LAND SUITABILITY EVALUATION FOR IRRIGATED SUGARCANE *(SACCHARUM OFFICNARUM)* AND ONION *(ALLIUM CEPA)* PRODUCTION: A CASE FROM YETNORA WATERSHED, EASTERN GOJAM ZONE, ETHIOPIA.

Abraham Mahari[a] and Azalu Alebachew[a]

[a]Debre Markos University, Department of Natural Resource Management, Ethiopia
*Corresponding author: e-mail: amahari73@yahoo.com, P.O. Box, 89, Debre Markos, Ethiopia,
Phone: +251(0)932184066)

ABSTRACT: The objectives of this study were to prepare spatial database of physical land resources for irrigated agriculture and to assess land suitability for irrigation and develop suitability map for sugarcane and onion in Yetnora watershed. Environmental factors such as mean temperature, relative humidity, EC, ESP, CEC, calcium carbonate, soil depth, soil texture, pH, soil stoniness, water table depth, flood hazard, and slope were used to evaluate irrigation suitability. The study revealed that, 72.6% was classified as moderately suitable (S2); 9.2% was marginally suitable and 18.2% was rated as permanently not suitable (N2) for both sugarcane and onion production. Soil texture, ESP, and slope, were the major limiting production factors for both irrigated sugarcane and onion production. Generally, the study area is suitable for irrigated sugarcane and onion production under proper management, which can benefit the local community to meet the food demand.
Key words: Soil properties, irrigation, qualitative evaluation, parametric method

INTRODUCTION

Irrigation has been a basic need for sedentary societies settled in arid or semiarid lands. However, in recent times the modernization or the enlargement of irrigation schemes has been called into question by nonagricultural water users in many developed countries where irrigation schemes were intended to alleviate situations of poverty [2, 8]. [11] suggested a parametric evaluation system for irrigation methods which was primarily based upon physical and chemical soil properties. In their proposed system, the factors affecting soil suitability for irrigation purposes can be subdivided into four groups: physical properties determining the soil-water relationship in the soil such as permeability and available water content; chemical properties interfering with the salinity/alkalinity status such as soluble salts and exchangeable Na; drainage properties and environmental factors such as slope. [7] and [3] improved the classification methods for evaluating suitability in effluent irrigation and land suitability for irrigation. [10] described that Ethiopia has immense potential in expanding irrigated agriculture. Despite its irrigation potential which is estimated to be about 3.7 million hectare, only about 190,000 hectare (5.3%) of the potential is currently under irrigation, which plays insignificant role in the country's agricultural production. Thus, to bring food security at national as well as household level, improvement and expansion of irrigated agriculture must be restored. In Ethiopia, limited number of reports and investigations were made to assess the irrigation potential based on the physical land and water resources [10]. Small scale studies conducted on soils of the country seem to be inadequate in providing basic soil information that can help to make decision on proper utilization of resources. Therefore, the objectives of this study were to prepare spatial database of physical land resources for irrigated agriculture and to assess land suitability for irrigation and develop suitability map for sugarcane and onion in Yetnora watershed.

MATERIALS AND METHODS

Study site

The study was conducted at Yetnora watershed of Dejen district, Amhara National Regional State which lies between 10^0 21' N and 38^0 05' E; elevation range from 1621m to 2730m. Geographically, it has a very flat (0-2%) and steep 10-20%) slopes.

The mean annual rainfall of the area is 1157mm. The mean annual temperature is 16.9^{0}C. *Eucalyptus* and *Juniperus* species are the dominant tree species in the study area. The dominant soil types of the area includes: Vertisol, Nitisols and Lepthosols.

Soil sampling and chemical analyses

Profile descriptions were made at nine sampling sites. Following to [5], coarse fragments were separated from the fine earth fraction and the content of coarse fragment was determined by weighing the residue left on a 2mm sieve in the laboratory according to Cf (weight %) = (Soil fraction >2mm/ Weight of the total dry soil)*100. The effective soil depth, drainage, and the slope were measured directly at the field. EC was determined using (1:2.5 ratio of soil: water) suspension using EC meter. Texture of the soil was determined by the hydrometer method [6].

Land evaluation procedure

To evaluate the land suitability for irrigation the parametric evaluation system of [11] was applied, using soil and land characteristics. These characteristics concern environmental factors, drainage properties, soil physical and chemical properties. They are rated and used to calculate the capability index for irrigation (Ci) according to the formula:

Ci = A*B/100*C/100*D/100*E/100*F/100

Where: Ci: capability index for irrigation, A: rating of soil texture, B: rating of soil depth C: rating of CaCO$_3$ status, D: salinity/alkalinity rating, E: drainage rating, and F: slope rating.

According to the results of measured land index in parametric method suggested by [11] lands having indexes >80 are in S1 (very suitable); 60-80 are in S2 (moderate suitable); 40-60 are in S3 (marginal suitable); 30-45 are in N1 (currently not suitable); and <30 are in N2 (permanently not suitable).

RESULTS AND DISCUSSION

The ultimate evaluation of the qualitative land suitability for irrigated sugarcane and onion using parametric methods is presented in Tables 1 and 2. As shown in Tables 1 and 2, there was not found highly suitable lands (S1) in the study area. However, this study revealed that the length of growing period (LGP) in the study area extends from 26 April to October 10 with a total of 193 days (Figure, 1). Therefore, farmers of the study area will be able to produce three times in a year using rainfed and irrigated agriculture simultaneously to achieve food self-sufficiency. [3] applied a parametric system of [10] to evaluate land suitability for both surface and drip irrigation in Ben Slimane Province, Morocco. They reported that there was no highly suitable (S1) area for irrigation and most of the areas were classified as marginally suitable (S3) for irrigation purposes. In their study, the most limiting factors were physical parameters such as slope, soil texture and soil depth. Similarly in this particular study, no highly suitable (S1) areas were found for sugarcane and onion production. Most of the areas were classified as moderately suitable (S2) for both onion and sugarcane irrigation purposes. The most limiting factors were physical parameters such as slope, soil texture, and ESP.
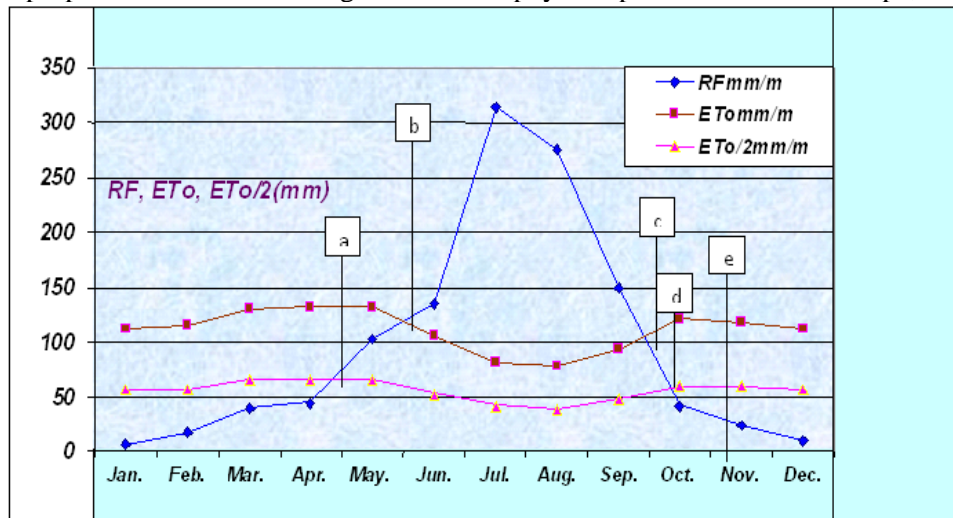

Figure 1: Graphical representation of the length of growing period

Where: a = start of the growing period, b = start of humid period, c = end of humid period, d = end of rains, e = end of the growing period

Table 1: Summary for capability indices of yetnora watershed irrigation suitability

Land unit	Area (ha)	Capability index	Suitability classes
1	62	67.2	S2
2	35	60	S2
3	222.7	61.5	S2
4	80.4	12.97	N2
5	28.5	62	S2
6	36.8	65	S3
7	55.5	48.05	S3
8	30.5	12.97	N2
9	56	72.2	S2

In the study area, 110.9ha (18.2%) was rated as permanently not suitable (N2) because of the high slope, gravelly soil texture and ESP. For almost the total study area elements such as salinity, drainage and $CaCO_3$ were not considered as limiting factors. These results are incongruent to [1] who investigated soil quality for different irrigation systems in Lali Plain, Iran. They found that factors such as drainage, salinity and $CaCO_3$ never influenced the suitability of their study area.

Table 2. Area coverage and ratio of the nine land units

Suitability classes	Area (ha)	Ratio (%)	Land unit
S2	441	72.6	1, 2, 3, 5, 7, 9
S3	55.5	9.2	6
N2	110.9	18.2	4, 8
Total	607.4	100	

CONCLUSION

The study area is suitable with respect to soil depth, $CaCO_3$, and soil stoniness but there was a problem of soil acidity in all land mapping units and slight problems of slope steepness and flooding hazard in some land mapping units of the study area. Generally, the area is suitable for irrigated sugarcane and onion production under proper management, which can benefit the local community to meet the food demand.

REFERENCES

[1] Ali R R, AbdAli N and Mohammad A. 2009. Assessment of soil properties for irrigation methods in North Andimeshk Plain, Iran. Journal of Food, Agriculture & Environment. 7 (3 and 4): 728-733.

[2] Ashraf S H, Afshari H, Munokyan R and Ebadi A. 2010. Multicriteria land suitability evaluation for Barley by using GIS in Damghan plain (Northeast of Iran). J. Food, Agri. & Environ., 8 (3 and 4): 626-628.

[3] Bond W J. 2002. Assessing Site Suitability for an Effluent Plantation in Mckenzie. Soil Physical Measurement and Interpretation for Land Evaluation. CSIRO Publishing, pp: 351-359.

[4] Briza Y, Dileonardo F and Spisni A. 2001. Land evaluation in the province of ben Slimane, Morocco. 21st Course Professional Master, Remote Sensing and Natural Resources Evaluation 10 Nov 2000-22 June 2001-IAO. Florence, Italy.

[5] Denis B. 1999. Soil Science Analysis. A Guide to Current Use. Paris, France.

[6] Gee G W and Bauder J W. 1986. Particle Size Analysis. Part 1. Physical and mineralogical methods, pp. 404-408. Madison, Wisconsin. USA.

[7] Hired C, Thomson A and Beer I. 1996. Selection and Monitoring of Sites Intended for Irrigation with Reclaimed Water in Proceedings. Water TECH, Sydney. May 1996. Australian Water and Wastewater Association, Sydney, Australia.

[8] Hargreaves H G and Mekley G P. 1998. Irrigation Fundamentals. Water Resource Publication. LLC, pp: 200.

[9] Rossiter D G. 1996. A theoretical framework for land evaluation. Geoderma. 72: 165-190.

[10] Seleshi A. 2005. Water Resources and Irrigation Development in Ethiopia Guidelines: Land evaluation for irrigated agriculture - FAO soils bulletin 55.

[11] Sys C, Vanranst E and Debvay J. 1991. Land evaluation. Part: III. General Administration for Development Cooperation Agriculture, Brussels, Belgium. pp: 199.