FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

SUSTAINABLE IRRIGATION DEVELOPMENT AND MANAGEMENT: MASTER KEY FOR NATIONAL FOOD SECURITY AND JOB CREATION

NOSA ANTHONY EGHAREVBA
B.Eng., M.Sc., PhD (ABU), MNSE, R.Eng (COREN)
Professor of Agricultural Engineering

INAUGURAL LECTURE SERIES 34

30TH APRIL, 2015

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

SUSTAINABLE IRRIGATION DEVELOPMENT AND MANAGEMENT: MASTER KEY FOR NATIONAL FOOD SECURITY AND JOB CREATION

By

NOSA ANTHONY EGHAREVBA
B.Eng., M.Sc., PhD (ABU), MNSE, R.Eng (COREN)
Professor of Agricultural Engineering

INAUGURAL LECTURE SERIES 34

30TH APRIL, 2015

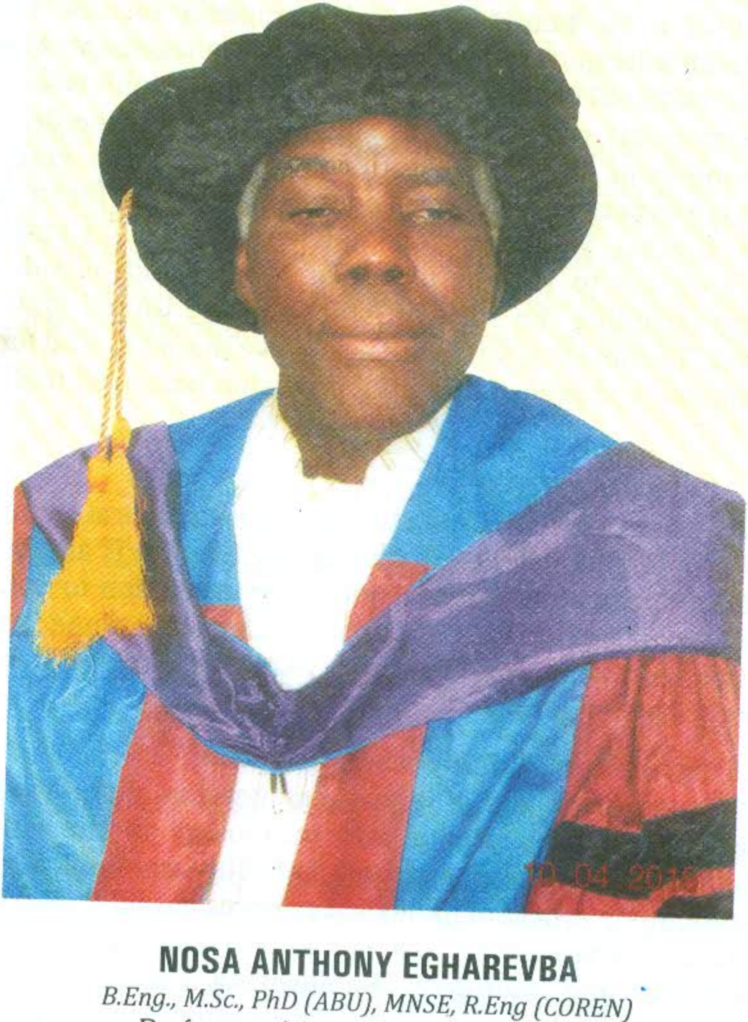
This 34th Inaugural Lecture was delivered under the Chairmanship of:

Professor M. A. Akanji, FNSMBM
Vice-Chancellor
Federal University of Technology, Minna

Published by:
University Seminar and Colloquium Committee,
Federal University of Technology, Minna.

30TH April, 2015

Design + Print:
Global Links Communications, Nigeria
©: 08056074844, 07036446818



NOSA ANTHONY EGHAREVBA

B.Eng., M.Sc., PhD (ABU), MNSE, R.Eng (COREN)

Professor of Agricultural Engineering

PREAMBLE

I give praise and thanks to God Almighty for making it possible for me to stand before you all this very day to communicate in part my academic/research stewardship and by implication my contribution to knowledge. The inaugural lecture titled: "Sustainable Irrigation Development and Management: Master key for National Food Security and Job Creation" is a brief summary of my research work spanning about three decades beginning from Ahmadu Bello University, Zaria (as a graduate student) and perfecting itself at Federal University of Technology, Minna, Nigeria. My search for knowledge as well as research work took me to various places in Nigeria and outside the country including the state of Israel and the United States of America. To come this far, I once again give thanks to God for His faithfulness, and indeed bountiful provision bestowed freely on me.

1.0 INTRODUCTION

Mr. Vice Chancellor, sir, I wish to begin this inaugural lecture by briefly explaining what Agricultural Engineering is all about. I will then, speak on Irrigated Agriculture in relation to national food security and Job creation as well as mention some notable research contributions we have made in Soil and Water Engineering in Nigeria.

1.1 Agricultural Engineering Discipline

Agricultural Engineering is the engineering discipline that applies engineering science and technology to the efficient production and processing of food, feed, fibre and fuels. For over a decade, some aspect of biological sciences got fully married to agricultural engineering. So we now have what is called Agricultural and Biological Engineering Discipline. Others choose to call it Agricultural and Bioresources Engineering or Agricultural and Bio-systems Engineering.

According to the American Society of Agricultural & Biological

Engineering (ASABE), Agricultural and Biological Engineering is a discipline of engineering that applies engineering principles and the fundamental concepts of biology to agricultural and biological systems and tools; ranging in scale from molecular to eco-system level for the safe, efficient and environmentally sensitive production, processing and management of agricultural, biological, food and natural resources systems.

The wide range of job opportunities for Agricultural and Biological Engineers as well as the job it can generate for many others rivals many types of engineering degrees. This is because of the broad scope of problems that biological and agricultural engineers are uniquely prepared to solve. Fig 1 is a chart showing the various options under agriculture engineering and areas of interest.

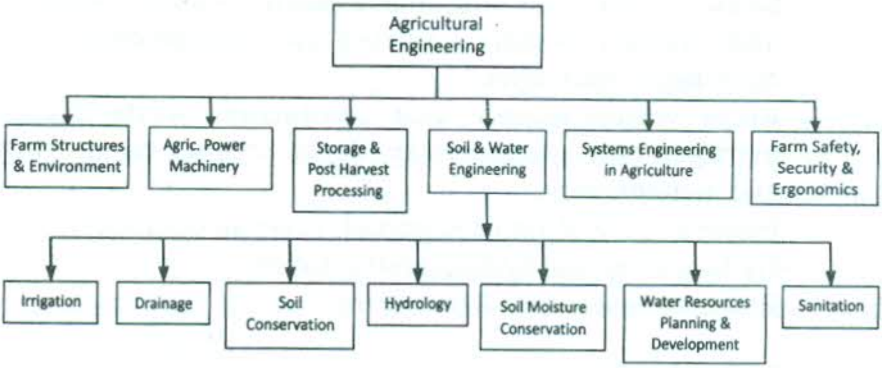


Fig. 1: Agricultural Engineering options/areas of interest

1.2 Areas of Interest to Agricultural Engineers

The various areas of interest to Agricultural Engineers are enumerated below:

- Design of agricultural machinery, equipment and farm products
- Environmental control systems, cooling and ventilation
- Energy conservation (bio fuels, bio-refineries, etc.)

- Crop production: seeding, tillage and irrigation practices
- Soil and water conservation
- Environmental controls for poultry, swine, beef, aquaculture, plants etc
- Animal production and care
- Biological production and utilization on the farm
- Post-harvest processing, handling and storage
- Precision farming technologies, machine vision GPS
- Farm operation and management
- Farm safety, security and ergonomics
- Precision agriculture, utilizing GPS, yield monitors, remote sensing and variable rate technology
- Worker safety, comfort and efficiency including the control of vibration noise, air quality, heating control etc.
- Sales, services, training management planning, market and product research related to implementing and applying technologies.
- Rural water, supply and sanitation; waste water management, groundwater development, monitoring and management
- Ponds and small dam design and reservoir operation
- Hydro power, and hydraulic structures
- Entrepreneurship in Agriculture.

1.3 Irrigation Process

Irrigation process can be explained in two ways (Levy, 1993, Egharevba, 2009)

i) Distribution of water in the fields after reserving it and transporting same from its source.

ii) Use of the input water in the most economical and efficient way in the agricultural system.

Irrigation is generally defined as the application of water to soil for the purpose of supplying the moisture essential for plant growth. A broader and more inclusive definition is that irrigation is the application of water to the soil for any number of the following purposes (Hansen, *et al*, 1980):

a) To add water to soil to supply the moisture essential for plant growth
b) To provide crop insurance against short duration drought
c) To cool the soil and atmosphere, thereby making more favourable environment for plant growth
d) To reduce the hazard of frost
e) To wash out or dilute salts in soil
f) To soften tillage pans and clods.

The water sources needed to supply moisture for crop growth may come from precipitation (rainfall), flood water, soil moisture residue, groundwater, irrigation and drainage water. Failure to consider all these sources and the proportion of water that each supply to the total crop water need may result in faulty design of an irrigation system. Irrigation water requirement is the net depth of water that is required to be supplied to a crop to fully satisfy its specific crop water requirement (CWR). It is the fraction of CWR not satisfied by rainfall, soil water residue and groundwater contribution. The crop takes its water requirement from moisture held in the soil. Useful water for the crop varies between two levels, the permanent wilting point and field capacity (Fig. 2).

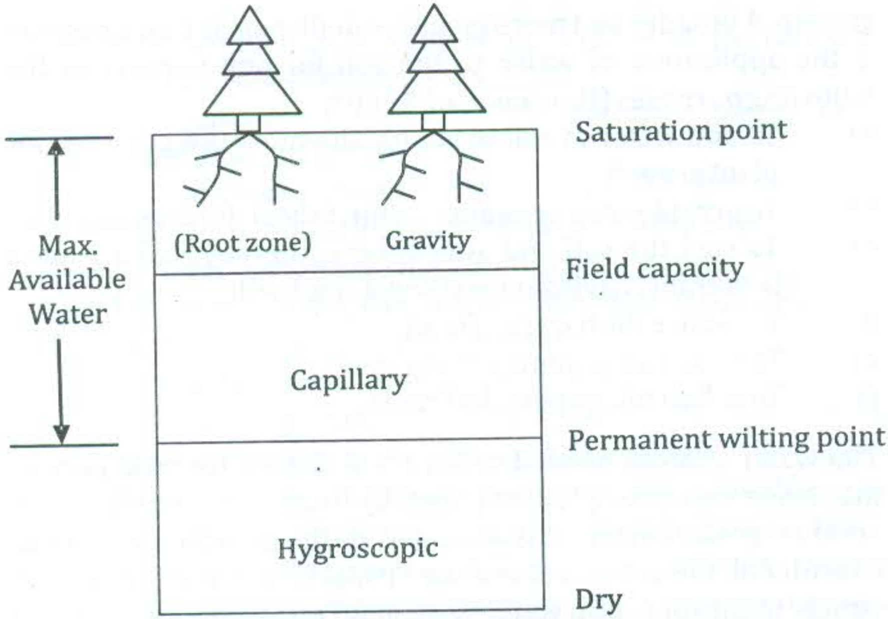


Fig. 2: Soil moisture quantities

Source: Adapted from Egharevba (2009)

1.4 Crop Growth as a Function of Soil Moisture

The rate of crop growth depends on the moisture content of the soil. There is an optimum growth rate condition in which the soil water content lies at a point between the field capacity and the permanent wilting point (Fig. 3). However, this point varies for different crops and for different stages of growth. The main practical aspects of irrigation are the determination of how much water to apply to a given crop and when to apply the water.

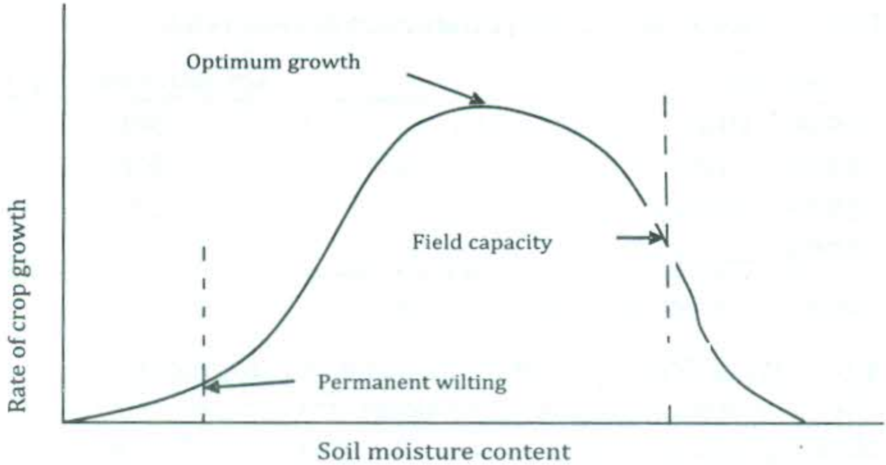


Fig. 3: Rate of crop growth as a function of soil moisture
Source: Egharevba (2009)

1.5 Trends in Global Agriculture

The world population is on the increase even with a declining growth rate. Population growth means a growing demand for food and fibre. However, the rate of agriculture is declining and so evidently noticeable in developing countries (Tables 1 and 2).

In Nigeria, the population growth rate remains at about 3% per annum, which indeed is far below food and agricultural rate o 6% per annum, Ingawa *et al,* (2009). It has been reported by Central Bank of Nigeria that food demand is higher than supply (CBN, 2001).

Table 1: Population growth trends (%)

	1980 – 1990	1990 – 2000	2000 – 2010	2010-2015
World	1.8	1.7	1.4	
Developed Countries	2.1	2.0	1.7	
Nigeria	2.1	2.5	2.7	2.8

Sources: Adapted from Alexandratos (1995); Worldometers (www.Worldometers.info)

Table 2: Global Agricultural Production growth rates

Period	Growth rate (%)
1960 – 1969	3.0
1970 – 1979	2.3
1980 – 1992	2.0
1993 – 2010	1.8

Sources: Alexandratos (1995); Egharevba (2009)

1.6 Water Resources Potential and Development

The development of water resources involves the conception, planning, design, construction, and operation of facilities to control and utilize water. Water resources development projects are planned to serve the following purposes (Modi, 1995); hydro-electric power, irrigation, employment, domestic and industrial water supply, drainage and so on.

An assessment by the National Water Resources Master Plan, NWRMP (1995) showed that the water consumption and demand in Nigeria would increase from 2;750 Mm^3 in 1995 to approximately nine fold increase (24, 140 Mm^3) by 2020. It was projected that only an average of about 8% of both the potential surface water resources will be consumed by 2020, with the notable exception of lake Chad Basin where 35.6% of the surface water and 11% of the groundwater shall be consumed. Therefore, it is significant to stress the need for greater attention to water resources monitoring, and more innovative water operations of projects (Jimoh, 2010). Multiple uses of proper facilities may increase benefits without a proportional increase in costs and thus enhance the economic justification for the project. In Nigeria the water allocation from reservoirs falls into three main uses: irrigation, domestic water supply and hydro power. Irrigation activity alone accounts for 36%, which is the highest proportion consumptive use of water (FAO, 1993).

2.0 IRRIGATION SCHEMES IN NIGERIA

2.1 Historical Background

Singh and Maurya (1979) reported that the first recorded survey for irrigation potential in Nigeria was along Sokoto Rima and Zamfara valley systems, and water impounded at Wurno for irrigation was carried out in 1918 and by the year 1929, a scheme was developed covering 243 ha for irrigation along Shella River, but these were later destroyed by floods. The first irrigation division was established in the then Northern region in 1949. The division then identified four areas viz., Wurno, Hadejia, Yobe and Gamboru, for small projects based on pumping from nearby streams/rivers. The first modern irrigation projects sited at Bacita Sugar Estate, Bacita, Kwara State, was established in 1964 along the flood plain of the Niger (Ahmed, 2003).

In 1963, the Food and Agriculture Organisation (FAO) reviewed the disappointing history of small-scale projects along the Sokoto–rima Rivers and prepared feasibility studies for the expansion of irrigation through dam construction. On the request of the Chad Basin Commission, the FAO and United Nations Economic and Scientific Commission (UNESCO) conducted a study of the water resources in Jama'are River Systems in 1965. Subsequent reviews of these studies marked a turning point for Nigeria's irrigation development and large irrigation projects were constructed in 1970s. In 1971, the FAO proposals were reviewed and the Federal Government embarked on the construction of Bakolori irrigation project. The present twelve River Basin Development Authorities (RBDAs) covering the whole country were established in 1976 (Table 3). Most of the irrigation activities were in the Northern Nigeria simply because of the seasonality of the rivers and the existence of large human population near the alluvial plains.

By early 1980s, there were numerous formal irrigation projects in the country. However, criticisms started in that the irrigation projects performed below expectation. In addition, there was so much environmental implications from the dams, water resources conflict and coupled with budgetary difficulties. This led to a slow pace in the development of large scale irrigation projects from 1980 – 1990 and increased interest on small scale irrigation schemes. During the late 1980s, the Federal Government took interest in small-scale irrigation via Agricultural Development Projects (ADPs).

Noticing the traditional irrigation using Shaduf, the ADPs identified -the potential of the shallow groundwater in the river valleys for irrigation. Various Asian Techniques for exploiting the shallow groundwater were tested and finally the small petrol engine pumps became more popular. Based on this success, the world Bank funded a separate programme, the National Fadama Development Programme (NFDP), under which small engine pumps (owned by individuals) were used to lift water from streams and shallow water tables (Ahmed, 2003).

Table 3: Irrigation Schemes under the River Basin Development Authorities (RBDAs) in Nigeria

Zone	**RBDA**	**No. of Schemes**
North East	Chad Basin	2
	Hadejia Jamaare	5
North West	Sokoto - Rima	4
	Lower Niger	6
	Upper Niger	5
Central	Upper Benue	5
	Lower Benue	10
South West	Ogun - Osun	7
	Benin Owena	6
South East	Anambra - Imo	3
	Cross River	6
South South	Niger Delta	4
Total	**12**	**63**

Source: Adapted from Egharevba (2009)

projects performed below expectation. In addition, there was so much environmental implications from the dams, water resources conflict and coupled with budgetary difficulties. This led to a slow pace in the development of large scale irrigation projects from 1980 – 1990 and increased interest on small scale irrigation schemes. During the late 1980s, the Federal Government took interest in small-scale irrigation via Agricultural Development Projects (ADPs).

Noticing the traditional irrigation using Shaduf, the ADPs identified -the potential of the shallow groundwater in the river valleys for irrigation. Various Asian Techniques for exploiting the shallow groundwater were tested and finally the small petrol engine pumps became more popular. Based on this success, the world Bank funded a separate programme, the National Fadama Development Programme (NFDP), under which small engine pumps (owned by individuals) were used to lift water from streams and shallow water tables (Ahmed, 2003).

Table 3: Irrigation Schemes under the River Basin Development Authorities (RBDAs) in Nigeria

Zone	RBDA	No. of Schemes
North East	Chad Basin	2
	Hadejia Jamaare	5
North West	Sokoto - Rima	4
	Lower Niger	6
	Upper Niger	5
Central	Upper Benue	5
	Lower Benue	10
South West	Ogun - Osun	7
	Benin Owena	6
South East	Anambra - Imo	3
	Cross River	6
South South	Niger Delta	4
Total	**12**	**63**

Source: Adapted from Egharevba (2009)

2.2 Agricultural Drought Implications

Agricultural drought is defined by a reduction in soil moisture available below the optimal level required by a crop during the different growth stages, resulting in unpaired growth and reduced yields. It typically occurs after a deficiency of rainfall over an extended period of time. It normally leads to a depletion of soil moisture (Okorie, 2003; Legesse, 2010). Historically, there have been reports that many droughts have occurred in the Northern regions of Nigeria. Otun (2005) reported that the effects of the 1971 – 1973 severe droughts and the 1983 – 1984 localized droughts on agricultural production prompted the Federal Government of Nigeria through its various relevant agencies (e.g. Department of Drought & Desertification in the Federal Ministry of Environment) to put in place some institutional arrangement and schemes to minimize drought impacts. This is called close monitoring of drought incidences and to put in place early warning systems. Hence, the role of irrigated agriculture to provide crop insurance against short or moderate duration drought cannot be overemphasized. Given the Nigerian Sudano - Sahelian region's susceptibility to drought, expansion of land under recession and irrigated agriculture is the most plausible option to stable and higher agricultural productivity.

2.3 Area Under Irrigation in Nigeria

The total area under irrigation in Nigeria is difficult to access because of two reasons. Firstly, the figures stated for formal irrigation are conflicting due to confusion on how much area was developed and what is actually being irrigated. Secondly, the area under informal irrigation is difficult to determine due to obvious problems of survey and especially if natural flooding plains are to be considered. Nwa *et al* (1999) gave total developed area of 108,000 ha under the River Basin Development Authorities but the area actually being irrigated under the State government was estimated to be 4,660 ha and 126,000 ha under fadama irrigation using engine pumps. These 1999 statistics excluded areas irrigated by the private sectors. IMMI (1992) estimated the irrigated area in the wetlands (natural flood plains) as 721,000 ha.

In 1975, the Agricultural Monitoring and Evaluation Unit (APMEU) were established to monitor the success of the ADPs as well as undertake its evaluation and provide technical support. Food and Agricultural Co-ordinating Unit (FACU) was established at about the same time with the ADP. The mandate of FACU include monitoring, management, evaluation and to undertake special studies and provide technical support to ADPs. At about 1999/2000, FACU and APMEU were merged to form project co-ordinating unit (PCU). Later, the National Food Reserve Agency was set up as a result of the merger of PCU, Strategic Grains Reserve, Fertilizer Cooperatives and Engineering/Mechinization and Post Harvest Technology Development with a view to address key issues/constraints to agricultural production, processing, storage of agricultural produce and marketing. Many states had irrigation departments under the state ministry of agriculture and were responsible for irrigation infrastructure development and management. However, their activities did not make significant progress and the total area under each of the states being about 10 – 12% of the total area under formal irrigation (Ahmed, 2003).

It is estimated that out of a total of 92, 377 million hectares in Nigeria, the arable land is about 71.2 million hectares and out of which less than 50% is actually cultivated. This is largely due to non-availability of irrigation water, agricultural implements and other agricultural inputs. The National Water Resources Master Plan (1995) reported that 39% of the land mass is potentially suitable for agriculture and out of this 4.0 to 4.5 million hectares (approximately 4.5 to 5% of the arable land) was judged suitable for irrigated agriculture. However, only 1.1 million hectares can be supported fully by the water available, the remaining 3.4 million hectares being fadama (wetlands). Thus, the urgent need to increase agricultural production through sustainable irrigation development and management cannot be over emphasized. There is also the need to upgrade the type of tools and equipment used in agriculture nationwide.

3.0 NATIONAL IRRIGATION POLICY AND STRATEGY

This policy provides the objective principles and strategy for development of both private and public irrigation in Nigeria as the sub-sector evolves in response to domestic and regional demand for food and fibre. The policy is based on an update of baseline information on the status of public irrigation schemes in Nigeria and indicated directions for institutional reform and public investment as established by the review of the public irrigation sector (ROPISIN) and guideline provided by the Food and Agriculture Organization (FAO) of the United Nations.

The specific challenges that the policy was designed to address were:

i) The widening gap between demand for food and domestic supply – as a result of population growth and changing pattern for consumption.
ii) The thinning rural economy and a poorly structured irrigation industry – unable to respond to domestic demand for food and fibre at a sufficient scale and with right quality.
iii) Poor performance of public irrigation investment – input driven not output led.
iv) Very little private investment beyond fadama – level production.

The specific policy objectives are summarized thus:

- Raise overall irrigation productivity in all public and private initiatives.
- Achieve a strategic balance between irrigated agriculture

and rain-fed production

- Improve water service to all irrigation farmers and work toward full operation and maintenance cost recovery from the users.
- Improve and sustain irrigation efficiencies at all schemes, provide extension services and facilitate the provision of inputs and the marketing of outputs.
- Stabilize the public irrigation sector and transfer operation and maintenance to the beneficiaries/private sector.
- Consolidate the responsibility for overall co-ordination and regulation of all irrigation development in Nigeria with the FMWR and request that the responsibility or the co-ordination and regulation of all agricultural support services shall reside with the FMARD.
- Remove constraints to private sector engagement and expand the capability of private sector in both equipment manufacture and supply in development activities including direct project operation and management.

4.0 SCOPE OF IRRIGATION TECHNOLOGY

The scope of irrigation science and technology extends from the watershed to the farm and to the drainage channel. The watershed yielding the irrigation water, the stream conveying the water, the management and the distribution of water as well as the drainage problems arising from irrigation practices are all of concern to the irrigationist. Focusing on one aspect of an irrigation system without considering its other components will lead to faulty design and inadequate preparation. Often times, management of this stream and its quality, the diversion structures built upon it, and remedial measures to reduce seepage losses along the stream and channels are of importance.

Diversion structures, measuring devices and conveyance channels are extremely important. Layouts of the irrigation and drainage systems on the farm, method of control and disposition of excess and waste water also have vital significance. Too often, irrigation projects are designed without adequate preparation to utilize waste water. The design of surface and subsurface drainage systems is of vital importance in maintaining high productivity of irrigation lands. Thus, properly designed and managed irrigation and drainage projects will make the world a better place to live. In general, irrigated agriculture can be improved through planning and management of the limiting resources (Hansen et al, 1980; Egharevba, 2009).

5.0 PLANNING AND DESIGN OF IRRIGATION AND DRAINAGE SYSTEMS

5.1 Planning and Design Sequence

The sequence from design parameters determination, selection of systems and maintenance aspects has to go through in a balanced way in order to get a proper design. Planners of irrigation and drainage schemes can incorporate sufficient flexibility in the system to cope with changes in the objective of the scheme. Such change may be due to climate, cropping pattern, agrarian structure (size of holdings, field layouts, and tenancy), agricultural practices, mechanization, hydrological regime, or water management capability (Egharevba, 2009).

Planning and design of irrigation systems should therefore be the integration of aspects like:

- The technical development of the main systems
- The development of the tertiary systems
- The extension to the farmers on proper management and new concepts
- Improvement of the operation and maintenance of the systems.

The objective should be to increase the efficiency of use of all resources with the ultimate goal of increase of the crop yield performance and crop production. Detailed project planning and monitoring is a first step to reach a proper project execution and constructability of designs is a major aspects of sound engineering. However, integration of design group and constructor is often lacking. Figures1and 2 shows the phasing of the planning and design of irrigation and drainage systems (Storsberge, 1993; Egharevba, 2009).

Thus, to meet future challenges of food security, further development of agriculture is necessary. This is not only development in the sense of agricultural output increase, but also in the responsible use of natural resources. A responsible use of the natural resources is important because of the dependence of agriculture on these resources. Natural environment should be treated or managed in such a way that the future of farming and agro allied industry are secured. Food security is not only a matter of quantity or increase yield per hectare (or per capita), but also of continuity or sustainability.

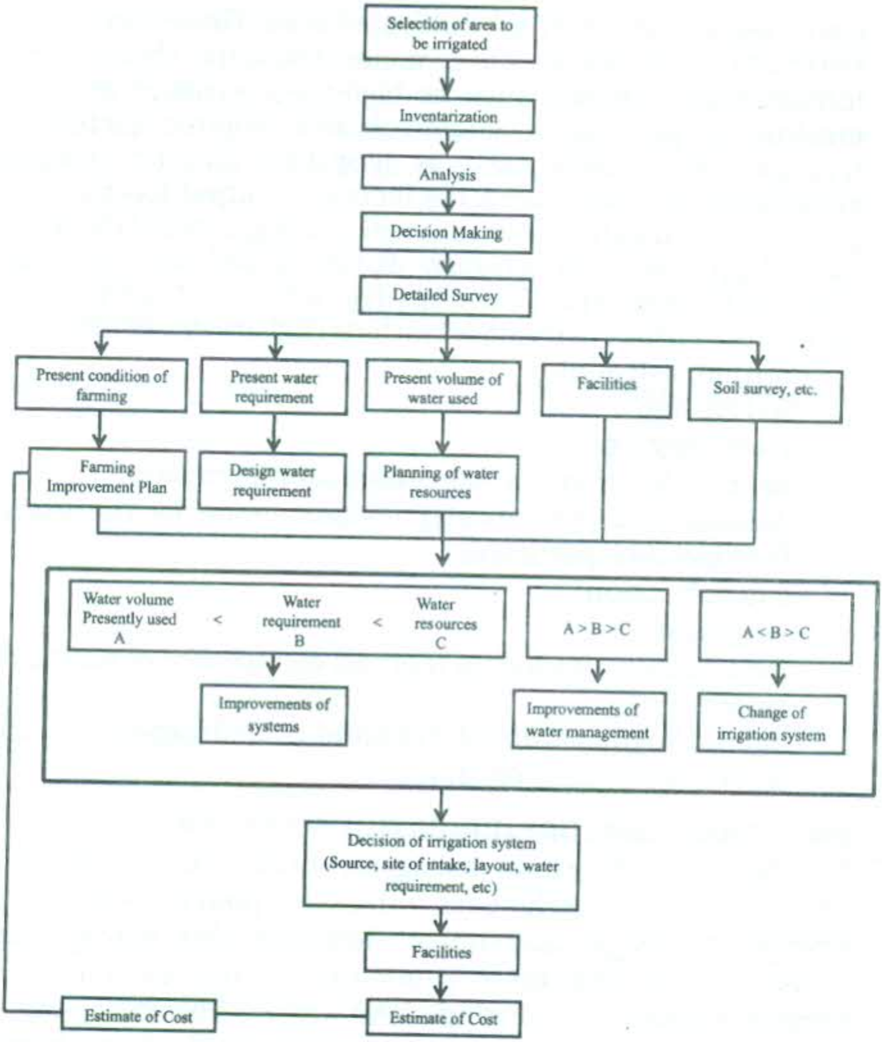


Fig. 4: Irrigation Planning

Source: Egharevba (2009)

5.2 Irrigated Agriculture and Its Environmental Impact

Any Sustained increase in output in agricultural production can be attributed to increase in output per capita, and in some countries, expansion of the cultivated area. These increases in agricultural produce were made possible through the introduction of inputs such as high-yield varieties of crops, machinery, pesticides, chemical and organic fertilizers, management systems such as irrigation and dry farming systems. On the other hand, the increased output has put great pressure on our natural environment. In many areas of the world, natural processes are seriously disturbed and non-renewable resources used up. The negative effects of unmanaged agriculture on the environment include (Egharevba, 2009):

- Soil nutrient mining
- Soil erosion
- Water logging
- Salinization of soils which causes land degradation
- Surface and groundwater contamination by the use of fertilizers and pesticides
- Eutrophication
- Acidification
- Deforestation leading to loss and disturbance of ecological system
- Habitat fragmentation, degradation of landscape due to land redevelopment and reclamation.

6.0 PARTICIPATORY IRRIGATION MANAGEMENT

Participation in irrigation management refers to the process in which all the stakeholders influence policy formulation, alternative design, investment decisions and management decisions affecting their communities and establish the necessary sense of ownership of the scheme. The willingness of farmers to participate in the management of irrigation schemes depends on the perception of the benefits derivable from such participation. The obvious benefits must clearly outweigh the cost to be incurred by the farmers' involvement in the management of the scheme. The persistence of maintenance problems in the main drain/irrigation channel which cuts across the entire project has lead to the creation of a Federated Water

Users Association (FWUA) which has the representation of all other sectorial Water Users Associations (WUAs) in order to be able to tackle problems that could not be handled by the individual sectorial WUAs. The main maintenance activities carried out were in the form of weeding, desilting and repairs of any damaged embarkment of the irrigation structures. The operational levels for maintenance purposes and the corresponding bodies as practised in the Hadejia valley irrigation projects are outlined in Fig. 4.

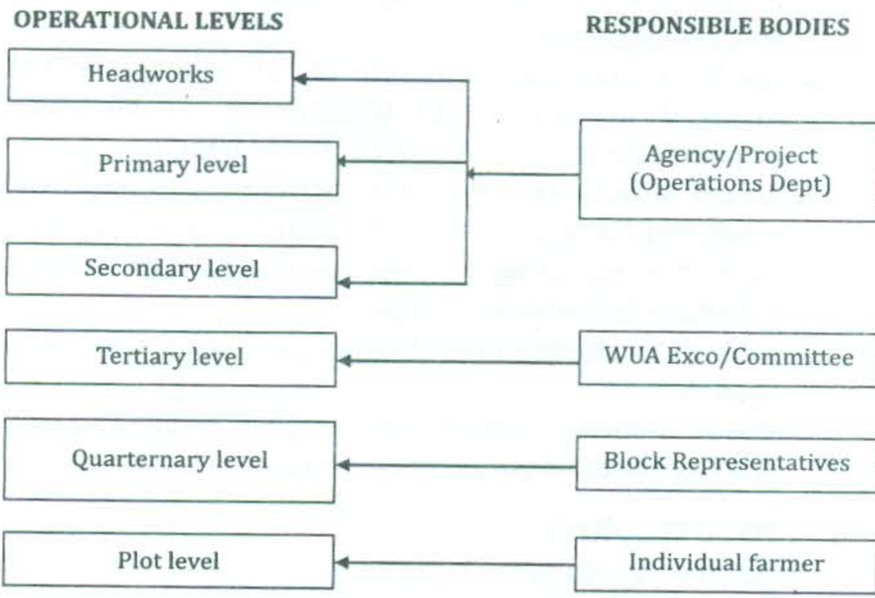


Fig. 5: Operational levels and corresponding responsible bodies

Source: Adopted from Kazaure, (2003)

Abubakar (2002) observed that the contribution of WUAs to system maintenance in Nigeria was about 15% of the total expenditure. Gerards (1995) reported that in Indonesia WUAs contribution to operation and maintenance costs could be up to 65–70%. Adequate incentives and proper guidance and encouragement as well as empowerment are the key element for sustained farmers' participation.

In Hadejia Valley Irrigation Project, the constraints of joint participation in irrigation management identified include (Garba, 2003):

i) Lack of adequate contact between the WUAs and their respective agency.
ii) Problems of inter-rivalry and the feeling of being marginalized by some villages constitutes a threat to farmers' participation
iii) The WUAs also needs further technical training as well as financial support (credit facilities) to enable them discharge their duties effectively and promptly.
iv) Access of farmers to essential inputs such as improved seeds, fertilizers, tractors etc need to be improved upon.
v) Lack of access to agro-processing and storage facilities especially for perishable crops.
vi) Lack of marketing opportunities and outlets for farm produce.

The combined effects of these problem resulted to very low cropping intensity especially during dry seasons.

7.0 FOOD SECURITY

The Food and Agriculture Organization (FAO) of the United Nations defines food security as a social condition "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. The key elements for food security to exist are (FAO, 1996):

* availability of food
* affordability (access by all) and
* adequacy (quality and nutritional value).

A major objective of the agricultural policy in Nigerian is the attainment of self sufficiency in basic food commodities with particular reference to those which consume considerable shares of Nigeria's foreign exchange and for which the country has comparative advantage in local production.

By 2009, the Federal Ministry of Agriculture estimated that the country (Nigeria) was spending over 3 billion dollars annually on food importation. Food per capita declined and the country faces high food security challenges (Falusi, 2014). At the current food production growth rate, Nigeria remains unable to feed its population. The food security challenges are growing with the population. Projections are that in 35 years time (2050), the world population will increase from the current 6 billion to about 10 billion and Nigerian current 170 million growing at a rate of over 2.8% will increase to well over 310 million. Therefore, the challenge for agricultural researchers and farm workers to meet the huge food demand is astounding. All forms of development must go hand in hand with food security as it is in other nations of the world. Nigeria is still far from meeting the 2015 deadline of World Food Security Summit commitments. Irrigated agriculture seems to be the only way out of the looming national food insecurity. Food insecurity can easily be traced to the root of different forms of violence and criminality taking place in our nation.

Mr. Chairman Sir, can we think of a line of agricultural production beginning from the seedling to the post harvest and marketing stages in this university? Yes we can, and can begin at small scale/pilot level. We have the required resources (human and materials) to take off without delay. With such pilot projects, the university will not only contribute to food security drive but to help solve job creation challenges as well. We can begin with the establishment of a database centre.

8.0 JOB CREATION CHALLENGES

The high level of dependence of agriculture on traditional production/processing implements is responsible for the disinterest in agriculture among the youths. Presently, the actual requirement for implements is largely uncertain owning to lack of inventory on farm machineries (NAERLS and NPAFS, 2010).

To attract and sustain the interest of youths in agricultural sector, concerted efforts must be made to ascertain inventory of farm machineries and effective and proper utilization of the few tractors available.

Nigeria is a country with vast areas of land waiting to be cultivated. Of the estimated 71million ha of cultivable land, only half is currently in use for farming. There is a similar potential for an expansion of irrigation, which only covers 7% of irrigable land (FAO stats/Nigeria). Table 4 outlines a number of strategic crops that can be produced in this fallow land that awaits cultivation. One time Israeli Ambassador to Nigeria, Mr. Moshe Ram once said, "This country (Nigeria) should go back to the basis and the basis is agriculture and feeding the people. There is the need to go back to agriculture and try to see how it could be developed and modernized and how technology could be applied in agriculture." Adeokun (2014) categorically asserted that agriculture can absorb 62 million youths. Just less than two years ago (2013), the Vice-President of the World Bank group reported that African farmers and agro-businesses can create a trillion dollar food market by 2030 if they can expand their access to more capital, energy (electricity), better technology and irrigated land to grow high value nutritious foods.

In a study undertaken by the British Council, it was reported that Nigeria's booming population of young people may be a great boom for the country's economy in the coming decades. The British council's study further added that if Nigerian government do not take steps to engage the youths, the country could face demographic disaster (British Council, 2010).

Table 4: Strategic Crops for Industrial Raw Materials in Nigeria

	Produce Category	Number of States involved (Nigeria)
1.	Cereals: Maize, Millet, Rice, Sorghum, Wheat, Acha	36
2.	Legumes: Cowpea, Bambara nut, Pigeon pea, Groundnut, Sword bean, Soya bean	32
3.	Roots and Tubers: Cassava. Sweet potatoes, Irish potato, Yam, Cocoyam, Ginger	30
4.	Fruits and Vegetables: Orange, Grape, Lemon, Tomatoes, Onions, etc.	37
5.	Industrial/Tree crops: Kolanut, Coconut, Oil palm, Cocoa, Neem, etc.	35
6.	Forest resources: Cotton, Sugar cane, Kernel, Timber, Rubber, Gum Arabic, Ginger, etc.	34

Source: Adapted from Bamikola et al (2013)

9.0 NOTABLE RESEARCH AND OUR LANDMARKS

At this junction, Mr. Vice-chancellor sir, eminent scholars, distinguished ladies and gentlemen, I humbly wish to highlight some of the modest efforts that we have made so far.

9.1 Lift Irrigation

A water driven wheel was designed in A.B.U., Zaria fabricated and tested in the distributary canal at the Kadawa station of the Kano River irrigation project, Nigeria. The lift irrigation device was operated by the stream current with no additional power source. With stream velocity of 0.8m/s, the speed of the wheel rotation was 3rpm, and the corresponding average discharge was 9 l/min at 1.5m pressure head. The water driven wheel had the ability of generating power of 5.25W when rotating at 3rpm. This project won UNESCO grant for further development. Though the power output and the discharge capacity were low, it is without operational cost and also has a twofold advantage of functional reliability and simplicity of design and fabrication at the village level. The performance of the water wheel at varying stream velocity is presented in Table 5.

Table 5: Relationship between Discharge (Q) power input (P_{in}), power output (P_{out}) and System efficiency

Stream Vel. (m/s)	N (rpm)	Q (l/s)	P_{in} (W)	P_{out} (W)	Eff. (%)
0.55	2.15	0.10	1.77	1.0	57
0.60	2.25	0.11	2.22	1.10	50
0.65	2.45	0.12	2.84	1.20	42
0.75	2.85	0.14	4.38	1.40	32
0.80	3.0	0.15	5.25	1.50	29

Source: Egharevba (1989)

9.2 Characterisation of Irrigation Pumps

Survey of irrigation water lifting devices commonly used in Nigeria during dry season was carried out in 1984. Lister, Honda and Yamaha motorised irrigation pumps (each of 75mm suction diameter) were acquired for comparative performance characteristics tests. The operating head as well as the discharge capacity was the highest for lister pumps at any given actual operating and simulated pump speeds.

Knowledge of performance characteristics of irrigation pumps is indispensable for proper selection. Such data are useful in matching pumps with the water source, soil intake rates, consumptive use of crops and hence, the total area that can be irrigated. The study further indicated that the information or specification supplied by manufacturers/dealers of irrigation pumps are inadequate and makes pump selection difficult.

9.3 Sub-Irrigation and Grain Yield

Sub-irrigation from an existing shallow water table will supply some of the crop water use requirements if that water table is at the proper crop rooting depth. Agricultural production, utilizing enormous portion of limited water resource, has been encouraged to utilize this resource with higher efficiency, not only to save the limited amount of water but also from environmental and energy conservation points of view (Yagi *et al.*, 1995). When existing shallow water table contributes to crop water use, significant water and energy can be saved in crop production (Egharevba and Mudiare, 1999). In one of our investigations, under green house condition, maize grain yield increased gradually from $0.3 kg/m^2$ at 10cm water table depth to a maximum value of $1.3 kg/m^2$ at 45cm water table depth (Table 6). Under open field condition for soils that consist of sandy loam to sandy clay loam, study showed that water table at 0.6 m to 1.0 m range can be very valuable for maize production. Thus, in developing an efficient and sustainable economic irrigation schedule, the knowledge of groundwater contribution to crop water use, together with its production functions under different soil water regimes are of practical importance (Egharevba, 2001). At Musa inland valley (Badeggi, Niger State), the groundwater contribution to groundwater use was up to 38% for water depth range of 0.5 to 1.0m. The study clearly showed that there are opportunities for second cropping in inland valleys (wet lands) of Nigeria. In some cases, depending on the crop under consideration, shallow water table can contribute up to 100% of the crop water requirement.

Table 6: Corn relative yield under greenhouse culture

Watertable depth (mm)	Relative grain yield (%)
100	23.1
200	37.1
300	45.4
400	100
450	100
600	80.0
Free drainage	50.8

Source: Egharevba et al (2001)

9.4 Appraisal of Irrigation Schemes

i) Transmission Losses in Canals of Chanchaga Irrigation Scheme

In the Chanchaga irrigation scheme, the mean seepage rates from the main canal and secondary field canals were obtained to be 0.014m/hr and 0.023m/hr corresponding to seepage loss of 20 % in the main canals and 24% in the secondary field canals. The mean depth of water table increment during the study period (2001 to 2002), resulting from canal seepage and surface runoff was 1.2m (Fig. 5). The study provides a base upon which decision for the rehabilitation and improvement in operation, maintenance and management of the irrigation system can be made.

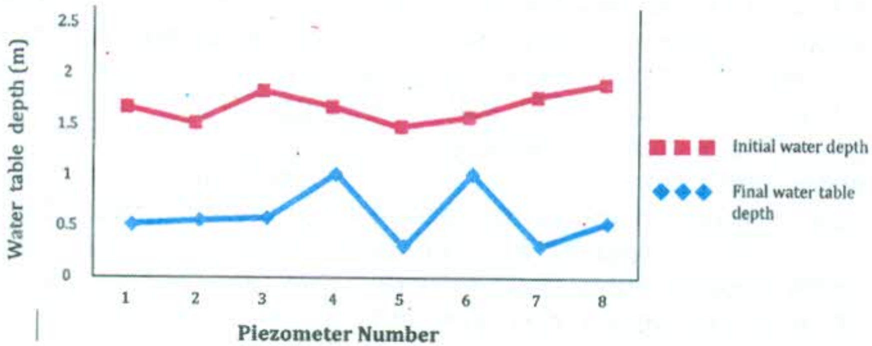


Fig. 6: Initial and final depths of watertable during 2002 irrigation season at Chanchaga irrigation scheme

ii) Economic Performance of the Chanchaga Irrigation Scheme

The result of the study of the economic performance of the Chanchaga irrigation scheme (2000-2002) indicated that the net returns and the benefit cost ratios were high (benefit-cost ratio = 2.60). Thus, the benefit from promoting small-scale irrigation schemes are worth of consideration by all policy makers interested in increasing agricultural output.

iii) Performance Assessment of the Jibwa Irrigation Scheme, Niger State

Jibwa Irrigation scheme of potential area of 95 ha, is one of the irrigation schemes developed by the Niger State Agricultural Development Project (NSADP) in Nigeria under its fadama development programme in 1994. The performance was evaluated in terms of the schemes physical infrastructural management and economic condition. The score grades used for the performance measures are given in Table 7. The scheme development ratio (SDR), environmental stability index (ESI), financial self-sufficiency index (FSI) and water conveyance efficiency (WCE), performance indicators obtained were: 44%, 96%, 82% and 43%, respectively (Tables 8 & 9). Figure 6 summarises the Jibwa scheme quantitative checklist of identified performance measures during the 2004 irrigation season. The major constraints affecting the performance of the irrigation scheme were lack of improved water distribution systems, access to tractors and fertilizers, poor access road, lack of storage facility, poor marketing of products and inadequate irrigation water pumps in the scheme.

Table 7: Score Grades Used For Performance Measures

Variable Score (%)	Grade	Qualitative Interpretation
0	0	Bad
1 - 49	1	Very Poor
50 - 69	2	Poor
70 - 89	3	Adequate
90 - 100	4	Good

Source: Ijir and Burton (1998); Egharevba and Sani (2006)

Table 8: Quantitative Performance Assessment of Selected Indicators of Jibwa Irrigation Scheme

S/N	Selected performance indicators	Type of Indicator	Achievable or target value	Actual value on scheme
1	Scheme Development Ratio	Process	100%	44%
2	Structure Condition Index	Input	100%	33.33%
3	Water Availability Index	Input	2	1.58%
4	Environmental Stability Index	Output	100%	96%
5	Crop Planting Date Indicator	Process	100%	62.22%
6	Cropped Area Index	Output	100%	50%
7	Financial Self Sufficiency Index	Process	100%	81.74%
8	Water Conveyance Efficiency	Input	80%	43%
9	Water Application Efficiency	Input	70%	40.04%
10	Fertilizer Application Index	Input	100%	40%
11	Mean Relative Crop Yield (Tomato)	Output	100%	45%
12	Field Water Use Efficiency (Maize)	Output	$1.6kg/m^3$	$0.7kg/m^3$

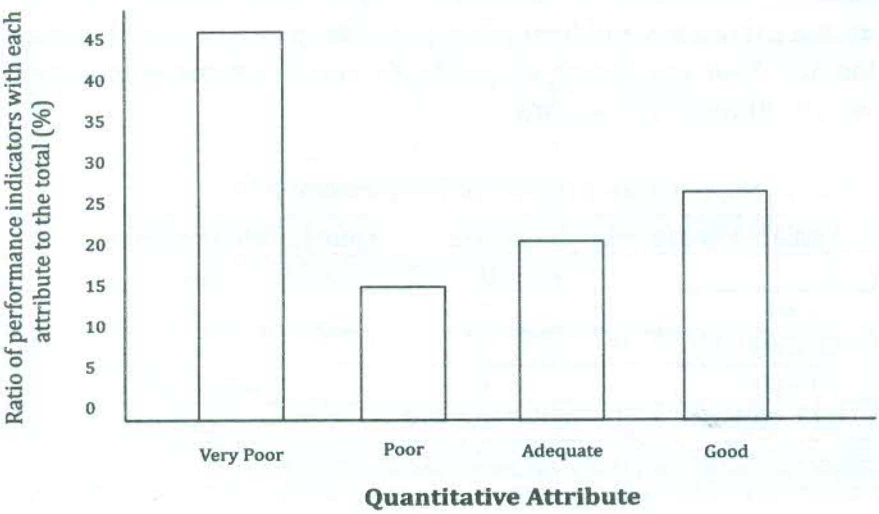


Fig. 7: Jibwa Irrigation Scheme quantitative checklist of identified measures during 2004 irrigation season

9.5 Crop Yield Prediction Using DSSAT Simulation Model

DSSAT is a software package integrating the effects of soil, crop phenotype, weather and management strategies to predict yield. DSSAT simulates crop growth, yield, water and nutrient uptake and environmental impact on agricultural production (Japtap *et al*, 1992; Sharon, 2004). DSSAT model has been used in Arkansas (USA) to help with early season soya-bean planting dates and in Georgia for predicting agricultural water usage as well as in some parts of Africa to diagnose yield loss of peanut crops from diseases (Boote, 2004).

In 2010, the DSSAT was tested in Minna, Niger State. The model over predicted the SOSSAT millet variety by 29%, 53% and 51% at irrigation intervals of 3, 5 and 7 days respectively. Similarly, DSSAT over-predicted millet local variety by 35%, 32% and 21% at 3,5 and 7 days irrigation intervals respectively (Maina and Egharevba, 2010). The next stage of the study is the calibration and validation of the model to match Nigeria's environment

9.6 Reservoir Sedimentation

Dam design and reservoir operations and maintenance are important aspect of Soil and Water Engineering. Reservoirs being an important source of irrigation water and domestic water supply need to be monitored and maintained. We embarked on the evaluation of sediment loads of the Kubanni reservoir located at Zaria during my sabbatical at Ahmadu Bello University, Zaria. The investigation showed that the total volume of sediment transported into Kubanni reservoir was estimated to be 74.94 m^3/yr. The loss of the reservoir capacity due to siltation was estimated to be 1.016×10^6 m^3 with a siltation rate of 2.988×10^4 m^3/yr. The study showed that the reservoir will be completely silted up in less than 30 years time. Mr. Vice-Chancellor sir, as I speak, dredging work is in progress at Kubbani reservoir located at A.B.U., Zaria consequent upon the recommendation of the study.

10.0 CONCLUDING REMARK

Nigeria is among the nations where irrigated agriculture is the only way left to grow enough crop produce for the population growing at the rate of 2.8% per year, the size of which is evident to have surpassed the limits of the carrying capacity of traditional agriculture. To attain a sustainable and competitive farming practices capable of meeting growing domestic and export demand for food commodities, a lot more efforts in terms of measures and incentives are required. Improved productivity of the agricultural sector and indeed the irrigation sub-sector in particular, would contribute significantly to reduce the trade deficit which is dominated by food and fiber imports. The absence of adequate infrastructure is hampering transference of functional agriculture to every area of the country. Weak and inadequate agricultural extension delivery can be identified as a short fall in the nation's agricultural architecture, as well as, the disconnect between researchers and the industries and the farm operators. Thus, the huge resources expended on agricultural research results hardly get to the door step of the farmers and farm workers. It is therefore regrettable that the opportunity of a full exploration and exploitation of agricultural value chains is never fully realized.

RECOMMENDATION

At the moment, the agricultural sector lacks detailed and accurate up-to-date information on agro-geographical potential of each state of the federation. Information and communication technology is critical to agricultural productivity and development of business linkages and trade. For increase access to market data, it is critical to connect farmers, agro-dealers, processors and other stake holders along agricultural value chain to market opportunities. Data must include research results on crop varieties, where they can be planted, trade statistics, directories of supplies and agro-dealers among others. For the agricultural sector to attract more international investors, there is need for a comprehensive data base which should provide credible sources of market information for all stake-holders.

In addition, the government and the private sector must encourage agric- business through incentives to help them respond to local and international market demand for high quality products. The pervading issues of lack of modern farming knowledge, poor agricultural practices as well as depletion and degradation of the ecosystem should be urgently addressed. The youths in Nigeria have a lot of opportunities in agricultural sector, but they need to be enlightened and well motivated on how to exploit these opportunities at the various ward levels. To attract and sustain the interest of youths, concerted efforts must be made to ascertain inventory of tractors and farm machineries, easy access to credit facilities, improved seeds/seedlings, fertilizers, energy need, research information, farm security/safety, and irrigation facilities. To this end therefore, member states of African Union including Nigeria are urged to implement their commitment of allocation of at least 10% of national budgetary resources to agriculture so as to reverse the declining investment in the agricultural sector.

Finally, it is recommended that we look back into ancient Egypt and adopt the Pharaoh and Joseph model. In that model, King Pharaoh had a dream of climate change that will have adverse effect on the crop yield and animal production. Joseph, son of Jacob came up with an inspiring solution of a coordinated strategy plan on marketing of the farm produce, processing and storage of excess grains for future use (14 years rolling plan) to take care of domestic demand and export to foreign nations. In this Pharaoh-Joseph model, all stake holders were involved in the planning stages and management of the agricultural project. The crop production was fully under private control while the post harvest storage facilities and other infrastructural investment were that of the government. It was a good example of Public-Private-Participation initiative. As a result, Egypt had a breakthrough in food security and was able to generate considerable job opportunity for many.

Ladies and gentlemen why the wait? We don't have to delay anymore. To make a difference, we need be positive and act differently. Let's embrace change and adopt the "Pharaoh-Joseph model" as a matter of national urgency in line with our quest for food security and job creation.

Thank you.

ACKNOWLEDGEMENTS

Mr. Vice-Chancellor, Sir, my ability to successfully deliver this lecture is a sum total of God's faithfulness and His loving kindness over me. Time and space will not allow me to also appreciate the contributions of individuals and groups of people all through my life's journey to date. May the good Lord reward them all according to their labour of love.

My Parents: I pay great tribute to my father and mother (Engr. T.J. Egharevba and Madam V. O. Obaseki), for their sacrifice to train me despite their limited financial resources. I am grateful for your care, support and love. I am glad you are both alive to witness this day. My mum is present here while my dad is well represented.

My Family: I am very grateful to my dear wife, Mrs. Millicent Olapetan Egharevba. I cherish the kindness, love, encouragement and support you have given me in these past 23 years we have lived together. I want to thank my dear children, Toluwani and Samuel for their constant cooperation and support.

My Pastors: I am most grateful to Pastor W.F. Kumuyi, General Superintendent, Deeper Christian Life Ministry, my state overseer, Pastor Araromi and his wife, mummy Araromi for their counsel, ministration and constant payers. I am also grateful to all other pastors present here -- including ministers from AFCS for their prayers and care.

My Deans/HODs/Colleagues: I am grateful to present and past Deans (SEET) and Heads, Department of Agricultural and Bioresources Engineering. I cannot forget to mention my colleagues in ABE as well as in other Departments in School of Engineering (SEET) and in other Schools (FUT, Minna). We have all lived together as a family.

My Brothers/Sisters & Relatives: I am most grateful to my Step Mother, Mrs Mabel Egharevba for her motherly care all along. I cannot fail to mention Dr. Ameh Egharevba, Erhunmwon, Osariemwen, Imuetiyan as well as Eddy, Osaretin, David, Victor, Augustine, Adelani, Augustar, Nosakhare (Jnr), Afediosa, etc. and their parents. I appreciate my uncles (Mr Abiodun Obaseki & Gabriel Obaseki), my aunties (mama Ighodaro, Adesuwa Sodipo and their entire family members). I must have to say a big thank you to Emmanuel Kuusu- a long standing friend who stood like a true brother to me. I thank him and his family for their hospitality each time I am in Zaria.

My Teachers: I appreciate greatly the roles placed by my teachers, right from primary school level. I am grateful to all my research project supervisors especially Professor O. J. Mudiare (my PhD research project supervisor).

My In-laws: I am specially grateful to Prof. Tim Ajani and family, Mrs. Carol Iwegbu and family as well as Mr. Taiye and Kehinde Ajani and their entire family and the host of others.

University Administration (Past and Present): I appreciate them all for giving me the opportunity to learn, teach, participate in research work and contribute to knowledge.

My Students: I am grateful for your cooperation and sense of duty.

Thank you all for your patience and attention. God bless.

REFERENCES

Abubakar, S. Z. (2002). Development and Application of AFJM Concept in HVIP, Nigeria. Unpublished PhD thesis, Department of Agricultural Engineering, A.B.U., Zaria – Nigeria.

Adekun (2014). The Nation - Nigerian Daily Newspaper Wednesday. March, 2014. Pp 46

Ahmed, A. (2003). Irrigation Schemes and the Fadama Farming: A Historical Perspective. In: Promotion of Participatory Irrigation Management in Hadejia Valley Irrigation project, Nigeria: Experiences on Approaches, Lesson and Prospects Synthesis Book. NAERLS/A.B.U., Zaria.

Alexandratos, N (ed) (1995) World Agriculture Towards 2010. An FAO Study. Food and Agriculture Organization of the United Nations.

Bamikola, G. B., Ode, F. K., and Olaniyan, S. B. (2013). Investment opportunities in Raw Materials Development. RMRDC Technical Publ. series 13.1. Raw Materials Res. & Dev. Council, Fed. Min of Science & Tech. pp 880 – 872.

Central Bank of Nigeria – CBN (2001). Economic and Financial Review Vol. 36 No. 1

Egharevba, N. A. (1989). Performance of a water driven wheel for low lift irrigation. Proceedings of the 11th International Congress on Agric. Engineering, Dublin. Pp727-730

Egharevba, N. A. (2009). Irrigation and Drainage Engineering: Principles, Design and Practices. Jos University Press.

Egharevba. N. A. (1999). Monitoring and Modeling Watertable fluctuation for soil moisture studies. *Journal of Modelling,* *Measurement and Control, ASME,* 69160 – Tassin, France 19(2): 23 – 26.

Egharevba, N. A. (2005). Evaluation of Transmission losses in unlined canals of the Chanchaga irrigation project, Niger State, Nigeria. *Journal of Sustainable Tropical Agricultural Research,* 15:58 – 63.

Egharevba, N. A. (2010). Evaluation of Aquifer Potential of Hand Dug Wells in Zaria, Kaduna state, Nigeria. Nigerian Journal of Engineering 16(2): 14 – 16.

Egharevba, N. A., Amadi, A. N., Olasehinde, P. I., and Okoye, N. O. (2010). Seasonal variation in the Physico-chemical and Bacteriological characteristics of Perched Aquifer water at Zaria, Nigeria. Int. Journal of Chem. Sci 3(1): 100 – 107.

Egharevba, N. A., and Mudiare, O. J. (1999). Depth to water table and corn yield under green-house condition using sandloam soil. Zuru Journal of Agric. 1(1)21 – 26.

Egharevba, N. A., Mudiare, O. J., and Adewumi, J. K. (2001). Estimation of groundwater contribution to corn water use in Musa Inland Valley, Badeggi, Nigeria. Proceedings of the 3rd Annual Engineering Conference of Sch. of Engineering & Engineering Tech., F.U.T., Minna, Nigeria. pp 98 – 103.

Egharevba, N. A. and Mudiare, O. J. (1999). Maize water use and performance under shallow watertable conditions. Proceedings of the International Seminar on Performance of large and small scale irrigation schemes in Africa held at Abuja, Nigeria. pp. 133 – 139.

Egharevba, N. A., and Otitolaiye, J. O. (2004). Financial performance of the Chanchaga Irrigation project, Niger state, Nigeria. Journal of Sustainable Tropical Agric. Research 15:58 - 63.

Egharevba, N. A., and Sani, M. A. B. (2006). Performance Evaluation of Jibwa Irrigation scheme, Niger state, Nigeria. Ife Journal of Technology. 15(1): 63 – 72

FAO (1993). Integrated Rural Water Management - Proceedings of the Technical Consultation of Integrated Rural Water Management, FAO, Rome.

FAO (1996). Report of the world food Submit, Rome, Italy. http://www.fao.org/docrep/0031/w3548e/w3548eoo.htm. Accessed 1st April 2015.

Falusi, O. (2014). Plant Genetic Resources and Food Security: incredible generosity, incredible responsibility. Inaugural lecture series 31, F.U.T. Minna - Nigeria.

Garba, H. (2003). Participation of water users' Association in System Maintenance. In: Promotion of participatory irrigation management in Hadejia Valley irrigation project, Nigeria. Synthesis Book, NAERLS/A.B.U, Zaria, Nigeria. pp 118 -123.

Gerards, L. M. H. (1995). Irrigation service fee (ISF) in Indonesia: Towards irrigation co-management with WUAs through contributed, voice, accountability, discipline and landwork. Irrigation throughout transfer (eds. Johnson, Vermillion and Sagardoy), Water Report of FAO and IIMI. pp 285 – 300.

Hansen, V. E., Isrealsen, O. W., and Stringham (1980). Irrigation Principles and practices. 4th Edition. John Wiley & Sons, New York. Pp. II.

IMMI (1992). Report of a mission to Nigeria for medium – term plan. IMMI, Dogana village, Sri Lanka.

Ingawa, S. A., Oyebanji, O. O., and Chude, V. O. (eds). National Position Paper on Nigeria's Performance in the 1999 World Food Summit Commitments and AU Nepad 2003 Maputo Declaration on Food Security in Africa, Pp 45-86.

Joptap, S. S., Mormi, M. and Kang, B. T. (1992). Simulation of Growth Development and Yield of Maize in the Transition zone of Nigeria. Agric. Systems, 41: 215 – 229.

Kazaure, Y. D. (2013). Organizational Aspect of Water Management. In: Promotion of Participatory Irrigation Management in Hadejia valley Irrigation project, Nigeria: experiences on Approaches, lessons and prospects. Synthesis Book, NAERLS/ABU pp 86 – 87.

Maina, M. M. and Egharevba, N. A. (2010). Prediction of Yield in Irrigated Pear Millet Yield using DSSAT Simulation Model. Journal of Engineering 6(2): 14 – 26.

Musa, I. K. (2007). National Irrigation Policy and Strategy for Nigeria. Keynote Address. Proceedings of the 13th National Irrigation and Drainage Seminar, Minna – Nigeria.

NAERLS and NPAFS (2010). Agricultural Performance Survey of 2010 Wet Season in Nigeria. NAERLS Press. Pp 8b.

National Water Resources Master plan – NWRMP (1995). The report of a study carried out by Japan International Co-operation Agency (JICA) with NWRMP team for Federal Ministry of Water Resources and Rural Development, Federal Republic of Nigeria. Sector Report, Vol. 2, part 2. Prepared by Sanyu Consultants Inc and Sumiko Consultants Co., Ltd.

Nwa, E. U., Adeniji, F. A., and Kwanshie, J. (1999). Status of irrigation in the Three Ecological zones of Nigeria. Proc. Performance of large and small scale Irrigation schemes in Africa. ICID/NINCID. Abuja pp. 263 – 275.

Oche, J. A., Egharevba, N. A., Otache., M. Y. and Shaba, I (2013), physico-chemical and Microbial Water Quality Assessment of Selected wells in Bida catchment area of Niger state, Nigeria. Proceedings at the 3rd Biennial Engineering Conf. held at F.U.T. Minna pp 45 – 429

Singh, A., and Maurya (1979). Salinity status and water logging in irrigated Agriculture of Northern Nigeria. Paper at the 6th National Irrigation and Drainage seminar, Zaria- Nigeria.

Storberger C. (1993). Planning and Design of Irrigation and Drainage systems. Transaction of the 15th Congress of Irrigation and Drainage. The Hague, Netherlands. pp 1 – 11.

Yagi, K. H., Murase, H., and Honami, N. (1995). Automated evapotranspiration rate measurement using Bowen ratio technique for development of intelligent irrigation system. Proceedings of ARIBIP, Kobe, Japan pp 169 – 174.

www.faostat.gov.ng accessed March, 2015

www.nigeriastat.gov.ng accessed Feb. 2015

Profile of the Inaugural Lecturer

Engr. Professor Nosa Anthony Egharevba was born on 8th of March, 1959 in Lagos, Nigeria. He attended Saint Joseph Primary School, Benin and thereafter proceeded to Evboneka Anglican Secondary School, near NIFOR (spent only a year here) and then relocated to Bishop Kelly College, Benin. He finished his secondary school education in 1976 and then got admission into Edo College, Benin for his higher school (Advanced Level) education. He thereafter proceeded to Ahmadu Bello University (A.B.U), Zaria where he bagged his B.Eng (Agric. Engineering) in 1982. He was the best graduant and his final year project on "Design and Construction of Water Wheel for Lifting Irrigation Water" won a UNESCO grant for further development.

He was in Calabar in 1982/83 for his National Youth Service under the then Nigerian Palm Produce Board (NPPB).

Engr. Professor Egharevba obtained his M.Sc. (Agric. Engineering) in 1986 and PhD (Agric. Engineering) - Soil & Water Engineering option in A.B.U., Zaria in 2000. He joined the services of the Waziri Umaru Polytechnic, Birnin Kebbi, Kebbi State, Nigeria as a lecturer in 1985. He was there until 1988 and then relocated to the Federal University of Technology, Minna on 1st October 1988. He progressed steadily from lecturer II in the Department of Agricultural and Bio-resources Engineering to the rank of a professor in 2011. Engr. Professor Egharevba had served the University under numerous committees including Academic and Professional Board, Centre for Preliminary and Extra Mural Studies, School of Engineering Examination Officer, SIWES Coordinator (SEET), SWEP Coordinator (SEET) and Students Disciplinary Committee (SDC). He also served as sub-Dean and Acting Deputy Dean, School of Engineering and Engineering Technology, FUT, Minna.

Professionally, Engr. Professor Egharevba's research interest and expertise include soil and water conservation; Environmental impact assessment (EIA) for irrigation and water resources development projects; design, fabrication, installation, operation, monitoring and evaluation of irrigation and drainage network systems. He has supervised several undergraduate and postgraduate diploma students, and has successfully supervised over twenty masters and four PhD students. In addition, he has served as External Examiner in various universities.

He is a member of the Nigerian Society of Engineers; Oversees Development Institute (ODI), London Irrigation Management Network, and has been duly registered by the Council of Regulation of Engineering in Nigeria (COREN). Engr. Professor Egharevba has numerous publications in reputable national and international journals. He fully participated in the EIA study for Auna (Kotangora) dam and irrigation project, Niger State and in the Irrigation master plan design for lawns/green areas and flowers/shrubs in the Federal Capital City, Abuja, Nigeria in 2011.

Engr. Professor Egharevba loves listening to gospel music. He is happily married to Olapetan (a seasoned chorister) and they are blessed with two children (Toluwani and Samuel).