# Evaluation of the Suitability of Alfisol of Derived Savanna for Rice Production in South-western Nigeria

*[1]Temitope S. Babalola, [1]Abayomi S. Fasina, [2]Deodatus S. Kiriba,
[3]Simon D. Basga, [1]Samuel O. Ajayi and [2]Matilda O. Oyewole
[1]Department of Soil Science and Land Resources management, Federal University, Oye-Ekiti, Nigeria
[2]Natural Resources Management Program, Tanzania Agricultural Research Institute, Arusha, Tanzania
[3]Institute of Agricultural Research for Development, Garoua, Cameroon
[4]Department of Agronomy, University of Ibadan, Ibadan, Nigeria
**seun.babalola@fuoye.edu.ng|sundayfash2012@yahoo.com|deodatus.kiriba@tari.go.tz|
simonbajak@yahoo.fr|samuel.ajayi@fuoye.edu.ng|matildaoyewole@gmail.com**

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**ORIGINAL RESEARCH**

**Abstract-** The combination of quantitative and qualitative studies in land evaluation is important for decision making on the adoption of specific land utilization type. This study evaluates the suitability of two locations for rice production in an alfisol of derived savanna, Ikole-Ekiti, Southwestern Nigeria. Two locations; Ikole - Ijesa-Isu road (K1) and Ikole - Osin road (K2) were selected and a profile was dug in each of the site, described according to the standard and sampled for laboratory analysis of soil physic-chemical properties. Field experiment was conducted in 2022 cropping session to evaluate the performance of rice in the two locations. The locations were considered as the treatment and rice was planted in the representative portion of each of the site in four replicates. The experiment was a randomized completely block design. Recommended cultural practices for rice in the derived savannah zone of Nigeria were followed. Yield data were collected in tons per hectare and analysed with T-test at 5% probability level. Results obtained revealed that the soils pH ranged from 5.5 to 6.2, organic carbon is from 0.4 to 5.01% and total nitrogen from 0.08 to 0.19%. K1 had actual index of suitability of 34.88 therefore rated marginally suitable while K2 was 19.37 for rice. The potential index of suitability of K1 was 80 highly suitable and K2 was 60 moderately suitable. Highest rice yield of 1.03 t ha$^{-1}$ was obtained in K1. K1 was recommended as preferred location for rice cultivation in the study area. Suitability evaluation should be followed by qualitative experiment in order to make recommendations that are adoptable for farmers.

**Keywords-** soil, suitability, rice, qualitative, quantitative

## 1 Introduction

Food production in the global south has not kept pace with population increase as reflected in the increasing levels of food (especially rice) importation and under-nourishment in countries such as Nigeria (Federal Office of Statistics 2009), Ethiopia (Ayehu and Besufekad 2015), Papua New Guinea (Samanta*et al.*, 2011), Pakistan (Naz and Rasheed, 2017), and Kenya (Kihoro*et al.*,2013). The role of rice in the world food budget cannot be overestimated. It is the staple food for nearly half of the world population as well as being a major source of employment and income for many especially the rural populace (FAO, 2003). I It is estimated that some 156 million hectares of land are in rice cultivation across the world with a combined production capacity of about 660 million tons (Genctan, 2009), approximately 4.23 t/ ha. Out of this, Nigeria is credited with 1.77 million hectares (Longtau, 2003).

*Corresponding Author

**Section A-** AGRICULTURAL ENGINEERING & RELATED SCIENCES
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In Nigeria, rice is both a key staple food and also a major source of livelihood for a significant proportion of the farming population but its production is still unable to meet the demand for local consumption, hence the importation of rice is a major factor in depleting Nigeria's foreign reserve. The Federal Government of Nigeria (FGN) through the Central Bank of Nigeria (CBN) is seeking to boost agricultural production with rice highly prioritized. Several studies (Adejuwon 2006; Mahmood *et al*. 2012; Adamgbe and Ujoh 2012, 2013; Ujoh 2013; Ujoh*et al* 2019) have suggested that the declining yield of crops particularly rice in Nigeria is attributable to several factors such as fluctuating climatic parameters, pressure on land due to population growth and attendant declining size of farm holdings, instability, and migrations resulting from ethnic conflicts and farmer-herdsman crises, and inability of the peasant farmers to access fertilizers. For Nigeria to make appreciable contribution to the world's rice production, the land utilization type must be that for which the soils of the rice producing regions are well suitable for. This is the essence of land suitability evaluation.

Land suitability refers to the ability of a portion of land to tolerate the production of crops in a sustainable way. Its evaluation provides information on the constraints and opportunities for the use of the land and therefore guides decisions on optimal utilizations of resources, whose knowledge is an essential prerequisite for land use planning and development. Moreover, such a kind of analysis allows identifying the main limiting factors for the agricultural production and enables decision makers such as land users, land use planners, and agricultural support services to develop a crop management able to overcome such constraints, increasing the productivity.

Land could be categorized into spatially distributed agriculture potential zones based on the soil properties, terrain characteristics and analysing present land use (Bandyopadhyay*et al.*, 2009). Production could be met through systematic survey of the soils, evaluating their potentials for a wide range of land use options and formulating land use plans which were economically viable, socially acceptable and environmentally sound (Sathish and Niranjana, 2010).

Rice as a strategic crop in Nigeria is important and commercially produced (Nwobiala & Adesope, 2010). Currently, the size of area under rice cultivation within the study area cannot be accurately ascertained due to poor statistics and record-keeping from local farmers. However, it is a common crop among the smallholder farmers in the study area, there are reports of poor yield in the area and production did not meet the local demand for rice (Nwobiala & Adesope, 2010). An assessment of suitable areas for rice production is important for land use planning and management for optimum and sustainable production in the area. The specific objectives of the study are to evaluate the physico-chemical properties of soils in the study area, conduct land suitability evaluation for rice in the study area and evaluate the performance of rice in the study area.

## 2 Materials and Methods

### 2.1 Description Of The Study Areas

The study sites are in Ikole-Ekiti, Ekiti State in the derived savannah agro-ecological zone of Southwestern Nigeria. The climate is sub-humid tropical with mean annual rainfall of about 1300 mm (90% of the rainfall is between June and August). The mean daily temperature rarely falls below 22°C with peaks of 36° between February to March and November to December. The mean relative humidity is 75%. The soils of the Ikole-Ekiti are Alfisols (USDA) developed from the basement complex rocks ranging from shallow to very deep soils overlying deeply weathered gneisses and migmatites. The slope of the locations is between 1.5 to 1.8%.

### 2.2 Soil Sampling

In 2021, Two small holder rice farms with no record of soil data were selected for the study. The sites were on 7°46'34.52''N 5°31'31.42'E at Ikole - Ijesa-Isu road (K1) and 7°46'52.74'N 5°27'51.03''E at Ikole - Osin road (K2). A profile was dug in each of the site and described according to the guideline of the Soil Survey Staff Division (2017). Soil samples were collected from the horizons and packaged for laboratory analysis.

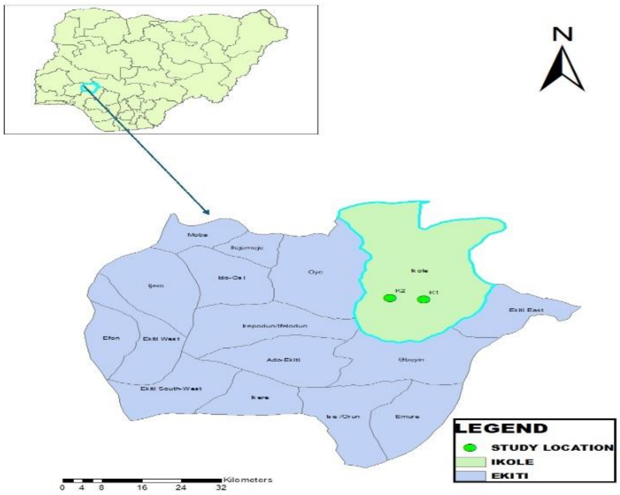


Fig 1: Map showing the study location

### 2.3 Laboratory Analyses

The samples were taken to the Soil Science laboratory of the Department of Soil Science and Land Management, Federal University Oye-Ekiti, air dried and gently crushed with porcelain pestle and mortar; and then passed through a 2mm sieve to remove coarse fragments. The fine earth samples (<2mm soil portion) collected were analysed. Particle size distribution was determined using hydrometer method (Gee and Bauder, 1986). Sand, silt and clay was determined by dispersing the soil samples in 5% calgon (sodium hexametaphosphate) solution. The dispersed samples were shaken on a reciprocating shaker after which particle size distribution was determined with the aid of Bouyoucous hydrometer at progressive time intervals. The textural classes were determined with the aid of USDA textural triangle.

The soil pH was determined both in water and 0.01M $CaCl_2$ solution, using a soil to solution ratio of 1:2.5 (IITA, 1979). On equilibration, pH was read with a glass electrode on a Pye- Unicam model 290mk pH meter. Delta pH (dpH) values were determined. The Walkley – Black (1934) wet digestion method were used to determine the organic carbon content of the soil samples. Total nitrogen was determined using the macro – kjedhal method. Soil available phosphorus was determined using the Bray I method calorimetrically. Electrical Conductivity of the saturated paste extract of 1:2.5 soils to water ratio were determine using a rheostat, Wheatstone bridge model at 250C (Bower and Wilcox, 1965).
Exchangeable Ca, Mg, Na and K were extracted with 1m ammonium acetate (1M NH4OAc) solution buffered at pH 7.0 as described by Anderson and Ingram (1998). Potassium and Salinity in the extract were read on a GallenKamp flame Analyzer. The extracts were diluted two times with the addition of 2ml of 6.5% lanthanuv cm chloride solution to prevent ionic interference before Ca and Mg were read. The Ca and Mg were read on a pyeunicam model SP 192 atomic absorption spectrophotometer (AAS) at 423 and 285nm wavelength respectively. The soils were leached with 1m KCl solution. Exchange acidity (Al+H) in the 1m KCl extract was determined by titration with 0.1m sodium hydroxide solution as described by Anderson and Ingram (1998). The effective cation exchange capacity and percentage base saturation were calculated.



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### 2.4 Field Experiment

Field experiment was conducted in 2022 cropping session. The two locations were considered as the treatment and rice was planted in the representative portion of each of the site in four replicates. Each experimental plot was 2 by 3m. The experiment was a randomized completely block design. Recommended cultural practices by Aduayi *et al.* (2002) for rice in the derived savannah zone of Nigeria were followed. NERICA 6 upland rice was planted at a seed rate of 45kg/ha, dribbled at 5-6 seeds at the spacing of 20x20cm and later thinned to 3 seedlings per stand at 3 weeks after planting. Weed was controlled with the application of glyphosate (4 - 6 litres ha), 2 weeks before planting followed by Propamil + bentazon at 3.0 kg a.i. $ha^{-1}$. 200 kg/ha N-P-K (20-10-10) was applied at 2 weeks after planting and first weeding, followed by second application of 150 kg/ha of urea at 7 weeks after planting.

### 2.5 Land Suitability Evaluation

The suitability of the soils of the location was evaluated for rice with the parametric method of land suitability evaluation (Ogunkunle, 1993). The land requirements for suitability of rice cultivation (Table 1) was compared with the land characteristics of the two sites to compute the actual and potential suitability rating of each soil for rice cultivation. The limiting factors of each profile were rated in percentage and the index of suitability of each profile was computed using the equation:

$$IP = A\,x\,\sqrt{\frac{B}{100}\,x\,\frac{C}{100}\,x\,\frac{D}{100}\,x\,\frac{E}{100}\,x\,\frac{F}{100}} \ldots\ldots\ldots\ldots\ldots (1)$$

Where: IP = index of suitability,
A= the overall lowest characteristics
B, C…..F= the lowest characteristics in each land quality group

The suitability classes S1(highly suitable), S2(moderately suitable), S3(marginally suitable), N1(currently not suitable) and N2(potentially not suitable) are equivalent to index of productivity value of 100-75, 74-50, 49-25, 24- 12.5 and 12.4-0 respectively.

### 2.6 Data Collection

Yield data were collected from each location by weighing harvested paddy rice with weigh balance.

### 2.7 Data Analysis

T-test was used to compare the yield of rice at the two locations. The test was conducted at 5% level of probability and analysis was done with the Statistix 12 software.

## 3 Results And Discussion

### 3.1 Soil Physico-Chemical Properties

The physico-chemical properties of soils studied is presented in Table 2. The surface horizons of the both soils have higher pH values at the surface than subsurface horizons. pH ($H_2O$) and pH ($CaCl_2$) are between 5.6 to 5.7 and 5.5 to 6.2 at the surface horizon.

The soils are strongly acidic. The subsurface horizons ranged from 4.2 to 6.2 (pH $H_2O$) and 4.1 to 6.1 (pH $CaCl_2$). They are classified as very strongly acidic to strongly acidic. The pH of K1 in comparison with K2 revealed that K1 fell in the range recommended for most crops by Adepetu (1990) (pH 5.5 – 6.5) while K2 is below the critical level. The higher pH at the surface horizon had been attributed to nutrient cycling through root absorption of bases from subsurface horizons and their return to the surface through litter fall (Adegbenro, 2015; Maniyunda, 2012). The electrical conductivity values are below the ratings of 4.00mmhos and above recommended for saline soils. The electrical conductivity of the surface horizons is between 0.26mmhos to 0.58mmhos while the subsurface horizons values ranged from 0.06mmhos to 0.42mmhos. Salinity is lower the surface than sub-surface and lower in K1 than K2.

Soil organic carbon values ranged at the surface horizons from 1.9 to 3.5 and 0.4 to 5.01 % at the subsurface horizons. The values are below 10 % and therefore rated low according to the ratings of FAO (2004). The regular supply and presence of more decomposable organic materials, phytocyling, microbial activities, better aeration and moisture condition occasioned the surface horizon to have higher organic carbon than the sub-surface horizon (Babalola, 2017; Olayinka, 2009). The soil organic matter values had similar trend of distribution as organic carbon, this is understandable in that organic carbon is a major component of organic matter and they are influenced by similar factors. The organic matter values are between 3.40 and 6.26 % at the surface horizons and 0.72 to 5.01 % at the subsurface horizons. Higher soil organic carbon at the surface is as a results of leaf litter decomposition and most organic residues are incorporated or deposited on the surface, so organic matter tends to accumulate on the surface horizons (*Yimer et al.* 2006), the total nitrogen values ranged between 0.14 and 0.19 % at surface horizons and 0.08 to 0.17 % at the subsurface horizons. The distribution is similar to that of organic carbon and organic matter. Carbon and nitrogen are the major constituent of organic matter (Babalola, 2017). The values obtained in the two locations are below the critical level of 0.2 % suggested by Aduayi *et al.* (2002) for Nigerian soils.

The available phosphorus of the surface horizon ranged from 5.10 to 8.47 $mgkg^{-1}$, that of the subsurface horizons ranged between 1.50 to 6.09 $mgkg^{-1}$. The values are rated low based on the critical level of 10 $mgkg^{-1}$ set by (Aduayi *et al.*, 2002). This could be as a result of the nature of parent materials from which the soils were formed or fixation in acidic soils.



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Table 1. Land requirement for upland rice for the study location (Modified from Sys et al., !993)

| Land qualities | 95-100 $S1_1$ | 70-94 $S1_2$ | 55-69 S2 | 40-54 S3 | 20-39 N1 | 0.00-19 N2 |
|---|---|---|---|---|---|---|
| Climate (c) | | | | | | |
| Mean annual rainfall (mm) | >1000 | 900-1000 | 800-900 | 600-800 | 500-600 | <500 |
| Mean annual temperature (°C) | >25 | 22-25 | 20-22 | 18-20 | 16-18 | <16 |
| Relative humidity (%) | >75 | 70-75 | 65-70 | 60-65 | <60 | - |
| Topography (t) | | | | | | |
| Slope (%) | <2 | 3-4 | 5-6 | 7-8 | 9-10 | >10 |
| Drainage (w) | | | | | | |
| Wetness | WD | MWD | MD | ID | PD | PD |
| Flooding | F0 | F0 | F1 | F1 | F2 | F3 |
| Soil Physical Properties (s) | | | | | | |
| Texture | L | Lfs, SL, | LS, SC, SCL, SiC, SiL, C | LS, S | S | S |
| Soil depth (cm) | >75 | 65-70 | 50-65 | 35-50 | 30-35 | <30 |
| Soil Fertility (f) | | | | | | |
| pH ($H_2O$) | 5.5-6.5 | 5.0-5.5 | 4.5-5.0 | 4.0-4.5 | <4.0 | - |
| Base Saturation (%) | >80 | 70-80 | 50-70 | 40-50 | 25-35 | <25 |
| Nitrogen (%) | >1.0 | 1-0.5 | 0.5-0.2 | 0.2-0.15 | <0.15 | |
| Available P (mgkg$^{-1}$) | >20 | 15-20 | 8-15 | 5-8 | 3-5 | <3 |
| Exchangeable K (cmolkg$^{-1}$) | >0.50 | 0.3-0.5 | 0.20-0.30 | 0.10-0.20 | <0.1 | |
| Exchangeable Ca (cmolkg$^{-1}$) | 8-10 | 6-8 | 6-3 | 2-3 | <2 | |
| Exchangeable Mg (cmolkg$^{-1}$) | 4-6 | 2-4 | 1.5-2 | 1-.1.5 | <1 | |
| Organic Carbon (%) | 2-4 | 1-2 | 0.5-1 | <0.5 | | |
| EC (mmhos) | <2 | 2-4 | 4-6 | 6-10 | >10 | |

*WD – Well drained, MWD – Moderately well drained, ID – Imperfectly drained, PD – Poorly drained; L – Loam, SL – Sandy loam, LS – Loamy sand, Lfs – Loamy fine sand, SCL – Sandy clay loam and C – Clay; F0 – Rarely Flooded, F1 – Flooding Expected, F2 – Irregularly Flooded and F3 – Regularly Flooded; C - Clay, CL – Clay Loam, LS – Loamy Sand, SL – Sandy Loam, LCS- Loamy Clay Sand, CS–Clay Sand, SiC–Silty Clay, SiL- Silty Loam, S-Sand.*

Table 2: Soil chemical properties of the study site

| Depth | PH | PH | EC | OC | OM | TN | Avail.P | K | Na | Ca | Mg | Exch. $AL^{3+}$ | Exch. $H^+$ | ECEC | BS | Gravel | Sand | Clay | Silt | BD | Texture |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cm | $H_2O$ | $CaCl_2$ | Dsm | % | | | mgkg$^{-1}$ | cmolkg$^{-1}$ | | | | | | | % | % | | | | gcm$^3$ | |
| K1 7°46'34.52''N 5°31'31.42'E at Ikole - Ijesa-Isu road | | | | | | | | | | | | | | | | | | | | | |
| 0 – 22 | 5.7 | 6.2 | 0.58 | 3.5 | 6.26 | 0.19 | 8.47 | 0.18 | 0.04 | 6.45 | 0.87 | 0.05 | 0.50 | 8.09 | 93.20 | 7.2 | 75.6 | 17.1 | 7.3 | 1.57 | SL |
| 22 – 35 | 5.9 | 6.1 | 0.42 | 2.8 | 5.01 | 0.15 | 6.09 | 0.12 | 0.05 | 3.36 | 0.53 | 0.03 | 0.53 | 4.62 | 87.88 | 30.3 | 80.2 | 10.4 | 9.4 | 1.48 | LS |
| 35 – 69 | 6.2 | 5.5 | 0.21 | 0.8 | 1.43 | 0.17 | 3.40 | 0.08 | 0.05 | 3.02 | 0.71 | 0.09 | 4.42 | 8.37 | 46.12 | 36.5 | 67.1 | 22.3 | 10.6 | 1.42 | SCL |
| 69 – 92 | 5.5 | 5.4 | 0.14 | 0.5 | 0.89 | 0.17 | 1.85 | 0.19 | 0.04 | 1.14 | 0.40 | 0.05 | 0.75 | 2.57 | 68.87 | 20.4 | 69.1 | 26.4 | 4.5 | 1.41 | SCL |
| K2 7°46'52.74'N 5°27'51.03''E at Osin - Ikole road | | | | | | | | | | | | | | | | | | | | | |
| 0 – 9 | 5.6 | 5.5 | 0.26 | 1.9 | 3.40 | 0.14 | 5.10 | 0.09 | 0.03 | 2.31 | 0.55 | 0.07 | 0.96 | 4.01 | 74.31 | 49.4 | 80.5 | 10.5 | 9.0 | 1.69 | LS |
| 9 – 40 | 6.2 | 6.1 | 0.17 | 0.9 | 1.61 | 0.10 | 3.68 | 0.12 | 0.02 | 1.28 | 0.60 | 0.10 | 0.55 | 2.67 | 75.66 | 22.0 | 77.3 | 16.1 | 6.4 | 1.53 | SL |
| 40 – 60 | 5.6 | 5.1 | 0.06 | 0.4 | 0.72 | 0.08 | 1.50 | 0.06 | 0.02 | 1.18 | 0.38 | 0.13 | 0.94 | 2.71 | 60.52 | 10.3 | 76.5 | 8.0 | 12.6 | 1.62 | LS |



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Exchangeable calcium dominates the exchange complex; this is a common feature of soils in the basement complex geology of Nigeria, this is as a result of higher absorptive power of calcium than other exchangeable cations. The surface horizon values ranged between 2.31 to 6.45 cmolkg$^{-1}$ and the subsurface horizons are between 1.14 and 3.36 cmolkg$^{-1}$. These values are considered to be low hen compared with ratings of FAO (2004) there is higher accumulation of exchangeable $Ca^{2+}$ at the surface horizons and this can be attributed to continuous recharge by mobile constituent liberated by decomposition of organic residue, irrespective of its exposure to leaching and runoff (Sehgel *et al*., 1972). Exchangeable magnesium values ranged from 0.55 to 0.87 and 0.38 to 0.71 cmolkg$^{-1}$ at the surface and subsurface horizons respectively. These values are low and below the critical value of 1.5 cmolkg$^{-1}$ set by Landon (1991) for soils of the basement complex. It is next to calcium in the exchange complex and a common feature of most tropical soils as reported by Fasina *et al*., (2006) and Noma *et al*., (2004). Exchangeable potassium ranged between 0.09 to 0.18 and 0.06 to 0.19 cmolkg$^{-1}$ at the surface and subsurface horizons respectively. There is likelihood of low nutrient K reserve and deficiency in that the values recorded in the soils are low. The low amount of K could be as a result of leaching and removal from the soil through harvested plant parts, especially under intensive cultivation without adequate K input (Das *et al.* 2019c). Exchangeable sodium ranged from 0.03 to 0.04 and 0.02 to 0.05 cmolkg$^{-1}$ at the surface and subsurface horizons respectively. The values are rated very low and this could be as a result of leaching, Mostafazadeh-Fard *et al.* (2008) assert the ability of leaching to reduce sodium in the soil.

For the exchangeable cations, location K1 has higher values than K2; these revealed that location K1 has more nutrients than K2. Specifically, a high exchangeable cations value is one of the indicators of good quality soils because it connotes the optimum capacity of the soil to hold and exchange more cations and it gives more information on the storage of nutrient (Ulery *et al.* 2017). The effective cation exchange capacity (ECEC) values ranged from 4.01 to 8.09 and 2.67 to 8.37 cmolkg$^{-1}$ at the surface and subsurface horizons respectively. Higher value was observed in one of the subsurface horizons at location K1. This can be attributed to the parent material and higher clay content of the particular horizon. Generally, the ECEC values are low and it indicates low nutrient reserves in the soils at the both locations (Ugwa *et al.* 2022).The percentage base saturation values ranged from 74.31 to 93.20 and 46.12 to 87.88 % at the surface and subsurface horizons. The result indicated that the exchange complex of soils at both locations are dominated by exchangeable cations therefore, the likelihood of effects of soil acidity is low. However, the lowest value of 46.12% observed in the subsurface horizon of location K1 is as a result of high value of exchangeable hydrogen and this can attribute to the clay content of the soil.

The soils had moderate to high gravel content (7.2 to 49.4 %), sandy (67.1 to 85.6 %) with sandy loam and loamy sand texture at the surface of K1 and K2 respectively. The subsurface horizons are loam sand, sandy loam and sandy clay loam. The texture is influenced majorly by the sand and clay fraction of the soils.

The bulk density values at the surface (1.57 and 1.69 gcm-1 in K1 and K2 respectively) are within the range where root penetration will not be impeded and there are enough pore spaces for plant-water-air interactions for most crops.

### 3.2 Land Suitability Classification for Rice

The actual and potential suitability of the two locations for rice is presented in Table 3. Climate, topography and drainage factors are highly suitable for rice production in both locations. This implies that the 1300 mm mean annual rainfall, 29°C mean annual temperature and 75% mean annual relative humidity as well as 1.5 and 1.8% slope angle at K1 and K2 respectively are optimum for rice production in the study areas with nitrogen at 54 (S3) and 30 (N1), available phosphorus and exchangeable potassium 50 (S3) and 39 (N1), exchangeable magnesium 39 (N1) and 25 (N1) at K1 and K2 respectively while texture and soil depth were 60 (S2) , exchangeable calcium 50 (S3) at K2. These are limitations to rice production in the soils of both locations and made the soils to be rated in classes lower than S1 with K1 having the index of suitability of 34.88 therefore rated marginally suitable while K2 is 19.37 and rated currently not suitable for rice production. These implied that farmers who have been cultivating the land for rice have not been achieving optimum yield and return. Coarse texture (Brady, 1981), K deficiency (Casanova et al., 2002) and N and P (Ren et al., 2020) have all been reported to influence rice yield. Furthermore, research revealed that rice yield is principally influenced by soil chemical properties (Ran et al., 2018; Trangmar et al., 1987).

Soil fertility limitations can be ameliorated with land management practices such as the use of organic and inorganic fertilizers, incorporation of legume in cropping systems and good post-harvest residue management (Abebe et al. 2017). Ren et al. (2020) emphasized the need for improvement of soil quality in rice production system. This was considered in the potential ratings and resulted in improved index of suitability ratings for rice at both locations with K1 rated 80 highly suitable and K2 rated 60 moderately suitable. This implied that farmers in the study will achieve optimum yield with adoption of proper fertility management practices and crop husbandry.

 

Table 3. Land suitability ratings of the location for rice

| Land qualities | K1 | K2 |
|---|---|---|
| Climate (c) | | |
| Mean annual rainfall (mm) | 100 | 100 |
| Mean annual temperature (°C) | 100 | 100 |
| Relative humidity (%) | 100 | 100 |
| Topography (t) | | |
| Slope (%) | 100 | 100 |
| Drainage (w) | | |
| Wetness | 100 | 100 |
| Flooding | 100 | 100 |
| Soil Physical Properties (s) | | |
| Texture | 80 | 60 |
| Soil depth (cm) | 100 | 60 |
| Soil Fertility (f) | | |
| pH ($H_2O$) | 100 | 100 |
| Base Saturation (%) | 100 | 80 |
| Nitrogen (%) | 54 | 30 |
| Available P ($mgkg^{-1}$) | 50 | 39 |
| Exchangeable K ($cmolkg^{-1}$) | 50 | 39 |
| Exchangeable Ca ($cmolkg^{-1}$) | 70 | 50 |
| Exchangeable Mg ($cmolkg^{-1}$) | 39 | 25 |
| Organic Carbon (%) | 100 | 94 |
| EC (mmhos) | 100 | 100 |
| Actual Suitability | 34.88 (S3) | 19.37 (N1) |
| Potential Suitability | 80 (S1) | 60 (S2) |

### 3.3 Yield Performance of Rice at the Two Locations

The grain yields in tons per hectare for the two locations are given in Table 4. Significant difference was observed between the two locations. The highest yield of 1.03 t ha-1 was recorded in K1 while lower yield values of 0.69 t ha-1 was recorded at K2. These are in agreement with the marginal suitability rating of K1 and currently not suitable for K2. The yield in K1 was within the average yield range of 1 to 2.5 tons per hectare reported for Nigeria (Cadoni and Angelucci, 2013) while K2 was lower. Furthermore, the yields obtained were not optimum and were below the minimum yield of 1.7 tons per hectare suggested for rice in Ekiti State, Nigeria (Oikeh et al., 2008). There had been low rice yield among farmers in Ekiti State. Akintayo and Rahji (2011) reported the average yield gap of 1.52, 1.38 and 0.91 tons per hectare for upland rice varieties. The low yield can be attributed to poor soil fertility as shown in the improved soil potential suitability ratings when the fertility related factors were expunged. This is in agreement with the reports of Dossou-Yovo et al. (2020), Tsujimoto et al. (2019), Haefele et al. (2014) all reported that rice producing soils in sub-Saharan Africa are generally poor in fertility when compared with other rice growing soils of the world.

Table 4. Yield performance of rice at the location

| Location | Yield $t\ ha^{-1}$ |
|---|---|
| K1 | 1.03 |
| K2 | 0.69 |
| T-Value | 1.32 |
| P(two tailed) | 0.022 |

## 4 Conclusion

It was concluded that the soils of the study area were low in fertility and marginal for rice production in their current state. Location K1 is more suitable for rice than location K2. Total nitrogen, available phosphorus, exchangeable potassium, exchangeable magnesium and exchangeable calcium were the identified constraints that can be ameliorated with proper with proper crop husbandry measures.

## 5 Recommendations

The location K1 at Ikole – Ijesha-Isu road is recommended for rice production in the study areas. Suitability evaluation studies are qualitative and should be followed by qualitative experiment in order to make recommendations that are adoptable for farmers. Further research should be carried out to identify other rice limiting factors in order to develop sustainable practices for rice farmers cultivating alfisols in derived savannah of Southwestern Nigeria.

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