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Full Length Research Paper

Qualitative land suitability evaluation for Tobacco (*Nicotiana tabacum*) in Talesh, Iran

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Land suitability assessment was conducted for flue-cure Tobacco (*Nicotiana tabacum*) in an area including 2880 ha in Talesh site in Guilan province, north of Iran. Using the findings of the semi-detailed soil studies for this area, 18 land units were selected. Then morphological and physico-chemical properties were determined. The results showed that soils were in three orders (Inceptisols, Entisols and Alfisols). The simple limitation method, the limitation method regarding number and intensity (second method) and the parametric methods including the Square root and the Storie methods were used for qualitative land suitability evaluation. Results of simple limitation method and the limitation method regarding number and intensity showed similar marginally suitability classes (S3). According to these methods, the major limiting factors were climate (total rainfall), fertility (pH and $CaCO_3$) and physical soil (texture) characteristics. In addition, the results of Storie method showed unsuitable condition (N2) for all of land units. The results of root square method showed non-suitable but correctable conditions (N1) for 13 land units and unsuitable condition (N2) for other land units. Based on these results (especially on those obtained with the parametric square-root method, which seems to be the best), the cultivation of tobacco cannot be recommended for this area.

Key words: Flue-cure tobacco, land suitability, qualitative land evaluation, soil characteristics.

INTRODUCTION

The land contains all components of physical environment in an ecosystem that affect on land use capabilities. These characteristics include climate, topography, soil, hydrology, vegetation, geology, animal and plant population (Rossiter, 1994).

The problem of selecting the correct land for the cultivation of a certain agriculture product is a long-standing and mainly empirical issue. Although many researchers, organizations, institutes and governments have tried to provide a framework for optimal agricultural land use, it is suspected that much agricultural land is used at below its optimal capability (Boonyanuphap et al., 2004). The land use planning involves making knowledgeable decisions about land use and the environment. Soil information is a vital component in the planning process, reflecting directly upon land-use suitability (Coleman and Galbraith, 2000).

In tobacco (*Nicotiana tabacum*), the commercial product is the leaf, which is the most dynamic part of the plant. It follows that the conditions in which the plant grows and develops have a strong influence on the end product, sometimes with contrasting quantitative results (Papenfus and Quin, 1984). Tobacco varieties are grouped according to type (flue-cured, light and dark air-cured, fire-cured and sun-cured) and differ in their specific characteristics and pedoclimatic requirements and for the drying or curing technique used on the leaves

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to obtain a commercially acceptable and storable product (Castelli and Costantini, 2009). Climate and soil characteristics, hydrological conditions and nutrient requirements all contribute to defining the suitability of a given environment for the cultivation of tobacco. Castelli and Costantini (2009) reported that some of these requirements are common to different types of tobacco grown in Italy. The soil can strongly influence tobacco characteristics such as the size, texture and color of the leaves (Castelli and Costantini, 2009). Leaf quality has always been below average, purportedly due to unsuitable soil and climatic conditions, as well as inadequate management (Orphanos and Metochis, 1990).

Despite of numerous studies land suitability evaluation for some of crops such as tea (Darvishi Foshtomi et al., 2011), German chamomile (Ghasemi Pirbalouti et al., 2011), cereal crops (Bagherzadeh and Mansouri Daneshvar, 2011), barley (Ashraf et al., 2011), olive (Rahimi Lake et al., 2009) and onion, potato, maize, and alfalfa (Jafarzadeh and Abbasi, 2006), in recent years in Iran, there were a few studies about cultivation of tobacco.

In the only study land about suitability evaluation for tobacco in Iran, Rezaei et al. (2010) performed an experiment land suitability evaluation for tobacco burley 21 in 13200 ha total area in the Marivan plain and near Zaribar Lake in Kurdistan province. They reported that the study zone is suitable from climate point of view and determination of suitability final class depends on land, type of cultivation, and management of production for cultivation of tobacco.

In recent years, computing technologies combined with GIS software have enabled a countless number of reports and the land evaluation FAO framework for addressing old and new challenges especially at the regional scale (Bagherzadeh and Mansouri Daneshvar, 2011). GIS has the ability to perform numerous tasks utilizing both spatial and attribute data. This powerful tool allows decision markets to simulate effects of management and policy alternatives within a geographic area prior to implementation (ESRI, 1996). In addition, GIS is a tool that can be used to predict alternative crop growth and yield (Ghasemi Pirbalouti et al., 2011).

The main objective of this study was to evaluate land suitability for tobacco based on simple limitation and parametric evaluation methods (Storie and Square root method) for Talesh, in Guilan province, Iran.

MATERIALS AND METHODS

Field description and sampling

The research was conducted in Guilan province in north of Iran. The study area is about 2880 hectare in areas of Talesh, located between 37° 52´ 7˝ (318254.9 m in UTM system) to 37° 55´ 13˝ (313308.9 m in UTM system) northern latitude and 48° 52´ 34˝(4199093 m in UTM system) to 48° 56´ 1˝ (4193265 m in UTM system) eastern longitude (Figure 1). The average annual precipitation and temperature of the region are 1080 mm and 16°C, respectively. Annual air humidity is 82% (determined by climatic maps). Climatic data were prepared from Rezvanshar synoptic weather forecasting data station that is nearest station to study area (Table 1). The tobacco growth cycle (about 145 day) on Talesh sites were from 1 May (Planting) to 23 September (Harvest). After interpretation of aerial photographs with scale 1:20000 and output results obtained from DEM/GIS, profiles were dug. In order to obtain a reliable soil data, the soil survey reports from the profiles inspected and then 18 profiles within different land units (Figure 2) were chosen as representative for a more detailed investigation. Morphological characteristic of horizons for the selected profiles were determined by field book for description and sampling soils that was presented by Schoeneberger et al. (2002) (Annex 1).

Laboratory analysis

Physical and chemical properties of the sieved soil samples (<2 mm) were determined after being air-dried. Particle size analysis by hydrometer method (Gee and Or, 2002), and bulk density by clod method (Blake and Hartge, 1986) were measured. The samples pH values were measured in the mixture of soil/water (1:1) (Thomas, 1996). Electrical conductivity (EC) was determined in a saturation extract of soil using conductivity meter (Rhoades, 1996). Organic carbon (OC) content was measured by the Walkley–Black wet oxidation method (Nelson and Sommers, 1996). Calcium carbonate was determined by simple titration method with 0.1 M HCl (Loeppert and Suarez, 1996). Cation exchange capacity (CEC) was determined using sodium acetate (NaOAc) at pH=8.2 (Sumner and Miller, 1996). Exchangeable cations (Ca, Mg, Na and K) were extracted using 1 M ammonium acetate (pH=7.0) and were determined by atomic absorption and flame emission spectrometer (Suarez, 1996; Helmke and Sparks, 1996).

Land suitability evaluation

A wide range of limiting physical, economic and social factors can restrict suitability of the land for different kinds of use (FAO, 2007). In evaluating of the qualitative land suitability, land properties were compared with the corresponding plant requirements presented by Sys et al. (1993). For qualitative land suitability investigation, simple limitation method, limitation regarding number and intensity method and parametric methods (Storie and square root) were used.

Simple limitation method (SLM)

The simple limitation method implies that the crop requirement tables are made for each land utilization type. Land classes are determined according to the most limiting characteristics. The advantage of this method is its simplicity and there is no overlap and interaction between, so many features can be used in evaluating (Sys et al., 1991).

Limitation method regarding number and intensity of limitations

In this method, firstly, climate class identifies, so, the climatic characteristics, are divided to 4 groups: Radiation, temperature, rainfall and humidity. To determine the climatic suitability class which is then used as the corresponding limitation level, the most severe limitation determine in each of this groups and subclass and climate limitation level according to table. This method is more difficult than SLM, but the approach is more accurate, because it

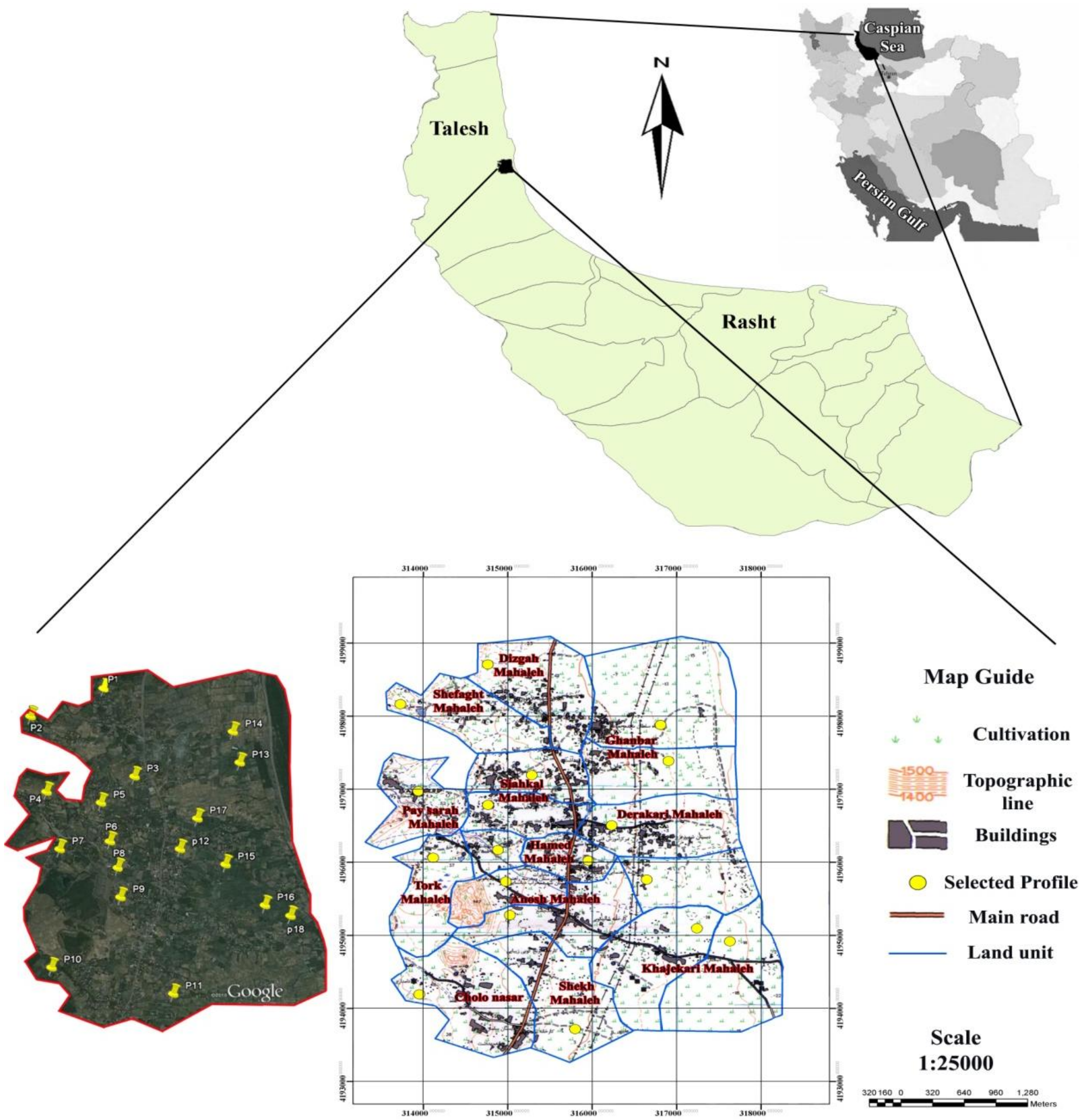

Figure 1. Study area in Talesh in Guilan province (north of Iran).

Table 1. Climatic characteristics from the Rezvanshar metrological station.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly temperature (°C)												
Max. mean	9.3	10.3	11.8	16.5	21.8	26.6	29.8	30.2	25.2	20.9	15.2	10.2
Min. mean	3.2	3.3	5.4	9.8	14.3	18.5	21.2	21.7	18.5	14.3	9	5
Absol. Max.	17.4	21.9	19.9	25.2	27.7	31	32.5	34.4	30.9	26.5	21.4	22.4
Absol. Min	-1.5	-1.5	0.8	4.3	9.8	14.2	17.6	18.4	14.9	9.2	4	-0.6
Mean monthy	10.9	6.8	8.6	25.3	18	22.1	25.5	28.3	21.8	17.6	21.1	7.4
Total Rainfall (mm)	105	104	132	80	88	55	41	90	258	217	194	120
Mean relative humidity (%)	84	82	84	83	11	75	73	75	83	76	86	84
Sunshine hours hrs/day	93	116	118	142	204	259	275	229	137	126	93	87
Day length (h)	3.1	4	3.8	4.8	9.6	8.6	9.2	7.4	4.6	4.1	3.1	2.8
Mean wind speed in 2 m (m/s)	1.15	1.1	1.2	1.4	1.3	1.5	1.2	1.15	1.05	1	1.2	1.15
Potential ET (mm) mm/day	26	29	45	96	140	132	160	134	76	55	28	20
½ ETp (mm.day-1)	13	14.6	22.6	48	70.1	65.8	80.1	66.9	37.9	27.4	13.8	9.9

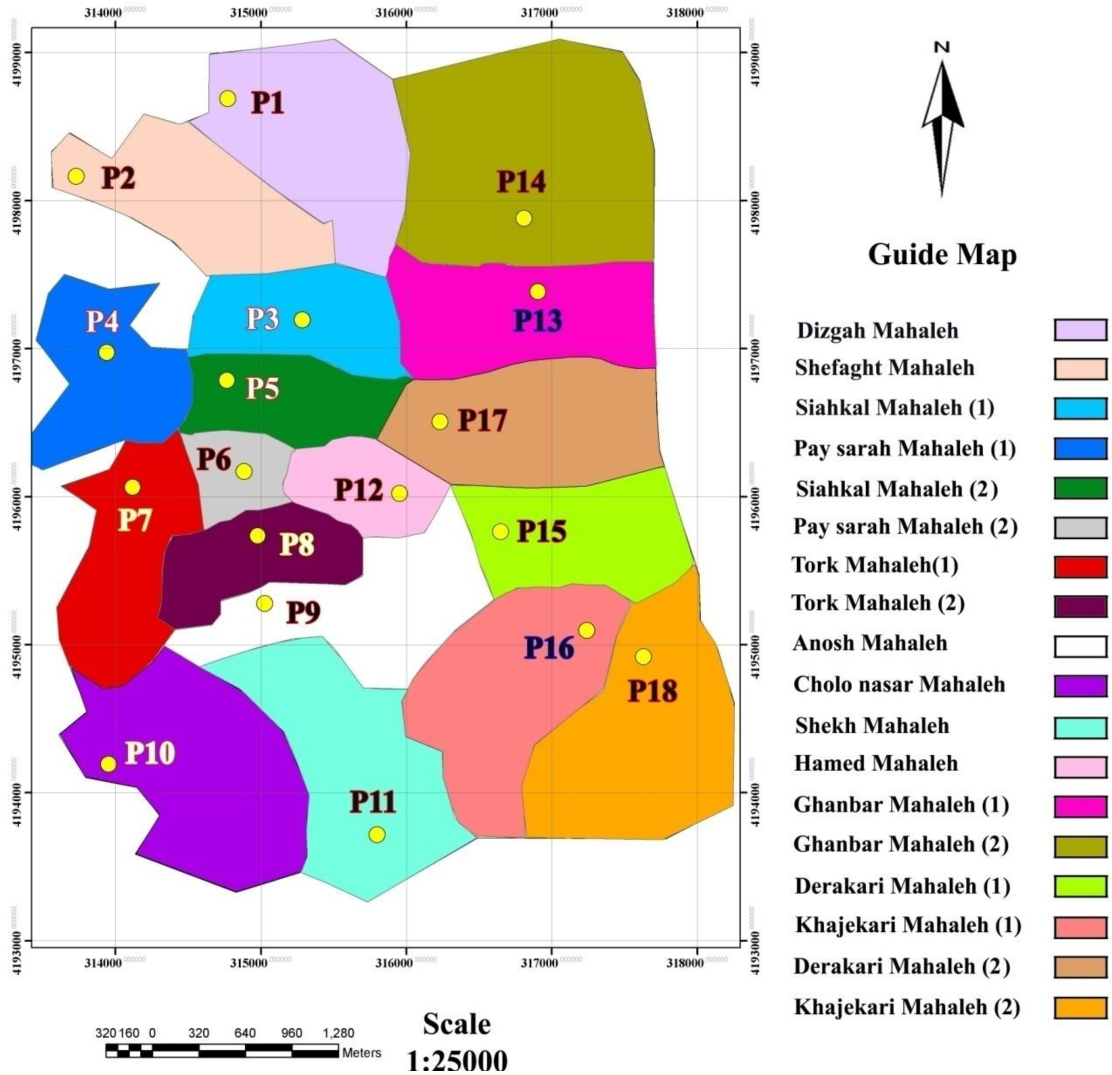

Figure 2. Study area based on land units.

considers the land with several limitations of the same level as belonging to a lower-class land than that with only a single limitation of the same level (Sys et al., 1991).

Parametric methods (PM)

The parametric method in the evaluation of land characteristics consists in a numerical rating of the different limitation levels of land characteristics in a numerical scale from a maximum (normally 100) to a minimum value. Finally, the climatic index, as well as the land index, is calculated from these individual ratings (Sys et al., 1991). The calculation of these indices can be carried out through following two procedures (Equations 1 and 2):

1. The Storie method (Storie, 1976):

$$I = A \times \frac{B}{100} \times \frac{C}{100} \times ... \qquad (1)$$

Where, I = index (%) *A*, *B*, *C* etc. = ratings (%) 2. Square root method (Khiddir, 1986):

$$I = R_{\min} \times \sqrt{\frac{A}{100} \times \frac{B}{100} \times ...} \qquad (2)$$

Where I = index (%) $R_{\min}$ = minimum rating (%) *A*, *B*, *C* etc. = remaining ratings (%). Application of these methods implies that requirement tables have to be produced for each land utilization type. We compared the land characteristics with the plant requirements tables introduced by Sys et al. (1993). For determination, the limits of land classes we used pattern introduced by Sys et al. (1991). The land suitability classes are defined as follows:

1. Lands having indexes >75 are in S1 (very suitable) class.
2. Lands having indexes 50-75 are in S2 (moderate suitable) class.
3. Lands having indexes 25-50 are in S3 (marginal suitable) class.
4. Lands having indexes < 25 are in N (non-suitable) class.

Of course, there is a sub division for N class as N1 and N2 classes. For N1 class, correction is possible in the future but N2 class has not any correction in future. In addition, after determination of qualitative and economic land suitability classes, we presented the output results as georeferenced soil suitability maps using Arc GIS

Table 2. Results of qualitative land suitability for tobacco.

Land unit	Slope (%)	Flooding[a]	Drainage	Texture[b]	Coarse fragment (%)	Soil depth	$CaCO_3$ (%)	CEC[c] (Cmol.kg^{-1})	TEB[d] (Cmol.kg^{-1})	pH	EC[e]	OC[f] (%)	ESP[g] (%)	B.S[h] (%)
1	0	F0	Moderate	SL	17	140	4.4	7.7	8.8	6.2	0.5	1.7	0.9	47
2	1	F0	Moderate	SL	5.5	140	6.1	12.7	4.5	6.1	0.5	2.7	3.2	24.4
3	1	F0	Moderate	SL	35.5	145	8.2	8.4	4.5	5.8	0.35	1.7	2.6	38.3
4	2	F0	Moderate	SL	5.8	140	4.4	8.9	4.2	6.9	0.3	2.1	2.2	43.4
5	1	F0	imperfect	LS	36	135	8.6	7.4	3.6	6.6	1.2	1.6	7.7	43.5
6	3	F0	Moderate	S	39	135	9.5	8.0	4.0	7.9	0.8	1.8	1.7	47.9
7	3	F0	Moderate	SL	37	150	4.6	8.2	4.2	6.9	0.7	1.4	3.1	57.5
8	0	F0	Moderate	LS	18	148	5.7	9.8	3.5	7.9	0.5	1.8	2.1	35.5
9	0	F0	Moderate	LS	8.5	143	5.2	5.2	5.4	7.9	0.5	1.7	7.1	55
10	2	F0	Moderate	SL	2	130	2.5	2.5	10.4	5.9	0.8	1.7	3.3	62
11	3	F0	imperfect	LS	38	122	4.4	4.5	4.1	6.8	0.5	2.1	3.1	38.1
12	2	F0	Moderate	SL	34	145	6.1	6.1	5.9	7.9	0.6	1.7	1.5	59
13	2	F0	Moderate	S	37.5	125	5.7	5.7	3.7	6.7	0.3	1.7	3.2	38
14	1	F0	Moderate	SL	4.5	128	4.2	4.2	6.1	7.9	0.5	1.8	0.6	41.6
15	3	F0	Moderate	SL	4.8	102	7.2	7.2	4.2	6.6	0.4	2.1	1.2	52
16	2	F0	Moderate	SL	5.5	92	2.6	2.6	3.7	7.9	0.5	2.1	2.5	26.6
17	3	F0	Moderate	SL	37	120	4.0	4.2	8.8	6.9	0.35	2.7	2.7	65
18	1	F0	Moderate	SL	35.7	53	4.9	4.9	7.9	6.7	0.7	1.9	5.5	61

[a]Flooding: F0- no flood limitation, the land is higher than the highest water level; [b]Texture class: SL- sandy loam, S- sandy, LS- loamy sand; [c]CEC- Cations exchange capacity; [d] TEB- total exchangeable bases; [e]EC- electrical conductively; [f]OC- organic carbone; [g]ESP- exchangeable sodium percentage, [h]B.S- base saturation.

software version 9.2.

RESULTS AND DISCUSSION

On the basis of performed morphology studies and physico-chemical analysis in selected lands (Annex 2), soils were classified as Inceptisols (for land units No. 1, 3, 6, 7, 8, 9, 13 and 16), Alfisols (for land units No. 2, 4, 10, 11, 12, 14, 15 and 17) and Entisols (for land units No. 5 and 18) (USDA, Soil Survey Staff 2010). Soil texture is majorly light in surface and bottom levels and soils have three texture classes sandy loam (SL), sandy (S) and loamy sand (LS).

Results of qualitative land suitability for tobacco were presented in Table 2. There was not any problem from the point of flooding in land units and all of land units were higher than the highest water level (Table 2). Moreover, the only problem of drainage was observed in land units with No. 5 and 11 that were imperfect and other land units had moderate drainage. Castelli and Costantini (2009) reported that soil must drain rapidly and have a good load-bearing capacity, so that machinery can have access after rainfall. The coarse fragment was high (>30%) in some land units (No. 3, 5, 6, 7, 11, 12, 13, 17 and 17) that was a limitation. The lowest value of soil depth was observed in land unit No. 18 that was 53 cm. The $CaCO_3$ was a limitating factor in some land units. The $CaCO_3$ values ranged from 2.5 (in land unit No. 10) to 9.5 (in land unit No. 6) (Table 2). This factor affected on pH values. The pH values ranged from 5.8 (in land unit No. 3) to 7.9 (in land units No. 6, 8, 9, 12, 14 and 16). The CEC values were very low that can be associated to OC and clay contents (Bohn et al., 2003). The CEC values ranged from 2.6 (in land unit No. 16) to 12.7 (in land unit No. 2). The OC values were very low that can be related to plough and cultivation. The OC values ranged from 0.3 (in land units No. 4 and 13) to 2.7 (in land units No. 2 and 17). The EC values ranged from 0.3 (in land unit No. 4) to 1.2 (in land unit No. 5). The ESP values ranged from 0.6 (in land unit No. 14) to 7.7 (in land unit No. 5). The OC, EC and ESP were low, so they were very suitable (S1 class). Furthermore, the TEB values ranged from 3.5 (in land unit No. 8) to 10.4 (in land unit No. 10). The BS values ranged from 24.4 (in land unit No. 2) to 65 (in land unit No. 17).

Qualitative land suitability and climatic suitability classes for tobacco plantation in study area (Table 3) showed that all land units had marginal climatic suitability class (S3) (Figure 3a). The limiting factor in determining climatic suitability classes was total rainfall in tobacco growth cycle.

Results of qualitative suitability class in simple limitation method showed that all of land units had marginal suitability class (S3) (Figure 3b). Based on, land units No. 1, 4 and 10 only had climatic limitation and land units

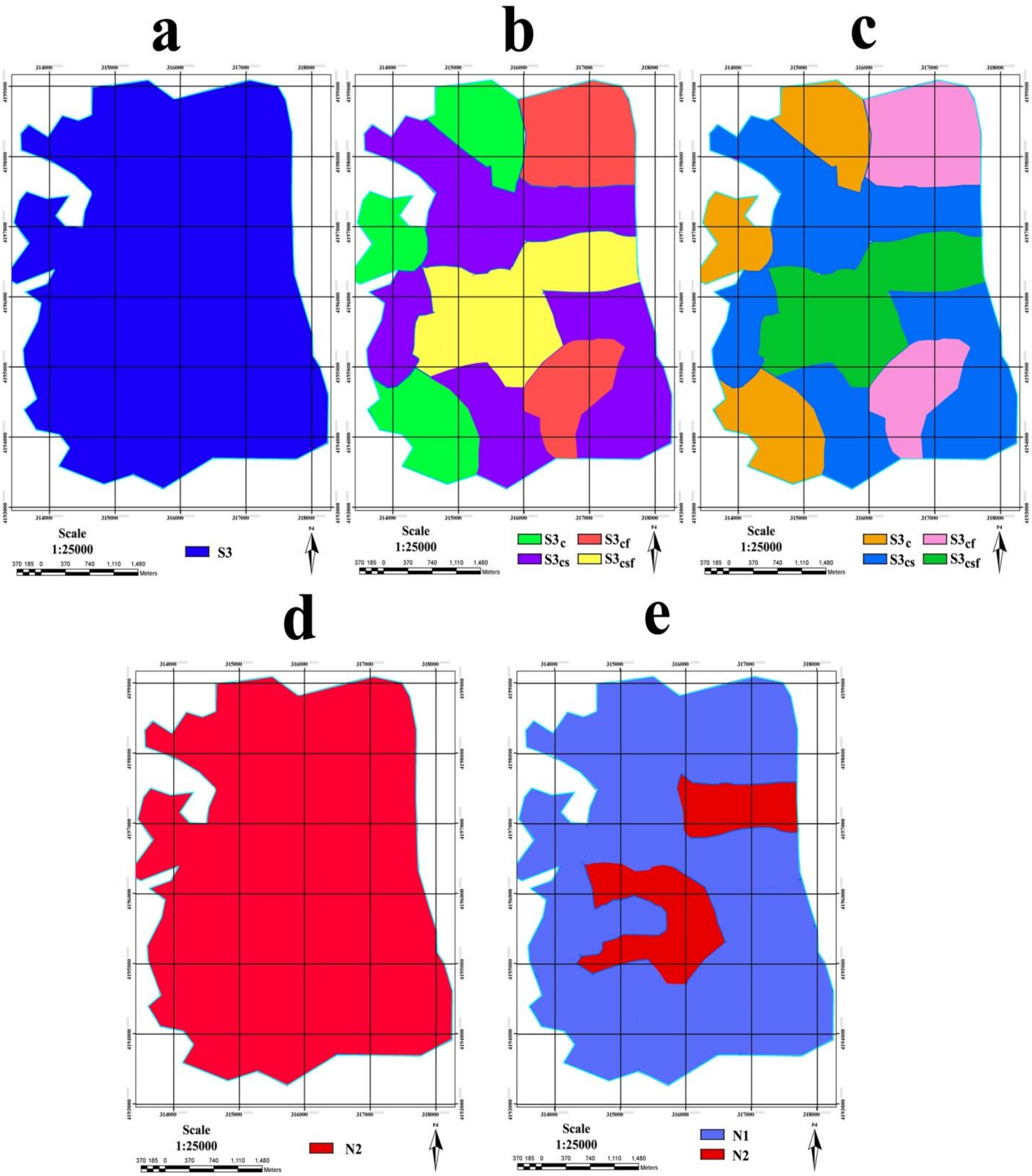

Figure 3. Qualitative land suitability evaluation maps of study area obtained from: (a) Climatic suitability class, (b) simple limitation method, (c) limitation regarding number and intensity method, (d) Storie parametric method, and (e) Root square parametric method (scale: 1:25000).

No. 2, 3, 5, 7, 11, 13, 15, 17 and 18 had climatic and soil physical characteristics. Land units No. 14 and 16 had climatic and soil fertility characteristics. Furthermore, land units No. 6, 8, 9 and 12 had climatic, soil fertility and soil physical characteristics (Table 3). The results of Rezaei et al. (2010) showed that simple limitation method identified a marginally suitable class (S3) in land units located at Zaribar, Veleh Zhir, Marivan for Burley tobacco. Results of qualitative suitability class in limitation regarding number and intensity method accurately were quite similar to those of the simple limitation method (Figure 3c).

Table 3. Qualitative land suitability and climatic suitability classes for tobacco plantation in study area.

Land unit	Area		Climatic suitability class	Qualitative suitability class					
	ha	(%)		Simple limitation*	Limitation regarding number and intensity	Parametric (Storie)		Parametric (Root square)	
						Land index	Land class	Land index	Land class
1	195.84	6.8	S3	$S3_c$	$S3_c$	3.6	N2	15.45	N1
2	152.64	5.3	S3	$S3_{cs}$	$S3_{cs}$	5.03	N2	14.35	N1
3	112.32	3.9	S3	$S3_{cs}$	$S3_{cs}$	5.13	N2	12.50	N1
4	126.72	4.4	S3	$S3_c$	$S3_c$	6.29	N2	20.6	N1
5	97.92	3.4	S3	$S3_{cs}$	$S3_{cs}$	6.2	N2	12.83	N1
6	48.96	1.7	S3	$S3_{csf}$	$S3_{csf}$	2.34	N2	6.23	N2
7	141.12	4.9	S3	$S3_{cs}$	$S3_{cs}$	5.709	N2	12.5	N1
8	95.04	3.3	S3	$S3_{csf}$	$S3_{csf}$	5.53	N2	13.30	N2
9	164.16	5.7	S3	$S3_{csf}$	$S3_{csf}$	4.11	N2	10.56	N2
10	227.52	7.9	S3	$S3_c$	$S3_c$	7.39	N2	21.82	N1
11	207.36	7.2	S3	$S3_{cs}$	$S3_{cs}$	5.15	N2	12.69	N1
12	72.00	2.5	S3	$S3_{csf}$	$S3_{csf}$	4.39	N2	11.53	N2
13	167.04	5.8	S3	$S3_{cs}$	$S3_{cs}$	5.67	N2	8.82	N2
14	316.8	11	S3	$S3_{cf}$	$S3_{cf}$	6.31	N2	13.30	N1
15	141.12	4.9	S3	$S3_{cs}$	$S3_{cs}$	5.76	N2	13.34	N1
16	204.48	7.1	S3	$S3_{cf}$	$S3_{cf}$	2.34	N2	13.55	N1
17	181.44	6.3	S3	$S3_{cs}$	$S3_{cs}$	4.90	N2	12.82	N1
18	227.52	7.9	S3	$S3_{cs}$	$S3_{cs}$	5.9	N2	12.89	N1

*c - climate limitations; f - Fertility limitations; s - Physical soil characteristics limitations.

Results of qualitative suitability class in parametric (Storie) method showed that all of land units had non-suitable class (N2) (Figure 3d). Based on, land index values ranged from 2.34 (in land units No. 6 and 16) to 7.39 (in land unit No. 10) (Table 3), which however, is an unrealistic result. Results of qualitative suitability class in parametric (Square Root) method showed that all of land units had non-suitable class (Figure 3e). Based on, the lowest values by Square Root were found in the map units 6, 8, 9, 12 and 13 where soil conditions were unfavorable (in class N2) due to pH, $CaCo_3$ and texture. Furthermore, land index values in Square Root ranged from 6.23 (in land unit No. 6) to 21.69 (in land unit No. 10) (Table 3). Land index values in Square Root method were higher than Storie method. The results obtained by the parametric squareroot method are probably more realistic, as suggested by comparison with other reports (Shahbazi and Jafarzadeh, 2004; Jafarzadeh and Abbasi, 2006; Malekian and Jafarzadeh, 2011; Darvishi-Foshtomi et al., 2011).

Conclusion

This study leads to the following conclusion.

1. Generally, the area is highly marginally suitable (S3) from the climatic point of view for tobacco. The major limiting factor in tobacco production is total rainfall during the plant growth.
2. Soil limitations are posed mainly by the texture, high pH and $CaCO_3$ either alone or in combination.
3. Results of qualitative suitability class in simple limitation method accurately were quite similar to those of the limitation regarding number and intensity method. Results of these methods showed that all of land units had marginal suitability class (S3).
4. Based on the parametric storie and square-root methods, the entire region is non-suitable for

tobacco. Based on these results (especially on those obtained by the parametric square-root method, which seems to be the best), the cultivation of tobacco cannot be recommended for this area.

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ANNEX

Annex 1. Some morphological properties of horizons for the selected profiles.

Land unit	Location	Horizon	Depth (cm)	Color (moist)	Texture Class[a]	Roots[b]	Structure[c]	Boundary[d]	Consistence			Gravel (%)
									Dry[e]	Moist[f]	Wet[g]	
Profile 1 Coarse Loamy skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)												
1	Dizgah Mahaleh	A	0-24	10YR3/3	SL	1vf	3fgr-2fabk	CW	lo	lo	so/po	-
		B1	24-40	10YR3/4	SL	1f	2mabk	GS	so	vfr	ss/ps	-
		B2	40-56	10YR3/5	LS	1f	2mabk	GS	so	vfr	ss/ps	2
		C1	56-70	10YR3/5	S	1f	sg	GS	sh	fr	ss/ps	12
		C2	70-78	10YR4/4	S	1f	m	GS	sh	fr-fi	ss/ps	18
		C3	78-110	10YR4/4	S	1f	m	GS	sh	fr-fi	ss/ps	20.3
		C4	110-140	10YR4/4	SL	-	m	-	sh	fr-fi	ss/ps	22.6
Profile 2. Coarse Loamy, mixed, semiactive, thermic, Typic Hapludalfs (Alfisols)												
2	Shefaght Mahaleh	A	0-25	10YR3/3	SL	1vf	3mgr	AS	so	lo	ss/ps	-
		B1	25-36	10YR4/3	SL	1f	2mabk	GW	sh	lo	ss/ps	-
		Bt1	36-72	10YR6/4	SL	1f	3mabk	GS	sh	vfr	ss/ps	4.5
		Bt2	72-97	10YR4/4	SL	1f	3fabk	GS	h	vfr	ss/ps	7.2
		Bt3	97-110	10YR4/4	LS	1m	2fabk	CS	h	fi	s/p	5.8
		C	110-140	10YR5/3	SL	1m-1c	m	-	h	fi	ss/ps	6.9
Profile 3 Coarse Loamy Skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)												
3	Siahkal Mahaleh (1)	A	0-25	10YR3/3	SL	2vf-1f	3mgr-2abk	AW	so	vfr	ss/ps	17
		B1	25-41	10YR3/4	SL	1f-1m	3fabk	GS	sh	fr	ss/ps	22
		B2	41-86	10YR4/4	LS	1f	2mabk	GS	sh	fr	s/p	31
		BC	86-112	10YR4/3	LS	-	1mabk	CW	sh	fr-fi	ss/ps	33
		C1	112-128	10YR3/4	SL	-	m	GW	h	fi	ss/ps	34.5
		C2	128-145	10YR3/3	LS	-	m	-	h	fi	ss/ps	37
Profile 4 Coarse Loamy, mixed, subactive, thermic, Typic Hapludalfs (Alfisols)												
4	Pay sarah Mahaleh (1)	A	0-25	10YR3/3	SL	1vf-1m	3mgr	CS	so	vfr-fr	ss/ps	-
		B1	25-46	10YR3/4	S	1f-1m	2fabk	GS	sh	fr-1fi	ss/ps	-
		B2	46-72	10YR4/3	S	1f-1c	2fabk-sbk	GS	sh	fi	s/p	5.9
		Bt	72-97	10YR4/3	SL	-	3mabk-sbk	CS	h	vfi	s/p	6.5
		C	97-140	10YR4/4	S	-	m	-	h	vfi	ss/ps	8
Profile 5 Coarse Loamy skeletal, mixed, subactive, thermic, Typic Udorthents (Entisols)												
5	Siahkal Mahaleh (2)	A	0-18	10YR3/4	SL	1f-2m	3mgr	CS	lo	lo	so/po	17.2
		C1	18-43	10YR3/3	S	1f-1m	sg	GS	so	vfr	so/po	21
		C2	43-60	10YR4/4	S	1f-1m	sg	GS	so	vfr	so/po	21
		C3	60-68	10YR4/6	S	1f-1m	sg	GS	so	vfr	so/po	30.5
		C4	68-90	10YR4/4	LS	1f	sg	GS	so	fr	ss/ps	35

Annex 1. Contd.

		C5	90-110	10YR4/6	S	1f	sg	GS	so	fr	so/po	38.5
		C6	110-135	10YR4/4	S	1f	sg-m		so	fr	so/po	38.7
		Profile 6 Coarse Loamy skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)										
6	Pay sarah Mahaleh (2**)**	A	0-25	10YR3/4	S	2vf-1f	2fgr	CS	lo	vfr	so/po	18.2
		B	25-38	10YR4/4	SL	1f-1m	2fabk	GS	so	vfr	ss/ps	20
		BC	38-59	10YR3/3	LS	1f-1m	2f-mabk	CS	lo	vfr	ss/ps	37.8
		C1	59-73	10YR3/4	S	1f-1m	sg	GS	lo	lo	ss/ps	37.5
		C2	73-88	10YR4/4	LS	1m	sg	GS	lo	lo	ss/ps	40
		C3	88-135	10YR4/4	S	1m	sg	-	lo	lo	ss/ps	41.5
		Profile 7. Coarse Loamy skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)										
7	Tork Mahaleh (1)	A	0-25	10YR3/3	LS	1vf-1f	3fgr	CS	lo	lo	so/po	19.1
		B1	24-46	10YR4/3	SL	1f	3mabk	GS	lo	vfr	ss/ps	25
		B2	46-65	10YR3/3	S	1f	3mabk	GS	so	fr	ss/ps	37.5
		B3	65-72	10YR4/3	S	1f	2mabk	AW	so	fr	ss/ps	35
		Bt1	72-95	10YR4/4	SL	-	2fabk	CS	so	fr	ss/p	29.7
		Bt2	95-120	10YR4/6	SL	-	2fabk	CS	sh	fr	ss/ps	40.1
		C	120-150	10YR4/4	LS	-	m	-	so	fr	s/ps	40
		Profile 8. Coarse Loamy skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)										
8	Tork Mahaleh (2)	A	0-20	10YR3/3	SL	2vf	3mgr	CS	lo	lo	ss/ps	-
		B	20-35	10YR3/4	SL	1f-1m	3mabk	AS	lo	lo	ss/ps	17.8
		C1	35-75	10YR4/3	LS	1f-1m	sg	GS	lo	vfr	ss/ps	22
		C2	75-116	10YR4/4	S	1f-1m	sg	GS	lo	vfr	ss/ps	21.7
		C3	116-148	10YR4/6	LS	1m-1c	m	-	lo	fr	ss/ps	23
		Profile 9. Coarse Loamy Skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)										
9	Anosh Mahaleh	A	0-20	10YR3/3	LS	1vf-1f	3fgr	AS	lo	lo	ss/ps	-
		B1	20-38	10YR4/3	S	1f-1m	2fabk	GS	lo	lo	ss/ps	-
		B2	38-74	10YR4/3	SL	1f	2fabk	GS	lo	vfr	ss/ps	7.6
		B3	74-115	10YR4/4	LS	-	2fabk	CS	so	fr	ss/ps	9.7
		C	115-143	10YR5/4	S	-	m	-	so	fr	ss/ps	10.5
		Profile 10. Coarse Loamy, mixed, subactive, thermic, Typic Hapludalfs (Alfisols)										
10	Cholo nasar Mahaleh	A	0-28	10YR3/2	SL	1vf-1m	3fgr	CS	so	lo	ss/ps	-
		B	28-40	10YR3/3	SL	1f-1m	3mabk	CS	so	vfr	ss/ps	-
		Ab	40-60	10YR2/2	SL	1f-1c	2fgr	GS	so	vfr	ss/ps	-
		B1	60-86	10YR4/4	SL	-	3mabk	GS	so	fr	ss/ps	5
		B2	86-130	10YR4/5	LS	-	2fabk	GS	so	fr	ss/ps	3
		BC	>130	10YR4/4	SL	-	2fabk	-	so	vfr	ss/ps	6.7
		Profile 11. Fine Loamy skeletal, mixed, Semiactive, thermic, Oxyaquic Paleudalfs (Alfisols)										

Annex 1. Contd.

11	Shekh Mahaleh	A	0-22	10YR4/3	S	2m	3fgr-2mgr	CS	lo	lo	so/po	18
		B	22-30	10YR4/6	S	1f	1fabk	CS	lo	lo	so/po	22.5
		C	30-38	10YR6/6	S	1f-1m	m	AS	lo	lo	ss/ps	39
		Bt	38-75	10YR3/6	SL	1f-1m	2fabk-sbk	CS	so	vfr	s/ps	31
		Btg	75-93	10YR3/3	LS	1f	2fsbk	GS	sh	fr	s/p	35.5
		BCtg	93-122	10YR4/6	LS	1f-	1fsbk	GS	so	vfr	s/ps	40.1
		Ctg	>122	10YR4/4	S	1f-	1fsbk-m	-	so	vfr	s/ps	40
Profile 12. Coarse Loamy skeletal, mixed, subactive, thermic, Typic Hapludalfs (Alfisols)												
12	Hamed Mahaleh	A	0-25	10YR3/2	LS	2vf	3fgr-2mgr	CS	so	L	s/ps	22
		Bt1	25-64	10YR4/3	SL	1f	3mabk	GS	sh	vfr	s/p	26.2
		Bt2	64-95	10YR4/4	S	1f-1m	3mabk	GS	sh	fr	s/p	29
		C1	95-121	10YR4/4	S	1f	sg	GS	so	L	s/p	37.5
		C2	121-145	10YR4/6	SL	1c-1f	m	-	so	vfr	ss/ps	35
Profile 13. Coarse Loamy skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)												
13	Ghanbar Mahaleh (1)	A	0-22	10YR6/6	SL	2vf	2fgr	CS	so	lo	ss/ps	23.82
		B1	22-35	10YR3/4	LS	1f	2fabk	GS	so	vfr	ss/ps	29
		B2	35-50	10YR4/6	S	1f	1fabk	GS	so	fr	ss/ps	30
		C1	50-63	10YR4/6	S	1vf	m	GS	sh	vfr	ss/ps	34.68
		C2	63-80	10YR4/4	S	-	m	GS	sh	lo	ss/ps	39
		C3	80-102	10YR3/3	S	-	m	GS	sh	vfr	ss/ps	43
		C4	102-125	10YR3/3	S	-	m	-	sh	vfr	ss/ps	45
Profile 14. Coarse Loamy, mixed, semiactive, thermic, Typic Hapludalfs (Alfisols)												
14	Ghanbar Mahaleh (2)	A	0-20	10YR3/1	SL	1vf	3fgr	CW	so	fr	ss/ps	-
		B1	20-30	10YR3/2	SL	1f	3mabk	GS	sh	h	s/p	-
		Bt1	30-59	10YR4/2	SL	1f	3mabk	GS	sh	vh	s/p	-
		Bt2	59-77	10YR4/3	SL	1f	2mabk	GS	h	h	s/p	5.7
		BC	77-128	10YR3/6	SL	1m-1c	m-1fabk	-	sh	vfr	ss/p	6.9
Profile 15. Coarse Loamy, mixed, semiactive, thermic, Oxyaquic Paleudalfs (Alfisols)												
15	Derakari Mahaleh (1)	A	0-22	10YR3/6	SL	2vf	3mgr	CS	so	vfr	ss/ps	-
		B	22-47	10YR3/4	SL	1f-1m	2mabk	CS	sh	fr	ss/ps	-
		Bt	47-67	10YR4/4	SL	1f	3mabk	GS	sh	fr	s/p	5.6
		Btg	67-102	10YR4/6	SL	1f	3mabk	GS	h	fi	s/p	4.2
		gC	>102	10YR3/3		-	sg		sh	fi	s/p	4.9
Profile 16. Coarse Loamy, mixed, semiactive, thermic, , Oxyaquic Dystrudepts (Inceptisols)												
16	Khajekari Mahaleh (1)	A	0-28	10YR4/3	SL	2vf-1m	2mgr	CS	sh	fr	ss/ps	-
		B	28-52	10YR4/4	SL	1f-1m	2mabk	GS	sh	fr	ss/ps	-
		BC	52-75	10YR4/6	LS	1f-1c	1fabk	GS	h	fr	ss/ps	6.7

Annex 1. Contd.

		Cg	75-92	10YR4/6	SL	-	m	GS	h	fi	s/p	5.9
		Cg	>92	10YR5/6	SL	-	m	-	h	fi	s/p	5.1
Profile 17. Fine Loamy skeletal, mixed, semiactive, thermic, Typic Hapludalfs (Alfisols)												
17	Derakari Mahaleh (2)	A	0-28	10YR3/2	SL	1f-2m	3mgr	CS	sh	fi	ss/ps	22
		B	28-48	10YR3/3	SL	1f-1m	3mabk	CS	sh	fr	ss/ps	36
		Bt1	48-65	10YR43	LS	1f-1m	2mabk	GS	h	fi	s/p	35.5
		Bt2	65-96	10YR4/4	SL	-	2fabk	CW	sh	vfr	ss/ps	41
		C	96-120	10YR3/2	SL	-	m	-	sh	vfr	ss/ps	42.9
Profile 18. Coarse Loamy skeletal, mixed, subactive, thermic, Typic Udorthents (Entisols)												
18	Khajekari Mahaleh (2)	A	0-20	10YR3/4	SL	1f	2fgr	CW	sh	lo	ss/ps	32.75
		C1	20-41	10YR3/2	SL	1f-1m	m	GS	sh	vfr	ss/ps	35
		C2	41-53	10YR3/1	S	1f	sg	GS	sh	fr	so/po	40
		C3	>53	10YR3/1	S	1m	sg	-	sh	fr	so/po	45.5

[a]Texture class: SL- sandy loam, S- sandy, LS- loamy sand; [b] Roots: 1- few, 2- common, vf- very fine, f- fine, m- medium; [c] Structure: 1- weak, 2- moderate, 3- strong, f- fine, m- medium, gr- granular, sbk- subangular blocky, abk- angular blocky, sg-single grain, m-massive; [d] Boundary: A- abrupt, C- clear, G- gradual, S-smooth, W-wavy; Consistence, [e] Dry: lo- loose, so-soft, sh- slightly hard, h- hard; [f] Moist: lo- loose, vfr-very friable, fr-friable, fi-firm, vfi-very firm; [g] Wet: so- non-sticky, ss-slightly sticky, s- moderately sticky, po- non-plastic, ps- slightly plastic, p-moderately plastic.

Annex 2. Some physico-chemical properties of horizons for the selected profiles.

Land unit	Location	Horizon	Depth (cm)	Texture (%)			pH	EC [a]($dS.m^{-1}$)	$CaCO_3$ (%)	TEB [b]	CEC [c]	OC [d]	ESP [e]	B.S [f]
				Clay	Silt	Sand				($Cmol.kg^{-1}$)		(%)	(%)	
Profile 1 Coarse Loamy skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)														
1	Dizgah Mahaleh	A	0-24	12	11	77	6.21	0.3	2.5	6	13	1.7	1.5	46
		B1	24-40	6	17	77	6.11	0.5	3.7	2.96	9	1.5	1.1	32.88
		B2	40-56	4	13	83	6.31	0.7	5.5	2.94	5	0.5	2	58.8
		C1	56-70	4	5	91	6.43	0.4	8.2	2.89	5	0.1	1	57.8
		C2	70-78	4	10	86	6.57	0.4	6.8	2.16	5	0.1	1	43.2
		C3	78-110	2	3	95	6.64	0.4	3.4	5.2	4	0.3	2.25	58
		C4	110-140	2	20	78	6.15	0.42	4.5	3.06	4	0.1	2.7	76
Profile 2. Coarse Loamy, mixed, semiactive, thermic, Typic Hapludalfs (Alfisols)														
2	Shefaght Mahaleh	A	0-25	9	14	77	6.14	0.5	5.2	4.5	16	2.7	3.7	28
		B1	25-36	12	14	74	5.94	0.6	7.4	5.06	14	1.5	3.5	36.14
		Bt1	36-72	7	20	73	5.81	0.4	5.2	4.3	9	0.8	2.3	47
		Bt2	72-97	15	11	74	5.7	0.47	5.8	4.7	11.18	0.4	2	42.03
		Bt3	97-110	9	10	81	6.08	0.4	4.5	2.58	7.8	0.3	1	33.07
		C	110-140	14	11	75	6.13	0.43	6.1	6.56	8.25	0.3	1	79.51
3	Siahkal	Profile 3 Coarse Loamy Skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)												

Annex 2. Contd.

	Mahaleh (1)	A	0-25	9	17	74	5.8	0.32	1.8	6	12	1.7	2.61	50
		B1	25-41	8	15	77	6.25	0.7	2.5	4.5	8	0.7	2.21	56
		B2	41-86	4	19	77	6.66	0.2	2.8	2.9	5	0.4	2.97	58
		BC	86-112	2	17	81	6.58	0.4	5.8	2.85	5	0.3	2.92	57
		C	112-128	11	18	71	6.42	0.24	4.7	2.43	9	0.2	2.60	27
		C	128-145	5	12	83	6.48	0.28	7.6	2	5.5	0.1	2.60	36
Profile 4 Coarse Loamy, mixed, subactive, thermic, Typic Hapludalfs (Alfisolsa)														
4	Pay sarah Mahaleh (1)	A	0-25	7	18	75	6.88	0.3	1.7	6	13	2.1	1.68	46
		B1	25-46	3	2	95	7.40	0.4	3.9	5	9.3	1.4	2.44	53
		B2	46-72	3	8	89	7.22	0.2	6.3	1.92	5.5	0.6	2.98	34.90
		Bt	72-97	9	16	75	6.91	0.45	5.6	1.5	6	0.4	2.71	25
		C	97-140	3	2	95	7.29	0.3	6.2	1.8	4	0.1	2	45
Profile 5 Coarse Loamy skeletal, mixed, subactive, thermic, Typic Udorthents (Entisols)														
5	Siahkal Mahaleh (2)	A	0-18	10	13	77	6.53	0.6	4.2	4.66	13	2	2.3	37.53
		C1	18-43	2	8	90	6.75	0.4	8.7	2.4	5.7	0.5	1.5	42.10
		C2	43-60	2	12	86	7.08	0.6	3.9	1.7	5	0.4	1.4	34
		C3	60-68	2	10	88	7.11	0.3	5.5	2.33	4	0.1	1.25	58.25
		C4	68-90	3	20	77	7.23	0.5	7.9	3.98	5.5	0.3	2.4	72.36
		C5	90-110	5	2	93	7.37	0.49	5.3	3.59	5.8	0.4	2.5	61.89
		C6	110-135	2	8	90	7.80	0.6	5.3	1.78	5.3	0.4	1.5	33.58
Profile 6 Coarse Loamy skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)														
6	Pay sarah Mahaleh (2)	A	0-25	4	8	88	7.90	0.6	8.2	4.26	10	1.8	2.04	42.6
		B	25-38	7	6	87	7.3	0.66	11.3	4.36	11	1.7	1.35	39.63
		BC	38-59	2	17	81	7.44	0.5	10	3.28	7	1.1	1.59	46.85
		C1	59-73	2	1	97	7.73	0.4	10.3	3.59	5	0.2	1.73	71
		C2	73-88	1	14	85	7.61	0.8	7.4	2	3	0.2	1	66
		C3	88-135	1	2	97	7.63	0.6	6.3	2.14	3	0.1	1	71
Profile 7. Coarse Loamy skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)														
7	Tork Mahaleh(1)	A	0-25	2	21	77	6.90	0.4	3.4	5	8	1.4	3.7	62.5
		B1	24-46	6	19	75	7.01	0.38	4.7	3.41	9.1	0.9	3.5	37.67
		B2	46-65	4	8	88	7.52	1	6.3	3.11	6	0.4	2.3	51.18
		B3	65-72	3	11	86	7.20	0.5	5	2.75	4	0.3	2	58.75
		Bt1	72-95	12	15	73	7.38	0.8	5.8	3.95	10	0.4	1.5	39.8
		Bt2	95-120	15	11	74	7.03	0.7	6.6	2.89	11	0.5	1.8	26.27
		C	120-150	6	15	79	7.10	0.4	2.6	6.08	7	0.5	1.3	86
Profile 8. Coarse Loamy skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)														
8	Tork Mahaleh (2)	A	0-20	7	17	76	7.30	0.7	6.1	5.32	13	1.9	2.9	40.92

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		B	20-35	6	18	76	6.96	0.5	6.6	3.26	11	1.5	2.8	29.45
		C1	35-75	7	10	83	7.08	0.53	4.7	2.76	9.25	0.8	2.1	29.83
		C2	75-116	3	3	94	7.62	0.8	5.5	2.5	5.5	0.6	1.7	45
		C3	116-148	5	17	78	7.68	0.5	6.6	3.67	7	0.2	1.7	52
		Profile 9. Coarse Loamy Skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)												
9	Anosh Mahaleh	A	0-20	4	10	86	7.09	0.5	4.5	5.4	10	1.8	3	54
		B1	20-38	3	6	91	7.46	0.6	7.4	5.5	7.9	1.3	2.9	69
		B2	38-74	5	21	74	7.32	0.5	3.7	5.68	8	1.1	2.72	71
		B3	74-115	4	19	77	7.34	0.6	7.4	4.04	7	0.6	2	57.71
		C	115-143	2	3	95	7.63	0.8	6.8	2.31	5	0.3	2	46.2
		Profile 10. Coarse Loamy, mixed, subactive, thermic, Typic Hapludalfs (Alfisolsa)												
10	Cholo nasar Mahaleh	A	0-28	10	18	72	5.99	0.6	1.3	12.54	13	1.7	3.9	96
		B	28-40	13	14	73	5.81	0.72	2.1	8.25	11.25	0.8	3.5	73.4
		Ab	40-60	11	17	72	6.07	0.6	1.3	10	12	1.4	2.71	83
		B1	60-86	13	12	75	5.59	0.6	5	7.37	10	0.3	2.5	73.7
		B2	86-130	4	14	82	6.12	0.7	2.9	5.19	6	0.5	2.6	86.5
		BC	130<	10	13	77	6.08	0.5	3.2	4.71	8.68	0.4	2	54
		Profile 11. Fine Loamy skeletal, mixed, Semiactive, thermic, Oxyaquic Paleudalfs (Alfisols)												
11	Shekh Mahaleh	A	0-22	2	9	89	6.79	0.5	6.8	4.83	11	2.2	3.7	43.9
		B	22-30	3	3	94	6.83	0.4	5	3	9	1.6	3.5	33
		C	30-38	2	2	96	6.75	0.2	10.8	3.72	8	1.5	2.72	46.5
		Bt	38-75	11	18	71	6.49	0.72	1.1	3.72	13	1.8	2.6	28.61
		Btg	75-93	6	16	78	6.70	0. 5	2.9	4.41	11	0.9	2.1	40.09
		BCtg	93-122	6	6	88	6.86	0.7	7.6	5.1	7	0.3	2.1	72
		Ctg	>122	5	5	90	6.82	0.3	2.6	4.44	5	0.3	1.5	88
		Profile 12. Coarse Loamy skeletal, mixed, subactive, thermic, Typic Hapludalfs (Alfisols)												
12	Hamed Mahaleh	A	0-25	6	19	75	7.62	0.7	6.1	8.42	10	1.7	1.7	84.2
		Bt1	25-64	10	18	72	7.39	0.5	3.4	4.19	11	1	1.5	38.09
		Bt2	64-95	3	9	88	7.41	0.4	2.5	2.81	9	0.4	0.9	31.22
		C1	95-121	2	1	97	7.54	0.3	3.4	2.17	5	0.5	0.6	43.4
		C2	121-145	2	14	84	7.52	0.4	7.1	2.25	5	0.1	0.5	45
		Profile 13. Coarse Loamy skeletal, mixed, semiactive, thermic, Typic Dystrudepts (Inceptisols)												
13	Ghanbar Mahaleh (1)	A	0-22	8	16	76	6.69	0.8	4.5	4.97	13	1.9	3.70	38.23
		B1	22-35	7	11	82	6.55	0.44	4.5	3.6	8.2	0.5	3.5	43.90
		B2	35-50	1	6	93	7.02	0.3	4.2	2.16	4	0.5	2.9	54
		C1	50-63	2	6	94	6.95	0.4	8.7	2.3	5	0.4	2.74	46
		C2	63-80	1	8	91	7.05	0.3	7.6	1.45	4	0.6	2.5	36.25

Annex 2. Contd.

		C3	80-102	2	2	96	6.43	0.4	6.3	2.06	5.5	0.4	2.5	37
		C4	102-125	2	5	93	7.47	0.5	11.3	3	6	0.6	1.8	50
		Profile 14. Coarse Loamy, mixed, semiactive, thermic, Typic Hapludalfs (Alfisols)												
14	Ghanbar Mahaleh (2)	A	0-20	4	17	79	7.52	0.7	2.5	5	11	2	0.8	45
		B1	20-30	8	19	73	7.43	0.6	4.7	6.42	11.5	1.2	0.7	55.82
		Bt1	30-59	11	17	72	7.06	0.5	3.4	6.18	11	1	1	56.88
		Bt2	59-77	10	21	69	7.40	0.6	3.1	6	12	0.4	1	50
		BC	77-128	9	14	77	6.62	0.42	5.8	4.14	7.8	0.1	1	53.07
		Profile 15. Coarse Loamy, mixed, semiactive, thermic, Oxyaquic Paleudalfs (Alfisols)												
15	Derakari Mahaleh (1)	A	0-22	5	23	72	6.52	0.58	3.4	4.88	13.4	2.3	1.64	36.41
		B	22-47	11	18	71	6.96	0.4	11.8	2.81	9	0.3	1.77	31.22
		Bt	47-67	13	12	75	7.18	0.5	3.2	4.44	13	1.3	1.89	34.15
		Btg	67-102	8	22	70	7.30	0.4	3.2	3.46	11	1.4	1.33	31.45
		gC	>102	2	19	79	7.30	0.3	4.5	1.70	4	0.2	-	42
		Profile 16. Coarse Loamy, mixed, semiactive, thermic, , Oxyaquic Dystrudepts (Inceptisols)												
16	Khajekari Mahaleh (1)	A	0-28	7	23	70	7.60	0.5	1.1	9	12	2.1	1.68	75
		B	28-52	11	24	65	6.48	0.90	4.2	4.08	15	2	2.44	27.02
		BC	52-75	3	20	77	7.51	0.5	3.4	2.13	6.5	1	2.98	32.76
		Cg	75-92	4	23	73	7.53	0.4	4.2	3.25	7	0.6	2.7	46.42
		Profile 17. Fine Loamy skeletal, mixed, semiactive, thermic, Typic Hapludalfs (Alfisols)												
17	Derakari Mahaleh (2)	A	0-28	8	22	70	6.59	0.5	1.3	10.18	15	2.7	2.61	75.46
		B	28-48	11	16	73	6.39	0.46	7.4	9.26	11	1	2.21	84.18
		Bt1	48-65	8	9	83	6.82	0.4	5.5	8.41	9	0.8	2.97	93
		Bt2	65-96	12	18	70	6.66	0.5	2.1	9.69	10	0.4	2.92	96
		C	96-120	12	18	73	6.88	0.3	3.4	8.76	10	0.3	2.60	87
		Profile 18. Coarse Loamy skeletal, mixed, subactive, thermic, Typic Udorthents (Entisols)												
18	Khajekari Mahaleh (2)	A	0-20	6	27	67	6.69	0.6	2.4	9.89	14	2.4	5	70.64
		C1	20-41	9	20	71	7.69	0.8	5.5	5	8	0.2	4.52	62.5
		C2	41-53	2	5	93	7.91	0.4	6.8	2.04	3	0.2	4.38	68
		C3	>53	2	5	93	7.8	0.3	6	2	3	0.1	-	66

[a]EC- Electrical conductively, [b] TEB- Total exchangeable bases, [c] CEC- Cations exchange capacity, [d] OC- Organic carbone, [e] ESP- Exchangeable sodium percentage, [f] B.S- Base saturati on.