Khalat Pushan research station. Biologia, Bratislava, 61/Suppl. 19, 349-352.

[7] Movahhedi Naeni, S. A. R., 1993. Land suitability evaluation of Gorghan area for main agricultural crops. MSc Thesis, Faculty of Agriculture, Soil Science Department, Tarbiat Modarres University.

[8] Saedi, S., Jafarzadeh, A. A., 2005. Detailed survey and soil classification of Bilverdy research station, 64 pp.

[9] Sarvari, S. A., Mahmoudi, S. H., 2001. Qualitative land suitability evaluation for irrigated sugar beet in Ghazvin region. Iranian Journal of Soil and Water. Special issue on soil survey and land evaluation, pp. 66-75.

[10] Shahbazi. F., Jafarzadeh, A. A., 2004. Qualitative evalution of land suitability in Khushe Mehr region of Bonab for wheat, barely, alfalfa, onion, sugar beet and maize. Agricultural Science, Scientific Journal of Faculty of

Agriculture, University of Tabriz, Vol.14, No.4, pp. 67-85.

[11] Sys, C., Van Ranst. E., Debaveye, J., 1991a. Land evaluation. Part I: Principles in land evaluation and crop production calculations. General Administration for Development Cooperation. Agric. Publ. No. 7.

[12] Sys, C. Van Ranst. E., Debaveye, J., 1991b. Land evaluation. Part II: Methods in land evaluation. General Administration for Development Cooperation. Agric. Publ. No 7. Brussels, Belgium, 247 pp.

[13] Sys, C. Van Ranst. E., Debaveye, J., 1993. Land evaluation. Part III: Crop Requirements. International Training Center for Post Graduate Soil Scientists. Ghent university, Ghent, Belgium, 199 pp.

[14] USDA, 2003. Soil Survey Manual. University Press of Pacific. Honolulu, Hawaii.

[15] USDA, 2006. Keys to Soil Taxonomy, 10th Edition.

[16] Vink, A. P. A., 1960. Qualitative aspect of land classification. In: Trans. 7th Int.Cong. Soil Science. Vol. 4, pp. 371-378.