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# Effect of Sawah Technology on Soil Physical and Chemical Properties of NERICA Rice Field in the South-East of Nigeria

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## ABSTRACT

Effect of sawah technology on soil physical and chemical properties of rice field in the South-East of Nigeria was carried out. Field experiments were conducted during rainy season in two different locations Ishieke in Ebonyi local government area of Ebonyi State (N 06° 22.704, E008 02.501') and the second location at Imeoha Nkerefi, Nkanu East local government area of Enugu State (N 06° 04.991, E007 42.072') all in the south-east of Nigeria. Six New rice for Africa (NERICA) rice varieties which include Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19 were used for the study. Two Sawah fields measured 0.3ha each were designed by constructing major bond at the perimeter of the rice field while peripheral bonding was done to get six basins. Another field in the same area was mapped out of the same measurement 0.3ha without bond known as non-sawah field. Samples were collected from both sawah and non-sawah field. Pre and post soil test were performed in the department of Soil Science, Ebonyi State University (EBSU), Abakaliki. The study revealed that before planting, the soil pH of sawah field was 6.2 while after planting it was 6.5, Phosphorus content in sawah field was 65% while after planting it was 75%, Nitrogen content in sawah field was 0.11% while after planting it was 14%, Organic matter content in sawah field was 1.73% while after planting it was 2.22%. Hence, the results show that all values of the mean and standard deviation of the twelve average samples of the soil chemical and physical characteristics are significantly (P>0.05) different

**Keywords:** Chemical properties, NERICA Rice, Physical properties, Sawah Technology, and Soil.

## INTRODUCTION

The term Sawah is Malay-Indonesian rice fields that have been enclosed by humans to help with water management. A good rice field with excellent bunds is based on topography, hydrology, and soils which is a major factor of developing standard sawah system (Wakatsuki, 2018). A sawah system is a bunded, puddled, flat rice field with water inlet and outlet. The Sawah method enhances the regulation of water especially the depth and flow of water in rice field, which subsequently raises soil fertility (Wakatsuki et al., 1998). According to Wakatsuki (2002), "Sawah Technology" refers to farmer-based automated rice development and production in lowland through an improved manner of maximizing the use of locally available water. In comparison to any other already existing methods of developing good rice environment in oder to achieve a higher yield and more acres for cultivation, Sawah system could be the fundamental framework for rice farmers to produce rice intensively and sustainably (Wakatsuki et al., 2018). The Sawah concept was introduced to Nigeria through conventional On-Farm Demonstration studies at Gara in 1986, Gadza in 1987, and Ejeti in 2001, all in the Bida area of Niger State but due to lack of creativity with the farmers, the research efforts were not fully achieved. That on-farm research and demonstration conducted in 2001 Nigerian researchers were invited to Ghana Sawah locations for observation and replication as a result of the success of the activity, the technology was creatively adopted in the demonstration site, from which point more research activities were conducted and diffusion efforts began in earnest. Additionally, there is a dearth of literature on the impact of Sawah Technology on rice field soil characteristics. As a new method for producing rice, Sawah field technology is still being researched for acceptance and adaption under various field conditions and agro zones in Africa. Similar research investigations are being conducted on the New Rice for Africa (NERICA) for food security, quality, and features under various processes like soil conditions and agronomic techniques according to Eze, Oluka, and Eze (2020); Eze, and Oluka, (2014); Eze, and Oluka, (2013).

The majority of people on earth consume rice as a staple food, making up 50% of all food consumed globally (Ogah, 2013). It is the most significant crop produced globally and occupies roughly 11% of the world's arable area. In terms of area grown, it is Nigeria's sixth-largest crop after sorghum, millet, cowpea, cassava, and yam (FAO, 1999). There are four main rice-growing environments which are classified as follows: upland, rain fed lowland, irrigated lowland, and deep water lowland. The main rice-growing environment in West Africa is rain-fed upland, which makes up approximately 60% of the total rice area in the region and upland rice which also makes up around 32% of the entire rice acreage in Nigeria (Singh et al., 1997). According to Ogah (2013), the consumption of rice is rising more quickly than that of any other food crop in several African countries. Given its expanding relevance and prominent position among Nigeria's staple food crops, rice is one of the crops taken into consideration by the Federal Government of Nigeria's Agricultural Transformation Agenda (Osawohie, et al., 2018). Consumer tastes, rising wages, and an increase in the number of urban residents are just a few of the factors contributing to Nigeria's increased domestic rice consumption (Nwanze, et al., 2006). According to Harold and Tabo (2015), rice is the single most significant source of dietary energy in West Africa and ranks third throughout Africa. As proof, despite an increase in local rice production, the gap between local supply and the excessive demand for the good continues to exist (Gyimah, et al., 2016). As a result, importation has increased to match the demand in the country. In order to reduce the demand-supply deficit, it is imperative to focus on strategies to increase rice productivity (Vange and Obi, 2006).

The continuous cultivation of soil, year in year out in the southeast agro-ecological zone of Nigeria makes soil nutrients to depreciate all the time. It is deficient in organic matter content due to continuous cropping without technology to restore the used nutrients. Organic matter from dead vegetation in the field is one of the parameters of soil productivity for both physical and chemical properties. Sawah technology increase organic matter that increase water holding capacity, fine tilth of the soil particles growth and yield of crop. Soils in the southeast of Nigeria are structurally unstable and possess high erodibility potentials, low organic matter content and other crop required essential minerals in the soil (Oguike et al., 2006). Piccolo and Mbagwu (1994) identified that soils of southeast of Nigeria have high infiltration rate and saturated hydraulic conductivity. Soils in the southeast of Nigeria lack many plant nutrients that necessitated the compulsory use of inorganic mineral fertilizers. Use of agro-chemicals increase soil acidity and it is very costly in the market. Sawah technology amends soil with little or no application of chemical fertilizer. In the study of Ogbodo (2011) observed that soils in Abakaliki area of southeast of Nigeria are low in nutritional content. Researchers have observed that soils have low organic matter, cation exchange capacity, macro and micro essential nutrients (Ogbodo, 2011, Enwezor et al., 1988; Asadu, 1990; Nnabude, 1990). The adoption and adaption of Sawah Technology using NERICA rice could boast the field performance of rice in the south-east states. Therefore, this study set out to evaluate the effect of Sawah Technology on soil physical and chemical properties of NERICA rice field in the South-East of Nigeria.

**Material and Method for Effect of Sawah Technology on Soil Physical and Chemical Properties of NERICA Rice Field**

Research experiment was carried out to determine the effect of sawah technology on soil physical and chemical properties of NERICA rice field in the South-East of Nigeria. Field experiments were conducted during rainy season in two different locations, Ishieke in Ebonyi local government area of Ebonyi State (N 06° 22.704, E008 02.501') and Imeoha Nkerefi, Nkanu East local government area of Enugu State (N 06° 04.991, E007 42.072') all in the south-east of Nigeria. Six NERICA rice varieties: Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19 were used for the study. Two Sawah fields measured 0.3ha each were designed by constructing major bond at the perimeter of the rice field while peripheral bonding was done to get six basins. Another field in the same area was mapped out of the same measurement 0.3ha without bond known as non-sawah field. Soil samples were collected from both sawah and non-sawah field. Pre planting (Before) and post planting (After) soil test were performed at Soil Science Department, EBSU, Abakaliki. The data were subjected to statistical analysis to obtain results.

## RESULTS PRESENTATION AND DISCUSSIONS

The samples of soil used for the study were presented in Figure 1 a and b.

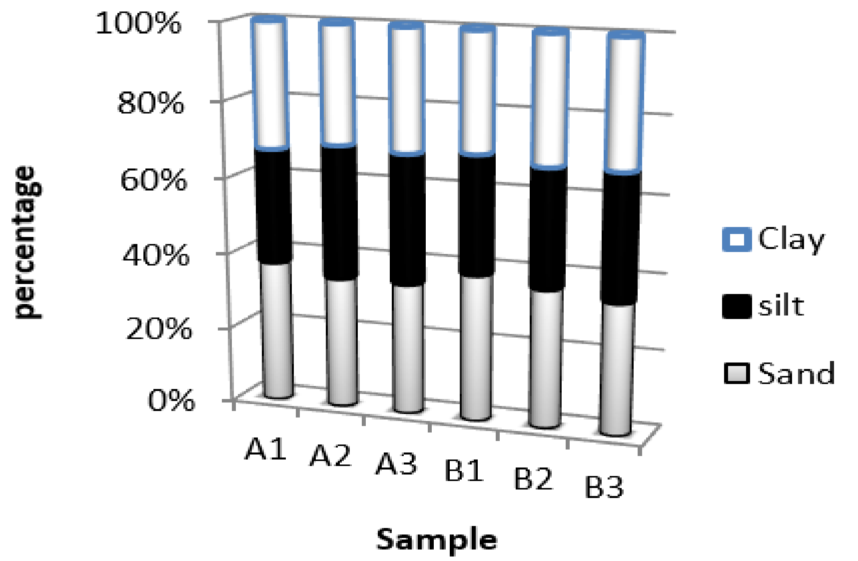


Fig. 1 a: Percentage of soil type at Ishieke Location in Ebonyi State

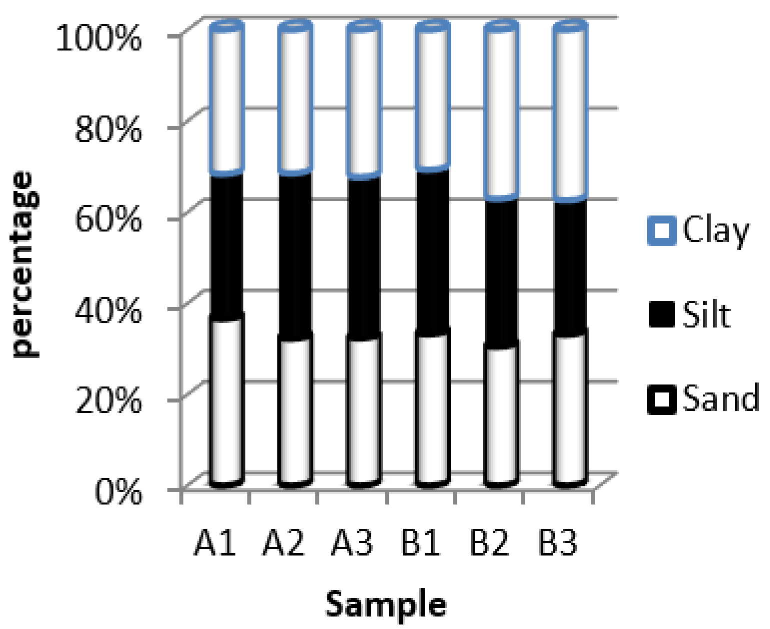


Fig. 1b: Percentage of soil type at Nkerefi Location in Enugu State

Fig. 1 a and Fig. 1b presented the soil samples collected in the two locations, one at Ishieke annex of Ebonyi State University, in Ebonyi State and the other from Nkerefi in Enugu State. A1 to A3 is the Sawah field while B1 to B3 is the non Sawah field. The textural type for both locations is clay-loamy soil. In Ishieke percentage distribution were 36% of sand, 32% of silt and 32% of clay while in Nkerefi, percentage distribution were 33% sand, 34% silt and 34% clay which result to clay-loamy soil.

**Soil Physical Properties**

The results physical properties of soil samples collected from the two experimental locations were presented in Figure 2 a to Figure 5 b

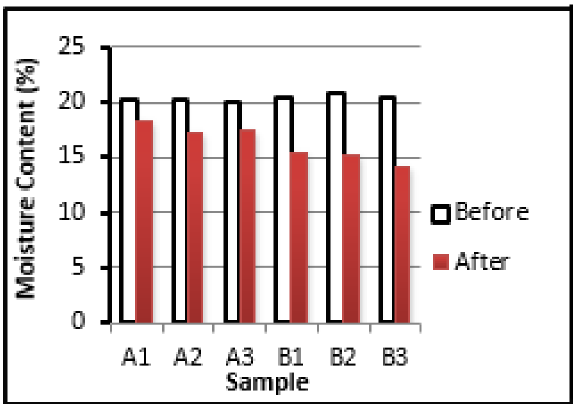


**Fig. 2 a: Ishieke Soil Moisture Content**

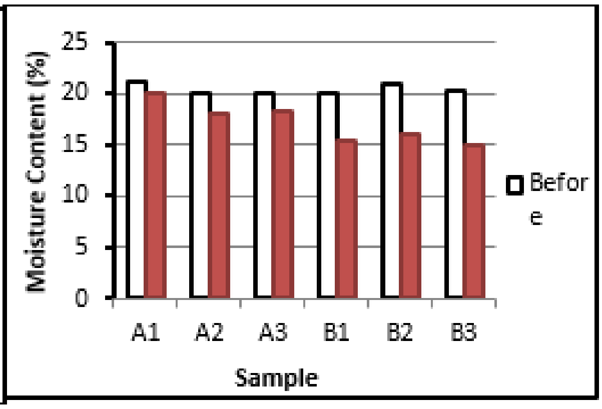


**Fig. 2 b: Nkerefi Soil Moisture Content**

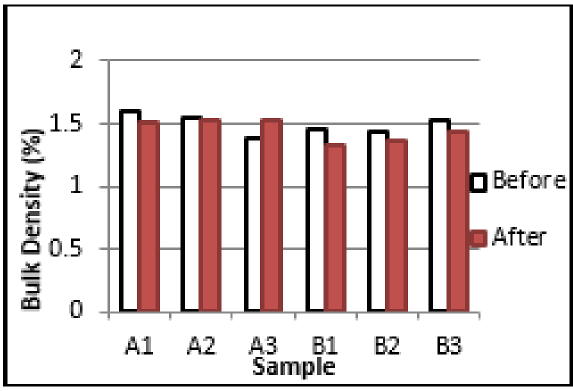


**Fig 3 a: Ishieke Soil Bulk Density**

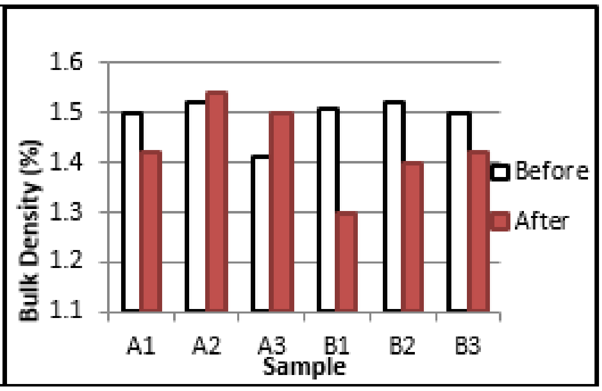


**Fig 3 b: Nkerefi Soil Bulk Density**

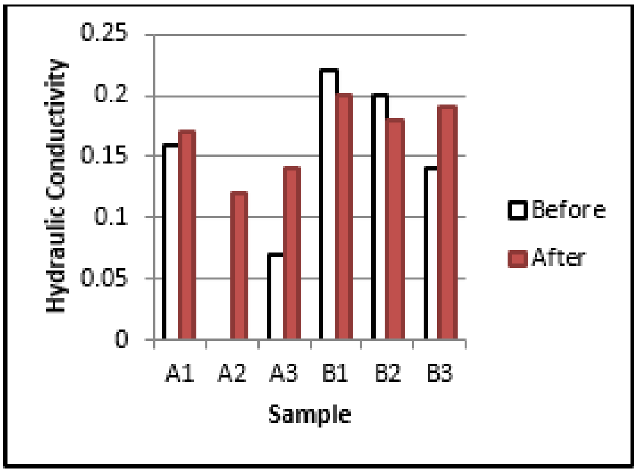


**Fig 4 a: Ishieke Hydraulic Conductivity**

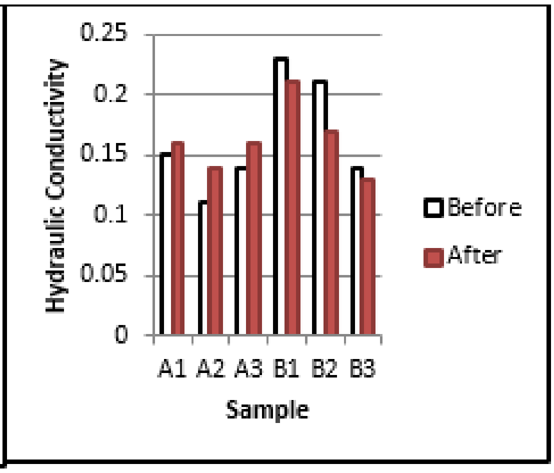


**Fig 4 b: Nkerefi Hydraulic**

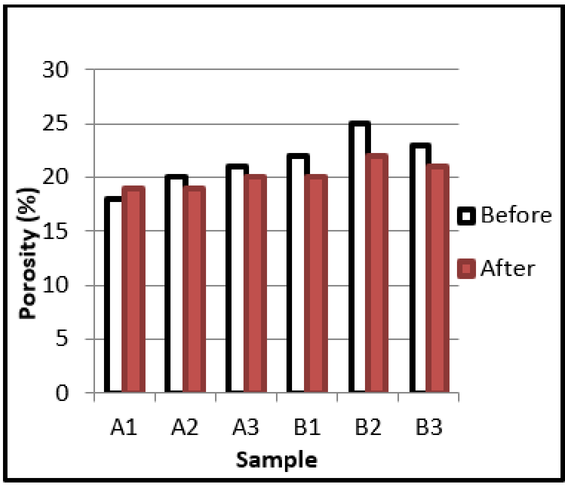


**Fig 5 a: Ishieke Soil Porosity**

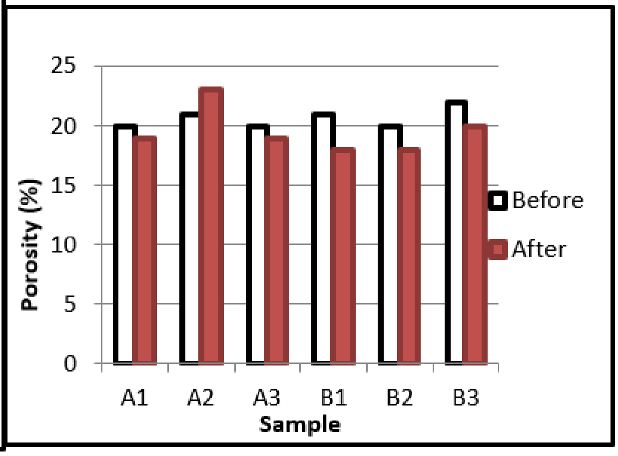


**Fig 5 b: Nkerefi Soil Porosity**

Table 1: Physical Characteristics of Soil

| **Samples** | **Moisture Content (%)** | | **Bulk Density (%)** | | **Porosity (%)** | | **Hydraulic Conductivity** | |
|---|---|---|---|---|---|---|---|---|
| | Non-Sawah (Control) | Sawah (Experiment) | Non-Sawah (Control) | Sawah (Experiment) | Non-Sawah (Control) | Sawah (Experiment) | Non-Sawah (Control) | Sawah (Experiment) |
| 1 | 24.6 ±2.50[a] | 21.2 ±1.32[b] | 1.45 ±0.01[a] | 1.57 ±0.04[a] | 23.5 ±2.12[a] | 19.0 ±1.41[c] | 0.21 ±0.02[a] | 0.09 ±0.11[c] |
| 2 | 20.4 ±4.34[b] | 22.6 ±6.18[a] | 1.42 ±0.14[b] | 1.35 ±0.06[b] | 21.5 ±2.12[b] | 21.0 ±1.41[a] | 0.17 ±0.04[d] | 0.17 ±0.00[a] |
| 3 | 18.6 ±0.69[c] | 18.0 ±1.13[c] | 1.40 ±0.04[c] | 1.17 ±0.06[c] | 21.5 ±0.71[b] | 19.5 ±0.71[b] | 0.19 ±0.01[b] | 0.13 ±0.01[b] |
| 4 | 24.6 ±2.50[a] | 21.2 ±1.32[b] | 1.40 ±0.01[c] | 1.57 ±0.04[a] | 23.5 ±2.12[a] | 19.0 ±1.41[c] | 0.21 ±0.01[a] | 0.09 ±0.11[c] |
| 5 | 20.4 ±4.34[b] | 22.6 ±6.18[a] | 1.42 ±0.14[b] | 1.35 ±0.06[b] | 21.5 ±2.12[b] | 21.0 ±1.41[a] | 0.17 ±0.04[d] | 0.17 ±0.00[a] |
| 6 | 18.6 ±0.69[c] | 18.0 ±1.13[c] | 1.40 ±0.04[c] | 1.17 ±0.06[c] | 21.5 ±0.71[b] | 19.5 ±0.71[b] | 0.18 ±0.01[c] | 0.13 ±0.02[b] |

In Figure 2 a and b, Sawah field represented by A1 to A3 before planting has the range of moisture content of 20.04 % - 20.23 % at Ishieke and 20.00 % - 21.25 % at Nkerefi experimental field, after planting it has moisture content of 17.15 % - 18.20 % at Ishieke and 18.00 % - 20.00 % at Nkerefi. In the non-sawah area represented by B1 to B3, before planting has the range of moisture content of 20.80 % - 20.33 % at Ishieke and 20.00 % - 21.00 % at Nkerefi experimental field, after planting it has moisture content of 14.12 % - 15.30 % at Ishieke and 15.00 % - 16.00 % at Nkerefi. Moisture content difference in Sawah and non-sawah rice field at Ishieke and Nkerefi are 2.03% and 1.25% respectively. In the area that received sawah treatment A1 to A3, moisture content was high with low differences on pre and post test conducted, unlike the non-sawah field B1 to B3 the moisture content was low with high differences on pre and post test conducted. The finding of the

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study implies that moisture content has positive influence on rice cultivation. This is in line with Paiman and Iqbal (2020) who stated that rice cultivation with high moisture content is better than low moisture content on the tillers number, panicle length, and harvest index. Zheng et al., (2021) also stated that between 15% and 35% moisture content, the cohesion increased first and then decreased with the increase of moisture content, while the peak cohesion value occurred at the moisture content of 20%. Moisture content was positively correlated with tangential adhesion and negatively correlated with soil swelling rate. All these parameters of moisture content support the growth of paddy rice.

In Figure 3 a and b, Sawah field represented by A1 to A3 before planting has the range of bulk density of 1.39 % - 1.60 % at Ishieke and 1.41 % - 1.52 % at Nkerefi experimental field, after planting it has bulk density of 1.51 % - 1.53 % at Ishieke and 1.42 % - 1.54 % at Nkerefi. In the non-sawah area represented by B1 to B3, before planting has the range of bulk density of 1.44 % - 1.52 % at Ishieke and 1.50 % - 1.52 % at Nkerefi experimental field, after planting it has bulk density of 1.32 % - 1.43 % at Ishieke and 1.30 % - 1.42 % at Nkerefi. Bulk density difference in Sawah and non-sawah rice field at Ishieke and Nkerefi are 2.03% and 1.25% respectively. In A3 the bulk density is even higher than when it was not planted which support the growth of rice plant because it is a water loving plant. Therefore, the study reduces soil bulk density at high level. This is in line with the submission of Kar (2009) who opined that increase in bulk density from low to medium resulted to the dry weight of shoot and root and the number of roots at the base significantly increasing. However, when the bulk density was increased from medium to high levels, the shoot and root growth parameter decreased under all temperature regimes. The study of Zheng et al., (2021) supported that when the bulk density increased in the range of 1 to 1.6 gcm−3, the cohesion, tangential adhesion, plasticity index, and swelling rate of paddy soil increased in different degrees.

In Figure 4 a and b, Sawah field represented by A1 to A3 before planting has the range of hydraulic conductivity of 0.00 g/cm3 - 0.16 g/cm3 at Ishieke and 0.11 g/cm3 - 0.15 g/cm3 at Nkerefi experimental field, after planting it has hydraulic conductivity of 0.12 g/cm3 – 0.17 g/cm3 at Ishieke and 0.14 g/cm3 - 0.16 g/cm3 at Nkerefi. In the non-sawah area represented by B1 to B3, before planting has the range of hydraulic conductivity of 0.20 g/cm3 - 0.22 g/cm3 at Ishieke and 0.14 g/cm3 - 0.23 g/cm3 at Nkerefi experimental field, after planting it has hydraulic conductivity of 0.13 g/cm3 – 0.20 g/cm3 at Ishieke and 0.13 g/cm3 - 0.21 g/cm3 at Nkerefi. Hydraulic conductivity difference in Sawah and non-sawah rice field at Ishieke and Nkerefi are 2.03% and 1.25% respectively. In the area that received sawah treatment A1 to A3, HC was high unlike the non-sawah field B1 to B3 HC was low after planting. It is in line with the study of Alvan and Leif (1979) who revealed that increasing hydraulic conductivity of the soils better the root development facilitated by more favorable physical conditions in highly permeable soils and could be the possible reason for the yield increase.

In Figure 5 a and b, Sawah field represented by A1 to A3 before planting has the range of soil porosity of 19.00 % - 21.00 % at Ishieke and 20.00 % - 21.00 % at Nkerefi experimental field, after planting it has soil porosity of 19.00 % - 20.00 % at Ishieke and 19.00 % - 23.00 % at Nkerefi. In the non-sawah area represented by B1 to B3, before planting has the range of soil porosity of 22.00 % - 25.00 % at Ishieke and 20.00 % - 22.00 % at Nkerefi experimental field, after planting it has soil porosity of 20.00 % - 22.00 %at Ishieke and 18.00 % - 20.00 % at Nkerefi. Soil porosity difference in Sawah and non-sawah rice field at Ishieke and Nkerefi are 2.03% and 1.25% respectively. In the area that received sawah treatment A1 to A3, porosity decreases with increase in hydraulic conductivity aid in development of plant root, biomass and increase the growth and yield of NERICA rice. In non-sawah field B1 to B3 the porosity was high after planting that has reduction index in growth and yield of NERICA rice. This is in line with study of Alvan and Leif (1979) who opined that increasing hydraulic conductivity as a result low porosity of the soils better the root development facilitated by more favourable physical conditions in highly permeable soils and could be the possible reason for the yield increase.

**Chemical Characteristics of Soil**

Chemical characteristics of the soil samples collected from the experimental field were presented in Fig. 6 a to Fig. 11 b.

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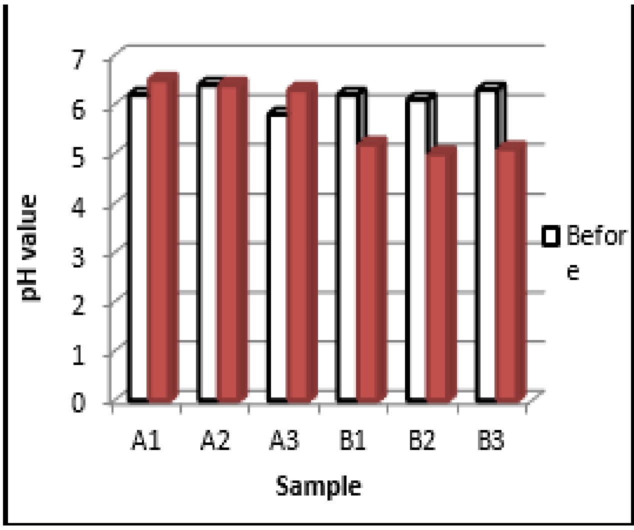


Fig 6 a: Ishieke Soil pH

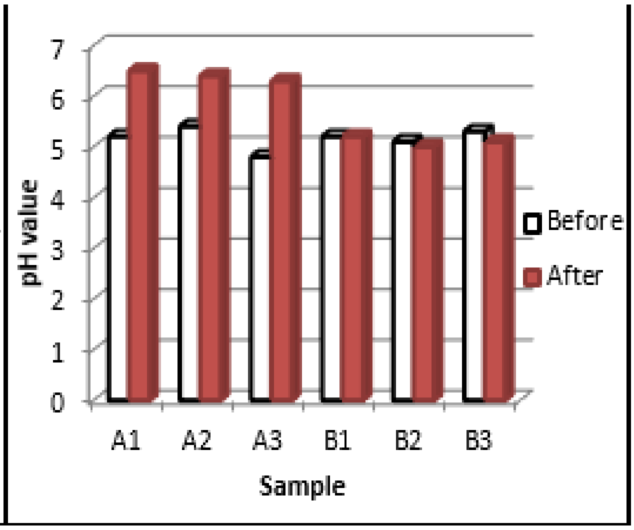


Fig 6 b: Nkerefi Soil pH

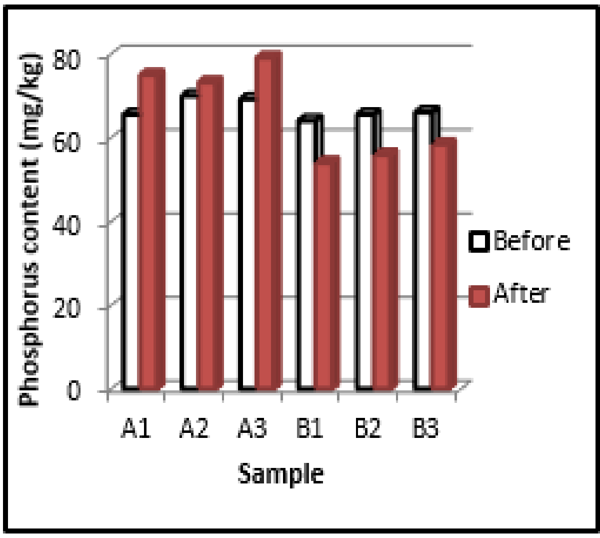


Fig 7 a: Ishieke Phosphorus Content

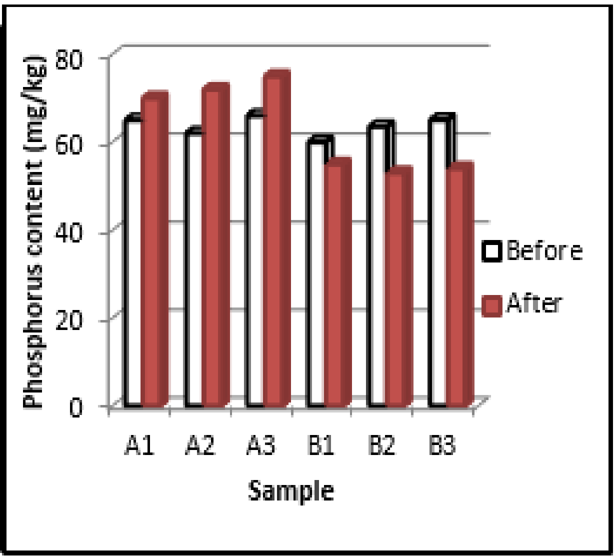


Fig 7 b: Nkerefi Phosphorus Content

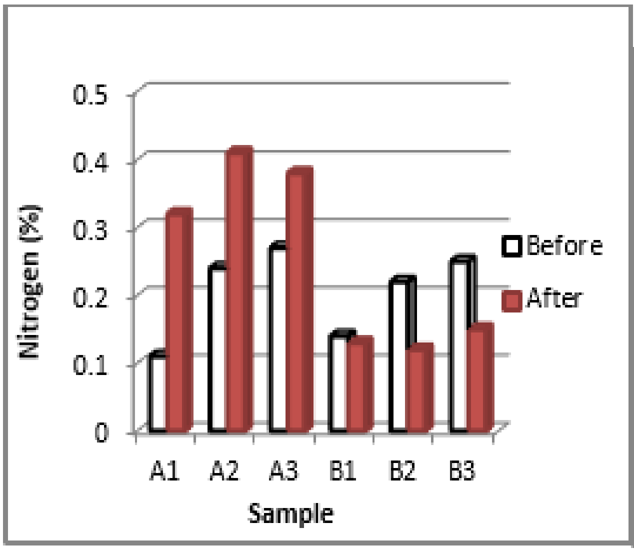


Fig. 8 a: Ishieke Nitrogen Content

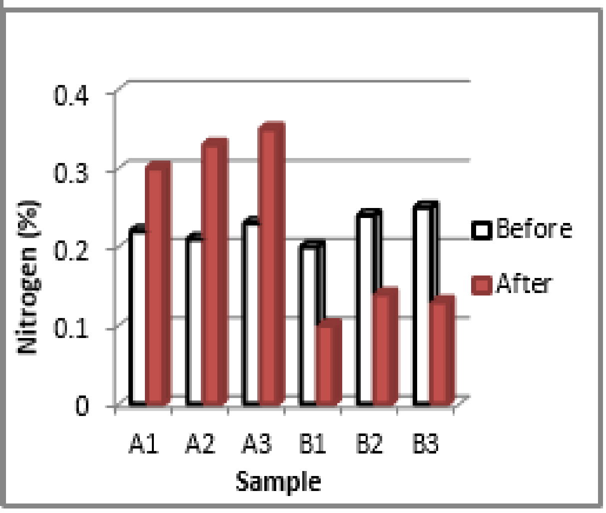


Fig. 8 b: Nkerefi Nitrogen Content

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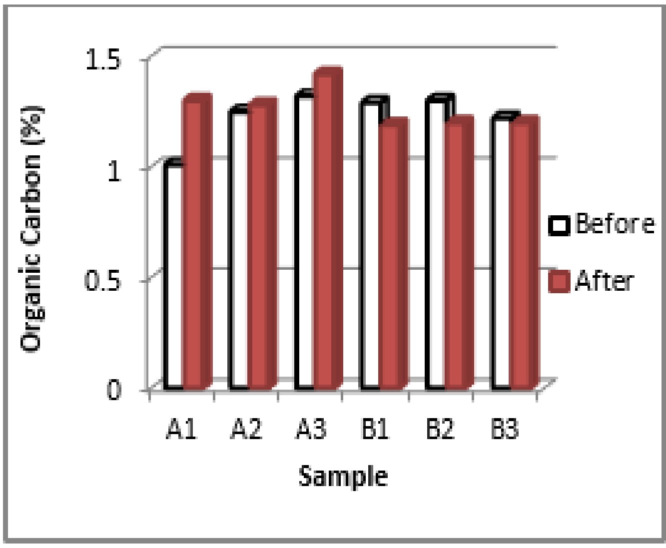


**Fig 9 a: Ishieke Organic Carbon Content**

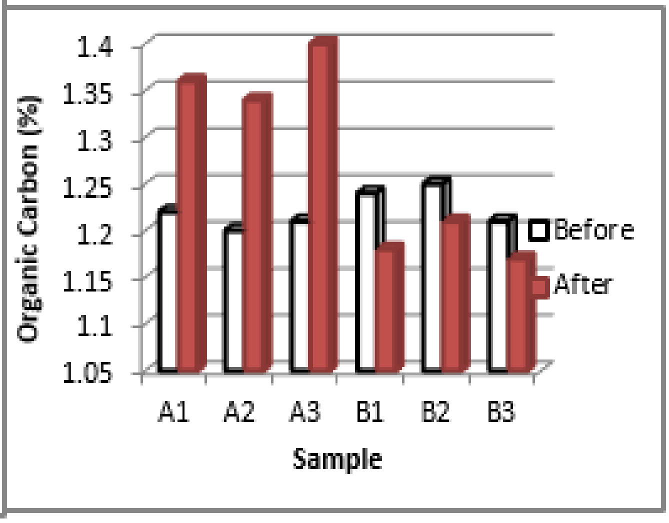


**Fig 9 b: Nkerefi Organic Carbon Content**

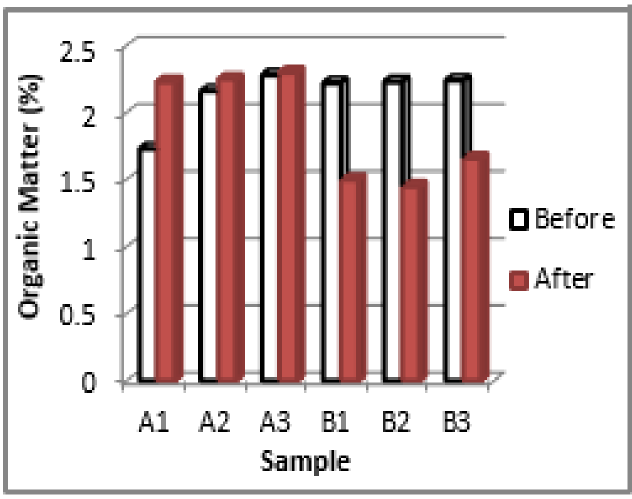


**Fig 10 a: Ishieke Organic Matter Content**

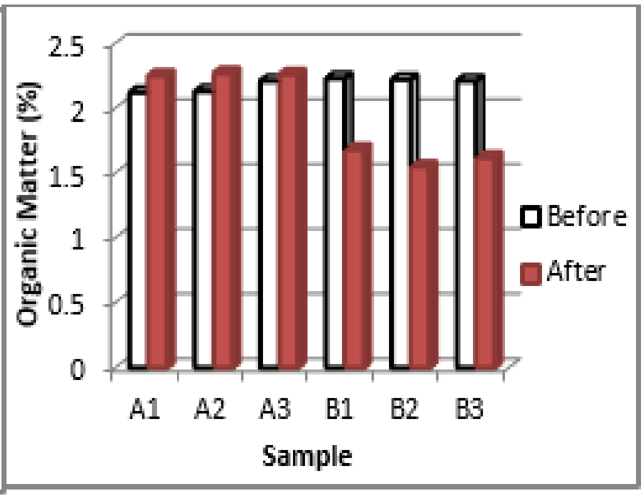


**Fig 10 b: Nkerefi Organic Matter Content**

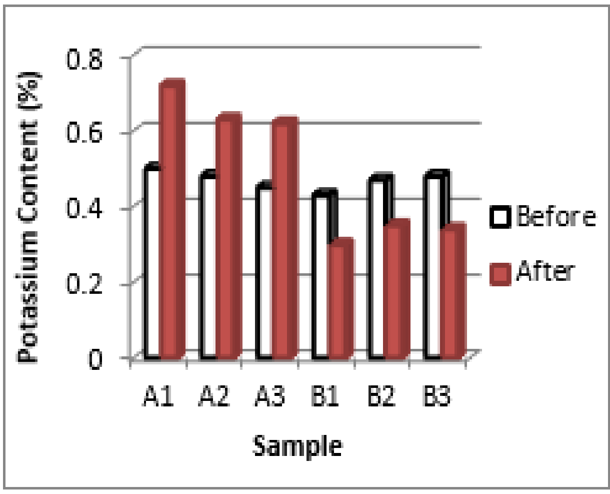


**Fig. 11 a: Ishieke Potassium Content**

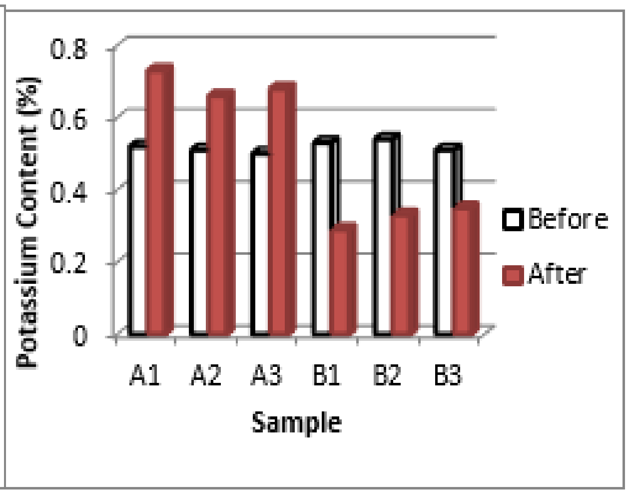


**Fig. 11 b:Nkerefi Potassium Content**

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Table 2: Chemical Characteristics of Soil

| Samples | pH (Non-Sawah) | pH (Sawah) | P (mg/kg) Non-Sawah | P (mg/kg) Sawah | N (%) Non-Sawah | N (%) Sawah | OC (%) Non-Sawah | OC (%) Sawah | OM (%) Non-Sawah | OM (%) Sawah | K (%) Non-Sawah | K (%) Sawah |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.2 $\pm0.01^b$ | 6.2 $\pm0.01^b$ | 64.03 $\pm0.01^b$ | 65.5 $\pm0.04^d$ | 0.18 $\pm0.06^e$ | 0.18 $\pm0.09^c$ | 1.30 $\pm0.01^a$ | 1.13 $\pm0.04^d$ | 2.233 $\pm0.01^b$ | 1.95 $\pm0.30^c$ | 0.45 $\pm0.03^a$ | 0.505 $\pm0.01^d$ |
| 2 | 6.1 $\pm0.00^c$ | 5.8 $\pm0.01^e$ | 66.01 $\pm0.01^a$ | 69.9 $\pm0.08^c$ | 0.19 $\pm0.08^b$ | 0.30 $\pm0.04^b$ | 1.21 $\pm0.02^c$ | 1.31 $\pm0.04^a$ | 1.873 $\pm0.52^c$ | 2.26 $\pm0.35^b$ | 0.39 $\pm0.13^b$ | 0.495 $\pm0.20^e$ |
| 3 | 6.3 $\pm0.04^a$ | 6.4 $\pm0.01^a$ | 55.90 $\pm0.01^c$ | 69.1 $\pm0.04^c$ | 0.14 $\pm0.02^d$ | 0.40 $\pm0.02^a$ | 1.20 $\pm0.00^d$ | 1.31 $\pm0.04^a$ | 1.553 $\pm0.15^e$ | 2.28 $\pm0.35^b$ | 0.35 $\pm0.01^c$ | 0.635 $\pm0.01^a$ |
| 4 | 5.2 $\pm0.01^d$ | 6.2 $\pm0.01^b$ | 64.02 $\pm0.03^b$ | 75.1 $\pm0.07^a$ | 0.18 $\pm0.04^c$ | 0.18 $\pm0.09^c$ | 1.19 $\pm0.01^e$ | 1.11 $\pm0.04^e$ | 2.273 $\pm0.05^a$ | 1.95 $\pm0.30^c$ | 0.45 $\pm0.03^a$ | 0.495 $\pm0.01^e$ |
| 5 | 5.1 $\pm0.04^e$ | 5.8 $\pm0.01^d$ | 66.03 $\pm0.01^a$ | 73.2 $\pm0.00^b$ | 0.20 $\pm0.02^a$ | 0.30 $\pm0.04^b$ | 1.22 $\pm0.06^b$ | 1.28 $\pm0.04^b$ | 1.833 $\pm0.46^d$ | 2.26 $\pm0.35^b$ | 0.39 $\pm0.13^b$ | 0.595 $\pm0.20^b$ |
| 6 | 5.1 $\pm0.07^e$ | 6.4 $\pm0.03^a$ | 55.90 $\pm0.01^c$ | 69.2 $\pm0.07^c$ | 0.20 $\pm0.05^a$ | 0.40 $\pm0.02^a$ | 1.22 $\pm0.03^b$ | 1.17 $\pm0.04^c$ | 2.103 $\pm0.14^b$ | 2.28 $\pm0.35^b$ | 0.35 $\pm0.01^c$ | 0.625 $\pm0.01^b$ |

Values are the mean and standard deviation of the six average samples of the soil chemical characteristics, Same superscript value in the column to indicate not significantly ($P>0.05$) different

In Figure 6 a and b, Sawah field represented by A1 to A3 before planting has the range of pH of 5.80 % - 6.40 % at Ishieke and 5.20 % - 5.80 % at Nkerefi experimental field, after planting it has pH value of 6.30 % - 6.50 % at Ishieke and 6.30 % - 6.50 % at Nkerefi. In the non-sawah area represented by B1 to B3, before planting has the range of pH of 6.10 % - 6.30 % at Ishieke and 5.10 % - 5.30 % at Nkerefi experimental field, after planting it has pH of 5.00 % - 5.20 % at Ishieke and 5.00 % - 5.20 % at Nkerefi. pH value difference in Sawah and non-sawah rice field at Ishieke and Nkerefi are 2.03% and 1.25% respectively. In the area that received sawah treatment A1 to A3, pH value was at the range of 6 to 7 which is the best for plant growth. This resulted in the increase of growth and yield of NERICA rice in the two locations that received Sawah treatment. Sawah technology maintained soil pH. In Nkerefi Sawah field, the soil pH was almost out of normal range for rice growth but was amended by application of Sawah Technology. In non-sawah field B1 to B3 the pH value after planting that did not make any change. This is in line with study of Fageria and Baligar (1999) that normal range of 6 to 7 help to make plant nutrients are readily available.

In Figure 7 a and b, Sawah field represented by A1 to A3 before planting has the range of Phosphorus content of 65.5 % - 70.00 % at Ishieke and 62.00 % - 66.00 % at Nkerefi experimental field, after planting it has Phosphorus content of 73.20 % - 79.10 % at Ishieke and 70.00 % - 75.00 % at Nkerefi. In the non-sawah area represented by B1 to B3, before planting has the range of Phosphorus content of 64.04 % - 66.05 % at Ishieke and 60.00 % - 65.05 % at Nkerefi experimental field, after planting it has Phosphorus content of 54.05 % - 58.40 % at Ishieke and 53.00 % - 55.00% at Nkerefi. Phosphorus content difference in Sawah and non-sawah rice field at Ishieke and Nkerefi are 2.03% and 1.25% respectively. In the area that received sawah treatment A1 to A3, most of their differences bear negative value indicating an additional Phosphorus content in the area after planting. This resulted to the increase of growth and yield of NERICA rice in the two locations that received Sawah treatment. There is positive effect of Sawah Technology in both locations. In non-sawah field B1 to B3 the Phosphorus content were reduced without replacement after planting. Sawah technology increases Phosphorus content through pulverization and puddling of the soil. This is in line with the submission of Ali and Ansari, (2006) that pulverization of soil improves Phosphorus release for the benefit of crop plant. Brandy and Weil, (2008) supported phosphorus plays vital role in energy storage and plant growth

In Figure 8 a and b, Sawah field represented by A1 to A3 before planting has the range of Nitrogen content of 0.11 % - 0.27 % at Ishieke and 0.21 % - 0.23 % at Nkerefi experimental field, after planting it has Nitrogen content of 0.32 % - 0.41 % at Ishieke and 0.30 % - 0.35% at Nkerefi. In the non-sawah area represented by B1 to B3, before planting has the range of Nitrogen content of 0.14 % - 0.25 % at Ishieke and 0.20 % - 0.25 % at Nkerefi experimental field, after planting it has Nitrogen content of 0.12 % - 0.15 % at Ishieke and 0.10 % - 0.14 % at Nkerefi. Nitrogen content difference in Sawah and non-sawah rice field at Ishieke and Nkerefi are 2.03% and 1.25% respectively. In the area that received sawah treatment A1 to A3, most of their differences bear negative value indicating an additional Nitrogen content in the area after planting. This resulted to the increase of growth and yield of NERICA rice in the two locations that received Sawah treatment. There is positive effect of Sawah Technology in both locations. In non-sawah field B1 to B3 the Nitrogen content were reduced without replacement after planting. Sawah technology increases Nitrogen content through pulverization and puddling of the soil. It is in line with the submission of Sainju, et al., (2006) that pulverization of soil causes decomposition of plant residue and mineralization which enhances the availability of nitrogen to the plant.

In Figure 9 a and b, Sawah field represented by A1 to A3 before planting has the range of organic carbon content of 1.01 % - 1.32 % at Ishieke and 1.20 % - 1.22 % at Nkerefi experimental field, after planting it has organic carbon content of 1.28 % - 1.42 % at Ishieke and 1.34 % - 1.40 % at Nkerefi. In the non-sawah area represented by B1 to B3, before planting has the range of organic carbon content of 1.22 % - 1.30 % at Ishieke and 1.21 % - 1.25 % at Nkerefi experimental field, after planting it has organic carbon content of 1.19 % - 1.20 % at Ishieke and 1.17 % - 1.21 % at Nkerefi. Organic carbon content difference in Sawah and non-sawah rice field at Ishieke and Nkerefi are 2.03% and 1.25% respectively. In the area that received sawah treatment A1 to A3, most of their differences bear negative value indicating additional organic carbon content in the area after planting. This resulted to the increase of growth and yield of NERICA rice in the two locations that received Sawah treatment. There is positive effect of Sawah Technology in both locations. In non-sawah field B1 to B3 the organic carbon content were reduced without replacement after planting. Sawah technology increases organic carbon content in the soil. It is in line with the submission of London (1991) that increase in carbon content makes land more productive.

In Figure 10 a and b, Sawah field represented by A1 to A3 before planting has the range of organic matter content of 1.73 % - 2.28 % at Ishieke and 2.12 % - 2.21 % at Nkerefi experimental field, after planting it has organic matter content of 2.23 % - 2.30 % at Ishieke and 2.25% - 2.27% at Nkerefi. In the non-sawah area represented by B1 to B3, before planting has the range of organic matter content of 2.22 % - 2.24 % at Ishieke and 2.21 % - 2.23 % at Nkerefi experimental field, after planting it has organic matter content of 1.45 % - 1.66 % at Ishieke and 1.55 % - 1.68 % at Nkerefi. Organic matter content difference in Sawah and non-sawah rice field at Ishieke and Nkerefi are 2.03% and 1.25% respectively. In the area that received sawah treatment A1 to A3, most of their differences bear negative value indicating additional organic matter content in the area after planting. This resulted to the increase of growth and yield of NERICA rice in the two locations that received Sawah treatment. There is positive effect of Sawah Technology in both locations. In non-sawah field B1 to B3 the organic matter content were reduced without replacement after planting. According to Tisdale et al. (1993), soil organic matter improves the chemical and physical properties of soil that increases the plant nutrients which enhances the growth of plant. Sawah technology increases organic matter content in the soil that improves the plants nutrients.

In Figure 11 a and b, Sawah field represented by A1 to A3 before planting has the range of Potassium content of 0.45 % - 0.50 % at Ishieke and 0.50 % - 0.52 % at Nkerefi experimental field, after planting it has Potassium content of 0.62 % - 0.72 % at Ishieke and 0.66 % - 0.73 % at Nkerefi. In the non-sawah area represented by B1 to B3, before planting has the range of Potassium content of 0.43 % - 0.48 % at Ishieke and 0.51 % - 0.54 % at Nkerefi experimental field, after planting it has Potassium content of 0.30 % - 0.35 % at Ishieke and 0.29 % - 0.35 % at Nkerefi. Potassium content difference in Sawah and non-sawah rice field at Ishieke and Nkerefi are 2.03% and 1.25% respectively. In the area that received sawah treatment A1 to A3, most of their differences bear negative value indicating additional Potassium content in the area after planting. This resulted to the increase of growth and yield of NERICA rice in the two locations that received Sawah treatment. There is positive effect of Sawah Technology in both locations. In non-sawah field B1 to B3 the Potassium content were reduced without replacement after planting. Sawah technology increases Potassium content in the soil that helps in rice plant development and yield quality. It is in line with the submission of Marschiner, (1995) that potassium involves in numerous biochemical and physiological processes vital to plant growth, development and yield quality.

## CONCLUSION

The study revealed that Sawah Technology amend soil and could be a source of solution to address problems of soil chemical and physical conditions. Sawah Technology improved soil chemical properties such as soil pH, Phosphorus, Nitrogen, Organic Carbon, Organic Matter and Potassium. Sawah Technology also maintained soil physical properties by increasing the moisture contents, hydraulic conductivity, porosity and reduction in bulk density which all enhanced the growth and yield of rice in the south east of Nigeria. Sawah Technology helps to pulverize and distribute soil nutrients evenly in the rice field. The agricultural extension service agents should educate rice farmers on the relevance of sawah technology to rice production since it improves soil physical and chemical properties.

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## REFERENCES

1. Ali, Q. and Ansari, Z. M. A. 2006. Phosphorus Requirements of Rice Grown in Soils with Different Sodicity. Journal of Plant Nutrition 29(12): 2105-2117
2. Alvan, A.K., and Leif, P. 1979. Soil Physical Properties in Relation to Rice Yield and Water Consumption Under Flooded and Unflooded Conditions. Plant Soil 52: 353–363.
3. Asadu, C.L.A and F.O.R. Akamigbo, 1990. Relative Contribution of Organic Matter and Clay Fractions Location Exchange Capacity of Soils in Southern Nigeria. Bamaeu J. Agric. Res., 7: 17-23.
4. Brady, N. C. and weil, R. R. 2008. The Nature and Properties of Soil 14th ed. Prentice – Hall Inc New Jersey, USA 978
5. Enwezor, W.O., Ohiri, A. C., Opuwaribo, E. E. and Udoh, E. J. 1988. A review of fertilizer use of crops in Southeastern Zone of Nigeria. Fertilizer Procurement and Distribution Department, Lagos.
6. Eze, p. C. and Oluka, S. I. 2013. Physical and Frictional Properties of NERICA. Journal of Experimental research, (JER), 1(2): 90 - 94
7. Eze, p. C. and Oluka, S. I. 2014. Selected Physical and Aerodynamics Properties of NERICA (New Rice for Africa). Journal of Agricultural Engineering and Technology, 22(3): 47 – 60.
8. Eze, p. C. and Oluka, S. I. and Eze, C. N. 2020. Effect of Moisture Content on Loading Positions on the Mechanical Properties of New Rice for Africa (NERICA). Scientific Journal of Agricultural Engineering ,38 – 50.
9. Fageria, N. K. and Baligar, V. C. 1999. Growth and nutrient concentrations of common bean, lowland rice, corn, soybean, and wheat at different soil ph on an inceptisol. Journal of Plant Nutrition, 22(9): 1495-1507.
10. FAO., 1999. FAO Statistical Database. Food and Agriculture Organization of the United Nations, Rome, Italy
11. Gyimah-Brempong, K., Johnson, M. and Takeshima, H 2016. [Eds]. The Nigerian Rice Economy: Policy Options for Transforming Production, Marketing, and Trade. Pennsylvania: University of Pennsylvania Press.
12. Kar, S. B. Varade, B. P. Ghildyal, 2009. Soil Physical Environment Affecting Root Growth of upland rice. Journal of Agricultural Science, 93(3): 719-726.

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13. London, J. R. 1991. A handbook for Soil Survey and Agricultural Land Evaluation in the Tropics and Subtropics. John Wihiley and Sons New York. Pp 474.
14. Marschner, H. 1995. Mineral nutrition of higher plants. Functions of mineral nutrients: Micronutrients: Iron. Academic Press, London. 313–323.
15. Nnabude, P.C. and J.S.C. Mbagwu, 1999. Soil water Relations of a Typic Haplustult Amended with Fresh and Burnt Rice will Waste. Soil and Tillage Research, 50: 207- 214.
16. Nwanze, K. F., Mohapatra, S., Kormawa, P., Keya, S., and Bruce-Oliver, S. 2006. Rice Development in Sub-Saharan Africa. Journal of the Science of Food and Agriculture (5): 675–677.
17. Ogah, E. O. 2013 Evaluating the Impact of New Rice for Africa (NERICA) in the Management of Rice Stem Borers. Journal of science International 10: 250 - 257
18. Ogobod, E.N. 2011. Effect of Crop Residue on Soil Chemical Properties and Rice Yield on an Ultisol at Abakaliki, Southeastern Nigeri. World Journal of Agricultural Sciences 7 (1): 13-18.
19. Oguike, P.C., Chukwu G.O.2 and Njoku N.C 2006. Physico-chemical properties of a Haplic Acrisol in Southeastern Nigeria Amended with Rice Mill Waste and NPK Fertilizer. African Journal of Biotechnology 5 (11): 1058-1061.
20. Osabuohien, E., Okorie, U. and Osabohien, R. 2018. Rice Production and Processing in Ogun State, Nigeria. Qualitative Insight from Farmers Association Food. Systems Sustainable and Environmental Policiesin Modern Economics. 27: 188 – 215
21. Piccolo A. and Mbagwu J. S. C. 1994. Humic Substances and Surfactants Effects on the Stability of Two Tropical Soils. Soil Sci. Soc. Am. J. 58:950 - 955.
22. Sainju, U. M., Singh, B. P., Whitehead, W. F. and Wang S. 2006. Carbon Supply and Storage in Tilled and Nontilled Soils as Influenced by Cover Crops and Nitrogen Fertilization. Journal of Environmental Quality. 35(4): 1507 - 1517
23. Tisdale, S. L., Nelson, W. L., Beaton, J. D. and Halvlin, J. L. 1993. Soil Fertility and Fertilizer. 5th Ed. MacMillan Publishing Company, Prentice Hall New York.
24. Vange, T. and Obi, I. 2006, Effect of Planting Date on Some Agronomic Traits Rice Genotypes at Markurdi, Benue State (Nigeria). Journal of Sustainable Development in Agriculture and Environment. 2: 80 – 84.
25. Wakatsuki, T., Buri, M. M., Bam, R., Oladele, O. I., Ademiluyi, S. Y., Obalum, S. E. and Igwe, C. A. 2018. Sawah Technology (3Paper) Principles: Sawah Hypothesis (1) the Platform for Scientific Technology Evolution and Sawah Hypothesis (2) the Platform for Sustainable Intensification in Watershed Agro Forestry (Africa SATOYAMA System) 3 & 18 July 2018 Version (http://www.kinkiecotech.jp/)OADA&JICATsukuba/ICCAENagoyaUniv&JICAChubu
26. Wakatsuki, T., Shinmura, Y. and Otoo, E. O. 1998. Sawah System for Integrated Watershed management of small inland valleys in West Africa. In: FAO (Ed.): Water Report No.17, Institutional and Technical Options in the Development and Management of Small Scale Irrigation, FAO, Rome, pp. 45–60.
27. Wakatsuki, T. 2002. Possible Self-Support Development of small Scale Sawah Systems in Inland Valley Watershed at West Africa, Japanese J. Agricultural Engineering, 70 (11): 999-1004
28. Zheng, K.; Cheng, J.; Xia, J.; Liu, G.; Xu, L. 2021. Effects of Soil Bulk Density and Moisture Content on the Physico-Mechanical Properties of Paddy Soil in Plough Layer. Water, 13: 2290.