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## IMPACT OF LAND-USE ON SOIL QUALITY IN FILIYA, SHONGOM LOCAL GOVERNMENT AREA OF GOMBE STATE, NIGERIA.

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### ABSTRACT

*Information on impact of different land-use types on soil quality is crucial for sustainable land management practices. The assessment of the impact of land-use on soil quality in Filiya, Shongom LGA was studied. Three land-use types were selected from the study area (Groundnut, Millet and Rice). Each land use was subdivided into three (3) plots; five soil samples were taken at the four corners and center of each subplot at soil depth of 0 - 30cm. Both undisturbed and disturbed soil samples were taken. Six (6) undisturbed soil samples were taken by core-sampler to measure the soil bulk density, whereas nine (9) disturbed soil samples were taken by using a soil auger to measure the selected soil physical and chemical properties and subjected to laboratory soil analysis. The result shows that bulk density were all  $< 1.6 \text{ g m}^{-3}$  and this indicates that air and water movement in the soils are optimum for plant growth and development. Soil pH in Groundnut land use was slightly acid to neutral while pH in Millet land and Rice land were all neutral. The soil organic carbon was rated medium in Groundnut land use while Millet and Rice land use were rated low ( $< 10 \text{ g.kg}^{-1}$ ). The total nitrogen content was all rated low ( $< 1.5 \text{ g.kg}^{-1}$ ) in all the three croplands. The available phosphorus was rated high in Millet while it was rated low in both Groundnut land and Rice land use ( $< 10 \text{ mg.kg}^{-1}$ ). The ECe was rated low across the three croplands. The soils in Groundnut land were higher in quality with no major limitation, soils in Millet land were moderate in quality due to low organic carbon content and high phosphorus and soils in Rice land use were lowest in quality due to low soil nutrients. Therefore, farmers should periodically fallow their lands to build up organic matter, stabilize soil aggregates, improves nutrients cycles for sustainable productivity.*

**Keywords:** Land use; Soil quality; Sustainability; Filiya.

### INTRODUCTION

Environmental degradation caused by inappropriate land-use is a worldwide problem that has attracted attention in sustainable agricultural production system (Ayoubi, Khormali, Sahrawat and Rodrigues, 2011). The productivity and sustainability of soil depends on dynamic equilibrium among its physical, chemical, and biological properties (Somasundaram, Singh and Parandiyal, 2013). These properties are continuously influenced by land uses (Lawrence, 2019). Soil is an indispensable resource that has been exploited for thousands of years for several purposes resulting in their degradation (Eswaran, Lal and Reich, 2001; Junge and Skowronek, 2007). Soil is a slowly renewable natural resource that determines the sustainability of agricultural system. Land use,



water movement, and vegetation productivity have relationships with soil. Soil provides food, fuel and fodder for meeting the basic animals and human needs (Kedir, 2015).

Nature of parent material has been found to influence development and characteristics of soils. The ability of a soil to support plant growth depends on its physical and biological properties which have found to play significant roles in crop production. A soil that supplies adequate nutrients needed by plants with favourable soil pH will produce better crops quality and yield if other conditions of growth such as biological and physical properties of the soil are favourable. The quality of soils does not depend on its ability to supply adequate nutrients alone but the nutrients must be in the right proportion as needed by plants (Ayeni and Adeleye, 2011). Soil properties are reflections of the dominant factors of soil formation such as parent material, climate, organism, relief and time. The influence of these factors on soil is distinct but has interdependent effects on soil, and it is their combined effect that gives rise to distinct soil type. The knowledge of soil properties is very useful in determining soil characteristics, quality and productivity (Bamikole, Abiodun, Durodoluwa and Fatai, 2020). The food insecurity and rural poverty in the African smallholder farming system are due to soil nutrient depletion. Agricultural quality of a land can be judge by the physicochemical properties of its soils which provide anchorage, water and nutrients to the plants (Singh, 1997). In Nigeria savannah region, nitrogen is reported as the most limiting nutrients for crop production (Muhr, Tarawari, Peters and Schulde, 2001; Odunze, 2006) and this problem has been compounded in recent times by difficulties farmers faced in obtaining nitrogen fertilizers. Those reasons made the efforts by farmers to replenish soil fertility in the Nigerian area low, thereby encouraging continued degradation of soils. This is manifested in their decline in yields, low fertility, salinization, increasing erosion and deforestation (Food Organization Agriculture, 2000).

Land use changes have altered the characteristics of the earth's surface; leading to changes to soil physicochemical properties (Nega and Heluf, 2009). Recent interest in evaluating the quality of soil resources has been stimulated by increasing awareness that soil is critically important component of the earth's biosphere, functioning not only in the production of food and fibre, but also in the maintenance of local, regional and worldwide environmental quality (Wakene, 2001).

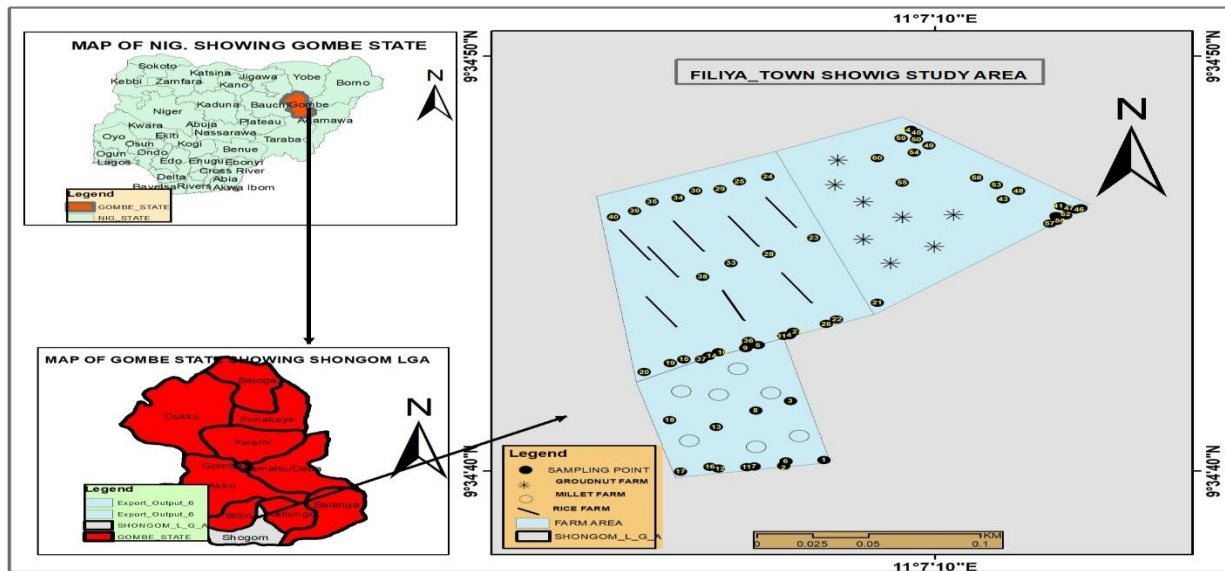
The declining soil fertility has been reported as a major limitation to increasing yields, and a threat to sustainability of crops (Nkhuzenje, Mughogho, Sakala and Saka, 2002). With continues cultivation, quality and productivity of many soils commonly decline due to decrease in organic matter content and soil pH (Oguike and Mbagwu, 2009). Knowledge of the physical and chemical properties of any soil is an integral part of soil quality studies, necessary for the development of as sustainability of management program (Ogunwole et al.; Junge and Skouronek, 2007; Konrad et al., 2001). Information on the impact on Soil Quality in Filiya , Gombe State has scanty data on soil requirement for providing management practices to attain food security. A number of several studies carried out by (Jimoh et al., 2019; Jimoh et al., 2022 and Babaji et al., 2019) have focused on Evaluation of soil Quality, assessment of the impacts of toposequence on soil properties and fertility status of soil assessment in some part of Gombe state. Due to the observed critical deepening problem of gradual deterioration of soil quality in recent times in the study area in relation to low farm yield, the need to assess the impacts on soil quality under different land use types arose. Therefore, in order to put the proper recommendations for sustainable utilizations of soil resources and improve crop productivity, the information about impact of land use types on

physical and chemical properties are imperative. The aim of this study is to assess the impact of Land-use on soil quality in Filiya, Shongom Local Government Area of Gombe state, Nigeria.

## MATERIALS AND METHODS

### Study Area

The study area is located in Filiya, Shongom local government area of Gombe State, Nigeria which lies between latitudes 9° 34' 31" N to 9° 35' 0"N and Longitudes 11° 6' 11" E to 11° 7' 10" E with an altitude of about 617m above sea level. It has an area of 922km<sup>2</sup> and a population of 94954. Shongom LGA is located at the southern fringes of Gombe State bordering Taraba State (Karin-Lamido LGA) to the South, Kaltungo LGA to the North – East, Billiri to the West and Alkaleri LGA in Bauchi State to the South –West (Figure 1). The climate of the study area is within the tropical climate (AW) type. Gombe State has two distinct climates, the dry season (November–March) and the rainy season (April–October) with an average rainfall of 850mm. The mean annual temperature is about 32°C, while the vegetation of the State is that of savanna woodland comprising scattered shrubs and trees such as *Butyrospermum*, *paradoxum*, *Tamarin indica*, *Parkiabiglibosa*, *Aflexia Africana* and grasses (Ikusemoran et al., 2018).



**Figure1: Map of the study area.**

**Source: Modified from Administrative map of Gombe, Nigeria (2022).**

Gombe State is generally underlain by six (6) different types of formations, the appropriate percentage of rocks in the study area are; basement complex 2%, Bima formation 31.1%, Yolde formation 10.5%, Pindiga formation 9.9%, Gombe formation 10.3%, Kerri-Kerri formation 34.2% and Alluviums 1.2%, (Zaborsiki et al., 1997). The dominant soil of the study area was ferruginous tropical soils and vertisols. The area is characterized by an undulating topography that is, it has low lands and high lands of crystalline basement rocks, plateau and isolated hills which are common in the area (Ikusemoran et al., 2018).

## Soil Sampling Technique

Firstly, a general visual field survey of the area was carried out to have a general view of the land use and management practice in the study area. Then three crops land (Millet land, Rice land and Groundnut land) were selected based on the similarity of topography, climatic condition and same soil formation factors. Hand held Global positioning system (GPS) was used to identify the site's longitude, latitude and altitude of the sampling points respectively. Composite soil samples were collected from the three landuse (Millet, Rice and Groundnut land) respectively at a soil depth (0-30cm). Each crop land was subdivided into four plots, five soil samples were taken at the four corners and center of each subplot in a systematic zigzag manner and thoroughly mixed to have heterogeneity of the land. Both undisturbed and disturbed soil samples were taken. Nine (9) soil samples were measured for selected soil physical and chemical properties. In all, soil samples covering the three study sites were carefully packed, labelled and store in polythene bags and transport to Institute for Agriculture Research (IAR), Ahmadu Bello University, Zaria for Laboratory analysis.

## Laboratory Analyses

The sampled soils were air-dried, crushed and sieved through a 2mm sieve, and less than 2mm fractions were used for laboratory analysis. Bulk density was determined using the core method (Blake and Hartge, 1986). Soil pH was measured in water and 0.01 M CaCl<sub>2</sub> (1:2.5w/v) using a glass electrode pH meter. Organic carbon was determined by the dichromate wet oxidation method of Walkley and Black (Nelson and Sommers, 1982). Available P was determined using the Bray - 1 method (Agbenin, 1995). TN was determined by the Kjeldahl method (Agbenin, 1995).

## Data Analysis

Soil samples were analyzed for Physiochemical properties. The analysis of the soil was subjected to analysis of variance (ANOVA). To find out whether variations in the soil physiochemical properties among the different land- uses are significant or not. The mean comparison was done using Duncan multiple range test at P<0.05 significant level.

### plates



**Plate 1 :** Measuring the study area.



**Plate 2:** Taken Bulk density of the study area.



**Plate 3:** Auguring the soil for disturbed soil sample.



**Plate 6:** Thoroughly mixture of collected five soil samples of sub-plot of the study area.



**Plate 5:** Collected soil samples of a sub-plot of the study area.



**Plate 4:** Taken coordinates of the sampling point of the study area .

## Plate 1: Plates showing soil sampling procedures in the study area

## RESULTS AND DISCUSSION

### Effects of Land use on soil quality indicators

Analyses of Variance (ANOVA) result on selected physical and chemical properties are presented in Table 1. The mean value ( $1.44\text{g/m}^3$ ) of soil bulk density (BD) under Groundnut land use was significantly ( $p < 0.05$ ) higher than other land uses (Rice and Millet), while Millet land use recorded the least value ( $1.32\text{g/m}^3$ ). Bulk density value was generally less than  $1.60\text{g/m}^3$ , thus rated medium, a range considered not to impede root growth and development (Odunze, 2006). This indicates that air and water movement in the soils are optimum for plant growth and development (Esu, 2010). However, the bulk density values of all the soils will support crop growth and development. The high Bulk density values recorded under Groundnut land use could be attributed to harrowing, compaction by animals trampling, continuous erosion and low organic matter input. Similarly, Weldemariam et al., (2020) reported high bulk density in Semi-arid watershed in Northern Ethiopia. High bulk density is an indicator of low soil porosity and soil compaction. It may cause restriction to root growth and poor movement of air and water through the soil (Osakwe and Igwe, 2013).

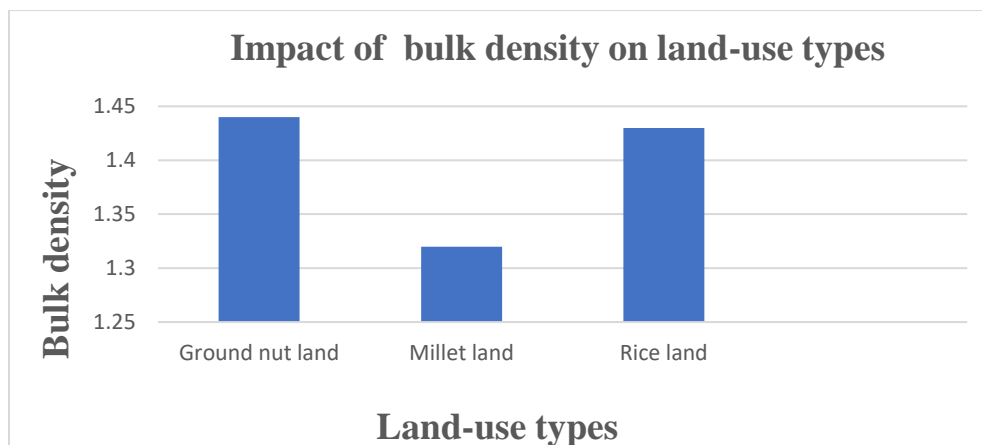


Figure 2: Impact of bulk density on land-use types

**Table 1: ANOVA Raking of Soil Quality Indicators under the land uses**

Land use	BD	Soil pH	Ece	OC	TN	AP
Groundnut	1.44a	6.97	0.1	8.00a	0.80	13.19b
Millet	1.32b	7.36	0.1	4.93c	0.77	22.25a
Rice	1.43b	7.03	0.1	6.15b	0.73	15.71b
P-value	.045	.441	.555	.001	.770	.024
LOS	*	NS	NS	**	NS	*
SE+	.02427	.1247	0.0000	.4722	.0333	1.6013

ECe=Electrical conductivity, OC= Organic Carbon TN= Total nitrogen &AP =Available phosphorus

**Source: Field work, 2023.**

### Soil pH

The soil pH ranges from mean value of 6.97-7.36. The value was rated slightly acidic to neutral (Adepetu et al., 2014) which is within the pH requirement for optimum plant growth. The mean pH of soil in water was 6.97 for Groundnut, 7.03 for Rice and 7.36 for millet. The findings of the study was similar to pH value reported by Jimoh et al., (2019) and Mbaya et al., (2012) in soil of Gombe State University and Gombe metropolis respectively. The result of this study contradicts with the finding of Muche Et al., (2015) who reported the pH of cultivated land are acidic than other land-use types. Mohammed et al., (2005) and Yihene et al., (2015) also reported that lower value of pH under the cultivated land and were attributed to depletion of basic cations in crop harvest and leached streams in runoff generated from accelerated erosion. Similarly, Bore and Bedadi (2015) also found the lower soil reaction under the cultivated land compared to the adjacent forest and grazing land in southern Ethiopia.

### Soil Organic Carbon (SOC)

Soil organic carbon (SOC) mean values (8.0 g/kg) under Groundnut land use was significantly ( $p < 0.05$ ) higher than other land uses (Rice and Millet), while Millet land use recorded the least value. Jendoubi et al., (2019) also reported a marked declined in SOC under different land uses in the Mediterranean landscapes. Majule (2003) also reported that clearing the natural forest in most of upper zones for cultivation has contributed significantly to reduction of SOC and Nin the soil. The results of the finding confirm Babaji et al., (2020) who reported low soil organic carbon (SOC) content in Gombe state. Amusan et al., (2000) observed a similar trend in their study; they reported the lowest SOC content in the cultivated plot. The result of this study agrees with other Studies that land use types have significant effect on SOC content (Houghton, 2003; Li et al., 2014; Alcantara et al., 2016). Sharu et al., (2013) reported that decrease organic carbon in soil of Savannah region were attributed to continuous cultivation and burning of plant residues which destroy most of the organic materials that will have contributed to more to soil organic matter.



### **Total Nitrogen (TN)**

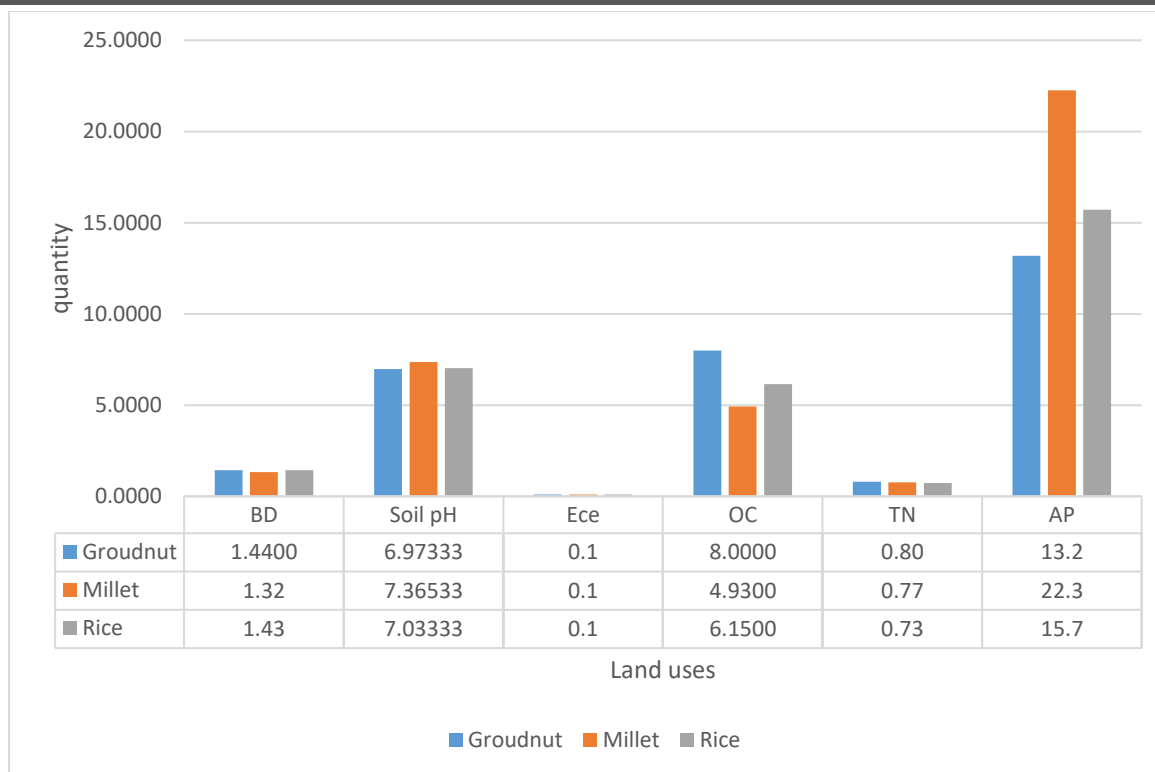
Soil total nitrogen (TN) content of the study area was higher in both Groundnut land (0.8gk/g), Millet land (0.8 gk/g) respectively, while Rice landuse recorded the least value (0.7gk/g). The soils were generally rated low in total nitrogen. The low value of nitrogen could ascribe to the influence of continuous cultivation, crop residual removal, bush burning and low level of N fertilizer application (Elias and Agegnehu,2020) uptake and volatilization. The result of the finding corroborated Babaji et al, (2019) who reported low nitrogen fertility status in soils of Gombe south in irrigated Fadamalanduse and this confirm with general characteristics of low total nitrogen in the Savannah soil (Jones, 1975).

### **Available Phosphorus (AP)**

Available phosphorus content in soil under Millet land use (22.3mg/kg) was significantly ( $p < 0.05$ ) higher than other land uses, while Groundnut land use recorded the least value (13.2 mg/kg). Soil under Millet land use was rated high in available phosphorus, while soil under Rice and Groundnut land use were rated medium respectively. The higher value of phosphorus in Millet land could be attributed to high rate of mineralization of organic matter which leads to release of phosphorus (Jimoh et al., 2019). The medium level of available phosphorus confirm the finding of Babaji et al., (2019) who reported low available phosphorus in irrigated Fadama land in Gombe south.

### **Soil Electrical Conductivity (ECe)**

The ECe mean value for Groundnut, Millet and Rice land use were  $0.01\text{dsm}^{-1}$  for all the land use. Soil electrical conductivity was rated low across the three croplands. The mineralogical composition of parent material and availability of water affects the electrical conductivity (Voicea et al., 2009). Soil electrical conductivity may be affected by climatic situation differences in the development of the soil (Selbhatleab, 2014). However, the study area had a homogeneous climatic situation.



### Soil Quality

The results of soil quality evaluation reveal that soil developed under Groundnut land use had moderate bulk density, soil pH and available phosphorous value, highest soil organic carbon and total nitrogen and low electrical conductivity than other land uses and had the least scoring of 10, indicating higher quality and rated SQ1 (Table 2 and Figure 3). In Parr's soils quality evaluation, the lower the quality index, the better the soil quality. Soils under Millet land use had optimal bulk density, soil pH condition, highest available phosphorous and low electrical conductivity, organic carbon and total nitrogen than other land uses and also had the least scoring of 10, indicating higher quality and rated SQ1. Soils under Rice land use was moderate in bulk density, pH value and available phosphorous and low in other soil properties and recorded highest aggregate scores of 11 indicating low quality and rated SQ3. Odunze et al. (2019) and Jimoh et al. (2022) also reported variation in soil quality over slope position in soils of Afaka forest. Generally, soil under groundnut land use had no major limitation. This suggests that soils were of high quality for sustainable crop production. The major limitation of soils under millet was slightly low organic carbon and total nitrogen and moderate in quality while major limitation of soils under Rice land use were slightly higher bulk density and low organic carbon and total nitrogen and lowest in quality. The low quality under Rice land use could be attributed to continuous cultivation and low addition of fertilizer which result in depletion of soil nutrients over time.





**Table 2: Soil Quality Ranking Index by Parr**

Parameter	Units	Groundnut	Millet	Rice
Bulk density	g/cm <sup>3</sup>	1.44 (3).	1.32 (1)	1.43 (2)
pH H <sub>2</sub> O		6.97 (1)	7.36 (3)	7.03 (2)
OC	g/kg	0.80 (1)	0.49 (3)	0.62 (2)
TN	g/kg	0.80 (1)	0.80 (1)	0.70 (2)
Avail. P	mg/kg	13.20 (3)	22.25 (1)	15.71(2)
ECe	dsm-1	0.01 (1)	0.01 (1)	0.01 (1)
Total/Ranking		10 /1	10/ 1	11/ 2

Adopted from Parr's et al. (1992).

Values scores on 1 - 6 range are the soil quality (SQ) ranks.

Note: In Parr's soil quality evaluation, the lower the quality index is, the better the soil quality.

## CONCLUSION AND RECOMMENDATIONS

This study assessed some selected physicochemical properties of soil under different land-use types (Groundnut, Millet and Rice land use) in Filiya, Shongom LGA, Gombe State. Several soil physicochemical properties varied significantly among land-use. The result revealed that soil bulk density across the all land-use was normal and will allow plant root development. The soil pH was slightly acid to neutral. The results show that, Groundnut land has high amount of soil organic carbon and soil nutrient which is more fertile followed by Rice while Millet land has the least amount of nutrient. The soils in Groundnut and Millet land use were higher in quality with no major limitation and soils in Rice land were lowest in quality due to low soil nutrients. The followings are recommended:

1. Phosphorus should be artificially supplemented for growth and yield of crops needing higher level of these nutrients in Groundnut land and Rice land of the study area.
2. Adequate application of manure or fertilizer may be necessary for amending deficiency in low total nitrogen across the three croplands of the study area.
3. Soil conservation measures such as manuring, mulching and conservation tillage should be adopted to improve the soil properties.



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