FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

STOMACH INFRASTRUCTURE, AGRIPRENEURSHIP AND OUR ENVIRONMENT

By

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INAUGURAL LECTURE SERIES 32

11TH DECEMBER, 2014

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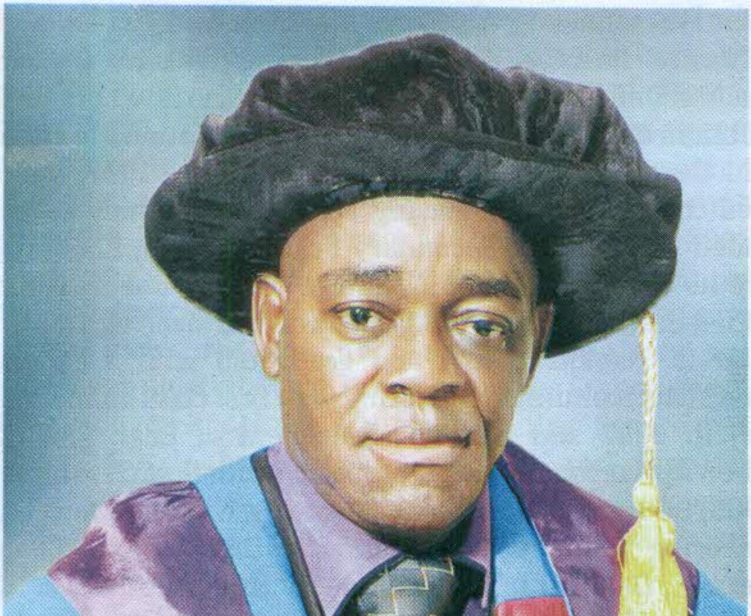

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Profiling the Inaugural Lecturer

Ogbonnaya Chukwu was born on 15 July, 1965 in a rural subsistence farming and wine tapping village, Obuno, in Amanator, Onicha Igboeze, Ebonyi State, Nigeria, where he lived and obtained his primary and secondary education. He attended Onicha Central School, Ebonyi State from 1972 – 1977, where he passed the first school leaving certificate at Credit level. He attended Government Secondary School, Afikpo, Ebonyi State where he obtained his WASC/GCE in Division one in 1982. He attended the department of Agricultural Engineering, University of Nigeria, Nsukka (UNN) and graduated with a bachelor's degree in Agricultural Engineering with first class honours (*cum laude*) in 1987 and became a recipient of Engr. Prof. E. U. Odigboh's prize for students graduating with first class honours. In 1985/86 session, he was the Secretary, Nigerian Universities Engineering Students' Association (NUESA), UNN Chapter; Secretary, Ohaozara Federation of Undergraduates, UNN Chapter; and Secretary, Agricultural Engineering Students' Association, UNN. In that session his CGPA dropped from 3.21 to 3.18 on 4 points scale and as a result he quitted students' unionism and politics. He obtained his Master's degree in Agricultural Engineering (Crop Processing & Storage) in the Department of Agricultural Engineering, UNN in 1995 and his PhD in the Department of Agricultural Engineering, Federal University of Technology (FUT) Minna in 2006, specialising in Food Engineering. In 2007, he obtained postgraduate diploma in education (PGDE) (Science Education) from the National Teachers' Institute (NTI), Kaduna.

His working experiences span from 1987 to date. He did his compulsory national youth service corps (NYSC) between 1987 and 1988 in the Departments of Mathematics and Physics, Federal College of Education (FCE) Kontagora, Niger State, Nigeria where he was appointed Head, Department of

Mathematics during the 1988/89 contact session. In 1988 he was employed as a Lecturer in the Department of Technical Education, FCE Kontagora and joined the services of FUT Minna as an Assistant Lecturer in the Department of Agricultural Engineering in 1992. When he completed his Master's degree, he was upgraded to the rank of Lecturer II in 1995; promoted to the rank of Lecturer I in 1999; Senior Lecturer in 2006; Associate Professor in 2009 and Professor in 2012. Between 2008 and 2009, he was a Visiting Consultant to the Department of Soils, Water and Agricultural Engineering, Sultan Qaboos University Muscat, Oman. He has held many administrative and management positions and served in many Committees (both statutory and ad hoc) in FUT Minna including: Senate member; deputy Dean, School of Engineering and Engineering Technology; member, Postgraduate School Board; member, University Board of Research; Director of collaborations, affiliations and linkages and Council member.

His research interest includes nutritional analysis of agricultural products; impact auditing of food processing industries; impact prediction, simulation and modelling; assessment of grain storage methods, structures and losses; sorption models and farm products stability during storage; and mapping postharvest losses of farm produce. He has supervised 78 undergraduate students; graduated 2 doctorate students and co-supervised one (now a Professor and seated in this hall) and currently supervising three. He has also graduated 6 master's students and currently supervising 4 in Nigeria and South Africa; and has graduated 8 postgraduate diploma students. He has published **62** journal papers (**10** in national and **52** in international journals) and **11** conference proceedings (national and international). He has also presented **11** conference and workshop papers (national and international); **9** invited papers at conferences, seminars, and occasional publications and has **2** technical papers to his credit. He is a member of **7** professional bodies (national and international) including Council for the Regulation of Engineering in Nigeria, Nigerian Society of Engineers, Nigerian Institution of Agricultural Engineers, American Society of Agricultural & Biological Engineers, Asian Association for Agricultural Engineering, European Society of Agricultural Engineers and Teacher's Registration Council of Nigeria. He is a Fellow of African Scientific Institute (*f*ASI).

He is a reviewer to many national and international journals including international journal of association for modelling and simulation techniques in enterprises, Lyon France; international journal of postharvest technology and innovation, Switzerland; Caspian journal of environmental sciences, University of Guilan, Iran; agricultural engineering international (CIGR); Pertanika journal of science and technology, University Putra Malaysia. He is a member, board of trustees, international centre for integrated development research; editor and member of editorial board, international journal of agricultural engineering and member, editorial board, international journal of postharvest technology and innovation, Switzerland. He is an external examiner to many universities at home and overseas and chief examiner to National Examinations Council (NECO) Nigeria since 2000. He was an examiner to the West African Examinations Council (WAEC) from 1989 to 2011 before he voluntarily retired. He was Treasurer, Academic Staff Union of Universities (ASUU), FUT, Minna Chapter from 1998 – 2000.

He is a minister of the gospel of Jesus Christ and loves the Lord. He is married to Nnenna and they have four children; Gideon (21), Marvellous (17), Daniel (15) and Mercy (10).

STOMACH INFRASTRUCTURE, AGRIPRENEURSHIP AND OUR ENVIRONMENT

I would like to begin this lecture by thanking the Almighty God who put it in the heart of my late brother, Dennis Chukwu, to ask my parents to send me to school. Due to his advice, I was picked from the backside of Nkwo forest of Onicha Igboeze where I was busy tending my father's goats and gathering mushroom to enrich the family meals of *akpu* (cassava meal), *ofe egusi* (melon soup) and *ofe achi* (from seeds of mahogany tree) and registered into primary one in 1972 in Onicha Central School. Today, the village boy, goat tender and mushroom gatherer is a Professor standing before men and women of repute and honour to deliver an inaugural lecture. To God is the glory.

An inaugural lecture is an occasion of significance in the career of an academic staff member in the University. An inaugural lecture provides Professors with the opportunity to inform colleagues, the campus community and the general public of their work to date, including current research and future plans. An inaugural lecture is a ceremonial occasion, and academic robes are worn by the inaugural Professor and the rest of the platform party.

1. Introduction

Over the past fifty years, the environmental problems experienced throughout the world have forced both developed and developing countries to question and re-assess their methods of planning and administration of their environment (Chukwu, 2005). For quite some time now the issue of development vis-à-vis environmental protection has become one problem that has continued to generate heated debate especially in developing countries. This is so because, first, environmental quality itself is part of the improvement in welfare that development attempts to bring. If however, the benefits from provision of more foods for the people and raising incomes offset the costs imposed on health and the quality of life by pollution, this cannot be called development. Secondly, environmental damage can undermine future productivity. Consequently, the need to audit the environmental impact of food processing industries was recognised by the Governing Council (GC) of United Nations Environmental Programme (U N E P) in 1990 (UNEP/GC, 1990).

Establishment of a food processing industry and in general, industrialisation is an activity promoted by governments in their developmental strategies to make a significant contribution to enhancement of human welfare through the provision of value - added food products. Food processing industrial operations or processes involve the conversion of raw materials and resources into semi-finished and/or finished products. As the conversion can never be completely total, residuals in the form of energy and matter will be formed. If the residuals are not utilised they become waste, and, if discharged into the biosphere, can become pollutants to receiving bodies such as air and water (World Bank, 1978). The degree to which the pollutants affect the physical environment depends upon their quantitative and qualitative characteristics as well as the receiving media. Some pollutants are readily biodegradable, while others persist for a long time and may not even decompose. Also, some pollutants have low toxicity, whereas others are highly toxic and/or carcinogenic even in trace quantities. In addition to effects on the physical environment, food processing industries also have societal impacts. Their impacts are generally much more difficult to assess and often cannot be perceived at the initial stages because of complex interacting, synergistic and symbiotic factors which do not follow any known rules. As these societal impacts can be very significant, they need to be considered at the national level during strategy formulation/planning and policy making (Barnor, 1993).

The truth is that the world as a system is finite, entropy keeps shooting up; more carbon dioxide (CO_2) and carbon monoxide (CO) are being produced than the rate they are scrubbed; more soil aggregates are being pulverised than the rate of aggregation; more gases (particularly toxic ones) are being released than the system is capable of converting; more fishes are being killed than are born; more freshwater is being consumed than made; and more trees, grasses, animals, human energy and oxygen are being consumed and utilised than are replaced. The ultimate picture is that the world is living on reserves of resources that are not being replaced, hence the fear that the end is near. This is because soils that are degraded, aquifers that are depleted and the ecosystems that are destroyed in the name of raising incomes today can jeopardise the prospects for earning incomes tomorrow (Chukwu, 2008a).

The area in which a food processing industry is sited has an important effect on the subsequent environmental impact. For instance, the physical impact would be less pronounced if the industry is not constructed in an ecologically fragile area with poor assimilative capacity. Similarly, if the industrial area already has an established socio-economic structure with schools, houses, markets, health services and water supplies, as well as an existing population with industrial jobs, then the societal impact caused by a new industry will be less and the marginal effects may not be noticeable (UK Department of the Environment, 1976).

It is generally agreed that food processing industries have impact on the physical and socio-economic environments. What is not known is the degree of impact, and whether the impact can be assessed and evaluated before they occur, so that they can be better controlled and managed. The issue of concern to me in this lecture is to relate agripreneurship which has been triggered off by the quest by man to fix stomach infrastructure and the impact of this relationship on the environment. I will, as much as I can, qualify and quantify the impacts and suggest mitigation measures for the attenuation of negative impacts. To do this I will use a key tool called environmental impact audit (eia) which is a method for environmental impact prediction and management.

2. Stomach Infrastructure

2.1 The Stomach

The stomach of man is an organ between the oesophagus and small intestine (Figure 2.1). The stomach has three tasks. It stores swallowed food. It mixes the food with stomach acids. Then it sends the mixture on to the small intestine. Because it is a distensible organ, it normally expands to hold about one litre of food (Sherwood, 1997).

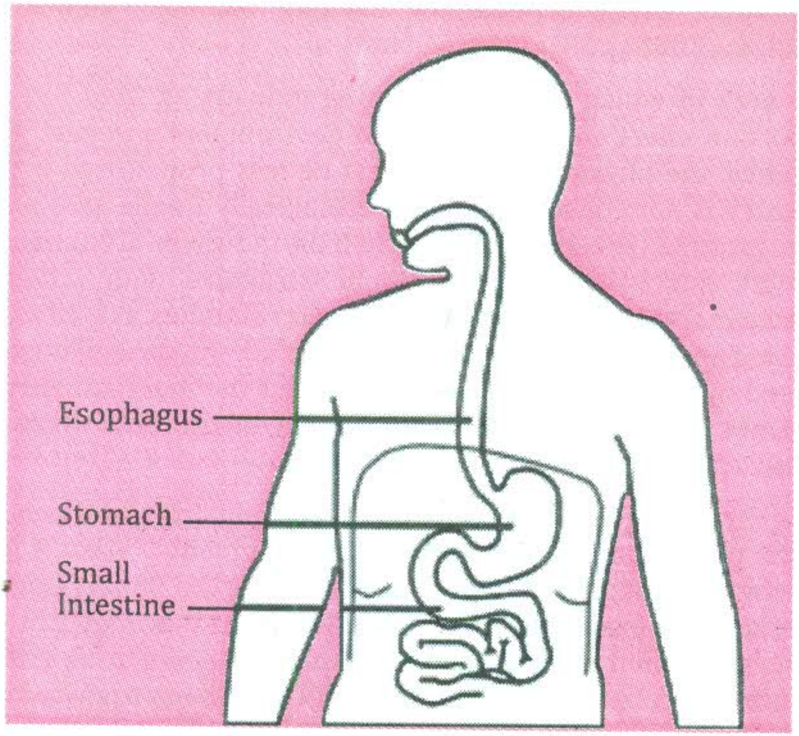

Fig. 2.1: The Stomach is located in the centre of the human body

Source: Wikipedia, the free encyclopedia (2014)

2.2 Infrastructure

The word infrastructure refers to the basic physical and organisational structures needed for the operation of a society or enterprise (Online Compact Oxford English Dictionary, 2014), or the services and facilities necessary for an economy to function (Sullivan and Steven, 2003). The term typically refers to the technical structures that support a society, such as road, bridges, water supply, electrical grids, telecommunications, and so forth, and can be defined as 'the physical components of interrelated systems providing commodities and services essential to enable or sustain or enhance societal living conditions' (Fulmer, 2009). Infrastructure can be hard or soft.

In this lecture, I will use the term hard infrastructure to refer to the physical networks (head, legs, hands, etc) necessary for the functioning of man, whereas soft infrastructure will refer to all the nutrients from food products which are required to maintain the health, economic, cultural and social standards of a person, such as the proteins, carbohydrates, vitamins, minerals, fats and oils. The essence of soft infrastructure is the delivery of specialised functions to a person. The delivery of those functions depends on the quality of what we eat, so healthy eating will be discussed.

Food, clothing and shelter are the three basic necessities of life of which food is the most important. If you put on good clothes and dwell in a good house but have no food, you are actually naked and in the streets because sooner than later you will sell your clothes and house to buy food. Food is so important that even Jesus Christ taught his disciples in the gospel according to Saint Matthew, Chapter 7 and verse 11 to pray to God thus: "Give us this day our daily bread" (The Holy Bible). And anyone in this hall, who has not taken food today, even water, should raise up his/her hand. So stomach infrastructure is a key policy developing nations must address. A recent UN report states the existence of vast income inequality gap between the rich and the poor: a glaring 70%. A discourse on stomach infrastructure, has to grapple with a host of compelling issues – how to provide highly nutritious and affordable food to the poor; how to empower disenfranchised peoples to release their skills and talents; and how to make food production pay.

2.3 Political Dimension of Stomach Infrastructure

The outcome of June 21, 2014 governorship election in Ekiti state has redefined the act of persuading voters in an election. The All Progressives Congress and former Ekiti state governor, Dr. Kayode Fayemi, after losing to the current governor, Mr. Peter Ayodele Fayose, accused Fayose of the PDP of dwelling most on stomach infrastructure instead of focusing on material infrastructural development. What then is stomach infrastructure as against material infrastructure? We can only understand stomach infrastructure by making a graphic comparison between the two concepts, because they are all goals of democracy; and one cannot be given more attention than the other. Material infrastructure is the vision that Fayemi religiously pursued in Ekiti. It is an elitist dream of building projects – big classroom blocks with ICT centres, big housing estates, big hospitals with world class equipment and big multi-purpose centres. Good vision, good dream!

But, stomach infrastructure looks down to the people's immediate needs: empowerment programme for unemployed youths and widows; assistance to the aged; health foundation to assist the poor; agricultural facilities for the rural poor farmers; skill acquisition centres for poor unskilled men and women; loan grants to enable them take off in little measure; direct food relief for the poorest of the poor; boreholes in rural communities to solve water scarcity problems; establishment of small-scale cottage industries in the villages where the rural community can work and also acquire experience on how to produce minor things. While material infrastructure is the big theory from exclusive business schools, stomach infrastructure is a product of street sense and native intelligence. It is a product of an experience with the predicament of the common masses and their heartfelt yearnings. *Stomach infrastructure does not need power-point presentation in a well decorated conference room of a big time hotel.* It does not need seminars and consultants. It only needs a leader to come down from his high horse to interact and feel the immediate challenges of the masses and deploy strategies to meet the needs. It is about giving governance a human face. Political office holders must maintain their relationship with the electorates, rather than depending on their aides and political beneficiaries who are fond of telling politicians what they want to hear instead of telling them the reality on ground.

The judgment of the people of Ekiti is that Fayemi built material infrastructure and ignored stomach infrastructure. While he was confident that he has performed and delivered on his campaign promises of providing democracy dividends, the people disagreed because they cannot enjoy the mighty infrastructure while their stomachs are twisting in discomfort from hunger pangs. The first and greatest need of man is food. The fact is that you have to be alive, healthy and happy to enjoy the big infrastructure and that is why the needs for food and shelter come first before comfort and social recognition in Abraham Maslow's hierarchy of needs. A dead man cannot live in a mighty fortress. He can only rest in a six-foot grave. A leader could not have satisfied his people if he builds mighty schools and hospitals and yet, the people cannot afford to send their children there and cannot afford the high medical bills of such glorious hospitals. There must be a point of convergence between material infrastructure and the lowly capacities of the masses and this is where the concept of stomach infrastructure becomes very relevant (Adindu, 2014; Oyelola, 2014).

2.4 Levels of Stomach Infrastructure

There are three levels of stomach infrastructure:

Feed the People: In the third appearance of Jesus Christ to His disciples after His resurrection, He fed them with bread and fish (a balanced meal) and went further to instruct Peter (the head of the disciples) to feed His 'sheep' (John 21: 13, 17) (The Holy Bible). This level of stomach infrastructure is a system of finding an urgent way to create food stamps, meal tickets and gifts as depicted in Figure 2.2. We saw the effectiveness of this at currying the favour of the electorates at the Ekiti state governorship election referred to already and we are likely to see this repeat itself in any other election, including the 2015 general election.

Cash Transfers to the very Poor: This level enables them to have some sort of income; to start farming or to be able to open a shop or sell in the market.

Figure 2.2: Struggling to Feed the Stomach *(For how long will this last?)*

Education and Financial Literacy: This level helps the poor and disadvantaged to grow their businesses, obtain skills for employment, save for more gain and learn to make informed choices.

In developed economies stomach infrastructure exists in form of social security programmes, the best of which occurs in the USA, Brazil and Singapore. To study how they have reduced their previously high poverty rates, the work of the Banco Familia of Brazil is a notable system Nigeria can adopt. If we can begin such massive programmes bereft of corruption, we can then help and focus on key touchpoints like power, transport, health, commerce and security.

2.5 We are what we Eat

The food industry faces the task of satisfying the many varied requirements of an increasingly demanding consumer population. Food must be safe, of consistently good quality, healthy and inexpensive; food must satisfy the palates (taste) of adventurous variety-seekers; food should be perceived as natural and fresh; and food should keep as long as possible and at the same time maintain its required qualities.

2.5.1 Malnutrition

Malnutrition refers to insufficient, excessive, or imbalanced consumption of nutrients by an organism. In developed countries, the diseases of malnutrition are most often associated with nutritional imbalances or excessive consumption. In developing countries, malnutrition is more likely to be caused by poor access to a range of nutritious foods or inadequate knowledge. Although there are many people in the world who are malnourished due to insufficient consumption, increasingly more people suffer from excessive over-nutrition. Malnutrition, in whatever form it occurs, leads to structural failure in an individual (may be in form of heart disease, obesity, diabetes or kwashiorkor) similar to building collapse. The question is what do we eat?

2.5.2 Whole Plant Food Diet is the Answer

Heart disease, cancer, obesity, and diabetes are commonly called 'Western' diseases because these maladies were once rarely seen in developing countries. An international study in China found some regions had virtually no cancer or heart disease while in other areas they reflected 'up to a 100-fold increase'. This was due to shifts from diets that were found to be entirely plant-based to diets that were heavily animal-based. Large regional clusters of people in China rarely suffered from 'Western' diseases possibly because their diets are rich in vegetables, fruits, and whole grains, and have little dairy and meat products (Campbell and Campbell, 2005). A *National Geographic* cover article from November 2005, entitled *The Secrets of Living Longer*, also recommends a whole plant food diet. In sum, it recommended: 'Eat fruits, vegetables, and whole grains'.

2.5.3 Processed Foods and Nutritional Profile

Since the Industrial Revolution some two hundred years ago, the food processing industry has invented many technologies that both help keep foods fresh longer and alter the fresh state of food as they appear in nature. Cooling is the primary technology used to maintain freshness, whereas many more technologies have been invented to allow foods to last longer without becoming spoiled. These latter technologies include pasteurising, autoclaving, drying, salting, and separation of various components. All these appear to alter the original nutritional contents of food. Pasteurisation and autoclaving (heating techniques) have no doubt improved the safety of many common foods by preventing epidemics of bacterial infection. But some of the (new) food processing technologies have downfalls as well.

Modern separation techniques such as milling, centrifugation, and pressing have enabled concentration of particular components of food to yield flour, oils, and juices; and even separated fatty acids, amino acids, vitamins, and minerals. Inevitably, such large-scale concentration changes the nutritional content of food, saving certain nutrients while removing others. Heating techniques may also reduce food's content of many heat-labile nutrients such as certain vitamins and phytochemicals (Morris *et al.*, 2004). Because of reduced nutritional value, processed foods are often 'enriched' or 'fortified' with some of the most critical nutrients (usually certain vitamins) that were lost during processing. Nevertheless, processed foods tend to have an inferior nutritional profile compared to whole, fresh foods. A dramatic example of the effect of food processing on a population's health is the history of epidemics of beri-beri in people subsisting on polished rice. Removing the outer layer of rice by polishing it removes with it the essential vitamin B1 (thiamine). Insufficient thiamine causes beri-beri. Another example is the development of scurvy among infants fed with milk that had been heat-treated to control bacterial disease. Pasteurisation was effective against bacteria, but it destroyed the vitamin C.

In general, whole, fresh foods have a relatively short shelf-life and are less profitable to produce and sell than are processed foods. Thus, the consumer is left with the choice between more expensive, but nutritionally superior, whole, fresh foods, and cheap, usually nutritionally inferior, processed foods. Because processed foods are often cheaper, more convenient (in purchasing, storage, and preparation), and more available, the consumption of nutritionally inferior foods has been increasing throughout the world along with many nutrition-related health complications.

2.6 What we have done and what we are doing

My desire to see that consumers get the best value from foods and food products (plant and animal sources) led us to carry out nutritional analyses of some common foods and food products. The list of such effort is presented below.

Proximate and nutritional compositions of some Nigerian foods and foodstuffs

- Proximate chemical compositions of acha (*Digitaria exilis* and *Digitaria iburua*) grains.
- Evaluation of some physicochemical properties of shea-butter (*Butyrospermum paradoxum*) related to its value for food and industrial utilisation.
- Physicochemical properties of acha (*Digitaria exilis* and *Digitaria iburua*) grains
- Determination of some physicochemical properties of guinea corn (*Sorghum vulgare*)
- Comparative analysis of non-destructive and destructive measurements of some proximate compositions of wheat for confectionery and pasta production.
- Determination of the nutritional properties of processed cow hide (*Kpomo*).
- Sensory evaluation of honey sold in different locations in Nigeria.
- The effect of ionising radiation on moisture sorption, physiochemical properties and anti- nutritional factors of vegetable cowpea (*Vigna sesquipedalis*) seeds.

Effects of heat treatment on nutritive values of foods and foodstuffs

- Response of nutritional contents of rice (*Oryza sativa)* to parboiling temperatures.
- Influences of drying methods on nutritional properties of tilapia fish (*Oreochromis nilotieus*).
- Effect of hydrothermal treatments on proteins from acha (*Digitaria exilis*) and wheat (*Triticum durum*).
- Effects of drying methods on proximate compositions of catfish.

- Influence of hydrothermal treatments on proximate compositions of fermented locust bean (*Dawadawa*).
- Effects of cooking on the nutritional compositions of wheat (*Triticum spp.*).
- Effects of cooking and frying on antioxidants present in sweet potatoes (*Ipomoea batatas*).
- Comparative analysis of the nutritional compositions of raw and cooked cucumber (*Cucumis sativus).*
- Effect of heat treatment on antioxidant and lycopene contents of some vegetables.
- Effect of heat treatment on soya cheese fortified with *Moringa oleifera* seed flour.

Influence of storage conditions on nutritive values of Nigerian foods and foodstuffs

- Storage stability of groundnut oil - and soya oil-based mayonnaise.
- Influence of storage conditions on shelf-life of dried beef product (*Kilishi*).
- Effects of storage conditions on nutritional compositions of banana.
- Impact of soil inter-space, bulk density and moisture content on vitamin A content of stored oranges in passive evaporative cooling structures.
- Impact of storage structures and soil sodicity on vitamin C contents of stored oranges.
- Empirical models for prediction of nutritional parameters of stored bananas (*Musa sapientum*).
- Influence of maturity and storage conditions on some mineral contents of lettuce.
- Development of model equations for selecting optimum storage parameters for stored cabbage.

Effects of moisture-sorption/desorption on shelf-life and storage stability of foods

- Misture-sorption isotherms of peanut (*Arachis hypogaea*).
- Moisture-sorption study of dried date fruits.
- Moisture-sorption isotherms of Irish and sweet potatoes.

Developed machines and process factors

- An assessment of factors causing loss during milling of rice.
- Development of a motorised '*Egusi*' melon seeds oil expeller.
- Design and construction of recyclable evaporative cooler for the preservation of fruits and vegetables.

Emerging technologies in food processing and novel foods

- Pepper and onion as additives in groundnut oil expression
- Characterisation of biscuits produced from bambara nut, wheat and cassava flours.
- Extraction and conversion of pectin from watermelon (*Citrullus lanatus*) rind into powder for use as food thickener.
- Extraction and conversion of *papain* from pawpaw (*Carica papaya*) leaves into powder for use as condiment in meat processing industry.
- Production, pasteurisation and characterisation of milk produced from tiger nuts (*Cyperus esculentus* L.).
- Development and evaluation of an integrated tilting solar tunnel for preservation of various agricultural produce.
- Production and characterisation of biopesticide from soursop (*Annona muricata*) seed kernel oil.

2.7 What is the Link between Stomach Infrastructure and Agripreneurship?

The attempt by man to satisfy the stomach led to the production of more food. This food must be processed by food processing industries and preserved for future use. This ultimately led to the introduction of entrepreneurship into agriculture and has led to agricultural and farm mechanization, crop/food processing and storage, use of food preservatives and food engineering. Introduction of entrepreneurship into agriculture at different levels of sophistication is what I refer to as *Agripreneurship*.

3. Agripreneurship

A shift from agriculture to agribusiness is an essential pathway to revitalise agriculture and to make it more attractive and profitable venture in any part of the world. Agripreneurship has the potential to contribute to a range of social and economic developments such as employment generation, income generation, poverty reduction and improvements in nutrition, health and overall food security in the national economy (Shoji *et al.*, 2014). This is complementary to stomach infrastructure. Due to the changing social, economic, political, environmental and cultural dimensions over the world, farmers' and nations' options for survival and for sustainably ensuring success in changing their respective economic environments have become increasingly critical. Therefore the emergence of the free market economies globally has resulted in the development of a new spirit of enterprise 'Agripreneurship' (Alex, 2011). Agripreneurship is the profitable marriage of agriculture and entrepreneurship. Agripreneurship turns your farm into an agribusiness. The term agripreneurship is synonymous with entrepreneurship in agriculture and refers to agribusiness establishment in agriculture and allied sector. Entrepreneurs are innovators who drive change in an economy by serving new markets or creating new ways of doing things. Thus, an agripreneur is someone who undertakes a variety of activities in agricultural sector, including food processing, in order to be an entrepreneur (Shoji *et al.*, 2014). However, it must be pointed out that the activities of agripreneurs via food processing operations have consequences on the environment.

4. Our Environment

4.1 Food Processing Industries and the Environment

Food processing is the transformation of raw ingredients into food, or of food into other forms. Food processing typically takes clean, harvested crops or butchered animal products and uses these to produce attractive, marketable and often long shelf-life and added-value food products. The last two decades marked the emergence, rapid proliferation, growth and development of food processing industries (both foreign and indigenous) in Nigeria. This is due to increasing demand for processed foods particularly in urban areas. The raw materials for the processed food industries are mainly agricultural, from where finished products such as beverages, edible oils, sugars and other sweeteners, drinks (both alcoholic and non-alcoholic), fish and meat products emerge. Food processing as an industry was introduced into Nigeria by the United African Company (UAC) in 1923. Today, food industries in Nigeria are so many that they could be sub-divided into thirteen categories. They include flour and grain; soft drinks and carbonated water; starch and miscellaneous food products; tea, coffee and other beverages etc (Chukwu, 2007). One of the main objectives of food processing is to extend the shelf-life of the raw commodities through transformation in industrial processes and the use of preservatives.

The food processing industry provides food products for immediate or future human consumption and by-products for use in the livestock industry. The industry generates large volumes of wastewater and solid wastes and may also be a source of air and water pollution. Since the environment within which food processing industries operate is the only one we have, and shared by both the consumers, and operators of other sectors of the economy, there is the need to ensure the preservation of the environment in as natural and as ecologically balanced state as possible for the use of all. This must and should be made to be the motivating factor during the design, construction and operation of all industrial set up.

4.2 Food Processing Industries and Environmental-friendliness

Nigeria is one of African countries with a great urge and propensity to produce and consume "processed" foods. Today, there are many food manufacturing/processing facilities in Nigeria and more are springing up day by day. To help at every level to ensure quality and safety of food products for the Nigerian consumer, the federal government established the Standard Organisation of Nigeria (SON) in 1970. The mandate of SON was entrenched in the food and drug act of 1974. Later a similar mandate was given to the National Agency for Food and Drug Administration and Control (NAFDAC) and Food and Drug Administration (FDA) (an arm of the Federal Ministry of Health). The overall aim of these quality control and safety assurance organisations is to ensure an environmentally-friendly product to the consumers and the environment (Chukwu, 2005).

Since the beginning of environmental legislation in the industrialised world in the 1970s, considerable attention has been paid to industrial pollution. Industries have directed their attention to the treatment of wastewater and air pollution and the introduction of cleaner technology. The term "clean technology" refers to "manufacturing processes or product technologies that cause less pollution or produces less waste, less energy use, or material use in comparison to the technologies they replace" (US-AEP, 2002). The underlying principle for cleaner production is that discharges can be most effectively reduced through prevention rather than repair and is recommended especially if sustainable development must be achieved (NORAD, 1994).

4.3 Sustainable Development and the Environment

One of the cardinal issues in agro-allied industries is sustainable development. This is because development is meaningful only if it is sustainable. Sustainable development simply implies development without destruction, the utilisation of resources available at present without depriving future generations of facilities for effective living. The establishment of any food processing industrial project is to benefit the socio-economic environment. However, it would lead to impacts on the structure, composition and functioning of some elements of the ecosystem. The impact may be both positive and negative. The plant and the accompanying processes may lead to incremental environmental changes or depletion of environmental resources. Similarly, the impacts may have short term, cumulative or long term effects. It is also possible that these effects or impacts may be reversible or irreversible. Food processing projects may also sometimes have direct or indirect impacts on the ecosystem. As a result, environmental impact audit is used to assess all impacts of the project (positive and negative) from the construction phase to the phase of operations of the facilities and its processes (Chukwu *et al.*, 2007).

4.4 Environmental Impact Audit

Environmental impact audit is a management tool that systematically, periodically and objectively reviews performance of existing projects, organisations, management and equipment with the aim to safeguard the environment (FEPA, 1995). It is one of the technical activities which characterise the Nigerian environmental impact assessment (EIA) procedure developed by FEPA in 1995. It involves a periodic assessment of the positive and negative impacts of a project. As a post-commissioning activity, environmental auditing is the organisation and analysis of environmental monitoring data in order to establish the record of change associated with a project. It also enables the comparison of actual and predicted impacts in order to determine the effectiveness of the impact assessment and management practices and procedures. When used in this way, it is called impact monitoring (Partidario, 1996). Impact monitoring is the activity undertaken to identify variation in environmental parameters which can be attributed with confidence to the presence of a project or other course of action. Its role is to identify project-induced change and it can assist in the management of environmental effects by observing the extent of change and the degree of mitigation which is necessary (FEPA, 1995; Sadler, 1996).

4.5 Environmental Impact Prediction

The identification and auditing phases of environmental impacts precede the impact prediction. Once the impacts have been identified, their potential size and nature must be predicted. Impact prediction is the activity of determining the extent, in terms of time and space, of an impact which is likely to occur and, where appropriate, the probability of the impact occurring is determined (FEPA, 1995). As far as it is practicable, prediction specifies the causes and effects of impacts, and their secondary and synergistic consequences for the environment and the local community (GTAS, 1993).

Prediction is used to estimate the changes in each environmental parameter (e.g. discharge rates for toxic effluents) and the subsequent effects on each sector (e.g. reduced water quality, adverse impacts on fisheries, economic effects on fishing villages, and resulting socio-cultural changes). Prediction may employ mathematical models, physical models, socio-cultural models, economic models, experiments or expert judgements in quantifying impacts (Christensen *et al*, 1990). But it must be pointed out that in order to prevent unnecessary expenses, the sophistication of the prediction methods used should be kept in proportion to the scope of the environmental impact audit (eia) and the importance of the impact. For instance, a complex mathematical model of atmospheric dispersion should not be used if only a small amount of relatively harmless pollutant is emitted. Simpler models are sufficient for such purposes. The essence of eia is predicting future environmental conditions with an industrial project or activity in place (Chukwu, 2008b).

4.6 Environmental Impact Audit Methods and Tools

Environmental impact audit methods are usually taken to include the means of gathering and analysing data. Considering the complexity of the interacting systems that constitute the environment, and the infinite variety of possible impacting actions, it seems unlikely that a single method would be able to meet all the above criteria. There is no single approved method for eia study. Therefore, what is important is the ability to think in a systematic way; to understand the interactions of the environment and technological change; to meet, in a practical way, the needs of the industrial developer; and to follow the fundamental process of preparing eia report (Chukwu, 2008c). A distinction between eia methods and tools must be carefully noted. The four fundamental methods which are commonly used as methods for conducting eia are *checklists*, *matrices*, *networks*, and *overlays*. Tools for eia support the application of the above basic methods. Some of the commonly used tools are *predictive models*, *nomographs*, *geographical information systems*, and *expert systems*. Generally, more than one method and tool are used, depending on the nature of the eia process, to accomplish the best results. In this lecture, I will discuss *Matrices* as a method for conducting eia while *predictive models* and *nomographs* will be used as tools to support the application of the adopted method.

4.6.1 Matrices

Matrices relate industrial activities to environmental components using boxes so that the box at each intersection can be used to indicate a possible impact. The term "matrix" does not have any mathematical implication, but is merely a style of presentation. The matrix can be used to identify impacts by systematically checking each industrial activity against each environmental component. If it was thought that a particular industrial activity was to affect an environmental component, a mark is placed in the cell at the intersection of the activity and the environmental component. There are three types of commonly used matrices namely, descriptive, symbolic and numeric.

5. Synergistic Impacts of Stomach Infrastructure, Agripreneurship and Food Processing Industries on our Environment

The attempt by man to satisfy the stomach has consciously led to the transformation of subsistence agriculture into an agribusiness that has adopted entrepreneurial approach and attitude. The result of this is agripreneurship which led to production of more food which must be processed by food processing industries into other forms convenient for preservation and storage for future use. The interplay between the food processing industries and the environment has led to both desirable and undesirable consequences on the later (Chukwu, 2005). The results of eia study carried out in Nigeria on two food processing industries (coded as NFNL and CNP) are discussed in the following sections.

5.1 Sources of Environmental Impacts

These are those elements of a food processing industry that have the potential to cause environmental impacts. The elements of NFNL and CNP identified as sources of impacts are: industrial inputs, industrial processes/activities, and industrial outputs.

5.1.1 Industrial Inputs

Industrial inputs refer to the inputs of land, renewable and non-renewable raw materials, intermediate materials, capital, equipment and labour that are required to implement a food processing project. These inputs are divided into two broad groups namely, inputs to site preparation and construction; and inputs to industrial processes/raw materials handling.

Inputs to site preparation and construction

The identified inputs to site preparation and construction of the case-studied food processing industries are: industrial buildings and process structures; highways, roads and tracks; bridges; railways; transmission lines and pipelines; barriers, including fencing; channel dredging and strengthening; canals, dams and impoundments; deepwater ports and marine terminals; blasting and drilling; underground works; surface excavation, including cuts and fills; land clearing, including burning; surfacing or paving; erosion control; landscaping; and noise/vibration.

Inputs to industrial processes/raw materials handling

The identified inputs to industrial processes/raw materials handling of NFNL and CNP are dusty and hazardous materials (e.g. gases, liquids, and solids); stockpiling of materials; fuel; water demand; labour (skilled and unskilled); processing facilities/machinery; and noise/vibration.

5.1.2 Industrial Processes/Activities

These are the activities undertaken within an industry which may give rise to environmental impacts. In the two industries, two major components of the industrial processes/activities were identified as process operations/activities and accidents/hazards.

Process operations/activities

The identified process operations/activities of NFNL and CNP that cause environmental impacts are water demand; energy production; process noise and vibration; maintenance (regular service and repair); waste-generating operations; septic tanks (industrial and domestic); odour; and processing unit operations (milling, drying, canning and packaging).

Accidents/hazards

The identified sources of accidents/hazards that have impacts on industrial workers and the environment are grouped into mechanical/physical sources including operator's errors, fatigue or ageing of plant facilities, loss of process control, and over-filling; chemical sources including missiles, impurities, corrosion, organic fluids, and mineral acids; and electrical sources which include explosion, fire, and spills/leaks.

5.1.3 Industrial Outputs

These are primarily wastes (solid, liquid and gas) and finished products of NFNL and CNP that cause environmental impacts. The elements of industrial outputs identified are:

Energy-producing operations

The sub-elements of energy-producing operations that have impacts on the environment are atmospheric emissions, wastewater discharge, re-circulatory cooling water discharge, liquid effluent, noise/vibrations, and stockpiling of material (finished products and wastes).

Transportation requirement

The sub-elements of transportation requirement identified to have environmental impacts are highways, roads and tracks; bridges; railways; and shipping.

Products/waste disposal and control

The sub-elements of products/waste disposal/control that have environmental impacts are products sales/merchandising; landfills; solid waste disposal; and effluent discharges.

5.2 Receptors of Impacts

The receptors of impacts mostly affected (usually adversely) by the sources of impacts identified above are the natural environment and its elements. The impacts on the natural environment are discussed based on baseline and screening assessments carried out on the natural environment and its sub-elements identified as receptors of impacts.

5.3 Baseline and Screening Assessment Data

The baseline data are the pre-project characteristics of the industrial area/site. Information from baseline data helps to determine whether any direct or indirect environmental impact(s) attributable to the food processing industry had occurred. The screening assessment data gave what were on ground in the industrial site at the time of impact audit. It is a form of situation report and helps to determine any direct or indirect environmental impact(s) attributable to the food processing industry. When compared with the baseline data, conclusions were drawn on whether the food processing industry had impact(s) on its immediate and/or adjacent environment or not (Chukwu and Nwachukwu, 2011).

5.4 Impacts of the Activities of Food Processing Industries on the Sub-elements of the Environment

5.4.1 Impact of activities of food processing industries on climate and air quality

The impediment to wind flow due to the height of the plant and offices of NFNL has contributed to hotter environment for the residents of the area. This was not the case before the establishment of the NFNL. The lowest and highest temperatures recorded at the industrial area prior to the establishment of the plant were $10^{0}C$ and $30^{0}C$, respectively at certain seasons of the year. In the case of CNP, the lowest and highest temperatures recorded prior to the establishment of the plant were $26^{0}C$ and $34^{0}C$, respectively (Chukwu *et al.,* 2007). The minimum and maximum temperatures recorded now are respectively $12^{0}C$ and $35^{0}C$ for NFNL and $28^{0}C$ and $36^{0}C$ for CNP. The consequences of such a modest increase in temperature may be devastating. Problems that may develop include a rise in sea levels that will completely inundate a number of low-lying island cities and flood many coastal cities, such as Lagos, Port Harcourt, and Warri (Chukwu *et al.,* 2007). However, it may be pointed out that the increase in temperature may not be due to NFNL and CNP plants activities alone as the issue of global warming is quite general.

The presence of NFNL and CNP plants has led to a modest increase in environmental temperature due probably to emission of hot gases during processing operations, emissions from vehicles bringing in raw materials/conveying away finished products and emissions from burning of waste materials. The air pollutants associated with NFNL are smoke, dust, heat and noise while those of CNP are smoke, dust, exhaust gases (SO_2, NO_2, and CO_2), heat, noise, particulates and flash ash (Chukwu *et al.*, 2007). The above emissions led to degradation of air quality, primarily in the immediate environment and can result to acute and chronic physiological effects on human beings.

Effects of air pollution on human health

Sulphur dioxide (SO_2) (a by-product of processing activities, gives rise to irritative reactions which cause pulmonary blood vessels (capillaries) to dilate and exude fluid. This leads to tissue fluid accumulation and swelling (oedema), bronchial spasms, and shortness of breath. In a chronic situation the gas contributes to and aggravates lung diseases like chronic bronchitis, pulmonary fibrosis via irritation leading to decreased pulmonary function and increasing stress on the heart (Kupchella and Hyland, 1991; Zimmerman, 2004). Nitrogen dioxide (NO_2), a by-product of food processing activities, at concentrations higher than acceptable level is responsible for respiratory tract oedema due to cell membrane disruption. In chronic cases, it causes cell membrane damage and acid-induced irritation leading to or contributing to diminished pulmonary function and right-heart stress (Schindler *et al.*, 1985). Dust and dusty environment are generated by the food processing industries. Inhalation of large doses of dust or accumulation of small doses of dust over a prolonged period may eventually help to bring about structural impairment and loss of lung function (Kupchella and Hyland, 1993).

Effects of air pollution on plants and animals

The air pollutants mostly responsible for plant damage are acids derived from the oxides of both sulphur and nitrogen. Schindler *et al.* (1985) reported the effects of these pollutants on plants and animals. Plants that are susceptible to these kinds of pollutants include vegetables, fruits, and other kinds of agricultural crops, grasses, shrubs, trees, and commercial flowers. For example, sulphur dioxide at levels above permissible causes bleached spots on leaf, chlorosis, suppression of growth, and reduced yields in crops such as barley, pumpkin, alfalfa, cotton, wheat, lettuce, apple and oat. Alfalfa, barley and cotton are known to be sensitive to sulphur dioxide at a concentration as low as 0.3ppm. Nitrogen dioxide at concentrations above optimal causes brown spots on leaf and suppression of growth in sunflower, mustard, tobacco and pinto bean. Pinto bean is sensitive to nitrogen dioxide at a concentration as low as 3ppm. Acid rain results when SO_2 and NO_2 dissolve in rain water.

The effects of acid rain on wildlife can be far-reaching. If a population of one plant or animal is adversely affected by acid rain, animals that feed on that organism may also suffer. Ultimately, an entire ecosystem may become endangered. Some species that live in water are very sensitive to acidity. Freshwater clams and mayfly young, for instance, begin to die when the water pH reaches 6.0. Frogs can generally survive more acidic water, but if their supply of mayflies is destroyed by acid rain, frog populations may also decline. Fish eggs of most species stop hatching at a pH of 5.0. Below a pH of 4.5, water is nearly sterile, unable to support any wildlife. Land animals dependent on aquatic organisms are also affected. It has been reported that populations of snails living in or near water polluted by acid rain are declining in some regions of the world (Hart, 2003; Chukwu *et al.*, 2007).

Effects of air pollution on microclimate of food processing industry environment

Impairment of visibility is perhaps the most noticeable effect of particulate matter. Smoke and haze distort visual range, the colour of the sky, and the ability to see stars at night. In socio-economic terms, reduced visibility has considerable impact on air travel and property values. Sulphur dioxide and nitrogen dioxide are involved in reactions that yield haze-generating fine particles in the atmosphere. The reactions and the hazes they form are influenced by meteorological conditions including wind, rain, sunlight, temperature, and humidity. These pollutants that reduce visibility may also affect climate via reduction of net solar radiation and enhanced cloud formation. The variations of annual rainfall for the cities where NFNL and CNP are located are presented in Figures 5.1 and 5.2 (Chukwu, 2005), respectively and could be linked partly to the food processing industries. The figures present the annual rainfall history of the two cities 15 years before and 15 years after the industries. The average rainfalls for the city where NFNL is sited before and after the establishment of NFNL plant were 1558.9 mm and 1533.5 mm, respectively. For the city where CNP is sited, the average rainfalls before and after establishment of CNP were 1865.2 mm and 1636.5 mm, respectively (FDMS, Lagos, 1997).

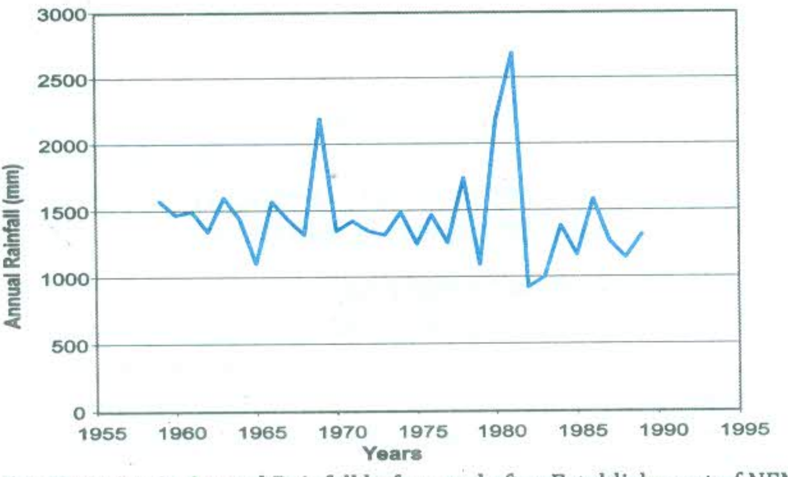

Fig. 5.1: Variation in Annual Rainfall before and after Establishment of NFNL

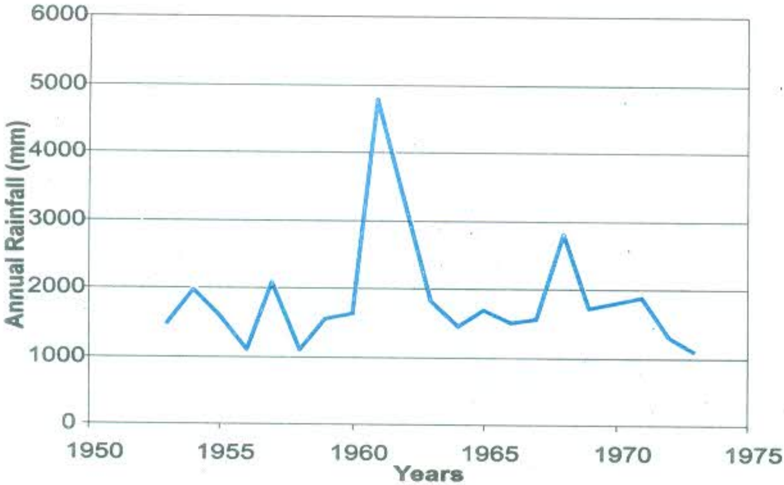

Fig. 5.2: Variation of Annual Rainfall before and after Establishment of CNP

Biological and ecological effects of an increase in carbon dioxide concentration

Carbon dioxide is one of the exhaust gases of food processing operations. An increase in the atmospheric carbon dioxide concentration can greatly affect living things. Green plants grow better when the air around them is enriched with carbon dioxide. The increasing CO_2 concentration in the atmosphere could have other indirect effects. If the climate were to warm, some kinds of vegetation would increase and others would decrease. The effects of changes in weather patterns, including rainfall could become complicated and difficult to predict. Increased CO_2 in the atmosphere contributes to global warming via the greenhouse effect (Zimmerman, 2004; Chukwu, 2005).

Effects of air pollution on materials

One of the off-shoots of the NFNL plant is a quarrying site. Dust and other emissions from on-site activities have spread sufficiently to affect homes and other properties around the site. Dust and emissions from vehicles carrying materials, particularly quarried rocks and aggregates generate dust

5.4.2 Impact of activities of food processing industries on water quality

The water quality of NFNL area was classified as good and hard before the establishment of the plant. The plant has impacted negatively on the water quality, which is now known to be coloured and tasty. The sources of surface water pollution identified are industrial wastes (solid and liquid); sewerage system and agricultural wastes generated from NFNL farms. Water pollution is the contamination of streams, lakes, underground water, or oceans by substances harmful to living things. However, there has been an attempt at treatment of water and improved water delivery through NFNL-improved rural water delivery scheme. Also, the construction of sub-surface drainage structures by NFNL has led to better drained environment.

In the case of CNP, the groundwater quality changed from good/hard to coloured and tasty. This could be due to ingress of leachates from solid and liquid wastes into the groundwater recharge path. The water table was also discovered to have depleted. The low water table led to slow recharge of wells in the industrial area. There has been surface water pollution due to industrial wastes, sewerage systems, and agricultural wastes. These have singly or in combination led to reduced aquatic life and their population. The impairment of existing surface water through filling from sediment influx and waste discharge also led to reduced navigation for fishermen. The overall implication of the above water pollutants is further discussed below.

Effects of water pollution on human health

The relationship between human disease and water has been recognised for centuries. A severe outbreak of cholera that occurred in the mid-nineteenth century in London was traced to contaminated well on Broad Street (Schindler *et al.*, 1985). In

Africa with less well developed public health programme and water purification systems, the rates of epidemics of water-borne diseases are increasing. Typhoid fever, dysentery, cholera, viral hepatitis and guinea-worm continue to be serious problems. The World Health Organisation estimates that well over 900 million people in developing countries lack access to safe water supplies (Chukwu, 2009a). The problem of water-borne disease can be due to contamination of humans' drinking water through the many activities of man.

In addition, NFNL and CNP projects have made women to no longer collect drinking water from nearby streams and ponds because of contamination from industrial effluents and chemicals. This has led to an increase in time used for collecting water from uncontaminated sources and a subsequent increase in health risks. Women now trek about 1.85 km to collect water whereas they trekked about 630 m before. More so, the conversion of communal ponds to aquaculture ponds has prevented access by women to the ponds to wash cassava. Consequently, they have to travel further to fulfill their needs and have less time for other activities. The need they usually met after travelling 950 m on the average now requires an average of 2.10 km.

Effects of organic and inorganic pollutants that enrich and over-enrich aquatic ecosystem

Energy-rich organic chemicals

Kupchella and Hyland (1993) reported that certain chemicals, even in the right concentrations, could distort and disrupt aquatic ecosystems by over feeding certain components of such systems. Over feeding (eutrophication) of aquatic ecosystems can occur in two basic ways via two kinds of chemical pollutants. One way is through the addition of inorganic nutrients that are normally limiting for plants. Another way is through the addition of organic chemicals that serve as food for decomposers. There are a number of influences on the supply of nutrients within any living system. For one thing, nutrients affect one another. Phosphorus, for instance, is often a key regulator of activity in ecosystems because of its relative scarcity in the form of soluble phosphate and because of its key role in storing and releasing energy as part of the ATP (Adenosine triphosphate) molecule. For example, in an aquatic system the supply of phosphorus to living systems may be linked to the presence of sulphur and iron. The binding of sulphur with iron under anaerobic conditions in an aqueous environment creates conditions that convert phosphorus from an insoluble form to a soluble form that can be used by living things. Bonding with sulphur may also tie up minerals such as copper, cadmium, zinc, and cobalt.

Emmett (1975) reported that the addition of dissolved organic matter to an aquatic ecosystem gives boost to the decomposers (organisms that use organic materials as sources of energy and nutrients). A problem arises when this activity increases to the point at which the decomposers use up all of the available oxygen as they oxidise organic matter. The oxygen-depleting strength of organic matter via the action of decomposers is called biological oxygen demand (BOD). Apart from absolute oxygen depletion, the reduction of oxygen in water can still seriously disrupt natural systems. For most aquatic systems, dissolved oxygen should never be lower than 3ppm (3.48 mg/m^3) at any time and should actually be above 5ppm (5.80 mg/m^3) for the greater part of everyday. Trout require at least 5ppm of oxygen to survive.

- ***Inorganic chemicals that enrich***

A second way in which aquatic ecosystems can be over-enriched (and thus polluted) is through the addition of inorganic matter, such as phosphates and nitrates. These substances can be added to aquatic ecosystems indirectly in the form of phosphorus and nitrogen-containing organic pollutants, and they can also be added as pollutants directly. Phosphate pollution is an especially serious problem because this form of the element phosphorus is often the plant-growth-limiting nutrient in aquatic environments. When phosphate is added to water supplies, it triggers off a rapid growth of plants. This plant growth results in an increase in oxygenation due to increased photosynthesis, but plant respiration and decomposition of dead plant materials create a problem similar to the one described for organic pollution of water (Emmett, 1975; Modak and Biswas, 1999; Chukwu, 2008d).

5.4.3 Impact of waste heat from food processing industries on aquatic environment

The industrial plants are located on rivers where water is available to carry away waste heat. As heat-laden water is discharged back into the main water supply, it raises the temperature of the aquatic environment. Heat affects the life found in water in several ways (Hart, 2003). First, every life form has a temperature tolerance range. At some point in the life cycle of every organism there is a most temperature-sensitive stage – hatching eggs, for example. All individual organisms have ranges of temperature within which they can survive and specific temperatures at which they function best. Temperature changes of only 2 or 3^0C under certain circumstances can have a very serious effect on fish and aquatic life. For example, Trout eggs take 165 days to hatch in cool water (3^0C) but will hatch in only a month if kept at 12^0C. They will not hatch if temperatures reach 15^0C (Chukwu, 2005).

5.4.4 Impact of floating solids and liquids from food processing industries on aquatic ecosystem

Oil, grease, and a number of other materials that float on the surface of water are another kind of pollutants. The effects of these substances can be unaesthetic since they occur where they can be seen, but certain types of organic materials that float are also toxic. Floating materials decrease light penetration and can retard the diffusion of gases such as oxygen. If floating materials break up and become suspended in water, they can concentrate toxins (for example, oil droplets can accumulate fat-soluble toxins) in water and deliver these to filter-feeding organisms such as clams and mussels (Kupchella and Hyland, 1993).

5.4.5 Impact of suspended/sedimentary solids from food processing industries on aquatic ecosystem

Among the things that affect water physically are undissolved solids, some of which dissolve over long periods of time and some of which practically never go into solution. Both types of solids decrease water quality in a physical way; silt and other insoluble materials clog waterways, fill up dams, and make water cloudy or muddy. Such solids can also be physical problems for gill breathers (fish) and filter feeders (such as clams) (Chukwu, 2005).

5.4.6 Impact of activities of food processing industries on geological features

The mineral resources of potential value identified in the industrial area of NFNL plant are tin, columbite, and tantalite. The mining of these minerals by a subsidiary of NFNL group of companies has depleted the natural reserves. However, the mining and extractive activities such as quarrying of rocks have increased the economic status of the residents. The presence of geologic features, e.g. rocks encouraged the setting up of modern recreational facilities and commercial outlets in form of parks and workshops. The geological features around the location of CNP plant have not been altered in any observable form. It is only the features of human interest such as parks and gardens that have been improved upon commercially. The setting up of parks and gardens involved land excavation, including the removal of vegetation. As a result, terrestrial habitats were endangered leading to migration of arboreal animals to safer places and loss of them in the host communities (Chukwu, 2008e).

5.4.7 Impact of activities of food processing industries on soil

There has been no significant impact on the soil properties of the industrial area after the establishment of NFNL plant just as there was no reported case of severe impact on soil properties, in the case of CNP, except for decreased water table. However, we do know that the activities of both industries do have deleterious effects on soil. In soil, acid rain (a consequence of the industries) dissolves and leaches away nutrients needed by plants. It can also dissolve toxic substances, such as aluminum and mercury, which are naturally present in some soils, freeing these toxins to pollute water or to poison plants that absorb them (Kupchella and Hyland, 1993; Chukwu, 2008e). A noticeable effect the activities of the industries have on soil is increased compaction due to increased vehicular traffic. More humans and vehicles now ply the industrial areas, leading to soil compaction. Compaction rearranges soil particles thereby increasing the density of the soil and reducing porosity. Crusts formed on compacted soils prevent water movement into the soil and increases runoff and erosion.

5.4.8 Impact of activities of food processing industries on ecology

The establishment of NFNL at the present site led to the extinction of unusual and endangered species such as monkeys. There has also been a reduction in yield of land on NFNL site and surrounding area. The reduced soil fertility could be attributed to leachates from the dump sites of chemical wastes from NFNL. The activities of NFNL have led to a reduction of 10 – 25% in yield for livestock grazed on the neighbouring lands. Consequently, farmers and their dependants (76 people in number) could no longer sustain their livelihood and were forced to seek alternative lands (Chukwu, 2008e). The establishment of CNP at the present location led to a reduction in yield of land on CNP site and surrounding area. The reduced soil fertility could be attributed to leachates from chemical wastes from abandoned and active landfill/waste disposal sites. Other ecological effects of the two industries are reduced yields of crops, animals, and fish. At the CNP site, the destruction of snail habitat led to a significant reduction in snail harvests gathered by rural women and consequent major reduction of the women's income (Chukwu, 2009a).

5.4.9. Impact of activities of food processing industries on environmentally sensitive areas

The location of NFNL plant is on prime agricultural land and fertile wetland. This led to the displacement of farmers and their families. The loss of wetlands (which protected plant and animal species) to NFNL led to displacement of fishermen and their families. Plant and animal species were also lost due to the removal of vegetal cover. Land filling and waste discharge also caused reduced shellfish yield. The attendant loss of their means of livelihood caused serious agitation by the farmers, fishermen and their families. This led to strained relationship between them and NFNL. CNP plant is also located on prime agricultural land and fertile wetland. Prime agricultural lands and fertile wetlands which hitherto protected plants and animals were lost and shellfish cropping was reduced. There was a loss of 30% - 45% of shellfish yields. This affected between 60 and 75 local shell fishermen who provided the principal or only source of income for 260 - 320 people. (Most fishermen had assistance from one or more members of their family). Up to 22 of the fishermen have skills which were needed in CNP but 40 - 55 men had to switch to other types of fishing. This imposed considerable stress on existing in-shore fishing and resulted in over fishing and bankruptcies. The consequence was displacement of fishermen and their families with its attendant social dislocation and loss of income (Chukwu and Nwachukwu, 2011).

5.4.10 Impact of activities of food processing industries on land use and land capability

The site of NFNL plant was used for food production, quarrying and grazing. The location of NFNL there displaced agricultural production and quarrying activities. The removal of vegetal cover due to site preparation and construction led to loss of pasture land. Rangeland and pasture land were hurriedly developed into recreation and commercial outlets. This had a negative effect on sedentary farmers. The land use and land capability before the location of CNP plant were for food production and forestry/silviculture. The location of CNP at the present place led to loss of forestry land and also displaced food production activities. As a result, proposed land use was altered and this necessitated the out-migration of farmers to seek alternative sites. Converting agricultural or forestry land to an industrial site, especially during the construction phase, increased the runoff and sediment yield or erosion of the land. As a result, streams became muddy and could not transport all of the sediment delivered to their channels. The channels became partially filled with sediment and this led to a moderate increase in runoff.

5.4.11 Impact from noise and vibration due to activities of food processing industries

Noise pollution represents the exposure of people or animals to levels of sound that are annoying, stressful, or damaging to ears. Noise generated by NFNL ranged from 60 to 115 dB. Before the establishment of the plant, the area was classified as being very quiet and sound of the order of 20 dB was common. Recreation centres, commercial outlets, milling and other processing machines, diesel engines, transport trucks, plant generators as well as packaging machines have singly and in combination caused discomfort among residents. The permissible noise level to guarantee minimal comfort to humans is 80 dB (Kupchella and Hyland, 1993; Chukwu, 2005). Exposure of employees to vibration has led to ear and hearing impairment/loss. In the case of CNP, the industrial area hitherto described as being quiet (40 dB on the decibel scale) is now classified as being moderately loud (60 dB) due to internal noise generated. Noise sensitive land users such as churches, mosques and recreation centres within 1.6 km of plant site now complain of discomforting noise. The permanent and temporary machines that cause vibration include boilers, transport trucks, Allen generators and ovens. The employees are exposed to vibration risk of the order of 115 dB sound level. This causes ear pain but there was no case of hearing loss due to internal noise because workers normally use ear muffles (Chukwu, 2005). Even at levels below those that cause hearing loss, noise pollution causes problems. Noise makes conversation difficult, interferes with some kinds of work, and disturbs sleep. As a source of stress, it can promote high blood pressure as well as nervous disorders. Noise from food processing operations puts stress on domestic animals and wildlife by frightening them. Since noise pollution is not a necessary price to pay for living in an industrial society, much can be done to reduce the severity of the problem on residents.

5.4.12 Impact of activities of food processing industries on visual quality

Visual quality here implies the visual amenity or aesthetics of the industrial location. One important effect of a new food processing plant is its visual impact. This is particularly noticed in areas with outstanding scenic quality and where the development impinges directly on people and their residential and recreational areas. At the NFNL location, developmental activities adversely affected the content of the scene formerly perceived by the residents of the surrounding area. The NFNL plant also distorted and impaired the visual coherence of the surrounding area. Before the location of NFNL plant, the area was described as serene and harmonious. The area became disfigured due to enhanced commercial and social activities, high rise buildings and emission/dispersion of dusts and exhaust gases into the atmosphere.

In the case of CNP, the visual content and coherence which were serene and harmonious respectively became seriously distorted and impaired due to developmental activities. The environment became disfigured due to enhanced commercial and social activities, noise from trucks conveying raw materials and finished products, emission and dispersion of gaseous air pollutants and dusts. More so, the hurly-burly which characterises city life became the life style of residents of the industrial area (Chukwu and Nwachukwu, 2011).

6. Development of Models for Prediction of Impact on Air and Water Quality in a Food Processing Environment

6.1 Air Pollution

Air pollution is the most threatening hazard at a food processing industrial environment. An important indicator of air pollution problem in an industrial environment is acid rain. This is because what goes up must come down - somewhere, sometime, and in some form. The six major air pollutants in an industrial area have been identified as total suspended particulates (TSP), sulphur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), carbon dioxide (CO_2), and nitrogen dioxide (NO_2) (Kupchella and Hyland, 1993; UNU, 1999; Chukwu, 2007).

In this lecture, three air pollutants namely, CO_2, NO_2, and SO_2 are implicated. They dissolve in rain water to form carbonic acid (H_2CO_3), nitric acid (HNO_3), and sulphuric acid (H_2SO_4) respectively. Therefore: $Acid\ Rain = f(CO_2, NO_2, SO_2)$ (6.1)

Analysis of Sample of Rain water (Acid Rain)

An acid rain refers to rainfall with pH << 5.6 (the normal uncontaminated value). Primary air pollutants such as CO_2, NO_2 and SO_2 are emitted from processing industries and react with moisture in the atmosphere to form H_2CO_3, HNO_3 and H_2SO_4 respectively. The analysis of samples of the acid rain using standard chemical methods is an indirect measure of the concentrations of the primary pollutants. The parameter of air quality estimated is the hydrogen ion concentration [H^+].

6.2 Water Pollution

There are many types of materials that may pollute surface (or ground) water. Pollution of water occurs when too much of an undesirable or harmful substance flows into a body of water, exceeding the natural ability of that water body to remove the undesirable material or convert it to a harmless form. The degree of water pollution is expressed in mg/l of water pollutants. Solid and liquid wastes are usually analysed for such water quality parameters as turbidity, total solids (TS), total dissolved solids (TDS), total undissolved solids (TUS), sulphide of Lead (PbS), nitrates, reactive phosphates, biological oxygen demand (BOD), chemical oxygen demand (COD), and dissolved oxygen (DO) (Chukwu, 2009b).

Biological oxygen demand (BOD) is a critical and commonly used measure in surface water quality management. Dead organic matter in streams decays. Bacteria carrying out this decay require oxygen. If there is enough bacterial activity, the oxygen in the water can be reduced to levels so low that fish and other organisms die. A stream without oxygen is a dead stream for fish and many organisms we value. The amount of oxygen required for such biological decomposition is called the biological oxygen demand (BOD). There is an inverse relationship between BOD and DO. The higher the BOD, the lower is the DO and vice-versa. In our research it was established that there is a relationship between BOD and TDS, PbS, TNL, and TUS (Chukwu, 2009b).

TDS, TNL and TUS (organics) all lead to eutrophication or nutrient enrichment. The overall effect is increased BOD and decreased DO. Lead sulphide (PbS) is linked with BOD in a different way. Some chemical elements are directly toxic to organisms. When lead is carried by streams and rivers, deposited in quiet waters, or transported to the ocean or lakes, it is taken up by aquatic organisms. In concentrations higher than the permissible limits, the organisms die. If the dead organisms are those involved in organic matter decomposition it leads to low BOD and high DO. Therefore Chukwu (2009b) established that:

$$BOD = f(TDS, TNL, TUS, PbS) \qquad (6.2)$$

6.3 Screening Experiments for Environmental Elements

Full factorial design (FFD) was used to efficiently screen variables in the "interaction grid/matrix" presented in Table 6.1. This permitted the determination of the degree and nature of the interaction between elements of the environment and characteristics of the food processing industries. The number of variables for each environmental element was selected for screening based on the interaction grid/matrix (Table 6.1). A 4-variable, 2-level factorial arrangement was used to develop the model for water quality while a 3-variable, 2-level factorial arrangement was used to develop the model for air quality.

A 4-variable, 2-level factorial arrangement has the calculation matrix shown in equation (6.3) and was used to analyse the environmental element being modelled. The 2^4 arrangement was used to estimate the fifteen (15) effects indicated in the linear model or equation (6.3). That is, with 4 variables coded as X_1, X_2, X_3, and X_4; a 16-run experiment permits unique solutions for the coefficients (parameters) of the equation or linear model (Montgomery, 1991; Chukwu, 2009b).

$$\begin{aligned} Y = {} & b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_{12}X_{12} + b_{13}X_{13} + b_{14}X_{14} + b_{23}X_{23} + b_{24}X_{24} + b_{34}X_{34} \\ & + b_{123}X_{123} + b_{124}X_{124} + b_{134}X_{134} + b_{234}X_{234} + b_{1234}X_{1234} + e_i \qquad (6.3) \end{aligned}$$

Where: Y = environmental element being modelled; b's = regression coefficients of the model; X's = coded variables; e_i =

random error with zero mean and constant variance. It measures the discrepancy in the functional relationship between the response and regressor variables.

Table 6.1: Interaction Grid/Matrix

CHARACTERISTICS OF THE EXISTING ENVIRONMENT		NATURE & XTERISTICS OF FPI						
		Site preparation and Construction	Process Operations	Raw Material Handling	Energy Producing Operations	Transportation Requirements	Accidents/Hazards	Waste Disposal and Control
	Climate and Air Quality							
	Water							
	Geology							
	Soils							
	Ecology							
	Environmentally Sensitive Areas							
	Land Use and Land Capability							
	Noise and Vibration							
	Visual Quality							
	Archaeological/historic/cultural Element							

Source: Chukwu, 2005

A 3-variable, 2-level factorial arrangement has the calculation matrix or linear model shown in equation (6.4). The 2^3 arrangement was used to estimate the seven (7) effects indicated in the linear model or equation (6.4). That is, with 3 variables coded as X_1, X_2, and X_3, an 8-run experiment permits unique solutions for the coefficients of the equation (Montgomery, 1991):

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_{12}X_{12} + b_{13}X_{13} + b_{23}X_{23} + b_{123}X_{123} + e_i \quad (6.4)$$

Where: Y, b's, X's, and e_i retain their meaning as in equation (6.3).

The assumed functional relationship between the dependent variable Y_i and the independent variables, X_i (i = 1, 2, 3, 4) is formulated as a linear model [equations (6.3) and (6.4)] (Chukwu, 2005).

6.3.1 Theory and Principle of Nomographs

A nomograph or alignment chart is a numerical scientific operations research tool that presents the relationships between two or more variables on a chart (Wilson, 1952; Opara, 1987). As a result, the first basic step in the design and development of nomographs is to establish some relationship between the decision variables. The general format of the nomograph used in our research is presented in Figure 6.1 (Chukwu, 2005). In a three variable nomographic model for instance and for the first two variables (say A and B), there is a scale for A (not necessarily linear) and there is a scale for B. A straight edge is laid across the A and B scales, intersecting them at the desired values. The intersection of this straight edge with a third scale is the value of C which is a function of A and B. Thus, the principle of nomographs is that a line joining a chosen point on a scale with a chosen point on another scale will intersect a third scale at the values of the roots of the variable for the third scale if they are real and lie within the range specified for the analysis.

7. Models for Predicting the Impact of Food Processing Industries on the Environment

The models are developed using key factors/indices for water and air quality management. Biological oxygen demand is used to mimic water quality while hydrogen ion concentration of acid rain in an industrial environment is used as an index of air pollution (Chukwu, 2008f).

7.2 Water and Air Quality Models for NFNL and CNP

The interaction matrix/grid between environmental elements and characteristics of NFNL/CNP presented in Table 7.1 is used to develop the water and air quality models 7.1, 7.2, 7.3, and 7.4.

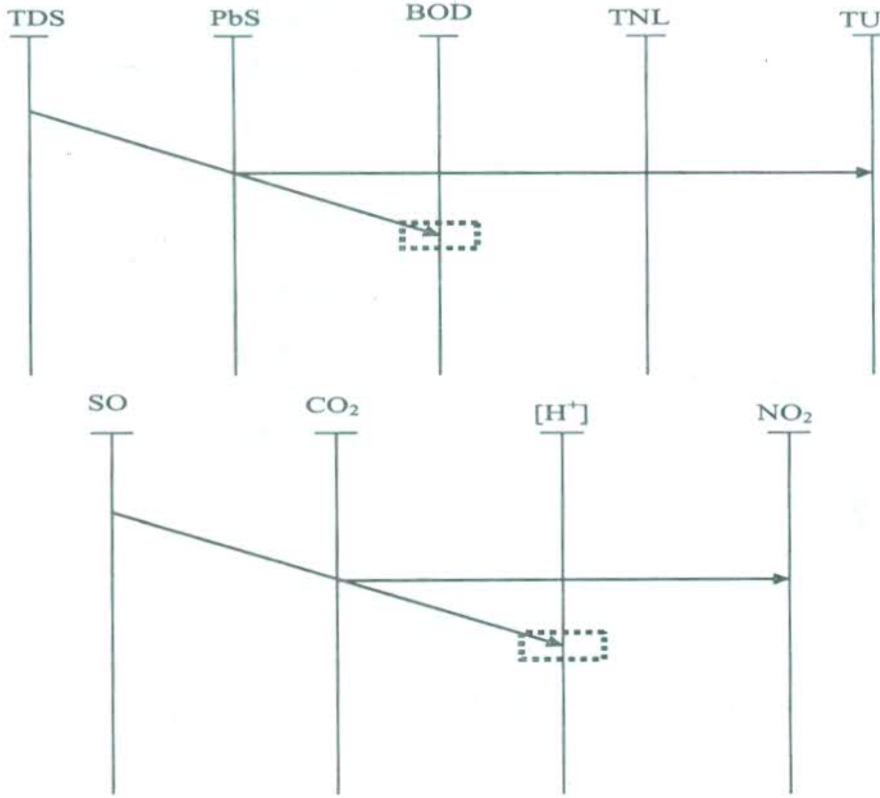

Fig. 6.1: The General Format of a Nomograph

7.2.1 Surface Water Quality Model for NFNL

$$B_N = 6.78 + 0.54X_1 - 0.14X_2 + 0.11X_3 + 0.51X_4 - 0.62X_{12} + 0.04X_{14} - 0.05X_{23} - 0.44X_{24} + 0.15X_{123} - 0.95X_{124} + 0.10X_{134} - 0.12X_{234} + 0.24X_{1234} \quad (7.1)$$

X_1 = Total Dissolved Solids (TDS), mg/1; X_2 = Sulphide of lead (PbS), mg/1

X_3 = Total Nitrate Leachates (TNL), mg/1; X_4 = Total Undissolved Solids (TUS), mg/1

B_N = Biological Oxygen Demand for NFNL (Index of Water Quality), mg/1

Table 7.1: Interaction Matrix for NFNL/CNP and the Natural Environment

Characteristics of the Environment	Nature and Characteristics of Food Processing Industries														
	Highways, Roads & Tracks	Channel dredging & Strengthening	Surface excavation, including cut & fill	Land clearing, including burning	Noise and vibration	Cooling water discharge	Liquid effluent	Septic tank	Spent lubricant	Dust	Atmospheric emission	Stockpiling of materials	Spills & Leaks	Landfill, Spoil & Overburden	Solid waste disposal
Air Quality	x		x	x	x	x +	x +			x	x +				
Temperature						x +	x +				x +	x			
Precipitation/ Rainfall		x	x +	x +		x	x +				x +				
Water Quality						x	x +	x	x +		x		x	x +	x +

Key: x = interaction, + = regressor variable

Source: Chukwu, 2005

7.2.2 Surface Water Quality Model for CNP

$$B_C = 142.663 - 2.109X_1 + 1.838X_2 - 4.088X_3 + 3.475X_4 + 3.731X_{12} - 1.269X_{13} + 2.731X_{14} + 0.838X_{23} - 1.450X_{24} + 3.125X_{34} + 2.731X_{123} - 3.269X_{124} + 3.231X_{134} - 2.050X_{234} - 2.519X_{1234} \quad (7.2)$$

X_1, X_2, X_3 and X_4 retain their meaning as in equation 7.1

7.2.3 Air Quality Model for NFNL

$$\left[H^+\right]_N = 16.579 - 0.604X_1 - 0.979X_2 + 4.066X_3 - 0.931X_{12} - 0.801X_{13} - 1.216X_{23} - 0.884X_{123} \quad (7.3)$$

X_1 = Nitrogen (iv) Oxide (NO_2), mg/m^3; X_2 = Carbon (iv) Oxide (CO_2), mg/m^3
X_3 = Sulphur (iv) Oxide (SO_2), mg/m^3; $[H^+]_N$ = Concentration of Hydrogen ions, mg/m^3

7.2.4 Air Quality Model for CNP

$$\left[H^{+}\right]_{C} = 18.239 - 0.666X_1 - 1.079X_2 + 4.471X_3 - 1.024X_{12} - 0.884X_{13} - 1.336X_{23} - 0.971X_{123} \quad (7.4)$$

X_1, X_2, X_3 retain their meaning as in equation 7.3

7.3 Validation and Application of the Predictive Models

7.3.1 Validation of the Predictive Models

The four models presented above were validated by determining the correlation between measured values during the field work and the calculated values (Figures 7.1, 7.2, 7.3 and 7.4) and also by using the values of the regressor variables for NFNL into the models for CNP and vice-versa (Figures 7.5 and 7.6).

7.3.2 Application of the Models

For a faster and easier application of the models (especially for those who do not like Mathematics), nomographs have been developed (Figures 7.7, 7.8, 7.9, 7.10) (Chukwu, 2005). The theory and principle of nomographs have been presented in section 6.3.1.

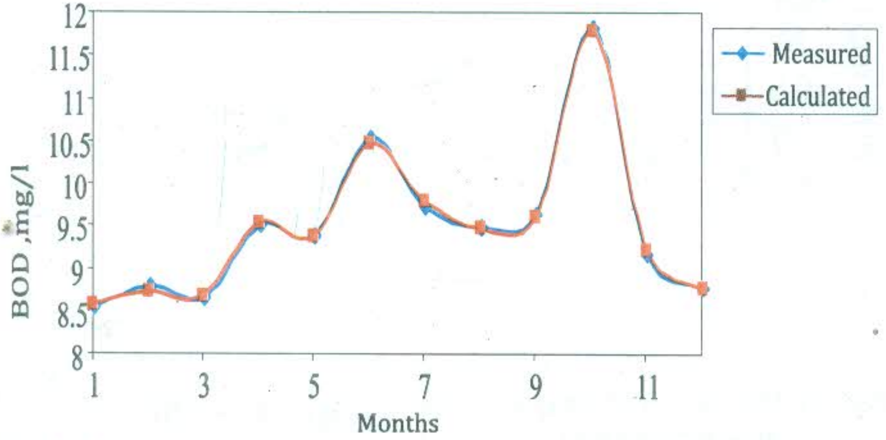

Fig. 7.1: Correlation between measured and calculated values for SWQ for NFNL

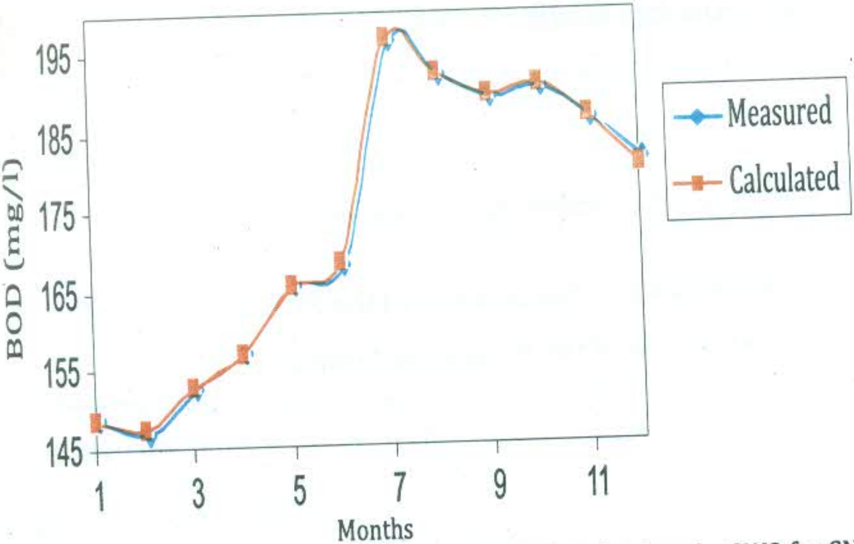

Fig. 7.2: Correlation between measured and calculated values for SWQ for CNP

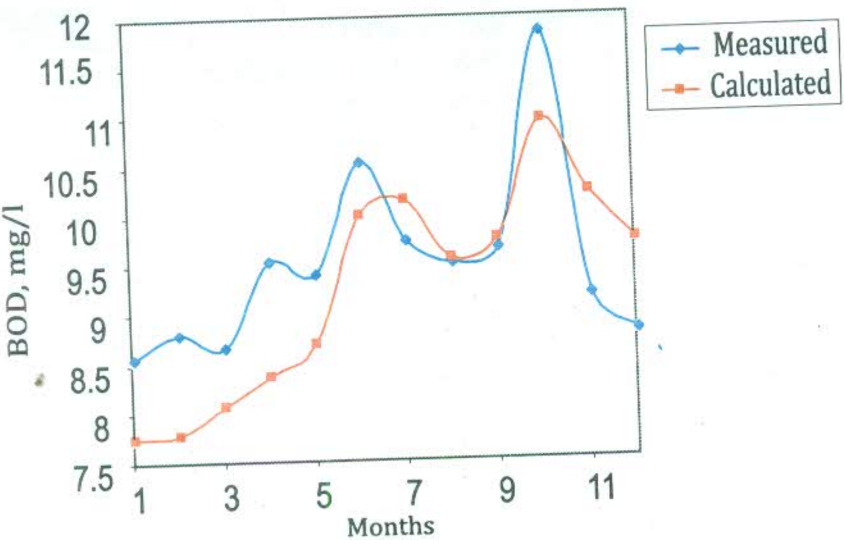

Fig 7.3: Validation of SWQ for NFNL using data for CNP

$R^2 = 0.725403$

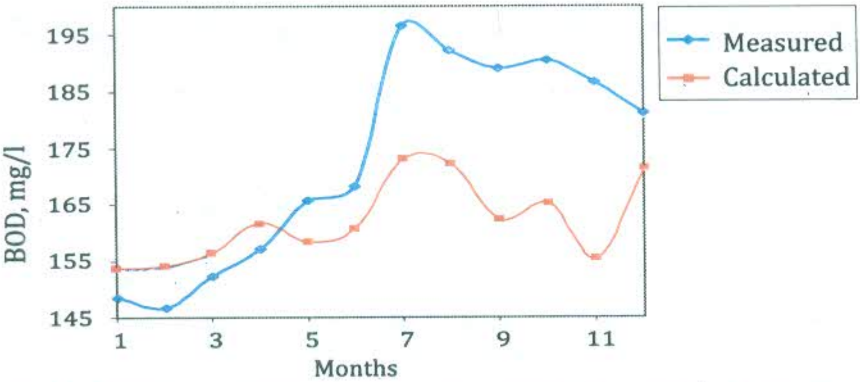

Fig. 7.4: Validation of SWQ for CNP using data for NFNL **R^2 = 0.740726**

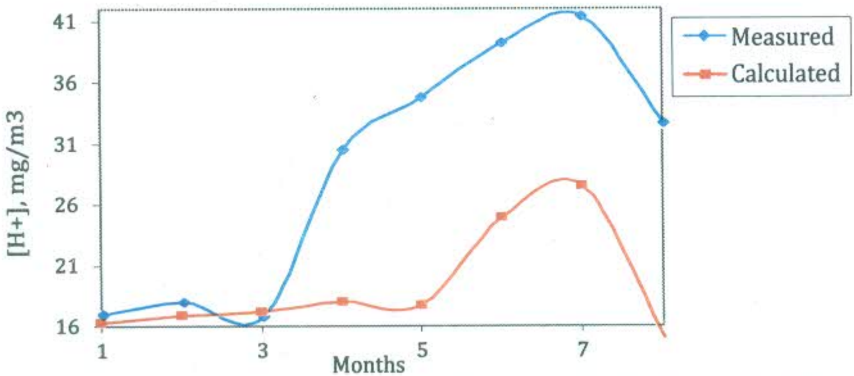

Fig. 7.5: Validation of AQ for NFNL using data for CNP **R^2 = 0.691007**

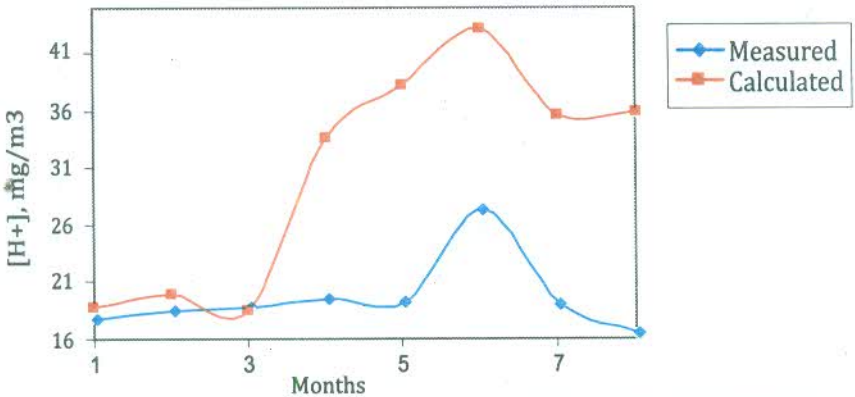

Fig. 7.6: Validation of AQ for CNP using data for NFNL **R^2 = 0.669479**

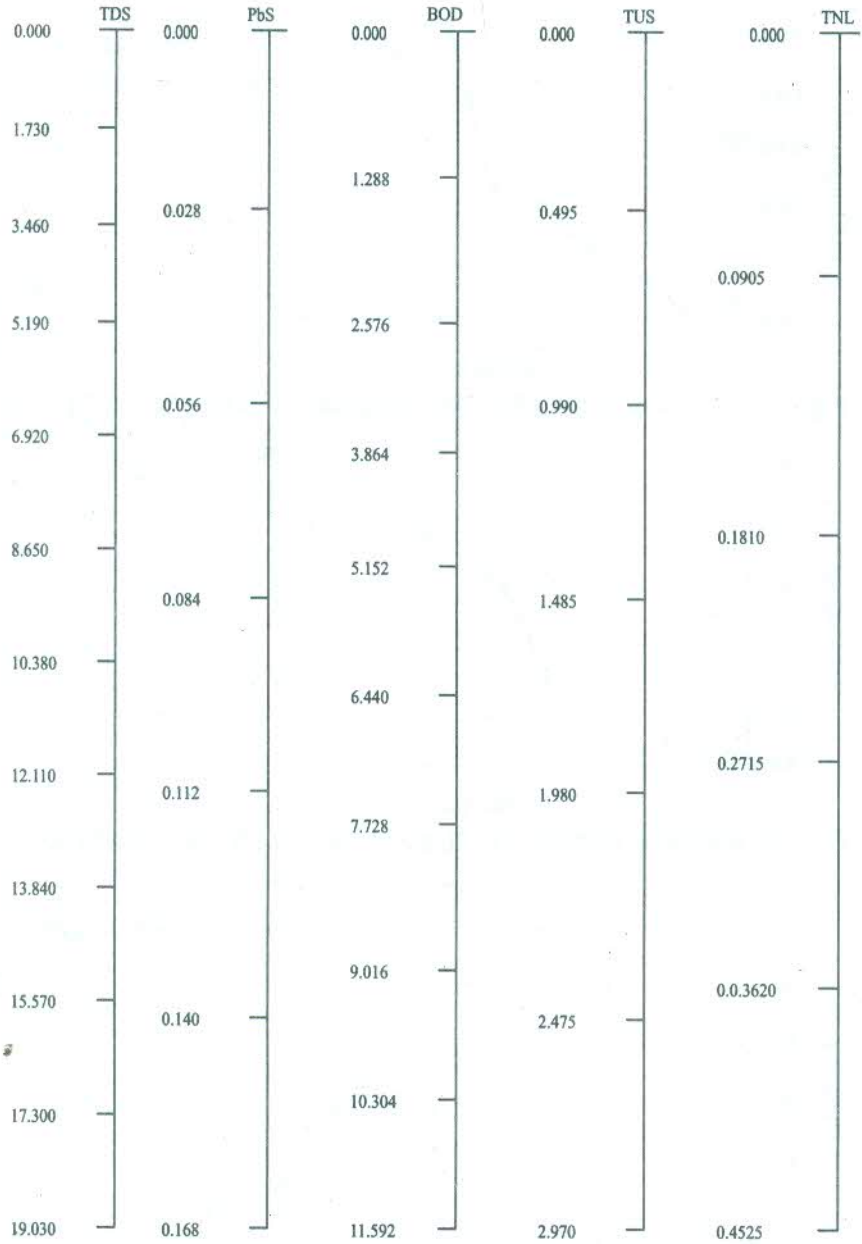

Fig. 7.7: Nomograph for SWQ for NFNL

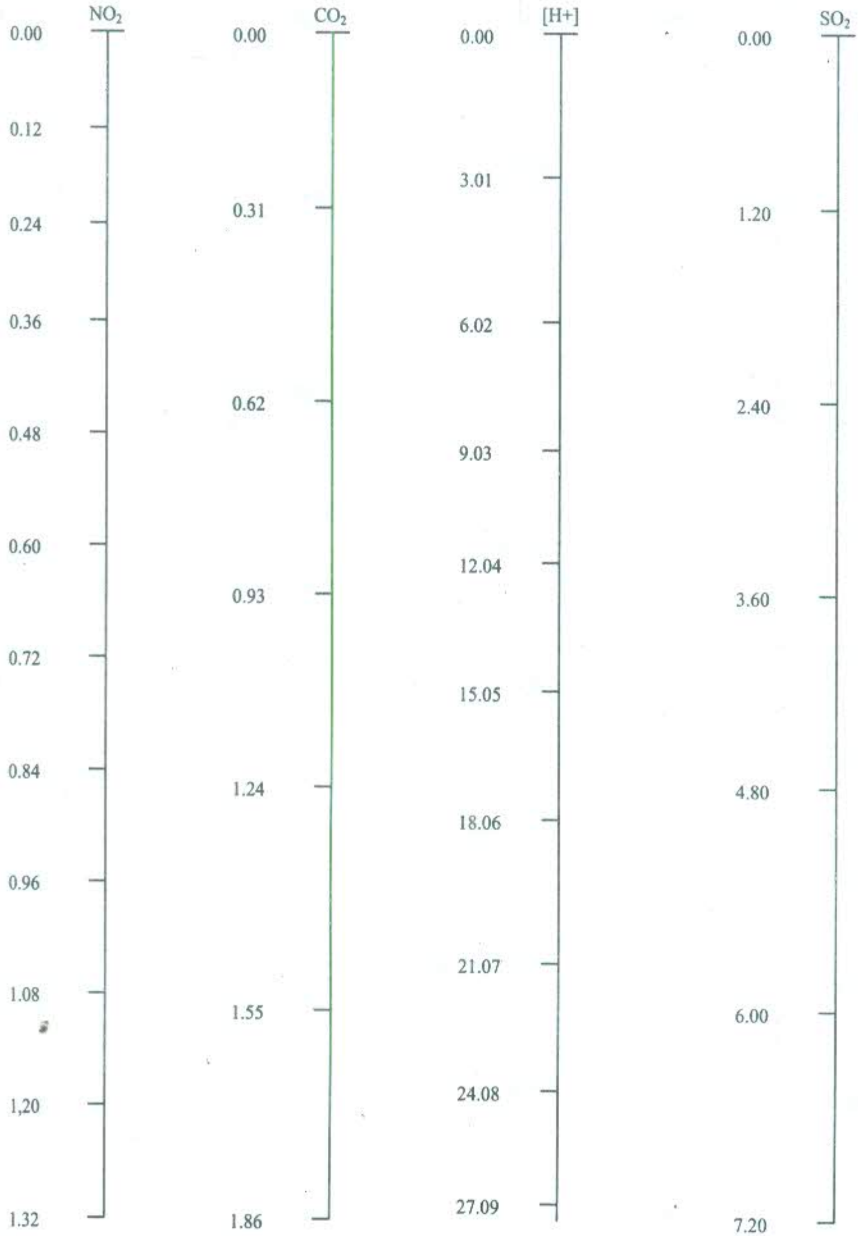

Fig. 7.8: Nomograph for AQ for NFNL

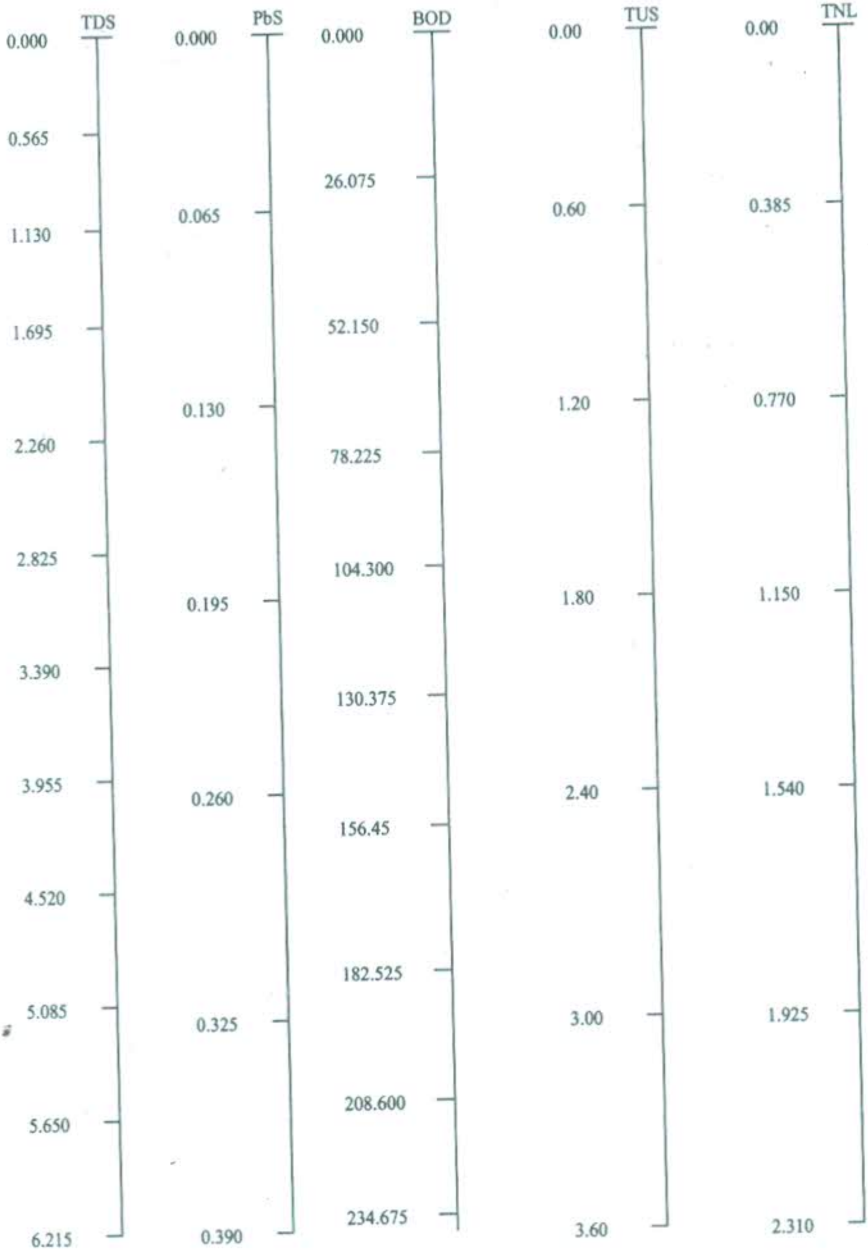

Fig. 7.9: Nomograph for SWQ for CNP

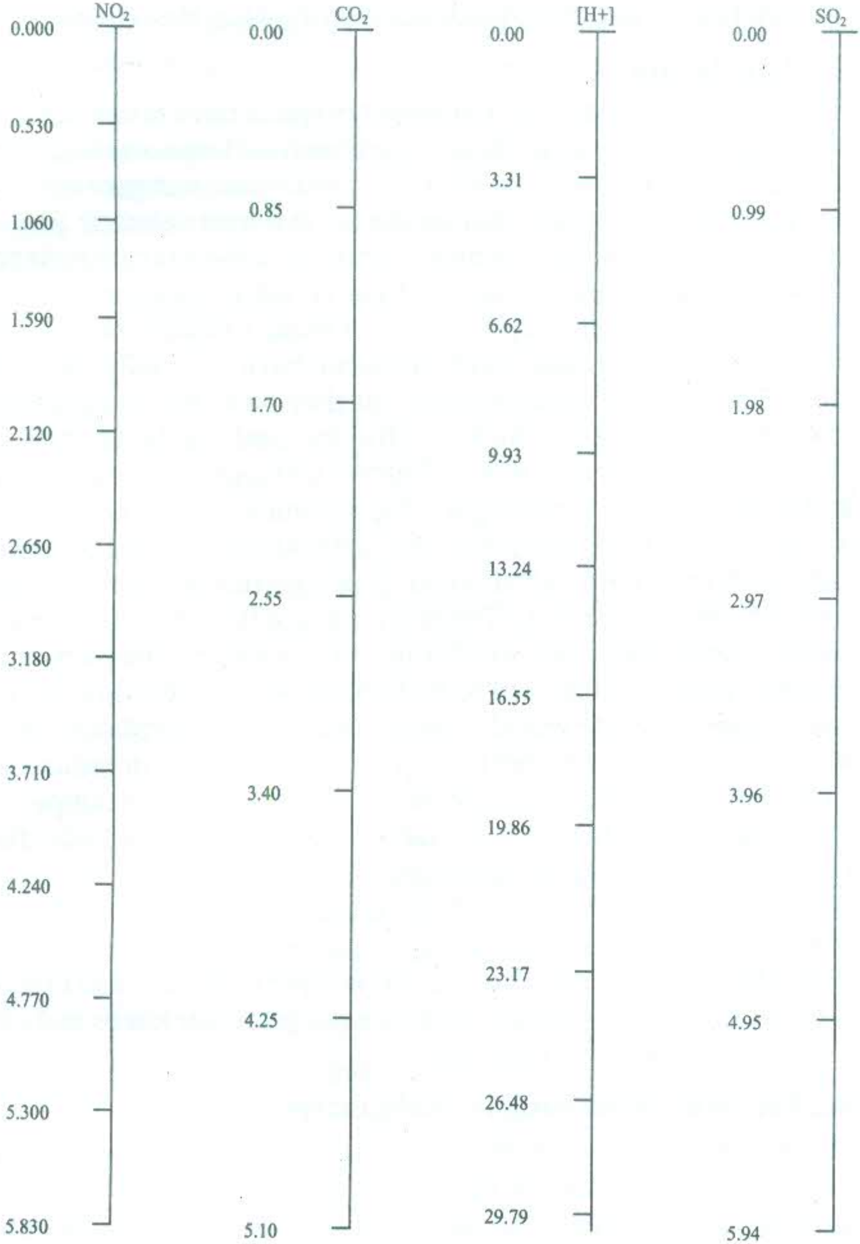

Fig. 7.10: Nomograph for AQ for CNP

8. Conclusion and Recommended Mitigation Measures

8.1 Conclusion

Too often in the past, development projects have taken place in developing countries without environmental impact assessment (EIA) studies or conscious efforts to predict and mitigate adverse environmental impacts. For instance, the hydroelectric power projects on the Kainji Dam and most of the different categories of food processing industries in Nigeria were undertaken with foreign and domestic capital without impact evaluation studies. Hence, in most cases, such projects have not only become destructive to the environment, but they have also endangered the very basis on which continuity and sustainability of development depends. It is no longer in dispute that mankind is today faced with a catalogue of environmental problems that seem to threaten the existence on earth. At first, it appeared that better life on earth solely depended on vigorous industrialisation and economic prosperity. There is no doubt that these important factors contribute to decent living and prosperity. The pursuit of comfort and advancement in technology seemed to have driven many nations of the world towards uncontrolled exploitation of natural resources, neglect for abatement measures in industrial processes and poorly managed environment. Man has tampered with nature in his bid to satisfy the stomach within the contemplation of agripreneurship. The result is that nature is now dealing with man. This underscores the numerous environmental problems being experienced today, including desertification, climate change, ozone layer depletion and loss of bio-diversity. As I conclude, I wish we can go on our knees and ask God to '*forgive us our trespasses*'.

8.2 Recommended Mitigation Measures

In order to protect the environment from the adverse effects occasioned by the twins, stomach infrastructure and agripreneurship, three mitigation measures and management options that should be implemented are recommended. For all the identified negative environmental impacts, the overbearing mitigation measures and options of choice include:

i. Utilisation of the best available technology (BAT).
ii. Payment of optimal liability compensation to local communities.
iii. Institutionalisation of adequate abatement measures.

9. Appreciation

To:	Remarks:
Almighty God	I wish to give all the praise, glory and honour to the Trinity (God the Father, God the Son and God the Holy Spirit) without whom I can achieve nothing. What I am today is by the special grace of God. God preserved me when I travelled the length and breadth of the streets of Lagos selling things in "go-slow" to make sure I completed my bachelor's education. God you are merciful.
My late parents	For your love and care; even when you could neither read nor write, you sold yams, cassava, cocoyams and vegetables to pay my fees in primary school. When my mates dropped out of school in 1973 because they could not pay N4 as school fees, you paid for me. I am grateful for your foresight. You have not laboured in vain. May your souls rest in peace.
My wife	For your love, forbearance and encouragement; and for agreeing to

marry me when I had no comeliness. I still remember the day we went for introduction at my uncles' place; you carried me on your 'Hero' bicycle and climbed hills and went down valleys. Today I am your hero and you are my heroine and the bicycle is no more your ride.

My children

You have been a source of joy and motivation; always asking questions and wanting to learn from me. Your impression that a Professor must know everything has kept me on my toes. Remain blessed!

My siblings (living)/ The Chukwu family

For your love and financial investment in my education despite your meagre resources, I say thank you. I hope I have not disappointed you.

My siblings (late)

Mr. Denis Chukwu and Mr. Chikaodi Chukwu; your deaths in 1973 and 1986, respectively were painful but I thank God for your immense contribution to see that I went to school. Continue to rest in peace.

Vice-Chancellor (Prof. M. A. Akanji)

For your unalloyed friendship not minding our disparities in many ways; I have learnt a lot from you. May God hear and answer your prayers. *Ese!*

Principal Officers of FUT Minna (past & present)

For believing in me and appointing me to serve the University in various capacities; especially Professors M. S. Audu, A. O. Osunde, Abdullahi Bala, and

	S. O. E. Sadiku; Mrs. V. N. Kolo, Alh. Datti Usman, Mr. M. A. Bello, Mrs. H. K. Abdullahi and Dr. A. J. Alhassan. *Na gode.*
	Late Prof. G. O. I. Ezeike (UNN) supervised my B. Eng. project, Prof. E. U. Odigboh and Late Prof. G. O. I. Ezeike (UNN) supervised my M. Eng. project and Professors E. S. A. Ajisegiri, K. R. Onifade and O. D. Jimoh (FUT, Minna) supervised my PhD thesis. This inaugural lecture is a testimony that your labour in me has not been in vain. I say thank you all.
My colleagues/Staff of DABE	For cordial relationship that exists among us. The elders in the Department (past and present), I salute you all. It is DABE and others.
My students	For your contribution in my research at different levels; especially my postgraduate students. God will send you help in time of need. Thank you .
Prof. L. U. Opara	This is a friend that sticks closer than a brother. God will increase you more and more. I remember our years at UNN, especially at Agbebi 4. I remember the cold winter nights in Oman & Stellenbosch, South Africa.
The body of Christ	For your prayers and support at different stages of my spiritual growth. Pastors, ministers and workers in Jesus' House Parish of RCCG, Minna

(past and present), you have been phenomenal; my Pastors in TREM, Minna, I say God reward you in proportion to your investment in my life. Excellent men of Jesus' House, Minna, it is well. Pastor Ojo Peters of Voice of Mercy, Minna and Pastor Matthias Echioda of Occupy Ministries, Minna; I appreciate all your prayers.

Research Associates	Those of you in Oman, South Africa, Norway, Scotland, Netherlands and Iraq, I say well done. This inaugural lecture is a testimony that I have not perished because I have published.
DCAL staff	I appreciate your love for and cooperation with me. You made it easy for me to concentrate and write this inaugural lecture. Even though some of you tried to see me when they shouldn't, you will not get query.
Staff of SEET (academic & non-academic)	For the good times we have shared together. It might have been rough some time ago but SEET, FUT, Minna must survive all of us. As far as FUT, Minna is concerned, SEET leads and others follow.
Senior Academic Colleagues	I thank you all for inspiring me when I was trying to find my feet in the academic arena. Prof. Mrs. V. I. Ezenwa, I must mention your name.

My Admirers/WAEC/ NECO Examiners	Thank you for believing in me. I have kept the academic faith and that is why I am here today.
The Army and the Police	Thank you for arresting me when I was selling kerosene at *'Kasua Gwari'* (Gwari Market) between 1994 and 1995. I was an Assistant Lecturer then. The more you arrested me, the more I wanted to sell because man must survive. Today my story has changed.

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