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Qualitative assessment of land suitability for cultivation of irrigated wheat and barley by using simple limited and the number and limiting intensity method (case study; Esfarvarin region of Qazvin province)

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ABSTRACT

This study was conducted to qualitative assessment of land suitability for irrigated wheat and barley and evaluation the performance of land suitability evaluation methods. The study area is the Esfarvarin which is located in Qazvin province. To perform classification, profiles of each of the separate land units excavated and the soil samples were classified using the classification of the American. Given the required characteristics of wheat and barley are all in group of the thermal requirements, so the lowest temperature among this group be considered as an indicator of climate (Because irrigated and non-attention to the amount and distribution of rainfall). The climate does not limit in this area. Fitness classes by simple limited method in this area for irrigated wheat and barley is (S1) and by the number and limiting intensity method for both plants is (0). The results of the simple limited method are S1 and for the number and limiting intensity method is (0). In Dizan, Zia Abad, Naser Abad, Zakan, and Gharghashin series, the results for irrigated wheat and barley are the same and for the simple limited method are (S1) and for the number and limiting intensity method are (0). In Joharein series, the results for wheat and barley are same and for the simple limited method are (S1) and for the number and limiting intensity

method are (0) and the fitness class is good. In Nargeh series, the results of the simple limited method are (S2S) and the number and limiting intensity method are (2) for wheat and barley. In Kharrud series, the results of the simple limited method are (S2S) and the number and limiting intensity method are (2) for both plants and the fitness class is average that limiting factor is reported high rates of lime that its amount is 21.56 percent. In Ak series, the results of the simple limited method for both plants are (S2S) and the number and limiting intensity method are (2) and fitness class is average that limiting factor is reported high rates of lime that its amount is 20.06 percent.

1. Introduction

Soil studies were carried out for years in our country. This study provides information as the extent of fertile, limitations, and the distribution of soil types but does not specify land suitability for different crops. Identifying strengths of lands and assign them to the best and most profitable type of efficiency is particularly important. Efficient use of land causes the maximum productivity, and also each land be protected for use of future generations (Farajnia, 2012).

In the past, several methods were used to assess land such as Land Capability Classification Method USDA United States of America (Klingebiel and Montgomery, 1966) and Iranian approach to land classification (Mahler, 2005). This type of land classifications were made for overall productivity and could not be used to assess Crop Plants. That's why in 1976, FAO has developed Publication No. 32 and defined the types of efficiency and classified land suitability for specific uses. In compiling this publication, several methods based on the framework established in different countries (Gholizadeh, 2008).

Land suitability evaluation is well suited for identifying land boundaries, land use planning, specialization of crops in different regions, providing optimal cropping pattern and Food Policy (Mahler, 2005).

Walia and Chamuah (1990) by using the FAO guide did classification of land suitability for cultivation of rice and tea in Tyrap Arunachal of India by using physical, chemical and morphological specifications in soils of floodplains, range lands, and range of hills. Located soils on the slopes of hills and piedmont plain (high land) have a good fit for tea cultivation due to its strong acidity and high Al and soils of floodplains and lowlands are wet and suitable for rice cultivation due to the flood and poorly drained of soils. Chinene (1991) determined production rates and the proportion of farms in Kapyny of Zambia for three crops of maize, sunflower and flax using Zambian Land Evaluation System. The pattern of this method is the FAO Evaluation Guide. The results have shown that despite the high correlation between the estimated and actual performance, the difference between them is significant and this difference is related to different levels of Land Management (Hennebert et al, 1996).

Burundi to confirm the accuracy of FAO evaluation, made comparisons between predicted and observed performance in five products such as: wheat, peas, beans, corn and potatoes. Performance of these products was predicted by using climate, soil and land data and also technology of land use, and was compared with observed performance in field.

Due to the accurate estimation of crop yield, it is very convenient to use in planning of land use, specialization crops in different areas, food policy, evaluating the economic return and sustainability of products. Seyed Jalali (1388) assessed the qualitative suitability of land located in the Mianab region of Khuzestan privacy for rainfed and irrigated wheat crop by four methods: simple limited and the number and limiting intensity, Story and square root and reported that the most important limiting factors of wheat are climate restrictions, lime, drainage, salinity and alkalinity of soil. In this study, the potential of rainfed and irrigated wheat production in different units of land has been calculated using both the FAO and the OPT. Seyed Jalali (1385) performed statistical analysis by land production potential or anticipated performance of irrigated wheat in the current situation with the observed performance of farmer indicate good compliance of the prepared model with the terms of area.

Ferjina and Bagheri (2001) evaluate land suitability of coastal barrier of Sattarkhan dam in Ahar for crops irrigated and rainfed wheat, barley, alfalfa, sugar beets, corn and peas with three methods: simple limited, the number and limiting intensity, and square root and reported that the square root method have more consistent related to the simple limited, the number and limiting intensity method.

This study was carried out to assess the land suitability of different units for the cultivation of wheat, cotton, soybeans and check the accuracy of evaluation methods of the land suitability in the Gonbade Kavoos region. The purpose of this study is to assess the qualitative suitability of land for irrigated wheat and barley using the simple limited, the number and limiting intensity method Esfarvarin region of Qazvin province to close the performance of farmers to appropriate potential yield by eliminating correctable restrictions and promoting management.

Identify the production capacity of each land and choosing the user proportional to its production capacity are from ways to increase production per area unit or in other words, the efficient use of land. Determining the production potential and evaluating the land suitability are good ways to achieve this goal. Sugar beet is plant from temperate regions that is compatible with a wide range of soil and climatic conditions and resistant to environmental stresses, so is robust and resilient plant (Rezaee and et al, 1389). This product can be used in crop rotation to help the land reform process.

Several studies are done in different countries by lining method from 1970. In Kenya, Lining in 2006 made determine the characteristics of different types of land productivity as the main subjects of an investigation and outlined characteristics of several important types of productivity. Endarkuye in 2009 conducted a survey in Sudan and classify a large number of land evaluations to detail and then he explained each of the limitations degrees in relation to many types of land productivity. Young and Goldsmith in 2011 according to the FAO guidelines studied the land assessment for developing countries and conducted a case study in Malawi. In this research, Landform is separated based on geological maps, elevation, land form, average rainfall, vegetation and soil. In the next step, land quality was defined and graded for the main uses. Finally, land suitability classes were determined for different types of land-use by matching the needs of use type with land quality in different units.

This method of assessment has been carried out in Iran initially dispersed and in the form of research projects that can be pointed studies such as Ghasemi and Dehkordi (1385) and Malekzadeh and Baghernezhad (1389). In recent years, these studies have been used at higher levels, especially in the coastal areas of dams to help local authorities to determine the cropping pattern. Land suitability is one of the main stages of evaluation which can be compared based on it the fertility of land together. Estimate radiation - heat potential by using FAO model makes it possible to determine the net production of biomass using data on climate and vegetation. Predicted production is the result of the impact of restrictions of soil, water and management on production potential (Seyed Jalali, 1388).

Kazemi and Mahmudi (88) estimated production potential of irrigated wheat in the Tabriz Plain 6,700 kg per hectare and reported that these amounts will drop to 1250 kg per hectare due to constraints of land, soil and management. Rahnama and et.al (1388) estimated FAO method 68 tons per hectare for Sugar in Silakhor of Lorestan and reported that there was good correlation between land indices are calculated using parametric and the farmer functional. Seyed Jalali (1385) studied production potential and land suitability of 36,205 acres of Mianab in Shoshtar for irrigated and rainfed wheat. The results of this project showed that production potential of wheat is 6457 kg per ha by FAO method. The correlation coefficient is 0.77 percent compared with the actual functionality and concluded that this model have good agreement with the local condition. Potential production of rainfed wheat in this region varies from 150 to 1111 kg per ha that the most important limiting factors are Lime, drainage conditions, salinity, alkalinity, and the lack of rainfall.

1.2. Irrigation methods for wheat and barley

Wheat and barley are the main crops. It is well known that wheat is planted every day somewhere in the world and is picked the same day at another point. This implies that this plant is highly adaptable to various climates. Globally, nearly 52 percent of the world's arable land is devoted to growing crops (Emam, 1385).

Food production in recent years has a fundamental role in maintaining independence and global research are conducting to find new food and raise the yield and maximum utilization of agricultural potential. Due to population growth, food shortages and the need for it in the world are more pronounced day-to-day. On the other hand, in most parts of the world, water restrictions are much more than soil restrictions for agricultural production. So should be maximum use of the unit volume of water. And necessary research and planning will be done to produce the more products. In Iran about 7 million hectares of cultivated land and orchards are grown in

irrigated and semi-irrigated. In the recent decade, nearly 50% of arable land is devoted to irrigated wheat and barley. Unfortunately, the efficiency of water use in this sector is still not satisfactory and in some estimates irrigation efficiency is reported from 15 to 25 percent and according to the rainfall and limited water resources, it is necessary to deal with this issue (Tahmasebi 1389). Using of wheat planting method on wide ridges with less water which is deficit irrigation, is a strategy for achieving this goal. Many searches have been done in this regard and the different results obtained. They observed in soils with sandy to sandy clay loam that density, soil permeability and the soil structure improved in furrows and ridges method and grain yield was 18% higher than the flat planting. Akramghaderi (2010) in an experiment with saline soils and low quality water with fertilizers (N, Zn, Cu) and different methods of improve soil observed that the highest yield was for creating ridges and increases the yield affected by planting method was higher than fertilizer. Karfut and Kramer (2009) investigated effects of irrigation depth in deficit and full irrigation in all stages and results showed that shortening the irrigation interval increased wheat and barley. Boder in 2003 concluded in their study on the production of wheat and barley that protein levels are reduced in high yields. This study is a step in order to determine the optimum efficiency of water in wheat production with comparison of different planting methods and also determining the best time to irrigate again Based on depletion percentage of available water in the soil.

1.3. Introduction the area

Esfarvaryn city with an area of 1571 hectares and 300 hectares of urban area is located in the southwest of Qazvin at distance of 55 km from the city Qazvin. In 1368, the city had a population of about 9,000 people, and now, with growing population has a population of 15,000 people.

2. Materials and methods

This method consists of three steps: A- Collect the required data about land characteristics (soil and climate characteristics). B- Identify the needs of use types of land (Preparation of Tables of soil needs related to irrigated wheat and barley). C- Qualitative Evaluation of Land Suitability (simple limited and the number and limiting intensity method) (Ayobi and Jalalian 1385)

Investigated variables in the region

Climatic characteristics that are taken of Qazvin synoptic station during the ten-year period

Soil and land properties that are including topography and steep, wet (flood and drainage), texture, structure, stone, gravel, soil depth, percentage of lime and gypsum, soil acidity and salinity.

Investigated variables for irrigated wheat and barley in this study:

Tables of earth needs to irrigated wheat and barley

Tables of climate needs to irrigated wheat and barley

Studied Soil characteristics in this research for irrigated wheat and barley: A- Ups and downs: Because of the susceptibility of irrigated wheat and barley to water and given that the slope and topography will affect on irrigation, so the best slope for the wheat and the answer is 0-15 and show a strong sensitivity to the topography. B- The amount of gravel: Much gravel will affect on crop growth due to the rapid loss of water. C- Soil depth: The best depth for growth of this plant is above 100.D- The amount of lime: Both plants are sensitive to high levels of lime. E- The amount of gypsum: Both plants are sensitive to high gypsum and react to it. F- PH: suitable PH for growing these two plants is approximately neutral. G- Salinity: irrigated barley can tolerate salinity than wheat about twice, so roughly comparable to wheat and barley will be different. H- Sodium: Sodium has many effects on soil structure and soil permeability, especially in the way of irrigation. Also in terms of adverse effects on plants and plant is considerable.

Table 1
Climate requirements of Wheat.

Climatic characteristics	**Class of Restriction levels and climate Rankings**				
	S1	**S2**	**S3**	**N1**	**N2**
	0	**1**	**2**	**3**	**4**
	100 95	**85**	**60 40 0**		**25**
Rainfall during the growth cycle(mm)	-1000 450	350-450 1000-1250	250-350 1250-155	200-250 -1750 1500	---	200> 1750<
Rainfall in the growth phase of chlorophyll (mm)	45-90	20-45 90-120	12-20 120<	8-12	---	8>
Monthly rainfall at the flowering stage(mm)	60-90	30-60 90-120	15-30 120<	10-15	---	10>
Monthly rainfall at grain filling stage (mm)	55-80	30-55 80-120	10-30 120-150	10> 150<	---	---
The average temperature during the growth cycle (c0)	15-20	12-15 20-23	10-12 23-25	8-10 25-30	---	8> 30<
The average temperature during Chlorophyll grow (c0)	8-12	6-8 12-18	4-6 18-24	2-4 24-28	---	2> 28<
The average temperature during flowering stage (c0)	14-22	12-14 22-26	10-12 26-32	8-10 32-36	---	8> 36<
The average temperature during grain filling stage (c0)	16-24	14-16 24-30	12-14 30-36	10-12 36-42	---	10> 42<
The average temperature of the coldest month (c0)	8> If 21>	---	8< If 21>	13-8 If 21<	---	13< If 21<
Average of maximum temperature of the coldest month (c0)						

Source: Adapted from the Sys and et.al, 1991

Table 2
Soil and topographical requirements of irrigated wheat.

Land properties	Class of restriction levels and grading scale					
	S1		S2	S3	N1	N2
	0		1	2	3	4
	100	95	85	60	40	25	0	
Ups and downs:	-	-	-	-	-	-
Slope (%)						
Average of small roughness	0-15	15-30	30-60	>60	-	-
Wet of land:		-	F1	F2	-	
1-Flood	F0					F3+
2-Status of drainage		50-100	20-50	<20	-	-
2-1-Depths of less than 2 cm	>100					
2-2- Depth of Ground water (m)						
EC>1.5ds/m						
EC<1.5ds/m						
	>3	2-3	1-2	0.75-1	0.5-0.75	<0.5
	>2	1.5-2	1-1.5	0.5-1	0.25-0.5	<0.25
Physical Properties of Soil:		SCL,L,SC, CL				
1- Texture and structure	SiCL,SiCs,		SL	LS,Cm,SiCm	-	S
2-Amounts of stones and pebbles	Si C<60s	3-15	15-35			
3- Soil depth		60-90	30-60	35-55	-	>55
4-The amount of lime (%)	0-3	<3		10-30		<10
5- The amount of gypsum (%)	>90	20-35				
	3-20	3-5	35-50	50-60	-	>60
	0-3		5-10	10-25	-	>25
Soil fertility:	7.0-8.0	6.0-7.0	5.5-6.0	5.2-5.5	<5.2	-
pH		7.8-8.2	8.2-8.5	>8.5		
Salinity and alkalinity:						
1-EC (ds/m)	0-4	4-8	8-12	12-16	16-24	>24
2-ESP (%)	0-15	15-25	25-35	35-45	-	>45

Source: Adapted from the Sys and et.al, 1991.

Table 3
Climate requirements of irrigated barley.

Climatic characteristics	Class of Restriction levels and climate Rankings									
	S1			**S2**		**S3**		**N1**		**N2**
	0			**1**		**2**		**3**		**4**
		100		**95**	**85**	**60**	**40**	**25**	**0**	
Rainfall during the growth cycle(mm)	400-900	300-400 900-1100		200-300 1100-1300		150-200 1300-1500		---		150> 1500<
Rainfall in the growth phase of chlorophyll (mm)	35-80	15-35 80-95		10-15 95-120		5-10 120<		---		5>
Monthly rainfall at the flowering stage(mm)	50-80	20-50 80-100		10-20 100-120		6-10 120<		---		5>
Monthly rainfall at grain filling stage (mm)	45-70	20-45 70-90		10-20 90-120		10> 120<		---		---
The average temperature during the growth cycle (c0)	8-12	6-8 12-18		4-6 18-24		2-4 24-28		---		2> 28<
The average temperature during Chlorophyll grow (c0)	14-22	12-14 22-26		10-12 26-32		8-10 32-36		---		8> 36<
The average temperature during flowering stage (c0)	16-24	14-16 24-30		12-14 30-36		10-12 36-42		---		10> 42<
The average temperature during grain filling stage (c0)	8>			8<		8-13				13<
The average temperature of the coldest month (c0)	IF 21>	---		IF 21>		IF 21<		---		If 21<

Table 4
Soil and topographical requirements of irrigated barley.

Land properties	Class of restriction levels and grading scale					
	S1		S2	S3	N1	N2
	0		1	2	3	4
	100	95	85	60	40	250
Ups and downs:						
Slope (%)	-	-	-	-	-	-
Average of small roughness	0-15	15-30	30-60	>60	-	-
Wet of land:						
1-Flood	F0	-	F1	F2	-	F3+
2-Status of drainage						
2-1-Depths of less than 2 cm	>100	50-100	20-50	<20	-	-
2-2- Depth of Ground water (m)						
EC>1.5ds/m	>3	2-3	1-2	0.75-1	0.5-0.75	<0.5
EC<1.5ds/m	>2	1.5-2	1-1.5	0.5-1	0.25-0.5	<0.25
Physical Properties of Soil:	SiCL ,SiCs,	SCL,L,SC,	SL	LS,Cm,Si	-	S
1- Texture and structure	sIl	CL	15-35	Cm	-	>55
2-Amounts of stones and	C<60s	3-15	30-60	35-55	-	<10
pebbles	>90	60-90	35-50	10-30	-	>60
3- Soil depth	3-20	<3	5-10	50-60	-	>25
4-The amount of lime (%)	0-3	20-35		10-25		
5- The amount of gypsum (%)		3-5				
Soil fertility:						
pH	7.0-8.0	6.0-7.0 7.8-8.2	5.5-6.0 8.2-8.5	5.2-5.5 >8.5	<5.2	-
Salinity and alkalinity:						
1-EC (ds/m)	0-8	8-12	12-16	16-20	20-25	>25
2-ESP (%)	0-15	15-25	25-35	35-45	--	>45

Source: Adapted from the Sys and et.al, 1991

Table 5
Results of the evaluation of climatic characteristics for irrigated wheat.

Climatic characteristics	Information	simple Limited	the number and limiting intensity method
The average temperature during the growth cycle (c0)	12	S1	1
The average temperature during Chlorophyll grow (c0)	7.2	S1	1
The average temperature during flowering stage (c0)	15.7	S1	0
The average temperature during grain filling stage (c0)	21.6	S1	0
Average minimum temperature of the coldest month (c0)	-8.9	S1	0
Average maximum temperature of the coldest month (c0)	1.7		
Final Evaluation	--	S1	1

Table 6
Results of the evaluation of climatic characteristics for irrigated barley.

Climatic characteristics	Information	simple Limited	the number and limiting intensity method
The average temperature during the growth cycle (c0)	7.2	S1	0
The average temperature during Chlorophyll grow (c0)	14.4	S1	0
The average temperature during flowering stage (c0)	20	S1	0
Average minimum temperature of the coldest month (c0)	-8.9	S1	0
Average maximum temperature of the coldest month (c0)	1.7		
Final Evaluation	--	S1	1

Source: Adapted from the Sys and et.al, 1991.

2.1. Restriction method

Simple restriction method: in this method, needs of land use be compared with the characteristics or quality of land and the most undesirable characteristic or quality of Class of land known as land suitability classes.

The number and limiting intensity method: In this way, the limitations of the quality and characteristics of land is defined as follows: No restrictions (0). Low restrictions (1). Moderate restrictions (2). Severe restrictions (3). Very severe restrictions (4) (Ayobi and Jalalian, 1385).

3. Results and discussion

Given that, the required characteristics of irrigated wheat and barley are all in the thermal requirements (Due to irrigated planting and lack of attention to the amount and distribution of rainfall) so, the lowest degree among the group is considered as a Climate Index. The climate of this region does not limit and Fitness class for irrigated wheat and barley is (S1) by simple limited in this area and is (1) by the number and limiting intensity for both plants. Summarizing the results of the evaluation of soil series in the area for irrigated wheat and barley are as follows:

In Dizan, Zia Abad, Naser Abad, Zakan, and Gharghashin series, the results for irrigated wheat and barley are the same and for the simple limited method are (S1) and for the number and limiting intensity method are (0). In Joharein series, the results for wheat and barley are same and for the simple limited method are (S1) and for the number and limiting intensity method are (0) and the fitness class is good. In Nargeh series, the results of the simple limited method are (S2S) and the number and limiting intensity method are (2) for wheat and barley. In Kharrud series, the results of the simple limited method are (S2S) and the number and limiting intensity method are (2) for both plants and the fitness class is average that limiting factor is reported high rates of lime that its amount is 21.56 percent. In Ak series, the results of the simple limited method for both plants are (S2S) and the number and limiting intensity method are (2) and fitness class is average that limiting factor is reported high rates of lime that its amount is 20.06 percent.

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