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A REVIEW OF THE INFLUENCE OF IRRIGATION WATER ON THE SELECTED PHYSICAL AND CHEMICAL PROPERTIES OF WETLAND SOILS OF NORTHERN NIGERIA.

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ABSTRACT

Wetlands are soils subjected to excessive wetness, to the extent that the wet conditions influence the possible land uses. To some extent, irrigation water is rampantly being applied on these wetlands without observing and considered the possible short and long-term effects on the soil. This paper provides a review on the influence of irrigation water on the physical and chemical properties of wetland soils. It is evident that most of these wetlands are of high importance to food security and sustainability which are however, influenced by the application of irrigation water. However, it has been reported that decrease in soil pH as a result of continuous build-up of salts due to poor soil management, fertilizer application and poor irrigation water quality has adversely affected the soil surface. The presence of exchangeable Ca, Mg and Na as carbonates influence hydroxyl ions over hydrogen ions in the soil solution therefore making the soil alkaline. The continuous intensive cropping without addition of organic matter and crop residues has rendered the irrigated areas low of organic carbon when compared to non-irrigated areas. Moreover, due to poor seasonal drainage taking place in wetlands, the rate of OM decomposition and mineralization reduces in the soils. Nonetheless, the influence of irrigation water on the physical and chemical properties of the wetlands differs among wetlands, and even within the same wetlands. In conclusion, most of the wetlands were neither saline nor sodic but if not properly manage, could lead to build-up of exchangeable bases.

Keywords: Wetland soils, physico-chemical properties, calcium carbonates, organic carbon, crop residues and irrigation water

INTRODUCTION

Hydromorphic soils are wetland soils, classified by high volume of soil water at least for a short period of time (Ibanga *et al.* 2005). In Nigeria, there are different classes of wetland soils but the soils found under such condition are termed gleysols and ferrolysis and these are caused by water saturation if organic matter and soil temperature allow microbial activities. Soils with gleying and pseudo-gley horizons are where mottles and accumulation of re-oxidized compound occur (PiPujol and Buurman, 1994). These horizons are easily identified either near the soil surface or at depth depending on the rise and or fall of water table regime (Ibanga and Nsokpo, 2001).

Wetlands with suitable soil-water balance, extended growing seasons, reduced soil erosion damage, vast land units with gentle to flat topography and moderate to high fertility index are influenced by the hydromorphic processes of the soils (Juo and Hosner, 1992).They have been reported to be potentially productive and suitable for intensive wet and dry land uses than upland soils (Juo and Hosner, 1992; Ogban and Babalola, 2009). Nonetheless, Enzewor *et al.* (1990), Omar and Nzamouhe (2017 a & b) and Nzamouhe and Omar (2020) reported that limited studies have been carried out to see the possible conditions on wetlands within Nigeria agro-ecological zones. This review is drawn to see the possible effect of irrigation water on the physical and chemical properties of wetland soils.

Particle size distribution

This is one of the major physical properties of the soil which is affected by the quality of irrigation water and is described as the percentage composition of sand, silt and clay in the soil (Adamu and Aliyu, 2012). Particle size distribution is strongly correlated with a soils ability to percolate water (i.e., permeability and infiltration), how much water the soil can store (i.e., water holding capacity), and the soil's ability to absorb or desorb chemical ions (Miller and Donahue, 1995). In a research carried out by Tekwa *et al.* (2013), it was found that the wetland soils within the Numan area of Adamawa State from both cultivated and uncultivated farms had clay soils as their dominant soil. Furthermore, Tekwa *et al.* (2013) noted that the soils were sticky and plastic when wet, friable when moist and extremely hard when dry which could however, be due to the presence of montmorillonite clay of 2:1 type of clay as described by Singh *et al.* (2004).

Adamu, (2013) reported that the soils in all the eight sectors within the Watari irrigation site had sand as the dominant textural fraction. However, it was stated that the preponderance of sand particles in both arid and semi-arid climates in Nigeria is common due to the formation of aeolian deposits blown from hundreds of miles as supported by Mortimore (1989). More so, Adamu (2013) stated that such deposits are mostly found over the surfaces of underlying soils that may be formed from other parent materials such as alluvial deposits referred to as *fadama* in Hausa. Omar and Nzamouhe, (2017a) found that sand fraction to be predominantly higher when compared to silt and clay fractions in both irrigated and non-irrigated farms throughout Warwade town. Nonetheless, the study agrees with Olofin (1987) who stated that Warwade town was developed from Precambrian rocks of Chad formation which is likely to give rise to sandy soils. It was also reported that the silt content ranged from 4.72 to 20.72% in the irrigated soils, while in the non-irrigated soils, it ranged from 2.72 to 18.72% in Tsohon Gari and Nada respectively. The clay fraction of irrigated soils of Tsohon Gari and Nada were found to range between 7.76 to 13.76% respectively, while in the non-irrigated soils, it ranged between 7.76 to13.76% in Sabon Gari and Nada respectively.

Soil pH

Soil pH is a measure of the soil solution's acidity and alkalinity. Soils are referred to as being acidic, neutral, or alkaline (or basic), depending on their pH values on a scale from approximately 0 to 14 (McCauley *et al.* 2017). Soil pH directly affects the life and growth of plants because it affects the availability of all nutrients in the soil (FAO, 2001). For instance, it has been proven that when the soil pH is below 5.5 or above 8.5 the availability of N decreases to the extent that plants are not able to take up any N from the soil FAO, (2001). Getaneh *et al.* (2007) reported that higher soil pH was observed in irrigated farmlands than their counter non-irrigated farmlands. Gabar, Kastemach, Basaka, Nageso, Gibe-lamu and Lugama had a pH of 4.98, 5.58, 5.54, 5.54, 5.30 and 5.85 respectively for the irrigated farms while 4.67, 5.32, 5.38, 4.69, 5.30 and 5.50 for the non-irrigated farms. However, the higher pH in irrigated soils could be as a result of different management practices as reported by Getaneh *et al.* (2007).

Omar and Nzamouhe, (2017b) observed that the general soil condition in farms found within Warwade Irrigation Scheme were slightly alkaline which might be in connection to the management practices such as poor drainage, excess application of irrigation water and inorganic fertilizers on the soil. Furthermore, it was reported that the pH (H_2O) ranged from 6.88 to 7.31 for irrigated soils while it ranged from 6.47 to 7.06 for the non-irrigated soils. It was also reported that the relationship between pH of the soil and that of the irrigation water was insignificantly correlated negatively with an *r*-value of -0.89^{NS}. Omar (2011) also found the pH of wetland soils in south western Bauchi state to range from 5.77 to 6.36. However, it is safe to say that the moderate acidity of most wetlands in Northern Nigeria is related to their silica rich parent material as reported by Ojanuga, (2006).

Electrical Conductivity

Electrical conductivity (EC) measures salinity of the soil and water samples (Olajire and Imeokparia, 2001). In an experiment conducted by Hailu *et al.* (2016) the electrical conductivity of the soil obtained in irrigation treatments T7 (1.60 dSm^{-1}), T6 (1.30 dSm^{-1}) and T5 (1.34 dSm^{-1}) were significantly higher than the control treatments i.e., non-irrigated. The trend in all treatments throughout the soil showed slight increase in EC at 30 cm depth after harvest. However, Chauhan *et al.* (2007) concluded that the EC increased with the increasing salinity of irrigation water, especially in the surface soil. Omar and Nzamouhe, (2017b) reported that the EC of the irrigated soils ranged from 0.05 (Tsohon Gari) to 0.15 dSm^{-1}(Zuwan Hawa) while that of non-irrigated soils ranged from 0.04 (Tsohon Gari) to 0.11 dSm^{-1} (Sabon Gari) in Warwade town. Furthermore, it was also reported that there was no significant difference ($p>0.05$) between the irrigated and non-irrigated soils which however concluded that the wetland soils in Wardwade Irrigation Scheme are non-saline and non-sodic and therefore considered safe for farming activities.

Tekwa *et al.* (2013) reported that the EC mean values of Numan area of Adamawa state were 0.75 dSm^{-1} the first 30 cm while 0.93 dSm^{-1} were found at about 100 cm depths. However, it was noted that the rise in EC values led to rise of exchangeable Na content with mean values of 1.29 and 2.09 cmol $_{(+)}$ kg^{-1} in the surface soil and subsoil respectively with about 5.03 cmol $_{(+)}$ kg^{-1} in the lower depths. The mean values of exchangeable Na and EC were invariably higher in the cultivated soils than the uncultivated soils which might be as a result of extensive irrigation activities carried out on the uncultivated soils as supported by Tekwa *et al.* (2008). However, due to the accumulation of Na in the subsoil, the soils are therefore, potentially saline sodic and would require special attention if irrigation activities would be carried out over time.

Soil Organic Carbon

Getaneh *et al.* (2007) reported that the organic carbon contents in all irrigated farmlands were lower than the non-irrigated farmlands. The organic carbon contents ranged from 4.19 to 6.37% in small scale irrigated farmlands where the lowest and the highest organic carbon were observed in Nagesso, and Kastemach, respectively. On the other hands, the organic carbon contents of the non-irrigated farmlands ranged 4.83 to 7.01% that were recorded from Gibe-Lamu, and Kastemach, respectively.

This is not in conformity with the findings of Mon *et al.* (2007) that there was no significant increase in the soil organic carbon of both irrigated and non-irrigated farms because they were both having 3.27 and 3.24% respectively. However, organic carbon levels in the Kano River Irrigation Project (KRIP) were generally very low throughout the study area, ranging from 3.1 to 7.1 g kg^{-1} in the top soil and 1.5 to 2.2 g kg^{-1} in the subsoil as reported by Jibrin *et al.* (2008). They further reported that the low levels of organic carbon is not surprising because of the continuous intensive cropping without much additions of organic matter **i**n form of manures and crop residues when compared to the non-irrigated farms which are left to fallow for the next growing season.

According to Omar and Nzamouhe (2017b), the soils found throughout the irrigated and non-irrigated soils of Warwade Irrigation Scheme were reportedly very low of OC (<10 g kg^{-1}). However, when compared to the irrigated soils (4.67 to 6.46 g kg^{-1}), the non-irrigated soils (4.85 to 9.52 g kg^{-1}) were much higher. Furthermore, it was reported that the higher value of OC in the non-irrigated soils was as a result constant decaying of plant and animals remains in the soils without cropping.

Total Nitrogen

Getaneh *et al.* (2007) found that the low levels of nitrogen in the soil could be partly associated with the low soil organic carbon levels. It was pointed out that the lower values of organic carbon and total nitrogen in small scale irrigated farmlands are attributed to the continuous cultivation throughout the year. Concluding that the frequency of cultivation was high in irrigated farmlands as they are being used for rain-fed crop production.

Tekwa *et al.* (2013) found that the total nitrogen gave a mean value of 0.17 g kg^{-1} in the irrigated farm while the non-irrigated farm had a mean of 0.14 g kg^{-1}. Nonetheless, similar findings were reported by Kaigama and Omeje, (1994) that the total nitrogen content of irrigated soils are generally very low varying from less than 0.06 to 0.20 g kg^{-1} within the subsoil when compared to irrigated soils. However, this is in contrast with the findings of Omar and Nzamouhe (2017b) who reported that the soil TN was high (> 0.2 g kg^{-1}) in both irrigated (0.70 to 1.75 g kg^{-1}) and non-irrigated soils (0.35 to 1.75 g kg^{-1}). Furthermore, it was reported that the high rate of TN maybe as a result of higher OC content of the soils. According to Utsev *et al.* (2014), the N contents of the soils in Katsina-Ala catchment areas were found to range between 0.15–1.0 mg kg^{-1} and 0.11–0.58 mg kg^{-1} in dry and wet season respectively, with higher concentration in dry season. Nonetheless, the higher concentration of N in dry season might be as a result of OM decomposition, excessive leaching down of nutrients, crop removal and erosion during the rainy season.

Available Phosphorous

The term available-P, also referred to as labile P is often used to express the amount of soil P in solution which can be absorbed or assimilated and utilized by plants for growth and development during its life cycle. Phosphorous plays an important role in controlling osmotic pressure within the soil while excess phosphorus has been known to increase the need for iron, calcium, and magnesium, reduce zinc and copper (Provin and Pitt, 1914). According to Omar and Nzamouhe (2017b), the available-P was found to range from low (<10 mg kg^{-1}) to medium (10–20 mg kg^{-1}) in the farms within Warwade Irrigation Scheme. Furthermore, it was observed that the irrigated soils had a higher mean P value when compared to the non-irrigated soils. Notably, the available phosphorous in irrigated farmlands were due to the application of fertilizer P in each cropping cycle i.e. in rain fed and irrigated crops on the same land, and this is in conformity with the findings of Getaneh *et al.* (2007). Furthermore, this was also similar to the P result of Numan area of Adamawa State where the irrigated farms had higher content of available phosphorous with mean value of 0.30 mg kg^{-1} compared to 0.28 mg kg^{-1} of the non-irrigated farms (Tekwa *et al.* 2013).

Utsev *et al.* (2014) reported that the available P content of the soils in Katsina-Ala catchment areas during the dry season (0.29 – 4.0 mg kg^{-1}) was higher than those of the wet season (0.19 – 3.62 mg kg^{-1}). However, it was observed that medium concentration of phosphorus in the soils is as a result of the moderate accumulation of organic materials and weathering intensity.

Exchangeable Sodium

Sodium is a dominant monovalent cation in soil solution and the irrigation water (Eldardiry *et al.* 2013). Positively charged, it is attracted by negatively charged soil particles, replacing the dominant calcium and magnesium cations. Excessive Na^+ has been known to disperse clay and also responsible for soil deterioration under the investigation conditions. Getaneh *et al.* (2007) reported that soil exchangeable sodium increased in irrigated soil when compared to the non-irrigated soil. Furthermore, Gabar, Kastemach, Basaka, Nageso and Lugama all had higher exchangeable sodium in their irrigated farms with 0.20, 0.09, 0.17, 0.02 and 0.02 cmol (+) kg^{-1} than their respective non-irrigated farms with 0.10, 0.04, 0.15, 0.01 and 0.02 cmol (+) kg^{-1} respectively which was attributed to different soil fertility management and irrigation practices as the use of irrigation water is a major source of salinity and sodicity and as such Na accumulation.

Nonetheless, Tekwa *et al.* (2013) observed that the increase in EC values were proportional to that of exchangeable Na^+ content which gave a mean of 1.29 cmol (+) kg^{-1} in the irrigated farms when compared to that of the non-irrigated farms which had a mean of 0.86 cmol (+) kg^{-1}. However, Tekwa *et al.* (2008) reported that this might be in connection with the irrigation practices on the irrigated soils. Also, with increase in the amount of exchangeable Na^+ in the sub-soils, the soils are therefore potentially saline sodic and would require special care if put under irrigation over a long period of time. According to Omar and Nzamouhe, (2017a) the soil exchangeable Na^+ was found to be low (0.1 – 0.3 cmol (+) kg^{-1}) to medium (> 0.3 cmol (+) kg^{-1}) in the irrigated and non-irrigated soils with the mean values of 0.09 cmol (+) kg^{-1} and 0.07 cmol (+) kg^{-1} respectively. It is concluded that the exchangeable Na was found to be higher in the irrigated than the non-irrigated soils throughout the farms within Warwade Irrigated Scheme of north-west Nigeria. Nonetheless, it is important to note that if proper soil management practices are not taking, the soil may develop a weak structure which can impair crop production in all the location studied. This is because the present moderate status of the exchangeable Na in the soils can easily become high with improper soil management (Omar and Nzamouhe 2017a and Nzamouhe and Omar, 2020). Therefore, soil management practices such as incorporation of organic material e.g crop residues and or farmyard manure should be practiced to address this likely problem (Nzamouhe and Omar, 2020).

Exchangeable Potassium

Rengasamy and Sumner, (1998) reported that potassium, being a monovalent cation, can cause clay swelling and dispersion. But, potassium appears not equivalent to sodium in causing structural problems in soils. However, in a research conducted by Getaneh *et al.* (2007), it is observed that the exchangeable potassium increased in irrigated soil when compared to the non-irrigated soil. Gabar, Kastemach, Gibe and Lugama all had higher exchangeable potassium higher in their irrigated farms with mean values of 4.70, 6.11, 1.84 and 5.46 cmol (+) kg^{-1} when compared to their non-irrigated farms with mean values of 3.97, 5.74, 1.67 and 4.73 cmol (+) kg^{-1} while in Basaka and Nageso, the exchangeable potassium was higher in the non-irrigated farms; noting that the variation in concentration of exchangeable K was as a result of different soil fertility management practices.

Chemura *et al.* (2014) found that the farms within Mutema irrigation scheme had lower exchangeable potassium which was between 0.3 to 1.2 mg kg^{-1} in all four irrigated farms while the non-irrigated farm had 1.9 mg kg^{-1} within the year 2006. However, in 2012 farm 1, 2 and 4 had 0.75, 0.78 and 0.85 mg kg^{-1} while farm 3 and the non-irrigated farm had 1.4 and 1.28 mg kg^{-1} respectively, indicating that the non-irrigated farms had higher potassium content. However, this result disagrees with Tekwa *et al.* (2013) who found that the irrigated soils of Numan wetland area had higher potassium content of 2.04 and 1.99 cmol (+) kg^{-1} respectively; though the differences could be due to different parent materials or history of the areas.

According to Omar and Nzamouhe, (2017a) the soil exchangeable K^+ was found to be medium to high throughout Sabon Gari, Tsohon Gari, Turgupha, Nada and Zuwan-Hawa. Similar report was made by Carroll and Klinkenberg (1972) and Nzamouhe and Omar (2020) who stated that wetland soils in North-East Nigeria have moderate content of soil K^+. Omar (2011) also reported high K content in similar soils. This may not be unconnected with the presence of muscovite which is common in fadama areas (Omar and Nzamouhe 2017a and Nzamouhe and Omar, 2020). Singer and Munns (1996) reported that muscovite is an important source of K in wet soils. They also reported that muscovite glitters in wet soils.

Exchangeable Calcium

The effects of soluble salts, especially sodium and calcium salts on soil physical properties have been intensively investigated. McNeal and Coleman, (1966) earlier noted that the presence of divalent cations such as calcium and magnesium, in the exchange sites, tend to stabilize (or flocculate) soil particles while the presence of sodium decreased particle stability. Getaneh *et al.* (2007) reported that soil exchangeable calcium increased in irrigated soil when compared to the non-irrigated soil. Gabar, Kastemach, Basaka, Nageso, Gibe lamu and Lugama all had higher exchangeable calcium in their irrigated farms (i.e., 9.50, 19.29, 11.88, 14.96, 10.77 and 19.28 cmol (+) kg^{-1}) than their respective non-irrigated farms (i.e., 8.10, 18.18, 10.55, 9.69, 10.09 and 17.89 cmol (+) kg^{-1}).

Furthermore, Oliveira *et al.* (2016) reported that soil calcium content showed a similar trend of decrease down the soil profile within the 0.00-0.20 m layer in all the irrigated plots. These results disagrees with the observations made by Firme (2007), who noted an increase in soil calcium that was proportional to the increase in the depth of applied irrigation within the first few months of sugarcane irrigation. However, it was observed that the addition of calcium via irrigation water or fertilizer did not lead to an increase in the calcium content of the surface layer of the soil probably because the calcium was leached into the deeper layers of the soil (0.20-0.40 m) where it was possible to identify an accumulation (Oliveira *et al.* 2016). Nonetheless, it was found that the calcium content within the irrigated and non-irrigated farms of Numan area of northeast Nigeria were at a mean of 24.37 cmol (+) kg^{-1} and 21.91cmol (+) kg^{-1}respectively. This also indicated that the irrigation water has a direct influence on the calcium content in the soil (Tekwa *et al.* 2013). The concentration of soil Ca^{+2} was found to range from low to medium and was higher in the irrigated than the non-irrigated soils with mean values of 3.06 and 2.39 cmol (+) kg^{-1} respectively. However, it was noted that the low concentration of soil Ca in the irrigated soils was as a result of low Ca^{+2} concentrations in the irrigation water (Omar and Nzamouhe, 2017a; Nzamouhe and Omar, 2020).

Exchangeable magnesium

Higher levels of magnesium have the tendency to increase the exchangeable sodium in clays and soil materials. The Mg^{+2} accumulations on the exchange complex of soils to a very high saturation levels affect their physical, chemical and biological properties (Ocampo, 2003). Elevated levels of magnesium (Mg^{+2}) in soils result in severe structural degradation that leads to lower infiltration rates and hydraulic conductivities. These effects are similar to those observed in sodium (Na^{+}) dominated soils (i.e. sodic soils) that are characterized by structural instability resulting in poor crop growth (Vyshpolsky *et al.* 2004).

Getaneh *et al.* (2007) reported that soil exchangeable magnesium increased in irrigated soil when compared to the non-irrigated soil. Gabar, Kastemach, Basaka, Nageso, Gibe lamu and Lugama all had higher exchangeable magnesium in their irrigated farms (i.e., 3.97, 4.00, 4.69, 4.99, 3.51 and 5.62 cmol (+) kg^{-1}) than their respective non-irrigated farms (i.e., 2.76, 3.13, 3.93, 3.03, 3.41 and 4.89 cmol (+) kg^{-1}) respectively. Furthermore, Tekwa *et al.* (2013) also reported that irrigated farms of Numan wetland area had higher magnesium content when compared to the non-irrigated farms with a mean value of 10.43 and 9.18 cmol (+) kg^{-1} respectively. Omar and Nzamouhe (2017a) reported higher Mg content in soils of Warwade Irrigation Scheme presumably due to litter accumulation over time.

Cation Exchange Capacity

Cation exchange capacity (CEC) is a measure of the soil's ability to hold positively charged ions, at a given pH value, available for exchange with the soil (FAO, 1985). It is a very important soil property influencing soil structure stability, nutrient availability, soil pH and the soil's reaction to fertilizers and other amendments. According to Tekwa *et al.* (2013) the irrigated farms of Numan wetland area had higher CEC content when compared to the non-irrigated farms with a mean value of 41.36 and 35.77 cmol (+) kg^{-1} respectively indicating that the irrigation water had effects on the soil's CEC. However, this finding was unconnected with that of Omar and Nzamouhe (2017a) who observed the CEC to be low to medium throughout Warwade town. In the irrigated soils, the soil CEC ranged from 3.95 to 7.75 cmol (+) kg^{-1} while the non-irrigated soils ranged from 4.53 to 6.80 cmol (+) kg^{-1}. Furthermore, Gachene and Kimaru (2003) observed that soils with CEC below 16 cmol (+) kg^{-1} are considered non-fertile while fertile soils have a CEC above 24 cmol (+) kg^{-1}. According to Afolabi *et al.* (2014), the cation exchange capacity of some soils of Minna southern Guinea savanna ranged from 5.34–8.01cmol (+) kg^{-1} (low to medium) which might be as a result of low clay and OC percentage of the soils.

Exchangeable Sodium Percentage (ESP) and Sodium Adsorption Ratio (SAR)

There are a number of parameters that have traditionally characterized sodic soils. The exchangeable sodium percentage (ESP) and the sodium adsorption ratio (SAR) are used to define the sodicity of the soil and soil solution (or applied water), respectively (Halliwell *et al.,* 2001). Sumner (1993) has shown that even soils with ESP values <1% can exhibit sodic behavior depending on the soil properties and the EC of the applied water. The ESP of the soil has been related to the SAR of the soil solution (or applied water); however, the relationship can vary according to the soil/solution ratio of the extracts examined (Rengasamy *et al*. 1984).

Omar and Sule, (2016) reported that there were no variation in the soils along River Tatsewarki wetlands as distance along the river had no effect on the distribution and no particular pattern of distribution was observed. Adding that the ESP was low, ranging from 7.91 to 14.11%. More so, the United State Salinity Laboratory Staff (1954) reported that soils with ESP lower than 15% are rated as non-sodic, implying that the soils along River Tatsewarki are non-sodic. This disagrees with the findings of Omar and Nzamouhe (2017b) that the ESP was observed to be higher in the irrigated soils (mean value of 1.70%) than the non-irrigated soils (mean value of 1.26 %) of Warwade Irrigation Scheme. Adding that the high Na content earlier observed in the irrigated soil (0.09 cmol (+) kg^{-1}) was the yardstick for high ESP in the irrigated soils than the non-irrigated soils. Landon (1991) reported that soils with ESP, EC and pH values of <15%, 4.0 dS/m and 8.5 respectively are non-sodic in nature. Based on this, both the irrigated and the non-irrigated soils were non-sodic. Omar (2011) reported ESP values of wetland soils in Bauchi state to range from 0.66–0.92%. The values of ESP obtained in Warwade were slightly higher than these values. Mustapha (2007) reported that of some wetlands in Bauchi local government area showed mean pH, EC and ESP as 5.55, 0.15 dSm^{-1} and 6.58% respectively, indicating that the values obtained from the wetland soils are less than the critical values as described by Landon (1991), adding that the soils wetlands could be free from salinity and sodicity problems for now but if not properly monitored, could lead the feared problems.

CONCLUSION

From the results obtained in this review, it can be concluded that the wetland soils in Nigeria are dominantly sandy loam; however, a few could be clay, clay loam and loamy sand in nature. Low EC, Total N, OM and available P were unevenly distributed across different wetlands. However, exchangeable Na was relatively high across all the wetland soils, Ca and Mg were reportedly low to medium and the CEC was very low. Most of the wetland soils were neither saline nor sodic but however proper care needs to be given to the soils if irrigation activities are to be continued over an extended period of time. More so crop residues should also be incorporated into the soils during tillage operations to conserve and improve on the organic matter status of the soils as well as using adequate quality irrigation water.

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