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ASSESSMENT OF SURFACE WATER QUALITY IN RIVERS AND PONDS FOR SUSTAINABLE IRRIGATION PRACTICE IN NIGERIA

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ABSTRACT

Nigeria is blessed with abundant surface water in rivers, streams, rivulets and ponds. However one of the greatest problems faced in the country is assessment of water quality from the numerous receiving surfaces for irrigation. This has resulted in the use of water likely to be injurious to the soils and plants, causing serious implications on the productive capacity of soils and the developmental processes of many crops. It is in this respect that this study undertook a review on assessment of water quality for irrigation and its application to Nigeria. The study used content analysis and reviewed relevant works on water quality for irrigation. The study examined major issues that affect the safety in the use of water for irrigation. These included issues associated to application of water high in salinity that may result in the built-up of salts in the soils, which cause difficulty in plants uptake of water a condition that causes plants to become stunted even when water is sufficient. High sodium ion in the irrigation water may raise exchangeable sodium percent in the soil and may impede the free flow of water and aeration in the soil thus interfering with normal developmental processes of many plants. Low or high pH in water affects the solubility of the soils and plants performance during irrigation. Other specific ion toxicity also have significant effect on water quality at levels that cause ailment to human health, for example the presence of trace elements in irrigation water can bio-amplify in due course within the food chain thus affecting the consumers of crops from such water. To use water wisely the study recommends that there is the need for intensive assessment of water quality for most surface sources and that research institutes be set in each state to monitor the quality of water to ensure standards recommended for a variety of uses are met.

Keywords: Salinity, Sodicity, Toxicity, Assessment and Irrigation.

INTRODUCTION

In Nigeria, the assessment of water quality for irrigation has not been given serious attention by most governments, as a result most dry season farmers use water for irrigation without taking into consideration the implication of the water on the soils, crops and health of the farmers. Despite the setting up of River Basin Development Authorities in most parts of the country, assessment carried out of water quality of the river basins are not observed by farmers as most are illiterates and may not be able to interpret and apply in practical terms the recommended standards considered safe for water use for irrigation. As observed by Samaila (2011) due to ignorance of farmers on the quality of water used for irrigation it may pose danger to the soil and crops produced from such water. Irrigation involves the raise in the level of moisture content in the soil for optimum crop production by means of artificial application of water to the soil. Majumdar (2004), viewed irrigation as the artificial application of water with good economic return and with no damage to land and soil, to supplement the natural resources of water to meet the water requirement of crops. In areas characterized by water deficit, at a particular period of the year irrigation augments rain-fed agriculture and raise food production thus providing food security for the rapid growing population. Cunningham *et.al*, (2007) also posit that in environments faced with inconsistency in climate it is only through irrigation that water requirement of crops can be assured. According to Enger and Smith (2006) there are four major uses of water worldwide namely; domestic, agricultural, and industrial and in-stream uses. Among the major uses of water agriculture is the major consumptive use of water in most parts of the world and accounts for over 80% of all the water consumed in North America (Cunningham, *et.al.* 2007). In addition to this, Fellman and Getis (1999) observed that despite the enormous water available on the earth surface only a small proportion is exploitable and suitable for use by humans, plants and animals. In-term of use irrigated agriculture accounts for nearly 73% of fresh water use for the world as a whole and about 90% in the poorest countries, irrigation therefore produces more than a third of the worlds harvest from about 16% of its cropland. FAO (1997) also observed that the area under irrigation is only 241.5 million hectres accounting for only 15.98% of the total arable land and land under permanent crops in the world. Humans use the water resources in numerous ways and in this process introduce into the natural drainage system wastes that because of their volume, composition or both cannot readily be disposed through the natural recycling process. Under natural processes organisms in water are able to degrade, assimilate and disperse substances in the amount in which they naturally occur and it is only in rare instances that pollutants overwhelm the cleansing abilities of the recipient waters. Human activities have however introduced substantial amount of substances into water recipient sources at higher intensities exceeding the ability of a given body of water to purify. The purifying processes is also affected by the nature of pollutants, for example, metals or in organic substances, take longer time to breakdown or cannot break down at all by natural mechanisms. Such substances where present in water degrade water quality and may result in the built up of harmful ionic substances and bio-amplification in due course (James, 1993).

Water Quality

This describes the chemical, physical and biological characteristics of water which, Christopherson (2006) observed as being the most important characteristics that determine water quality. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose (Wright 2007). Water quality is also considered based on its suitability for a general or a particular purpose. It is most frequently used by reference to a set of standards against which compliance can be observed. Water quality depends on the nature of the water, climatic condition and most importantly the intended use of the water. Different water uses have different water quality requirement as such water that may be considered usable for a particular purpose may not apply for others. It is because of this that Hansen and Stringham (1979) observed that particular water should not be pronounced as fit or unfit for irrigation without carefully considering all the factors concern. To support this Samaila, *et.al*, (2011) opined that water quality is relative and that water considered not suitable for a specified use may not be for others as different uses have different quality requirements. According to Ibrahim (2002) the irrigation use of water has the advantage of potential treatment mechanisms in soils to include biological oxidation, ion exchange, chemical precipitation, adsorption and assimilation into growing plants. Despite this however, the amount and kinds of impurities present in particular water should be determined for necessary guide for the use of the water for irrigation. It should be noted that the suitability of particular water for irrigation will depend on the adequacy of the drainage, the method of irrigation, salt tolerance of the crop and the management of irrigation and drainage. In their contribution Cunningham et.al., (2007) observed that under natural condition quantities of pollutants in water are so small that they can be ignored as the natural healing condition of the surface water restores it to a usable state devoid of pollution. However, before any water is used for irrigation its suitability must be ascertained and compared with existing water quality and or standards. Water when it is used directly for irrigation can increase the quantities of solutes there by raising the concentration of certain ions and eventually lowering the quality of the water for irrigation (Ayers and Westcots, 1994).

Water Pollution

Pure water hardly exists in the environment, as all water contain dissolved ionic constituents from gaseous particulates from the atmosphere and other ionic concentrates from the earth surface. Water therefore comprises of several substances some of which are necessary for human, animals and plants developmental processes. As observed by Hansen et.al (1980) small amounts of substances seen as pollutants in water are not only harmless but stimulate good health and growth. The concentration of these substances in water at high intensity however may have adverse and negative effects on humans and environmental systems. Water pollution results from two main sources; point and non-point. Point sources are discrete and identifiable as such they are relatively easy to monitor and regulate example from pipes, ditches, and drains, industrial discharge outlets and sewer outfalls. Non-point sources are scattered and diffused having no specific location where they discharged into a particular body of water they are episodic as they are not predictable, examples are farm fields, lawns, gardens and construction sites, (Ayoade, 2003 and Wright, 2007). The vulnerability of water to degradation depends on a combination of the natural landscape features such as, geology, topography, soils, climate and atmospheric contributions (Cunningham *et.al.* 2007). The concentration of substances in water at high intensity is objectionable for use for a variety of purposes. Though irrigation may offer a viable option for management of otherwise poor quality water, studies have shown that excessive concentration of ionic elements in water may lead to the build-up of salts in the soil colloids which in turn is detrimental to crops developmental processes. The quality of irrigation water therefore should fall within the recommended allowable limit considered safe for irrigation.

Properties of Water Quality for Irrigation

Water quality used for irrigation **is** essential for the yield and quality of crops, maintenance of soil productivity and protection of the environment. As observed by Abdulkadir, (1993) water quality should satisfy the requirement of standard set for a specific or general use. Where this condition is not met it is accompanied by serious after effects on the environment, endangers the users and crops produced from such water. Water quality therefore should be evaluated in term of the properties that affect the acceptability of the water for irrigation. As viewed by Samaila *et.al*, (2011) water quality is made up of many variables too numerous to evaluate, the choice of the variables will depend on nature of the water, geology, climatic condition, management practices and the intended use of the water. According to Dusa, (2010), important properties affecting irrigation water is the presence of total dissolved salts and amount of sodium in water compared to ions of calcium plus magnesium. While Ibrahim, (2002) is of the view that carbonate and bicarbonate concentrations are as well important variables to consider in irrigation water. Ayoade, (2003) emphasized the need to evaluate irrigation water quality in-terms of the chemical, physical and biological properties. The first two may pose direct effect on the soil and the crops produced while the later is likely to be detrimental on the health of the users of the water. In addition to this is the presence of heavy metals, though minute in concentration are potentially harmful substances in irrigation water Ademorati, (1996). The concentration of substances in water should be a guide if water is to be used for irrigation successfully. The chemical, physical and biological properties in water most not fall above the threshold value limit considered for irrigation water. Where there is high concentration of properties in irrigation water it will have negative effect on the growth and yield of crops and may result in the built up in the soils of harmful ionic elements thus affecting the productivity of the soils and yield of crops.

Assessment of Water Quality for Irrigation

Water contains numerous dissolved ionic elements that affect its quality for irrigation. Water may appear suitable for irrigation to farmers however, the concentration of substances if not closely monitored may affect the productivity of most soils and the yields of crops. Ayoade, (2003) is of the opinion that assessment conveys the process of finding out or deciding the amount or value of a resource for a particular purpose. Assessment of water is therefore an important aspect of water resources evaluation. In their view Fellman and Getis, (1999) see the assessment of water quality to involve evaluation of existing water quality data or the generation of water quality data by collecting samples and analyzing them according to the quality needs of the water. The utility of water is limited by its quality which may make it unsuitable for particular uses. Assessment of quality of irrigation water therefore involves evaluating those parameters in water that are likely to pose problem in the use of water for irrigation. Most assessments of water quality for irrigation take into consideration the chemical properties of water for irrigation (Musa *et.al.* (1993) and Samaila and Gimba (2006).
The physical and biological properties of water are as well important variables that affect water quality for irrigation (James 1993). The choice of the variables for assessment of

irrigation water hence will depend on the adequacy of the drainage, the method of irrigation, salt tolerance of the crop and the management of irrigation and drainage. However, the chemical properties of water are seen as the major determinant of suitability of water for irrigation use (USDA, 1954 and Ayers and Westcots, 1985). According to Majumdar (2004) and Bauder *et.al.* (2012) the evaluation of irrigation water effects on crop production and soil quality take into consideration salinity hazard by determining the total soluble salts content, sodium hazard; the relative proportion of sodium to divalent cations of calcium and magnesium ions, acidity and basicity (pH), alkalinity as a result of carbonates and bicarbonates and specific ions toxicity of chloride, sulfate, boron and nitrate.
Therefore the most important characteristics of irrigation water are,
Total concentration of soluble salts
Proportion of sodium to other cations
Concentration of potentially toxic elements and
Carbonate and bicarbonate concentrations as related to the concentrations of calcium plus magnesium ions. The assessment of water quality will therefore involve the determination of Salinity as affected by total dissolved salts, sodicity caused by high sodium concentration over divalent cations of calcium and magnesium, bicarbonate concentration which affects the soil when in excess to ions of calcium and magnesium and toxicity from heavy metals most of which are in traces in irrigation water but are potentially harmful to soils and plants growth.

Salinity
The most influential problem to irrigation water quality is salinity, which is the sum of all the ionized dissolved salts in the water without reference to specific ions present (James, 1993). High level concentration of dissolved salts in the irrigation water reduces water availability to the crops due to osmotic pressure and cause yield reduction. Above a certain threshold, reduction yield is proportional to the increase in salinity level, different crops vary in their tolerance to salinity and therefore have different thresholds and yield reduction rates. According to Samaila *et.al,* (2011) at higher salinity the crops yield reduces linearly as salinity increases. High concentration of soluble salts in soils leads to unfavorable soil-water-plant relations (Folorunso et.al. 2005) and as observed by Assactian and Miyamoto, (1987) salt affected soils are usually associated with poor stands of crops arising from poor seed germination. Tivy (1990) also observed that high amounts of soluble salts reduce the ability of plants to absorb water through their root hair membranes at very high concentration water actually starts to move out of plant roots into the soil leading to the death of plants, it also results to plasmolysis, stunting and defoliation. Some arid climate soils as observed by Abubakar et.al. (2006) were free from excessive salts before cultivation but have been rendered non-productive by use of irrigation water containing excessive quantities of salts. Wright, (2007) estimated 1.5 million hectares of agricultural land lost yearly to salinization and waterlogging worldwide. Salinity is measured by the total dissolved solids (TDS)

expressed in milligram of salt per liter of water (mg/l) or grams of salt per cubic meter of water ($g/.m^{3/}$) or parts per million (ppm). Another measure of salinity of irrigation water is electrical conductivity (ECw), which measures the ability of water to conduct current. Electrical conductivity is also used to estimate the amount of total dissolved solids rather than each dissolved constituent in water and determines the leaching requirements and sometimes the crops to be grown (Bauder *et.al* 2012). It is usually expressed in millimhos per centimeter (mmhos/cm) or deci siemens per meter (dS/m) or micro siemens per centimeter (mS/cm). The major concern in the use of water with excess salts for irrigation is that a high salt concentration will negatively impact on the yields of crops, degrade the soil and pollute groundwater resources. The suitability of water for irrigation with high salt content will depend largely on;

Salt tolerance of the crop.

Characteristics of the soil under irrigation.

Climatic condition, example, in arid regions high evaporation rates results in high accumulation of salts in the soil.

Soil and water management practices.

The use of water with high salinity will require soils which must be permeable, drainage must be adequate, water must be applied in excess to provide considerable leaching and crops that can withstand high salinity should be selected.

Sodium Hazard

The assessment of the relative concentration of sodium ion to that of calcium plus magnesium is also imperative as it takes into consideration the limit to which the soil can absorb sodium from the irrigation water. When irrigation water does not have the proper proportions of sodium, calcium and magnesium, significant problems with water infiltration and breakdown of soil structure can develop (Tanko, 1994). This is because sodium when present in the soil in exchangeable form replaces calcium and magnesium adsorbed in the soil colloids and causes dispersion of soil particles. The dispersion results in breakdown of soil aggregates the soil becomes hard and compact when dry and reduces infiltration of water and air into the soil thus affecting its structure. Other problems to the crops caused by an excess of sodium is the formation of crusting seed beds, temporary saturation of the surface soil, high pH and the increased potential for diseases, weeds, soil erosion, lack of oxygen and inadequate nutrients availability. As observed by Ibrahim (2002) Excess concentration of soluble sodium over ions of calcium and magnesium results in potential sodicity and permeability problems, a condition of pH likely to be over 8.5. The presence of excess sodium in irrigation water causes poor physical condition in soil colloids, resulting in dispersion and in-anaerobic situations. This impedes internal drainage leading to reduced soil permeability and consequently renders the soil impervious to water (Abdulkadir, 1993). The effect of sodium in irrigation water depends on the amounts of other cations present in the water expressed as a percentage of sodium (Na %). Ayers and Westcots (1994) provided a formula for calculation of Sodium percent as presented in formula 1.

$$Sodium Percent\,(Na\%) = \frac{Na}{Ca + Mg + K + Na} \times 100 \;(Ayers\; and\; West\,cots\; (1994) \quad (1)$$

The units of cations are in milliequivalents per liter (meq/l). Sodium percent is used to evaluate the level of sodium in water. The lower the percentage of sodium the better is the water for irrigation and this may enhance permeability. An increase in sodium percent will result in decline in soil permeability thus reducing the value of the soil for irrigation. Water below 60% sodium is usually considered satisfactory for irrigation (Samaila, 2006).

Exchangeable Sodium Percent (ESP) is also used in evaluating the status of soil and irrigation water and to estimate the sodium hazard. James, (1993) proposed a formula for the estimatation of eschangeable sodium percent as shown in formula 2

$$ESP = \frac{Exchangeable\; Na(meq/100\; of\; soil)}{cation - exchange - capacity(meg/100\,g\; of\; soil)} \times 100 \;(James, 1993) \quad (2)$$

Over the years a popular measure to predict the potential problems of sodium for soil productivity and crop yields is the Sodium Adsorption Ratio (SAR). This expresses the relative activity of sodium ions in the exchange reaction with the soil. The ratio measures the relative amount of sodium to the cations of calcium and magnesium. Ayers and Westcots, (1994) produced a formula for the determination of Sodium Adsorption Ratio in irrigation water and is expressed in formula 3.

$$SAR = \frac{Na}{\frac{\sqrt{Ca + Mg}}{2}} \qquad (Ayers\; and\; West\,cots, 1994) \quad (3)$$

Where Na^{+}, Ca^{++} and Mg^{++} represent the concentration in milliequivalents per liter of the respective ions. The lower the Sodium Adsorption Ratio the higher the quality of the water for irrigation. As observed by Ayers and Westcots (1994) there is no restriction on the use of water at Sodium Adsorption Ratio 3, slight to moderate sodicity problem is between 3 - 9 and acute at 9. High SAR implies that there is the need for proper management if sodicity is to be overcome. This can be achieved by liming the soils with calcium sulfate (gypsum) and the selection of tolerant crops. An adjusted Sodium Adsorption Ratio value can be calculated for water high in carbonate and bicarbonate content. For example, when the irrigation water contains free lime (calcareous soil), high carbonate and bicarbonate in water will cause the precipitation of calcium and magnesium ions and increase the relative concentration of sodium thus raising SAR. As observed by Ayers and Westcots (1994) most SAR_{adj} values of irrigation waters are about 10-15% greater than the unadjusted SAR. This measure provides a truer index of sodicity of the water and the risk of dispersion caused by excessive presence of sodium. The amount of sodium may be also indicated by the Residual Sodium Carbonate (RSC) which estimates the relative concentration of carbonate and bicarbonate to calcium and magnesium ions. When total carbonate level exceeds the total amount of calcium and

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magnesium this interferes negatively with the water quality and when the excess carbonate (residual) concentration becomes too high, the carbonates combine with calcium and magnesium to form a solid material which settles out of the water. The end result is an increase in both the sodium percentage and Sodium Adsorption Ratio. Residual Sodium Carbonate is calculated as shown in formula 4.

$$RSC = (CO_{3} + HCO_{3}) - (Ca^{++} + Ma^{++}). \qquad (4)$$

The higher the RSC the greater will be the amount of sodium in the irrigation water and hence will raise the SAR

Carbonate and bicarbonate sometimes referred to alkalinity cause calcium and magnesium ions to form insoluble minerals leaving sodium as the dominant ion in the solution. The alkaline water could intensify the impact of high SAR water on sodic soils.

The acidity or basicity of irrigation water is expressed as pH (<7.0 acidic; >7.0 basic and 7.0 neutral). The pH of most rivers unaffected by human activities ranges between 6.5 and 8.0. According to Bauder, et.al (2012) the pH range of survivability of most freshwater organisms ranges about 4.5 to 9.0. The normal range for irrigation water is from 6.5 to 8.4 (Ayers and Westcots 1994). Low pH affects physiological (biological) functioning of aquatic life through the reduction of enzyme activity and effectiveness. Low pH in irrigation water results in most elements becoming highly soluble and can easily precipitate or leached from the root crop zone thus affecting the productivity and yields of crops. High pH above 8.5 is often caused by high bicarbonate (HCO_3) and carbonate (CO_3) concentrations which causes alkalinity. High carbonates cause calcium and magnesium ions to form insoluble minerals leaving sodium as the dominant ion in solution, this could intensify the impact of high SAR water on sodic soil condition. Food and Agricultural Organisation, (FAO, 1985) classified irrigation water into three groups based on salinity, sodicity, toxicity and miscellaneous hazards as shown on

Specific ion Toxicity

Certain ions are potentially harmful substances in irrigation water as they accumulate in a sensitive crop to concentrations high enough to cause damage and reduce yields. The degree of damage depends on the uptake and the crop sensitivity. The concentration of these substances though may appear minute in water constitute some of the most hazardous substances that can bio-accumulate (Zwieg et. al 1999) and given that trace metals are not biodegradable and have a density of at least five times that of water. Damage often occurs at relatively low ion concentration for sensitive crops. It is usually evidenced by marginal leaf burn and inter-veinal chlorosis. One serious threat of their persistence in aquatic environment is their biological amplification in the food chain, which cause ecological damage and health problems to humans. Most studies on irrigation water quality have taken into consideration the presence of toxic elements such as boron, lead, chloride, sulfate, nitrate and phosphate as being important in the assessment of water quality for irrigation. Though the presence of these substances in irrigation water may appear minute but the concentration is lethal to the growth of many crops.

Boron is present in water as boric acid and in this form may be toxic to plants even at very low concentrations. As observed by Rainwater and Thatcher (1960) boron content in natural water hardly exceeds 2mg\l. According to Musa, et.al (1993) highly sensitive crops are affected by boron concentration at as little as 0.5 mg/l. Some crops however are tolerant to boron than others examples are sugar beets, cabbage, and lettuce who have relatively high tolerance when compared to pear, apple and peach (Goodfellow et.al 2000). Boron is however an important substance required in small amount by the plants. Chloride is also toxic to most plants when present in irrigation water and at high concentration it can be toxic to sensitive crops. When applied with sprinkler irrigation high chloride concentration causes leaf burn. Tanji, (2004) observed that tolerance of plants to chloride differ and that below 70ppm it is generally safe for plants, 70 – 140ppm sensitive plants show injury, 141 – 350ppm moderately sensitive plants show injury and above 350ppm can cause severe problems.

Classification of Irrigation Water

A more accurate evaluation of the infiltration/permeability hazard requires using the electrical conductivity (ECw) together with the Sodium Adsorption Ratio (SAR). At a given SAR the infiltration rate increases as salinity increases or the other way round. Therefore the SAR and EC are used in combination to evaluate potential irrigation problems. Permeability effects are complicated by the interaction of Sodium Adsorption Ratio and salinity. The higher the salinity, the higher the SAR index in order to cause infiltration problem. On the other hand the lower the salinity, the greater the risk of infiltration problems independent of the SAR value. As observed by Abubakar et.al (2006) irrigation water high in SAR in the colloid, the poorest irrigation water would be that which is low in total salts but which has high Sodium Adsorption Ratio. According to Ibrahim, (2002) the presence of soluble salts in irrigation water exerts buffering effect and help in counteracting the sodic effect of water or soils. There are various classifications on the suitability of irrigation water that have been proposed, of these the classification as suggested by the United State Salinity Laboratory staff (USSLS) (1954) is widely used for its consideration of both the factors of salinity and sodium hazards. The classification is based on the electrical conductivity and sodium adsorption ratio (SAR). This scheme has been adapted by many studies in classifying irrigation water (James, 1993, Ayers and Westcots, 1994, Samaila 2005 and Maas, 2010). Four classes of irrigation water were identified based on the combination of Electrical Conductivity and Sodium Adsorption Ratio. The classes range from low/class 1 to very high/class 4. Low salinity water (C1) and low Sodium Adsorption Index (S1) water can be used for irrigation for most crops on most soils with little likelihood of soil salinity or development of harmful levels of exchangeable sodium. Medium salinity water (C2) and medium sodium water (S2) can be used if a moderate amount of leaching occurs. It will present an appreciable sodium hazard in fine textured soils especially under low leaching condition. High salinity water (C3) and high sodium water (S3) cannot be used on soils with

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restricted drainage and may produce harmful levels of exchangeable sodium in moist soils and will require special soil management, good drainage, high leaching and organic matter addition. Very high salinity water (C4) and very high sodium water (S4) is not suitable for irrigation under ordinary condition but may be used occasionally in very special circumstances such as on permeable soils, adequate drainage, considerable leaching and salt tolerant crops. The classification as suggested by the USSLS was modified by Thorne and Peterson (1971) to include a higher salt class with comments on their suitability for irrigation. The classification comprises of six classes of water based on electrical conductivity from zero to 6000 micromhos/cm and above. Classes are designated as low, moderate, medium, high, very high and excessive salinity respectively denoted as C_1, C_2, C_3, C_4, C_5 and C_6. The EC scale is logarithmic (to base 10). Diagonal SAR lines are given a negative slope to show the dependence of sodium hazard on the total salt concentration. Kanwar (1961) suggested a triangular diagram for water quality rating based on EC, SAR, and soil texture and soil tolerance characteristics of crops to be grown as shown in appendix 5. His classification includes five salinity classes from low to very high and incorporates a class with EC from 5000 – 20000 micromhos/cm for quality rating of well water in India.

CONCLUSION

Water quality is vital in ensuring the safety of crops produce and improving the productive capacity of soils. Human activities have introduced into water receiving surface substances at levels affecting the use of water for irrigation. The high concentrations of substances in water have reduced the potential of this important resource for a variety of uses. If water is to be used without after effects then assessment of water quality becomes necessary. Though irrigation may require less stringent water quality however, before any water is used for irrigation its suitability most be ascertained and compared with existing water quality standards. Properties associated to sodicity, salinity and specific ion toxicity are important in the assessment of the quality of water used for irrigation.

RECOMMENDATIONS

To address issues associated to poor quality water used for irrigation, there is the need to undertake comprehensive assessment of water quality for most rivers in the country so as to guide farmers of the implication of the use of the water for irrigation.

There is the need for sensitization programs organized by the government to educate the farmers on the implication of use of poor quality water for irrigation. The farmers should also be informed of the standards of water quality of the rivers, streams and or ponds the use for irrigation and ensure that the water quality is within the allowable limits considered safe for irrigation use. Agricultural extension officers should assist in ensuring that proper water standards are adhered to by farmers in order to ensure the quality of crops produced from irrigation. Research institutes should be set in each state to monitor the quality of water for recipient surfaces to ensure standards recommended for a variety of uses are met. Monitoring of the water quality should be continuous so as to keep farmers informed of the dangers in the use of water that polluted.

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