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Quality of Water Used For Urban Farming and Dry Season Cropping in Nigeria: Lessons Learnt

Mynepalli K. C. Sridhar, Mumuni Adejumo

[1]Department of Environmental Health Sciences
Faculty of Public Health, University of Ibadan, Ibadan, Nigeria

[2]Department of Environmental Health Sciences
Faculty of Public Health, University of Ibadan, Ibadan, Nigeria

Abstract: ***Urban and dry season farming in flood plains known as 'Fadama' farming is encouraged in Nigeria by the World Bank to boost agriculture and food security. State Ministries of Agriculture through Agricultural Development Programmes (ADPs) nationwide manage this activity. The paper describes a case study in Taraba State. Fadama farmers enjoy subsidized incentives viz. farm inputs, agrochemicals, pump sets, wash bores and others. However, farmers use any available water e.g. rivers, streams, polluted streams, ground water or untreated effluents, manures or pesticides with no quality regulations. Some of these also receive hazardous chemicals and pathogens, breed vectors and pose environmental and health risks. The water samples for quality analyses were collected from selected areas and their physico-chemical and heavy metal contents were determined using standard methods. The waters showed varying amounts of dissolved solids, boron, copper and chromium. Some samples showed values above the national permissible limits. Some of the risk factors identified for unacceptable irrigation water quality were composition, choice of sources not guided by quality, indiscriminate disposal of municipal wastes, and use of agrochemicals when available which enter the water bodies as runoff, and stagnant water bodies promoting vector breeding and aquatic growths. Certain mitigation measures are suggested.***

Keywords: Irrigation, Agriculture, Floodplains, Groundwater, Public health.

1. Introduction

Water plays a very important role in sustaining life. Though water appears plenty on the planet, in reality it is a scarce commodity. Agricultural activities have the highest demand and have top priority in any national planning in the tropics. Available water on the planet may conveniently be grouped into "Green water" (Soil trapped and rain) and "Blue water" (in rivers, wetlands, lakes and ground water) [1]. While rain is the principal source (100 per cent), it is shared as follows: landscape 56%, crops and livestock (4, 5%), irrigated agriculture 2%, water storage in biodiversity 1.3%, cities and industries 0.1% and oceans 36%. It is understandable and therefore water is also considered as an 'endangered species' as put by late Werner Stumm from EAWAG, Switzerland.

Irrigation which is an artificial application of water to the land /soil is used to assist in the growing of food crops, maintenance of landscapes, and re-vegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Irrigation is also useful in improved crop production, in protecting plants against frost, suppressing weed growth in grain fields and preventing soil consolidation [2]. The total irrigation potential in Nigeria is about 3.14 million ha comprising of 2.04 million Ha for formal farmer owned and managed schemes based on conjunctive rise of surface water and shallow Fadama (in Nigerian Hausa language it means flood plains or wetlands characterized by seasonal or perennial floods and used by farmers for agricultural needs) aquifers; and 1.1 million Ha for formal public irrigation projects, which are under government control. All naturally available water in Nigeria is listed as a national asset and a resource common to all. Its use is subject to national control. The objective of managing the quantity, quality and reliability of the nation's water resources is to achieve optimum, long term, environmentally sustainable social and economic benefit for society. People may have rights on water but not ownership. Nigeria has established eight hydrological areas as the basic units of water resources management [3].

To ascertain food security and to create job opportunities, Federal Government of Nigeria obtained World Bank support to develop 'Fadama' farming activities in the country in three stages- Fadama I, Fadama II, and Fadama III since 1990. The programme was initially started in northern Nigeria's four states Kano, Bauchui, Sokoto and Katsina and later covered all the 36 states and the Federal Capital Territory, and concluded a few years ago. Here, farmers were encouraged through provision of farm tools, water points, irrigated agriculture, pump sets, manures and other farm inputs. Agricultural Development Programmes of state Ministries of Agriculture implemented the programme. The farming can be urban, per-urban or rural. The lead author was a part of this successful programme in all the three phases and many farming populations benefited from the outcome.

1.1 Water for Irrigation

Irrigated agriculture depends majorly on adequate water supply of usable quality. Nigerian water policy also demands environmental and sustainability requirements for its proper use. However, water quality concerns have often been given little attention. Quality of water used for irrigation is paramount for the yield and quantity of crops, maintenance of soil productivity, and protection of the environment. For instance, the physical and mechanical properties of the soil, soil structure (stability of aggregates) and permeability are very sensitive to the type of exchangeable ions present in irrigation waters. The types of waters used for urban and Fadama agricultural activities are shown in Figure 1. The water sources vary from stream to industrial effluents. Excessive accumulation of salts in soil lead to salinity, sodicity and other changes which will lead to reduced crop yield and soil degradation requiring soil treatment. The problems that result vary both in kind and degree, and are modified by soil, climate and crop, as well as by the skill and knowledge of the farmer or water user [4, 5, 6, 7, 8].

The water meant for domestic and agricultural uses must comply with quality parameters, in particular physico-chemical quality, heavy metal content and absence of undesirable microorganisms [9, 10, 11, 12]. Factors that govern the quality may be natural (e.g., rocks, soils and surface through which it flows) and anthropogenic (e.g., industrial, agricultural and mining) activities [13, 14, 15, 16, 17, 18, 19]. The main objective of this paper is to provide available information on the various types of water resources used in irrigated agriculture in Nigeria particularly for urban farming and in Fadama farming, the quality issues and effects on soil and crops.

Irrigation farming can source water from 'Green waters' or 'Blue waters'. Blue waters may also include non-conventional sources like treated wastewater, desalinated water or drainage water are used to supplement the water demand. As the Nigerian waste waters are not treated, farming populations are tempted to use any available water irrespective of quality or inherent public health concerns. There can be significant health hazards related to using water loaded with pathogens in this way, especially if people eat raw vegetables that have been irrigated with the polluted water. In the Niger Delta area, a UNDP report listed 6817 oil spills between 1976 and 2001 [20]. Oil spills and refinery effluents contribute to a variety of toxic chemicals in addition to oil and grease to the receiving water bodies beyond the permissible limits.

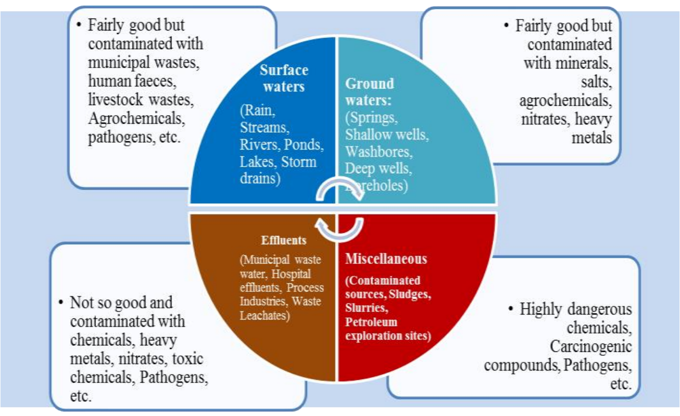

Figure 1. Irrigation waters used in Urban and Fadama farms and the associated problems

1.2 Irrigation Water Quality Indicators

The indicator parameters of irrigation water that appears to be most crucial in the determination of irrigation water quality are: the salt contents, concentration of toxic chemical like boron, concentration of carbonate and bicarbonate and the essential nutrients in irrigation water.

1.2.1 Salt content. A high concentration of salts in irrigation water source is one of the major indicators to determine the quality of water required for irrigation purposes. Excessive salt level present in the water and soil will negatively affect the crop yields, degrade the land and pollute ground water. Suitability of water reuse for irrigation with high salt content depends on the following factors: Salt tolerance of the type of crop, characteristics of the soil under irrigation, and climate conditions. Salt level is important in arid areas affected by high evaporation rates and cause high concentrations of salt accumulating in the soil. Generally water reuse for irrigation purposes must have a low to medium salinity level (electrical conductivity of 0.6 to 1.7dS/m).

1.2.2 Sodium Adsorption Ratio (SAR). Sodium Adsorption Ratio (SAR) is the index used to expresses the relative activity of sodium ions in the exchange reactions with the soil. This ratio measures the relative concentration of sodium to calcium and magnesium. High sodium ions in water affect the permeability of soil and causes infiltration problems. Sandy soils may not get damaged as easy as other heavier soils when it is irrigated with high SAR water.

1.2.3 Carbonate and Bicarbonate. High carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) concentration in irrigation water source increases SAR index. Bicarbonate and carbonate ions combined with calcium or magnesium will precipitate as calcium carbonate ($CaCO_3$) or magnesium carbonate ($MgCO_3$) when the soil solution concentrates in drying conditions. This will cause an alkalizing effect and increase the PH.

1.2.4 Toxic chemicals. The most common toxic ions present in sewage waters are: Boron (B), Chloride (Cl) and Sodium (Na). Sodium and chloride are usually absorbed by the roots; when the absorption is through the leaves the rate of accumulation is higher. Direct absorption usually occurs in sprinkler irrigation systems at high temperatures and low humidity conditions. The concentration suitability of these anions depends on the type of crop, state of growth, concentration of the toxic ion or ions and combination, climate and soil conditions.

Boron can be toxic at very low concentration levels. Boron concentration less than 1mg/L is essential for plant development, but higher levels can cause problems in sensitive plants. Most plants exhibit toxicity problems when the concentration of boron exceeds 2mg/L. The main source of anthropogenic boron comes from domestic effluents (average level of 1mg/L) for the use of products such as perborate as bleaching agent (i.e. boron can be found in urban wastewater at concentration levels as high as 5mg/L in dry countries and concentrated sewage) with an average level of 1mg/L.

1.2.5 Trace elements. Trace elements are chemical compounds which are required, usually in micro quantities, for the growth, development and physiology of plants and animals. There elements includes aluminum, arsenic, cadmium, chromium, cobalt, copper, fluoride, iron, lead, manganese, nickel and selenium. High concentration of these elements in irrigated water sources could be accumulated in the crops thus posing a health risk to the potential consumers. Fortunately, most irrigation supplies and sewage effluents contain low concentrations of trace elements not posing a risk for irrigation with recycled water. However, more than 85% of the applied trace elements are likely to accumulate in the soil, and may be leached into ground water and cause pollution. The toxicity limit will depend on the type of plant. For example, fluoride added to drinking water may be toxic at low levels for interior plants (e.g. Dracaena). It will also depend on the type of soil.

When an element is added to the soil from irrigation, it may be inactivated by chemical reactions or it may build up in the soil until it reaches a toxic level. For example some soil structures may retain these elements making them available at the root area. The irrigation system also can affect the absorption of toxic elements by the plant. Example, sprinkler irrigation may pose a higher risk of absorption of these toxic elements through the leaves.

1.3 Quality Evaluations

Both irrigation water quality and proper irrigation management are critical to successful crop production. The quality of the irrigation water may affect both crop yields and soil physical conditions, even if all other conditions and cultural practices are favourable/optimal. In addition, different crops require different irrigation water qualities to suit their tolerances to certain chemicals. Therefore, testing the irrigation water prior to selecting the site and the crops to be grown is critical. The quality of some water sources may change significantly with time or during certain periods (such as in dry/rainy seasons), so it is recommended to have more than one sample taken, in different time periods. The parameters which determine the irrigation water quality may be divided into three categories: chemical, physical and biological. In this review, the chemical properties of the irrigation water are discussed. These include Electrical Conductivity/ Total Dissolved Solids (EC/TDS), Sodium Adsorption Ratio (SAR), alkalinity and hardness.

2. Materials and Methods

2.1 Study Location and the Nigeria's Water Assets

The study location is northern part of Nigeria. Nigeria has land area of about 924,000 sq.km, and has tropical climate. The country is semi-arid in the North and gradually becoming humid in the South. The annual rainfall varies from over 4,000mm in the South-East to below 250mm in the extreme North-East and is subject to significant temporal variation. The country is drained mainly by the River Niger and its main tributary, the River Benue and their numerous minor tributaries as well as by the Lake Chad basin and the rivers that discharge into it. The surface water resources potential (through major perennial rivers Gongola, Hadejia-Jama'are, Kaduna, Cross River, Sokoto, Ogun, Osun, and Imo) of the country is estimated at 267.3 billion cubic metres while the ground water potential is 51.9 billion cubic metres.

Taraba state is located between latitude 6^{o}25'N to 9^{o}30'N and longitude 9^{o}30'E to 11^{o} 45'E, with tropical continental type of climate. Rainfall starts in the month of April and ends in November in the southern part, while in the north, rainfall starts in May/June and ends in October/November. The State has vast potentials of fadama land as a result of the numerous rivers that traverse the state such as Rivers Benue, Taraba, Donga etc. River Benue traverses the State for a distance of over 240 kilometres with wide extensive flood plain on both side of the river suitable for irrigation farming [21, 22, 23, 24].

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2.2 Sampling Methods

The data presented in this paper limit to Taraba State as a case study. Information was collected through community visits to Fadama farmers, in depth interviews and sampling of waters commonly used for irrigation Water samples were collected from rivers, streams and ground water and tube well sources in the area where Fadama mode of farming is at its peak within the state. A total of 15 water samples (3 each from the 5 water sources) were collected from river, stream and ground water and tube well sources. Some of the typical water sources are shown in Figure 2. Water samples were collected according to recommended standard methods described by the American Public Health Association [25]. Samples were analyzed for pH, Electrical, Chloride, major cations (Na^{+}, Mg^{2+}, Ca^{2+}, K^{+}) as well as heavy metals zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), chromium (Cr), nickel (Ni). In addition boron, CO_3, HCO_3 and NO_3 were measured. All analyses were carried according to the standard methods described by [25].

All the irrigation water samples collected here for laboratory analysis were collected in 2L clean PET bottles and were carried to laboratory according prescribed standard procedures. Parameters like pH, Dissolved oxygen and temperature were measured on the spot. For samples that will be analyzed to determine heavy metals concentration, samples were fixed with a few drops of concentrated nitric acid to prevent the metals from adsorbing to the walls of the containers. Standard methods by American Public Health Association (APHA, 1998) were followed. Sample bottles were tightly closed and transported under 4^{0}C to the laboratory since most of the parameter might not be analyzed in-situ.

Figure 2. Typical water sources (Polluted) and the Farms irrigated for crops

2.3 Laboratory Analysis

pH was determined on-site using a pre-calibrated pH meter with glass electrode. Conductivity meter was used to measure Electrical Conductivity. Argentimetric titration technique was used to determine chloride while major cations (Na^{+}, Mg^{2+}, Ca^{2+}, K^{+}) as well as heavy metals zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), chromium (Cr), nickel (Ni) were analyzed by the Atomic Absorption spectrophotometer. Boron, CO_3, HCO_3 and NO_3 were determined using spectrophotometer. In addition, appropriate reagent blanks were prepared for each analysis using instrumentation technique in order to ensure Quality Control and Quality Assurance.

2.4 Data Analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) Windows Version 18 (Chicago, IL). The mean and the corresponding standard deviation were used to summarize the characteristics of the water samples, while the results were compared with Federal Environmental Protection Agency (FEPA) Limits for Inland water. Analysis of Variance (ANOVA) test was used to determine if there were significant variations in some water quality parameters (Cu, Cr and B) across the water source location. Also detection of significance differences in the mean values of Cu, Cr and B among the water sources location was done by Duncan's New Multiple Range Test (DNMRT). The level of significance was set at 5%.

3. Results and Discussion

3.1 Quality of Irrigation Waters

Characteristics of water used for irrigation purpose are presented in Table 1. It is evident that the pH of the irrigation waters was within the recommended limit for inland water by FEPA [26]. However, the pH value of 5.86±0.15 mg L^{-1} and 5.60±0.05 mg L^{-1} obtained for Taraba River (Gassol) and Bali (ground water) irrigation water sources were below the recommended limit. Likewise, the electrical conductivity, CO_3, HCO_3 and chloride were observed to be generally low in all the water sources/locations while calcium, magnesium, sodium and potassium were respectively below the permissible limits. Although, the mean values obtained for Zinc, Manganese, Iron and Nickel were within the permissible limits, Copper levels were found to be higher. in Garin Dogo (Stream) (3.10±0.10 mg L^{-1}), Garin Dogo (Ground water) (10.23±0.21 mg L^{-1}) and Garin Dogo (Tube well) (1.31±0.03 mg L^{-1}). Chromium level in Taraba river (Gassol), Garin Dogo (Stream), Garin Dogo (Ground water), Bali (Ground water) and Garin Dogo (Tube well) were (1.51±0.01 mg L^{-1}), (1.35±0.10 mg L^{-1}), (1.25±0.10 mg L^{-1}), (1.31±0.31 mg L^{-1}) and (1.19±0.004 mg L^{-1}) respectively. All the values were higher compared to the recommended limits by FEPA.

Table 1: Quality of irrigation water samples

Parameters	Taraba river (Gassol)	Garin Dogo (Stream)	Garin Dogo (Ground water)	Bali (Ground water)	Garin Dogo (Tube well)	*Nigerian Permissible Limits for Inland water
pH	5.86±0.15	8.70±0.15	7.2±0.20	5.60±0.05	6.20±0.05	6-9
Electrical Conductivity (ds/m)	0.18±0.20	0.25±0.01	2.20±0.20	0.70±0.05	0.36±0.01	0-3
CO_3	0	0.37±0.20	0.80±0.15	0	0	-
HCO_3	9.03±0.20	7.90±0.11	56.90±0.06	24.06±0.11	12.02±0.06	-
Cl	0.53±0.06	0.29±0.01	3.60±0.10	1.63±0.10	0.80±0.15	600
Ca	5.30±0.10	6.60±0.05	120.30±0.58	22.9±0.05	11.90±0.05	200
Mg	2.30±0.10	2.40±0.10	25.0±0.10	10.03±0.15	3.76±0.10	200
Na	5.26±0.15	11.60±0.05	106.0±2.0	32.3±1.60	19.70±0.61	-
K	2.30±0.06	3.10±0.10	55.02±0.06	28.10±0.10	6.70±0.03	-
NO_3	0.33±0.01	1.20±0.01	3.63±0.10	0.68±0.01	0.42±0.02	20
Zn	0.28±0.01	0.38±0.05	0.92±0.02	0.36±0.01	0.43±0.01	1
Mn	0.18±0.01	0.18±0.01	0.19±0.01	0.17±0.02	0.18±0.02	5
Fe	0.50±0.05	6.02±0.06	4.60±0.10	4.36±0.10	5.70±0.15	20
Cu	0.81±0.01	3.10±0.10	10.23±0.21	0.41±0.02	1.31±0.03	< 1
Cr	1.51±0.01	1.35±0.10	1.25±0.10	1.31±0.31	1.19±0.04	< 1
Ni	0.75±0.02	0.93±0.15	0.84±0.12	0.71±0.03	0.69±0.05	< 1
B	0.45±0.11	0.38±0.02	0.16±0.01	0.40±0.03	0.37±0.04	-

Results are expressed as mgL^{-1} except for pH and EC;*From FEPA [25]

3.2 Comparison of Boron, Copper and Chromium Levels

The mean boron, copper and chromium values among the water sources/Location of the sampling area were compared (Table 2, Figures 3-5). Boron level in Taraba river (Gassol) (0.45±0.01 mg L^{-1}) was significantly higher compared to Garin Dogo (Stream) (0.38±0.02 mg L^{-1}), Garin Dogo (Ground water) (0.16±0.01 mg L^{-1}), Bali (Ground water) (0.40±0.03 mg L^{-1}) and Garin Dogo (Tube well) (0.37±0.04 mg L^{-1}), respectively. This is corroborated by the result of DUNCAN test (Figure 3) which showed that least Boron level was recorded in Garin Dogo (Ground water) source/location which differed significantly from the other location.

Likewise, the copper level in Taraba river (Gassol), Garin Dogo (Stream), Garin Dogo (Ground water), Bali (Ground water) and Garin Dogo (Tube well) were (0.81±0.01 mg L^{-1}), (3.10±0.10 mg L^{-1}), (10.23±0.21 mg L^{-1}), (0.41±0.02 mg L^{-1}) and (1.31±0.03 mg L^{-1}) respectively. There existed a significant difference between the copper values in all the sampled sources. Similarly, Garin Dogo (Ground water) source/location had significantly the highest level of copper compared to the other source/location as depicted in Figure 4. Furthermore, chromium was significantly higher in Taraba river (Gassol) (1.51±0.01 mg L^{-1}) compared to Garin Dogo (Stream) (1.35±0.10 mg L^{-1}), Garin Dogo (Ground water) (1.25±0.10 mg L^{-1}), Bali (Ground water) (1.31±0.31 mg L^{-1}) and Garin Dogo (Tube well) (1.19±0.04 mg L^{-1}), respectively. Although, the chromium value in Garin Dogo (Stream), Garin Dogo (Ground water) and Bali (Ground water) source were similar but significantly lower compared to the value obtained for Taraba river (Gassol) source (Figures 3-5).

Table 2: Comparison of boron, copper and chromium levels among source/ location

Parameters	Source/Location	N	Mean±SD	F-statistics	p Value
Boron	Taraba river (Gassol)	9	0.45±0.01	59.097	0.000
	Garin Dogo (Stream)	9	0.38±0.02		
	Garin Dogo (Ground water)	9	0.16±0.01		
	Bali (Ground water)	9	0.40±0.03		
	Garin Dogo (Tube well)	9	0.37±0.04		
Copper	Taraba river (Gassol)	9	0.81±0.01	4545.653	0.000
	Garin Dogo (Stream)	9	3.10±0.10		
	Garin Dogo (Ground water)	9	10.23±0.21		
	Bali (Ground water)	9	0.41±0.02		
	Garin Dogo (Tube well)	9	1.31±0.03		
Chromium	Taraba river (Gassol)	9	1.51±0.01	9.642	0.002
	Garin Dogo (Stream)	9	1.35±0.10		
	Garin Dogo (Ground water)	9	1.25±0.11		
	Bali (Ground water)	9	1.31±0.31		
	Garin Dogo (Tube well)	9	1.19±0.04		

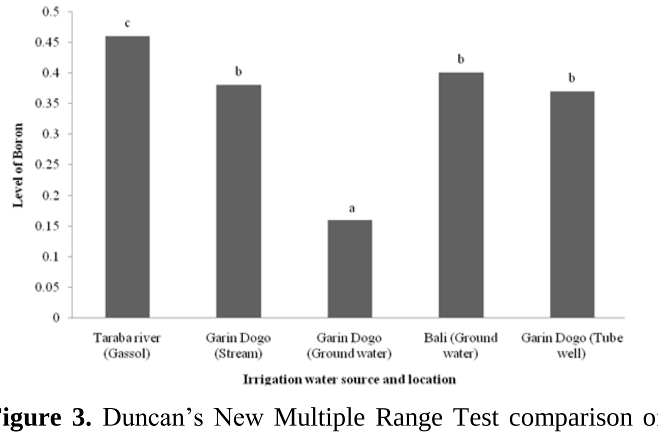

Figure 3. Duncan's New Multiple Range Test comparison of boron levels among the water sources

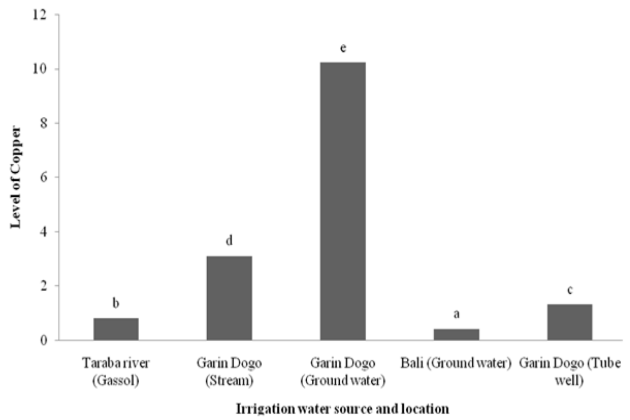

Figure 4. Duncan's New Multiple Range Test comparison of copper levels among the water sources

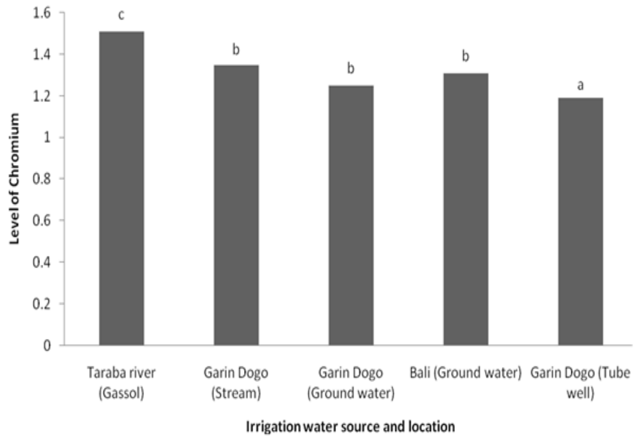

Figure 5. Duncan's New Multiple Range Test comparison of chromium levels among the water sources

3.3 Risk Factors for Irrigation Water Quality Deterioration

The studies revealed that in Fadama areas several risk factors exist which may affect the quality of irrigation water and health of the users. The common risk factors are open defecation, discharge of municipal wastes and the leachates from solid wastes, washing of livestock, and other traditional activities including navigation. These activities enrich the waters with nutrients and also promote aquatic macrophyte growths and water-borne infections among the people living in the area.

Some of the emerging risk factors are related to technology oriented and those which may be entering agricultural market. Nigeria is fast in embracing newer products when they enter the market. Intensive Fadama farming necessitates extensive use of fertilizers and pesticides. The irony of the study area is that there is a dichotomy in the farming sector, the poor and the rich. The rich gets the benefits of modern technology, which also includes agrochemicals. All the farmers interviewed expressed that if they have access to agrochemicals, they would like to use them in order to obtain better crop yields. This became evident as some of the water bodies showed signs of eutrophication. In addition, fishing in the Fadama water bodies is carried out through use of toxic chemicals such as 'gammaline' which is banned by the Federal Government but still in use. Some of the pesticides found in fish caught from water bodies and marketed in the area showed (mg/Kg^{-1}): Gamma BHC 5.4 to 35.2, and dieldrin 1.2 to 10.2. Some of the selected risk factors, effects and mitigation measures are given in Table 3. By adopting certain mitigation measures, they can be prevented.

Table 3. Identified risk factors that affect irrigation water quality and mitigation measures

Serial No.	Risk Factor	Effect	Mitigation measure
1.	Indiscriminate use of Agrochemicals -Chemical Fertilizers	-Eutrophication, nutrient enrichment, loss of fish in waters	-Judicious use under supervision
	- Pesticide and weedicides	-Build up of toxic chemicals	-Selective use under supervision
2.	Use of animal manures	-Pathogen contamination	
3.	Insanitary conditions (e.g. urination, defecation)	- Epidemics of water-borne infections (diarrhea, typhoid, dysentery, worm infestations etc	-Improve sanitation around water sources
4.	Stagnant water	-Mosquito breeding	-Avoid stagnation of water; encourage free flow, apply biodegradable larvicides
5.	Dams/Culverts to control water flow	-Spread of Schistosomiasis	- clear weeds, apply molluscicides, control urination into waters
6.	Use of irrigation water for bathing and drinking	-It is a risky behavior as some of the toxic chemicals and infectious agents may enter the body	-Discourage such behaviours

4. Conclusion

Urban and Fadama farming activities are on increase in Nigeria as the Federal government is encouraging food security as a National Policy. International Development partners such as World Bank, FAO and others are supporting such activities. As a result, farmers are motivated to grow food crops and they resort to using any kind of water available in the vicinity. Though, Agricultural Development Programmes attached to Sate Ministries of Agriculture play a supervisory role, their involvement is minimal and insufficient. The Fadama/urban farmers are semiliterate and their level of knowledge is scanty. Some of the irrigation waters used by them are effluents from municipal sewage, septic tank effluents, industrial effluents and some of these contain toxic / hazardous chemicals and infectious agents. The irrigation water sources from Fadama areas of Taraba state reported here were fairly good quality. However, the pH, lead, boron and chromium level of some of the samples were of concern which required immediate attention and appropriate solution. Routine irrigation water examination is recommended in all area where irrigation agriculture is being practiced. It is very important to evaluate quality of irrigation waters before they are used for farming activities. The National regulatory bodies under Ministry of Environment (National Environmental Standards and Regulation Enforcement Agency, NESREA) should educate the water users and bring out quality guidelines to prevent use of any untreated and contaminated waters for irrigation purposes.

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Professor Mynepalli K.C. Sridhar obtained Ph.D. from Indian Institute of Science, Bangalore in 1971 and moved to University of Ibadan, Nigeria in October 1977. He served in several capacities and became Professor of Environmental Health in 1986. He trained over 250 students at Master of Public Health and over 30 at PhD levels. His research interests include water, sanitation, and hygiene, 'Waste to Wealth', Waste to Energy', Sustainable Resource utilization, Environmental toxicology, vector control, and involvement in Environmental management. He is a Member/Fellow of professional bodies and Societies and published over 300 scientific papers and Technical reports.

Mumuni Adejumo is a Lecturer in the Department of Environmental Health Sciences, Faculty of Public Health, College of Medicine, University of Ibadan. He holds a Master of Public Health (MPH, Environmental Health) degree from the University of Ibadan, Nigeria and Bachelor of Technology (B.Tech Honours) degree in Pure and Applied Chemistry from Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. His areas of research and interest are water and wastewater management, vector control, hygiene and sanitation promotion and environmental statistics. He has published several of his research in various local and international journals.