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Physical Land Suitability Analysis for Barely in Debre Tabour Agricultural Research Sub-Center Area, Amhara Region (Ethiopia)

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Abstract

The objective of this study was to assess the suitability of Debre Tabour Sub-agricultural Research Center area for the production of food barley and malting barley. Aggregate data from various sources have been used for the analysis. The study has been benefited from the soil survey report by the FDRE Ethiopian Institute of Agricultural Research, National Soil Research Center (NSRC) Soil Survey and Land Evaluation Section. The methodology used for the physical land suitability assessment was simple matching method. It consisted of matching environmental requirements of barley with the land qualities of the 12 land map units of the study area and rating suitability for each land characteristics and identifying limiting factors. Results of the simple limitation method showed that all the 12 land map units of the study area are moderately to marginally suitable for the production of both food barley and malting barley. The major limiting factors are nutrient availability, erosion hazard, workability and rooting condition. The study showed that despite some differences in their environmental requirements, there are no any differences between food barely and malting barley in suitability in the study area.

Key Words: Barley, Debre Tabour, Land suitability, Research Center, Ethiopia

1. Introduction

Inappropriate use of the land which is the ultimate source of wealth and the basis on which many civilizations are constructed leads to inefficient exploitation of natural resources, destruction of the resource, poverty and other social problems (Rossiter, 1996). The natural resources are affected negatively as a result of misusage of the land which along with the increasing population makes, among other things, sustainable agriculture impossible (Sarisamur and Kiliç, 2011). Thus, society must ensure that land is not degraded and that it is used according to its capacity to satisfy human needs for present and future generations while also maintaining the earth's ecosystems (Amiri and Mohamed Shariff, 2012). Part of the solution to the land-use problem is land evaluation in support of rational land-use planning and appropriate and sustainable use of natural and human resources (Rossiter, 1996).

Land evaluation, as defined by FAO (1976), is concerned with the assessment of land performance when used for specified purposes and involves the execution and interpretation of basic surveys of climate, soils, vegetation and other aspects of land in terms of the requirements of alternative forms of land use. As such it provides a rational basis for taking land-use decisions based on analysis of relations between land use and land (Sys et al., 1991). Land evaluation is the process of predicting the use potential of land on the basis of its attributes but does not include optimal land allocation rather it supplies the technical coefficients necessary for optimal land allocation (Rossiter, 1996).This means that two phases are considered for defining a land use planning model: land evaluation, in which the suitability of the land for the uses considered is evaluated, and land use allocation, from which the optimum allocation of uses to land units is decided according to the results of the previous phase (Santé & Crecente, 2006).

The objective of this study was to assess the suitability of Debre Tabour Sub-agricultural Research Center for the production of food barley and malting barley using simple limitation method.

2. Materials and Methods

2.1 The study Area

This suitability analysis was conducted in the Debre Tabour Sub-agricultural Research Center which is located in South Gondar Administrative Zone of the Amhara Regional State, Ethiopia. Its Geographic extent ranges from 11^0 51' 40' to 11^0 52' 10'' north latitude and from 37^0 59'' 35'' to 38^0 00' 05'' eastern longitude and it has a total area of 35.09 ha (FDRE Ethiopian Institute of Agricultural Research, National Soil Research Center (NSRC) Soil Survey and Land Evaluation Section, 2006).

2.2 Data Sources

Aggregate data from various sources have been used for the analysis. This study has been benefited from the soil survey report by the FDRE Ethiopian Institute of Agricultural Research, National Soil Research Center (NSRC) Soil Survey and Land Evaluation Section (2006); which was supposed to have valuable information for researchers. The report was based on a soil map at a scale of 1:5,000. Twelve land map units were identified in which each mapping unit was distinguished by three criteria (slope, soil depth and surface texture). Each mapping unit is indicated by three elements: a number indicating the first criteria (slope class), a lower case letter indicating the second criteria (soil depth class) and a number following the lower case (surface texture code). For example, a mapping unit 5b5; where in 5-slope class, b-soil depth class and 5-surface texture code.

Table 1: Distinguishing criteria of the mapping units

Slope %		Soil depth (cm)		Surface texture (0-30 cm)			
Class	Code	Class	Code	Type	Code	Type	code
0-1	1	>150	a	Heavy clay	1	Loam	8
1-2	2	100-150	b	Clay	2	Sandy loam	9
2-5	3	50-100	c	Sandy clay	3	Silt loam	10
5-10	4	30-50	d	Silty clay	4	Silt	11
10-15	5	<30	e	Clay loam	5	Loamy sand	12
15-30	6			Silty clay loam	6	Sand	13
>30	7			Sandy clay loam	7		

***Source**: FDRE Ethiopian Institute of Agricultural Research, National Soil Research Center (NSRC) Soil Survey and Land Evaluation Section (2006)*

The climate data and the length of growing period were obtained from an Agro-climatic Resources Inventory for Land Use Planning (FAO, 1983). The rainfall data is for a period of 10 years and the temperature data is for 11 years. The data for Debre Tabour Station is presented below.

Table 2: Climate Data of the study area

	Jan	Feb	Mar	Apr	May	June	July	August	Sep	Oct	Nov	Dec	year
Mean Min. Temp. (^{0}C)	8.0	8.4	9.0	9.8	10.1	9.0	8.8	8.7	8.1	7.3	7.1	6.7	8.4
Mean Max. Temp. (^{0}C)	29.1	27.8	28.2	27.2	26.9	24.9	21.1	21.0	23.0	23.0	23.8	24.5	25.0
Mean Temp. (^{0}C)	18.6	18.1	18.6	18.5	18.5	17.0	15.0	14.9	15.6	15.2	15.5	15.6	16.8
Rainfall (mm)	6	11	42	46	93	180	501	476	193	66	21	16	1651
Potential Evapo-transpiration (mm)	102	107	136	135	120	91	58	59	84	100	91	66	1169

The environmental requirements of the crops of this study were obtained from the report prepared for the Government of Ethiopia by FAO (1983) to assist land use planning. The ranges of suitability are slightly different from the FAO (1976) suitability in that it has used three classes instead of five classes and are presented below:

i) S1- highly suitable
ii) S2 – moderately to marginally suitable
iii) N – not suitable

2.3 Methodology

The methodology used for the physical land suitability assessment is simple matching method based on Sys et al. (1991) matching tables. It consists of matching environmental requirements of barley with the land qualities of the 12 land map units of the study area and rating suitability for each land characteristics and identifying limiting factors.

The land qualities used in this study include temperature regime, moisture availability, oxygen availability, nutrient availability, rooting condition, soil workability and erosion hazard. Several diagnostic characteristics have been used to determine these land qualities. The land characteristics of mean growing period and altitude have been used to determine the land quality temperature regime. Moisture availability of the study area was indirectly determined by three land characteristics which include total soil depth, length of growing period and total growing period rainfall amount. Oxygen availability was determined by the soil drainage characteristics. The land quality nutrient availability was also determined indirectly by two land characteristics namely: soil organic matter and mean pH value. Rooting condition, soil workability and erosion hazard were indirectly determined by soil texture and slope steepness characteristics.

Table 3: Crop Environmental Requirement for Food Barley (Hordeum vulgare)

No	Land Quality	Land Characteristics	Unit	Ranges of Suitability		
				S1 Highly Suitable	S2 Moderately to Marginally Suitable	N Not Suitable
1	Temperature Regime	Altitude	m	2000-3000	1500-2000	Below 1500
					3000-3800	Over 3800
		Mean temperature for growing period	^{0}C	12.5-17.5	7.5-12.5	Below 7.5
					17.5-22.5	Over 22.5
		Possible occurrence of flood hazard	Month	None Oct. – Nov. slight Dece.	None Oct. slight Nov. – Dece.	Any frost in Oct. –severe in Nov. Dece.
2	Growing Period	Length of growing period	Day	120-180	90-120	Below 90
3	Moisture availability	Rainfall during growing period	mm	400-800	200-1200	Below 200
					800-1200	Over 1200
4	Drainage	Soil drainage	Class	W	I	VP-P
					SE	E
5	Degradation Hazard	Mean temperature for growing period	^{0}C	12.5-17.5	7.5-12.5	Below 7.5
					17.5-22.5	Over 22.5
		Length of growing period	Day	120-180	90-120	Below 90
		Soil unit	FAO unit	Jgrthblan	EV	IQZYXO
		Soil texture	class	L-SC	SL	S-LS
					SiC-C(b)	
		Stones and rock outcrops	%	0-3	3-15	Over 15
		Slope angle	%	0-8	8-30	Over 30
6	Nutrient Status and Retention	Soil texture	Class	L-SC	SL	S-SL
					SiC-C(b1)	
		Soil reaction	pH	5.5-7.3	5.0-5.5	Below 5.0
					7.3-8.5	Over 8.5
		Organic Matter	%	Over 3	1-3	0-1
7	Rooting Condition and workability	Effective soil depth	cm	Over 100	25-100	0-25
		Stones and rock outcrops	%	0-3	3-15	Over 15
		Soil texture	class	L-SC	SL	S-SL
					SiC-C(b1)	
		Soil structure	class	Acr, Agr, FBl, FPr, FCo	CBl, MPr, MCo, FPl	CPr, CCo, MPl-CPL, Mas, Inc
8	Toxicities	Electrical conductivity	mmhs/cm	0-10	10-16	Over 16
		Other limiting toxicities	ESP% $CaCO_3$%	0-35 0-30	35-50 30-60	Over 50 Over 60
9	Management Land Preparation and Mechanization Potential	Slope angle	%	0-8	8-30	Over 30
		Stones and rock outcrops	%	0-3	3-15	Over 15
		Soil texture	class	L-SC	SL	S-SL
					SiC-C(b1)	

Table 4: Crop Environmental Requirement for Malting Barley (Hordeum vulgare)

No	Land Quality	Land Characteristics	Unit	Ranges of Suitability		
				S1 Highly Suitable	S2 Moderately to Marginally Suitable	N Not Suitable
1	Temperature Regime	Altitude	m	2000-3000	1500-2000	Below 1500
					3000-3800	Over 3800
		Mean temperature for growing period	^{0}C	12.5-17.5	7.5-12.5	Below 7.5
					17.5-22.5	Over 22.5
		Possible occurrence of flood hazard	Month	None Oct. – Nov. slight Dece.	None Oct. slight Nov. – Dece.	Any frost in Oct. –severe in Nov. Dece.
2	Growing Period	Length of growing period	Day	150-180	120-150	Below 120
3	Moisture availability	Rainfall during growing period	mm	500-800	400-500	Below 400
					800-1200	Over 1200
4	Drainage	Soil drainage	Class	W	I	VP-P
					SE	E
5	Degradation Hazard	Mean temperature for growing period	^{0}C	12.5-17.5	7.5-12.5	Below 7.5
					17.5-22.5	Over 22.5
		Length of growing period	Day	150-180	120-150	Below 120
		Soil unit	FAO unit	Jgrthblan	EV	IQZYXO
		Soil texture	class	L-SC	SL	S-LS
					SiC-C(b)	
		Stones and rock outcrops	%	0-3	3-15	Over 15
		Slope angle	%	0-8	8-30	Over 30
6	Nutrient Status and Retention	Soil texture	Class	L-SC	SL	S-SL
					SiC-C(b1)	
		Soil reaction	pH	5.5-7.3	5.0-5.5	Below 5.0
					7.3-8.5	Over 8.5
		Organic Matter	%	Over 3	1-3	0-1
7	Rooting Condition and workability	Effective soil depth	cm	Over 100	25-100	0-25
		Stones and rock outcrops	%	0-3	3-15	Over 15
		Soil texture	class	L-SC	SL	S-SL
					SiC-C(b1)	
		Soil structure	class	Acr, Agr, FBl, FPr, FCo	CBl, MPr, MCo, FPl	CPr, CCo, MPl-CPL, Mas, Inc
8	Toxicities	Electrical conductivity	mmhs/cm	0-8	8-12	Over 12
		Other limiting toxicities	ESP% $CaCO_3$%	0-35 0-30	35-50 30-60	Over 50 Over 60
9	Management Land Preparation and Mechanization Potential	Slope angle	%	0-8	8-30	Over 30
		Stones and rock outcrops	%	0-3	3-15	Over 15
		Soil texture	class	L-SC	SL	S-SL
					SiC-C(b1)	

3. Results

Environmental requirements of food barley and malting barley and land qualities are matched based on Sys et al. (1991) matching tables. The succeeding tables show the simple matching results for each of the 12 land map units.

Table 5: Land Map Unit:- Dystric Luvisols (5b5)

Area:- 0.71 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem. ^{0}C) (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil rganic matter (%) (som) • Mean pH value (pHs)	0.24-3.31 5.0-5.84	S2 S1	S2 S1
Rooting Conditions (r)	• Soil texture/structure class (text)	CL	S1	S1
Soil workability (w)	• Soil texture class (tex)	CL	S1	S1
Erosion hazard (e)	• Slope steepness, percent (slop)	10-15	S2	S2

Table 6: Land Map Unit:- Dystric Luvisols (4b5)

Area:- 1.28 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem. ^{0}C (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil organic matter (%) (som) • Mean pH value (pHs)	0.76-3.07 5.0-5.7	S2 S1	S2 S1
Rooting Conditions (r)	• Soil texture/structure class (text)	CL	S1	S1
Soil workability (w)	• Soil texture class (tex)	CL	S1	S1
Erosion hazard (e)	• Slope steepness, percent (slop)	5 - 10	S1	S2

Table 7: Land Map Unit:- Dystric Luvisols (4a5)

Area:- 1.83 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem. ^{0}C (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil organic matter (%) (som) • Mean pH value (pHs)	0.41-3.34 5.0-6.3	S2 S1	S2 S1
Rooting Conditions (r)	• Soil texture/structure class (text)	CL	S1	S1
Soil workability (w)	• Soil texture class (tex)	CL	S1	S1
Erosion hazard (e)	• Slope steepness, percent (slop)	5 - 10	S1	S2

Table 8: Land Map Unit:- Haplic Phacozems (3c2)

Area:- 1.50 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem. ^{0}C (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil organic matter (%) (som) • Mean pH value (pHs)	0.38-2.62 5.0-6.6	S2 S1	S2 S2
Rooting Conditions (r)	• Soil texture/structure class (text)	C	S2	S2
Soil workability (w)	• Soil texture class (tex)	C	S2	S2
Erosion hazard (e)	• Slope steepness, percent (slop)	2 -5	S1	S2

Table 9: Land Map Unit:- Eutric Fluvisols (1c5)

Area:- 1.43 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem. ^{0}C (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil organic matter (%) (som) • Mean pH value (pHs)	1.97-3.4 6.0-6.5	S2 S1	S2 S1
Rooting Conditions (r)	• Soil texture/structure class (text)	CL	S1	S1
Soil workability (w)	• Soil texture class (tex)	CL	S1	S1
Erosion hazard (e)	• Slope steepness, percent (slop)	0 - 1	S1	S1

Table 10: Land Map Unit:- Eutric Vertisols (3a5)

Area:- 9.01 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem. ^{0}C (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil organic matter (%) (som) • Mean pH value (pHs)	0.58-7.71 5.0-8.5	S2 S2	S2 S2
Rooting Conditions (r)	• Soil texture/structure class (text)	CL	S1	S1
Soil workability (w)	• Soil texture class (tex)	CL	S1	S1
Erosion hazard (e)	• Slope steepness, percent (slop)	2-5	S1	S1

Table 11: Land Map Unit:- Eutric Fluvisols (2a9)

Area:- 1.66 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem. ^{0}C (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil organic matter (%) (som) • Mean pH value (pHs)	0.79-2.55 5.0-6.5	S2 S1	S2 S1
Rooting Conditions (r)	• Soil texture/structure class (text)	SL	S2	S2
Soil workability (w)	• Soil texture class (tex)	SL	S2	S2
Erosion hazard (e)	• Slope steepness, percent (slop)	1-2	S1	S1

Table 12: Land Map Unit:- Haplic Nitosols (3b2)

Area:- 2.36 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem. ^{0}C (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil organic matter (%) (som) • Mean pH value (pHs)	0.45-3.03 5.7-6.6	S2 S1	S2 S1
Rooting Conditions (r)	• Soil texture/structure class (text)	SL	S1	S1
Soil workability (w)	• Soil texture class (tex)	SL	S1	S1
Erosion hazard (e)	• Slope steepness, percent (slop)	2-5	S1	S1

Table 13: Land Map Unit:- Haplic Luvisols (4a5)

Area:- 5.02 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem. ^{0}C (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil organic matter (%) (som) • Mean pH value (pHs)	1.28-3.34 5.1-7.1	S1 S1	S1 S1
Rooting Conditions (r)	• Soil texture/structure class (text)	CL	S1	S1
Soil workability (w)	• Soil texture class (tex)	CL	S1	S1
Erosion hazard (e)	• Slope steepness, percent (slop)	5-10	S2	S2

Table 14: Land Map Unit:- Dystric Cambisols (5b5)

Area:- 2.46 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem. ^{0}C (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil organic matter (%) (som) • Mean pH value (pHs)	2.36-3.67 5.3-6.3	S1 S1	S1 S1
Rooting Conditions (r)	• Soil texture/structure class (text)	CL	S1	S1
Soil workability (w)	• Soil texture class (tex)	CL	S1	S1
Erosion hazard (e)	• Slope steepness, percent (slop)	10-15	S2	S2

Table 15: Land Map Unit:- Eutric Vertisols (4a1)

Area: - 5.54 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem. ^{0}C (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil organic matter (%) (som) • Mean pH value (pHs)	0.72-2.79 6.1-6.64	S2 S1	S2 S1
Rooting Conditions (r)	• Soil texture/structure class (text)	C	S2	S2
Soil workability (w)	• Soil texture class (tex)	C	S2	S2
Erosion hazard (e)	• Slope steepness, percent (slop)	5-10	S2	S2

Table 16: Land Map Unit:- Haplic Vertisols (3a8)

Area: - 6.01 ha

Land Quality	Land Characteristics	Value	Rating	
			Food Barley	Malting Barley
Temperature Regime (t)	• Mean growing period (Tem.) ^{0}C (gpt) • Altitude (m.a.s.l) (m) (alt)	16.0 2,580	S1 S1	S1 S1
Moisture availability (m)	• Total soil depth (cm) • Length of growing period (days) (lgp) • Total growing period rainfall amount (mm) (gprf)	100-150 214 1535	S1 S1 S1	S1 S1 S1
Oxygen availability (o)	• Soil drainage (class)	W	S1	S1
Nutrient availability (f)	• Soil organic matter (%) (som) • Mean pH value (pHs)	0.65-6.74 4.9-7.9	S2 S2	S2 S2
Rooting Conditions (r)	• Soil texture/structure class (text)	L	S2	S2
Soil workability (w)	• Soil texture class (tex)	L	S2	S2
Erosion hazard (e)	• Slope steepness, percent (slop)	2-5	S1	S1

Table 17: Results of the qualitative suitability assessment of land map units for food barley and malting barley

No	Mapping Units	Food Barley	Malting Barley
1	5b5 (Dystric Luvisols)	S2ef	S2ef
2	4b5 (Dystric Luvisols)	S2f	S2fe
3	4a5 (Dystric Luvisols)	S2f	S2fe
4	3c2 (Haplic Phaeozems)	S2f	S2fe
5	1c5 (Eutric Fluvisols)	S2f	S2f
6	3a5 (Eutric Vertisols)	S2f	S2f
7	2a9 (Eutric Fluvisols)	S2fw	S2fw
8	3b2 (Haplic Nitosols)	S2f	S2f
9	4a5 (Haplic Luvisols)	S2e	S2e
10	5b5 (Dystric Cambisols)	S2e	S2e
11	4a1 (Eutric Vertisols)	S2frwe	S2frwe
12	3a8 (Haplic Vertisols)	S2fw	S2fw

Limiting factors

f = nutrient availability e = erosion hazard w = workability r = rooting condition

4. Conclusion

Results of the simple limitation method showed that all the 12 land map units of the study area are moderately to marginally suitable for the production of both food barley and malting barley. The major limiting factors are nutrient availability, erosion hazard, workability and rooting condition. The study showed that there are no any differences between food barely and malting barley in suitability in the study area despite some differences in their environmental requirements.

References

Amiri, F. & Mohamed Shariff, A. R. (2012). Application of geographic information systems in landuse suitability evaluation for beekeeping: A case study of Vahregan watershed (Iran). *African Journal of Agricultural Research*, 7(1), 89-97.

FAO (1983). Assistance to land use planning, Ethiopia land evaluation, Part Three: Crop environmental requirements. Addis Ababa.

FAO, (1976). A Framework for Land Evaluation, Roma, FAO.

FDRE Ethiopian Institute of Agricultural Research, National Soil Research Center (NSRC) Soil Survey and Land Evaluation Section, 2006). Soils of adet Agricultural Center and its testing sites.

Rossiter, D.G., (1996). A theoretical frame work for land evaluation. Geoderma, 72(3-4): 165–190.

Santé, I. & Crecente, R. (2006). Models and Methods for Rural Land Use Planning and their Applicability in Galicia (Spain). *Environment and Planning B:Planning and Design, 33, 165 183.*

Sys, C. Van, E. Ranst and J. Debaveye, (1991a). Land Evaluation. Part II: Metod land evaluation. General Administration 1 for Development Cooperation.