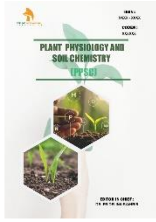
ZIBELINE INTERNATIONAL™ PUBLISHING

Plant Physiology and Soil Chemistry (PPSC)

DOI: http://doi.org/10.26480/ppsc.01.2022.12.15

ISSN: 2805-5063 (Online)
CODEN: PPSCCU



CrossMark

RESEARCH ARTICLE

SURFACE IRRIGATION SUITABILITY ASSESSMENT OF THE SOME SOILS IN AKOKO EDO LOCAL GOVERNMENT AREA OF EDO STATE, NIGERIA

Agbai W. P.*

Department of Soil Science and Land Management, Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria
****Corresponding Author E-mail: Agbaiwilliams@gmail.com***

ARTICLE DETAILS

Article History:

Received 28 November2021
Accepted 30 December 2021
Available online 04 January 2021

ABSTRACT

Irrigation is necessary and important for all year round cultivation of crops and fertigation, without which some crops will perish. Surface irrigation is the cheapest means of irrigation applied amongst farmers, which has sustained food security over the years. The purpose of this study is to provide irrigation data for land users in the area, as irrigation survey has not been carried out in the said area. This study assesses surface, drip and sprinkler irrigation suitability for some sandy soils in Akoko Edo Local Government Area of Edo state including Ikpeshi, Unem-Nekhua and Ososo, Nigeria. A parametric approach was employed. The result shows that the sandy soils of the areas were marginally suitable (S3) for surface irrigation with Ikpeshi, Unem-Nekhua and Ososo soils recording suitability index of 44.67, 52.25 and 52.25. Ikpeshi and Unem-Nekhua soils were moderately suitable (S2) for sprinkler and drip irrigation with suitability index of 63.2 and 76.7, 70 and 71.3. Ososo soils were highly suitable (S1) for both sprinkler and drip irrigation system with suitability index and 95 and 80.8. The result will guide land users in utilizing the lands according to their suitability.

KEYWORDS

irrigation, land user, sprinkler

1. INTRODUCTION

There is upward alarm over food security in Africa, mainly in sub-Saharan Africa. Productivity dependent on rain-fed agriculture is diminishing. The assessment of a land capability for irrigation is fundamental in plans for improvement, as irrigated crops make up the most industrious system of agriculture, and they are specifically gainful in arid and semi-arid areas (Mandal *et al.,* 2017).

To promote food production, water has been reflected as the utmost significant constituent for the transformation of low productive rain-dependent agriculture into the most effective and efficient irrigated agricultural system.

The negative impact made by dependence on rainfall agriculture is clearly seen in overall crop production all over the world and has caused experts to consider alternative methods capable of relieving the current dependency. (Kasa *et al.*, 2010).

Referring to a researcher, the irrigation of additional land is important for world food security (Dengiz, 2006). To advance into a sustainable irrigation system, the land irrigation potential must be assessed and known. It is a criterion that the suitability of soils be considered for irrigation before any project is commenced.

Land classification for irrigation is the methodical investigation, description, review, and grouping of land on the foundation of physical and chemical characteristics affecting its suitability for sustained production under irrigated agriculture. The selection of any land for irrigation purpose involves forecast of the behaviour of the land after improvement and use of irrigation water (Fasina, 2008).

Irrigation suitability provides information which helps to predict soil potential and also limitation for irrigation considering different methods and to attain food security. Exposure of suitable lands increases the total number of irrigable lands. Irrigable soils will therefore be treated with caution, as they support sustainable agriculture.

This research aims at evaluating the surface irrigation suitability for the soils of Akoko Edo Local Government Area of Edo State, Nigeria, as such data is currently not available.

2. RESEARCH STUDY AREA

Akoko-Edo local government area is bounded to the North: Ogori /Mangogo, Okehi, Adavi and Okene local government areas all in Kogi state; to the West by Akoko South East, Akoko North East and Ose local government areas in Ondo state; to the South by Owan East and Etsako West; and to the East by Etsako East all in Edo state. It has an area of 1,371 km² (137,100 hectares) and a population of 262,110 as at the 2006 census. It lies between 6° 06' 0" East longitude and 7° 17' 0" North latitude.

The research was conducted in November, 2019 in Akoko Edo Local Government Area of Edo State covering three areas: Ikpeshi with coordinates - N 07.18674°, E 006.15456°, Unem Nekhua - N 07.33174° E 006.08360° and Ososo - N 07.40648°, E 006.25318°).

Quick Response Code	Access this article online	
	Website: www.ppsc.org.my	**DOI:** 10.26480/ppsc.01.2022.12.15

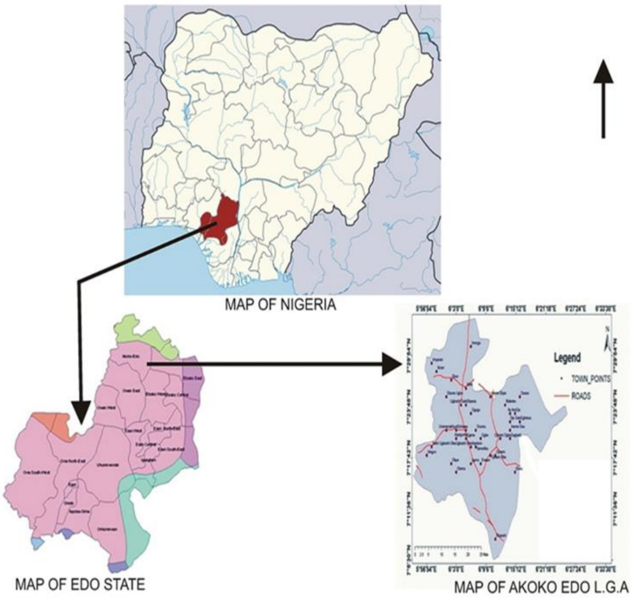


Figure 1: Location Map of Akoko-Edo Local Government Area of Edo State

2.1 Climate of the study area

Akoko Edo Local Government is located in the Northern part of Edo State, characterized by tropical climate with an annual average rainfall amount of 1200 - 1500 mm, mean annual temperatures range of 27° C to 32° C and mean annual relative humidity ranging from 30.5 % to 94.0 % (Olowojoba *et al.,* 2016). The study area is characterized by two distinct seasons: the wet and the dry. Rainfall is at its climax in July and August with a short break in mid August. The dry season begins early November and ends by March.

2.2 Geology/Parent material of the study area

The project area lies within the basement complex formation, which consists of various rocks like shale, coarse grained granite and granite gneiss etc with some outcrops visible around the entire local government area. Physiographically, Ikpeshi and Unem-Nekhua can be described as situated on gentle plains of low relief while Ososo is quite steep due to the presence of high hills visible in the area. (Olowojoba *et al.,* 2016).

3. Field Work and Soil Sampling

The soil units surrounding the area were identified by means of the rigid grid method using the guidelines of Soil Survey Staff (SSS, 2014). The soil units were identified and delineated using the soil texture and colour. Three representative soil units were considered because of their depth and topographic positions. Soil profiles were dug to represent the different soil units. The delineated and identified horizons were described and soil samples gathered for laboratory analysis. The soil depth, drainage and slope were measured in-situ using FAO (2006) method. At each observation point, soil samples were collected across all horizon with auger for the determination of particle size distribution.

The disturbed soil samples collected from each horizons was air dried, crushed and passed through 2 mm sieve. The sieved samples was be bagged and labeled to be subjected to standard laboratory analysis for physical and chemical parameters.

3.1 Laboratory analysis

The electrical conductivity was assessed using (1:2.5 ratio of soil : water) suspension. The soil texture was determined using the hydrometer method (Gee and Bander, 1980). Exchangeable Sodium percentage, Total nitrogen (%) available P (ppm), pH, organic carbon (%), exchangeable acidity (Cmol/kg), $CaCO_3$, exchangeable bases (Cmol/kg), were determined using the International Institute for Tropical Agriculture procedures (IITA, 1979).

3.2 Index for determination of Irrigation suitability

To appraise the land suitability for irrigation, the parametric evaluation method of Sys (Sys, 1985, Sys *et al.*, 1991) was considered using the soil and land characteristics. These characteristics include drainage properties, environmental factors, and soil physical and chemical properties. They were rated and then used to calculate the capability index for irrigation Ci according to the formula:

$$\mathrm{Ci} = \frac{A}{100} * \frac{B}{100} * \frac{C}{100} * \frac{D}{100} * \frac{E}{100} * \frac{F}{100}$$

Where Ci = suitability index for irrigation

A= Rating of soil texture B=Rating of soil depth C= Rating of $CaCO_3$ status

D = Electrical Conductivity E = Drainage rating and F = Slope rating

3.3 Percent calcium carbonate (% $CaCO_3$)

Percent Calcium Carbonate (% $CaCO_3$) was measured using acid neutralization method.

3.4 Exchangeable sodium percentage (ESP)

Exchangeable Sodium Percentage (ESP) was calculated from values of Exchangeable Sodium and Cation Exchange Capacity, as follows:

$$\mathrm{ESP} = \left(\frac{Exch.\ Na}{CEC}\right)*100$$

Where:

Exch. Na= Exchangeable sodium (Cmol/kg soil)

CEC= cation exchange capacity (Cmol/kg soil)

3.5 Sodium Adsorption Ratio (SAR)

Sodium adsorption ratio (SAR) was computed from values of soluble sodium, calcium and magnesium.

$$\mathrm{SAR} = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+}+Mg^{2+}}{2}}}$$

Where:

SAR: sodium adsorption ratio (mmol/l)1/2

Na: sodium in mmol/l

Ca: calcium in mmol/l

Mg: magnesium in mmol/l

Table 1: Suitability Index for Irrigation Suitability Indices Ci classes

Capability Index	Class	Definition	Symbol
>80	I	Highly suitable	S1
60-80	II	Moderately suitable	S2
45-60	III	Marginally suitable	S3
30-45	IV	Currently not suitable	N1
<30	V	Permanently not	N2

Source: Sys (Sys, 1985)

Table 2: Rating of soil depth for irrigation

Soil depth [cm]	Rating for surface Irrigation	Rating for sprinkler Irrigation	Rating for drip Irrigation
< 20	25	30	35
20-50	60	65	70
50-80	80	85	90
80-100	90	95	100
>100	100	100	100

Table 3: Rating of CaCO3 for irrigation

$CaCO_3$ [%]	Rating for surface Irrigation	Rating for sprinkler Irrigation	Rating for drip Irrigation
< 0.3	90	90	90
0.3-10	95	95	95
10-25	100	100	95
25-50	90	90	80
>50	80	80	70

Table 4: Rating of salinity for irrigation

EC (ds m^{-1})	Rating for surface Irrigation		Rating for sprinkler Irrigation		Rating for drip Irrigation	
	C, SiC, SiCL, S, SC Textures	Other Textures	C, SiC, SiCL, S, SC textures	Other Textures	C, SiC, SiCL, S, SC textures	Other Textures
< 4	100	100	100	100	100	100
4-8	90	95	95	95	95	95
8-16	80	50	85	50	85	50
16-30	70	30	75	35	75	35
>30	60	20	65	20	65	25

C – clay; SiC – silty clay; SiCL – silty clay loam; S – sand; SC – sandy clay

Table 5: Rating of drainage classes for irrigation

		Rating	
	Infiltration rate cm/hr.	Clay, silty clay, sandy clay, silty clay loam	other textures
Excessively drained	> 12.5	100	100
Somewhat excessively drained	4.2-12.5	100	80
Well drained	4.2	95	85
Moderately drained	1.7	80	65
Somewhat poorly drained	0.42	70	55
Poorly drained	0.04	55	45
Very poorly drained	<0.04	50	30

Table 6: Rating of slope for irrigation

Slope classes (%)	Rating for surface Irrigation		Rating for sprinkler Irrigation		Rating for drip Irrigation	
	non-terraced	Terraced	non-terraced	Terraced	non-terraced	Terraced
0-1	100	100	100	100	100	100
1-3	95	95	100	100	100	100
3-5	90	95	95	100	100	100
5-8	80	90	85	95	90	100
8-16	70	80	75	85	80	90
16-30	50	65	55	70	60	75
>30	30	45	35	50	40	55

Table 7: Rating of Textural Classes for Irrigation

Texture	Rating for Surface Irrigation					Rating for Sprinkler Irrigation					Rating for Drip Irrigation				
	Fine gravel (%)		Coarse gravel (%)			Fine gravel (%)		Coarse gravel (%)			Fine gravel (%)		Coarse gravel (%)		
	< 15	15-40	40-75	15-40	40-75	< 15	15-40	40-75	15-40	40-75	< 15	15-40	40-75	15-40	40-75
CL	100	90	80	80	50	100	90	80	80	50	100	90	80	80	50
SiL	100	90	80	80	50	100	90	80	80	50	100	90	80	80	50
SCL	95	85	75	75	45	95	85	75	75	45	95	85	75	75	45
L	90	80	70	70	45	90	80	70	70	45	90	80	70	70	45
SiL	90	80	70	70	45	90	80	70	70	45	90	80	70	70	45
Si	90	80	70	70	45	90	80	70	70	45	90	80	70	70	45
SiC	85	95	80	80	40	85	95	80	80	40	85	95	80	80	40
C	85	95	80	80	40	85	95	80	80	40	85	95	80	80	40
SC	80	90	75	75	35	95	90	80	75	35	95	90	85	80	35
SL	75	65	60	60	35	90	75	70	70	35	95	85	80	75	35
LS	55	50	45	45	25	70	65	50	55	30	85	75	55	60	35
S	30	25	25	25	25	50	45	40	30	30	70	65	50	35	35

4. Results and Discussion

Ikpeshi soils were mainly Loamy sand at the surface with average 807.3 g/kg of sand, 100 g/kg of silt and 92.7 g/kg of clay. Unem-Nekhua soil also was Loamy sand (837 g/kg of sand, 65 g/kg silt and 98 g/kg of clay); while Ososo soils were Sandy clay loam with 706 g/kg of clay, 89 g/kg of silt, and 205 g/kg of clay. The pedons show increase in clay content down the horizons, which could be due to the high rainfall in the region.

Ikpeshi soils had a total depth of 147 cm, Unem Nekhua – 193 cm and

Ososo – 187 cm. The average pH of the Ikpeshi soils was 5.62 which is moderately acidic to acidic; and had the highest value compared to Unem-Nekua (5.36) and Ososo (5.37). The organic matter content in Ikpeshi was low, with an average of 14.85 g/kg with a decrease down the horizon, with Unem Nekhua and Ososo recording lower organic matter content of 9.28 g/kg and 12.88 g/kg.

The high sand content especially at the surface soils indicates that illuviation have taken place over time, reducing the level of fine particles in the soil and leaving them susceptible to erosion and disaggregation.

4.1 Irrigation suitability evaluation

Surface, sprinkler and drip irrigation systems were considered for the three mapping units, as indicated in table 8.

Ikpeshi soils had suitability index of 44.67 and with suitability class of S3 which is marginally suitable for surface irrigation. Also, the soils had suitability index of 63.2 and suitability class of S2 (Moderately suitable) for sprinkler irrigation. For drip irrigation, the soils suitability index was 76.7 with suitability class of S2 (moderately suitable).

Unem-Nekhua soils had 52.25 suitability index and suitability class of S3 which is marginally suitable surface irrigation. The soils were moderately suitable for sprinkler and drip irrigation with suitability index and class of 70, S2 and 71.3, S2.

Ososo soils had 52.25 suitability index and suitability class of S3 which is marginally suitable surface irrigation. The soils were highly suitable for sprinkler irrigation with suitability index of 95 and highly suitability for drip irrigation with suitability index of 80.8 and suitability class of S1.

Table 8: Suitability index values (Ci) and suitability classes of different irrigation methods

Mapping unit	Surface irrigation		Sprinkler irrigation		Drip irrigation	
	Ci	Suitability classes	Ci	Suitability classes	Ci	Suitability classes
IKPESHI	44.67	S_3	63.2	S2	76.7	S2
UNEM-NEKHUA	52.25	S_3	70	S2	71.3	S2
OSOSO	52.25	S_3	95	S1	80.8	S1

S1 – Highly suitable, S2 - Moderately suitable, S3 - Marginally suitable, N1 - Currently not suitable

5. Conclusion

The results shows that the soils of the study areas which are mainly dominated by the sand fractions were marginally suitable for surface irrigation and therefore require proper management practices such as organic matter addition, green manuring & mulching should be practiced to improve the water holding capacity, soil structure, aggregate stability and texture of the soil. Ikpeshi and Unem-Nekhua soils were moderately suitable for sprinkler irrigation and drip irrigation, while Ososo soils were highly suitable for drip and sprinkler irrigation system. Hence proper amelioration should be carried out in soils with marginal suitability for any form of irrigation system. Soils with lower suitability and class below S1 were deterred mainly by the soil texture of the soils, which was caused mainly by the parent material in the area. The drainage, slope, $CaCo_3$, depth and salinity values were above average. The result indicates that soil texture, slope and organic matter played a major role in determining the suitability of the soils for surface irrigation. The texture determines to a large extent permeability, infiltration capacity including infiltration rate and cumulative infiltration; and water holding capacity of soils. The soils of the study areas were found to be coarse textured therefore increasing water and nutrient losses. The low organic matter content indicates that the soils will hold limited volume of water, thereby permitting leaching of water and nutrients. The macro porosity will reduce fertigation and chemigation effectiveness and also decrease irrigation water economy. Land users can now have access to the irrigation suitability status and information of sandy soils found in Ikpeshi, Unem-Nekhua and Ososo, all in Akoko Edo Local Government Area of Edo State.

References

Dengiz, O. 2006. A comparison of different irrigation methods based on the parametric evaluation approach. Turk J. Agric. For., 30, pp. 21–29.

FAO (Food and Agricultural Organization) 2006. Guidelines for soil description. 4th ed. Viale delle Terme di Caracalla. Rome, Italy.

Fasina, A.S. 2008. Irrigation suitability of Asu river basin soils, south eastern Nigeria. International Journal of Soil Sciences, 3(1), pp. 35-41.

Gee, G.W., Bander, J.W. 1980. Particle Size Analysis Part I. Physical and Mineralogical Method, pp. 404-408. Madison. Wisconsin. U.S.A.

IITA (International Institute of Tropical Agriculture) 1979. Selected Methods of Soil and Plant Analysis. IITA Manual series, I IITA Ibadan pp. 60.

Kasa Teka, Van Rompaey, A., Poesen, J. 2010. Land suitability assessment for different irrigation methods in Korir Watershed, Northern Ethiopia. Journal of the Drylands, 3(2), pp. 214-219.

Mandal, B., Dolui, G., Satpathy, S. 2017. Land suitability assessment for potential surface irrigation of river catchment for irrigation development in Kansai watershed, Purulia, West Bengal, India.

Olowojoba, S.O., Kappo, A.A., Ogbole, J.O., Alaga, A.T., Mohammed, S.O., Eguaroje, E.O. 2016. Land Suitability and Evaluation for the Production of Cassava in Akoko-Edo L.G.A. of Edo State using Geo-Technology Techniques. Greener Journal of Agricultural Sciences, 6(2): pp. 059-068, http://doi.org/10.15580/GJAS.2016.2.011416008.

Soil Survey Staff. 2014. Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 51, Version 2.0. R. Burt and Soil Survey Staff (ed.). U.S. Department of Agriculture, Natural Resources Conservation Service.

Sys, C. 1985. Land Evaluation. International Training Centre for Postgraduate Soil Scientist, 1,2 and 3. State University Ghent.

Sys, C., Van Ranst, E., Debaveye, J. 1991. Land evaluation. Part 1. Principles in land evaluation and crop production calculations. International Training Center for Post-graduate Soil Scientist, University Ghent.