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Present and Prospective Roles of Irrigation in National Food Security in Nigeria

Cosmas Ngozichukwu Anyanwu[1], Chinenye Chukwuemeka Anyadike[2] Okala. Okala Nwoke[3] and Godwin Osita Chukwuma[4]

[1,3]National Centre for Energy Res. & Dev't
University of Nigeria, Nsukka 410001 Enugu State Nigeria.
[1]E-mail: cnasofia@yahoo.com, [3]E-mail: okalanwoke@yahoo.com
[2,4]Dept. of Agric. and Bioresources Engineering, University of Nigeria, Nsukka 410001 Enugu State, Nigeria
[2]E-mail: chinenye.anyadike@unn.edu.ng, [4] E-mail: ositachukwuma2001@yahoo.com

Abstract

Irrigation and drainage infrastructure form a vital and necessary leg of the green revolution triangle of seeds, fertilizer and water control. As such, they have played a crucial role in raising the standard of living in many parts of the world. Although irrigation arrived Nigeria around 700 AD, it has yet to be developed to the extent of making serious contributions towards national agricultural output owing to lack of a thoroughly articulated and implemented programme. Presently, the contribution of irrigation in the national food output is rather low as much of the crop production activities are still carried out under rain-fed conditions. Irrigation appears to have a great future in Nigeria due to proven huge water resources potentials in the country but there is need to embrace smaller farmer-owned irrigation schemes, which show greater promise.

Keywords: agriculture, ecological zones, irrigation, river basin, food security.

Introduction

Nigeria is located north of the gulf of Guinea and bounded by the Republic of Benin, Chad, Niger and Cameroon with an area of 923,768 km^2. It extends northwards from the elbow of the gulf of Guinea between latitudes 4^0N and 14^0N and longitudes 3^o and 15^o East of Greenwich [1]. The Atlantic Ocean forms the southern limits of Nigerian territory. Land cover ranges from thick mangrove forests and dense rain forests in the south to a near-desert condition in the north-eastern corner of the country. Three broad ecological zones are commonly distinguished in the country: (a) The northern Sudan Savannah; (b) The Guinea Savannah zone and (c) The southern rainforest zone.

Based on rainfall and temperature the county is divided into eight agro-ecological zones [2]. In Table 1 these zones are presented in a north-south succession, except the mountainous zone which is found at the border with Cameroon and the plateau zone in the centre of the country.

Table 1: Agro-ecological Zones in Nigeria.

Zone Description	*% of Country Area*	*Annual Rainfall*	**Monthly temperature (^{o}C)**		
	%	mm	Minimum	Normal	Maximum
Semi-arid	4	400-600	13	32-33	40
Dry sub-humid	27	600-1,000	12	21-31	49
Sub-humid	26	1,000-1,300	14	23-30	37
Humid	21	1,100-1,400	18	26-30	37
Very Humid	14	1,120-2,000	21	24-28	37
Ultra humid (Flood)	2	>2,000	23	25-28	33
Mountainous	4	1,400-2,000	5	14-29	32
Plateau	2	1,400-1,500	14	20-24	36

Source: Kundel (2007) [1]

The climate is predominantly semi-arid in the north and humid in the south. Except for an ultra humid strip along the coast with rainfall averages of over 2 000 mm/year, where it rains almost all year round, rainfall patterns are marked by distinct wet and dry seasons. Rainfall is concentrated in the period June-September. Deficiency in total annual precipitation is a problem in parts of the country, particularly in the northern parts. In most other areas, however, the major problems are the distribution in time and space and the low dependability of rainfall. Mean annual rainfall over the whole country is estimated at 1150 mm. It is about 1 000 mm in the centre of the country and 500 mm in the northeast.

The total population of Nigeria, according to 1991 census was about 88.5 million people, although a stable population growth rate of about 2.83% per annum, coupled with reduced infant mortality has led to present estimates of nearly 150 million. According to the International Fund for Agricultural Development [3], the agriculture sector employs about two-thirds of the country's total labour force and provides livelihood for about 90 per cent of the rural population. Nigeria is the world's largest producer of cassava, yam and cowpea. It is also a major producer of fish. Yet it is a net food-deficit nation and imports large amounts of grain, livestock products and fish. The rate of growth of Nigeria's food production has been very low; food production has been growing at the rate of 2.5% per annum in recent years while food demand has been growing at the rate of more than 3.5% per annum due to high rate of population growth of 2.83% [4]. In fact, Nigeria is listed by the Food and Agriculture Organization (FAO) among nations that are, at the moment, technically unable to meet their food needs from rain-fed production at low level of inputs and appear likely to remain so even at the intermediate levels of input at sometime near 2025 [2].

Inadequate supply of water is a major limiting factor in agriculture hence the need for irrigation in crop production. In Nigeria, crop production is heavily dependent on

rainfall thus production suffers from the seasonality of rainfall in time for a given locality. According to Frenken (2005) [2], total cultivable area is estimated at 61 million ha, which is 66 percent of the total area of the country. In 2002, the cultivated area was 33 million ha, of which arable land covered 30.2 million ha and permanent crops 2.8 million ha. About two-thirds of the cropped area is in the north, with the rest about equally distributed between the middle belt and the south. Nigeria's wide range of agro-ecological zones allows for a diversity of crop production activities. However, crop production is adversely affected by rainfall. For instance, in southern Nigeria, where annual rainfall is in the neighbourhood of 2000mm, crop farmers characterised by small scale holdings which range from 0.05 to 3 hectares per farm land [5] cultivate maize once in a year. Although this rainfall depth could support maize cultivation more than once a year, its distribution in time naturally does not permit more than one successful cultivation hence the need for irrigation and drainage facilities. With irrigation and good agronomic practices, different farmers can produce different crops in the year thus sustaining availability of fresh produce all year round. With such measure, food security can be said to be good.

National Food Security Situation in Nigeria

The 1996 World Food Summit in Rome defined food security as existing "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" [6]. A major challenge often encountered in ascertaining the food security situation is paucity of data. However, the food security situation in Nigeria according to Maziya-Dixon et. al. (2004) [7] can be seen from the "Nigerian Food Consumption and Nutrition Survey" (NFCNS) conducted between 2001 and 2003 by International Institute for Tropical Agriculture (IITA) in conjunction with National Planning Commission (NPC), Federal Ministry of Health, National Institutions and Universities. It is summarized as follows;

- More often than not, staple and non staple foods were available but not everybody could afford them
- Severe food insecurity was found in over 40% of all households surveyed in all the zones across the country and in all sectors
- Foods people consumed were determined by the foods that were available in their areas and these were, in turn, determined by the agro ecological characteristics of the area
- Nationally, 42% of the children in this study were stunted (chronic, longer standing malnutrition), while about 10% were wasted (acute, ongoing malnutrition). Underweight was 25%.
- Among the mothers, nationally, under nutrition was found in about 12%. At the time of the survey, 29.5% of the children had deficiency of vitamin A. This was above 20% in all zones and sectors. In mothers, those at risk of vitamin A deficiency were 13%. Of these the highest prevalence (19.6%) was in the dry savannah and lowest (8.8%) in the humid forest. Among pregnant women, 19.2% were at risk of vitamin A deficiency nationally. There was a

gradual decrease in risk from the dry savannah, through the moist savannah, to the humid forest.

- Almost 20% of the children surveyed were Iron deficient and another 8% with Iron store depletion. Iron deficiency in mothers was about 12% while it was higher (20%) in pregnant women.
- Iodine deficiency was mild in 14.6% of the children surveyed, moderate in 8%, and severe only in 4%. Almost one-third of the children had optimal iodine levels. For mothers, about 18% had mild iodine deficiency, 10% had moderate iodine deficiency, and only about 7% had severe iodine deficiency
- 20% of the children surveyed were deficient in zinc, higher (36.5%) in the most savannah and lowest (6.3%) in the humid forest. In mothers and pregnant women zinc deficiency was found in about 28% and 42%, respectively.

The report listed the staple foods as rice, cassava, maize, and yam. Also listed are cowpea, groundnut and soybean as major sources of plant proteins. The non staple foods were meat products, vegetables, fats and oils.

In the dry savannah zone, rice was more available and affordable followed by maize and sorghum. Cassava and yam were the least available and affordable. The most available non staple foods were meat products, vegetables, fats and oils. The least available and affordable were banana, bakery products, fruit, and beverages.

In the moist savannah, rice was more available and affordable followed by cassava, maize and yam. Soybean, plantain, and sorghum are the least available and affordable. Among legumes, cowpea was the most available and affordable followed by groundnut and soybean.

In the humid forest, the most available staple foods are rice, cassava, maize and yam. Cowpea, soybean, and groundnut are the major sources of plant proteins. Cowpea was the most available, followed by groundnut. Soybean was the least available. For affordability, the same trends were observed. Cassava was the most affordable, followed by rice, yam, and maize. For legumes, cowpea was the most affordable followed by groundnut. The most available non staple foods were meat products, vegetables, fats and oils, and fish. The same trend was observed for affordability. The least available and affordable were banana, bakery products, fruits, and dairy products.

Households in the rural sector were relatively more food insecure, followed by those in the medium and urban sectors. Similarly, households in the moist savannah were more food insecure than those in the dry savannah and the humid forest. Comparisons across primary occupations of household heads showed that families headed by farmers were the most severely affected by food insecurity. The level of severity decreased as one moved from households headed by farmers to those headed by traders, artisans, civil servants, and fishermen.

To cope with the food situation, several strategies such as borrowing food or money to buy food/purchasing food on credit, eating foods that are less preferred or less expensive, rationing money to household, limiting portions at meal time, and skipping meals; adopted by households were observed by the report. From this report,

it is also clear that families headed by farmers are the most food insecure. This is directly linked to their purchasing power which also is linked to the quantity, quality and the time farmers bring farm produce to the market.

Irrigation is one sure way of producing crops at a time when the crops are not usually grown to take advantage of higher crop prices thereby gaining a higher profit margin. Apart from improving the purchasing power and standard of living of farmers, off-season farming enhanced by irrigation will contribute to the food security situation in Nigeria.

Although there has been some increase in food production recorded in the recent past in Nigeria, Musa (2001) [8] maintains that these increases were due largely to expansion of cultivated land, and to a lesser extent based on intensification programmes. In Nigeria, intensification seems a better option since the land tenure system makes it difficult for many farmers to expand farmland. If current population growth rate of nearly 3.0% continues, strategies of productivity increase will have to place more emphasis on intensification and less on land expansion in view of the fact that some regions of the country are moderately food insecure [9]. There is an urgent need to improve food production in the country, through the development of intermediate low-cost water and soil conservation technologies, which include water harvesting/irrigation and soil tillage, mulching, bunding, terracing etc.

Arability of Nigerian Soils

A recent survey by the Japan International Co-operation Agency (JICA) reported by NINCID (2008) [10] suggests that 39% of the land mass of Nigeria is potentially suitable for agriculture and out of this, about 4.0-4.5 million hectares (approximately 4.5 -5.0% of the land) are adjudged suitable for irrigated agriculture. Out of this figure, only 1.1 million hectares can be supported fully by the water available; the remaining 3.4 million ha being flash flood plains (known as fadama). A close look at the agro-ecological zones of the country presented in Table 1 [1] (Kundell, 2007) indicates that the semi-arid and mountainous parts of the country constitute only 8% of the total land mass. Nigeria's wide range of agro-ecological zones enables a diversity of crop production activities:

- The dry northern savanna is suitable for sorghum, millet, maize, groundnuts and cotton. Sorghum and millet are the most important crops.
- In the middle belt and south, the main food crops are cassava, yam, plantain, maize and sorghum.
- In the south, the main cash crops are oil palm, cocoa and rubber.
- Low-lying and seasonally flooded areas are increasingly producing rice.

In 1987, the FAO prepared a working document on "the need and justification for irrigation development", which undertook a scientific assessment of the size of populations that the agricultural land resources of African countries can support. The report assumed a projected population of 238 million for Nigeria in year 2025, 47.9 million hectares of potential rain-fed land and 2.0 million and 3.73 million hectares of

potential shorter and longer transport irrigable land respectively. The shorter transport irrigable areas were defined as land close to the source of irrigation water, i.e. transport distances were limited to those within one agro-ecological zone. On the other hand, longer transport referred to land farther away from source: irrigation water may be transported from one agro-ecological zone to another. The potentials were calculated for three alternate levels of inputs namely low, intermediate and high levels of input. The report noted that irrigation practice was rudimentary, using residual flood waters and moisture in the low lands called fadama (flash flood plains), and supplemented with shaduf (a traditional device that lifts water onto the land). The main crops produced using these traditional methods of irrigation were vegetables and rice.

A more recent report of the FAO [8] indicates that 20-25% of the agricultural output in Nigeria now comes from the one-sixth of the arable land that is irrigated but the country will have to expand her irrigated land by 350% in order to be in a position to feed the projected population of 240 million by 2025. Other inputs needed to achieve the national food security target include expansion of cultivated land by 12%, an average increase in crop yields of 50% and expansion of livestock herds by 30-60%. The government's food security objective is to reach a per capita calorie intake of 2900 kCal/day by the end of 2010.

Irrigation Practice in Nigeria

Nwa (1987) [11] 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) [8] 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

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 as shown in Table 2, namely (i) public irrigation projects which are under government control (formal irrigation); (ii) farmer owned irrigation projects, which receives assistance from government in form of subsidies (informal irrigation) and (iii) 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.

Table 2: Features of Irrigated Agriculture in Nigeria.

Item	***Area Covered (Million ha)***	**Percent**
Total Land Area	98.3	-
Cultivable Area	73.0	74
Crop Cover	25.0	34 (of cultivable land)
Cereal Crop Coverage	13.0	52 (of crop area)
Rice Coverage	1.0	8 (of cereal crop cover)
Irrigated Area	0.9	6 9of cereal crop cover)
Area under formal (modern) irrigation	0.1	15 (of irrigated area)
Area under informal irrigation	0.1	14 (of irrigated area)
Traditional irrigation	0.76	71 (of irrigated area)

Source: Musa (2001) [8]

The Nigerian National Committee on Irrigation and Drainage [10] estimated the average costs of irrigation development at ₦750,000 (about US$5,000) per hectare, whereas annual operation and maintenance costs range between ₦5,000 per ha for gravity systems and ₦22,000 per ha for pumping systems and up to ₦30,000 per ha for sprinkler systems. These costs are quite close to figures put forward by Kundell

(2007) [1], who estimated O & M costs at ₦5,000 ($61 per ha), for gravity systems and $530 /ha for schemes using pumps. According to projections, land under irrigation has increased at less than 1% per annum in the last decade and it is not foreseen that the situation would change significantly in the near future. The harvested irrigated areas would increase to about 2,351 thousand ha by 2025.

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 m^3 will experience only occasional local water shortages. On the other hand, a country having an annual supply of less than 1,000 m^3 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 10^9 m^3, comprising 190 x 10^9 m^3 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 11^0 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.

Table 3: Equipped and Irrigated Areas in the River Basin Development Authorities for 2004.

River Basin Dev't Authority	***Equipped area (ha)***	***Actually irrigated Area (ha)***	**Actually irrigated as % of equipped area (%)**
Anambra-Imo	3,941	10	0.3
Benin-Owena	317	0	0
Chad Basin	26,180	1,000	3.8
Cross River	364	40	11.0
Hadejia Jama'are (including areas outside of equipped area using water from main canal)	18,475	21,000	113.7
Lower Benue	1,310	70	5.3
Niger Delta	187	0	0
Lower Niger	1,344	115	8.6
Upper Niger	3,697	722	19.5
Ogun-Osun	512	110	21.5
Sokoto Rima	27,580	5,290	19.2
Upper Benue	8,410	783	9.3
Total	**92,317**	**29,140**	**31.6**

Source: Kundel (2007) [1]

Water and Irrigation Policy Problems in Nigeria

Although the Shaduf lift irrigation system was possibly imported to Northeast Nigeria from North Africa around 700 AD [16] only about 10% of arable land in the country is currently under irrigation because of lack of any comprehensive irrigation policy. Perhaps the greatest problem facing irrigation and water resources management in Nigeria is lack of continuity in government water policies. Other problems in the sector include lack of public awareness about water conservation, erratic and inadequate power supply, shortage of qualified technical personnel etc.

Another major problem of irrigation systems in Nigeria stems from inadequate financial resources to sustain these systems. The present policy is for River Basin Development Authorities to charge only $10/ha per annum for irrigation water supply (with little variation between schemes) although this has proven very difficult to implement [1]. It has been demonstrated that small-scale farmer-owned and individually operated schemes are better maintained and more successful. Among the larger public schemes, only few are operational and all are beset with O & M problems [2].

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

lands 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 (given in Table 4) shows that 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.

Table 4: Comparative Yields of Selected Crops in Nigeria in 1998/1999 Season

Crop	**Yield**	
	Rain-fed (t/ha)	Irrigated (t/ha)
Wheat (northern Nigeria, dry season)	-	2.8
Rice (weighted average yield)	2.2	3.5
Sugar cane	6.5	26.0
Tomatoes	6.4	10.0
Onions	6.1	6.6
Pepper	3.1	5.3

Source: Kundel (2007) [1]

Conclusions

Although Nigeria has reasonable resources of both water and arable land, with nearly 70% of her population engaged in agriculture the country is still classified by FAO among nations unable to meet their food and fibre needs based on rain-fed practices. Nearly 40% of the country's 923,000 is arable with 57,300 km^2 suitable for irrigation. This not withstanding, only about 10,000 km^2 has been irrigated mainly for rice and vegetable production. Nigeria's physical potential for irrigation is about 31,400 km^2 which is about ten times the area currently under formal irrigation.

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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