**WASTEWATER MANAGEMENT FOR SUSTAINABLE IRRIGATION AND AGRICULTURAL PRACTICES IN NIGERIA**

**BY**

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**Abstract**

The ever-popular issue on environment preservation and sustainability all over the world has led to innovations of new material using by treated generated from various sectors resulting from never ending research conducted. In many area or community untreated wastewater will cause significant environmental damage to local water supply or resources.

Irrigation practice across the world is vital to successful green revolution all year round to achieving sustainable development goals in food security, socio-economic and rural development. However, irrigation practice in Nigeria has not achieved the set goals despite the huge investment involved. Moreover, the level of investment and abundant water resources ought to have expedited the goals of food self-sufficiency and socio-economic development in the country. This review attempts to uncover the underline issues regarding the irrigation practice in Nigeria through the evaluation of past and present practices, and its prospects. The review showed that the major persistent issues that have been hindering the performance of irrigation practice to achieving the set goals were inconsistent government policies, lack of political commitment, low awareness and lack of technical know-how among the farmers on irrigation farming system, and untimely financial intervention. In addition, the communication gap between the government and the farmers was responsible for some cases of underutilization and abandonment of large-scale irrigation system. The study concluded that to achieve food security and socio-economic development through irrigation systems practice in Nigeria, there is need to provide proper policy framework, appropriate technology, and farmers’ awareness and their inclusion in the decision-making process.

Key words: Irrigation practice, Green revolution, socio-economic development.

**Aims and Objectives**

The aim and objective will be treated in order to meet standard for reused and to used appropriate equipment to study or to determine the type of test to be used to treat each characteristic.

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Nigeria is located between Latitudes 4° and 14° N and Longitudes 3° and 15°E on the Gulf of Guinea with a land mass of 923,768 km2, signifying about 14% of the West African landed area (Balarabe et al., 2016). Approximately, 13,000 km2 (1.4%) of the land is covered by water and the remaining 98.6% ranges from thick mangrove forests and dense rainforests in the south to a near-desert condition in the north-eastern part of the country (Ibe and Nymphas, 2010).

Table 1: Agro-ecological zones of Nigeria with some climatic characteristics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Zone description | Percentage of country area | Annual rainfall (mm) | Monthly temperature (⁰C)  Minimum Normal Maximum | | |
| Semi – arid | 4 | 44 – 600 | 13 | 32 – 33 | 40 |
| Dry sub – humid | 27 | 600 – 1000 | 12 | 21 – 31 | 49 |
| Sub – humid | 26 | 1000 – 1300 | 14 | 23 – 30 | 37 |
| Humid | 21 | 1100 – 1400 | 18 | 26 – 30 | 37 |
| Very humid | 14 | 1120 – 2000 | 21 | 24 – 28 | 37 |
| Ultra humid (flood) | 2 | >2000 | 23 | 25 – 28 | 33 |
| Mountainous | 4 | 1400 – 2000 | 5 | 14 – 29 | 32 |
| Plateau | 2 | 1400 – 1500 | 14 | 20 -24 | 36 |

Additionally, the country has a coastline of over 853 km with about 80% in the Niger Delta region. The country is adjoined by four countries including the Republic of Benin in the West, Niger and Chad Republic in the North, the Cameroon Republic in the East, while the Atlantic Ocean forms the southern limits of the territory (FAO-Aquastat, 2016). There are three distinct ecological zones in the country including Guinea savannah, Northern Sudan savannah and Southern rainforest (Cosmas et al., 2010). However, the agro-ecological zones, governed by the combined effects of rainfall variations, soil, humidity, and temperature, are divided into eight zones for the purpose of irrigation practice (Table 1).

The climate in Nigeria is characterized by relatively high temperature and variations in the amount of precipitation throughout the year with alternating two seasons (rainy and dry) (Ibe and Nymphas, 2010). The rainy season is generally from April to October and the dry season from November to March, with some degrees of spatial and temporal variations in the amount and distribution of rainfall across the agro-ecological zones (Akande et al., 2017; Bibi et al., 2014). The southern part of the country has the highest average annual rainfall, ranging from 1524 to 2035 mm with duration of eight to nine months. The middle belt ranges from 508 to 1524 mm while it is less than 508 mm annually for a period of five to six months in the north and less than four months in the far north (Oriola and Alabi, 2014).

Furthermore, a short dry season is known as “August break” generally comes up in the month of August. The dry season persists from late October to early March. This period witnesses dusty north-east winds (Chineke et al., 2010). However, the Northern Nigeria which experiences short wet season, the dry season is very long, from October to mid-May. Annually, the average temperature ranges from 21 to 32°C in the south while the north has a temperature range of 13 to 41°C. Nigeria, the most populous country in Africa, was estimated to have a population of over 140 million in 2006 and the United Nation estimate in 2015 was roughly 181 million (United Nations, 2017). However, the exponential projection growth in the population has not translated to food sufficiency but rather the agricultural production is on the decline. There is an uneven spatial population distribution with about 65% living in rural areas and the rest in urban areas (Aidi et al., 2016). The major occupation of people in rural areas is agriculture but with a low level of productivity (Dayo et al., 2009). The level of food insecurity in the rural areas of Nigeria is alarming with 84.3 % reported in some communities in the north and about 56% in the south west of the country (Akinyele, 2009). The country relies mostly on the importation of agricultural produce to feed its growing population in spite of her production potential in agriculture. The only way out to address the challenges of food insecurity and rural poverty is to find the solution to agricultural production in the country (Xie et al., 2017).

In Nigeria, agriculture remains the bedrock of the economy as it provides a living for the majority of its populace. World Bank (World Bank, 2014) reported that the agricultural sector alone accounts for 33% of the total GDP of Nigeria and the sector employs around 23% of the total economically active population (FAO, 2014). Agriculture used to be the Nigerian major source of foreign exchange from independence in 1960 up to the mid-1970s when Nigeria was the world‟s largest producer of groundnuts, palm oil, and cocoa, and one of the major producers of millet, maize, yam, cassava, coconuts, citrus fruits and sugar cane (Ladan, 2014). However, the sector has been on the neglect and contributed less economically since the early 1970s when attention was shifted to oil revenues. Notwithstanding the reliance of the country‟s economy on proceeds from oil export, Nigeria remains agrarian with her endowed substantial natural resources including 68 million hectare of arable land, abundant freshwater resourcess covering about 12 million hactare, and an ecological diversity which enables the country to produce a wide variety of crops and livestock, forestry and fisheries products (Arokoyo, 2012). Moreover, the dry northern savannah is appropriate for sorghum, millet, maize, groundnuts, and cotton while cassava, yam, plantain, maize, and sorghum can successfully be grown in the Middle Belt. Cash crops like oil palm, cocoa and rubber can be grown in the South whereas low-lying and seasonal flooded areas can grow rice (FAO-Aquastat, 2016). The government has acknowledged the need to diversify the country‟s economy by giving adequate attention and promoting the development of the agricultural sector in order to shift from a mono-cultural economy of oil exports (Olajide et al., 2012).

Farming system in Nigeria can still be regarded as subsistence-based and it is predominantly rainfed, which makes it overly dependent on weather fluctuations. The irrigated agriculture only accounts for one percent of the cultivated area (FAO-Aquastat, 2017). Many farmers are out of jobs during the dry season and local food prices are on the rise as a result of food scarcity during this period. However, the green revolution requires all-year-round farming. The role of irrigation cannot be ignored as it is the only way to achieve the mandate of “Green Alternative” of the present administration. Hence, there is a need to evaluate the irrigation practices in the country so as to know what has been done in the past, the present status, and how to improve for the future developments.

**Literature Review**

**Irrigation Practice in Nigeria**

Nwa (1987) defined irrigation farming as the application of water to supplement soil moisture in order to make up water requirements for crops. The practice is justified in three cases:

1. when settled agriculture is restricted by inadequate rain (as in arid areas) or inadequate land to meet food needs of growing population (as in densely populated parts of the country)
2. when there are wide variations in rainfall from year to year and during the year, with respect to the amount, incidence, temporal and spatial distribution (a common experience throughout the country)
3. when irrigation is likely to make significant contribution to national food security and poverty alleviation. In this regard, Musa (2001) observed that the overall unreliability and inconsistency in the temporal and spatial distribution coupled with inadequacy of the rainfall, recurrent droughts and rapid population growth have all combined to make irrigation an essential factor in the food security strategies on Nigeria.

The development of water resources especially for irrigation purposes in Nigeria dates back to the pre-colonial era. The traditional application of water to land for dry season farming in northern Nigeria was one of the earliest attempts made towards increasing agricultural production. Although modern irrigation practice in Nigeria commenced around 1973, only about one million hectares is currently irrigated throughout the country. By contrast, India which has about 3.5 times the land mass of Nigeria irrigates nearly forty five (45) times as much land. The draft national

Present and Prospective Roles of Irrigation 461 irrigation policy in Nigeria [12] stipulates that a strategic balance between rain-fed and irrigated production has to be achieved but the former still accounts for the bulk of agricultural production in the country. Between 1976 and 1990, Nigeria invested about US$2,000 million in the development of medium and large scale public irrigation projects as a result of which irrigation witnessed a spectacular growth, rising from slightly more than 25,000 ha in 1975 to 974,900 ha.

Irrigation practice in Nigeria can be classified into three main categories namely

1. public irrigation projects which are under government control (formal irrigation);
2. farmer owned irrigation projects, which receives assistance from government in form of subsidies (informal irrigation)
3. the fadamas (traditional flood plain irrigation system) where no government aid is supplied [8,13]. Irrigated areas include those equipped with full or partial water control, spate irrigation, equipped wetlands and inland valley bottoms (including fadamas), irrespective of their size and management type.

The Nigerian Special Programme for Food Security has launched 80 small (2.5 ha) irrigation schemes, which include integrated irrigation-aquaculture (IIA) demonstrations [14]. According to reports by Musa (2001) [8] and IBRD (1995) [15], the use of surface floods in conjunction with ground water resources has augmented the production of dry season crops considerably owing to the fact that about 100,000 ha of land is now equipped with 40,000 wells and gasoline pumps, which are used by small holder farmers.

**Irrigability and Water Resource Potential of Nigeria**

Surface and subsurface water flows are changing due to changes in land use in Nigeria. Important changes are due to agriculture itself especially logging, urbanization and development of infrastructure. Population growth also reduce the per capita availability of fresh water supplies leading to stress and even scarcity. Under a new classification scheme, a country with an annual renewable fresh water supply per capita of more than 1,700 m3 will experience only occasional local water shortages. On the other hand, a country having an annual supply of less than 1,000 m3 per capita will experience chronic water shortages leading to serious environmental problems [1]. Although, Nigeria has sufficient water potential to meet the 2025 requirement, serious efforts have to be made to develop water sources to do so.

The water resources potential of Nigeria is estimated to be 250 x 109 m3, comprising 190 x 109 m3 of surface water with the balance in form of groundwater. This not withstanding, water is still a limiting factor to agriculture in much of the country but most especially, in the northern semi-arid and dry sub-humid zones lying above latitude 110 N. According to Adedeji (2008) [16], there are a total of 149 dams in the country. Out of these, 81 are owned by State governments, 59 by the Federal government and 9 belong to private companies. There are 107 large dams out of which 59 are principally for irrigation whereas 20 are for hydropower. Of the 34 small and medium dams in the country, only 15 are for irrigation purposes.

As a result of the FAO and US Bureau of Reclamation studies conducted in the early 1970s, three pilot public irrigation schemes were developed all in the sub-arid and dry sub-humid agro-ecological zones, namely: Bakolori scheme, the Kano River Irrigation scheme and the Chad Basin scheme. The success of these pilot schemes coupled with five year drought between 1970 and 1975 led to the establishment of eleven (11) River Basin Development Authorities (RBDAs) in the country (see Table 3). Development of drainage systems and improved water management practices could return large areas to productive use especially in the RBDAs where there are still huge potentials since irrigated areas constitute 31.6% of actually equipped area.

**Potentials of Irrigation in Nigeria**

Although irrigation has played an important role in the provision of food and fibre in Nigeria, it is quite clear that it would play a more important role when more arable ands are irrigated for future food production. Presently, the impact of irrigation is only felt with regard to specific crops such as wheat, sugar cane and, to some extent, rice and vegetables. In 2003-2004 season, irrigated grain production contributed about 0.9% of the total grain production while irrigated vegetable production contributed about 2.3% of the total vegetable production. Apart from vegetables, wheat, maize and sugar cane, other crops grown under irrigation systems in Nigeria include rice, potatoes, cotton, cowpeas, oil palm, citrus, fruits, cocoa, rubber, cashews etc. A close look at the typical irrigated crop yields in Nigeria the highest increase in net return resulting from irrigation is sugar cane, which exhibited a four-fold per hectare yield increase, followed by onions and tomatoes.

The least profitable crops are rice and wheat. Irrigation in Nigeria will grow as fast as the urban demand in fruit, vegetables and rice. It is also expected that local rice production will continue to increase and would most likely come from irrigated farms and be supplemented from fadamas and rain-fed production. Rainwater harvesting in dug out ponds and earth dams has the prospects of making irrigation water available to the arable lands in high rainfall areas which are far from water sources. With a low O & M pumping system such solar water pumps, more land could be cultivated in the dry season.

**Conclusion**

This study reviewed the Nigerian irrigation systems development on the basis of historical backgrounds, current conditions of development, challenges, and the future development prospects. There are diverse points of view on the underline problems of the irrigation development in Nigeria. A sizeable number of the authors are of the opinion that investment on large-scale irrigation systems has been resulted in costly failures because of their under-utilization and cases of abandonment when compared to the success recorded in small-scale irrigation system across the country. All the authors agreed that with the appropriate policy framework, political commitment, institutional reform, and sensitization of farmers on the operation and management of the modern irrigation technology. Nigeria irrigation will meet up with its developmental plan on the national economy and rural development. However, irrigation development in Nigeria, whether small or large-scale, offers some benefits, which also comes with some challenges. Already, considerable amounts of private and public funds have been invested in both large and small-scale irrigation development. Investment in irrigation development should not be an issue of debate but rather on how to improve the performances of various irrigation schemes across the country by addressing the various challenges encountered. Generally, the government is now aware of the significant role of irrigation development and its efficient utilization of food security and economic growth. The confidence of other stakeholders‟ participation in modern irrigation development and its sustainability also needs to be enhanced. Agriculture needs to be seen as a serious business by both the government and the farmers. Hence, there should be a performance index which must be effectively pursued for each irrigation scheme across the country by the government, non-government organization, and private investors. Specifically, the roles of individual actors in the development of irrigation systems across the country should be well defined and as such should be evaluated from time to time accordingly.

**Recommendations**

Nigeria needs to develop low cost water and soil conservation technologies, which include improved water harvesting in the areas with high rainfall, soil tillage, mulching, terracing etc in order to close the food supply gap in the country.

There is an urgent need to improve the traditional irrigation schemes for application in the production of staple food crops, notably rice, vegetables and tuber crops. In order to achieve her food security targets, the country must introduce the use of small farmer owned sprinkler systems which could assist in boosting cash crops production.

Nigeria has to shift emphasis towards rehabilitation and modernization of existing irrigation systems, but the cycle of construction-deterioration-rehabilitation has to be broken through greater mobilization of resources from the farmers to ensure adequate operation and maintenance. Dung out ponds and earth dams should be exploited by local governments for rainwater harvesting in high rainfall areas for dry season farming.

The Federal Government through the ministry of Agriculture should subsidize and make available low O & M water pumps such as solar water pumps to farmers

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