Suitability Evaluation of Lowland Soils of Dadinkowa For Rice Cultivation in Yamaltu Deba Local Government Area, Gombe State, North Eastern Nigeria

 **ABSTRACT**

*The study was carried out to examine the suitability of lowland soils of Dadinkowa Yamaltu Deba Local Government Area of Gombe State, North Eastern Nigeria for rice cultivation. Four profile pits were dug at the crest, middle slope, lower slope and valley bottom positions of the lowland soils. The soils morphological description were done in the field and thereafter samples were taken from each identified diagnostic horizon. Soil samples were analysed for soil pH, organic carbon, total nitrogen, available phosphorus, exchangeable potassium, calcium, magnesium and cation exchange capacity using standard laboratory procedures. Soil properties were evaluated for all year rice cultivation using the FAO (1976) framework for land evaluation. The results indicate that soils were sandy clay loam and loams in texture. Soil reaction was slightly acidic to neutral (6.73 to 6.97), with low organic carbon (4.20 to 13.20 g/kg), low total nitrogen (0.53 to 0.88 g/kg), low available phosphorus (3.54 to 13.05 mg/kg), low exchangeable calcium and magnesium and a high potassium content. The four locations (pedons) were assessed not suitable (N1) for rice cultivation. The major limiting factors to rice cultivation were the low fertility status of the soil particularly organic carbon, total nitrogen, available phosphorus and exchangeable calcium and magnesium. The soils will be productive if farm yard manure and fertilizers containing nitrogen, available phosphorus, exchangeable calcium and magnesium are applied to correct the limitations to rice cultivation.*

**Keywords**: Rice cultivation, suitability evaluation, limiting factors, manure and fertilizers

 **INTRODUCTION**

“Suitability evaluation of soils is a fundamental requirement for crop production.It provides the basis for a sustainable soil use and for conservation of environmental resources. For assessing the suitability of soils for crop production, soil requirements for crops must be known” (Maniyunda and Gwari, 2014 and Obasi *et al*, 2021). “The requirements must be understood within the context of limitations imposed by the soil and other features which do not form a part of the soil but may have a significant influence on use that can be made of the soil” (FAO, 1976). “From the basic soil requirements of crops, a number of soil qualities are directly related to crop yield performance. For most crops, soil characteristics have been identified for high, moderate, marginal and unsuitable levels. Beyond critical levels, crop performance is reducing unless some precautionary management measures are applied. Soil suitability classifications are based on matching requirements for crops and soil qualities” (FAO, 1995). “The suitability classes obtained from the matched characteristics are combined to obtain overall soil suitability classes through use of principle of limiting condition” (FAO, 1995). T”he FAO framework for land evaluation (FAO, 1976), recognizes the concept of land characteristics or qualities and attempts to match them against a defined land use with known requirements. Land suitability is therefore the fitness of a given piece of land for a defined use” (FAO, 1976).

 “Soils of Dadinkowa have a lot of agricultural potentials and contribute substantially to food supply and income of the inhabitant more than ever before. A renewed attention is given to soils due to rapidly declining land area for agriculture, declining soil fertility and increasing soil degradation, wrong land use practices and irrational and imbalanced use of inputs” (Kanwar, 2004). “The above factors call for a paradigm shift in research away from maximum crop production to sustainability of crop production systems, without degradation of soil health and environmental and soil quality. Dadinkowa has a variety of soils distributed in different landforms supporting wide variety of vegetation. Rice cultivation is intensively carried out all year round in Dadinkowa, however detailed information on its suitability for rice production is scanty” (FAO, 1976). This information is so vital for planning sustainable management practices for rice cultivation.in the area. Taking these factors into consideration, there is a need for suitability assessment of the land which will assist in identifying key soil properties for optimum yield of rice in the area.

**Objectives of the Study**

 Keeping the aforementioned in mind this study is undertaken for the following objectives.

 1 To characterize the lowland soils of Dadinkowa

 2 Determine suitability of the soils for rice production;

 3 To determine the productivity limitations and evaluate the agricultural potentials of the soils with the aim of recommending the best management strategies/practices for optimum rice production.

**MATERIALS AND METHODS**

**Study Area**

Dadinkowa lies on latitude 10o 17oN and longitude 10o 15oE in Yammaltu Deba Local Government Area of Gombe state, Nigeria. The area is 609m above sea level and is of a charnochite, lithology formed on an older granite suite of Paleozoic age The soils are mostly shallow to deep (Carter, 1964). The area falls within the upper fringe of the Northern Guinea Savanna ecological zone (Kaey, 1959).

**Field Studies**

 Four profiles were dug at the crest, upper slope, middle slope and valley bottom positions of the lowland soils of Dadinkowa. Each profile pit measured 2.0 m long, 1.5 m wide and 2.0 m deep or to a lithic paralithic or water table contact zone if less than 2.0 m.

 Profile pits were described for morphological properties in the field following standard procedures as contained in the Soil Survey Staff (2010). Soil descriptions were done for soil colour (moist and dry moisture condition), presence of mottles (name, notation, abundance, size and contrast) texture, structure (grade, class and type) consistence (dry, moist and wet) presence of cutans (type, frequency and thickness), pores (abundance and size), roots (abundance and size), presence of concretions and nodules, minerals and animal activities as well as horizon boundary (distinctiveness and topography).

**Soil Sampling and Handling**

After morphological description of profiles, soil samples were collected from each identified genetic horizon from the bottom upwards. The soil samples were placed on polythene bags and labeled appropriately. The soil samples were air dried, ground, using a porcelain pestle and mortar and passed through 2.0mm sieve. The sieved samples were subjected to laboratory analysis using standard procedures.

**Laboratory Analysis**

 Sieved soil samples were used for the particle soil analysis using the Boyoucous hydrometer method as described by Day (1965). Soil pH was determined in both water and 0.01m CaCl2, solution at 1:1 soil water and 1:2 soil solution ratios using a glass electrode pH meter. Exchangeable bases (K, Na, Ca and Mg) were extracted using the ammonium acetate saturation method as described by Chapman (1965). The cations were determined in leachate by atomic absorption spectrophotometer at appropriate wavelength (Ca at 766.5 nm, Na at 589 nm, Ca at 422 nm and Mg at 285 nm). Cation Exchange Capacity (CEC) was determined using the ammonium acetate saturation method (PH 7) as described by Page *et al* (1982). Organic Carbon (O.C) content was determined using the dichromate oxidation method of Walkley – Black as described by Black (1965). Total Nitrogen was determined using the microkjedahl method as described by Bremner (1965). Available Phosphorus was determined using Bray-1 method as provided by Bray and Kurtz (1945).

**Land Evaluation**

 The FAO framework for land evaluation (FAO, 1976) was used for land evaluation. In the scheme four categories are recognized the soil is considered either as suitable (S) or not suitable (N) for a given use. This is the highest category and is referred to as the Order. The second category is the Class that reflects the degree of suitability then the Subclass as the third category and the fourth is the Unit that establishes the differences within the subclasses as a function of the desired use.

**Result and Discussion**

Morphological properties of the lowland soils are shown on Table 1. Dadinkowa lowland 1 (DLL1) was moderately deep (99 cm) and poorly drained. The Ap was dark brown (7.5YR 4/4), sandy loam, stuctureless massive, slightly sticky, slightly plastic, friable and slightly hard. It had common fine pores and few iron nodules. The Bt1 was black (10YR 2/1), silty clay, strong medium subangular blocky, very sticky, very plastic, firm and hard with common fine pores and a clear smooth boundary. Bt2 was pale brown (10YR 6/3), loamy sand, weak medium subangular blocky, non-sticky, non-plastic, firm and loose. It had common very fine pores with a clear smooth boundary. Bt2 was very dark grayish brown (10YR 3/2), strong coarse subangular blocky, very sticky, very plastic, firm and very hard, with common fine pores.

Dadinkowa lowland 2 (DLL2) was deep (108 cm) and poorly drained. The Ap horizon was dark brown (10YR3/3), clay, strong medium subangular blocky, very sticky, very plastic, firm and very hard. It had common fine pores with a clear smooth boundary, Bw was black (10YR 2/1), clay, strong medium subangular blocky, very sticky, very plastic, firm and very hard. It had common medium pores with iron and manganese concretions.

Dadinkowa lowland 3 (DLL3) was deep (114 cm) and poorly drained. The Ap was weak red (2,5YR 3/3), strong medium subangular blocky, clay, very sticky, very plastic, very firm and very hard. It had common very fine pores with a clear smooth boundary. Bw1 was brown (7.5YR 5/3), sandy clay, weak subangular blocky, slightly sticky slightly plastic, firm very hard with common fine pores and a clear smooth boundary. Bw2 was black (10YR 2/1), clay, strong coarse angular blocky, very sticky very plastic, firm and hard. It had common very finr pores with iron nodules. Water table was approached at 114 cm.

Dadinkowa lowland 4 (DLL4) was shallow (35 cm) and very poorly drained. The Ap was dark brown (7.5YR 3/2), silty clay, strong coarse subangular blocky, very sticky very plastic, firm slightly hard with a gradual wavy boundary. The Bw was dark brown (7.5YR 4/4), silty clay, strong coarse subangular blocky, very sticky very plastic, firm and very hard. It had common very fine pores with iron and manganesese concretions. Water table was approached at 35 cm.

In the lowland sand predominated in DLL1, DLL2 and DLL3 and decreased with depth but was lower in the surface horizon of DLL4 where silt was higher. The colour varied from dark brown to pale brown to very dark grayish brown to black. This variation in colour was due to the drainage conditions, chemical and mineralogical and organic matter composition of the soil. With poor drainage conditions subsoil colour reflect an increasing influence of Fe2+ on soil colour. Fe2+ imparts a bluish gray colour to poorly drained soils, often referred to as gley colour (Schoenenberger *et al,* 2012). The lowland subsurface horizons have gleying in the B horizon due to fluctuating water table. The observed variation in colour on the soil landscape is attributable to drainage conditions (Teshome *et al*, 2016). The variation in soil structure is a reflection of the physiographic position of the pedon (Singh and Agarwal 2003). Many of the peds were held together by coatings of materials and clay as well as microbial exudates which tend to aggregate the soil thereby forming strong soil structures. In the lowland sand predominated in DLL1, DLL2 and DLL3 and decreased with depth but was lower in the surface horizon of DLL4 where silt was higher. The preponderance of sand in the Bw of DLL4 could be attributed to lateral transport and deposition and subsequent overlaying of silt and clay over and above it. This deposition of other finer materials (silt and clay) over sand is due to lateral transport and erosion and influence of topographic position (Rao *et al*, 2008).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pedon** | **Horizon** | **Depth** | **Munsell Colour** | **Texture** | **Structure** | **Consistence** | **Pores** | **Boundary** | **Miscellaneous Observations** |
| DLL1 | Ap | 0-8 | 7.5YR 4/4 | Sl | Om | wss,wsp,mfr,dsh | c,f | d,i | iron oxides present |
|  | Bt1 | 8-22 | 10YR 2/1 | Sicl | 3mbsk | wvs,wvp,mfi,dh | c,f.cvf | c,s | mn.quartz |
|  | Bt2 | 22-65 | 10YR 6/3 | Ls | 1msbk | wns,wnp,mfr,dl | Cvf | c,s | Concretion |
|  | Bt3 | 65-99 | 10YR 3/2 | Sl | 3cabk | wvs,wvp,mfi,dvh | c,f | - |  |
| DLL2 | Ap | 0-16 | 10YR 3/3 | C | 3msbk | wvs,wvp,mfi,dvh | c,f | c,s | Mn and iron oxide present |
|  | Bw | 16-108 | 10YR 2/1 | C | 3msbk | wvs,wvp,mvfi,dvh | c,m | - |  |
| DLL3 | Ap | 0-21 | 2.5YR 5/2 | C | 3msbk | wvs,wvp,mvfi,dvh | c,vf | c,s | iron oxide |
|  | Bw1 | 21-51 | 7.5YR 5/3 | Scl | 1msbk | wss,wsp,mfi,dvh | c,f | c,s | Si O2 |
|  | Bw2 | 51-114 | 10YR 2/1 | C | 3cabk | wvs, wvp,mfi,dvh | c,vf | - | iron oxide |
| DLL4 | Ap | 0-19 | 7.5YR 3/2 | Sic | 3csbk | wvs,wvp mfi,dsh | f,m | g,w | Mn and Fe concretions |
|  | Bw1 | 19-35 | 7.5YR 4/4 | Sic | 3csbk | wvs,wvp,mfi,dvh | cvf,f | - | iron ovide Mn |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |

Table 1: Soil Morphological Properties of Lowland soils of Dadinkowa

ls=loamysand,g=gravelyscl=sandyclaysic=siltyclaysl=loamysandsc=sandyclaysl=sandyloam

we=weak mo=moderate cr=crumb sbk=sub angular blocky o=structureless m=massive st=strong fc=fine to coarse vf=very fine to medium wss=wet slightly sticky mfr=moist friable dh=dry hard ws=wet sticky dvh=dry very hard ds=dry soft wns=wet non sticky dl=dry loose dsh=dry slightly hard mfi=moist firm wvs=wet very sticky mvfr=moist very friable c,w=clear wavy g,w=gradual wavyg,i=clear irregular d,i=diffuse irregular dw=diffuse wavy d,i=diffuse irregular

**Chemical Properties of Dadinkowa Lowland Soils**

***Soil pH, Organic Carbon, Total Nitrogen (N) and Available phosphorus (P)***

The chemical properties of the lowland soils are shown on Table 2. Soil pH in all the horizons of the four pedons in the lowland soils were rated slightly acidic to neutral (ranging from 6.22 to 7.01), this pH range falls within levels considered highly suitable for rice production (Sys *et al*, 1993) Organic carbon (O.C) was rated ‘low’ in all the horizons of the four pedons in the lowland soils as values were lower than 45g/kg regarded as adequate for productive soils (Holland *et al,* 1989). The highest O.C content (0.84 gkg-1) was recorded in the Ap horizon of DLL3, while the lowest (0.14 gkg-1) was found in Bt1 of DLL1. Soil O.C content decreased with increase in depth down the profile which could be attributed to concentration of plant roots and other plant residues on the topsoil (Usman *et al*, 2022). Similarly total nitrogen followed the same trend as organic carbon and was rated ‘low’ in all the horizons of the pedons of the lowland. The total nitrogen content were below 4.5g/kg required for productive soils (Federal Fertilizer Department FFD, 2012). The low nitrogen content could be attributed to rapid microbial activities, loss due to leaching, surface runoff and crop removal (Osinuga *et al*, 2020). Equally available phosphorus was rated ‘low’ (3.98 to 9.29mg/kg) in all the horizons of the lowland soil pedons. The low available phosphorus content could agrees with the views of Usman *et al* (2020) that most native soils are low in phosphorus and can also be attributed to parent materials that are low in phosphorus and low organic carbon content (Osinuga *et al*, 2020). Both available phosphorus and total nitrogen followed the same trend with O.C by decreasing with increase in depth.

***Exchangeable Potassium (K), Calcium (Ca), Magnesium (Mg) and Cation Exchange Capacity (CEC)***

Potassium (K) content in all the horizons of the pedons in the lowland was rated ‘medium’ except in the Ap horizon of DLL2 where it was rated ‘high’. K content were higher in the surface than subsurface horizons. The higher K content in the surface horizon may be as a result of slash and burning of organic matter residues, and lateral translocation of bases (Usman *et al,* 2022). Exchangeable calcium (Ca) content was rated ‘medium’ in all the horizons of the four pedons in the lowland except in the Bt2, Bw1 and Bw of DLL1, DLL3 and DLL4 respectively where it was rated ‘low’. The surface horizons had higher Ca content than the subsurface. The highest Ca content (4.25 cmol(+)kg-1) was recorded in the Ap horizon of DLL2, while the lowest (1.43 cmol(+)kg-1) was recorded in the Bt2 of DLL2. Lower content of Ca in the subsurface could be as a result of leaching and lower organic matter content (Obasi *et al* 2021). Magnesium (Mg) was rated ‘medium’ in all the horizons of the four pedons of the lowland soils. The Mg content decreased with increase in depth except in DLL3 where it was irregularly distributed. The highest Mg content (1.12 cmol(+)kg-1) was found in in the Ap of DLL2 and the lowest (0.43 cmol(+)kg-1) was recorded in the Bt2 of DLL1. Similarly the decrease in Mg content with depth could be as a result of low organic matter content down the profile, low activity clay and leaching down the profile (Obasi, *et al* 2021). Cation exchange capacity (CEC) was rated low in all the locations but were higher in the Ap horizon of all the lowland. CEC values were higher in the surface than subsurface horizons. Higher CEC content in the surface horizons could be attributed to higher organic matter content in the surface than subsurface (Usman *et al*. 2022). The low CEC values generally could be as a result of low level of organic matter and clay observed in the different locations. This result confirms with that of Mare *et al* (2024). Calcium, Magnesium and CEC values were low and could be attributed to the nature of the silicate clay minerals (Kaolinite) believed to be the dominant clay types in lowland or depressed soils, nature of the underlying materials and low organic matter content (Ibrahim *et al,* 2020 and Usman *et al,* 2022)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pedon** | **Depth (cm)** | **PH WI:I** | **PH C1:2** | **Org. C** | **Tot. N** | **Av. P mg/kg** | **Ca** | **Mg** | **K** | **Na** | **CEC** |
| **g/kg** | **cmol(+)kg-1** |
| DLL1 |  |  |  |  |  |  |  |  |  |  |  |
| Ap | 0-8 | 6.89 | 5.81 | 0.62 | 0.10 | 9.26 | 3.75 | 0.73 | 0.24 | 0.08 | 12.36 |
| AB | 8—22 | 6.22 | 5.43 | 0.43 | 0.06 | 7.54 | 2.13 | 0.59 | 0.18 | 0.09 | 7.45 |
| Bt1 | 22-65 | 6.87 | 5.76 | 0.14 | 0.04 | 3.98 | 1.95 | 0.52 | 0.16 | 0.10 | 8.13 |
| Bt2 | 65-149 | 6.97 | 5.86 | 0.46 | 0.04 | 7.75 | 1.43 | 0.43 | 0.13 | 0.11 | 6.93 |
| DLL2 |  |  |  |  |  |  |  |  |  |  |  |
| Ap | 0-16 | 7.00 | 6.18 | 0.83 | 0.09 | 4.93 | 4.25 | 1.12 | 0.35 | 0.10 | 15.39 |
| Bw | 16-108 | 6.95 | 5.79 | 0.76 | 0.07 | 6.75 | 3.64 | 0.84 | 0.27 | 0.09 | 11.75 |
| DLL3 |  |  |  |  |  |  |  |  |  |  |  |
| Ap | 0-21 | 6.74 | 5.66 | 0.84 | 0.07 | 7.90 | 2.11 | 0.63 | 0.19 | 0.10 | 7.18 |
| Bw1 | 21-51 | 6.81 | 5.83 | 0.42 | 0.05 | 4.11 | 1.81 | 0.70 | 0.23 | 0.10 | 5.32 |
| Bw2 | 51-141 | 7.01 | 6.10 | 0.60 | 0.07 | 6.35 | 2.06 | 0.53 | 0.15 | 0.11 | 6.84 |
| DLL4 |  |  |  |  |  |  |  |  |  |  |  |
| Ap | 0-19 | 6.93 | 5.81 | 0.28 | 0.04 | 5.90 | 2.54 | 0.69 | 0.25 | 0.08 | 7.33 |
| Bw | 19-35 | 6.89 | 5.79 | 0.18 | 0.04 | 4.21 | 1.45 | 0.60 | 0.16 | 0.11 | 4.32 |
|  |  |  |  |  |  |  |  |  |  |  |  |

Table 2: Chemical properties of lowland soils of Dadinkowa

Table 3: Site Characteristics of Dadinkowa Lowland Soils

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Pedon** | **Depth (cm)** | **PH WI:I** |  **Org. C** | **Tot. N** | **Av. P mg/kg** | **Ca** | **Mg** | **K** | **CEC** | **Sand** | **Silt** | **Clay** | **Textural Class** |
| **g/kg** | **cmol(+)kg-1** |  |  |  |
| DLL1 | 149 | 6.73 | 4.20 | 0.53 | 3.54 | 3.66 | 0.76 | 0.32 | 12.80 | 55.00 |  25.00 |  20.00 | SCL |
| DLL2 | 108 | 6.97 | 6.21 | 0.79 | 6.57 | 4.08 | 0.66 | 0.26 | 15.30 | 44.00 |  31.00 |  25.00 | L |
| DLL3 | 141 | 6.85 | 13.20 | 0.88 | 12.50 | 3.24 | 0.70 | 0.32 | 9.66 | 40.33 |  37.00 |  22.67 | L |
| DLL4 | 35 | 6.91 | 7.25 | 0.70 | 13.05 | 3.73 | 0.85 | 0.31 | 13.20 | 50.00 |  26.00 |  24.00 | SCL |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Table 4: Soil requirements for suitability evaluation of rice

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  Climate (c) | S1 | S2 | S3 | N1 |  N2 |
|  Rainfall (mm)  | >900 | 800-900 | 600-800 | <600 | <500 |
|  Temperature (Oc) | 24-30 | 30-32 | 32-35 | <35 | Any |
|  | Soil Physical characteristics (s) |  |  |  |  |  |
|  | Texture | C,SC,SiC | L,SCL,CL,SL | HC | S,LS | Any |
|  | Rooting Depth (cm) | >75 | 50-75 | 25-50 | <25 | Any |
|  | Drainage/Wetness (w) | PD, VPD | MWD, SPD | WD | ED | Any |
| Fertility Status (f) |  |  |  |  |  |  |
|  | pH(water) | 5.5-7.5 | 5.2-5.5 | <5>8 | <5 | Any |
|  | O.C (g/kg) | 20-40 | 10-20 | 5-10 | <5 | Any |
|   | Total N (mg/kg) | >2 | 1-.2 | 0.5-1 | <0.5 | Any |
|  | P(Bray) (mg/kg) | >20 | 15-20 | 10-15 | <10 | Any |
|  | K (Cmol) (+)/kg | >0.2 | 0.1-0.2 | <0.1 | <0.1 | Any |
|  | Ca (Cmol) (+)/kg | 10-15 | 5-10 | 1-5 | <1>5 | Any |
|  | Mg (Cmol) (+)/kg | 2-5 | 1-2 | <1 | <1>5 | Any |
|  | CEC (Cmol) (+)/kg | >16 | 10-16 | 5-10 | <5 | Any |

SL**=**Sandy Loam, L=Loam, SiL=Silty Loam, Si=Silt, SC= Sandy Clay, LS=Loamy Sand, CL=Clay Loam, SiCL=Silty Clay Loam, HC=Heavy Clay,, S=Sand WD=Well Drained, MWD=Moderately Well Drained, ED= Excessivel drained, VPD=Very poorly Drained, SPD=Slightly poor drained S1=Highly suitable S2=Moderately suitable, S3=Marginally suitable, N1=Currently nor suoitable, N2=Permanently not suitable

**Source: Sys *et al* (1993), FAO (1976, 1983)**

Table 5: Suitability Evaluation of Dadinkowa Lowland Soils for Rice Cultivation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Soil Factor | Unit | DLL1 | DLL2 | DLL3 | DLL4 |
|  | Soil Physical characteristics  | (s) |  |  |  |  |
|  | Rooting Depth | (cm) | S1 | S1 | S1 | S3 |
|  | Texture |  | S2 | S2 | S2 | S2 |
| Fertility Status (f) |  |  |  |  |  |  |
|  | pH(water) | (water) | S1 | S1 | S1 | S1 |
|  | O.C (g/kg) | (g/kg | N1 | S3 | S2 | S3 |
|   | Total N (mg/kg) | (mg/kg) | S3 | S3 | S3 | S3 |
|  | P(Bray) (mg/kg) | (mg/kg) | N1 | N1 | S3 | S3 |
|  | K (Cmol) (+)/kg | (Cmol) (+)/kg | S1 | S1 | S1 | S1 |
|  | Ca (Cmol) (+)/kg | (Cmol) (+)/kg | S3 | S3 | S3 | S3 |
|  | Mg (Cmol) (+)/kg | (Cmol) (+)/kg | S3 | S3 | S3 | S3 |
|  | CEC (Cmol) (+)/kg | (Cmol) (+)/kg | S2 | S2 | S3 | S2 |
|  | **Current Suitability** |  | **N1(f)** | **N1(f)** | **N1(f)** | **N1(s,f)** |
|  | **Limiting Factors** |  | **Org.C, Total N, Ca, Mg** | **Org.C, Total N, P, Ca, Mg** | **Total org, C N, P, Ca, Mg,CEC** | **Depth, Org.C, Total N, P, Ca, Mg** |

 S1=Highly suitable S2=Moderately suitable, S3=Marginally suitable, N1=Currently nor suoitable, N2=Permanently not suitable

**Suitability Status of Dadinkowa Lowland Soils for Rice Cultivation**

Suitability ratings of the four pedons of Dadinkowa lowland soils as its affects rice cultivation are shown on Table 5. The assessment ratings resulting from matching of land qualities and the requirements for rice were considered for the soil physical properties, (s) (rooting depth and texture) and soil fertility status (f) (pH (water), organic carbon, total N, available P. exchangeable K, Ca, Mg and CEC).

Soil depth was found to be highly suitable (S1) for pedons DLL1, DLL2 and DLL3 as the rooting depth were deeper than the 75cm required for rice cultivation (Sys, *et al,* 1993). However, DLL4 was found not suitable (N1) for rice cultivation as the soils’ water table was approached at 35cm rendering the soils to have an aquic soil moisture regime with a Bw horizon. However, for rice cultivation approaching a water table at 35cm may not pose a serious depth limitation since rice is a hydromorphic cereal crop. This findings agrees with that of Mare *et al* (2024). Texture was found to be moderately suitable (S2) for all the pedons.

All the locations were assessed to be highly suitable (S1) for soil pH, as it falls within 5.5 to 7.5 considered highly suitable for rice cultivation. Organic C was assessed to be moderately suitable (S2) for DLL3, marginally suitable (S3) for DLL2 and DLL4 and not suitable (N1) for DLL1. Total N was found to be marginally suitable (S3) for all the locations in the lowland. Available P was assessed not suitable (N1) for DLL1 and DLL2 and marginally suitable for DLL3 and DLL4. Exchangeable K was rated highly suitable (S1) in all the locations in the lowland soils of Dadinkowa. Exchangeable Ca and Mg were found to be marginally suitable (S3) in all the locations studied in the lowland. CEC was assessed moderately suitable (S2) in DLL1, DLL2 and DLL4 but marginally suitable in DLL3.

**Overall Suitability of the Lowland Soils of Dadinkowa for Rice Cultivation**

Pedon DLL1 was evaluated and found not suitable (N1) for rice cultivation. The major limiting factors are soil fertility (f) related and they include deficiency of organic C, total N, Ca and Mg. DLL2 was found not suitable (N2) with organic C, total N, available P, Ca and Mg as the fertility limiting factors. DLL3 was assessed not suitable (N1) with total N, available P and exchangeable Ca, Mg and CEC as the major limiting factors. Pedon 4 (DLL4) was rated not suitable (N1) with rooting depth (s) and fertility status (f) organic C, total N, available P, Ca and Mg as the major limiting factors.

**Conclusion and Recommendations**

The main objective of this study was to assess the suitability of Dadinkowa lowland soils for rice cultivation. The results of the study revealed that all the pedons (locations) were assessed not suitable (N1) for rice cultivation. Pedons DLL1, DLL2 and DLL3 had soil fertility status (f) as the major factors limiting rice cultivation, while DLL4 had rooting depth in addition to soil fertility status as major limitations. The major fertility factors limiting the soils for rice cultivation were organic C, total N, available P, and exchangeable Ca, Mg and CEC deficiencies. The lowland soils of Dadinkowa will benefit immensely if proper soil fertility management practices or strategies are adopted. It is therefore recommended that

1. Farm yard manure (FYM) be applied and incorporated into the soil to raise the raise the organic carbon, total N and available P content. The FYM will also improve soil structure and activate the biotic life of the soil.

2. Application of fertilizers containing N, P, Ca and Mg to enhance the fertility status of the soil, thereby making it appropriate for rice cultivation.

3. Avoid burning of farm refuse, shrubs, grasses and other organic materials. Allow such organic matter to decompose thereby leading to mineralization of the organic matter.

**Disclaimer (Artificial Intelligence)**

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text to image generators have been used during writing or editing this manuscript.

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