IMPACT OF IRRIGATION PRACTICES ON SOIL NUTRIENTS IN KAMPE (OMI) SCHEME

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ABSTRACT

Irrigation applications have impacts on soil properties and these impacts may be negative on soil, crop and groundwater quality. This could be as a result of the quality of water used, method of application and the nature of the soil viz the physical and chemical composition of the soil. For sustainable use of the soil, it therefore becomes necessary to evaluate the effects of irrigation application on the soil from time to time. This project work was aimed at investigating the impacts of irrigation on the soil nutrients on Kampe irrigation scheme. Soil samples were collected from three operating lands of the scheme. Samples were collected at depths 0 – 20 cm, 20 – 80 cm and 80 – 120 cm in accordance with the baseline data available. The samples were taken to the laboratory and analysed for physical and chemical parameters (K^+, Mg^{2+}, Ca^{2+}, P and TKN). It was observed that there were little changes in the macronutrients such as Mg^{2+} and Ca^{2+} which reduced appreciably as compared to the baseline data for the operating lands. There is a need for proper monitoring of the soil condition in the irrigation scheme should be employed in order to prevent further deterioration since changes have been observed compared to the baseline data.

KEYWORDS: Irrigation, groundwater, soil nutrients, operating land.

1. INTRODUCTION

The increased use of irrigation technology though yielding the expected results in terms of agricultural productivity, has a far-reaching negative effect on the ecological sphere. The technology transforms the land in two major ways, first by direct modification of the land surface that occur when networks are constructed and land is cleared and leveled for irrigation" and secondly by indirect transformations that take place when the water and salt balances in the region are changed following the import of additional quantity of water and salts in the area ((Poustini and Siosemardeh, 2004). According to Poustini and Siosemardeh, (2004), Soil is the loose material that covers the land surfaces of Earth and supports the growth of plants. Soils vary widely from place to place. Many factors determine the chemical composition and physical structure of the soil at any given location. According to Poustini and Siosemardeh, (2004) "when irrigation is introduced to a piece of land, it affects soil aeration, soil moisture, soil microorganism, soil organic matter content soil pH, and soil texture and soil temperature". All these will invariably affect the level of exchangeable bases and extractable copper, iron, manganese and zinc in the soil. It should be noted that these soil nutrients are required for plant growth some in large quantities as the case of cations and micronutrients in small quantities.

During the last 3 - 4 decades due to increased demand for food, the use of irrigation has increased by about 300%. Due to scarcity of surface water resources especially in arid and semi-arid region for supplying irrigation water for agricultural lands, the excessive discharge of the ground water with low quality has occurred, which has imposed a further increase in soil salinization (Poustini and Siosemardeh, 2004).
Over-watering has a direct impact on water resources at a time when they are at their lowest. Overwatering will also result in increased drainage during the growing season, which increases nitrate leaching to groundwater. Under-irrigation may conserve water resources, but by reducing nitrogen uptake by the growing plant, may increase the risk of winter nitrate leaching. A good irrigation plan will set trigger deficits as high as possible and irrigation applications should leave sufficient storage capacity in the soil to allow for rainfall.

Type of irrigation methods can be broadly divided as under: Surface irrigation method, Subsurface irrigation method, Sprinkler irrigation system, and Drip irrigation system. In Surface Irrigation system of field water application, the water is applied directly to the soil from a channel located at the upper reach of the field (Kharagpur, 2000). It is essential in these methods to construct designed water distribution systems to provide adequate control of water to the fields and proper land preparation to permit uniform distribution of water over the field. In subsurface, the application of water to fields in this type of irrigation system is below the ground surface so that it is supplied directly to the root zone of the plants (Kharagpur, 2000). The main advantages of these types of irrigation is reduction of evaporation losses and less hindrance to cultivation works which takes place on the surface. Sprinkler irrigation is a method of applying water which is similar to natural rainfall but spread uniformly over the land surface just when needed and at a rate less than the infiltration rate of the soil so as to avoid surface runoff from irrigation and Drip Irrigation system is sometimes called trickle irrigation and involves dripping water onto the soil at very low rates (2-20 litres per hour) from a system of small diameter plastic pipes filled with outlets called emitters or drippers. Water is applied close to the plants so that only part of the soil in which the roots grow is wetted, unlike surface and sprinkler irrigation, which involves wetting the whole soil profile (Kharagpur, 2000).

A critical problem confronting mankind today is how to manage the intensifying competition for water between expanding urban centres, traditional agricultural activities and in-stream water uses dictated by environmental concerns. Therefore, the required increase in agricultural production will necessarily rely largely on the affordability to apply new technologies, a more accurate estimation of crop water requirements, and on major improvements in the construction, operation, management and performance of existing irrigation systems.

Although several studies are carried out on the impacts of irrigation on soil in Nigeria, little or no attempt is made to look at impact of irrigation on the soil properties and the implications on crop production. Now irrigated agriculture is entering an "age of management" in which crop water deficit may not be totally avoided but instead, favourably controlled. So, there is need to adopt management practices that limit evaporation losses. The focus of this study is on the aspect of irrigation that affects the various properties of soil, which in many cases brought in deleterious impact on the biological environment. Therefore, the effect of irrigation on the distribution of soil nutrients and organic matter in Nigeria need to be determined.

Today, doing local research on irrigating the farmlands and studying the effects of which from different aspects have been of great importance. The major aim of this research is to determine the various effects of irrigation on soil nutrients. The objectives are to collect the baseline data and identify status of the soil nutrients in the scheme at inception, determine the present state of the soil nutrients on some parts of the scheme where irrigation is being carried out, evaluate the impacts of irrigation on the soil nutrients in these sections of the scheme and to make recommendations on the effects of the impact observed.

2. MATERIALS AND METHODS

Kampe Omi Dam Irrigation Project is located in Yagba West Local Government Area of Kogi State, Nigeria. It is about 146 km from Ilorin the capital of Kwara State. It lies between longitude $6^o37\ ^1$and 6^043^1E of the Greenwich and latitude 8^034^1 and 8^038^1N of the equator. (Figure 1).

Areas sampled were field 0L18, 0L20 and 0L5.NB; 0L5 which served as the control area since it has been long that it was left fallow without either of tillage or irrigation. Maize, Rice and potatoes were grown on this land. Each field was separated into sampling units representing a relatively uniform area. The criteria used to delineate a sampling unit include soil type, slope, drainage, and past management. Each sample unit was not more than forty acres (40a). A 120cm auger was drilled into the soil at each location of sample collection on the operating land which were (OL5, OL18 and OL20A & OL20B) as shown on figure 1. The soil (sample) was collected at each depth (0-20cm, 20 -80cm and 80-120cm) respectively with the help of the auger that was drilled into the soil and then dropped into a well labelled black polythene paper. At the end of sample taking, a total of 60 samples was taken.

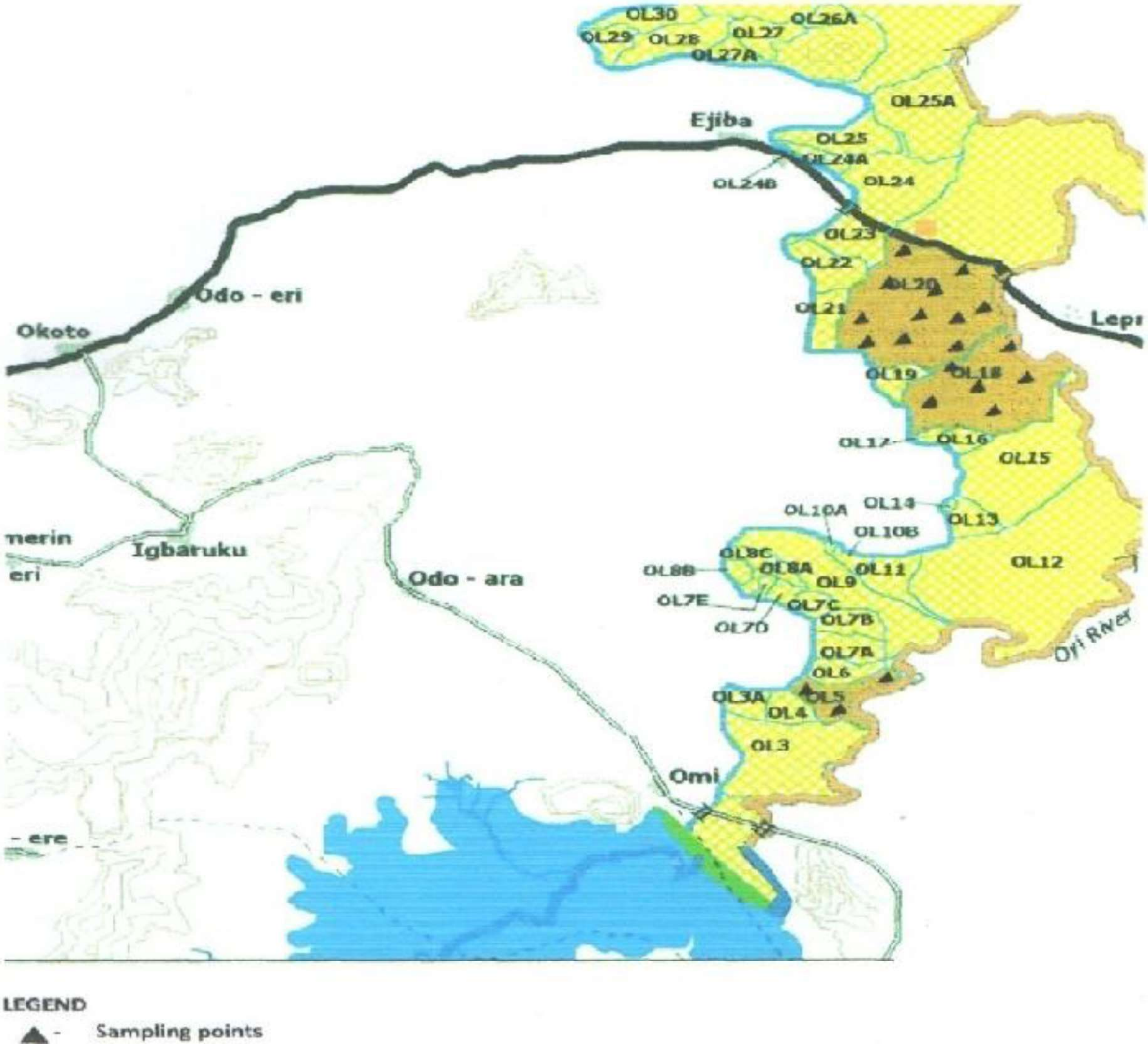

Figure 1: Soil sampling points of the Kampe Omi Dam irrigation project

The samples collected were taken to lower Niger river basin laboratory for analyses; testing for micro and macronutrient present using Flame photometry to determined potassium (K) while Atomic Absorption Spectrometer (AAS) was used in determining calcium (Ca) and magnesium (Mg). Calcium helps plants respond better to environmental and disease stresses and Magnesium is another important macronutrient needed by plants, important for chlorophyll production or plant photosynthesis (Tesfai *et al.,* 2002). Crops with potassium at the low end of the range are classed as having a low K^+ content and crop yields are expected to be 50-80% of the yield that could be obtained with adequate fertilizer application. Potassium is important for over-wintering ability of perennial crops, overall growth and longevity and disease resistance, Potassium is important for legumes. Adequate amount of phosphorus in soils favours rapid growth, early fruiting/ maturity and improves the quality of produce (Amjad *et al*., 2006). Nitrogen is a major plant macronutrient stimulating leaf and stem growth.

The results were analyzed using Microsoft excel spreadsheet, using average to find the value required according to the result of the analysis.

3. RESULTS AND DISCUSSION

3.1 Calcium (Ca^{2+})

There are reductions in Ca^{2+} in all the operating lands in the current data of the scheme as compared with the baseline data. From the figures 1a-c, Ca^{2+} values at all depths for the operating lands in the baseline are greater than values in recent years including the current data. Ca^{2+} deficiency may be reduced in the operating lands since the soil pH is adequate according to Marx *et al*., (1997) and as shown illustrated in Figure 1a – c.

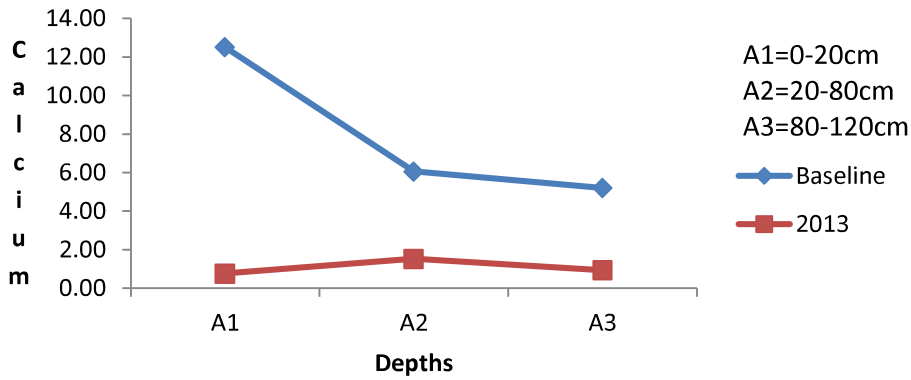

Figure 1a; chart for the values for Ca^{2+} with depth for OL5

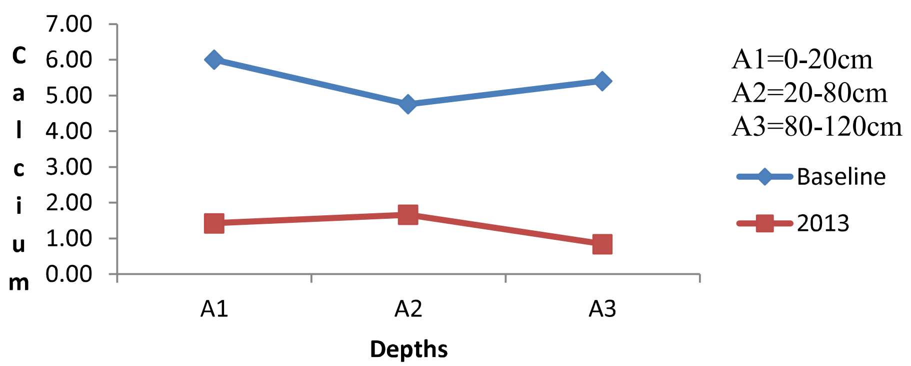

Figure 1b; chart for the values for Ca^{2+} with depth for OL18

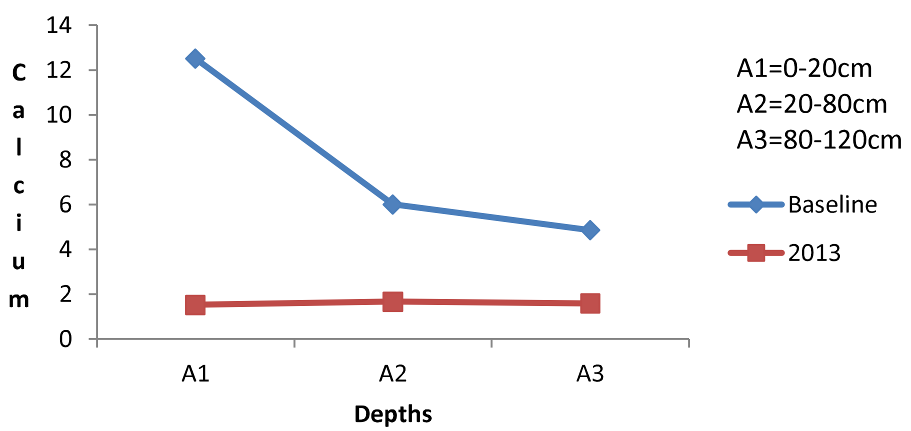

Figure 1c; chart for the values for Ca^{2+} with depth for OL20

3.2 Magnesium (Mg^{2+})

The values of Mg in the baseline data for all the operating lands fall under the medium class. In the current data, OL5 falls in the low class; OL18 falls in medium class only depth 80-120cm of OL20 falls in the medium class. The other two depths of OL20 fall in the low class but are close to the medium class (Oriola 2004). This is illustrated in Figure 2a – c.

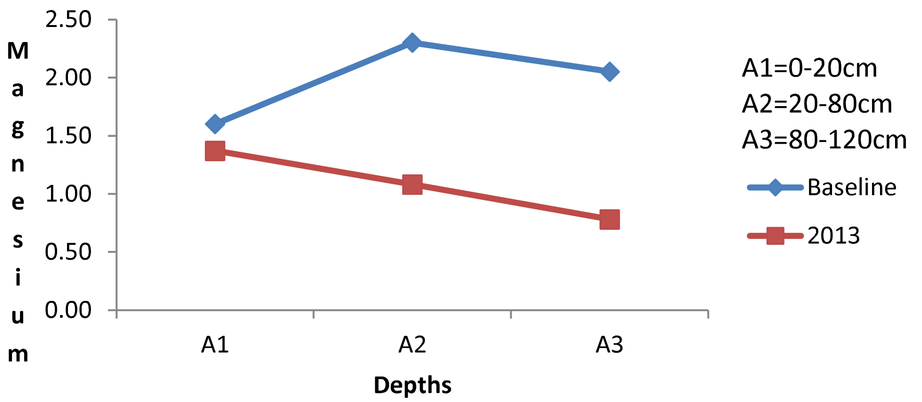

Figure 2a; chart for the values for Mg^{2+} with depth for OL5

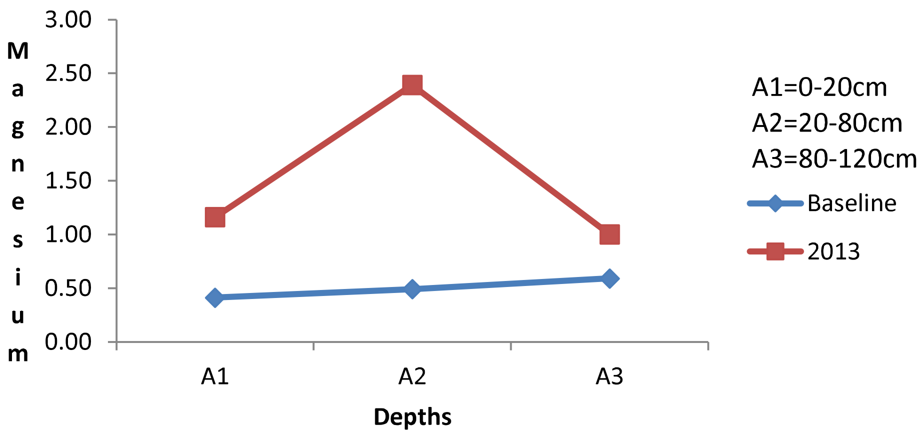

Figure 2b; chart for the values for Mg^{2+} with depth for OL18

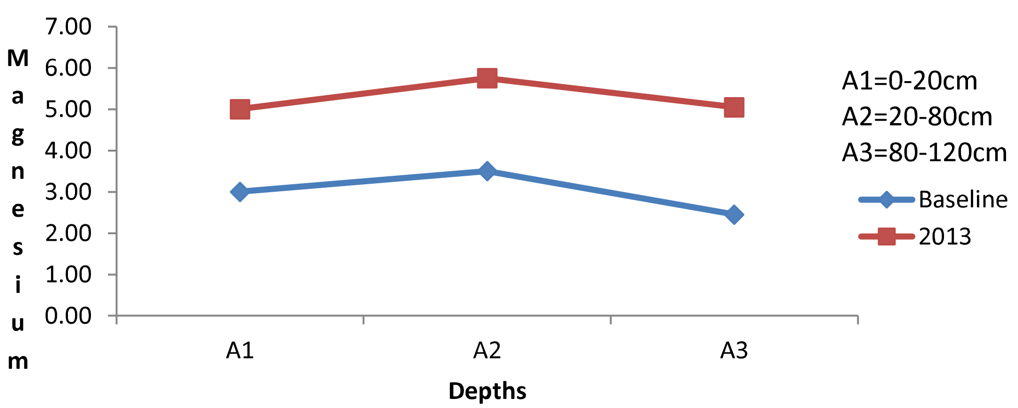

Figure 2c; chart for the values for Mg^{2+} with depth for OL20

3.3 Potassium (K^+)

Considering Figure 3a - c, it is shown that there is an increase in potassium levels compared to the baseline data and over the years at each depth and for all the operating lands. The values of K^+ at all depths for OL18 and OL20 are higher than that of OL5 and the irrigated land can yield 100 percentage without application of fertilizer (Oriola, 2004).

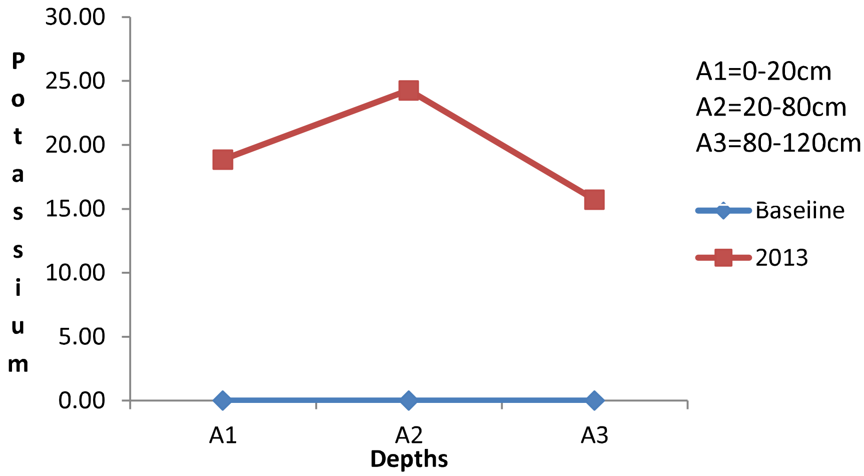

Figure 3a; chart for the values for Potassium with depth for OL5

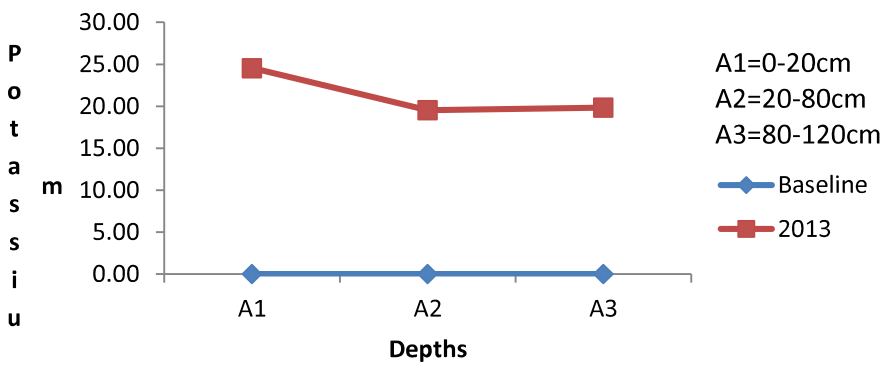

Figure 3b; chart for the values for Potassium with depth for OL18

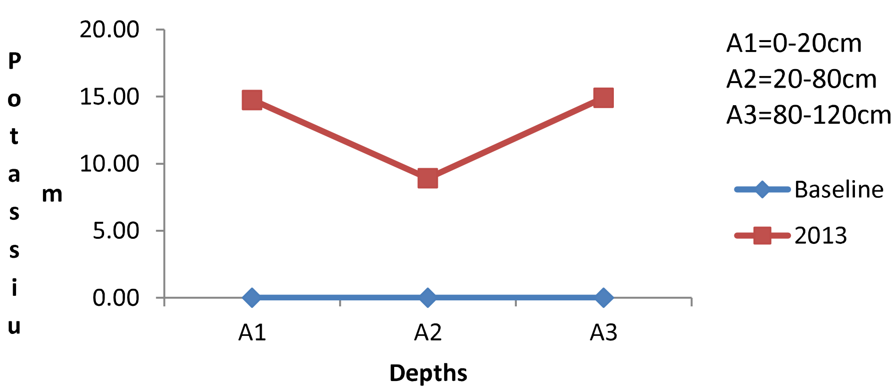

Figure 3c; chart for the values for Potassium with depth for OL20

3.4 Phosphorus

From Figure 4a, there is an increase in the phosphorous levels over the years but in comparison to the baseline data, a slight decrease occurred for the current data while in Figure 4b and c, an increase over the years with baseline data was observed at each depth. There is greater increase in phosphorus in the operating lands so there is sufficient phosphorus in all the lands for plant's root growth, protein synthesis and crop maturity.

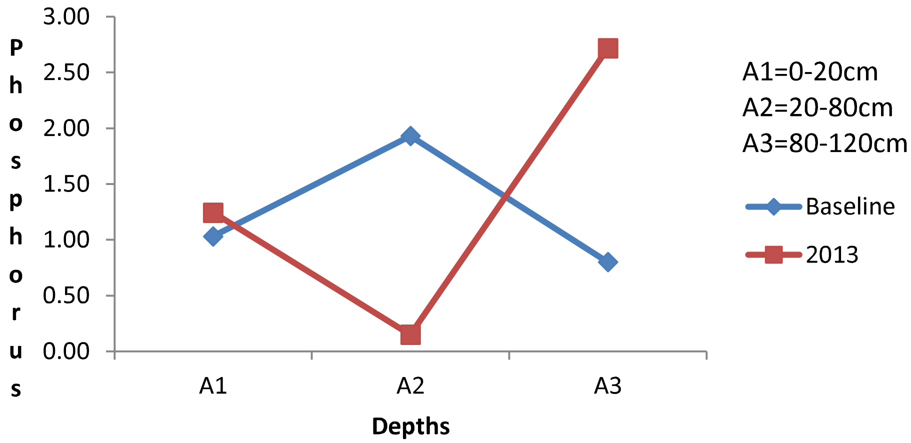

Figure 4a; chart for the values for Phosphorus with depth for OL5

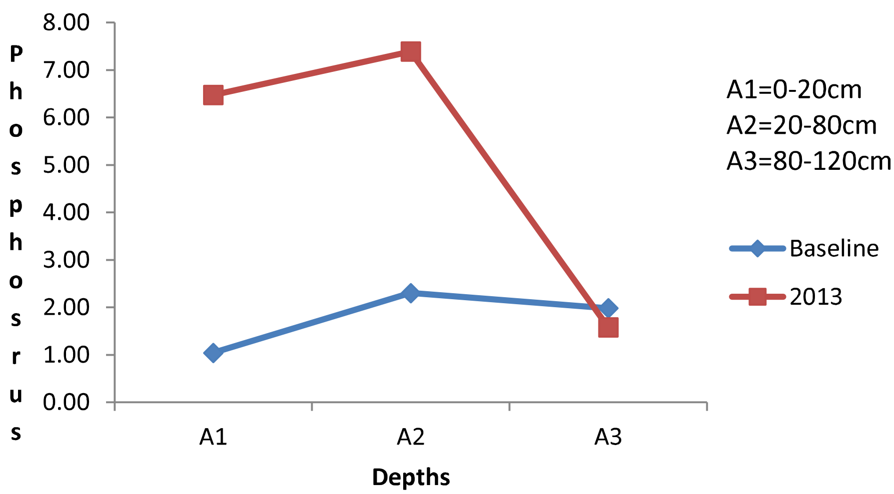

Figure 4b; chart for the values for Phosphorus with depth for OL18

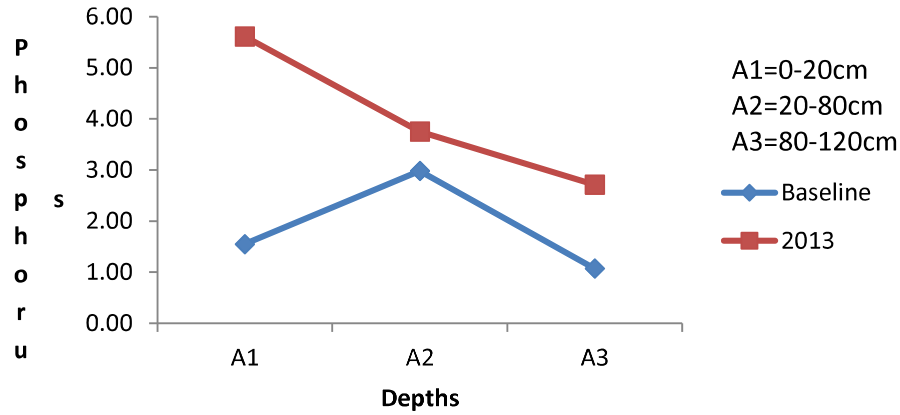

Figure 4c; chart for the values for Phosphorus with depth for OL20

3.5 TKN

The current result showed increase in nitrogen in all the operating lands. There is a drastic increase for current data compared with baseline data and over the years for the operating lands (OL 18 and OL20) at all depths. This may be as a result of different soil management employed by famers using the operating lands, especially the use of N.P.K fertilizer which has added some level of nitrogen to the soil as illustrated in Figure 5a – c.

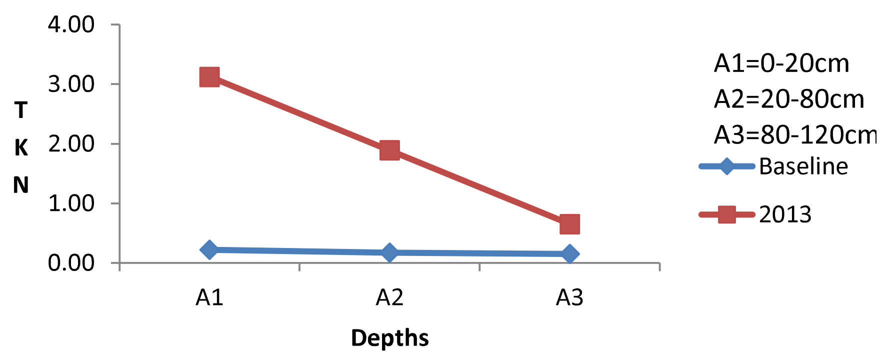

Figure 5a; chart for the values for TKN with depth for OL5

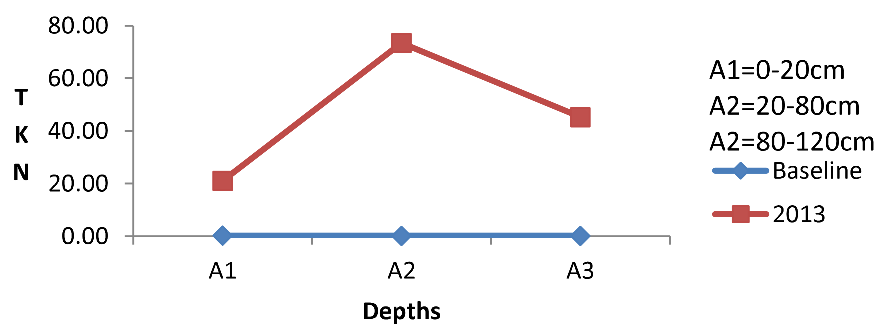

Figure 5b; chart for the values for TKN with depth for OL18

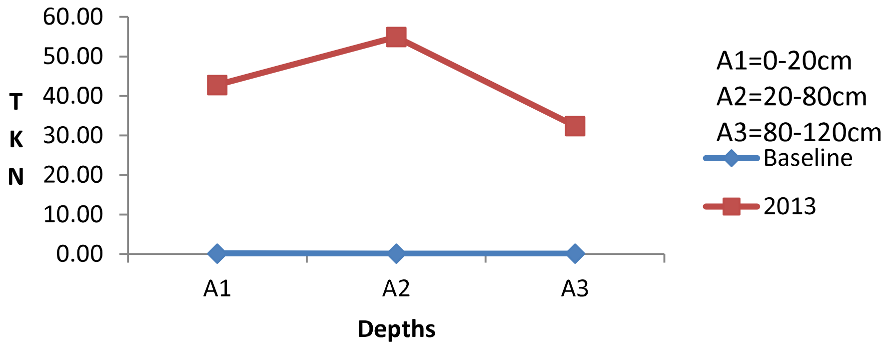

Figure 5c; chart for the values for TKN with depth for OL20

4. CONCLUSIONS

The current data shows macronutrients such as $Ca^{2+}$and Mg^{2+} required by crops have reduced compared to the baseline and this in turn could reduce the fertility of the soil due to the deficiencies. This reduction can also be traced to the decreased levels of base saturation and the slight acidity noted by the pH range.
There was an increase in K^{+} and Phosphorous levels which makes them still available in the soil when they are removed in large quantity during harvest.

Nitrogen (TKN) largely increased and these high levels are detrimental to soil tilth and plant growth. Generally, the analysis indicated that a need for proper monitoring of the soil condition in the irrigation scheme in order to prevent further deterioration is highly encouraged since some changes have been observed compared to the baseline.

Improper soil management are the major problem in the scheme, the control of soil management problem, development and maintenance of successful irrigation project should be taken important. For efficient production output in the irrigation scheme, thus it is recommended that fertilizer should be applied in the appropriate proportion to stabilize and correct nutrient deficient in the soil of the irrigation scheme, allow proper decomposition of crop residues and cleared bush because if not, it could lead to water logging, Chemical and physical properties of the soil should be carried out often effectively to detect any sudden rise or fall of the nutrients in the soil and a drainage outlet should be provided in the field so that excess water used for irrigation practice can be drain away from the field (preventing accumulation of salt and water logging).

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