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University-Led Knowledge and Innovation for Sustainable Development

**Book Series
on Sustainable Development**

Editors:

**Felicia Azuoma Anyogu, Ph.D
Cecilia Amaoge Eme, Ph.D
John Agbo Ogbodo, MSc.**

University-Led Knowledge and Innovation for Sustainable Development

*Nnamdi Azikiwe University Book Series
on Sustainable Development*

Editors

Felicia Azuoma Anyogu, Ph.D
Cecilia Amaoge Eme, Ph.D
John Agbo Ogbodo, MSc.



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PREFACE

Sustainable Development is a comprehensive concept which simply refers to "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." In the course of protecting this future which is common to all, 17 Sustainable Development (SDGs) were set springing from the constructive expansion of the earlier eight goal target set in the Millennium Development Goals (MDGs) of the year 2000. The SDGs are all encompassing, multidisciplinary and address the most pressing global challenges of our time, calling upon collaborative partnerships across and between countries to balance the three dimensions of sustainable development: economic growth, environmental sustainability, and social inclusion. The Millennium Development Goals (MDGs) had their target and timeline of halving extreme poverty by 2015 as a midpoint towards eradicating poverty in all its forms. The MDGs focused on the many dimensions of extreme poverty, including low incomes, chronic hunger, gender inequality, lack of schooling, lack of access to health care, and deprivation of clean water and sanitation, among others. Great successes were achieved, yet many countries did not make sufficient progress, particularly on environmental sustainability.

According to a World Bank Report, around 700 million people still live below the World Bank's poverty line, and billions more suffer deprivations of one form or another. Many societies have experienced a rise of inequality even as they have achieved economic progress on average. Moreover, the entire world faces dire environmental threats of human-induced climate change and the loss of biodiversity. Poor governance, official corruption, and in dramatic cases overt conflict, afflict much of the world today. It then dawned on all that additional work is needed to achieve the ultimate goal of ending extreme poverty in all its forms, hence the consensus to broaden the scope of the MDGs to reflect the challenges the world faces today leading to the formulation of the 17 SDGs. These seventeen SDGs now form a cohesive and integrated package of global aspirations of which the whole world is committed to achieve by 2030.

From the foregoing, it became obvious that there is great need to expand the knowledge base on the issue of Sustainable Development through research and development to increase the level of awareness of all, and direct the policy makers and all stakeholders, to ensure articulate decision making for our today to be sound, and our tomorrow safe. This position is aptly captured in the theme of this Maiden Edition "University-Led Knowledge and Innovation for Sustainable Development" To this end, the Centre for Sustainable Development Nnamdi Azikiwe University (CSD, NAU), whose core objective is "to undertake a strong policy advocacy on sustainable development based on empirical, evidence-based results, in order to influence Government action and public opinions in these domains; thereby making the University system an effective and result-oriented player in public policy articulation" decided to produce this book.

This book is a compendium of original research findings, short communications and review articles of distinguished academics and erudite scholars of various institutions on sustainable development, each relating to their area of research interest, possibly with focus on any of the 17 Goals of the United Nations SDGs forming the Chapters of the book. Each work featured in the book was selected through a thorough review process and originates from the author(s) as contained. This maiden edition provides a concise, well-illustrated and accessible discussion and findings on the characteristics, challenges and opportunities of sustainable development issues, with particular reference to Nigeria and other developing countries. Some of the topical issues x-

rayed in this book include: The role of Nigerian Universities in the attainment of SDGs; Gender equality; sustainable infrastructural development; environment and health of children; Corporate Social Responsibility; Corruption and SDGs attainment; Adequate nutrition and SDGs; Water resources and food security; sustainable building construction; Sustainable Strategy for Agricultural Waste Utilization; Early Childhood Education; Global pandemic and SDGs; sustainable natural resources exploitation; sustainable solid mineral industry; physics education; skill acquisition and SDGs; cyber security and legal frameworks for achieving sustainable development; agricultural development; capital investment and inclusive growth ; climate change mitigation and adaptation.

The Centre for Sustainable Development, Nnamdi Azikiwe University, is eternally grateful to the Almighty God who makes all things possible. We appreciate the Vice Chancellor of Nnamdi Azikiwe University Awka, Professor Charles Okechukwu Esimone, and the entire school authority for the approval and support given to the CSD NAU in the pursuit of this vision. We appreciate also our eminent father of CSD NAU, Emeritus Professor Ikenna Onyido for standing by us in the pursuit of this vision till its actualization. We specially thank all the Chapter contributors for making available to us their intellectual and financial resources for the successful emergence of this book. Finally to all the associates of CSD NAU, you are wonderful people and we are proud of you all.

We regret any short comings in this ‘Maiden Edition’, but promise to improve in subsequent editions as we are committed to ‘excellence’ in the pursuit of Sustainable Development.

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FOREWORD

Sustainable Development is succinctly defined as the organising principles by which human societies seek to meet today's needs without compromising the ability of future generations to meet their own needs. The idea of sustainable development was one of the aftermaths of the industrial revolution, arising when industrial nations began to observe the serious negative impacts of their economic and industrial practices on society. Since then this concern has increasingly drawn the attention of the developed economies of the world, slowly filtering to the developing economies. It was against this background that the United Nations convened its first conference on the environment in 1972, to evaluate human impact on the environment and how this is related to economic development. Thereafter, many United Nation conferences have been held on this issue, culminating in the world body articulating its Sustainable Development Goals that were adopted by member nations in 2015.

World-wide, the core mandate of a University is teaching, research and public service. Deriving from this, the mission statement articulated by the founding fathers of Nnamdi Azikiwe University for the University is to use teaching, research and public service to solve societal problems. Recognizing the challenge poised by man's over exploitation of the finite resources of the planet and that this was posing a potent threat to man's continued existence, Nnamdi Azikiwe University established a Centre for Sustainable Development in 2011 to lend its efforts to the drive for sustainable development.

I assumed office in June, 2019 with a vision to pilot Nnamdi Azikiwe University to rank among the top 200 Universities in the world using a strategy in which translational research occupies a prime place. I am therefore delighted that, keying into this vision and strategy, the Centre for Sustainable Development is publishing the maiden edition of its envisaged annual book series on sustainable development, which I understand is the first such publication by a Nigerian University. I congratulate the Director, the contributors of the chapters and all who have to do with this auspicious development.

The Chapters of this maiden edition of this book series span all spheres of human endeavours: the economy, environment, health, socio-cultural practices, corporate social responsibility, transparency and accountability, among others. It and, hopefully, subsequent editions will make interesting and useful reading for the academia, government policy makers, corporate organizations and all who are aware that sustainable development is the cornerstone for the survival of human-kind.

Prof. Charles O. Esimone, FAS, FPSN
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Guest Author

The Intersection between Effective Corporate Social Responsibility (CSR) and Sustainable Development Goals (SDGs)

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1. Introduction

The concept of Sustainable Development Goals (SDGs) is reassessing the discussion on Corporate Sustainability and Responsibility. According to the International Institute for Sustainable Development, “if sustainable development is to achieve its potentials, it must be integrated into the planning and measurement systems of business enterprises. And for that to happen, the concept must be articulated in terms that are familiar to business leaders.”

Sustainable Development Goals (SDGs) were adopted on September 25, 2015 by 193 countries as a follow up to the Millennium Development Goals. The SDGs focus to end poverty, protect the planet, and ensure prosperity for all, as part of a new sustainable development agenda. A total of 17 goals and 169 targets are set to be achieved by 2030 and the attainment of the same calls for a collective effort from the government, the corporate entities, and the civil society organisations.

Nigeria has also signed the declaration for sustainable development along with other countries. While the government initiatives in Nigeria are linked to achieving SDGs, local implementation and data validation has become a challenge. To add on to the situation, Nigeria ranks 159 out of 162 on the SDG index published in 2019, thus calling for immediate action through a collaboration between the corporate sector, civil society organisations and the government at all levels.

On one hand, businesses are now being seen as the key drivers of SDGs as they can apply their creativity and innovation in solving the sustainable development challenges and can play a strong role as facilitators to catalyse implementation of the SDGs. On the other hand, they are also discovering new growth opportunities and lower risk profiles by designing and delivering solutions for the achievement of the SDGs. SDGs can be used as an overarching framework to create, integrate, communicate, and report goals, objectives, and activities to leverage on a range of benefits through an effective CSR programme. In today’s world of being socially and environmentally conscious, customers and employees now place a premium on spending their money and working for businesses that prioritise corporate social responsibility. It is a known fact now that what the public thinks of your business is critical to your success.

International Organisation for Standards (ISO) defines Social Responsibility as: “the responsibility of an organisation for the impact of its decisions and activities on the society and environment, through transparent and ethical behaviour that:

- contribute to sustainable development, including health and welfare of the society.
- take- into account the expectations of stakeholders.

- are in compliance with applicable law and consistent with international norms of behaviour; and
- are integrated throughout the organisations and practiced in its relationships.”

As the consciousness of CSR increases, companies are concerned about having a good social image. In the West, consumers, employees, investors, and other stakeholders are already prioritising CSR when choosing a brand or company. Stakeholders are holding corporations accountable for effecting social change with their business beliefs, practices, and profits. A robust CSR programme is an avenue for businesses to show their good corporate citizenship and protect it from social and environmental risk says Skye Schooley, staff writer at businessnewsdaily.com.

CSR is an ever-evolving activity that takes into cognisance sustainable development in a company's business model. CSR policy is an in-built procedure for a business entity to monitor and ensure adherence to laws, ethical standards, and norms of its environment. It has become extremely important to have a socially conscious image while proactively managing risks. It is, therefore, no longer a 'do-good' thing but has become a 'do-well' for businesses.

2. Principles for integrating Social Responsibility in Business operations

CSR when undertaken with dedication promotes the public interest by encouraging community growth and development, and by eliminating practices that harm the public sphere regardless of legality. ISO 26000 recommends seven core principles for integrating Social Responsibility into the operations of a business and its relationships. Adapted from the Professional Evaluation and Certification Board (PECB), Canada – one of the world's largest professional certification bodies - they include:

i. Organisational Governance is the system by which an organisation makes and implements decisions in pursuit of its objectives. This is the most crucial factor in enabling an organisation to take responsibility for the impact of its decisions and activities. It is the deliberate inclusion of public interest into corporate decision-making and the honouring of a triple bottom line known as People, Planet and Profit. It should be the starting point for integrating social responsibility throughout the organisation. Effective governance should be based on incorporating the principles of social responsibility (accountability, transparency, ethical behaviour, etc.) into decision making and implementation.

ii. Human Rights are the basic rights to which all human beings are entitled. The United Nations Guiding Principles on Business and Human Rights (UN GPBHR) has further clarified the responsibility of non-state actors in the respect of rights. These Guiding Principles provided the first global standard for preventing and addressing the risk of adverse impact on human rights linked to business activities. In addition, the Guiding Principles continue to provide internationally accepted framework for enhancing standards and practice regarding business and human rights. It encompasses three pillars outlining how states and businesses should implement the framework as follows:

- a. the State's duty to protect against human rights abuses by third parties, including business;
- b. the corporate responsibility to respect human rights; and
- c. greater access by victims to effective remedy, both judicial and non-judicial.

This involves proactively assessing specific functions/operations that may be linked to human rights risks. Some of the ways to address human rights issues include - due-diligence, human

rights risk assessments, avoidance of complicity, resolving grievances, avoidance of discrimination and protecting vulnerable groups, upholding rights - civil and political rights, economic, social, and cultural rights, and labour rights.

iii. Labour Practice is a term that encompasses all the policies and practices relating to work performed on behalf of the organisation, including the recruitment and promotion of workers; wages, social security, disciplinary and grievance procedures; transfer and relocation of workers; termination of employment; training and skills development; health, safety and industrial hygiene; and any policy or practice affecting work conditions. These are the most important socio-economic contributions of an organisation to the employees.

For instance, improving the occupational health, safety and hygiene conditions for all men and women is a significant part of a strategy to fight against poverty in Africa. The modern systems approach to occupational health and safety (OHS) now systematically promoted by the International Labour Organisation (ILO) emphasizes the need to ensure that attention is given to OHS at the highest national policy levels and that coherent national action is taken in this respect. There is need to develop enterprise-level efforts to enhance working conditions and apply the national and international OHS standards in line with the labour laws.

The World Economic Forum in the preface to its 2016 Human Capital Report stated that, “a nation’s human capital endowment — the knowledge and skills embodied in individuals that enable them to create economic value — can be a more important determinant of its long term success than virtually any other resource,” – That is to say that human capital development by organisations contributes directly towards the achievement of the SDGs.

iv. Environmental Responsibility is a precondition for the survival and prosperity of human beings. As the global population and global consumption continue to increase, several environmental and social threats are imminent. Pollution, use of natural resources, climate changes, destruction of natural habitats, and loss of biodiversity are some of the environmental issues covered by ISO 26000. In the last few years, many organisations are taking steps toward becoming environmentally and socially responsible.

v. Fair Operating Practices concern the way an organisation uses its relationships with other organisations to promote positive outcomes. These include relationships between organisations and government agencies, as well as between organisations and their partners, suppliers, contractors, customers, competitors, and associations to which they belong. Fair operating practice issues covered by ISO 26000 are anti-corruption, responsibility for political involvement, fair competition, promoting social responsibility in the value chain, and respect for property rights.

vi. Consumer Issues regarding the social responsibility are related to, among other matters, fair marketing practices, protection of health and safety, sustainable consumption, dispute resolution and redress, data and privacy protection, access to essential products and services, reference to the needs of vulnerable and disadvantaged consumers, and consumer education.

vii. Community Involvement and Development are two of the most important initiatives that all the organisations, public and private, can take towards developing a sustainable society. Social responsibility issues through which an organisation can contribute to their communities

include their involvement in and support for civil institutions, promotion of culture and education, creation of employment opportunities and provision of full and safe access to modern technology. It can also contribute through social investment, wealth and income creation and health promotion.

3. Enhancing Corporate Social Responsibility through the Global Sustainable Development Goals Implementations

In line with ISO comparative document, therefore, the Sustainable Development Goals provide a powerful framework for businesses to engage in Corporate Social Responsibility. CSR and SDGs together have tremendous potential to develop an interconnected model for sustainable growth. SDGs have colossal opportunities for the corporate sector’s participation. These goals are bringing private players from various sectors to achieve the common aim of sustainable development by exploring synergies between different stakeholders for cumulative synchronised growth. For instance, when an organisation defines its CSR focus area on enhancing livelihoods through for example skills development training for women and youth, it is contributing to various SDGs like creating a means to end poverty, zero hunger, quality education, gender equality and decent work and economic growth.

The diagram below (adapted from ISO 26000) shows the interrelation of activities that when carried out, will contribute to the attainment of SDGs.



Examples of situations where businesses can support sustainable development goals through effective corporate sustainability and responsibility programmes include; implementation and

compliance with the principles of ISO 26000 (Social Responsibility) to successfully foster sustainable economic growth, increase sustainable livelihood, create green jobs, alleviate poverty, reduce inequality, foster policy coherence, and promote investment & resource efficiency. The above listed points will contribute to the attainment of the following SDGs: no poverty (SDG 1), zero hunger (SDG 2), good health and well-being (SDG 3), quality education (SDG4), achieving gender equality and empowering women and girls (SDG 5), clean water and sanitation (SDG 6), affordable and clean energy (SDG 7), decent work and economic growth (SDG 8), industry innovation and infrastructure (SDG 9), reduced inequality (SDG 10), sustainable cities and communities (SDG 11), partnership for the goals (SDG 17). From the above example, it is obvious that just by applying the principles of ISO 26000 through an effective implementation programme, 12 out of the 17 SDGs will be achieved.

In line with the above example, if an organisation decides to implement and comply with the principles of ISO 14001 (Environmental Management) as an effective corporate sustainability and responsibility programme, it will be able to address climate change, promote green investment and resource efficiency, protect natural capital, create green jobs, foster policy coherence, foster sustainable economic growth, and increase sustainable livelihood. This organisation would have contributed to the following SDGs: climate action (SDG 13), clean water and sanitation (SDG 6), life below water (SDG 14), life on land (SDG 15), responsible consumption and production (SDG 12), sustainable cities and communities (SDG 11), affordable and clean energy (SDG 7), decent work and economic growth (SDG 8) and partnership for the goals (SDG 17).

These are ideal examples that showcase diligent and optimal use of CSR activities to achieve the SDGs. Through the various programmes outlined, when undertaken and implemented contribute to all the 17 sustainable development goals.

4. Conclusion

The above cases strongly show how the convergence of integrated CSR with the knowledge and expertise of sustainability practitioners are key in achieving the sustainable development goals seamlessly. Along with strategic business benefits, SDGs also serve as a tool to manage increased scrutiny from various stakeholder groups over various social, environmental, and governance issues. Thus, it is industry best practice and to achieve the desired aims to always engage the services of certified and experienced ISO practitioners for all implementation and audit processes.

Although, it can be acknowledged that significant strides are being made by African businesses, there is still need to engage in meeting the SDGs in a way that helps in developing blueprints to manage the social and environmental performance of companies. This will result further in developing smart businesses that capture opportunities and come up with innovative products and services to achieve the highest standards of corporate sustainability and the SDGs.

About the Author

Eustace Onuegbu is board level management consultant, a member of the United Nations Major Group on Business and Industry, a member of the Global Advisory Group on Business and Human Rights. He is an expert in sustainability strategies and implementation using both national and international platforms. Eustace is a certified Management Systems (ISO Standards - ISO 14001 Environmental Management Systems, ISO 26000 Social Responsibility, ISO 45001 Occupational Health and Safety) Consultant, Facilitator and Auditor by the Professional Evaluation and Certification Board, (PECB) Canada and a Distinguished Fellow of the Institute of Management Consultants (IMC) Nigeria. He is presently serving

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Eustace has worked with leading organisations such as the Financial Reporting Council of Nigeria (FRC), Dangote Group, Zenith Bank PLC, Centre for International Governance and Innovation (CIGI) Canada; Central Bank of Nigeria (CBN), Voices4Change/UKAID, University of Lagos; The Federal House of Representatives, Abuja; Oil and Gas Free Zones Authority (OGFZA), Green Energy International, the National Human Rights Commission of Nigeria (NHRC), the Government of Tanzania, among others on Sustainable Development frameworks including Sustainable Banking, Consumer Protection and Financial Inclusion, Corporate Sustainability and Responsibility, and Corporate Governance. He has also worked on key developmental projects and made several representations to the international community including the United Nations, African Union, ECOWAS, and The Senate of Federal Republic of Nigeria on a wide range of environmental and social impact issues. He is an avid advocate of instituting global best practices in the conduct of Corporate Sustainability and Responsibility (CSR) in Africa and the pioneer ISO 26000 certified practitioner in West Africa. Eustace holds a degree in Marketing from Abia State University in Nigeria, another in International Business and Management from Amsterdam School of Business, The Netherlands, and a post graduate degree in International Human Rights Law from Birmingham City University in the United Kingdom.

Chapter 1

The Role of Nigerian Universities in Nigeria's Quest to Attain the Sustainable Development Goals

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Abstract

The sustainable development goals (SDGs) articulated by the global community using the platform of the United Nations in 2015 offer a clear pathway to economic development that is equitable, inclusive and environmentally sustainable for Nigeria and other members of the global community. In this paper, it is argued that the many false starts at development across the years and the deepening misery index of the majority of Nigerians forcefully contend for a new development paradigm for Nigeria which the SDGs provide, with the caveat that the pursuit of the SDGs must be anchored on good governance in the context of a less predatory political culture and a substantial reduction of corruption. The paper shows how knowledge has replaced capital, land and volume of labour as agents of production in a knowledge society, in which the vital elements are the national innovation system of which universities are part, and epistemic communities of experts to which universities copiously contribute, are the drivers of economic development in this age. Teaching, research and engagement with society are the pillars of the core mandate of modern universities. Generation of knowledge and innovation through research for the practical solution of identified sustainable development challenges in the universities' narrow and wide catchment areas through their problem-solving research activities is a mechanism for the universities to engage with, and be in the vanguard for, Nigeria's pursuit of the SDGs. Extrinsic and intrinsic factors which impede the universities in playing this role are identified and discussed.

Introduction

Present day Nigeria is faced with daunting developmental challenges, some of which have accumulated across the years and have grown in intensity and acuity to become near existential threats. We are faced with a sceptre of environmental degradation and ecological disasters of such scope and magnitude that pose great risks to present and future generations. More Nigerians fall below the poverty line every day to join the estimated 40% of Nigerians who live on less than one US dollar a day (National Bureau of Statistics, 2020). Other estimates of extreme poverty in Nigeria present a grimmer picture by far (Oxfam, 2017; Ajibola, Loto & Enilolobo, 2018). Our educational system has become increasingly ineffective and dysfunctional, turning out products who are ill prepared for the challenges of a rapidly changing world that has been flattened by technology (Friedman, 2007), while our healthcare regimes are perilously inadequate for catering for the health needs of a vulnerable society with an attendant low life

expectancy. The present rate of unemployment, especially as it concerns the youth, which was 23.13% at the end of 2018 (National Bureau of Statistics, 2020) and has worsened further due to the progressive weakening of the economy, is dangerously high. The level of insecurity of lives and property, fostered by terrorist activities, rampaging criminal gangs that kill, maim and rape their victims and loot captive communities, circumscribes the social disarray which describes present day Nigeria. Other indicators of a degraded and crumbling society rapidly descending to a Hobbesian type are no less flattering: the high level of energy poverty, low penetration of technologies, governance and institutional failures, politics that is dominated by primitive and predatory rent-seeking and prebendal behaviour, a ravaging level of corruption which has taken every stratum of society hostage, crumbling and inadequate infrastructures which have birthed a severe deficit of this indispensable pillar of economic development and so on, which have been with us for some time now (Onyido, 2013) are gaining in intensity and severity. Such a depressing scenario is best reflected and quantified by the 2018 human development index (HDI) of 0.534, a value which is below the average of 0.541 for sub-Saharan Africa, which ranks Nigeria as 158th out of 189 countries according to the 2019 United Nations Development Programme (UNDP) Human Development Report (UNDP, 2019) and conveys the sense of a high misery index as a defining characteristic of life in Nigeria today.

The foregoing forcefully argues for a complete change of paradigm in governance and developmental strategies in order to translate Nigeria from its backward state that is characterized by a lot of motion without movement into a modern 21st century nation, which is achievable by proper and beneficial utilization of her hitherto mismanaged and misapplied vast human and material resources. It is argued in this paper that the adoption of the sustainable development paradigm, in which universities play a vanguard role in generating and adapting knowledge and innovation required for building an inclusive, progressive society that is based on the overarching principle of enhancing human welfare and dignity in the context of responsible environmental stewardship, is the mechanism for achieving equitable, inclusive and sustainable economic development that conveys decent life to present and future generations of Nigerians. This, of course, rests on the caveat that promoting a political and governance mode that recognizes the equality, dignity and sanctity of all human lives is a corollary at the base of building a just and equitable society where the rights and lives of the high and the low in society are protected. The paradigm flowing from this caveat is left for those knowledgeable in such matters to develop and espouse.

The Concept of Sustainable Development and Age of Sustainable Development

Anticipating the end of the life span of the Millennium Development Goals (MDGs) in 2015, the United Nations under the leadership of its then Secretary-General, Ban Ki-Moon, set in motion the process for evolving a 15-year development agenda to commit world leaders to combat poverty, hunger, disease, illiteracy, environmental degradation and gender inequality. The Rio+20 Conference in June 2012 provided the impetus for the advancement of a set of international development goals to be integrated into the UN's post-2015 Development Agenda, with sustainable development at its core. The underlying philosophy reflected the need for global accountability in the deployment of the planet's material and human resources for inclusive and equitable economic development that is driven by responsible environmental stewardship (Mensah & Casadevall, 2019). In September 2015, the United Nations Member States adopted the 2030 Agenda for Sustainable Development "as a shared blueprint for peace and prosperity for people and the planet, now and into the future" (United Nations, 2015). Foreseeing a new era

for global development undergirded by international cooperation and collaboration led Sachs (2015), one of the leading thinkers and visionaries of this time whose robust intellectual input contributed to the articulation of the Agenda, to dub these times in which we live the *Age of Sustainable Development*.

We need to consider and understand the meaning of the term *sustainable development*. The literal meaning of sustainable development is development that is maintained over time (Eliot, 2006). The concept has benefitted from ideas from and interactions across several disciplines and human activity domains which has given it a multidisciplinary context and scope and which recognizes *ab initio* that the drive for a more prosperous, equitable and secure future for the world would require a different set of normative actions that takes the interests of all into consideration. Thus, *inclusivity* has become a kind of organizing essence for the concept. A historical milestone in the evolution of the concept of sustainable development was the institution of the UN's World Commission on Environment and Development (UNWCED) which was chaired by the first female Prime Minister of Norway, Gro Harlem Brundtland. The Report of this Commission, named the Brundtland Commission after its chairperson, *Our Common Future*, has provided a classic definition of sustainable development as (UNWCED, 1087):

... development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

This definition of sustainable development links economic development with responsible long-term stewardship of the environment and emphasizes intergenerational equity and accountability (Emas, 2015). It is generally recognized (Sachs, 2015; Taylor 2016) that the three cardinal issues of sustainable development are economic development, social inclusion and environmental sustainability. As a consequence, Mensah & Casadevall (2019) have reasoned that the sustainable development construct stands on the three interdependent, normatively-derived pillars of economic sustainability, social sustainability and environmental sustainability, as illustrated by Wanamaker (2018) in Figure 1. It has been posited that the pillars of sustainable development are four, not three, the additional pillar being governance, which includes the activities and performance of governments and businesses (Sachs, 2015).

Sustainable development has also been described as a science of complex, interacting systems, identified as pillars above, which respond non-linearly to changes or shocks. Each of these complex systems – economic, social, environmental and governance – is characterized by the properties of complex systems, identified by Sachs (2015) as emergent behaviour and compulsive, nonlinear dynamics. These characteristics of sustainable development which are derivatives of the complexity of the contributing systems and the outcomes of their cross-interactions, boil down to the fact that sustainable development problems themselves are complex and not amenable to simple analysis and solutions. This innate property of sustainable development and the problems associated with the construct should be borne in mind as the strategic roles of universities in knowledge and innovation generation within the context of evidence-based approach to the solution of the challenges of sustainable development are discussed below.

The critical objectives for sustainable development were identified in the UNWCED Report as the following (see Eliot, 2007):

- Reviving growth
- Changing the quality of growth
- Meeting essential needs for jobs, energy, water and sanitation

- Ensuring a sustainable level of population
- Conserving and enhancing the resource base
- Reorienting technology and managing risk
- Merging environment and economics in decision-making.

The conditions necessary for sustainable development as identified by the UNWCED Report cited above are (see Eliot, 2007):

- A political system that secures effective citizen participation in decision-making
- An economic system that provides for solutions for the tensions arising from disharmonious development
- A production system that respects the obligation to preserve the ecological base for development
- A technological system that fosters sustainable patterns of trade and finance
- An international system that fosters sustainable patterns of trade and finance
- An administrative system that is flexible and has the capacity for self-correction.

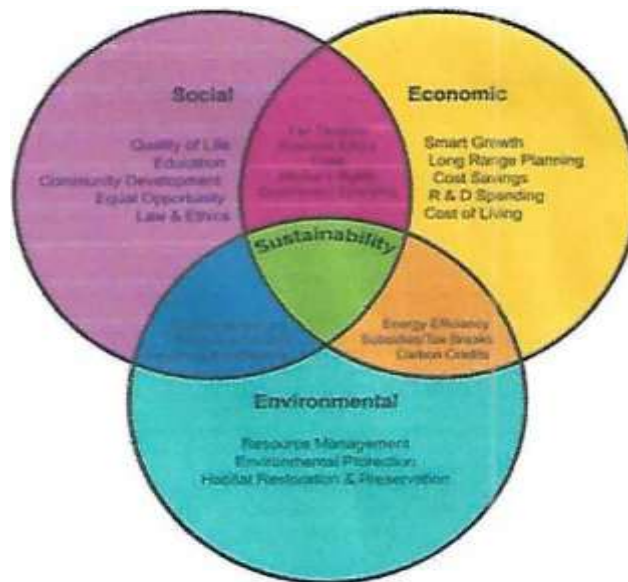


Figure 1: *Interactive relationships among the three pillars of sustainable development – economic development, social inclusion and environmental sustainability (Source: Wanamaker, 2018)*

With the foregoing as context, the global community proceeded to articulate, through multi-layered processes and negotiations, the 17 sustainable development goals (SDGs), shown in Table 1, which were adopted in September 2015 as the successor agenda to the MDGs. The framework for the implementations of the SDGs includes 169 targets and 231 indicators to enable the tracking of progress on the goals and targets. The thinking behind the SDGs is that their implementation engages the global community – not only governments as happened in the case of the MDGs, but also businesses, scientists, academia, civil society leaders and organizations, non-governmental organizations (NGOs), and students everywhere. The MDGs were directed at poor countries while the rich developed countries played the role of donors. The

SDGs, on the other hand, are universally applicable to rich and poor countries alike, developed and developing countries as well (Sachs, 2015).

Table 1: The Sustainable Goals (Source: United Nations, 2015)

Goal	Narration
1	End poverty in all its forms everywhere.
2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
3	Ensure healthy lives and promote well-being for all at all ages.
4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5	Achieve gender equality and empower all women and girls.
6	Ensure availability and sustainable management of water and sanitation for all.
7	Ensure access to affordable, reliable, sustainable and modern energy for all.
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
10	Reduce inequality within and among countries.
11	Make cities and human settlements inclusive, safe, resilient and sustainable.
12	Ensure sustainable consumption and production patterns.
13	Take urgent action to combat climate change and its impacts.
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
17	Strengthen the means of implementation and revitalize the global partnership for sustainable development.

An important corollary pertinent to the thrust of this paper is the creation in 2012 of the United Nations Sustainable Development Solutions Network (UNSDSN) as a global network for sustainable development problem-solving with the foresight that the challenges of sustainable development in the domains of health, education, urbanization, energy systems, conservation of biological diversity, environmental and ecological degradation, conflict prevention and

resolution, etc. are complex problems which require evidence-based approaches. The activities of the UNSDSN are guided by its Leadership Council, a distinguished group of scientific, business, civil society, and policy leaders from around the world (Sachs, 2015). Renowned economist and thinker, Professor Jeffrey Sachs of Columbia University was tasked with articulating the framework and objectives of this aspect of UN's work in sustainable development and constituting its Leadership Council. It was an honour and a rare privilege for this author to be appointed to the UNSDSN Leadership Council and, in this capacity, charged with constituting the Nigerian chapter of the UNSDSN, the Nigerian Sustainable Development Solutions Network (SDSN-Nigeria) as a consortium for Nigerian universities committed to sustainable development, which was accomplished with the help of some distinguished Nigerian scholars and launched in April 2013.

Nigeria's Chequered and Tortuous Road to Economic Development

Several decades ago, before the military shot its way to power and gate-crashed into governance, the economic development agenda of post-independence Nigeria was predicated on periodic national development plans. When the military took over power in 1996, the emergent federal military government inherited the first national development plan of 1962-68 which was formulated by the Balewa-led Federal Government. The federal military government then went on to formulate the second, third, and fourth national development plans for the periods 1970-74, 1975-80, and 1981-85, respectively, as it perpetuated itself in governance. Then came the structural adjustment programme in 1986 which may be taken as the animating essence for development during the military government of General Ibrahim Babangida (1985-1993). General Sani Abacha's military regime muted the idea of Vision 2010 as an economic and politico-social development plan. This plan was in the works when Abacha died in 1998. Although his successor, General Abdusalami Abubakar sanctioned Vision 2010, nothing came out of it before the military handed over power to civilians in 1999. The post-military civilian government at the federal level was led by President Olusegun Obasanjo, whose two-term tenure spanned the period 1999-2007. The creation of the Niger Delta Development Commission by Obasanjo was a major initiative to address the development conundrum in that region of Nigeria that produced the country's oil wealth. His administration initiated the National Economic Empowerment Development Strategy to transition Nigeria to a modern economy, which was expected to deliver economic development that had hitherto eluded Nigeria. President Umaru Yar'Adua when he took the reins of government in 2007, initiated the Vision 20:2020 which was a bold dream of making Nigeria one of the 20 top economies in the world by year 2020. When Yar'Adua died in 2010, he was succeeded in office by President Goodluck Jonathan, his erstwhile Vice-President, whose development thrust was called The Transformation Agenda. The coming of President Muhammadu Buhari in 2015 saw the adoption of the Economic Recovery and Growth Plan (ERGP) as his administration's economic development agenda, which aimed at the restoration of "economic growth through the leveraging of the ingenuity and resilience of the Nigerian people" (Nigeria, Ministry of Budget & National Planning, 2017).

The track traversed by Nigeria in her quest for economic development sketched above clearly shows a country whose political instability has resulted in a constantly changing economic development policy frame, with the end result that there is little or nothing to show for all the wealth the country has garnered and squandered across the years. Among the factors that have been identified to hinder the achievement of result-oriented economic development are the lack of commitment of the political leadership to the pursuit of clearly stated policy objectives,

institutionalized corruption at virtually every stratum of our national public life, poor prioritization in the allocation of resources, a persisting culture of poor budget processes and implementation, policy inconsistency and policy somersaults leading to a complete absence of policy continuity that engenders a new start every few years, over-reliance on foreign doctrines, and lack of coordination and harmonization of programmes and policies (Ibietan & Ekhoesuehi, 2013; Ikeanyibe, 2017; Ejeh & Orokpo, 2019; Uche, 2019).

The palpable and visual manifestations of underdevelopment in Nigeria, a country with an abundance of human and natural resources, in the form of deepening poverty; food insecurity; absence of social safety nets, especially for the vulnerable in society; collapsed infrastructures; underperforming social sectors; an import-dependent economy that is dominated by and dependent on crude oil sales as the revenue source; export of unprocessed raw materials; a poor manufacturing and industrial base; a high level of insecurity which tends towards complete social disarray; explosive population growth, and so on (International Peace Institute, 2009; Akinyetun, 2016; Jack, Nkwocha & Boroh, 2016; Augustine, 2018), constitute clear evidence of failed developmental efforts and suggest the urgent need for the adoption of an alternative development paradigm. The SDGs provide this alternative model of development which envisions the structuring of national development goals in the short and medium terms to drive towards the targets provided in the SDGs which could then be tracked by the inbuilt indicators to measure progress. This approach envisions a new attitude to budget formulation, implementation and evaluation as well as a new governance culture that is constructed on equity and inclusivity and which addresses the debilitating problem of corruption as no development paradigm, no matter how progressive, would survive the gutting ferocity of unbridled corruption. The rest of the paper now turns to the relevance of our universities in Nigeria's quest for sustainable development.

Universities and Societies in which They Are Embedded

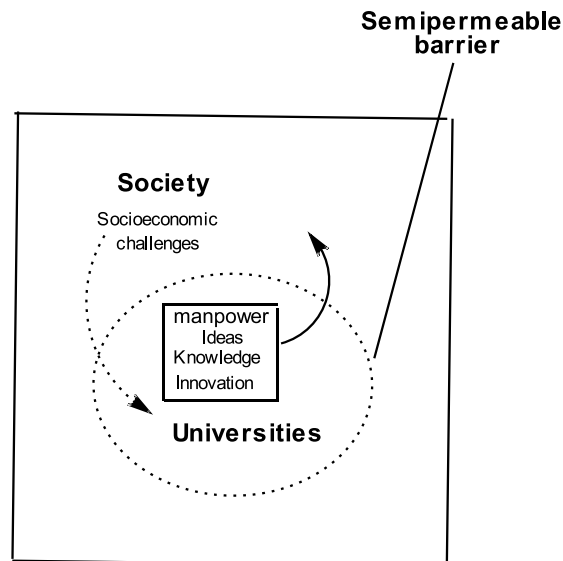
The University, as a social institution, has a long history and tradition rooted in the intellectual activities of Plato's Academy in ancient Greece which may be equated to the first university in Europe (Murphy, 2015). Although there were older centres of learning in Africa and Asia, such as Al-Azhar University in Cairo, Egypt, founded in 970 AD (Times Literary Supplement, 2020), Sankore University in Timbuktu, Mali, founded in 989 AD (Khair, 2003), the University of Bologna in Italy, founded in 1088 (University of Bologna, 2020), is regarded as the oldest university in Europe that has been in continuous existence till today. A brief overview of the evolution of universities has been given by Onyido (2018a) in his recent book on the Nigerian university system; the main thrust of that overview is summarized here. The European medieval university was branded by its teaching mission and Scholasticism (Scott, 2006; Onyido, 2018a), the latter being a school of philosophy in the Middle Ages that engaged a critical method of philosophical polemics which was based on the Catholic theistic paradigm. It was the German model of the university that made research one of the cornerstones of the university enterprise and sought a harmony between teaching and research, such that the mission of the university became an "interplay of teaching and research" as the focus of European universities (Onyido, 2018). This mission of teaching and research was assimilated by American universities when they came into being from the late 17th century. It was, however, the coming of the land grant (or agricultural) universities in the United States by the 1862 Morrill Act that problem-solving and engagement with the practical challenges facing society became part of the mission of universities. Schuh (1986) conveys the essence of land grant universities as follows:

The land grants (land grant universities) were created in response to elitism and limited relevance of the (private) universities in this country. They were to provide upper-level education for the masses – especially in agriculture and the mechanical arts. In addition, land grant universities were to generate new knowledge, apply it to the problems of society, and extend that knowledge to others beyond academia. It was a tripartite mission: teaching, research and extension. Every area of activity was to be a legitimate subject of inquiry. The land grant concept was not limited to agriculture and the mechanical arts. From medicine to music, the resources of the land grant universities were to make significant contributions to knowledge – and to its practical application.

The land grant concept, once implemented, triggered radical changes in the American higher education and society, with many of the existing universities at the time, including Harvard, integrating the essential principles of the Morrill Act into their institutional philosophy. Such was the impact of this brand of higher education that Bloom, Hartley and Rosovsky (2004) characterized land grant universities in the following words:

They (the land grant universities) epitomised the paradigm of the institution of higher learning as a solver of local problems and a servant of the people.

The land grant concept planted the seed of the public service mission of universities to society by making available useful knowledge derived from research to the citizenry (Scott, 2006; Onyido, 2018a). This role of universities has placed them squarely as agents of societal change (Parsons & Platt, 1973) which enabled their function to be visualized as one of *engagement*, which presages mutual relationships with communities in which they are embedded (Ward, 2003; Scott, 2006). This role of engagement of universities in their host communities has been represented diagrammatically as Figure 2, which pertains to the situation in which the university system-society relationship is ideal (Onyido, 2018; Onyido, 2019). In this diagram, engagement of universities with society makes them aware of the challenges which face the communities. These problems are investigated by the universities in the research conducted in their laboratories. Knowledge and innovation resulting from research, along with manpower trained by the universities, are exported to society and the latter applied to problems identified earlier.



Ideal University System- Society Relationship

Figure 2: A diagram in which the university system-society relationship is ideal and productive. The universities in the system produce manpower and generate ideas, knowledge and innovation which are utilized to drive development in society (Source: Onyido, 2019).

The idea that universities are elitist institutions which are detached from their societies is no longer a realistic one; any vestige of such an anachronistic and wasteful concept must be done away with entirely. This is because it is now widely recognized that universities have indispensable roles to play in societal transformation through the skilled manpower, they produce the teaching and training they offer, the new knowledge and innovation they generate through research, and their commitment to community service through engagement (Onyido, 2018a). Sachs (2008) articulated the following innate fundamental strengths which set universities apart as unique institutions:

- Aggregation of scientific enterprise
- Possession of the long view
- Ability to maintain an unbiased position
- Imbued with a mission of service to society

These characteristics of universities, according to Sachs (2008), coupled with the fact that they generate knowledge and innovation through research, place universities at a vantage, unassailable position for promoting sustainable development in societies in which they are embedded. Unfortunately, governments at the different levels in Nigeria in their quest for development have not partnered with their universities, apparently because many of our politicians either lack an appreciation of the capacity of universities as agents of societal transformation or because they are indifferent to the fortunes of these institutions. Either way, not giving universities the recognition, attention and resources they deserve and need in order to fulfil their obligations to society is a factor which will continue to stymie efforts at development. The heavy toll this exacts from society has been described in the following words (Onyido, 2018a):

Societies that fully understand the nature of universities and wholly

appreciate their innate capacity to serve civilization have ensured that their universities run well and are equipped with all they need, human and material, to enrich the social order.... There is no country where government plays an absentee role in the development of its universities and the furtherance of research conducted in them that will ever hope to develop economically. Such a country, like Nigeria, will be condemned to consuming products and services for modern living developed in societies which take their universities seriously.

On the other hand, university leaders, both at the level of policy and management have also hardly orientated their universities to play the role they should play to catalyze development (Onyido, 2013), while academic staff in these institutions do not see their roles beyond teaching and research, research that is mainly tied to career progression. Until this chasm is bridged, efforts at development will only amount to throwing money at problems which achieves little or nothing because the fundamental element of applicable knowledge and innovation for development which universities produce is missing.

The Knowledge Society, Universities and Economic Progress

The 21st century has been characterized as a knowledge society. In its 2005 landmark document, *Towards Knowledge Societies*, the United Nations Educational, Scientific and Cultural Organization, UNESCO (2005) described knowledge societies in terms of their capabilities and ultimate objective as follows:

Knowledge societies are about capabilities to identify, produce, process, transform, disseminate and use information for human development.

We can see from the description given above that the objective pursued by knowledge societies is human development. A more accessible definition of a knowledge society is that given by the Library and Information Science Network (2013):

The term knowledge society refers to a society in which the creation, dissemination, and utilization of information and knowledge has become the most important factor of production. In such a society, knowledge assets are the most powerful producer of wealth, side-lining the importance of land, the volume of labour, and physical or financial capital.... It values human capital as the prime input to production and innovation.

It must be pointed out here that there is still some ambiguity in the definition of a knowledge society, evident from the interchanged use of knowledge and information society as well as knowledge economy in the literature on development. For our purpose, however, it is sufficient to understand the fact that the world in which we now live is driven by knowledge and those societies within the global context which produce applicable knowledge and innovation in the quantities, quality and in a timely fashion to solve their problems will be able to produce or be economically viable to purchase goods and services necessary for modern life (Onyido, 2018).

There are two important functional elements of the knowledge society which need to be considered at this point. The first is the *national innovation system* (NIS) which generates knowledge and innovation and feeds industries with competitive technologies that boost economic development (Sachs, 2015), through a complex interplay of its components as shown in Figure 3, which also illustrates the linkages involved and includes enterprises (industries and businesses), universities and government research institutes. Clearly, the educational system, in

which universities are vital members and participants, plays a critical role in the NIS. The NIS is a conceptual framework that explains the dynamics of innovation, which is centred on the interaction of several agents at the national level – government, firms, universities and public research centres, funding agencies, etc. This approach emphasizes the fact that flows of technologies and information among people, enterprises and institutions are key to the innovative process (OECD, 1997).

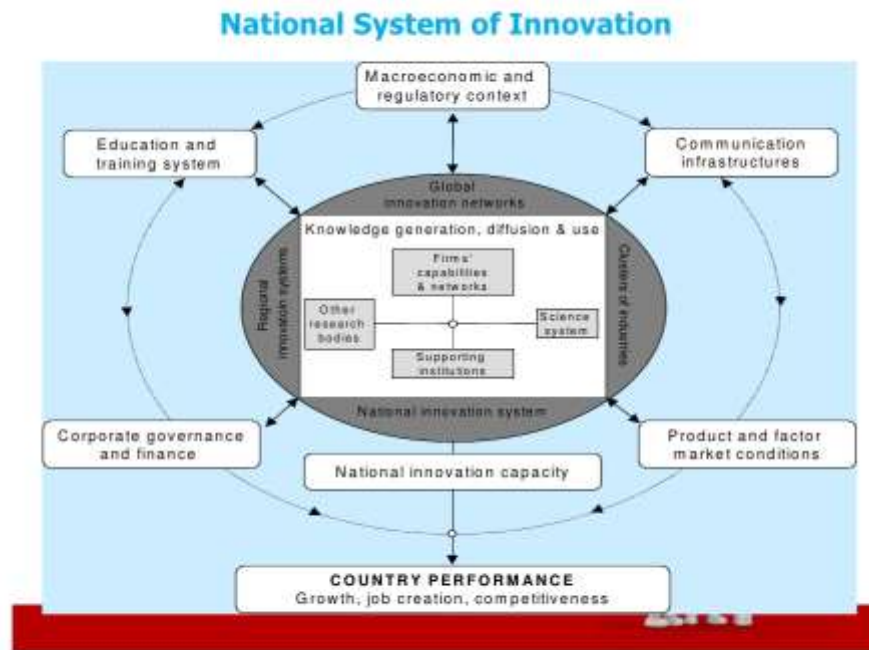


Figure 3: An illustration of the National Innovation System. Source: OECD (1997).

Universities are very important members of the NIS because of the research they conduct, the skilled workforce they produce and the teachers they train who, in turn, train the workforce, and the help they offer in identifying and solving local problems (Sachs, 2015) through their engagement with society. They are key knowledge centres preoccupied with the generation, processing, sharing, dissemination and transmission of knowledge. This important function of universities places them at the core of society in which the knowledge they produce is deployed for positive change (Onyido, 2018b). Across time, the knowledge and innovation which universities produce have been utilized to meet economic needs. It is the lack of appreciation of the role of universities in particular and the NIS in general in driving technological advances and economic development that is at the root of governments not funding universities properly to acquire the tools needed for their roles in society.

The second element of knowledge societies which facilitates their roles in economic development is the existence of *epistemic or knowledge communities*. The following quote from Sachs (2015) will serve to define the term and relate it to our objective in this paper, that of defining a role for universities in sustainable development:

Epistemic communities are networks of expertise, knowledge and practice around specific challenges like growing food, fighting diseases, or designing and implementing city plans. When goals are set, those communities of knowledge and practice come together to recommend

practical ways to achieve results. I have watched how the goal to fight malaria, for example, has helped to organize and mobilize the world's leading malariologists. As a group, these experts recommended practical steps to fight the disease, and those recommendations have worked. The role of the epistemic community is extremely important, because governments by themselves do not have the expertise that exists to guide action. The expert-knowledge communities can make critical recommendations of what actually to do....

In this context, the approach in universities the world over is to form multidisciplinary groups within and across groups of universities to execute research, especially applied or adaptive research, that is geared towards problem-solving, is clear evidence that our universities have the potential of marshalling epistemic communities with requisite expertise to tackle the problems of sustainable development.

To summarize, the fact that universities are part of the NIS and that epistemic communities are inherent in universities and other institutions which are ecosystems for expert-knowledge, sets out a clear role for, and beckons on, the involvement of universities and the experts who reside and function in them in problem-solving research geared towards producing knowledge and innovation for tackling the challenges of sustainable development as articulated in the SDGs.

The Role of Universities in Nigeria's Pursuit of the Sustainable Development Goals

From the foregoing, it is clear that Nigeria's universities have an indispensable catalytic role to play in her quest for sustainable development. This is because, historically, service to and engagement with society has become one of the strong pillars of the institutional mandate of universities, which are part of the ecosystem of the knowledge society. The problems of sustainable development being complex and involving issues which cut across several disciplines require knowledge and innovation that is produced by research and development efforts in a multidisciplinary setting. Such problems call for inputs from the NIS which are operationalized by epistemic communities, mostly resident in universities which are, in turn, part of the NIS. For example, solving the health problem of eradicating malaria requires input from parasitologists who have knowledge about the lifecycle of the parasite that causes the disease, entomologists who are experts in the biology of the mosquito vector of the parasite, physicians who lead the charge for designing the best clinical practice to treat the disease, including the drug resistant variants, pharmaceutical scientists who develop the drugs and drug industrialists concerned with the manufacture of the drugs, chemicals who synthesize insecticides and chemical engineers who lead chemical companies to manufacture the insecticides, researchers who conceptualized the idea of insecticide-treated bed nets, health economists who are concerned with costs and obtaining multilateral financing for access to insecticide-treated bed nets by poor countries, etc., such a complex conglomerate of experts that recommended practical steps to fight the disease (Sachs, 2015)! Similar examples can be cited for the involvement of epistemic communities in designing the pathways to food security, poverty alleviation, access to clean water and good sanitation, etc., which are goals in the 2015-30 sustainable development agenda.

Although Nigerian universities have over the years been substantially devitalized mainly by poor funding and neglect by their government proprietors, the required culture of multidisciplinary research is ingrained in them and there is no shortage of experts in them who can form goal-specific epistemic communities which can then be challenged with the design of pathways for solving SDG-specific problems. Strategies for revitalizing Nigerian universities

have been canvassed elsewhere (Onyido, 2018a). Besides, universities are located in towns and cities where they are surrounded by communities. Universities, using their staff and students, can lead the charge in identifying sustainable development challenges at different levels of complexity in their immediate catchment communities and fashioning out pathways for their solution, using the research input and output of their undergraduate and postgraduate students, depending on the complexity of the problems involved.

From the information available in the public domain, the sustainable development challenges facing Nigeria today may be articulated to include the following, which are complex in scope and multi-sectoral in nature (Onyido, 2018b):

- Environmental degradation and ecological disasters in several areas of the country, including crude oil pollution, erosion, and desertification, resulting from natural causes and anthropogenic activities
- Climate change and its socio-economic consequences
- Extreme poverty and food insecurity
- Ineffective and dysfunctional educational system
- Low penetration of and poor access to technology
- Inadequate healthcare regimes and the attendant low life expectancy and high infant and maternal mortality rates
- Dangerously high unemployment rates within the context of a frightening youth bulge
- Spiralling growth in population
- Absence of social and economic safety nets for vulnerable groups in society
- Gender biases and socio-economic exclusion
- Energy poverty in the context of a high carbon footprint resulting from using petroleum-based sources
- Governance and institutional failures, with predatory politics and pervasive corruption
- A very high index of insecurity of lives and property and the accompanying social disarray, etc.

A look at the portfolio of sustainable development challenges listed above would reveal that these issues subsume a good number of the SDGs formulated by the United Nations. It therefore follows that research in our universities that is aimed at providing pathways and mechanisms for addressing these challenges is tantamount to driving towards the SDGs.

One of the major constraints to meaningful, problem-solving and adaptive research in the Nigerian university system over the years has been the issue of poor funding. There has been little or no funding for research geared towards solving local problems. Fortunately, the Tertiary Education Trust Fund has recently introduced the National Research Fund which may be accessed on a competitive basis, to finance research projects denominated by the SDGs, which require significant infusion of resources because they are usually complex in nature. This prospect of funding raises and highlights the importance of the ability of researchers in conceptualizing and undertaking research projects that are developmental in nature, with a high potential for solving practical problems. Where such capacity is lacking, capacity building in that area as well as in the area of research grants prospecting would be a worthwhile investment to improve the human capital component of our universities.

In addition to the points already made, there are additional requirements which Nigerian universities must attend to in order to play their historically assigned catalytic role in Nigeria's pursuit of the SDGs. First, our universities must learn to practice sustainability in all facets of their activities and operations. To be in the vanguard and champion the cause of sustainable

development, universities must lead from the front and practice what they would preach to others. They must learn to inject efficiency in their use of resources. For example, air-conditioning is utilized indiscriminately on many university campuses, even in situations where the natural flow of air could be deployed to cool classrooms and offices without cost. High energy consumption electric bulbs are still in use on many campuses whereas low energy consumption and cheaper alternatives are available in the market. In some universities, the environment is abused, unkempt and unwelcoming. Natural vegetation is cleared without regard to the habitat it provides for flora and fauna and without replacing removed vegetation in the vicinity of the cleared land to serve as micro carbon sinks. In this way, little actions that contribute to climate change and environmental degradation are initiated to have far reaching cumulative effects later. The list is endless. As physicians, universities should first heal themselves in order to become credible agents for sustainable development and the attainment of the SDGs.

The second requirement is building consciousness of and sensitivity to sustainability and sustainable development issues as well as mainstreaming sustainability and sustainable development into the teaching, learning, research and outreach activities of our universities. As much as possible, pedagogic examples should involve local examples and phenomena which are recognizable to students. Student projects should be geared towards solving local problems, especially in the catchment communities around the universities. In this way, students are drawn into thinking about issues and challenges of development, with the ultimate emergence of a crop of future leaders who have been 'wired' to think in terms of development. The benefits to society for such an orientation of future leaders may not be easily quantified.

The third requirement would be for universities to install academic organs dedicated to coordinating and streamlining institutional activities in sustainability and sustainable development in the domains of teaching and training, research and outreach to society and for constantly raising awareness and disseminating information on these issues on their campuses. In this regard, the University of Ibadan and Nnamdi Azikiwe University have shown commendable leadership in the Nigerian university landscape by creating Centres for Sustainable Development. Other universities try to fulfil this role through other university organs such as the directorates or institutes of research and development or extension centres or centres for rural development, albeit in informal settings and using informal mechanisms. Sustainable development and sustainability are at the core of the human and planetary survival. Since universities are at the core of society, these issues should be given the priority they deserve; these issues should also command priority in the hierarchy of institutional activities which should be reflected in budgetary allocations to this domain of activity.

The fourth and final requirement is that Nigerian universities must network and collaborate with each other in their commitment to sustainable development in order to benefit from the economies of scale and the delocalization of experts such that, on occasion, a university in location A can seamlessly make use of a particular expert who belongs to another university in location B in the prosecution of a particular research project aimed at solving a sustainable development problem in location A. Such synergies are accessible to Nigerian universities through the agency of SDSN-Nigeria, such that universities which belong to that consortium are enabled to share human assets without incurring prohibitive costs and without inflicting severe disruptions to other university functions in the process. It is therefore important that universities take the advantages that membership of SDSN-Nigeria offer which could include international

collaboration at the levels of experts and their universities because the Nigerian consortium is a member of the worldwide body, the UNSDSN.

Concluding Remarks

Visionary leadership by the political establishment of any country, as has been argued elsewhere (Onyido, 2018a), is a prerequisite for enabling universities and the science they produce play strategic roles in economic development and societal transformation. Such leadership has been largely lacking in Nigeria, which is one of the major reasons responsible for Nigeria's several false starts in translating the huge potentials of human and material resources at her disposal into better life for her people, in addition to the debilitating effects of extremely poor and predatory political culture, policy instability and pervasive corruption. For Nigerian universities to play vanguard roles in Nigeria's attainment of the SDGs, these causative factors that have impeded development must also be addressed at the level of university leadership. Universities, as prominent members of the knowledge society and major contributors of epistemic communities to the knowledge ecosystem need to assume their role in societal transformation by engaging in research activities that seek practical answers to sustainable development challenges and thereby play a vanguard function in Nigeria's quest to attain the SDGs. To be able to do this, the extrinsic factors of poor funding, neglect and lack of recognition of their role in society by governments, which undermine the vitality and viability of universities, need to be addressed. In the same vein, several intrinsic requirements – adoption of sustainability as a way of life and sustainable development as an overarching institutional philosophy, the installation of dedicated university organs to promote, coordinate and facilitate the mainstreaming of sustainability and sustainable development in their teaching, research and outreach activities, and networking with other universities in order to exploit the economies of scale, derived synergies and delocalization of expertise – need to be addressed.

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Chapter 2

Gender Parity and Corporate Social Responsibility in the Oil Industry: An Impetus to Sustainable Development in Nigeria

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Abstract

Social Corporate responsibility is a legitimate demand of the communities in which businesses reside. As part of being socially responsible, many different business empires conduct social programmes for their host communities. These include helping the youth acquire skills, offering them employment and involving in scholarship schemes for the youth. The acceptable trend is for community developments to be sustainable. In view of this, the developmental projects need to be gender sensitive', so as not to leave any gender (especially the female gender that has faced a long-standing discrimination in the past) out of the social corporate responsibility programs. This paper seeks to examine the need for the corporate bodies to involve the males and the females equally in their corporate social responsibility programmes creating a healthy developmental agenda which marginalizes nobody on account of sex. Using scholarly articles, books, internet sources and the doctrinal methodology, the paper, not only makes a case for the need in having gender mainstreaming in developmental strategies, but also creates a nexus between Gender Equality, Corporate Social Responsibility, and Sustainable Development in the host communities of the Oil Companies.

Introduction

Nigeria is one of the world's largest producers of oil. In fact, it has been reported severally as the largest oil producer in Africa and the eighth largest in the world which since the 1970s has changed the economy of the Country (Igbara *et al* 2014). Consequent upon this, series of legislations were made to regulate the exploration and exploitation of oil. In 1969 the principal legislation regulating the Nigeria Oil Industry till today was made (Act 1969). Of the about fifty pieces of legislations dealing with petroleum operations, the 1969 Petroleum Act and regulations precisely the Regulation (Petroleum Drilling and production Regulations 1969) contained rights and obligations of the holder of a mining lease, prospecting license, or oil pipeline license. These are usually issued to prospective applicants upon fulfilment of the requirements provided in the Regulations. These would compositely form a great part of the Corporate Social Responsibility of the lease. Perhaps oil companies and other operations that pose environmental hazards should be more agile and agreeable in performing social responsibility. The relationship between the oil companies and some of their host communities to say the least, has not been so cordial in recent years due to the expectations of the host communities with respect to the Corporate Social

responsibilities, which they believe that the oil Companies are not performing well. This is considering the amount of wealth the Companies have taken away from their communities. There are still gross inequalities between the sexes in many communities, especially in access to paid employment, gaps between men and women in the labour market and unequal division of unpaid care and domestic work, and these remain barriers to the Sustainable Development Goals aimed to build on existing achievements. Gender sensitivity builds parity ultimately to do away with gender inequality, as gender equality is key to Sustainable Development; A development that uses the resources for the present generation or consumers without jeopardizing the needs of future generation. This paper still discusses the role of the Oil Companies, through their Corporate Social Responsibilities in promoting Sustainable Development even if it is through one of its Goals (2015). This will set the relevant community up in the World Agenda.

Conceptual Frame Work

Gender Parity/Equality

Without going in-depth onto the theories and analysis of feminism and social construct, gender as used in this paper is construed to be the condition of being a male or a female, and considered alongside sex both are being used interchangeably. In most parts of the world, gender parity/equality has been established largely on paper but for many communities, this has been eroded by some cultural/traditional practices all under the umbrella of ‘male preference’ which have left the female gender with lesser social and legal status than the male gender (Anyogu 2015). Gender equality is the egalitarian situation where the sexes enjoy equal human rights, opportunities, resources and benefits from development. This extends to equal visibility, empowerment and participation of the sexes in all spheres of public and private life. This is equally achieved when the sexes enjoy on equal footing, opportunities for the distribution of power, influence and financial independence through work. The interests of both sexes in their diversity are also to be taken into account for if half of the world’s population is relegated to the dull drums in terms of their human rights, it becomes a concern for us all because no society can develop-economically, politically, or socially- when half of its population is marginalized. We must leave no one behind (World Economic Forum).

Gender Equality/parity, within the ambit of this paper refers to a situation where men, boys, women and girls enjoy equal opportunity in all life’s endeavor. The importance of gender equality is demonstrated by it being placed at the sterling No. three in the Millenium development goals of the United Nations development programmes and at No 5 of the Sustainable Development Goals (SDGs). It is also considered as an important point in the Achievement of the remaining 17 goals of the SDGs. Gender equality means the presence of gender considerations in all decision making programmes, attaching equally weight to male and female considerations in terms of their rights in allocation of resources and socio-economic, and cultural issues more especially in the area of “equality before the law”

Corporate Social Responsibility

Prior to now, all the Oil Licensees in Nigeria were expatriates, but even up till now 95% of the holders are still expatriates; thus, the international oil companies dominate the Nigerian Oil Industry. Consequent upon this, the principle of permanent sovereignty over natural resource Instituted by the United Nations regulations (1969) was put in place. The principle of permanent sovereignty over natural resources was made to protect the developing host Nations from acute

exploitation by the international oil companies. The said Regulation (1969) provided to the effect that

- (a). The international Oil Company should submit a detailed programme for the recruitment and training of Nigerians to the ministry on the grant of the lease. Once the programme has been approved, it can only be varied with the minister's permission (26 and 28)
- (b). The international Oil Company or any holder of a mining lease or license should ensure that within ten years from the grant of his lease, the number of Nigerians employed by him in managerial, professional, and supervisory grades shall not be less than 75% of the total number of persons employed by him in those grades. Also, the number of Nigerians in any one such grade shall not be less than 60% of the total; and all skilled, semi-skilled and unskilled workers are Nigerians (para. 37).

The Development Fund Act (2014) was made for the purposes of training Nigerians to qualify as graduates, professionals, technicians and craftsmen in the field of engineering, geology, science and management in the petroleum industry in Nigeria or abroad; and without prejudice to the generality of the foregoing; the fund shall be utilized as follows:-

- To produce scholarships and bursary, wholly or partially in Universities, colleges, institutions and in petroleum under takings in Nigeria or abroad,
- To maintain, supplement or subsidize such training or education as specified in paragraph (a) of this Section
- To make suitable endorsements to faculties in Nigerian universities, colleges, or institutions approved by the minister.

This forms the Legal frame work upon which the Oil Companies are to perform their Corporate Social Responsibility. The Corporate Social Responsibility has emerged as an initiative to develop host communities, through programmes to meet their needs. Since the needs of the two parties differ substantially, the Oil Companies whose primary need is to make financial profits, have a basic responsibility to assess the needs of the communities and provide these needs within the framework of the law. This, they have to balance with the interest of the shareholders. It is for the shareholders that the companies strive to make profits in their Operations. They also have to contribute to the development of the environment within which they live in and operate from (2014). Corporate Social Responsibility has not leant itself to an easy definition, however a survey (2006) reported the commission of the European Communities (CEC) definition as having the highest frequency count in the study. The definition which is adopted in this paper says; CSR is "a concept whereby companies integrate Social environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis". The essence of this is that, while the companies struggle in their bid, to make profit for their shareholders, they should also mind, the environmental issues connected with their business and also the social and developmental concerns of the stakeholders (the host communities). In fact, Amaewhule (1997) summarized the situation thus;

Social Responsibility is becoming an immutable corporate policy in many Organizations all over the world. Just as people are expected to be good citizens no less is expected of corporate bodies. A business and its external environment coexist in a symbiotic relationship. An enabling environment is one of peace and good neighborliness. In such an atmosphere, businesses can thrive and generate profits. In turn, social responsibility requires that some of the profits be ploughed

back into the environment. That full circle helps maintain a social and psychological harmony between a community and the oil companies that operate within. It is a social Concept which tries to satisfy the expectation dynamics of the stakeholder, and in this regard, the communities wherein the companies operate. This satisfaction is seen in the performance of socio-economic activities in search of equilibrium between the economy and the ecosystem. It ensures ethical practice of business in economics development and welfare of the communities where business is carried on

Sustainable Development

The dictionary meaning (Typhion Media 2010) is ‘to expand’ or bring out the potentialities, capabilities etc. it also means to come to completeness. Taken together with ‘sustain’ which is endure without yielding, to withstand, Sustainable development ordinarily would mean an expansion, or coming to completeness or perfection which endures without yielding. Economically and internationally developed nations are rated as having two thousand dollars or more per Capital Annual Incomes, and developing nations are those with less. It is construed from this, that development whether social, technological, whether personal or group is rooted in economic growth.

Sustainable Development is a development that is self-subsisting, maintained and can be kept going. The issue of Sustainable development has been in world agenda but was given very keen and special attention in 2015 when the United Nations met with World leaders and officially declared the 17 sustainable development goals and 169 targets to be met by 2020 tagged the global goal agenda 2030. The United Nations led process had its 193 member states and the global society in its invocation. The resolution (internet source) is an inter-governmental agreement acting as a post 2015 development agenda. It was also instituted as Option B or alternative plan to Millennium Development Goals of 2000 which was supposed to be actualized by the year 2015. The world commission on Environment created by the United Nations (UN 1983) later defined Sustainable development as “meeting the needs of the present without compromising the ability of the future generations to meet their own needs”. The United Nations also established a 30-member United Nations General Assembly working group to articulate on the goals. Gender equality was articulated as Goal No. 5 making it consistent and prominent as it was Goal No. 3 in the Millennium Development Goals, 2000. Sustainable development can be conceptually broken into three parts namely environmental sustainability, economic, and Socio-political Sustainability. It is an intersection between the environment, society and economy.

The Nexus

Here, it is sought to create a nexus between corporate responsibility on one side, and gender equality and sustainable development on the other side.

Empowering women and promoting gender equality is crucial to accelerating sustainable development, and ending all forms of discrimination against women and girls is not only a basic human right, but it also has a multiplier effect across all other development areas (internet). Those participating on global sustainable development agenda, would be wise to remember that inclusive sustainable development can be realized only when all human rights- including gender equality are protected, respected, and fulfilled. We all share a common zeal for our life and endeavors in protecting our planet for our children and grandchildren, and ensuring the development of a world where all people- regardless of their gender, race, religious and political affiliations, and age have an equal opportunity to achieve their aspirations. The implication of

not giving girls equal voices, choices and opportunities does not just affect their lives, but also future of the planet. Climate change, greenhouse-gas effects will damage the natural system on which life depends, and women are usually the most vulnerable to the impacts of unsustainable practices with the attendant climate change. This is not just because most of them have no independent income and no land rights, but are the custodians of domestic issues in their families, and when the normal sources of these are disrupted or destroyed, women in their bid to meet these duties, are forced to travel farther, spend long hours working for less rewards, and taking life threatening risks and choices.

The issues raised above are of utmost relevance to the Oil Companies in the performance of their Corporate Social Responsibilities. If they operate with such effort to protect our planet in mind, the degradations will be minimal and women who are saddled with household challenges of water, food and energy will not have periods of extreme hardship. If they would observe gender parity/equality tenets in their Corporate Social Responsibility, women and girls who are qualified would have equal opportunities to be recruited alongside the men. This will probably leave lesser number of women to deal with the nexus of food, water and energy. The once in employment can also employ the others to do this for them for payment. If the females are considered equally with the males, for Scholarships, they have equal opportunities to fulfill their dreams and attain their highest potentials possible. This will improve greatly the quality of life in the entire Community. The gains of the respect for gender parity/equality by the Oil Companies in their Corporate Social Responsibility can therefore never be over emphasized

Conclusion

It is said that when a woman gets educated, the whole world is educated, but educate a man, you only educate an individual. If the Oil Companies grant scholarships to deserving candidates regardless of sex, many of the females in the communities where they operate will have the opportunity of being educated. This has a multiplier effect as educated women are known to be the ones who would want their own daughters to be educated. Recruitment will also improve the socio-economic situation in the community. If all the Oil Companies in different Communities do this, many communities will also develop under this arrangement. The entire country will benefit from this, and the feeling of being ripped off will be no more. This practice will set the communities up for inclusion into the world agenda and the communities will no longer appear to be shooting themselves in the leg and coming out to match with the rest of the Country and the world at large.

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Chapter 3

Evaluating the Inter-Links among Environmental Related SDGs

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Abstract

The 2030 sustainability Agenda recognizes that, meeting environmental objectives is as vital as meeting social and economic objectives. Despite Tobler's First Law of Geography which states that, '*everything is related to everything else....*'; it remains unclear which are the mutual inter-linkages among the SDGs making up the environmental pillar of sustainable development. Hence, this research was conducted from internet-based literature sources to establish the inter-linkages existing between SDG-15 (Life on Land) and the other environmental related SDGs. The finding of this research indicates a mutual inter-linkage between SDG-15 and Zero Hunger (2.2 and 2.4), Clean Water and Sanitation (6.3 and 6.6), Climate Action (13.1, 13.2 and 13.3) and Life below Water (14.1). The outcomes of this present study are required to raise awareness among relevant Nigerian stakeholders on the significance of implementing and monitoring the environmental related SDGs.

Keywords: Inter-links of environmental related SDGs, the defunct MDGs, Nigeria, SDG-15

1. Introduction

Amongst all the Targets of the Sustainable Development Goals (SDGs), those related to a sustainable use of natural resources are of particular importance since anthropogenic pressures on the Earth's resources are expected to rise in the future due to projected increase in human population across the Globe. Countries are obliged to implement the 17 Sustainable Development Goals and 169 Targets together with 232 Global Indicators (Figure 1) in such a way as to leave no one behind.



Figure 1: Reporting progress of the SDGs using Indicators and Targets (Paganini et al., 2018)

Meanwhile, UNDP, (2012) opines that, all 17 SDGs are interconnected to one another. However, the inter-linkages existing between SDG-15 (Life on Land) and other environmental related SDGs, particularly, those brothing on the sustainable use of natural resources such as SDG-2 (Zero Hunger), SDG-13 (Climate Action) and SDG-15 (Life in Water) have not been proactively underscored and published in Nigeria. This research gap buttresses the findings of (Allen, et al., 2018) that, there is an unclear understanding of the interplay among the 17 UN SDGs, in many countries. Based on the foregoing, by analyzing the relationships among the 17 SDGs could ensure a more holistic and far-reaching effect on all determinations concerning the SDGs. Therefore, it is imperative to understudy the relationships existing among the SDGs, particularly, the interconnections among SDG targets relating to the sustainable use of natural resources.

The overall aim of this research therefore, is to analyze the inter-links existing among the environmental related SDGs towards delivering scientific and practical solutions that could enhance policy setting, monitoring and reporting environmental dimension pillar of the SDGs in Nigeria.

2. Methodology

The three pillars upon which the sustainable development goals rest-on, are: social, economic and environmental dimensions (Figure 2).



Figure 2: The three (3) dimension of SDGs (Nigeria-SDGs, 2017)

The ‘environmental dimension’ of SDGs is defined as the range of pressures, causality, *relationships*, and dynamics related to natural resources and nature that potentially influence the achievement of the SDGs (UN Environment / FLEDGE, 2018). To establish a link between SDG-15 and the other environmental related SDGs in this present study, analyses are mainly based on ‘*the relationship component*’ of the above definition on environmental dimension through a desk research. According to Hague, (2020), a desk research includes analyzing data from sources of information that do not involve a field survey. Hence, internet search was adapted as highlighted in Winchester & Salji, (2016).

3. Differences and Similarities Between the defunct MDGs and the operational SDGs

Accordingly, there are some key similarities between the erstwhile MDGs and the current SDGs. Two-thirds of the defunct MDGs were translated into the SDGs following the adoption in 2015 of the 2030 Agenda for Sustainable Development (South African SDGs, 2019). Table 2, presents the overview of such MDG-related SDGs. Kumar, et al., (2016) and the Hunger Project Global Advocacy, (2014) assert that, the Global 2030 Agenda is a continuation of the unfinished business of MDGs.

Table 2: Overview of MDG-related SDGs (modified from South African SDGs, 2019)		
SDG Number	Defination of the enironmental related SDGs	Formerly MDG
1	No poverty	1
2	Zero hunger	1
6	Clean water and sanitation	7
13	Climate Action	7
14	Life Below Water	7
15	Life on Land	7

Therefore, it is apt to at this juncture, distinguish between MDGs and SDGs. Eleven (11) clear differences between the defunct MDGs and SDGs are presented in Table 3.

Table 3: Eleven (11) Differences between defunct MDGs and the current SDGs [adapted from Kumar, et al., (2016) and the Hunger Project Global Advocacy, (2014)]

SN	MDGs era (2000 – 2015)	SDGs era (2015 – 2030)
1.	189 UN member countries ratified the Millennium Development Goals.	193 member countries ratified the 2030 Global Agenda on Sustainable Development.
2.	MDGs had a focus on developing countries with funding came from rich countries. In other words, the MDGs were in the context of “rich donors aiding poor recipients.	All countries, developed or developing, are expected to work towards achieving SDGs. That is, the SDGs will then be a set of goals applicable to every country.
3.	The MDG targets for 2015 were set to get us “half way” to the goal of ending hunger and poverty, with similar proportional goals in other fields.	The SDGs are designed to finish the job – to get to a statistical “zero” on hunger, poverty, preventable child deaths and other targets.
4.	MDGs were focused with only 8 goals, 21 targets and 63 indicators.	SDGs include 17 goals with 169 targets.
5.	MDGs implementation largely ignored the three pillars that are crucial for the sustainable end of hunger: empowering women, mobilizing everyone, and partnering with local government.	The SDGs address these critical elements much more effectively, with far stronger gender goals, people’s participation and government “at all levels.” That is, leaving no one behind philosophy of the SDGs.
6.	The MDGs were created through a top-down process. Basically, the MDGs were drawn up by a group of experts in the basement of the UN headquarters.	SDGs evolved from a long and extensive consultative process including 70 Open Working Groups, Civil Society Organizations, thematic consultations, country consultations, participation of general public through face-to-face meetings and online mechanisms and door to door survey.
7.	In the MDGs, the goals of Hunger and Poverty were lumped together in MDG-1, as if solving one would solve the other.	The SDGs treat the issue of poverty separately from Food and Nutrition Security.
8.	The MDGs were largely envisioned to be funded by aid flows – which did not truly materialize.	The SDGs put sustainable, inclusive economic development at the core of the strategy, and highlight the ability of countries to address social challenges largely through improving their own revenue generating capabilities.
9.	Over the past 15 years, we’ve seen that peaceful, reasonably well governed countries prosper. After 2015, experts predict that the majority of those in extreme poverty	SDGs stress the need to uphold peace and justice for sustainable development to be achieved.

	<p>will live in conflict-affected states. The inclusion of peace-building is thus critical to the success of ending hunger and poverty — yet, this was totally ignored in the MDGs.</p> <p>10. The MDGs did not highlight the need for monitoring, evaluation and accountability</p> <p>11. The MDGs focused on quantity (e.g. high enrollment rates) only to see the quality of education decline in many societies.</p>	<p>The SDGs target by 2020 to “increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts.</p> <p>Through the SDGs, the world global community focuses on the quality of education – of learning – and the role of education towards achieving a sustainable world.</p>
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4. Framing the relevance of environmental dimension of the SDGs

Every country in the world strives to have a great economy. Meanwhile, an economically great country has two basic laws of economics to contend with. The two laws in economics are the law of demand and the law of supply. However, excessive demands for economic activities can drastically reduce the environmental resources of any country and can further lead to the scarcity of natural resources, thereby, resulting into social strife and environmental consequences.

Furthermore, to achieve environmental sustainability, (Junker et al., 2015) recommended for the integration of socio-economic development processes into conservation strategies as a means of achieving sustainable environmental resource management (SERM) and further stated that, SERM requires a deep understanding of the interactions between human activities and natural processes. The foregoing assertion by Junker et al. makes a lot of sense because, natural landscapes have become complex socio-ecological systems in which human-induced activities and biophysical factors always interact across multiple scales.

Accordingly, natural environment, including biodiversity and ecosystem services, can contribute to sustainable development. Sequel to the Brundtland Report on ‘Our Common Future’ in 1987, environmental concerns were increasingly connected to opportunities and challenges to development.

At the Rio+20 Conference in 2012, UN member States reaffirmed that “intrinsic value of biological diversity, as well as the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its critical role in maintaining ecosystems that provide essential services, which are critical foundations for sustainable development and human well-being” (WWF, 2018). They also recognized “the severity of global biodiversity loss and degradation of ecosystems (SDG-15)” and stressed the negative impact that this situation has on food security and nutrition (SDG-2), access to water

(SDG-6), health of the rural poor and people worldwide with regards to impacts of climate change (SDG-13) and natural resources conservation (SDG-14 and SDG-15).

5. Inter-linking SDG-15 with the environmental related SDGs

Just as Tobler's First Law of Geography states that "everything is related to everything else. But that, near things are more related than distant things" (GIS Geography, 2020), this present Section attempts to establish a link between SDG-15 to the other environmental related SDGs as listed in the last paragraph of Section 4.

The core focus of SDG-15 is to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" (UN, 2020). This Global Goal 15 aims at promoting healthy ecosystems because; a healthy environment will play a critical role in achieving the 2030 Agenda for Sustainable Development with the imperative of 'leaving no one behind'. Biodiversity which is essential for all life on Earth, including human life, is one of the key highlights in the definition of SDG-15.

One of the components of SDG-15 is ensuring biodiversity conservation. Biodiversity is a cross-cutting issue of all dimensions of human well-being and so this goal is strongly linked to all other SDGs. Therefore, sound ecological management is required, not just to prevent all SDGs from being achieved at the same or a higher environmental cost than previously, but to increase persistent and better-quality flows of ecosystem services to humanity (ICSU, ISSC, 2015). Hence, all SDGs are supposed to receive benefits from the protection, restoration and promotion of sustainable use of terrestrial and freshwater ecosystems but are also threatened if management for sustainability is not reached (ICSU, ISSC, 2015).

5.1. Inter-linking SDG-15 (Life on Land) with SDG-2 (Zero Hunger)

Biodiversity provides the essential resources and ecosystem services that directly support a range of economic activities, such as agriculture, agroforestry and aquaculture (fisheries), thereby contributing to achieving SDG-2 (Zero Hunger). Target 15.3 under SDG-15 provides that we should combat desertification to restore land and soils affected by floods and droughts. Thus, Target 15.3 is directly linked to SDG-2.5 because, through an increase in the restoration of degraded land and soil can support food systems and enhance resilience in food production thereby boosting nutrition security among communities living in both desertification and flood prone areas of Nigeria.

In a nutshell therefore, Target 15.3 (SDG-15) supports the realization of Targets 2.2 (end hunger and malnutrition) and 2.4 ("by 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality") (Ivanova, et al., 2016).

5.2. Inter-linking SDG-15 (Life on Land) with SDG-6 (Clean Water and Sanitation)

Water is inextricably linked to the sustainable development. The sixth Sustainable Development Goal (SDG-6) is not all about drinking water, sanitation and hygiene; it also considers the availability of clean water. The loss of access to clean water, and the pollution of

water sources, is partially due to deforestation (i.e., conversion of forest cover to other landcover types). Forests play an important role in producing and regulating freshwater flows, and forested watersheds are essential for sustaining freshwater supply. Therefore, SDG-6 (water) and SDG-15 (life on land) explicitly acknowledge the linkages between water and forests. According to UNFAO, (2018), water and forests are interdependent: For example, forests play an important role in producing and regulating temperature and freshwater flows as they intercept sunlight and regulate temperature, retain water in the forest ecosystem and reduce floods. Moreover, forested watersheds are essential for sustaining freshwater supply. Ellison et al., (2017) highlights some interrelations existing between forest and water as follows:

- i. Through evapotranspiration, trees recharge atmospheric moisture, contributing to rainfall locally and in distant locations;
- ii. Cooling is explicitly entrenched in the capacity of trees to capture and redistribute the sun's energy;
- iii. Microbial flora and biogenic volatile organic compounds from trees can directly promote rainfall;
- iv. Trees enhance soil infiltration and, under suitable conditions, improve groundwater recharge;
- v. Precipitation filtered through forested watersheds purifies both ground and surface water.

Based on the foregoing, it can be explained that, forest cover has been directly linked to drinking water treatment costs, so the more forested a watershed, the lower the cost to treat that water for drinking. This is because; clean water depends on healthy forests (Ellison, 2018). Forests are capable of filtering sediments and other pollutants from the water in the soil before it reaches a water source, such as a stream, lake or river. In addition, forested watersheds improve water quality and protect water supply. Having a buffer of forest trees surrounding streams and riverbanks can provide more services than just filtering the polluted water, the trees can also help prevent eroded soil sediments from reaching the water bodies downstream, thereby, helping to recharge the water table by allowing water to enter the ground.

Therefore, there are strong links between SDG-15 and SDG-6. SDG 15.1 (ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems) and SDG 6.6 (protect and restore water related ecosystems) can vice versa, support each other to actualizing their targeted objectives. Consequently, Target 6.3 (improve water quality by reducing pollution) can lead to achieving Target 15.5 which bothers on reducing degradation of natural habitats to prevent extinction of species).

5.3. Connecting SDG-15 (Life on Land) with SDG-13 (Climate Action)

Climate change is the contemporary largest environmental threat to sustainable development, especially, as it is said to greatly impacts on poorest and the most vulnerable communities in the world, the most. No doubt, such could be the reason as why the thirteenth Sustainable Development Goal (SDG-13) was adopted by the member countries of the United Nations. SDG-13 calls for urgent actions to combating all forms of climate change related problems. SDG-13 reflects the Paris Agreement adopted during the 21st Conference of the Parties (COP-21) where,

in 2015, Parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed to action to hold the increase in the global average temperature to well below 2 °C above pre-industrial levels, and strive to limit the temperature increase to 1.5 °C above pre-industrial levels (United Nations, 2015). SDG-13 has mutual relationship with the realization of SDG-15.

Target 13.1 (i.e., strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries) has direct link to achieving SDG 15.1 (ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems). Consequently, SDG-15.9 (i.e., by 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts) support the implantation of SDG-13.2 (Integrate climate change measures into national policies, strategies and planning). Lastly, SDG-13.3 (Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning) correlates with the SDG-15.b (UNSD, 2020) which states as follows: ‘mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation’.

5.4. Linking SDG-15 (Life on Land) with SDG-14 (Life below Water)

The Sustainable Development Goal number 14 otherwise known as ‘Life below Water’, aims to protect and ensure the sustainable use of oceans, seas and marine resources for sustainable development. This includes the reduction of marine pollution and the impacts of ocean acidification, the ending of overfishing and the conservation of marine and coastal areas and ecosystems. SDG 14 has strong interdependencies with a broad range of other SDGs, as oceans sustain coastal economies and livelihoods and contribute to food production, while at the same time function as a sink for land-and sea-based pollution (ICSU, ISSC, 2015).

There is a synergy between SDG-15 and SDG-14, as actions to promote terrestrial ecosystem protections could undermine the status of marine ecosystems. For example, an action to reduce illegal trafficking of protected terrestrial wildlife fauna and flora species could lead to increased pressure on marine species. Also, management of terrestrial ecosystems (SDG-15.5) may increase or reduce pollution loads to oceans (SDG-14.1). Similarly, the status of coastal and marine ecosystems impacts terrestrial ecosystems through provision of habitat and enhance terrestrial biodiversity (Blanc & Freire, 2017). Therefore, protection of coastal areas has great benefits for terrestrial ecosystems. Figure 3 summaries the inter-linkages that exist among the Targets of the environmental related SDGs.

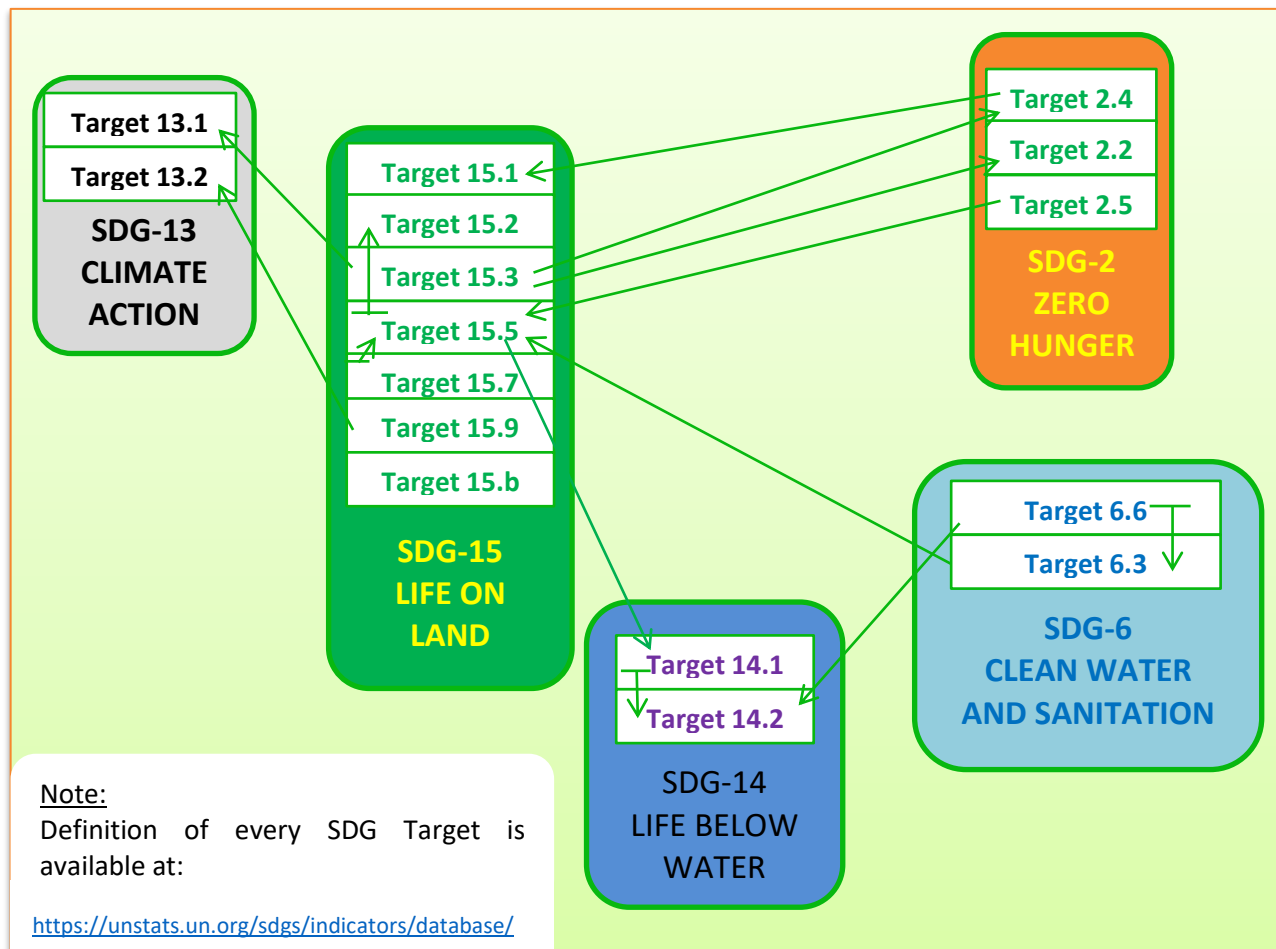


Figure 3: Inter-linkages between Targets of SDG-15 and other environmental related SDGs

6. Concluding remarks

In this chapter, the environmental SDGs have been examined to determine the interaction between them. One of the findings indicates a synergy between SDG-15 and SDG-14, such that, an action aims at promoting terrestrial ecosystem protections could undermine the status of marine ecosystems. In other words, an action to reduce illegal trafficking of protected terrestrial wildlife fauna and flora species could lead to increased pressure on marine species. In conclusion, there are mutual relationships existing between SDG 15 and SDGs (2.2 and 2.4); SDG 15 and (6.6 and 6.3), SDG 15 and (13.1, 13.2, 13.3) and SDG 15 and (14.1) Targets. The outcomes of this present study are required to raise awareness among relevant Nigerian stakeholders on the significance of implementing and monitoring the environmental related SDGs towards achieving the desired global sustainable development goals in Nigeria by 2030.

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Chapter 4

Helping Climate Change Mitigation Actions in Communities through the Mass Media

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Abstract

In the days of old, climate change sounded like a *distant drum* to many people in most Nigerian rural communities. In other words, people in decades past, used to think that: ‘climate change phenomena’ were only occurring in distant lands, particularly in developed nations. Nowadays, the negative effects of climate change are signposted everywhere for everyone who cares to look, to see. The increase in the frequency and intensity of floods, the prolonged and scorching nature of the sun and accompanying heat waves, the short spell of rainfall are all signs of the present dangers, posed by a changing climate. With upsurges of the above-mentioned consequences, many communities have come to the understanding that climate change phenomena are not hoax. They are real! Therefore, any community that ignores climate change does so at its own risk, heavy risk. It has become more imperative than ever, that the consequences of climate change and various efforts to mitigate them are properly communicated to the people through articulated and sustained awareness creation campaigns. What is better positioned for public awareness creation than the Mass Media? This article therefore, critically underscores the *pros-and-cons* of the Mass Media as a veritable tool for climate change education in rural communities.

Introduction

I recently visited my mother in our village, Orokam. Orokam is in Ogbadibo Local Government Area of Benue State in Nigeria. After spending time with her, savouring her uniquely delicious meal and motherly blessings, I decided to pay homage to our Clan Head, the *Omneje of Oko*, Chief Abah Onoja, who happens to be a childhood friend. After an hour or so with him, I was ready to leave, so I requested him to give me some bush-meat to take back to the city. By that request, I inadvertently launched him into a lengthy session of lamentations over how things have gone wrong in the community. I sat in his modest palace as he told me, almost in tears, how hunters no longer find games in the bush to hunt, hence could not give him his due share; how the *Enumabia* Spring had dried off; how the rains had become too sparse; how the soil no longer brings forth good yield for farmers. He went on and on blaming the gods of the land and enemies of the community for being responsible for his people’s predicament! All my attempts to make him realise that, all he had complained of were symptoms of climate change and not peculiar to his community, fell on deaf ears. Sadly, Chief Onoja is not the only one who shares this line of thinking. Based on ignorance, many people are yet to come to terms with the reality of climate change; how they contribute individually to escalating the problem; and what modern efforts they can adapt to mitigate its impacts.

What is climate change?

As a phenomenon with a life of its own, climate change enjoys varying definitions to suit the mode it takes at each turn. In its ordinary term, climate change should mean any variation in the components that make up the climate: temperature, rainfall, wind, etc. If in short, limited spell, the change will not be considered as a serious threat. Unfortunately, from the middle of the 20th century, climate change became more lasting, wider in scope and dangerous, spreading disasters of great proportions in its wake; such that more definitions have come up to properly capture the contemporary environmental scenario.

According to one of the definitions by WIRED (2018), “Climate change is the catch-all term for the shift in worldwide weather phenomena associated with an increase in global average temperatures; while this temperature increase is more specifically referred to as global warming. Climate change is the term currently favoured by science communicators, as it explicitly includes not only Earth’s increasing global average temperature, but also the climate effects caused by this increase”.

In another definition, Wikipedia (2018) sees climate change as “the variation in the Earth’s greenhouse or regional climates over time. It describes changes in the variability or average state of the atmosphere or average weather-over time scales, ranging from decades to millions of years. In recent usage, especially in the context of environmental policy, the term “climate change” is often used to refer only to the on-going changes in modern climate, including the average rise in surface temperature known as global warming”.

To reduce it to the layman’s language, climate change (more encompassing than global warming) is the phenomenon that encapsulates long term changes in our climate. Whether the change is caused by human actions such as greenhouse gas emissions, deforestation and pollution of all kinds; the dynamic activities within the bowel of the earth such as earthquakes, volcanic eruptions and the like; or extraneous factors, it is real and has far-reaching consequences for human, animal and plant lives.

The negative effects of climate change, and specifically global warming, are signposted everywhere for everyone who cares to look, to see. The increase in the frequency and intensity of floods, the prolonged and scorching nature of the sun and accompanying heat wave, the short spell of rainfall are all signs of the present danger. What of the attendant depletion in the ozone layer, the drying up of natural sources of water and the threat of famine due to poor yields from farms? What of the ugly clashes between herdsmen and crop farmers which is arguably driven by climate change occurrences that forced pastoralists to migrate from their homes to other lands in search of greener pastures for their herds? More clashes are bound to continue and with greater ferocity because, as the scourging impacts of desertification in the Sahel region continue unabated, many herdsmen will be compelled to migrate into relatively greener regions, in search of nutritive forages for their cattle to graze on.

Unfortunately, as a result of their activities, humans are accused of being largely responsible for most of the changes in our climate, especially global warming. “Life on earth is dependent on an atmospheric “greenhouse”-a layer of gasses, primarily water vapour, in the lower atmosphere that traps heat from the sun as it is reflected back from the earth, radiating it back and keeping our planet at a temperature capable of supporting it. But human activity is currently generating an excess of long-lived greenhouse gasses that-unlike water vapour-don’t dissipate in response to temperature increases, resulting in a continuing build-up of heat.” WIRED (2018). Now, if human activity is responsible for the greater percentage of climate change, then it is possible that

with properly coordinated collaborative actions, such harmful activities can be reduced and the impact of the change on people and environment, in turn, mitigated.

Owing to the magnitude of the danger posed by climate change to the global community, various countries and organisations have taken, and are taking different actions towards either mitigating the impact of the change or adapting to it. Midwifed by the United Nations Environment Programme (UNEP), several international conferences and conventions have been held on climate change and several agreements and protocols have been ratified by member nations. Examples of international environmental actions include: the Kyoto Protocol or agreement among industrialised nations, placing mandatory limits on greenhouse gas emissions; the Montreal Protocol on substances that deplete the ozone layer, and the Paris Agreement on greenhouse gas emissions, mitigation, adaptation and financing with a 2020 target. Unfortunately, positive impacts from the implementations of the international environmental actions are not too seriously felt in numerous rural communities, especially in developing countries.

Nigeria for instance, is a signatory to several Multi-lateral Environmental Agreements (MEAs) and has a Directorate of Climate Change in the Federal Ministry of Environment, which is charged with the responsibility of driving the national action plan on climate change. Information gleaned from the Directorate's online platform, <http://climatechange.gov.ng/#> shows that the Federal Government has structured operational policies that promote Green and Resilient Cities, Climate Smart Agriculture, Reduction of Gas Flaring, and Low Carbon Electrification, among other interventions. Non-governmental organisations, civil society groups and private bodies interested in climate change mitigation are also involved in one form of climate-smart interventions or the other in Nigeria.

The question however is: how much of these policy thrusts or implementation strategies aimed at mitigating in our country, are in the public domain? Stretched further, how many ordinary Nigerians in the various communities, particularly the rural areas, know about government policies and intervention actions on climate change; and can easily relate with them? Answers to these questions are not far-fetched. Many are ignorant of what climate change is all about; let alone their impacts, and efforts to mitigate such impacts! The poor, vulnerable groups in communities are barely informed of the huge threats which climate change poses to them. If a community that depends solely on agriculture is not properly informed about climate change and its impacts on the weather, soil, temperature, etc., the farmers will not be able to properly adapt in a manner to avoid the negative effects on farm produce and thus, cannot possibly be alerted and prepared against any impending famine. In the same way, a riverine community that is not well informed about the effect of climate change on the water level and quality, may in ignorance, continue to do things the same old way and thus, not getting the expected results from their fishing or aquaculture activities. This assertion is much confirmed by Abaje, *et al.*, (2016) in a research they conducted on the impacts of climate change and adaptation strategies in some communities of Kaduna State. The research concluded that awareness creation and sustained education of the people are fundamental to the effective climate change mitigation and adaptations in rural communities. And I agree no less. This is where the Mass Media come in.

How the Mass Media can promote climate change education in rural communities

The Media are accorded the status of Fourth Estate of the Realm not just for the fun of it but in recognition of the large sphere of influence it exerts on public opinion formation on a whole range of issues. Over time, the Media have shaped government policies, pointed the public

towards specific directions and actions, and become indispensable in the society. It goes without saying that the Mass Media have a huge base, capacity and reach, to drive any campaign successfully to its logical conclusion, *ceteris paribus*. From the traditional Media (newspaper, radio, television, films) to the *new Media*, otherwise popularly known as *Social Media* (i.e., Facebook, WhatsApp, Instagram, Twitter, etc.), the Mass Media provide the best option for pushing messages on climate change mitigation and adaptations, for the realisation of desired results. This is largely because the Mass Media, taken together, can reach everywhere and everyone, in addition to a reasonably high level of public acceptability and believability. Apart from that, driving such messages will come very easy to the Media because informing and educating the people form part of their traditional roles. This foregoing expression is in agreement with the finding of Elaigwu, (2005, p.64): “very often the un-politicised Masses look up to the Media to champion their interests, such areas as environmental sanitation, roads, water and electric power supply, health services and other basic necessities of life. In community development efforts the Media are looked up to as great effort-mobilising agencies”.

Talking specifically about the coverage of issues relating to science and the environment, the Mass Media are also on ground. According to Boykoff and Roberts (2007), the Mass Media stand out as one of those communication approaches that have influenced public understanding and action about science. *Boykoff and Roberts* further states “Mass Media representational practices have broadly affected translations between science and policy and have shaped perceptions about various issues of environment, technology and risk”; and the authors concluded: “there have been many studies over the last two decades that have examined how Mass Media have covered a range of environmental issues”. Indeed, Mass Media coverage or information dissemination on climate change is already doing so much to point individuals, groups and the international community towards taking actions to mitigate the challenge. Equally, Indira, (2014) opined some central roles of the Mass Media in public awareness creation on climate change mitigation and adaptation. The author acknowledged that the Media set agenda on issues relating to the subject matter and also spread information on how to effectively mitigate the impact through the reduction of the spread of greenhouse emissions.

However, in this present dispensation, and without prejudice to past efforts, how can the Mass Media be of greater benefit to climate change mitigation actions in rural communities? Within this context, this present paper highlights the following five (5) viewpoints:

- i. **Constitution of dedicated desks and specialised programmes:** To start with, all Media organisations that do not already have a specialised desk dedicated to climate change and issues related thereto, should set-up one as a matter of urgency. Such desk should be manned by competent personnel, with constant training opportunities that can enhance their capabilities on climate change reporting and communication in the face of emerging scenarios and innovations on the subject matter. In the same vein, radio and television stations could create special programmes for addressing climate change issues in addition to the normal news reports. The broadcast stations could host guests who are well informed about the issues surrounding climate change, global warming, depletion of the ozone layer, the impacts on the people and what is being done in form of mitigation. Listening to such guests, greater awareness would have been created in communities.
- ii. **Qualitative content scoping and consistent editorial:** Following from the constitution of the specialised climate change desk, attention should be given to content scope, quality and

precision. The content churned out by the desk should be designed to address specific climate change mitigation actions and directed to specific targets. For instance, a newspaper could, in addition to the regular news reportage of climate issues, dedicate a special page to the subject matter where special features can appear. In addition, information on weather forecast, rainfall indices and impending threats of natural disasters should be timely and regularly conveyed to affected communities through newspaper reports and features; radio and television reports, features and interviews, with snippets repeatedly posted on the Social Media. In communities where tree planting campaign has long become a mere ritual without any concrete result, fresh Media campaigns in that regard must also contain assurances that there is a new thinking and it is not business as usual. The various Social Media platforms can also be effectively used to pass climate change intervention messages to the people, especially considering that many people; the youth in particular, are hooked to the internet 24/7.

- iii. **Participatory broadcasting:** For agrarian communities, when there is a public intervention relating to adoption of new farm inputs such as fertilizer, seedlings and planting technologies that can withstand the change in weather and lead to high crop yield, the Media should be kept in the loop in helping to disseminate the information and the associated best practices. For wider acceptability in rural communities, climate change related programmes and jingles can be produced by radio stations in local languages and pidgin (i.e., Nigerian English) depending on which is more applicable and capable of producing the desired results. Where the activities of the people contribute to climate change, efforts targeted at making them change their behaviour pattern can also be communicated to them using the Mass Media. For instance, in some communities, the people have a penchant for blocking drainages or building on water channels, thereby frustrating the free flow of water, which in turn causes erosion and floods. In yet other communities, the leaders connive with timber merchants and sell off trees in community forests for logging and in the process render such forestlands bare. Uncontrolled logging destroys medicinal plants and homes to many bush animals (games). Therefore, intervention programmes or campaign messages from government or non-governmental organizations that are aimed at discouraging unwholesome environmental degradation practices can be packaged and disseminated through the Mass Media. The locals should be involved in the packaging of the jingles and programmes to make it participatory.
- iv. **Face to Face community engagements:** Mass Media professionals can also organise town hall meetings, debates and other forms of awareness campaigns on specific climate change mitigation actions in communities. By taking such steps and getting the people directly involved in owning those programmes, the messages will go down better and faster. More specifically, those running intervention or mitigation programmes should understand that it is critical to partner with Media organisations. Through such partnership, interventions or mitigation efforts can be packaged in a manner that the Media can easily buy into them and disseminate to the people. For instance, if a mitigation action is targeted at discouraging indiscriminate felling of trees, bush burning for bush-meat, and illegal excavation of sand at riverbanks, partnership should evolve a comprehensive and inclusive awareness campaign towards encouraging community tree planting, rearing of grasscutters, reclamation of excavated sites, respectively. This way the people can buy-into any special interventions and become *partners in environmental peace*.

- v. **Community radio for effective climate change education:** Without prejudice to the capacity of the other Mass Media platforms to effectively disseminate information on climate change education to the people, it must be said, and with emphasis, that the radio stands shoulder high above the rest. When you combine its qualities of immediacy, reach, affordability and the ability to pass messages directly to the people in their own languages, the radio remains the best platform through which any form of public awareness, including climate change education, can be carried out in communities. This is because the radio has upper edge over other Media types. Nowadays, there are numerous community radios everywhere in Nigeria. Community radio stations all over, uses local content and belief-system as fulcrums to drive home their messages by broadcasting their programmes to the people in the native languages of their host communities. Between Years 2000 and 2006, I came face to face with the power of the radio in shaping collective opinions in rural communities of Benue State, Nigeria in my capacities as first, the Head of News (2000 and 2001) at the then Katsina-Ala Sub-station of Radio Benue and later as Manager (2001 – 2006) at the Idekpa Sub-station of Radio Benue. Radio Benue is a public Radio organization owned by the Benue State Government of Nigeria and has its headquarters in Makurdi. The love and in attachment of many of the local people to the radio, was simply palpable. On their farms, in their homes, in market places, and indeed everywhere, the people clutched their transistor radios, listening attentively to the content. Whatever they heard on the radio was gospel and whatever the radio had not yet said, couldn't be true. Even those without personal radio sets would gather around a neighbour who has one. Here, I remember the case of a farmer who came all the way from his farm settlement to our Radio Station to inquire why we had not promoted any of his farming achievements on our Radio. According to him, he was the greatest farmer in the area! That is how much the rural dwellers cherish the radio, particularly when the content is packaged in an appealing manner, in their own language. Therefore, at a time when the consequences of climate change are increasingly making rural communities most vulnerable, the radio can play a critical role in climate change education towards achieving related goals of sustainable developments in communities.

Challenges of the Mass Media

Nobody disputes the fact that, the Mass Media remain a credible institution that is giving quality support to climate change mitigation efforts in communities. More successes could have been achieved on climate change education except for some obvious challenges. Five (5) major problems are enumerated hereunder:

To start with, there is a saying that you cannot give what you do not have. Many Media practitioners are themselves not too familiar with climate change issues. Not many science graduates are opting journalism as their career and majority arts graduates that work for Media, perceived reporting climate change as a difficult task. Hence, Media organizations are again confronting with the non-availability of trained environmental journalists.

Secondly, science and other technically oriented fields are not the darlings of Media practitioners. In the average Media organisation, while you will see many practitioners scrambling to cover beats such as politics, state house, the parliament, economy, etc., you will hardly see them asking to be posted to purely science-oriented beats. Climate change and the issues around it also fall into the 'unattractive beat' category. As a result, there are not many Media practitioners who are well trained and interested in covering it. Owing to its technical

nature, trained Media practitioners are needed to properly understand the issues at stake, to be able to disseminate them appropriately for the people to understand and appreciate what is involved. As such, a situation where confusing, conflicting and false reporting of climate change scenarios, will be checked. This much Indira, (2014) alludes to when she states that “Media organisations are confronted with certain challenges while reporting climate change information”.

The third challenge is the untimely availability of climate change information and in its right dosage. Sometimes, the custodians of such information (basically, scientists) are either too busy or too haughty to descend to the ‘level’ of the Media practitioner to present the information to him/her in the simplest of forms, to enable the journalists understand immediately and do the needful. Consequently, those seeking the assistance of the Media to creating awareness on climate change policy actions have a duty to package their interventions in a manner that the Media can indeed, properly assist them.

Funding is another key challenge hindering the activities of Media organisations, bothering on climate change reportage and coverage. From logistics required to move around and do some stories (i.e., when such stories involve moving around), to the entire gamut of the production process; funds are required. This is even worse for broadcast organisations because effective broadcasting is capital intensive. Related to the challenge of funding is the impression, out there, that some NGOs (Non-Governmental Organizations) who are into climate change and other development issues allegedly draw huge sums of money from development partners for their programmes, but each time they want to involve Media organisations in their programmes and campaigns, they plead penury! I have not confirmed this independently but the ‘story’ is there in the Media space. This belief can also influence how far Media organisations are willing to go in supporting mitigation actions especially those that are spear-headed by NGOs.

Lastly, not everyone in the community has easy access to the Media. Except the radio, access to Media such as newspapers, television and the online platforms are not easily available to the poor in the community. This factor limits the scope and effectiveness of the support such Media platforms may give to propagating climate change public education.

Conclusion

No doubt, the Mass Media remain a credible institution that is giving quality support to climate change mitigation efforts in communities. Mass Media have been looked up to as indispensable sources for information dissemination and opinion moulding on all societal issues. This position has been further strengthened by the emergence of the Social Media. The enormous power and potential the Mass Media boast of today can be profitably deployed in disseminating climate change information to achieve the desired results that mitigation and adaptation efforts, target. Stakeholders need to collaborate more with the Media in this regard. The Media too, recognising the enormity of the danger posed to humanity by climate change, must go beyond the peripheral coverage of the issues involved to a much more deliberate, encompassing and focused awareness and sensitisation campaigns on the menace, particularly, the mitigation and adaptation actions. The Media owe the people this social responsibility.

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Chapter 5

Gender Dynamics and Climate Change in Nigeria

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Abstract

Climate Change is impacting human lives in very many ways. It threatens the very existence of global wellness in many important aspects. It threatens the essential components of good health, safe drinking water, clean air, food supply and even safe shelter. Between 2030 and 2050, climate change is expected to cause approximately 250,000 additional deaths per year from malnutrition, malaria, diarrhea and heat stress alone. Climate Change is any change in climate over time, and may be natural or may be as a result of activities by man. Just as in many life situations, men and women are affected differently by the impacts of climate change. Although it has a devastating effect for men, women and children, women seem to be disproportionately affected. This work seeks to x- ray the incidences of climate change and the ravaging effect on the world generally; and the disproportionate effect on women especially in Nigeria. The work uses the doctrinal methodology with expert views from books, journal articles, judicial pronouncements and internet sources, and proffers recommendations as deemed necessary.

Introduction

Climate Change has become a global issue and a major challenge. It is said to be fundamentally an issue of human dignity and therefore a human rights imperative, a global security threat, a pervasive economic strain and an environmental concern (Alam, Bhatia, & Mawby, 2015). Its adverse impact in Nigeria, Africa and the world at large cannot be over-emphasized. Consequently, the Nigerian Government, due to the importance it attaches to the issue of climate change, established the Department of Climate Change in the Ministry of Environment to drive its climate change efforts to mitigate and adapt to the impacts of climate change.

Climate change affects everyone, male and female, young and old. Gender could therefore be a decisive factor with respect to the degree to which persons are affected by climate change impacts. Men and women all over the world and in Nigeria in particular seem to be differently affected. However, women do face multiple and complex challenges due to climate change, more than men, and are more exposed to the adverse effects of climate change which even exacerbate their challenges. This is due to inequalities between men and women, in terms of their rights and opportunities, and the different roles they play in the society. This paper therefore, discusses the gender dynamics with respect to climate change in Nigeria, to determine how men and women in their specific circumstances perceive and experience vulnerability, and adapt to the adverse effects of climate change. It suggests complementarity of the female and male genders, and gender integration and mainstreaming, which involves taking into consideration the differences and inequalities between men and women in climate change adaptation policies, programme planning and implementation in Nigeria.

What is Gender?

Gender refers to roles and responsibilities of men and women that are created in our families, our societies and our cultures (UNESCO, 2003). It is said to also include the expectations held about characteristics, aptitudes and likely behaviours of both women and men (femininity and masculinity) (UNESCO, 2003). Gender equally refers to attributes, feelings and behaviours that a given culture associates with a person's biological sex (CARE International, 2015). It defines what it means to be a man or woman, boy or girl in a given society, and carries specific rules, status and expectations within households, communities, institutions and cultures (CARE International, 2015).

It is therefore no wonder that gender roles vary greatly in different societies, cultures and historical periods, as well as depend also on socio-economic factors, age, education, ethnicity and religion (Ramsak, 2015). These gender roles are learned, and are deeply rooted. However, they can change over time since political status, class, ethnicity, physical and mental disability, age and more, modify the roles (Ramsak, 2015; UNESCO, 2003). We must acknowledge that not only are these roles not static, but can also be changed or even be put to an end. For Nigerians, there are some roles that cannot be changed. For instance, only a woman can give birth to a child and only a woman can breastfeed (Ramsak, 2015). Up to seven genders seem to exist today, namely: male/female, homosexual male/female, transgender male/female, & bisexual. Nigeria recognizes only two – male /female.

Gender dynamics therefore, has been defined as the way in which men and women are treated or behave differently in society, either with their own gender or with each other (Urban Dictionary). USAID office of Women Development stated that Gender Dynamics could be perceived as; "...relationships and interactions between and among girls, boys, women and men. Gender dynamics are equally informed by socio-cultural ideas about gender and the power relationships that define them, more so, depending on how they are manifested, gender dynamics can reinforce or challenge existing norms."

1. Meaning of Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC, 2007), "Climate Change is any change in climate over time, whether due to natural variability or as a result of human activity." It has been described as a catch-all term for the shift in worldwide weather phenomenon associated with an increase in global average temperatures (WIRED, 2018). Climate Change is the long-term changes in the weather patterns in any region and temperatures have indeed been going up around the world for many decades. Another term interchanged with climate change is global warming which is the rise in global temperatures due to the increasing concentrations of greenhouse gases in the atmosphere. Global warming, defined as, "the increase in the average temperature of the earth's near-surface air and the oceans since the mid-twentieth century and its projected continuation", is real, and is caused by human activities (Olaniyi, Funmilayo, Olutimehin, 2014). The direct effect of this global warming is in fact called climate change, said to mean the disruption of climate pattern, with consequent impact on climate change (Olaniyi, Funmilayo, Olutimehin, 2014). The United Nations Framework Convention on Climate Change (UNFCCC), defines it as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere, and which is in addition to natural climate variability, observed over comparable time periods" (UNFCCC, 1992). Here, a distinction seems to have been made between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes

(UNFCCC, 1992). Whatever the case, and from whatever angle it is viewed, climate change has many adverse and devastating effects on Nigeria, the whole world and the people living in it, whether male or female.

2. Causes of Climate Change

There seems to be an apparent consensus that human activity is the cause of climate change. WIRED (2018) stated that human activity generates an excess of long-lived greenhouse gasses that, unlike water vapour, do not dissipate in response to temperature increases, resulting in a continuing buildup of heat. The important greenhouse gases include: carbon dioxide whose main source is from the burning of fossil fuel; methane that enters the atmosphere from animal and arable farming and abandoned oil and gas wells; nitrous oxide, and chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs) which come from industrial applications such as refrigerators (WIRED, 2018). Again according to Ilevbare (2019), “The major causes of climate change are either natural or anthropogenic factors...the anthropogenic factors in climate change are directly linked to man-environment transactions whose consequences result in the emission of large amount of greenhouse gases into the atmosphere that depletes the ozone layer or activities that reduce the amount of carbon absorbed in the atmosphere.” Anthropogenic factors, which include urbanization, deforestation, population growth, industrialization, and the release of the greenhouse gases are said to be major factors responsible for the depletion of the ozone layer (Odjugo, 2007; Buba, 2004). Ozone layer absorbs ultra violet light from the sun, thus, its depletion increases the amount of ultraviolet (UV) radiation that reaches the surface of the Earth, and this leads to increase in the rate of skin cancer, eye cataracts, among others.

3. General Effects of Climate Change

Climate change is ongoing and its effects are global, though not felt equally across the globe, because they differ in magnitude and frequency in different countries and regions. Thus, some nations experience more adverse effects than others. “Climate change destabilizes the earth’s temperature equilibrium and has far reaching effects on human beings and the environment” (My Climate, what are the effects of climate change?). The African continent has been identified as the most vulnerable to the impacts of climate change (Ilevbare & Idemudia, 2017). Nigeria is therefore, so affected.

General effects of climate change are numerous and includes increase in temperatures. According to IPCC, increase in temperature may bring about beneficial impacts in some regions and harmful ones to others (IPCC, 2007). It noted that, taken as a whole, the range of published evidence indicates that the net damage costs of climate change are likely to be significant and increase over time. IPCC (2007), also noted that global temperatures will continue to rise for decades to come due to greenhouse gases produced by human activities; and so, will the effects. Other general effects of climate change include: rising sea levels, increase in heavy precipitation (heavy rainfall and hail), shrinking glaciers, and thawing permafrost. Apart from these direct effects, there are indirect effects such as; increase in hunger and water crises, especially in developing countries, health risks, spread of pests and pathogens (Observable Effects - Effects/Facts of Climate Change), extreme heat waves, wild fires, droughts, among others. Climate change also brings about rapid and easy spreading of diseases, flooding, and prompts increase in migration of people (Climate Reality, 2019).

4. Effects of Climate Change in Nigeria

There is no gainsaying the fact that climate in Nigeria has continued to undergo changes with many negative consequences. Seventy percent of the Nigerian population are said to engage in agriculture as their primary occupation and a means of livelihood (Onwutuebe, 2019, Shiru et al., 2018; Federal Government of Nigeria, 2013). Thus, agriculture plays a crucial role in the Nigerian economy and indeed is the backbone of growth and poverty eradication even in the whole of Sub-Saharan Africa (IPCC, 2007). It is a source of employment, income generation, and a source of raw materials to small and medium enterprises (Aliyu, Olawepo and Muhammed, 2019), with about ninety percent of the rural dwellers depending on it for their livelihood (Akinola, Ene and Baiyegunhi, 2017). These are mainly women who make up the bulk of Nigeria's food producers (UNDP, 2009). Thus, climate change affects agriculture in Nigeria very much, because it is rain fed and sensitive to environmental variability and weather extremes such as droughts, floods and severe storms (Usman, Yelwa, Gulumbe and Danbaba, 2013). Some authors have also noted that effects of climate change in Nigeria arise from increase in temperature, variable rainfall, sea level rise, flooding and erosion, drought and increasing desertification, land degradation, extreme weather events, (such as thunderstorm, bush fires, drought lightning and landslides) which have affected freshwater resources and loss of biodiversity (Elisha, et al, 2017; Ebele & Emodi, 2016; Olaniyi, et al., 2013). Consequently, once there is a slight change in climate, there would be devastating consequences on the economic and social life of the people (Olaniyi et al., 2013). In Nigeria, droughts are getting worse, and food security has become a challenge, showing the reality of climate change. There are also increasing incidences of diseases, declining agricultural productivity, and a rising number of heat waves (Olaniyi et al., 2013). Climate change brought about a decline in rainfall too and this has resulted to increase in desertification leaving farmers in a confused state as their livelihood is destroyed (Olaniyi et al., 2013). The effect of climate change on human health in Nigeria cannot be overlooked. There are cases of mental health, allergies, cardiovascular diseases, cerebral-spinal meningitis, cholera, high blood pressure, deaths, among others.

One major effect of climate change in Nigeria is the drying up of the southern part of Lake Chad some years ago (Illevbare, 2019). Due to this drying up of Lake Chad, farm lands and surrounding villages in the North have become barren, leading to massive migration of people in search of more fertile land (Doha and Emodi, 2018; Elisha et. al, 2017; Beyioku, 2016). With this, land is laid to wastages by the rise in temperature, leading to Southwards expansion of the Sahara Desert. Consequently, the farmlands and surrounding villages become barren due to advancing desertification, leading to serious migration of the people in search of fertile land (Illevbare, 2019). In recent times, Nigeria has experienced severe rainy seasons too, floods, and other devastating effects of climate change. In 2012, flood in South East caused houses, farms, farm products, properties and human beings to be swept away (Beyioku, 2016). Around the river Niger and Niger Delta region, flooding killed hundreds of people and drove millions out of their homes; so, did high winds, heat waves and wildfires (Beyioku, 2016). The effect was severe and lethal, especially in the rural areas and overcrowded slums with poor drainage, or none at all. Also, gully erosion in South East has devastated many settlement areas and farmlands (Beyioku, 2016), leading to poverty among the people. In the North, desertification forced thousands of Fulani herdsmen to move to the South and middle belt leading to clashes with farmers, culminating in the displacement and death of hundreds of people. In the South West, windstorm destroyed 60 houses and 5,000 people were affected and the forest around Oyo is said to have been reduced to grassland (Beyioku, 2016).

All these adverse effects of climate change mentioned above are felt in various areas including: agriculture, food security, water resources and human health. Climate change is thus a great threat to poverty reduction, gender equality and even the achievement of some Sustainable Development Goals.

5. The Roles of Men and Women in Nigeria

Climate change affects men and women differently and this tends to increase gender inequality because, women face disproportionate burdens when compared with men. It seems the different roles they play in the society influence their capacity to adapt to climate change; that is to say, that the issue is not their biological differences but the social construction of their roles which affect their accepted behavior. The roles and responsibilities of women in the society, whether at household or community level, make them more vulnerable than men.

Men are involved in more lucrative work and activities. They represent communities and dominate decision making at any level. They are involved in agriculture and high value economic activities, such as mining, timber, cattle rearing, among others (Ashwill, Blomqvist, Salinas, and Ugaz-Simonsen, 2011). Indeed, they have access and are in control of the important resources. Men indeed control most resources and make the most important decisions. Women, on the other hand, are traditionally and basically responsible for domestic tasks (cooking and cleaning), reproductive and care giving activities (Ashwill, Blomqvist, Salinas, and Ugaz-Simonsen, 2011), food security (subsistence farming), small income generating activities, securing water, food, fuel for cooking, care for small livestock in the household, processing of agricultural products, petty trading, among others (Olawoye, Omololu, Aderinto, *et al.*, 2004). In fact, women are often responsible for managing the household even when they are not perceived as heads of household (IUCN, 2020). Unfortunately, their work ends to be less valued. Their work does not empower them but rather deprives them of opportunities and makes them more vulnerable to climate change. In traditional Igbo culture for example, women are regarded as subordinate and complimentary to men, and therefore would plant what may be termed inferior crops such as maize and cocoa-yam, while the men planted and harvested the yams which are seen as the “king of crops, and used in determining factor of wealth” (Sohn, M). These gender roles are discriminatory against women.

6. Unequal Gendered Access and Control of Resources

The question is: Do men and women have equal access to the use of, and benefit from resources ranging from natural, material, financial, human, social to political? Natural resources include, land water, trees, livestock and others. Material resources are: agricultural inputs, equipment, houses, vehicles and transportation, water supply and sanitation facilities, among others; financial resources include savings and credit; human resources are education, skills, knowledge, information, health, labour and others; social resources concern membership in organisations and groups, social networks among others, while political resources are citizenship, effective participation in governance, among others (Goh, 2012). Men and women have different levels of access and control over resources. Women have more limited rights, limited mobility and less access to resources than men. The socially constructed differences between them in their roles and responsibilities have translated into unequal access to, and control over resources with women at a disadvantage (Paul and Meena, 2016). Due to the roles women and men play in the society, women have fewer opportunities and privileges. Women are not independent, therefore, have no access to resources or control of such resources. A writer noted that they do not even

have resources such as education, money and time, do not own land, and are not part of decision making (Ishengoma). Heavy workload limits women's mobility and opportunities for human development of their potentials (Ishengoma). Majority of the women are illiterates or are semi-literate. They are poor and also unable to go to school. They thus cannot get good paying jobs that require skills or political office to enhance their power (Ishengoma).

Women are marginalized and discriminated against once it comes to access and control of resources and decision making. Under the custom and tradition of the Igbos in Nigeria for example, women could not own or have access to land except through the males, until recently. Daughters and widows can now inherit land from their fathers and husbands respectively, as pronounced by two Supreme Court decisions. In *Ukeje v Ukeje* (2014), the Supreme Court held that the Igbo customary law which disentitles a female child from partaking in the sharing of her deceased father's estate is in breach of section 42 (1) and (2) of the Constitution, a fundamental rights provision guaranteed to every Nigerian. By this decision, every female child in South East Nigeria has a share of her deceased father's property whether the deceased had a male child or not. Also, in *Anekwe v Nweke* (2014), the Supreme Court condemned the Igbo custom which denied widows inheritance of their late husband's estate, as being repugnant to natural justice, equity and good conscience. In spite of these pragmatic decisions of the highest court of the land, the age long discriminatory practice of disinheritance of women remains unabated. The truth is that practice is yet to catch on with the decisions. A study even found that in Nigeria, women own 10% of the land but are responsible for 70% of agricultural labour (UN General Assembly, 2009). This makes it hard for women to have access to capital or credit. Due to difficulties still persisting in securing land rights, they cannot use land as collateral to secure credit as compared to men. These women are so poor that they cannot hire or buy new technology like ploughs, graders, chemical fertilizer, among others, to help their adaptation to climate change, while men can easily get credit facilities to enable them purchase and benefit from the new farm equipment and other devises (Ishengoma.).

Women do not have the necessary information regarding climate change or necessary training, rather, these information are passed on more and more to the men. Again, because women are bogged down with a lot of responsibilities in their homes, they may find it more difficult than men to present themselves for training on climate change, new technologies and innovations even when there is opportunity for that.

Women also have little or no say in family decisions because the men who are regarded as heads of family take almost all decisions, especially major decisions. They also have fewer positions than men in governing bodies, and little impact on decision making or public policies (Ishengoma), consequently, women play little or no role in decision making even in matters that affect them regarding climate change. Such important decisions are mostly made by men!

The disadvantages women suffer due to lack of access to and control of resources when compared to men, affects their ability to respond to climate change. Again, with changing traditional roles, women are now assuming greater responsibilities of men, for example, as family heads, especially where the men are away, sick or deceased; they are also bearing the brunt of climate change mitigation and natural disasters. Their workload is thereby increased as they become overworked, and unable to take part in climate change adaptation efforts, necessary technical trainings and productive developmental activities (Ashwill, Blomqvist, Salinas, and Ugaz-Simonsen, 2011). Women are thus more vulnerable to climate change effects than men.

7. Impact of Climate Change on Women and Men

As already noted, women and men do experience climate change differently in terms of their resources and well-being, due to their socially constructed roles and responsibilities (FAO, 2011). The poor amongst them experience serious negative impacts because they lack the capacity to prepare for and cope with the effects of the changing climate. These poor ones could be men or women. However, among the poor, the women seem to suffer more negative impacts of climate change than the men. The negative impacts are in the following areas: agricultural production, food security, health, water and energy resources, climate change induced migration and conflict and climate-related natural disasters (Goh, 2012).

In agriculture, women are mostly affected since their subsistence farming and animal husbandry yields reduce significantly because of decline in precipitation. With respect to information and technology necessary in managing climate related problems in agricultural production, men have more access to these resources than women and are equally better equipped to adapt (CARE International, 2010). In the rural communities where a lot of agricultural activities take place, men may have forecast information through radio, while the women may have to rely on information given to them by the men, and this may not even come through; these women due to their workload (agricultural and household work) may also not have the time to sit and listen to a radio program (Goh, 2012).

With respect to food security, because women are the main providers of food and meals for their families, it becomes a great burden for them to meet up with this task when there is a climate change issue. These women may just reduce their own food intake so others may eat; they may even sell their personal effects like wrappers, small livestock in order to meet up with the feeding of the family (Goh, 2012).

In terms of health, women are more adversely affected than men. Climate change stress may cause serious emotional and psychological distress in women than in men, especially where children take ill due to malnutrition and they are not sure of the next meal for the family. Again, so many diseases do come or get worse due to climate change, such as, malaria, diarrhea, asthma, ulcer, among others. Women, as care givers, may not afford to go to clinics or hospitals and may no longer access the traditional herbs that could help them combat some of the diseases. This also increases the workload of women, as they are the ones who bear the burden of caring for the sick. All these responsibilities inflicted on women, make them miss out on educational opportunities, income generating activities, with little or no time to care for their own health (BNRCC, 2011).

Climate change brings with it the problem of water scarcity and energy resources, and these affect women's health, time and labour because they are the ones that, cook, wash clothes, clean houses and give their animals water. Flooding, for example, makes families move away from rivers to protect themselves. Consequently, the women would have to walk farther to fetch drinking water since the flooding would have destroyed access points to the river, and the quality of drinking water would have decreased. Women equally walk very long distances to source fuel such as firewood, charcoal and agricultural wastes for cooking, and for other things (Annecke, 2002; Bardasi and Wodon, 2006). The women's health may be in jeopardy due to these burdens.

Climate change induced migration and conflicts impact more adversely on women than men. During flood periods and dry seasons in Nigeria, Agwu and Okhimambe (2009) noted that temporary migration of men to urban areas, result in women being left alone to take care of the house hold. Their work load is thus increased as they become family heads, engage in petty trading and street hawking with their children, with the attendant exposure to physical and sexual

abuse. Some of these men who migrated may remit part of their meager income, but this may not even be enough for the family to feed. Some who have exposed themselves to unprotected sex while away may end up infecting their wives at home with HIV/AIDS. Problems still abound more for the women than men.

Climate change conflicts due to migration have serious consequences for the women than men. The migration of Fulani herdsmen with their families and cattle from the North to the Southern parts of Nigeria has brought about the issue of human security, with resultant conflicts between these herdsmen and farmers in many communities. Women and children are the most vulnerable here. They are displaced, killed, maimed and raped. Human security is hereby undermined by the violent conflicts. Men also suffer negative impacts due to such migration and attendant conflicts, but not as much as the women.

Natural disasters brought about by climate change affect women and men differently. In case of serious flooding for example, men would be more likely to swim to safety while most women cannot. These women would end up losing evacuation time trying to look for and after their children and relatives. It is the same where there is fire outbreak. In the wake of the 2004 Asian Tsunami, Oxfam report was stated to have found that surviving men outnumbered women by almost 3:1 in Sri Lanka, Indonesia and India (Halton, 2018). The reason was that when the Tsunami hit, women put the safety of their children first, before their own survival (Goh, 2012). One would rightly attribute this to the role of women as care givers, and the social expectations of acceptable behavior for women, and, lack of resources. They thus fare worse than men with respect to impacts of natural disasters.

8. Vulnerability and Adaptation of Women and Men to Climate Change

We have noted that Nigerian women, and indeed women in various environments are disproportionately affected by natural disasters and extreme weather events such as floods, droughts and mudslides (BNRCC, 2011). Therefore, the impact of climate change on women in Nigeria as noted already, is indeed very devastating, because of vulnerability and low coping capability. Vulnerability is said to describe a state of risk and lack of security (BNRCC, 2011). According to Wisner et al. (2004), it is “the characteristics of a person or group and their situation influencing their capacity to anticipate, cope with, resist and recover from the impact of natural hazard.” IPCC defines vulnerability as:

...the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.” (IPCC, 2001).

Adaptation on the other hand is defined as:

“Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation” (IPCC, 2001).

Adaptation from a practical perspective could be seen as a process of building adaptive capacity (BNRCC, 2011). Adaptive capacity is thus the ability of a human or natural system to adjust to climate change. This includes adjusting to climate variability and climate extremes, the ability to

avoid moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC, 2001).

Women are more vulnerable to climate change than men, and less capable to cope with its effects. In fact, women are disproportionately affected as they face many difficult challenges more than men do. The impact of climate change on women is greater than that on men, again, because, they are socially excluded and lack equal access to resources, information, and mobility (Aguilar, 2008). Some reasons for the vulnerability of women to climate change in Nigeria include the facts that: women are mostly poor; they mainly depend for their livelihood on natural resources threatened by climate change, for example, water, food, fuel (firewood) for cooking. These are climate sensitive livelihoods. Subsistence agriculture, which is an area that is greatly affected by climate change, is their main source of livelihood. Climate change induced migration exposes these women to domestic violence, sexual assault, rape, among others.

Women are either under-represented or not represented at all in the decision - making processes, whether at the household, community or social level. They equally lack climate education and education generally, and have no access to climate information. Women cannot therefore contribute their important and valuable perspectives even regarding gender-specific issues in policy formulation, implementation, and monitoring and evaluation processes.

Women face social, economic and political barriers which limit their coping capacity; they have to secure water, food and fuel for cooking, and these are areas that have the greatest challenges; they face cultural and social challenges, resulting to gender inequality. For example, patriarchy reinforces gender discrimination against women as rooted and manifested in our belief system and cultural practices. Patriarchy is a system that practices male domination and superiority, preference for male child, and gives all power, privileges and recognition to men. In some parts of Nigeria, for example, Igbo land, the birth of baby boy brings excitement and joy, while that of a female comes with no jubilation, but anger, sadness and weeping. Sons are thus idolized, celebrated, while daughters are inferior and seen as liability. In some areas in Nigeria also, obnoxious widowhood practices still take place in spite of the legal prohibition, and a woman's husband's land and houses may be taken away from her making it impossible for her to engage in agriculture effectively. At the end of the day, women's dependence on natural resources for their sustenance, traditional gender roles that are discriminatory against them and lack of autonomy, place them at a disadvantage and increase their vulnerability to adverse impact of climate change. The "Building Nigeria's Response to Climate Change (BNRCC, 2011) project" stated that historic and cultural disadvantages together with women's restricted and limited access to information and power in decision-making combine to result in women being particularly vulnerable to the impacts of climate change.

It is therefore due to all these reasons given above, that often; the capacity to adapt to and mitigate the impacts of climate change is lower for women than those of men. Truly, women's adaptation capacity is low. For example, they have a low application of technology to agriculture unlike men, even though the agricultural sector in Nigeria is highly underdeveloped and excessively depend on rainfall with almost a zero or total absence of mechanized agricultural development. Therefore, adaptation efforts should be made towards systematically and effectively addressing gender-specific impacts of climate change in the areas of energy, water, food security, agriculture and fisheries, biodiversity and ecosystem services, health, industry, human settlements, disaster management, and conflict and security (BRNCC, 2011).

There are many adaptive strategies for women, that is, adjustments, in response to actual or expected climate change or their effects. Some of these strategies by women are practical and innovative improvements though low, and include (WEDO, 2008):

- a. For water security -Seeking alternative water supplies and water saving practices including, rainwater harvesting and purchasing water from water-vendors;
- b. For food security – Adapting agricultural practices such as planting new crop varieties, switching to other animals and methods, saving food, seeds and adapting to new diets;
- c. Economic security – Selling of their assets and services, finding of alternative income generating activities and also supplementing of income through other local activities;
- d. Health security – applying the use of traditional medicines and other preventive or alternative methods to help in fighting diseases and taking care of the sick;
- e. Energy security - providing and switching to other fuel sources, and using other energy-saving devices.

In fact, women make more efficient use of existing resources, that is, they use available resources more efficiently than men; thus, they can also go as far as improving their homes and houses to reduce risk of disaster (WEDO, 2008). This shows that women could be powerful agents of change and therefore need to play leadership roles in climate change issues as a matter of great necessity. They are generally overworked, and because of the devastating effects of climate change and the serious challenges that they are put through, the women have no time to participate in climate change adaptation efforts, training and projects, and other productive activities, making adoption of all important climate adaptation strategies more difficult for women than for men.

12. What Can Be Done?

The following should be considered:

- a. Nigerian government should empower and invest in women to enable them respond to challenges posed by climate change. This will definitely help improve climate change adaptation outcomes and also to achieve some of the Sustainable Development Goals.
- b. Women should be well represented in decision-making processes on climate change or adaptation strategies. Their inclusion is not only because they are more vulnerable, but because they have different perspectives and experiences to contribute, for example, in implementing adaptation measures (UNDP, 2009). A balanced representation of men and women would yield good results.
- c. Women should participate in discussions and trainings on climate change adaptation methods. Thus, capacity building workshops should be organized. However, they should be well timed to enable women attend. It is notable that the average representation of women in national and global climate negotiating bodies is below 30%. (Halton, 2018). It is important to ensure gender participation in Nigeria.
- d. More women are to be educated, as education has been described as “the only effective liberator of human disadvantages” (Makura, Ndabangingi, Chikwir, 2016). This gives women more confidence in pushing their impeded rights, such as, equitable education, unequal access to resources and exclusion from decision-making processes regarding climate change adaptation strategies.

- e. Women must learn to speak out and share their problems and let their voice be heard because they could act as real agents of change in Nigeria just like men, if there is for example, equal access to information, resources, training, and others.
- f. There should be gender mainstreaming and integration in climate change discuss in order to bring women from the periphery to the centre of the decision making process, and to achieve equality. Gender mainstreaming according to UNESCO (2003), is a process rather than a goal. Thus, UN ECOSOC aptly describes it as “the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in all areas and at all levels. It is a strategy for making women’s as well as men’s concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres, so that women and men benefit equally, and inequality is not perpetuated. The ultimate goal is to achieve gender equality” (ECOSOC, 1997/2). Mainstreaming and integrating gender in climate change problems would help in designing and implementing policies, programmes and projects that would lead to greater equity and equality; it would also contribute to building more capacity to adapt and mitigate climate change (UNDP, 2009).
- g. There should be serious awareness campaign on climate change and awareness creation to encourage attitudinal change on changing climate and adaptation related information on adaptation strategies. The adaptation measures that some women generally put in place are not targeted at reducing the impact of climate change because some of these women blame themselves and God for the disasters, and not climate change. They have no information and know nothing about climate change, hence the importance of awareness creation. Massive awareness also needs to be created, for women to embark on tree planting programs, even by individuals. Here, capacity building and funding would be necessary and important.
- h. Discriminatory laws and practices already struck down should be discarded and abandoned, to improve and enforce women’s access to land or to grant them land rights. Thus, obnoxious widowhood practices already outlawed should be jettisoned, and all lands taken away from widows thereby increasing their vulnerability, should be restored to them. Let the equality of rights of women and men not be in theory, but be exercised in practice. What is important is to correct gender inequality. This is only possible if the rights, responsibilities, and opportunities of women and men are recognized, and their interests, needs and priorities are taken into consideration, while also recognizing the diversity of different groups of women and men (UNDP, 2009).
- i. Complementarity of the genders is advocated, and this involves dialogue and negotiation. Men and women should therefore cooperate and watch each other’s back while participating and dealing with climate change issues, to ensure none is disadvantaged in any way.

9. Conclusion

Women can add a lot of value to climate change effort if given the opportunity. They have strength and resilience. Thus, if capacity is built, constraints removed, are empowered, they will become real change agents in the community, natural resource management, innovation, farming and care giving. That is why the 2015 Paris Agreement has made specific provision for the empowerment of women, recognizing that they are disproportionately impacted. These justify

calls for gender mainstreaming into climate change (Alston, 2014). Nigeria would cope better in its efforts towards effective and sustainable policies and efforts to mitigate and adapt to climate change if directed to both men and women without discrimination. There is therefore need for gender sensitive responses to the impacts of climate change. Authors of the UNDP Resource Guide urged everyone, "...women as well as men, to take concrete and gender responsive steps so that we can address the increasingly urgent challenges of climate change with more than words. To fail to do so in short order would amount to an abdication of our responsibility to nothing less than the planet itself – and to ourselves" (UNDP, 2009).

Climate change is a global challenge without borders and without gender preference; it is therefore not a fight for power or freedom; it is rather a fight for survival!

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Chapter 6

Review of Natural Fiber Composite Design for Sustainable Infrastructural Development

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Abstract

This chapter reviews recent advancement and applications of natural fiber-reinforced polymer composites with special reference to achieving environmentally sustainable infrastructural development. High static charge accumulation, non-biodegradable characteristics, high cost, high density and poor recycling properties of synthetic fiber composite and monolithic materials has triggered renewed search for a sustainable alternative. Detailed background to natural fiber reinforced composite materials were given, highlighting dominant properties that flag their potentials as reliable alternative to regular materials such as wood, steel, glasses etc. Sectorial applications of fiber reinforced composites, design process innovation for sustainable infrastructural development and sustainable infrastructural development process were presented. It was canvassed that innovation has relevant systemic features which require that the design team should comprise of experts that contributes relevant sectoral knowledge base, technologies, inputs and potential/existing infrastructural need profiles. Furthermore, the Taguchi technique was embraced as a tool for robust design of sustainable and resilient infrastructure with the ultimate goal of finding optimal material factor settings to reduce cost and environmental impact by minimizing variations. However, a major impediment to robust design of infrastructural facilities in Nigeria is the absence of new fiber characterization framework with basic constructs and the availability of manufacturing technology. Advocacy for sustained use of natural fiber reinforced composite materials for low strength application in the industries was therefore propagated and recommended.

Keywords: innovation, composite infrastructure, material, design, sustainable development, value.

Introduction

Sustainable infrastructure involves development of essential facilities with due consideration to economic, social and ecological implications. Specifically, Sustainable Development Goal Nine (SDG-9) anchors on infrastructure, industry and innovation and geared towards a common goal of achieving environmentally sustainable economic development (The United Nations, 2015). Thus, sustainable infrastructural development is an output that is engineered for the benefit of society, while design and process innovations mediate between inputs and outputs. From material science perspective, innovative ideas and concepts can be translated to reality of a useful product through materials which are designed to support loads, accept or reject magnetic

flux, transmit or reflect light, survive in often-hostile surroundings, insulate heat and conduct electricity without damage to the environment (Ashby, 2011). Sustainable infrastructural development is basically rooted in affordable and innovative material utilization. Thus, the use of natural fiber composites for infrastructural and industrial applications are evolving quickly in automotive, civil works and transportation sector, oil and gas sector, wind energy industry, housing sector, maritime sector, power and telecommunication industries. The various types of renewable natural fiber strands such as jute, banana, hemp, kenaf, sisal, oil palm, plantain and bamboo reinforced composite have gotten an incredible significance in various car applications, auxiliary parts, packaging, electrical and electronic businesses, aviation, sports, entertainment hardware, pontoons, apparatus office items, transportation infrastructure and construction (Shalwan and Yousif, 2013; Sassoni et al, 2014).

The significance of infrastructure to the industries can't be ignored, in this way making its advancement key to the infrastructural development in different sectors of the economy. Infrastructure is essential for sustainable development; from transportation to electricity, water and sanitation systems, it offers the types of assistance that empower society to operate seamlessly and economies to flourish (Arimah, 2017). This puts robust and innovative material design at the very heart of endeavours to meet the SDG-9 targets. Enveloping everything from wellbeing and education for all to access to clean water and sanitation, the greater part of the SDGs suggest upgrades in infrastructural development. Innovative infrastructural resources are relevant in natural resource conservation and lessening the effect of climate change to the environment. Natural fiber reinforced composites are environmentally friendly structural materials that have minimal effect on environment arising from the characteristic nature of their processing, usage and afterlife disposal (Kutnar & Muthu, 2016).

Infrastructural application of natural fiber reinforced composites is classified into structural and non-structural composites, while structural composites include bridges, roof structures, roofing, ceiling, and walling for the construction of low-cost houses; non-structural composites include window, exterior construction, composites panels, and door frame (Uddin, 2013). The wide preferences of various classes of composites in structures arise due to their high strength to weight ratio and lightweight (Kakroodi et al., 2013). Van-de Weyenberg et al., 2003) have indicated that great properties of thin-walled components give it a wide zone of utilization in basic structures such as tanks, veneers, long range material components, and channels used in reinforcing of existing structures.

Innovative natural fiber composite material design is therefore critical to development of quality, reliable, sustainable and resilient infrastructure which is engineered to support economic development and human well-being, with a focus on affordability, renewability and reduced environmental impact. Right now, researches are advancing toward the improvement of one hundred percent renewable bio-composites, where the fiber is gotten from a plant and the biopolymer is additionally produced using a similar plant (Sahari et al, 2013).

Background to natural fiber reinforced composite materials

Natural fiber reinforced composites are basically produced using a polymer matrix that is fortified with cellulose fibers. Although cellulose fibers have been in use for various conventional uses in construction, decoration and clothes manufacturing; in time of growing concern for environment protection and containment of global warming, natural fibers value has significantly increased as reinforcement for polymer matrix (Kalia, Kaith & Kaur, 2011). Various classification of natural fiber as applied in polymer composite reinforcement is presented in Figure 1. As a renewable resource, natural fibers are used for manufacture of recyclable “green”

composites in industrial, civil, energy and telecommunication infrastructures causing reduction of carbon emission and waste minimizing.

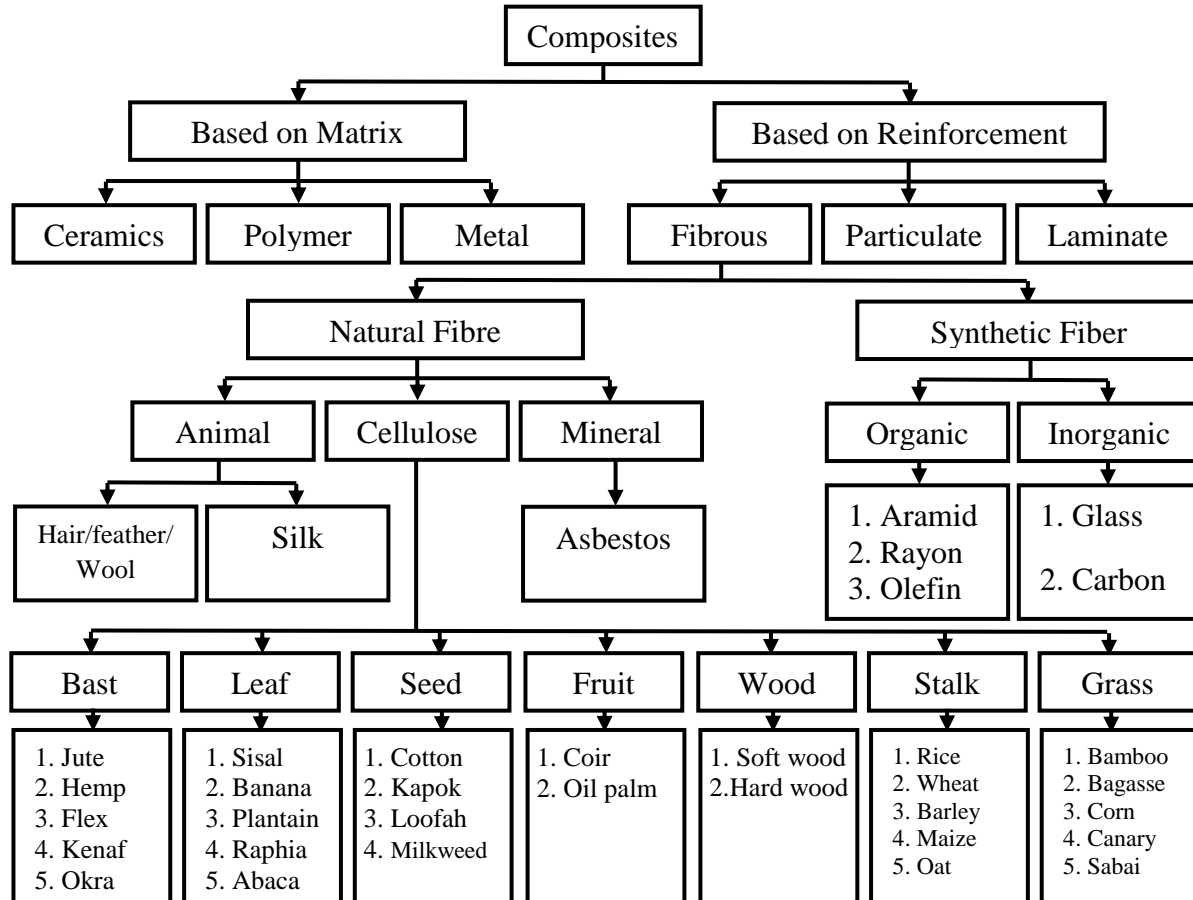


Figure 1: Classification of natural fiber reinforced composites (Saba et al., 2014).

Natural fiber composites from renewable resources offer significant sustainability advantages. Industrial ecology, eco-efficiency, and green chemistry are guiding the development of the next generation of materials, products and processes (Faruk et al, 2012). These composites are produced using at least two different constituent materials with essentially unique physical and mechanical properties that, when consolidated, produce a material with qualities not quite the same as the individual parts. The matrix shields the filaments from environmental degradation and transfers the load between the fibers, while the fiber reinforcement provides the designed strength and stiffness. Composites may also contain fillers and additives designed to improve the manufacturing process, appearance and performance of the final product.

The matrix as shown in figure 1 includes polymers like polyester resins, epoxy resins, vinyl ester resins, phenolic, polyurethane which acts as a bond to hold the treated natural fibers together. As a result of very strong and flexible properties of natural fiber reinforced composites, it has potential to replace wood, aluminium, granite and sometimes steel in infrastructural and industrial facilities. The strategies for composite fabrication as reported by Rajak, Pagar, Kumar

and Pruncu (2019) ranges from basic and minimal effort direct molding activities (hand lay-up and spray up) to complex machine procedures (filament winding, vacuum bag molding, vacuum infusion, resin transfer molding, compression molding, pultrusion, reinforced reaction injection molding, centrifugal casting, continuous lamination, cast polymer molding, gel coated cultures stone molding, solid surface molding, engineered stone molding and additive manufacturing). Making the choice composite fabrication process depends on the number of parts required, part intricacy, design needs and required surface finishing. Based on the selected fabrication process and the desired characteristics of the composite part, reinforcement material can be processed into continuous, discontinuous or particulate fibers.

Literature has reported various factors that influence the properties of natural fiber reinforced composites during design and fabrication stages. The factors include pH, thickness of fiber laminate, fiber weight fraction, fiber volume fraction, fiber particle size, fiber aspect ratio, fiber orientation, fiber treatment, injection temperature, melt temperature, mold temperature, holding pressure and injection speed. Effective and innovative control of these factors at design stage with respect to selected infrastructural application is the basics for optimal property and performance of natural fiber reinforced composites.

Sectorial applications of fiber reinforced composites

Sustainable development goal nine targets upgrade of infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies (The United Nations, 2015). In this regard, design and development of natural fibers composites for industrial applications are two significant perspectives which ought to be considered in evaluation of afterlife characteristics of infrastructural facilities (Kabir et al, 2012). Common fiber strands have a short lifetime with minimum environmental damage upon degradation whereas synthetic and other conventional materials affect environment due to pollution caused by their degradation.

Sustainable development goal nine encourages domestic technology development, research and innovation including industrial diversification and value addition to commodities (The United Nations, 2015). Although production and manufacturing companies in Nigeria are currently facing global competition and needed to advance critical endeavors to restrict this pressure and remain in the cutting edge of infrastructural development. Innovative natural fiber composite design could contribute high quality criteria and cost-effective production to sustain low-priced product as consumers are increasingly price-savvy and value centric.

Innovation in advanced materials enables broad value creation across many sectors of the economy. 2020 – 2025 forecast by Mordorintelligence (2020) suggest that the global fiber reinforced composites market is expected to grow with a Compound Annual Growth Rate greater than 7% during the forecast period. Major driving factors of the market no doubt are the beneficial properties of fiber reinforced composites like high strength to weight ratio, corrosion resistance, energy absorption on impact, moisture and chemical resistance. This forecast is a pointer that massive investment in natural fiber reinforced composite material can contribute in promoting inclusive and sustainable industrialization and significantly raise industry's share of employment and gross domestic product, in line with national circumstances.

Figure 2a shows a distinctive application of natural fiber composites in automotive industries. Natural Fiber Composite holds huge potential for car industry on the grounds that the interest for light weight and ecologically receptive materials is higher. Light weighting is legitimately attached to energy efficiency of automotives. With only a 10 percent weight decrease, fuel efficiency ascends by 6-8 percent for Internal Combustion (IC) engines. In car

applications, Natural Fiber Composite could diminish the heaviness of a vehicle by 50 percent and improve its fuel efficiency by around 35 percent without trading off performance (Salazar et al, 2011).

Fiber reinforced composites are juicy material for design of blast and fire-retardant structures, recent rise in terrorist attacks and wild fire incidences has prodded a huge scope usage of natural fiber reinforced composite in design of military and civil infrastructural facilities (Lane, 2005). Natural fiber reinforced composite (Figure 2b) can be produced using fire-retardant resins and treated fiber mats with a thin passive fire inhibitor to further improve its fire-retarding capacity (Miller et al., 2007; Petersen et al, 2015).



Figure 2: (a) Car door produced from hemp fibre (Peças, Carvalho, Salman &Leite, 2018), (b) fire- retardant fiber reinforced composite bonnet (Solvay, 2018)

In civil works and transportation sector, steel was at some point the basic material utilized in majority of infrastructural development, however, engineers have made progress towards improvement of new materials. As bridges deteriorate due to corrosion, engineers have begun to use lightweight, solid, erosion safe composites for repairs. These days, fiber reinforced composite is one of the most utilized materials in construction sector, particularly in bridge building and repairs. Figure 3a show fiber reinforced composite pedestrian bridges and there are other highway bridge decks and girders made of only fiber reinforced components and/or of a mixture of hybrid reinforced concrete and fiber reinforced polymer components (Moore, 2019).

In power and telecommunication industries, fiber reinforced composites are increasingly being used in production of electric, telecommunication and other utility poles. Purposefully engineered fiber reinforced composite poles utilise automated process controls, added advanced ultra violet/fire inhibitors and coatings for long life in adverse weather conditions; this is in contrast to wooden poles usually treated with dangerous pesticides that will likely leach into the environment or cause occupational hazards. One other motivation for use of fiber reinforced composite utility pole (Figure 3b) as an option in contrast to wood poles is on the grounds that innovatively designed composites poles have superior impact energy absorption in event of collision with vehicles among other advantages (GangaRao, 2011). Light fiber reinforced composite pole cavity could be a clever way to disguise thousands of antennas which will be needed for the 5G network, also reinforced composite poles with integrated miniturized antennas and base stations will create a high-capacity 5G data transmission network (Noora, 2017).

Expanded use of fiber reinforced composites in telecommunication sector is advocated in line with SDG-9 which targets significant increase in access to information and communications

technology and provision of universal and affordable access to the internet (The United Nations, 2015). Optimally designed natural fiber reinforced composites fits in squarely in support for realisation of this target through advancement of new materials for Information and Communications Technologies (ICT) as key to development of energy efficient execution gadgets and high-power applications. In addition, fiber reinforced composites possess good dielectric properties useful in telecommunication base stations and radomes, where they offer minimal signal attenuation (Noora, 2017).



Figure 3: applications of fiber reinforced composites in (a) pedestrian bridge construction (Moore, 2019) (b) Utility pole in-service (GangaRao, 2011). (c) Water and Oil transportation

In oil and gas sector, large magnitude of petroleum gas pipelines is laid annually across thousands of miles, which require consistent and timely monitoring and replacement of damaged parts. So, to satisfy the expanded needs, keep up security and unwavering quality, the pipeline business is adopting fiber reinforced composites (Figure 3c) as an alternative to regular steel pipe. Recent studies (Ihuezze et al, 2017; Anuar and Sapuan, 2014; Okafor et al, 2017; Okafor & Metu, 2019) has pointed to light weight, corrosion inhibition, renewable, recyclable and comparable properties as the most alluring traits that support composite utilization in this sector.

In the wind energy industry, natural fiber composite materials are used by designers in building longer, lighter, and more grounded blades to make more energy (Beauson et al, 2016). Turbine rotor blades are fabricated using fiber reinforced composites as shown in Figure 4a. Assembling composite blades of lighter weight and of any length will be the essential concentration for turbine makers due to associated economic advantages. Some improvement deal with cross breed rotor blades is pushing ahead to control self-weight while upgrading swept area.

In housing sector, conventional materials like stone, timber, steel and cement have been in use. However, the need for energy efficient buildings has resulted in adoption of fiber reinforced composites for windows, coverings, entryways, and other beautifying highlights. Fiber reinforced composites have been utilized to meet some specialty applications in building infrastructure (Figure 4b). GangaRao (2011) reported that reinforced composite houses has striking features and advantages over conventional building architecture which includes no maintenance (no painting and do not deteriorate from weather, rot, or insect infestation); lower heating and cooling cost (the composite panels have built-in insulations, and the dome shape further increases energy efficiency); high structural strength; quick construction (modular design for ease of erection); earthquake resistance (the composite panels flex instead of breaking); water resistance (completely sealed from the ground up) and portability (reinforced composite house can be easily disassembled and relocated to a new site). In addition to shelter applications for

disaster relief, these systems are applicable for grain storage, fuel storage, cistern and septic tank manufacture, jail facilities, cold storage facilities, military barracks, school buildings, industrial factory and warehouse buildings, large dormitory settings for workers in remote locations, greenhouses, etc.

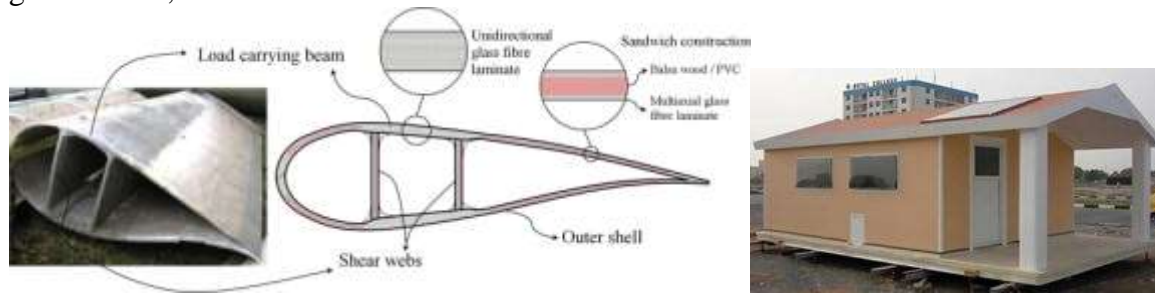


Figure 4: (a) Reinforced composite infrastructure for turbine blade (Beauson, Madsen, Toncelli, Brøndsted, &Bech, 2016) (b) Energy efficient buildings using fiber reinforced composite panels (Amanda, 2010)

In maritime sector, the ease of adjustment of input variables during the design stage of composites, high strength, high-impact strength, dimensional stability, nonconductive, nonmagnetic, corrosion resistant and low thermal conductivity has placed natural fiber reinforced composites at high preference in the development of hulls and marine craft structures as shown in figure 5 (Rajak et al, 2019). Besides, the utilization of natural fibres would make business opportunity in rural and less created locales thereby contributing actualization of sustainable development goal nine. Along these lines, innovative natural fiber composite design is advocated for sustainable infrastructural development across sectors of Nigerian economy.

Obviously, the global fiber reinforced composites market is moderately fragmented as the market share is divided between many players. Considering the low capital needed for commercial production of robust composite designs, it can as well increase the market shear contribution of small-scale industrial and other enterprises to sustainable infrastructural development in Nigeria. In this situation, natural fibres reinforced composites are an appealing choice for designers to meet financial and ecological demands.



Figure 5: (a) Ship hulls (Rajak, Pagar, Kumar &Pruncu, 2019) and (b) Marina composite decking (GangaRao, 2011)

Design Process Innovation for sustainable infrastructural development

An ideal design process innovation assembles expert team to productively concentrate on providing specific solution to industrial, environmental, societal and infrastructural problems. The abundant advantages of natural fiber reinforced composites can be effectively put to

infrastructural use through innovative design ideation. Design innovation in part, is a process used to create industrial facilities which focuses basically on addressing needs with what is technologically feasible and devising a viable business strategy to derive value from market opportunity. Design process innovation is a unique blend of design thinking, computational thinking, culture, experimentation and problem solving strategies.

Innovative natural fiber composite design encompasses product, process, agent, organization, tool and goal system in a task. Nonetheless, the vast majority of scholars concentrated to a great extent on the procedure and industrial relevance with little consideration to the knowledge aspect of infrastructural facility development. Knowledge of innovative material design strategies, application and afterlife disposal is considered as a sustainable source of competitive advantage (Zhang et al, 2012). Subsequently, it is important to comprehend a more extensive extent of innovative design as portrayed in Figure 6 showing the four aspects involved. These aspects are connected by means of an assorted types and degrees of collaborations.

The design team represents the experts saddled with the responsibility of designing the infrastructural facility. The facility, team and design process relate to each other as shown in Figure 6, hence a good understanding of these relationships could improve our understanding and ability to work with innovative design. There is obvious relationship between infrastructural development and design process as informed by the facility architectural requirements (Mortati, 2013). Various optimization schemes are at the designer’s disposal which helps to capture design control and noise factors that help in reducing uncertainty of innovative alternatives. There is a parallel relationship between design team and design process tasks; this means that integrated design activities are essential for new and creative outputs.

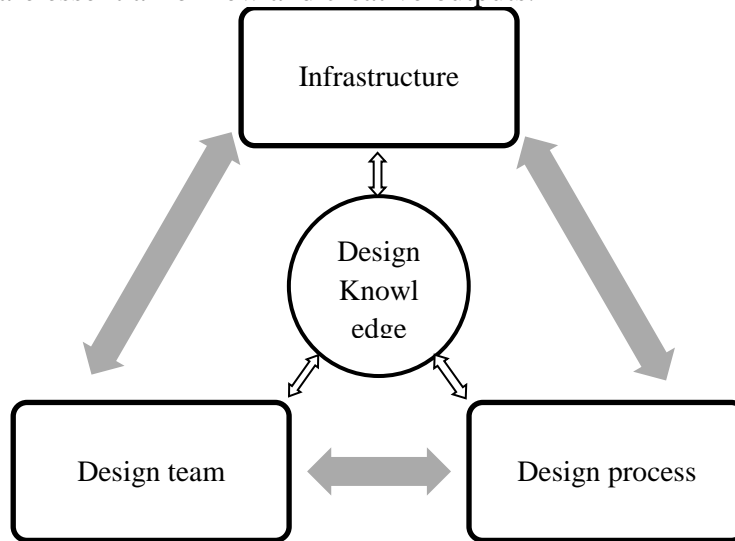


Figure 6: Aspects of innovative design (Adapted from Zhang et al, 2012)

Sustainable infrastructural development is an output that is engineered for the benefit of society, while design and process innovations mediate between inputs and outputs. The thrust of innovative composite material design is the opportunity to exploit various knowledge of material properties, control factor levels, optimal design processes and the relationships between them to create sustainable infrastructure assets with optimum use of natural fibers that is hitherto disposed as waste (Taura & Nagai, 2017). Sustainable infrastructure is a key enabler of economic and social development, as well as environmental sustainability.

Innovative design of complex infrastructure is an exceptionally intuitive logical procedure involving group of specialists structuring interrelated parts and settling on coupled choices. Design innovation cycle matrix of Figure 7 shows that the rate and type of innovation and the organization of innovative design activities will greatly differ across sectors. A sector is a set of activities which are unified by some related product groups for a given or emerging demand and which share some basic knowledge (Malerba, 2005). The key point is that innovation has relevant systemic features, so it is very essential that the design team should comprise of experts that contributes relevant sectoral knowledge base, technologies, inputs and potential/existing need profile. They are composed of a set of actors, networks and institutions carrying out market and non-market interactions for the creation, development and diffusion of new sectoral demands. Therefore, sectoral knowledge base is a key segment of all types of infrastructural development, particularly in consistent advancement. Along these lines, the knowledge base ought to be additionally considered into a venture of innovative design (Zhang et al, 2012).

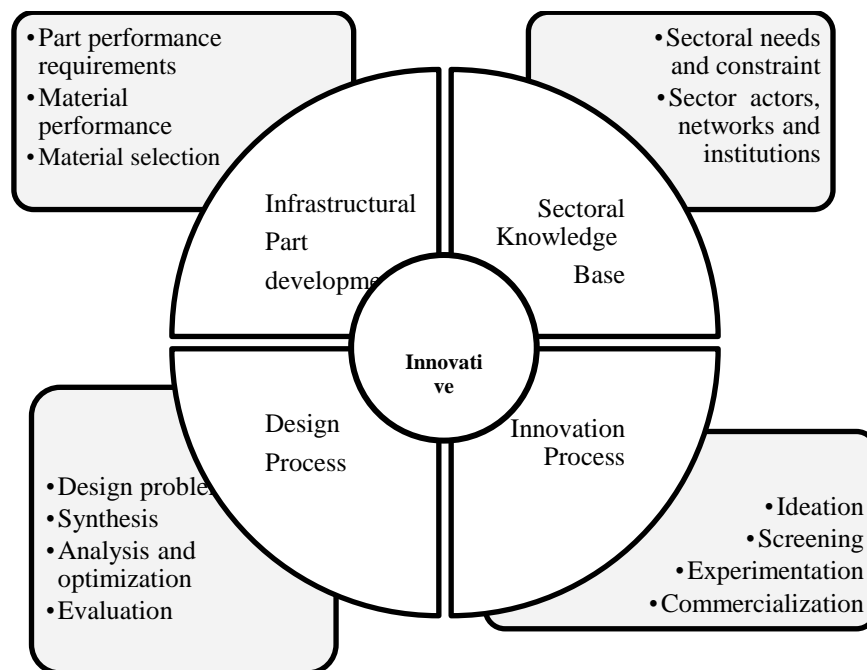


Figure 7. Design innovation cycle matrix in infrastructural development

Advocacy and screening help evaluate an idea and measure its potential benefits and problems. It requires extensive review of literature, survey and interviews representing prevailing practices in relevant sector. Each stage of innovation process in figure 7 should be evaluated in the light of critical success factors (factors that are necessary and guarantee new product commercialization success) and product value matrix (measure of performance over cost). Additionally, the use natural fiber composite in design of sustainable infrastructural part requires that both the product designers and the fabricators/developers have an understanding of the properties of material. Apart from being conversant with the mechanical properties of the materials a designer must specifically appreciate the anisotropy, shrinkage, bulk compression, stress concentration, temperature, creep, ageing and after life of materials. Therefore, in the course of design of infrastructure for any sector, the qualities of the design material and the components vis-à-vis service/operating environmental must be related as shown in Figure 8.

In this regard, domestic designers can tap into the boundless flexibility of composite technology to create value during analysis and optimization stage. During this stage, the design team can set parameter control levels, investigates alternate design solutions, alternate materials and systems using relevant optimization strategies (El-Alfy, 2010).

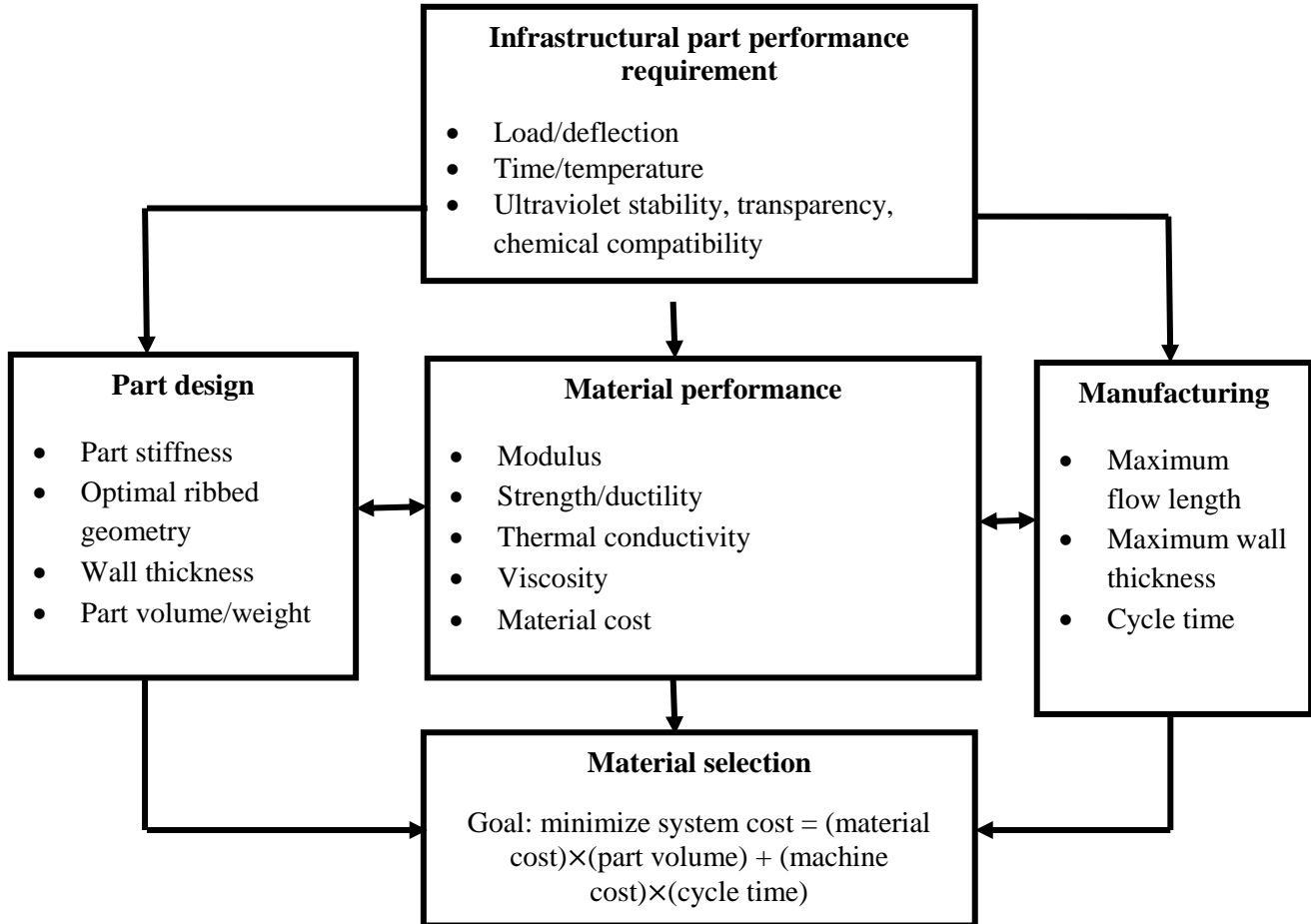


Figure 8: Interrelationship between material selection and Infrastructural part design.

Sustainable infrastructural design is one of the most critical development processes as product designer needs to develop values. These values are as essential to product design as solving an interaction problem. A designer works in the space where customer needs, business goals and sector technical feasibility converge. Therefore, decisions need to be made that take into account sectorial peculiarity, technical feasibility, costs and how this decision might affect revenue. Efficient reinforced composite facility development process will thus require strong design knowledge base. The designer will need knowledge of end user needs, the capabilities of the value production processes and the ability to integrate the market need with technical expertise. Technical expertise is essential in product development stage as it measures the designer’s in-depth knowledge of product and its production process. The market needs have to be tallied with the available manufacturing technology. The design alternatives, manufacturing

capabilities and availability of raw materials are the combined science of possibilities for meeting the need.

Sustainable infrastructural development process

The infrastructural design and development are particularly challenging in geographical areas such as Sub-Saharan Africa, whose industrialization levels remain low or stagnated, thus undergoing a much slower pace of progress in poverty eradication. By adopting Goal 9 in particular, the global community addresses these and other challenges by committing itself to indigenous product design and adaptive domestication of existing technologies, thus highlighting close linkages with virtually all other SDGs as regards job creation, sustainable livelihoods, SME development, better health, technology and skills development, food security, green technologies, environmental protection, building resilient cities and climate change mitigation. However, there has to be an absolute knowledge of need for innovation (Figure 9). A clear statement of the problem is a prelude to sound infrastructural and industrial innovations, therefore the problem statement could be in form of market need, clients' frustration or improvement on an existing product. Achieving Goal 9 by 2030 will require addressing a range of resource constraints, it is therefore essential to understand the nature of the product usage, the class of people using it and ergonomic considerations. Also, the environmental condition needs to be incorporated.

The decision about the type of matrix (thermoset, thermoplastic or metal matrix) to be used for a given composites infrastructure depends of the products operating environment. For example, it is a common knowledge that thermosets do not melt when exposed to heat, they do not deform, warp or lose their shape in extreme cold temperatures either. This makes them ideal for any parts or machinery that will be used in extreme climates or environments which experience regular variations in temperature. In contrast, Thermoplastics are ineffective for parts which are regularly exposed to extreme heat or rapidly varying temperatures, because of their ability to melt.

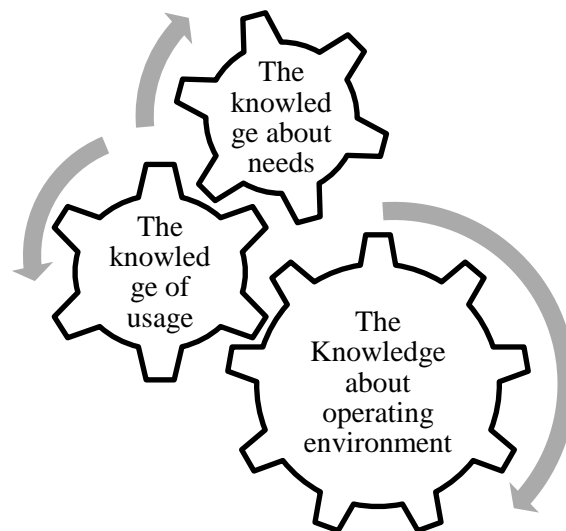


Figure 9: Key Knowledge components of in infrastructural development process

SDG-9 targets facilitation of sustainable and resilient infrastructure development in developing countries through technological and technical support (The United Nations, 2015).

Resilient infrastructure is seen as that which is robust, resourceful and rapid; these dimension of infrastructural growth is vital for enabling development that meets the growing demand for improvement driven by ongoing urbanization, population growth and an aspiration to move towards a more sustainable development pathway, innovative production and manufacturing require the use of different material design strategies and factors to create resilient, custom infrastructure of all shapes, sizes, and complexities providing a lightweight, corrosion-resistant alternative to steel.

Resilience captures various set of skill, competence and dexterity which are succinctly described as adaptability over stability (Norris et al, 2007). While conventional approaches to infrastructure development plan focus on resources and structures, there is a pressing need to understand resilience from a design point of view. This is because new composite product development presents an opportunity for designer to incorporate resilient paradigm through variation of control factors, this is a winning strategy and a sustaining approach for the various option in the application of end product. The infrastructure development stage is a critical period which defines the functional and physical framework of the product providing all that is needed to satisfy customers' needs or provide solution to a problem (Figure 10).

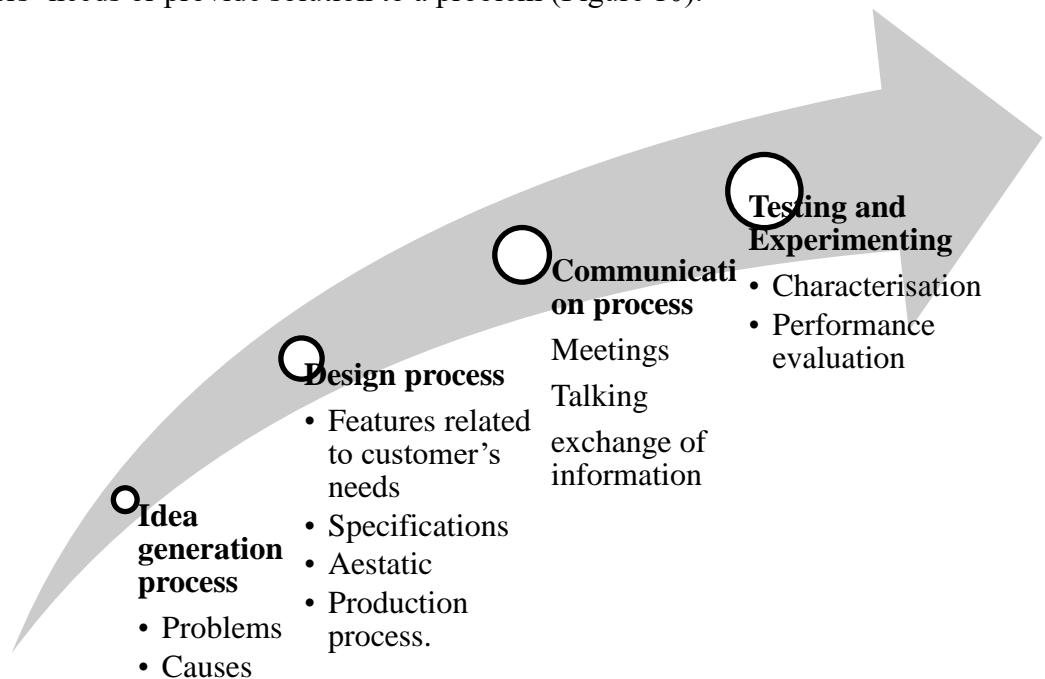


Figure 10: Value added sub processes in infrastructural development

Technical support is usually incorporated during market demand assessment regarding specific problems with a product, essentially long run technological and technical support for composite structures are emerging as a viable and often preferred alternative to metallic repairs in diverse industries. Technological support for composite structures is seamless in the administration and support of developing armadas in the aviation, car, and marine composite-vehicle enterprises. For example, bonded fix and scarf fix are especially appealing from quality rebuilding and mechanical viewpoints, permitting uneven access while just insignificantly influencing the outer shape of the structure.

The Taguchi technique is a powerful tool for robust design of sustainable and resilient infrastructure (Amar and Mahapatra, 2006). The Taguchi approach to testing and

experimentation (Figure 10) provides an orderly way to collect, analyze, and interpret data to satisfy infrastructural design objectives. In the design of experiments, one can obtain the maximum amount of information for a specific amount of experimentation.

Taguchi parameter design is applied to determine the outcome of an analytical approach consisting of design parameters. It can predict the combination of standard factors for optimal factor level by measuring the significant variance in factor which reduces the level of system sensitivity to the source of variation (Bhattacharya, Dev & Das, 2017). Taguchi's methods focus on the effective application of engineering strategies rather than advanced statistical techniques (Mavruz and Ogulata, 2007). Taguchi considers making a structure robust in the parameter configuration part. In parameter design, the objective is to discover values for controllable settings that minimize the negative effects of the uncontrollable settings. Tests are utilized to decide the effect of specific settings on both the controllable and uncontrollable factors. The thought here is that by watching changes in a controllable factor, a worth can be found for that factor that lessens the impact (distorting) of variable that can't be controlled (the the noise factors). The ultimate goal is to find the optimal settings to reduce cost by minimizing variations. The testing and commercialization stage is proposed to addresses the components that obstruct the progress of new materials from ideas into commercial use, this is because Competition in global market is quite high which makes businesses to give more concern to meeting customer needs. It is really difficult for businesses to be successful in global market by depending only on high-volume production and low cost (Gürbüz, 2018; Fletcher & Bourne, 2012). On the whole, the adoption of new materials requires recognition of the relative advantage that they offer. Marketing research on product adoption has shown that innovations are likely to be adopted more rapidly if they are compatible with existing practices and offer benefits that can be understood, observed and trialled (Rogers, 2003; Moore, 2014).

Challenges and way forward

A major impediment to robust and innovative design of infrastructural facilities in Nigeria is the absence of new fiber characterization framework with basic constructs and the availability of manufacturing technology. For effective deployment of fiber reinforced composites in various sector of the economy, extensive characterization of fibers and reinforced composites to establish their properties is fundamental. Unfortunately, paucity of advanced manufacturing technology and mass production facility has impacted on the unit cost of production for reinforced composite products.

Considering the multi-sectorial demand of SDG-9 targets, the current chapter has advocated interdisciplinary collaboration of reinforced composited design teams to facilitate integration of information, data, techniques, tools, perspectives, concepts, and theories from relevant sectors and bodies of specialized knowledge to advance actualization of sustainable infrastructural development in Nigeria. Interdisciplinary researches lead the way to answering questions and solving problem that are too complex to be dealt with adequately by a single discipline or profession; the approach will hopefully draw on disciplinary perspectives and integrates their insights through construction of a more comprehensive perspective.

Conclusions and recommendation

The design flexibility offered by natural fiber reinforced composites has made it attractive choice of material in sustainable infrastructural development. The present review has shown that composites products can be formed into complex shapes more effectively than most conventional

materials (like steel) by harnessing different control factors during initial component design. This gives designers the opportunity to make practically any composition and shape. In this chapter, various applications have been highlighted in automotive, civil works and transportation sector, oil and gas sector, wind energy industry, housing sector, maritime sector, power and telecommunication industries. Design process innovation was then identified as a unique blend of design thinking, computational thinking, culture and problem-solving strategies.

It was obvious that innovative natural fiber composite design encompasses product, process, agent, organization, tool and goal system in a task. From a waste perspective new polymer resin is required that can either be reused or degraded at the end of life for those composites in order to recover the costly fillers and reduce overall costs. Additionally, the use of natural fibers as reinforcement for polymer matrixes is justifiable because they have less environmental impact and high sustainability with comparable properties to synthetic fiber.

As new application of natural fiber reinforced composites pops up on regular basis, efforts should be geared towards reducing material processing costs and functional knowledge of material anisotropy, shrinkage, bulk compression, stress concentration, temperature, creep, ageing and after life is essential. Therefore, in the course of design of infrastructure for any sector, the qualities of the design material and the components vis-à-vis service/operating environmental has to be considered. Also, multi-sectoral approach to design involving industry players is recommended to ensure functionality.

Over all patterns in sustainability and reuse of reinforced composite materials require more attention on limiting waste and environmental effects. Future directions of research in this field may consider specific energy requirements for natural fiber comminution, natural fibre reinforced aluminium composite for industrial applications and micro structural analysis of natural fiber composites. These new focuses will contribute immensely to the existing knowledge of natural fiber design criteria, pre-processing demand and characterisation.

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Chapter 7

Charting a Roadmap to Achieving the Sustainable Development Goals in Nigeria

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Abstract

Sustainable Development Goals (SDGs) have become indices for measuring the growth and development in most Countries of the world. It is a yardstick for determining the level of progress being made by Countries especially on social, economic and environmental fronts. It commits the world leaders into providing solutions to numerous challenges militating against overall wellbeing of humanity and our environment. This paper looks at the global performance of Millennium Developments Goals (MDGs) and the possible ways to achieve Sustainable Development Goals (SDGs) in Nigeria, and advocate for paradigm shift in the governance business of the Country and involvement of all and sundry. Achieving sustainable Development goals in Nigeria involves strategic planning, effective leadership, restructuring of system of governance, integration of SDGs into national visions and plans, research and innovation, creativity, restoration of core family values and reward system, creation of awareness by civil society organizations and philanthropic gestures.

Introduction

At the turn of 21st century specifically in the year 2000, the United Nations in its bids to confront exciting challenges facing the entire population of the planet-earth came up with development agenda known as Millennium Developments Goals (MDGs) to be fulfilled in fifteen years (2015). This United Nations Millennium Declaration was signed in September, 2000 and commits world leaders to combat poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women.

These goals include;

- (i) To eradicate extreme poverty and hunger
- (ii) To achieve universal primary education
- (iii) To promote gender equality and empower women
- (iv) To reduce child mortality
- (v) To improve maternal health
- (vi) To combat HIV/AIDS, malaria and other diseases
- (vii) To ensure environmental sustainability
- (viii) To develop a global partnership for development

All 189 United Nations member states at that time (there are 193 currently) were committed in achieving these goals on or before 2015. Those fifteen years have passed and it is obvious that some countries of the world did not achieve this developmental agenda including our dear country Nigeria.

1.1 The Millennium Development Goals Report 2015

Statistical results have shown that MDGs were achieved in some countries of the world though not 100 percent successful. Take for instance the 2015 MDGs report;

GOAL 1: To eradicate extreme poverty and hunger:

- (i) The report shows that the number of people living in extreme poverty declined by more than half falling from 1.9 billion in 1990 to 836million in 2015. Most progress was recorded from 2000.
- (ii) The proportion of undernourished people in the developing regions falling from 23.3 percent in 1990-1992 to 12.9 percent in 2014-2016.

GOAL 2: To achieve Universal Primary Education

- (i) The primary school net enrolment in the developing Countries recorded a remarkable improvement from 83 percent in 2000 to 91 percent in 2015
- (ii) The number of out-of –school children of primary school age worldwide has fallen by almost half to an estimated 100 million in 2000 to 57 million in 2015.
- (iii) Sub-Sahara Africa recorded the best improvement in primary education since the MDGs were established. The region achieved a 20 percent point increase in the net enrolment rate from 2000 to 2015 as against 8 percent points between 1990 and 2000.

GOAL 3: To promote gender equality and empower women

- (i) Many more girls are now in school as compared to what is obtainable 15 years ago.
- (ii) In Southern Asia, only 74 girls were enrolled in primary school for every 100 boys in 1990. But today, 103 girls are enrolled for every 100 boys
- (iii) Between 1991 and 2015, women have gained ground in parliamentary representation in nearly 90 percent of the 174 countries over the past 20 years.

GOAL 4: To reduce Child Mortality

- (i) The global mortality rate of children under five years has declined by more than half, dropping from 93 to 43 deaths per 1000 live births between 1990 and 2015.
- (ii) Despite population growth in the developing regions, the number of deaths of children under five has also reduced from 12.7 million in 1990 to almost 6 million in 2015 globally.
- (iii) In Sub-Saharan Africa, there was significant annual rate reduction of under-five mortality in 2005-2013 than in 1990-1995.

GOAL 5: To improve maternal health

- (i) The maternal mortality ratio dropped by 45 percent worldwide since 2000 as against what it used to be in 1990s.
- (ii) In Northern Africa, the proportion of pregnant women who received antenatal visits increased from 50 percent to 89 percent between 1990 and 2014.
- (iii) In Southern Asia, the maternal mortality ratio reduced by 64 percent between 1990 and 2013, and in sub-Saharan Africa it fell by 49 percent.

GOAL 6: To Combat HIV/AIDS, Malaria and other Diseases

- (i) New HIV infections dropped by approximately 40 percent between 2000 and 2013 from an estimated 3.5 million cases to 2.1 million.
- (ii) People living with HIV have more access to antiretroviral therapy (ART) with 7.6 million deaths from AIDS averted between 1995 and 2013.
- (iii) In sub-Saharan Africa, over 6.2 million malaria deaths were averted between 2000 and 2015 for children less than five years of age.

GOAL 7: To ensure environmental Sustainability

- (i) Ozone –depleting substances have been virtually eliminated since 1990
- (ii) In 2015, 91 percent of the global population is using an improved drinking water source compared to 76 percent in 1990
- (iii) The proportion of urban population living in slums in the developing regions fell from approximately 39.4 percent in 2000 to 29.7 percent in 2014.

GOAL 8: Develop a global partnership for development

- (i) Official development assistance from developed countries increased by 66 percent between 2000 and 2014 reaching \$ 135.2 billion.
- (ii) The imports from developing to developed countries were admitted duty free from 65 percent to 79 percent in 2014.
- (iii) As of 2015, 95 percent of the world’s population is covered by a mobile-cellular signal

Despite the successes recorded by the prosecution of MDGs, progress has been uneven across regions and countries. Millions of people were left behind especially the poorest and those disadvantaged because of their sex, age, disability, ethnicity or geographical location.

In order to solve the problem and further consolidate on the achievements recorded by MDGs, in 2012 the UN Secretary –General Ban Ki-moon established the “UN System Task Team on the Post-2015 UN Development Agenda”, bringing together more than 60 UN agencies and international organizations to focus and work on sustainable development.

On 19th July, 2014, the UN General Assembly’s Open Working Group on Sustainable Development Goals (SDGs) forwarded a proposal for the SDGs to the Assembly. The proposal contained 17 goals with 169 targets covering a broad range of sustainable development issues.

On 25th September, 2015, the final document was adopted by UN General Assembly at the UN Sustainable Development Summit in New York, USA; officially known as “Transforming our world” as part of its 54th United Nations Resolution A/RES/70/1 with delivery date of 2030.

1.2 Sustainable Development Goals

Sustainable Development is a four dimensional concept that revolves around Economic, Social, Political/Culture and Environmental development. It goes with following definitions;

- (a) It is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Commission report, 1987)

- (b) It can also be defined as the means of finding better ways of doing things both for the future and the present.
- (c) Sustainable development is a process for meeting human developmental goals while sustaining the ability of natural systems to continue to provide the natural resources and ecosystem services upon which the economy and society depend.

In fact, any action that is tailored towards making the human existence favourable and comfortable is a function of sustainable development.

1.3.1 Sustainable Development Goals (SDGs)

Sustainable Development Goals (SDGs) is a 17- point agenda. The new agenda includes:

- (1) **Poverty**- End poverty in all its forms everywhere
- (2) **Hunger and Food Security** – End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- (3) **Good Health and Well-Being**- Ensure healthy lives and promote well-being for all at all ages
- (4) **Education**- Ensure availability and equitable quality education and promote lifelong learning opportunities for all
- (5) **Gender Equality and Women’s Empowerment**- Achieve gender equality and empower all women and girls
- (6) **Water and Sanitation**- Ensure availability and sustainable management of water and sanitation for all
- (7) **Energy**-Ensure access to affordable, reliable, sustainable and clean energy for all
- (8) **Economic Growth**- Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work
- (9) **Infrastructure, Industrialization**- Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- (10) **Inequality**-Reduce inequality within and among Countries
- (11) **Cities**- Make cities and human settlements inclusive, safe, resilient and sustainable
- (12) **Sustainable Consumption and Production**- Ensure sustainable consumption and production patterns
- (13) **Climate Change**- Take urgent action to combat climate change and its impacts
- (14) **Oceans**- Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- (15) **Biodiversity, Forest, Deforestation**- Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forest, combat desertification and halt and reverse land degradation and halt biodiversity loss
- (16) **Peace and Justice**- Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institution at all levels
- (17) **Partnerships**- Strengthen the means of implementation and revitalize the global partnership for sustainable development.

It is a well thought out developmental plan which has the capacity of making our planet a pleasurable place to live.

1.3 The Road Map towards achieving SDGs in Nigeria

Achieving Sustainable development goals (SDGs) in Nigeria requires the involvement of all and sundry. Government Institutions of higher learning together with the private sectors, family, communities, States, Civil Society Organizations, and Philanthropists should take more proactive responsibilities to restoring societal core values and rewards for hard work, integrity and excellence.

1.3.1 Institutions of Higher learning

The institutions of higher learning should be at the fore front of the crusade in achieving SDGs in Nigeria. The traditional role of higher institutions especially Universities revolve around teaching, research and community services. There should be;

- (i) Curriculum review: Universities should introduce a compulsory SDGs courses in their programmes and housed in GS Units
- (ii) Innovative research: Researches should be goal oriented, that is towards solving a particular problem within the proximate environment
- (iii) Link with Industries: The commercialization of research finding should be funded and executed through industries.

1.3.2 Restructuring of system of Governance in the Country

Government has greater role to play in the implementation of sustainable development goals. These include reforms through;

- (I) Making National and State Assemblies Part-Time Occupation: The legislatures should be a part-time job and their meetings should be three or four times in a year aside from emergencies when the need arises. This will ensure that 25 percent National budget allocation to this arm of Government is deployed to infrastructural development and other productive areas of need.
- (II) Judiciary: More judges should be appointed for quick dispensation of justice.
- (III) Corruption: People involved in corruption should be adequately punished. Corruption restraining mechanism should be built in the system of governance like TSA, BVM etc.
- (IV) Education: 26 percent of the National budget should be allocated to education sector for proper funding of research and innovations.
- (V) True federalism. Every State should be allowed a measurable unit of autonomy. The States should be encouraged to harness their natural resources and pay a tax to the central government.
- (VI) Inclusive governance: The Communities should be consulted before siting of any developmental project in their areas.
- (VII) Monitoring and Evaluation offices. Different layers of Government should have SDGs offices for project monitoring and evaluation.

1.3.3 Family, Society and Reward System

Core values are like a navigation system that guild our actions and behaviours and helping children develop core values is essential for a life of purpose and significance.

The core values of integrity, hard work, honesty and sincerity of purpose should be inculcated in our children. The ones that excel in their chosen career should be recognized and honoured.

1.3.4 Civil Society Organizations

The CSO should be up and running in their activities. They should take a lead in'

- (i) Enhancing transparency and good governance by contributing to increase public debate on issues surrounding the formulation and implementation of government budgets
- (ii) Educate the citizens on their rights and privileges
- (iii) Organize town hall meetings for public office holders to give report of their activities
- (iv) Raise awareness and educate the citizens on governmental programmes
- (v) Help develop, implement and monitor education strategies.

1.3.5 Philanthropists

Philanthropists must play a crucial role in the achievement of the SDGs. There should be a SDG philanthropy platform to enable the philanthropist engage in providing solutions to the problems posed by SDGs. This can be done through;

- (i) Provision of small-scale loan scheme for indigent people to access
- (ii) Partnering with Government for infrastructural development
- (iii) Establishment of education loan scheme targeted at bright indigent students
- (iv) Funding of research and innovation
- (v) Institution of awards for people with bright ideas.

1.4 Conclusion

The sustainable development goals (SDGs) are a 17-goal frame work for global development. The SDGs are the follow-up to the UN's Millennium Development Goals (MDGs) with delivery date of 2030. The performance of any country wishing to achieve the SDGs depends primarily on its leadership. Effective leadership translates into prudent policy formulation and implementation as well as good public delivery to meet the needs and aspirations of its citizens. Sustainable development goals can be achieved in Nigeria if there is deliberate plan and strategy to do so. The plan includes the restructuring the system of governance in the country, involvement of civil societies in creating awareness, higher institutions in taking a lead in research and innovations, restoration of family cores values, awards to achievers and philanthropists supporting the Government in infrastructural developments.

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Chapter 8

The Environment and Health: Implications for Children

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Abstract

Human population is still growing and needs space and environmental resources. This assertion means that sustainable environmental resources management could be weighed against physical development and the health of any people. How can unhealthy environment put the lives of people, especially children in jeopardy? This paper attempts the foregoing question by correlating the consequences of degrading environment with the well-being of people, particularly, the children. One solution among many, on which individuals can be proactive on, is to promote the tenets of environmental health in their communities for the overall benefits of both present and future human future generations.

Introduction

Children are the future leaders of Africa. However, many of them cannot develop to maturity/survival if their health is negatively affected by environmental components. Components of the environment most affected and pivotal for human survival include; air, water, and climate. Air and water pollution have been at the forefront of causes of environmental pollution related deaths in both developing and developed countries. In 2012, 1.7 million deaths in children under the age of 5 in the World were attributable to the environment. Last (1995), defined the term ‘environment’ to mean “all that which is external to the individual host which can be divided into physical, biological, social and cultural factors (any of which can influence status of populations)”¹. This definition by Last (1995) seems to be widely accepted in the public health sector. Whereas, WHO (World Health Organization) defines ‘health’ as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.²

The impact of environmental risk factors on health are extremely varied and complex in both severity and clinical significance. Environmental risk factors can either be classified as chemical (air pollutants, toxic wastes, pesticides); biologic (disease organisms present in food and water, insect and animal allergies) or physical (noise, ionizing and non-ionizing radiations). Globally, an estimated 12.6 million deaths each year are attributable to unhealthy environments; nearly 1 in 4 of total global deaths. Environmental risk factors such as; air, water and soil pollution, chemical exposures at workplace, climate change and ultraviolet radiation contribute to more than 100 diseases and injuries.³ The effects of environmental degradation on human health can range from death caused by cancer due to air pollution to psychological problems resulting from

noise.³ Although, there are many factors that influence the health of a population, such as diet, sanitation, socio-economic status, literacy, and lifestyle⁴; literature has it that, more than 10% of preventable deaths are mainly due to two (2) factors: (a) lack of clean water and (b) the effects of indoor air pollution resulting from the use of fuelwood, for cooking and heating.⁵ Although, emissions of many air pollutants have declined in high income/developed countries in recent years, air-emissions made worse by industrialization and poor sanitation. However, the environmental determinants of human health in high income/developed countries, relate more to their exposures to air pollutants (particularly in urban areas) and chemicals in the environment than to poor living conditions. On the other hand, for low and middle-income countries - the major environmental health threats such as cholera, Lassa fever and tuberculosis which frequently ravage its peoples are primarily due to poverty, malnutrition, poor housing, poor health-care system and unsafe drinking water. Consequently, more than half the world's population is still exposed to unsafely managed water, inadequate sanitation and poor hygiene, resulting in more than 800 000 preventable deaths each year. A large fraction of malaria cases and other vector-borne diseases is closely linked to the management and manipulation of the environment, such as drainage, irrigation schemes, or design of dams. More than one million workers die each year because their workplace is unsafe, and more than one million people die from exposure to chemicals.⁶ Taking Nigeria as a case study, the diseases of public health concern which are endemic and highly difficult to tackle despite the billions of dollars in funding and grants from numerous international and national donor agencies stem from the environmental issues faced ranging from; overcrowding, poor housing structure. Many of the diseases killing millions yearly include but are not limited to malaria, diarrheal diseases, tuberculosis are due to issues like; poor housing (overcrowding), water and vector control for malaria and diseases like dengue fever and could be easily averted by environmental control.⁷

X-raying related environmental health issues in communities

Based on the increasing relevance of the impacts of the environment on the health of the people, the 'Environmental Health' profession was created as a branch of public health to advance knowledge that balances the benefits between the environment and human wellbeing. Environmental health comprises those aspects of human health including quality of life that are determined by chemical, physical, biological, social and psychological factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that can potentially affect adversely the health of present and future generations⁸. Evidence based researches have been carried out by different individuals and groups across different levels of development of human life: i.e., from prenatal to old age with respect environmental impacts; with varying results. Children's susceptibility to environmental exposures is different from those of the adults; though, it may result in more or lesser risks at various stages of their development. A number of child health endpoints – birth defects/other birth outcomes including neurotoxicity, developmental disabilities, reduced growth, childhood cancer, and asthma' have all been associated with exposures to environmental pollutants such as air pollution⁹.

Nowadays, air pollution is hard to escape from. Urban air quality problems related to some pollutants are on the increase, with serious repercussions for human health⁴. As the Earth gets hotter and more crowded with people, our fuel-engines continue to pump out dirty emissions. Therefore, air we breathe-in becomes heavily polluted with carbon emissions.¹⁰ The World Health Organization recognizes air pollution as a critical risk factor for non-communicable

diseases, causing adult deaths resulting from at least heart diseases (24%), strokes (25%), chronic obstructive pulmonary diseases (43%) and lung cancer (29%).¹¹ The highest ambient air pollution parameters with annual mean levels most often exceeding more than 5 times World Health Organization limits; are reported in Asia and Africa. (Although African cities have a serious lack of air pollution data).¹¹ In 2016 alone, ambient air pollution caused about 4.2 million deaths while household air pollution from cooking with polluting fuels such as solid fuels or kerosene for lighting, cooking and heating.¹¹ With almost 3,000 million people still depending on polluting fuels, air pollution is said to be among the largest risks to health, causing about seven million preventable deaths per year. Quite a huge number of easily preventable deaths!

A critical review of the diseases outlined above could show the different ways the lack of a degraded environment can have on people's health development. In 2012, it was globally estimated that 26% of childhood deaths and 25% of the total disease burden in children less than 5 years could be prevented through the reduction of environmental risks such as air pollution, unsafe water, sanitation and inadequate hygiene or chemicals.⁷ It was further stated that reducing environmental risks could prevent 1 in 4 child deaths¹² through proper sanitation. Environmental sanitation is defined as art and science of applying sanitary, biological and physical science principles and knowledge to improve and control environment and factors therein for the protection of the health and welfare of the public¹³. Safe sanitation is essential for the health, from preventing infections to improving and maintaining mental and social well-being/health. Unsanitary conditions have been linked to stunting in children, affecting one quarter of children under 5 years of age, through several mechanisms i.e., repeated diarrhea, helminthes infections etc.¹⁴

Way forward for sustainable environmental health

A publication by the World Health Organization, titled: "*Preventing Disease through Healthy Environment*"¹⁵ enumerated the following interventions:

- Focus on primary prevention
- Systematically consider health in all sectors (inter-sectoral collaboration)
- Promote and support local governance to address environmental health planning.
- Integrate actions to address the social determinants of health and provide basic services to all.

Conclusion

In conclusion, given the myriad of diseases attributed to the deviation from environmental standards, it is obvious that the environment has deleterious effects on the health of individuals, especially children – the leaders of tomorrow in line with sustainable development. This further means that environmental problems do not only affect the health of the present generations but of the future generations. This calls for proactive public health efforts geared at protecting the environment, preventing deviations from health and ensuring the future of present and future generations. Organized community efforts through regular environmental sanitation, protection of water bodies and safe disposal of human wastes are pivotal. Governmental/ political will and support through inter-sectoral collaboration, community mobilization will go a long way to reduce the burden of disease. Health education of the community via governmental and non-governmental organizations will help tackle the problem.

- Become an advocate of environmental health, today!!!

- Safeguard the health of future generations, through environmental conservation!!!

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Chapter 9

Corruption and the Implementation of Sustainable Development Goals in Nigeria: An Overview

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Abstract

Corruption is perceived across the board to be an illegal transaction that often takes the form of embezzlement, bribes, money laundry, and other forms of vices that could threaten the implementation of policies in both developed and developing countries across the world, and especially sustainable development goal of any nation. The implementation of sustainable development goals in Nigeria has been a daunting task for the government, policymakers and the citizenry due to corruption. The paper appraisal the challenges posed by corruption to the overall implementation of the sustainable development goals in Nigeria. The paper relied on articles from journals, books, conferences, working papers, and official documents, which form the basis for the adoption of the secondary method of data collection. Using content analysis, the paper found that corruption which appears in the form of embezzlement and bribes constituted a huge setback to the implementation sustainable development goals in Nigerian. Unfortunately, no end in sight due to the lack of political will to curb the menace called corruption in the country. This paper recommended that for implementation of sustainable development goals to see the light of day in Nigeria there is the need to tackle the issues of corruption headlong with complete commitment from the political leaders in Nigeria.

Keywords: Sustainable Development; Corruption; Implementation; Nigeria; Political Will

1. Introduction

The level of poverty among the Nigerian citizen is alarming, youth unemployment is at its peak, the collapse of infrastructure remains obvious, insecurity is astronomically high, the citizen feels less secure than ever, and the nation is rooted at the bottom of the Human Development Report in recent time, due to the ascendancy of corruption in the country (Akanle & Adesina, 2015). Corruption remains the single greatest hindrance to the attainment of sustainable development goals in Nigeria. Corruption hinders development and economic empowerment, it promotes an increase in public spending, a decrease in public revenue generation, thus hampering the implementation of sustainable development goals in the country (Catan & Chaffin, 2003). Corruption has also hindered the realization of the enormous potential inherent Nigeria's oil resource, and other natural resources, and the large market which helps to enhance the social, political and economic strength of any nation (Azeez, 2011). The socio-economic condition

which prompted this endemic corruption in Nigeria includes lack of economic opportunity, poor reward system, and the immediate opportunity provided through illicit enrichment by elites, an absence of rule of law and enforcement of existing laws and the prolong military rule in the country (Shehu, 2005). This social malaise has holistically spread in all spheres, cutting across religious groups, political system, socio-economic sectors, governmental and non-governmental organizations, the young and old, male and female, the malignant nature of corruption in Nigeria has proved to defer treatment (Aluko, 2002; Olagunju, 2012).

Hence, since Nigeria's independence in 1960 the country has grappled in policy implementation such as sustainable development goals as a result of corruption. The situation has generated a negative perception of any new development goal in the country, which may struggle with an implementation like the previous policies. One key setback to successful sustainable development goals implementation in Nigeria is the endemic corruption in the socio-political system of the country, and especially among the public and political officeholders. This paper attempts to review the related literature on the subject of corruption and its impact on sustainable development goals in Nigeria. Thus, this chapter is further sub-divided into five sections. Section one talks about the general introduction, while section two looks at conceptual clarification, while section three reviews the history of corruption in Nigeria. In section 4 we see a review of the impact of corruption on the implementation of sustainable development goals in Nigeria, while section five is the conclusion and recommendation.

Conceptualization Clarification

2.1 Corruption:

The issue of conceptualization of phenomenon in social science has generated a lot of problems because most scholars have a different perspective on a given issue at any point in time; apparently, the concept of corruption is no different. According to Adeyemi (2012), the concept of corruption has defied uniform definition among the practicing policy administrators and the academic communities, and it has continued to be enveloped by value differences, preference amongst the victims and perpetrators. While Nwabueze (2002) sees corruption as social or criminal deviance as a result of a lack of will to respect social norms with an extra-legal approach or mal-adaption to gaining access to public resources. According to Olasupo (2009) corruption is an act of taking and giving a bribe, acquisition of wealth illegally from the resources of the nation, and exercise of discretion in the position of authority for personal benefits.

While Dukor (2005) opined that corruption is found to have occurred when unfaithful and dishonest behavior defiled the social structure of society. In the work of Otite (1986) corruption is perceived to have occurred when their perversion of integrity through favoritism, bribery, moral depravity through the injection of an improper transaction with the target of changing or altering of judgments from those in the position of trust. Corruption is the act of manipulation and the use of the public office or using private capacity or position of trust to divert funds and materials meant for the benefits of a vast majority of the people for personal need and interest. Omotola's (2006) definition of corruption was captivating; the scholar sees it as having both political and economic context with a joint effect. Political corruption is a situation where policy-making and politics are characterized by intimidation of position groups, abusive patronage, fraud, and exchange of money and materials for utility franchise. Osoba (1996) conceived corruption as anti-social behavior by a group of individuals which confers fraudulent or unjust benefits on its perpetrators, which violate established legal norms and moral beliefs of the

society and subvert or diminish the general wellbeing of the citizens. Corruption in the policy cycle occurs when the public officials take bribes in the form of money and other forms of material gains for personal interest, which invariably hampers the effective policy spheres and importantly the implementation of a given policy.

1.2 Policy Implementation

Policy implementation comprises those actions by private individuals (or groups) and public institutions that are targeted at achieving set objectives embodied in a prior policy decision, which include transforming policy decisions into operational or concrete terms (Van Meter & Van Horn, 1975). Pressman and Wildavsky (1984), who are foremost scholars of policy implementation, see it as a process of interaction built in a form of relationship between goals setting and action is taken towards achieving these set goals. Implementation process only began when goals and objectives have been set or established by the concerned body either through legislation or otherwise and necessary apparatus such as fund has been committed to it (Van Meter & Van Horn, 1975). Brynard (2005) sees policy implementation as accomplishing the policy objectives through programming and planning of projects and operations to achieve the desired impacts/outcome agreed. Policy implementation is that an iterative process in which decisions communicated as policy are transformed from ordinary ideas (or decisions) into social action and behavior (Ottoson & Green, 1987). Policy implementation involves carrying out the set policy decisions through the detailed or planned cause of actions, with the overall objective of accomplishing the policy target.

1.2.1 Approaches to Policy Implementation

Policy implementation is commonly viewed from the top-down approach or bottom-up implementation approach which involves the methods of structuring implementation of policy to ensure it achieves the goal upon which it was established (Birkland, 2014). Goggin (1990) view policy implementation from three (3) generations; the first generation of policy implementation study mainly found in the 1970s which was characterized by pessimistic undertone, this generation of studies only raise awareness of the issue of implementation; the second generation included a wide range of hypotheses and theoretical framework, the period centered its debate on top-down and bottom-up implementation study of policy; while the third generation of policy implementation study tried to narrow the gap between top-down and the bottom-up approaches with more scientific orientation and experimenter observation.

Top-Down Approach: The approach sees policymakers as the central or main actors in the policy implementation process, attention is focused on manipulating factors at the central level (Matland, 1995). For effective policy implementation, this approach believes that clear objectives, implementation processes must be legally structured, casual theory, officials that are committed, and support groups are needed (Sabatier, 2005). The strength of the top-down approach to Cerna, (2013) is that its generalization and its consistency in the policy advice and implementation; the top-down approach is often criticized for considering policy implementation as an administrative process while ignoring other aspects and it places emphasis on the makers as key actors in the implementation process.

Bottom-Up Approach: The bottom-up approach unlike the other approach places emphasis on groups and those who deliver services believing that policy implementation is done at the local level (Matland, 1995). To Cerna, (2013); Hanf, et al, (1978) the approach recognized the series of actors involved in delivering services by establishing contacts in order to arrange the

connection of techniques to identify other actors from local, regional, sub-regional and national actors involved in the outlining, financing and implementing governmental programs. The bottom-up approach focuses essentially on the local actors who implement programs of the government and describe or explain the factors that may hinder policy goals; this approach adopts flexible strategies in order to suit the local difficulties that may face the implementation of policies (Cerna, 2013; Matland, 1995). The approach is faced with some criticism for overemphasizing on local autonomy in policy implementation.

Combined Approach: Some literature has shifted attention to combining both bottom-up and top-down approaches in policy implementation studies in order to gain from the strengths of the approaches and to enable them to interact regularly (Cerna, 2013). An implementation strategy that uses the bottom-up approach is mostly found in the area of low conflict, where there is lack of consensus on the achievement of goals, while strategies that use the top-down approach as a guide to policy implementation and governance are often found in high conflict area (Suggett, 2011). According to Cerna, (2013) combined approach is important in policy implementation because of the wide ranges partners, and the interaction from both local actors and the central policy-makers geared towards successful implementation of governmental policies; and the critics of this approach see those policy implementations differing according to peculiar content and policy types.

1.3 Sustainable Development:

Sustainable development according to the International Institute for Sustainable Development (IISD) the most frequently quoted definitions of the concept was gotten from Our Common Future, also known as the Brundtland Report, as cited Akintoye & Opeyemi (2014;35) which is state thus:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: - The concept of needs, in particular the essential needs of the world’s poor, to which overriding priority should be given; and - The idea of limitations imposed by the state of technology and social organization on the environment’s ability to meet present and future needs”.

Table-1: Sustainable Development Goals

Goal	Indicator
Goal 1.	End poverty in all its forms everywhere
Goal 2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
Goal 3	Ensure healthy lives and promote well-being for all at all ages
Goal 4	Ensure inclusive and equitable quality education and promote life-long learning opportunities for
Goal 5	Achieve gender equality and empower all women and girls
Goal 6	Ensure availability and sustainable management of water and sanitation for all
Goal 7	Ensure access to affordable, reliable, sustainable, and modern energy for all
Goal 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster

Goal 10	Reduce inequality within and among countries
Goal 11	Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12	Ensure sustainable consumption and production patterns
Goal 13	Take urgent action to combat climate change and its impacts
Goal 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17	Strengthen the means of implementation and revitalize the global partnership for sustainable

Source: *Sustainable Development Solutions Network, Cited in Malaolu & Ogbuabor (2017:483).*

The table 1 above shows the summary of the 17 sustainable development goals. Sustainable development is that quest for development that does that not just capture the immediate needs of the citizens, it also takes care of the future needs of the people at large, through enhance technology, social facilitate and adequate use of the available resource. Dansabo (2016:11) capture the very essence of the sustainable development goals thus:

The UN Agenda for Sustainable Development adopted last year at the United Nations Sustainable Development Summit includes 17 Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice, and tackle climate change by 2030. The SDGs is the successor global development programme that replaced the MDGs.

To Lele (1991) sustainable developments is that new way of life and of course approach to economic and social activities for all societies across the board, including the rich and poor which is compatible with the preservation of the environment through viable and efficient management of available resources for the survival of human immediate need and future generation.

2. Corruption in Nigeria: A brief Historical Review

Corruption in Nigeria can be traced to the colonial epoch. Colonialization in the country was built on corruption because of the predilection of these colonialists whose intention was to exploit the state for their benefit at the expense of the people through the aid of traditional rulers, which were used a tool for swaying the natural resources of the land (Omotola, 2006). According to Jain (2003), the activities of colonialists in Africa prompted the emergence of a primordial public sphere which was built on control, high moral principles, and accountability, at the same brought about civil public which has no moral principles and embraces private accumulation. The colonialists supervised the accumulative corrupt system, through shipment of huge surpluses via unequal trade (Osoba, 1996). Having gotten her independent from the colonial rule in 1960, the military stepped in to distort the then existing political system, a tread with continued until the late 1990's when the emergence of democratically elected administration was inaugurated. The distortion of the democratic administration/the activities of the military junta did not stop the

endemic corruption in the country. Nigeria under the military regime witnesses the institutionalization of corruption, which was a tool for retaining power, and rule of law was neglected, cutting corners amongst the citizens and public officers became a norm, thus the corruption which they (the military) claimed to be the reason for seizing power became worst under their regime (Shehu, 2005).

Corruption escalated dramatically during the era of the oil boom in the 1970s when revenue from petroleum was fourfold high in the international market, while Nigeria treasury was awash with foreign currency, stealing from the country's treasury equally increased (Osoba, 1996). The endemic corruption led to the collapse of Nigeria's first, second, third republics and it remains a major threat to the continued existence of the present republic in the country (Omotola, 2006). Despite, initiatives such as the promulgation of the public officers' Decree No.5 of 1966, the enactment of the Corrupt Practices Decrees No. 38 of 1975, the Corrupt Practices and other Related Offences Act of 2000, Economic and Financial Crimes Act 2002, and host of Probe Panels carried out in the country, unfortunately, all these enabling legislation did not ease the endemic corruption in Nigeria.

3. Impact of Corruption on the Implementation of Sustainable Development Goals in Nigeria

Corrupt activities in Nigeria have denied the overwhelming majority of the citizen of the country the gains inherent in sustainable development goals. The corruption denied the citizens the basic means of livelihood, with a worsening level of unemployment which has eroded almost all available goals of sustainable development and the policy strategies inherent in it. For instance, despite the existence of 17 sustainable development goals target aimed at reducing poverty in the country not much have been achieved due to corrupt tendencies in the both bureaucratic and political system of Nigeria. Policies such as the National Poverty Eradication Program (NAPEP) and National Directorate of Employment (NDE), as well as the huge amounts of gains derived from oil and other natural resources which was geared towards reduction of corruption for easy attainment of sustainable development, many citizens of the country are still living abject poverty, which keeps growing due to poor implementation as a result of corruption (Aminu & Onimisi, 2014).

The serious nature of corruption in the political system of Nigeria has not only affected the implementation of sustainable development in the country, but corruption has also caused the greater political deficit and question the credibility of basic policies measure which focuses on empowerment, poverty reduction, inequality, accountability, popular participation, and unfortunately, the political will, as well as the legitimacy of such policies remains affected (Omotola, 2006). The damage corruption has done the attainment of sustainable development goals in Nigeria cannot be quantified as epidemic corruption in the country has held back the loft desired goal of sustainable development. The collapse of most sustainable development goals or the failure in the implementation of most of the goals in Nigerian has some element of corruption when critically examined. The country's oil boom era in the 1970s led to a rapid increase in corrupt activities, which hindered the decisions (policies) of the government as well as the implementation of such decisions. As the governing class saw the oil boom as an instrument of political gains, while political office holders exploited the system for private interest, with the high level of indiscipline, self-seeking, greed, selling off public assets to friends during the military regime and corruption was made worsen under democracy administration as it became

systemic and endemic in the country making it practically impossible for policy implementation to the light of the day (Omotola, 2006). Corruption has particularly hampered the implementation of sustainable development goals in the nation's public institutions as public officers tend to be more interested in collecting bribes rather than achieving the targeted policy objectives (Dike, 2011).

The impact of corruption can be further felt on various projects across the country which ordinarily assist in attaining or achieving sustainable development goals, unfortunately, as poor and weak infrastructures spread in all sections of the country due to poor supervision, as supervisory officers are more interested in collecting 'kickback' against ensuring the successful completion of such projects or policy actions remains a setback to the attainment of the goals (Olagunju, 2012). The primitive quest for private accumulation of wealth and the diversion of resources at the expense of the citizens of Nigeria by key public office holders has no doubt contributed to the low implementation of public or social policies in the country (Osoba, 1996). Dansabo (2016:9) According to Ogbeidi (2013) corruption in Nigeria remains the biggest hindrance to the implementation of sustainable development. Ogbeidi, notes thus:

Corruption is the most critical impediment to achieving the Millennium Development Goals (MDGs)...Nigeria remains desperately poor due to bad management of its wealth by successive corrupt governments. Today, Nigeria is one of the poorest countries in the world. Its unadjusted GNP per capita of \$ 300 leaves it in 164th position among other counties in 1999. The per capita GNP PPP (purchasing power parity) figure of \$ 820 looks better at first glance but it ranks 199th out of the 209 countries covered in the World Bank's 2000 World Development Report...In 2010, Nigeria's GDP per capita (PPP) of \$ 2.365 ranked as 138th in the world out of the 180 countries, while the GNI per capita (PPP) of \$2.160 left the country in the 172nd position out of the 215 countries listed in the World Development Indicators Database (Cited in Dansabo, 2016:9).

Thus, corruption remains an undermining factor in Nigeria's drive for the implementation of sustainable development goals. Corruption in the country's political and bureaucratic cycle which often takes the form acceptance of gratification, inducements, embezzlement of the fund, conflict of interest, influence peddling, padding of budget, extortion, fraud, bribery, misappropriation, falsification of financial records, these acts perpetrated by some public office holders are inimical to the implementation of sustainable development goals in Nigeria (Aina & ICPC, 2014).

A study has equally shown that Nigeria is known to be among the countries with least recipients of aid from foreign donor due to the history of endemic corruption in the political system of the country, which invariably has hampered the implementation of certain goals of sustainable development that require assistance from donor agencies, organization and countries (Aina & ICPC, 2014). Corruption is the fundamental cause of mass impoverishment, agonizing poverty, grinding, which has compelled the citizens of the nation to resign to their faith in the phase absence of socio-political development and non-implementation of sustainable development which would have improved their standard of living (Olojede, 2006). The enormity of corruption has impacted negatively implementation of sustainable development goals in Nigeria. This, unfortunately, set the country a few decades backward, thus presenting a situation

of non-existence or absence of socio-economic and political development in the country. One major source of concern is its threat to the nation's development, thus complicating the socio-economic and political problems in the country.

Furthermore, Akanle & Adesina (2015) were of the view that corruption is often encouraged by the collection of social networks and kinsmen who place demands that are beyond the official capacity of the public officers from their section of the country, making these officers go beyond their constitutional mandate to please their social, ethnic and kin networks, thus pursuing them to cut corners and subsequently jeopardizing an existing sustainable development goal. These scholars equally stated that those ethnic groups and kinsmen apart from the psychological boost of seeing their kinsmen in public offices, their major concern is the social benefits deliverable from public office holders, even when it distorts the implementation of the sustainable development goals.

Corruption in Nigeria constitutes an impediment to the implementation of not only sustainable development goals, but it also affects resource mobilization, poverty eradication, poor quantity/quality of service delivery of the government agencies, educational institutions, ineffective health facilities, poor infrastructure, social insecurity and high cost of living in the country (Derin, 2007; Chukwuemeka, Ugwuanyi, & Ewuim, 2012). According to Dahida & Akangbe (2013), the massive and prevalent corruption among the political and bureaucratic class has not helped the implementation of sustainable development goals in Nigeria and the promotion of governance and infrastructure development. Systematic corruption among some public officials have frustrated sustainable development goals implementation and the direct flow of administrative provisions needed for growth, and the idea of good governance is jettisoning for private interest (Ovienloba, 2007).

Furthermore, Awofeso & Odeyemi (2014) see public policymakers and implementers saddled with the responsibility of formulating and implementing policies of the government are themselves corrupt, which often manifests in the non-implementation sustainable development goals in the country. Overt and covert corruption in the government institution and amongst key bureaucrat has contributed greatly to hunger and deprivation due to failure in the implementation of key policies on poverty eradication, thus putting the vast majority of Nigerian below poverty line (Awofeso & Odeyemi, 2014). Even when the country remains among the largest exporter of crude oil, with several natural resources, majority of the population still live below the poverty line because of corruption, arising from the self-serving political leadership, and the unfortunate purse of personal interest at the expensive of the collection goal of the citizen (Ogbeidi, 2012). Corruption remains the greatest challenge to the contemporary world and it fundamentally distorts policy implementation and the entire cycle of public policy, thereby undermining good governance, and increasing misallocation of resources needed for development and poverty reduction (Transparency International, 2005). Sustainable development goals touch on all spheres of human life, as seen in the 17 goals, unfortunately, the implementation of these goals in Nigeria remains difficult because of corruption.

4. Conclusion and Recommendation

The implementation of sustainable development goals in apparently suffers a setback due to endemic corruption in the political and bureaucratic system in Nigeria, which presents itself in the form of bribery, embezzlement of public fund, and placing personal interest and the quest for material acquisition at the expense of implementation of the governmental policies. Corruption hinders the successful implementation of sustainable development goals in Nigeria and has over the years deferred solution due to the absence of political will and misplacement of priority on

the part of political office holders and bureaucrat in the country. The attitude towards corruption especially amongst the leaders of the country, unfortunately, does not help matters. The bane of failure in the implementation of sustainable development goals in Nigeria rests on endemic corruption in the country. However, the implementation of sustainable development in Nigeria can be better achieved through committed leadership, who have the interest of the citizenry at heart, and the strong institution as well as awaken watchdog role of the media in the country these will go a long is setting implementation of the goals in the country on the part of improvement. The paper recommends the following:

Variable Institution: The endemic corruption in Nigeria which has hampered the implementation of sustainable development goals in the country can be overcome with a strong and variable institution. The institutions of government need to be built in such a way that it does not have to depend on the williness of an individual or government in power to perform its responsibility of implementing policies. These institutions cut across agencies of government responsible for the implementation of policies and importantly the body established to fight anti-corruption in the country.

Leadership Commitment: To ensure that corruption does not hinder the implementation of sustainable development in Nigeria, there is a need for strong leadership commitment. Considering the implication and the seriousness of the issue of corruption in the country and its effect on the implementation policies of the government, the leaders occupying public offices, leaders of a political party, kinsmen, ethnic and religious leaders must pledge their commitment to ensuring that policies of the government, thus monitoring and ensuring full implementation of policies for the overall wellbeing of the masses. And by putting aside their personal interest for the overall good of the society and the country in general. To ensure effective implementation of the goals in Nigeria the fight against corruption must be championed by a good and exemplary leader who are meaningfully committed to tackling the socio-economic and political issue in the country, thus when leaders are paradigmatic in their conduct the chances of successful policy implementation remains high (Chukwuemeka, Ugwuanyi, & Ewuim, 2012).

The Media and Policy Implementation: The media can play a critical role in the fight against corruption and its effect on the implementation of sustainable development goals. The Nigerian media in the last few decades demonstrated its capability on exposing corruption and corrupt officers whose activities hampers government policies since the media often sets societal agenda, through their reports, news coverage, and interviews (Akanle & Adesina, 2015). However, the Nigerian media cycle needs to step up its game especially in the area of investigating journalism, in order to expose corruption among the public office holders who are bent on sabotaging the implementation of the policies of the government.

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Chapter 10

Analysing the Role of Architects in Achieving the Sustainable Cities Goal by 2030

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Abstract

Cities are vital entities of any nation because it serves as the nuclei for trade, innovation, science, technology, social development etc. However, many Nigerian cities are experiencing rapid urbanization and are faced with many developmental challenges in their bid to function in a way that it can continue to prosper in all spheres without straining land and available natural resources. Some of the peculiar urban challenges include traffic congestion, inadequate provision of basic services, extreme poverty, affordable housing deficit, declining infrastructure, and rising environmental pollution within cities. These myriads of challenges with environmental, economic and sociocultural perspectives have impact on city and community sustainability which is goal 11 of United Nations sustainable development goal. The rising city population provides both challenges and opportunities for environmentally-conscious developers. This research x-rays the role of the professional architect in the built environment towards the struggle for city and community sustainability. Through review of existing literature, the research result notes unabated rising urbanization among other factors as the bane of uncontrollable Nigeria's urban sustainability issues, consequently exerting huge pressure on the existing urban infrastructure and putting a strain on the earth's finite resource. It concludes and advocates that proactive steps should be taken to initiate sustainable building construction measures as best practices in the built environment among architects and also marshalling adequate framework to ensure its implementation.

Introduction

Humans are social creatures and thrive in urban spaces that foster social connections; hence there exists a strong connexion between the quality of urban life and how cities consume and manage the natural resources at their disposal. Cities in developing economies are expanding so rapidly as a result of rising populations and increasing migration. This has led to a boom in mega-cities, and slums are becoming a more significant feature of urban life. The economic role of cities cannot be overemphasized as it generates approximately 80 percent of the global gross domestic product (GDP). Available United Nations statistics reveal that in 1990, there were only 10 cities with 10 million people or more; by 2014, the number of mega-cities rose to 28 and was expected to reach 33 by 2018 with 9 out of 10 mega-cities situated in the developing world. However, in 2018, the hallmark was crossed with 4.2 billion people and 55 percent of the world's population living in cities. With the number of people living within cities projected to rise to 5 billion people by 2030, and by 2050 another prediction estimates the urban population is to reach 6.5 billion; it's important that efficient urban planning and management practices are in place to deal with the challenges brought by urbanization.

Sustainable development cannot be achieved without significantly transforming the way we build and manage our urban spaces. Cities occupy just 3 percent of the Earth's land but account for 60 to 80 percent of energy consumption and at least 70 percent of carbon emissions. Having 828 million people already living under slum condition, the number is constantly rising. Only three countries, namely China, India and Nigeria will account for 40 percent of global population growth over the next decade (Muggah, 2016). It indicates that People are not just moving to cities; cities are coming to them (Okeke et al, 2020) and urbanization is here to stay. The negative environmental footprints of these repaid urbanizing cities are quite alarming and threaten the natural resources required to sustain the economic development and poverty alleviation rates.

Most of the World's largest slums are located in Africa with a slum population of approximately 195.5 million which is 61% of its urban population; Nigeria on the other hand has the 9th largest urban population in the world and is home to some of the largest slums in the region (UNDP, 2010). It has seven cities with more than a million people, 80 cities with between 100,000 and 1 million people, and 248 cities with between 10,000 and 100,000 people (World Population Review, 2019). Lagos, for instance is Nigeria's largest city and it's still growing at a very fast rate. The population of Lagos is predicted to increase by an astonishing 77 people every hour between 2010 and 2030. This is according to United Nations World Urbanization Prospects (2014) and this rapid population growth has continued to put strain on scarce urban resources. Studies suggest that the social problems experienced in many cities usually have a uniquely 'urban' dimension. In this way of thinking, urbanization processes- the concentration of people and socioeconomic activities in cities- affect the extent to which problems occur and the particular forms they take in those places.

Since the end of the Nigerian civil war in the 1970, no aspect of society has aroused the passionate concern of reforms more constantly than the massive population increase, the housing condition and the living standard of the urban poor. These profound changes have led to the proliferation of modern-day slums. The word "slum" carries with it the perception of an evil environment. For an outside observer, there is a kind of visceral reaction to the total environment of urban slum and to the inhabitant a drop in the perceived desirability of the city as a place one can to live, work or shop in. However, the concentration of people, power, and wealth in cities creates many possibilities for tackling some of the world's most pressing problems. At the same time, urban areas are on the frontline of challenges that range from climate change and extreme poverty to multiple layers of violence and pandemics. Therefore, making cities sustainable means creating career and business opportunities, safe and affordable housing, and building resilient societies and economies. It involves investment in public transport, creating green public spaces, and improving urban planning and management in participatory and inclusive ways. The 2030 Agenda for Sustainable Development recognizes the interconnectedness of contemporary challenges and the need for comprehensive and participatory approaches to address them. That is why building inclusive societies by focusing on city safety and resilient government lies at the heart of the United Nation's work at the urban level.

Extreme poverty is often concentrated in urban spaces, and national and city governments struggle to accommodate the rising population in these areas. Making cities safe and sustainable in Nigeria must incorporate slum settlements upgrade and ensure access to safe and affordable housing for all, these housing as space for different human and other activities which are products of architecture. Also, the quality of public realm and sustainable urban transport infrastructure needs to be provided and improved. As human, there is a dare need to reflect on

how we live, and for the professional architect, it is apropos to ask; if the present role in the society is setting the veracious foundation required to transform the Nigerian cities to achieve the set sustainable development goal? It draws a conclusion to the urgent need to recreate urban centres to achieve all the 17 sustainable goals by the year 2030 and the architect's role is indispensable towards this course.

Definition of Sustainable cities

Sometimes referred to as eco-city, it is a city designed with consideration for social, economic, environmental impact (commonly referred to as the triple bottom line), and resilient habitat for existing populations, without compromising the ability of future generations to experience the same. These cities are inhabited by people dedicated to minimizing the inputs of environmental resources, energy, water, waste and output of heat, air pollution and water pollution etc. Richard Register first coined the term "*ecocity*" in his 1987 book *Ecocity Berkeley: Building Cities for a Healthy Future*, where he offered innovative city planning solutions that can be applied to many cities. Other prominent researchers who envisioned the sustainable city are architect Paul F Downton (2009), Timothy Beatley (1997) and Steffen Lehmann (2009), and they have also written extensively on the subject with varying definitions of the term depending on their area of specialization.

However, from the review of published literature, there remains no completely agreed-upon definition for what a sustainable city should be or completely agreed upon paradigm for what components should be included. Generally, developmental experts agree that a sustainable city should meet the needs of the present without sacrificing the ability of future generations to meet their own needs. Put succinctly, it can be inferred that it is a city that minimizes the inputs and outputs. This means that they use fewer resources and create less waste. The ambiguity within this idea leads to a great deal of variation in terms of how cities carry out their attempts to become sustainable.

Ideally, a sustainable city creates an enduring way of life across the four ecological, economic, political, and cultural domains. The Goals of a sustainable city are to be able to feed itself with a sustainable reliance on the surrounding natural environment and have the ability to power itself with renewable sources of energy. The central focus of the context is to create the smallest conceivable ecological footprint while also producing the lowest quantity of pollution achievable. All of this is to be accomplished by efficiently using the land in ways such as composting used materials, recycling, and/or converting waste-to-energy. The idea is that these contributions will lead to a decrease of the city's impact on climate change.

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

The built environment is important to the development of sustainable cities and communities. To date, the trend towards urbanization has been accompanied by increased pressure on the environment and accelerated demand for basic services, infrastructure, jobs, land and affordable housing, particularly for the nearly 1 billion urban poor who live in informal settlements. To make cities and human settlements inclusive, safe, resilient and sustainable, United Nations has defined 10 Targets and 15 Indicators for SDG 11. Targets specify the goals and indicators represent the metrics by which the world aims to track whether these targets are achieved. Below are the SDG 11 targets as set by United Nations.

11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums

- 11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, elderly and persons with disabilities.
- 11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
- 11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage
- 11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
- 11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
- 11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities
- 11.a Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning
- 11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels
- 11.c Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials.

The place of architecture in SDG 11

SDG 11 talks about sustainable cities and communities. Cities are made up of inhabitant and infrastructure that supports their existence made of buildings and structures. On the other hand, Architecture is a field of study for planning and ordering of the built environment through ensuring design safety and functionality (Okeke et al, 2019). The Architects Registration Council of Nigeria (ARCON) CAP A19 Architects Act, Laws of the Federation of Nigeria, 2004 defines "Architecture as the art and science in theory and practice of design, erection, commissioning, maintenance and management and coordination of all allied professional inputs thereto buildings, or part thereof and the layout and master plan of such building or groups of buildings forming a comprehensive institution, establishment or neighbourhood as well as any other organized space, enclosed or opened, required for human and other activities;" It is directly influenced with the trend in the environment as it stems to provide solution to mishaps in the environment like global warming. Shelter, constituting of architectural building is one of the three basic necessities of life after food and clothing; that is why its absence or inadequacy is viewed with serious concern. However, the International Energy Agency released a publication that reveals that existing buildings are responsible for more than 40% of the world's total primary energy consumption and for 24% of global carbon dioxide emissions (Howe, 2010), accounting for roughly a quarter

of the world greenhouse gas emissions. With daily human activities revolving around buildings and structure, there is currently a real appetite for sustainable architecture globally and particularly in tropical Nigeria where we experience extreme weather conditions, resources depletion and environmental degradation. Below is the average performance of Nigeria in the attainment of the SDGS.

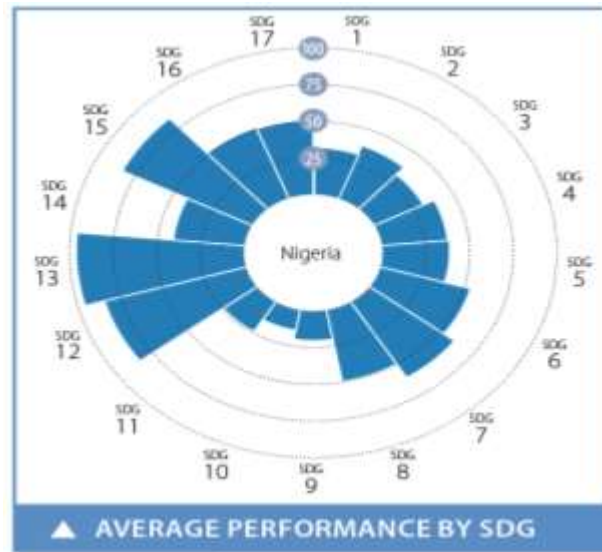


Figure 1: Nigeria SDG Index and Dashboards Report 2019

Source: United Nations (2019)

According to Africa Sustainable Development Goals (SDG) Index and Dashboards Report 2019, Nigeria ranks 43 out of 52 countries with a score of 47.03% (Nnaemeka-Okeke et al, 2020) which is very poor and the statistics demonstrates that progress are being made in SDG 13 (climate action), SDG 12 (responsible consumption and production) and SDG 15 (life on land). Consequently, SDG 9 (infrastructure), SDG 10 (reduced inequalities) and *SDG 11 (sustainable cities and communities)* face the greatest challenges in Nigeria. Architecture places much emphasis on SDG 11; (sustainable cities and communities) because this is the product of the built environment and it is made up of buildings and structures designed by man (architects). The statistics present that Nigerian cities lack sustainability and it invariably indicates that the building designs are not sustainable structures or can be said that sustainable design practise is at its infancy. Furthermore, the energy demand in Nigeria outweighs energy power supply, thus compelling building occupants who spend approximately 90% of their daily life indoors to depend on mechanical air conditioning, resulting to building becoming the largest energy consumers in Nigeria and impacting negatively on the environment. The available housing stock and infrastructure is a reflection of the image of a city and its public realm and it beholds on architecture and urban planning to address the factors that negate sustainable development. Urban image in this context refers to the way a city is perceived both by the citizens and foreigners. This image is based on reality on a city's physical attributes and on the human perception of those attributes and very important to the strength of a city.

The role of the architect towards achieving sustainable cities and communities in Nigeria

Buildings provide the infrastructure for a functioning city and allow for many opportunities to demonstrate a commitment to sustainability. According to Chendo (1990) the architect by the

nature of the training he has acquired, has solutions to every problem relating to the environment. The implication is that he has the challenge to improve the standard of living of the people by the practise of his profession. Since it has been established that human daily activities revolving around buildings and structures, thus the architect's role to achieve sustainable cities and communities include:

- To reduce the embodied energy of building materials and one way to achieve this is by reduction of the amount of transportation of building materials over long distances by land and sea through the development of local manufacturing industries, and the abolishment of plastic wrapping of building materials to reduce the source of non-biodegradable waste that ends up in water ways and leads to blockages or cause environmental pollution.
- Building designs as well as layout of settlements and urban areas are very important to curb the spread of diseases and exposure to pathogens. According to Udeh & Okeke (2018) one of the critical problems facing the Nigerian cities has been that of deteriorating living conditions leading to increased death rate and diseases caused by pollution and poor sanitation. Therefore, architects should consider Lighting, ventilation, acoustics, air quality and solar radiation as crucial issues in a building design for healthy indoor climate and user comfort.
- Nigeria is in the tropics where there are extreme weather conditions of dry and rainy seasons, architects therefore are to analyze the given geographical, climatic and cultural conditions, and to design the built environment accordingly to reduce energy consumption through optimal building layout and the built environment selection to minimize the excessive heating and ensure energy recycling, by storing excess heat during the day and employing it at night.
- Architects should support society's expression of its values through buildings and public spaces which are inclusive, welcoming, secure, and non-discriminatory. As the prime consultant in the building industry and project manager, they must from design to construction stages avoid a narrow-gendered work culture to promote diversity, equality and ownership so that more women can join and get involved in community development services. Also buildings, settlements and urban areas must be designed with accessibility as a core functionality, it must be inclusive to all citizens regardless of gender to avoid marginalization and condition of city fragility.
- Statistics has it that Lagos state has the highest number of building collapse in Nigeria due the near location to the coastal waters coupled with low soil bearing capacity and high rate of urbanization leading to increased demand for accommodation with short housing supply. Other States of the federation with relatively good soil bearing capacity usually experience increased cases of building collapse during the rainy season resulting from heavy rainfall. Therefore, architects must ensure that buildings and urban areas are designed so that rainwater can be collected, purified and used as drinking water and other domestic purpose rather than letting it wash away building foundation. The design of the built environment should be targeted to withstand the climate change related to water, including extreme precipitation, drought and floods. Furthermore, Landscape architecture and urban planning should as a matter of urgency protect freshwater resources through conservation projects and the design of recreational areas that protect, collect and handle water.

- Buildings, settlements and urban areas must be planned so that they allow and encourage physical activities and reduce risk of accidents especially in traffic. Safe public spaces & affordable transit routes to the workplace are crucial for finding employment. Since all commercial activities takes place in one form of organised space, workplaces should be designed as a healthy & productive space for employees, customers and general public as this promotes good working relationship and sustainability in business.
- Landscape Architects must ensure that pollutants like pesticides, nitrogen and human waste are handled on site and do not reach the groundwater or the oceans and develop sustainable solutions that reduce cost and add benefits to water-managing infrastructure. The use of environmental hazardous materials & substances should be avoided in building design projects.
- The architect must pay close attention to tendering, procurement and construction processes in order to discourage all forms of organized crime, as well as frauds and contribute by sharing knowledge, promoting sustainable solutions and engage in collaboration with research and institutional partners for the effective implementation.
- The role of local government is vital as this is the layer of government closest to the people, and it often has significant decision-making and spending power. Therefore, architects in local government town planning authority and building plan approval offices should grant building permit only to development projects designed and supervised by registered and certified built environment professional in accordance to design standards and available legislation.
- Many cities in the developing nation are rapidly urbanizing, the architect has a role to develop resilient building and settlements in the face of also other environmental challenges like climate change and include green areas to help counteract the loss of vegetation and biodiversity caused by urban growth. They are also to apply region specific building design that ensure environmental responsiveness.
- The architect's specifications and working drawing should aim for utilization of the local industries to developing sustainable products locally. The focus must be from a no waste in production to a focus on lifecycle perspective. It does not only encourage environmental friendliness but also create jobs for the locals and boost the cities GDP.
- Architects in the public sector should enact policies for the provision of affordable and healthy living environment as well as infrastructure that helps to reduce pollution from transportation, and enhance non-motorised mobility and accessibility between parts of a city, as well as between cities, rural areas. Slum clearance and advocacy programme to enlighten the populace should be initiated with sustainable construction measures enforced as the best practices.

Conclusion

The challenges Nigerian cities face can be overcome in ways that allow them to continue to thrive and grow, while improving resource use and reducing pollution and poverty. The future Nigerian cities should have equal opportunities for all, with access to basic services, energy, housing, transportation and more. However, since the world's population is constantly increasing and urbanization of many cities in the developing nations like Nigeria is rising, *to accommodate and address these problems, architects need to build modern sustainable cities with intelligent urban planning strategies that create safe, affordable and resilient cities with green and*

culturally inspiring living conditions. This can be achieved through a Participatory and an all-inclusive design process involving of all the stakeholders.

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Chapter 11

Sustaining Investment on Adequate Nutrition: A Panacea for Sustainable Development Goal - Two

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Abstract

This work looked at how sustained investment in adequate nutrition can be used in the achievement of all the nutrition targeted sustainable development goals (SDGs). Without good nutrition, the mind and body cannot function well. When that happens, the foundations of economic, social and cultural life are undermined. Eating healthy diets contribute to preventing malnutrition, future illnesses and in leading healthy life styles. SDGs are goals set by United Nations for the global community to consolidate on past commitments to improve peoples' health. These goals will also help global partnerships in a new spirit of solidarity, cooperation, and accountability. Malnutrition is not just a lack of sufficient and adequate nutritious and safe food, but from a host of interacting processes linking health, care, education, sanitation and hygiene, access to resources, women's empowerment and more. Good nutritional status leads to higher individual earnings and mental acuity, which in turn support macroeconomic and societal growth. Adequate nutrition sits at the core of global development and without adequate and sustained investments in good nutrition; the SDGs will not be realized. It is such a component through which to consider how actions taken to address one or more SDGs would translate into improved health, and how these would support attainment of other individual goals. A better understanding of the multidirectional relationships among nutrition and the SDGs requires acknowledgement of the multifaceted nature of nutrition. The opportunity created by the SDGs must be utilized to invest in adequate nutrition for our future generation regardless of ethnicity, gender, race or other status.

Keywords: Get nutrition right, change bad habits, health improves

Introduction

Nutrition is one of the hottest topics whenever health of people is discussed. What we eat and drink can affect our health, our happiness, our wallets and our environments. Nutrition is indeed, a characteristic of the quality of an individual's diet in relation to their nutrient needs; and it is a benchmark or metric against which the effectiveness of numerous development goals is assessed (United Nations Sub Committee on Nutrition (UNSCN), 2014). It is life and health but combating mal-nutrition requires a multi-disciplinary and multi-sectoral approaches. It is a fundamental right of all every individual and a major component of the SDGs. The world at large is interested in better health of all people and has initiated Sustainable Development Goals (SDGs). The SDGs is an international policy framework which provides a roadmap to end

poverty, provide health and prosperity for all while protecting the planet. It represents a common framework of international cooperation to promote the desired development that can be sustainable. The SDGs were set by the United Nations General Assembly in 2015 for the year 2030. This policy framework provides a shared blueprint which calls for a global partnership and ranges from reducing global poverty and hunger, to tackling climate change and preserving the environment in which we live in. The SDGs are inter-linked. They are an integrated indivisible set of priorities that build on the unfinished business of the Millennium Development Goals (MDGs). Like the MDGs, the SDGs are synergistic; that is, they represent neither a sequential order of proposed actions, nor a ranking of urgency, they are mutually supportive and of equal priority (UNSCN, 2019). Furthermore, the relationships among SDGs are multi-directional. That is, a reduction in inequality within nations (supportive of SDG10) would need to involve gender equality (SDG5), and vice versa. Similarly, if production patterns can be nudged in the direction of sustainability globally (SDG12), this will support the achievement of food security (SDG2), and vice versa. In other words, most elements of the agenda represent both inputs to, and outcomes of, the overall objective (Webb and Block, 2012).

Adequate nutrition is important for human, national and global development. Poor nutrition is influenced by several socio economic factors including food insecurity attributed to poverty and war. About 800 million individuals globally are suffering from hunger caused by poverty with 43 million in Europe Union being unable to afford regular quality meals every second day (Sachs, Schmidt Taraub, Kroll, et al., 2019). Nutrition is an important pillar of efforts designed to facilitate achievement of sustainable development goals and all the SDGs are all related to nutrition directly and indirectly as none can be achieved without nutrition. It is noteworthy that achieving several SDGs is also crucial for achieving the nutrition goals as it is an important factor that crosses all the SDGs in one way or another. Although, the need for better nutrition in all forms was ultimately recognized in SDG2, improving nutrition goes beyond SDG2 alone and is linked to each of the SDGs and can play a transformational role in driving sustainable development. Achieving SDG2 will depend on progress across many of the other SDGs, including those aimed at education, wealth and gender equality etc. The SDGs are 17 with 169 targets that balance the economic, social and ecological dimensions of sustainable goal. Each SDG has its targets to realize the achievement of the seventeen set goals however, for the purpose of this document, SDGs (1, 2, 3, 4, 5, 6, 8, 12 and 17) which directly requires nutrition input to be achieved, will be discussed in details while a table that summarizes all is attached as an appendix.

SDGs that Need Sufficient Sustained Investment in Adequate Nutrition

SDG 1: The first goal is **End poverty in all its forms everywhere**. The international aid debate defines poverty as multiple deprivations of basic capabilities: economic, human, socio-cultural, political and protective. Poverty limits access to adequate food intake due to low purchasing power of adequate and nutritious foods and even food production. This makes it difficult for such poor individuals to meet their nutritional requirements. Ending poverty will encourage improvements in access to adequate nutrition, reduced morbidity, mortality, school dropout rates, improve attention span in schools, personal safety and health care seeking behaviour. This, in turn enhances the prevention, detection and management of diseases. It will also reduce the incidence of catastrophic health expenditure resulting from diseases that affect people's economy, ensure healthy lives and promote well-being for all at all ages. Improving nutrition is

essential to eradicating poverty and accelerating the economic growth of low- and middle-income countries.

The effects of malnutrition are long-term and trap generations of individuals and communities in the vicious circle of poverty (World Health Organization (WHO), 2013). Evidence has shown that the mental impairment caused by iodine deficiency is permanent and directly linked to productivity loss. The loss from stunting is calculated as 1.38% reduced productivity for every 1% decrease in height while 1% reduced productivity is estimated for every 1% drop in iron status (Prado, 2014). On the national and global scale, the economic cost of malnutrition is estimated to range from 2-3 percent of Gross Domestic Product to as much as 11% in most sub-Saharan Africa (World Bank, 2006). Furthermore, it is estimated that each dollar invested in nutrition yield about 24.4-26.6 USD in Nigeria (Hoddinott et al., 2013). Under nutrition and non-communicable diseases have been reported to significantly increase health costs in resource constrained health systems which places a huge financial toll on the individuals, families or nation to avoid live above \$1.25 per day. Hence, these evidences are a proof that synergy exists between poor nutrition and poverty. Improving nutrition is essential to eradicate poverty and accelerate the economic growth of low- and middle-income countries. Thus, countries will be unable to break out of poverty and sustain economic advances without ensuring that their populations are adequately nourished on a sustainable basis.

SDG2 End hunger: The role of nutrition in sustainable development goals was well recognized in SDG goal 2. Extreme hunger and malnutrition remain huge barriers to development in many countries. The SDG2 aims to end all forms of hunger and malnutrition by 2030, making sure all people especially children have sufficient and nutritious foods for eating all year.

Hunger is an uncomfortable or painful physical sensation caused by insufficient consumption of dietary energy. Statistics show that hunger continues to be a dramatic problem in developing and emerging countries as about 820 billion hungry people, also 24,000 people across the world die every-day from hunger or hunger-related causes (FAO, 2017). Examining the progress towards Sustainable Development Goals (SDG) aimed to end hunger and all forms of malnutrition by 2030, although there is concern that on the current trajectory, this goal will not be met (FAO et al., 2017). The world has seen approximately only a 4 percent decline in prevalence over the past decade – from 14.1% to 10.7% (FAO et al., 2017). The Food and Agriculture Organization of the United Nations (FAO) defines food deprivation, or undernourishment, as the consumption of fewer than about 1,800 kilocalories a day—the minimum that most people require to live a healthy and productive life (FAO , 2018). Under-nutrition on the other-hand goes beyond calories and signifies deficiencies in any or all of the following: energy, protein, or essential vitamins and minerals. Under-nutrition is the result of inadequate intake of food—in terms of either quantity or quality—poor utilization of nutrients due to infections or other illnesses, or a combination of these factors. The majority of the world’s hungry people live in the developing countries, where 12.9 percent of the population is undernourished (<https://www.un.org>). Unsustainable food production and inadequate feeding cause hunger and undernourishment.

Achieving food security, improved nutrition and sustainable agriculture will help to end hunger. Healthy and sustainable nutrition will improve food satiety, reduce hunger and may reduce premature death including from non-communicable disease which also affect ability of individuals to plant foods. FAO (2010) defined “sustainable diets” as those diets with low environment impacts that contribute to food and nutrition security and to healthy lives for present

and future generations. Sustainable diets are protective and respectful of biochemistry and ecosystems, culturally acceptable, accessible economically fair and affordable are nutritionally adequate, safe and healthy and optimize natural and human resources. These foods are what people have eaten for thousands of years up until 20th century. Adequate food availability, accessibility and stability will provide household food security and dietary choices. Increase in food value chain from agricultural production to individual food intake should be encouraged. To properly end hunger, everybody should be encouraged to go back to farming in form of land/food cultivation, individually and commercially eg goat rearing, poultry, snail, piggery etc. This will help average families have reasonable quantities of food to eat from and consequently prevent hunger as expected in SDG2.

Data from world bank and IFRI has also shown that hunger eradication will be achieved by improving agricultural productivity in the context of climate change (Impact model from IFPRI); ending hunger by targeting vulnerable households (MIRAGRODEP model from IFPRI); and reducing under-nutrition through select nutrition interventions (Investment Framework for Nutrition from the World Bank). Global Panel (2014) has argued that actions to address not just agricultural productivity but improvements throughout the food and healthcare system represent critical opportunities for reducing malnutrition. Food insecurity we are witnessing today also contributes to overweight and obesity; thus, food security is a pre-requisite for nutrition security. The evident impact of nutrition on work capacity signifies that malnourished or sick individuals lacks the propensity to be actively engaged in the food chain, which undermines the efforts to improve agricultural yield, ensure food security and ultimately end hunger. Food choice is also targeted and it is selecting food that could be afforded and adequate. The approach to eradicate hunger should be addressed from a nutrition perspective which extends beyond minimum caloric requirement. National and global evidence shows that ensuring an adequate food supply is still an important contribution to eradicating hunger. The fact that hunger still persists despite the world hitting a new record by producing over 2.5 billion metric tons of cereal grains—up from 1.8 billion tons 20 years earlier is indication that an increased supply of food alone is neither the solution to hunger nor an answer to malnutrition (FAO, 2016). The followings are then desired:

1. **Ensure food security:** Food and Agriculture Organization noted that food security exists when all people at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (http://www.fao.org/wfs/index_en.htm). Amechi (2018) defined sustainable food security as when people have physical and economic access to sufficient food to meet their dietary needs for a productive healthy life at present as well as in the future. This means that food security involves a production of diverse, safe and nutritious food that can sustain the consumption demand of the population and ensure that availability of food is backed by consumers purchasing ability to acquire desired food varieties that promote their well-being and wellness (IITA, 2019). Food availability means the physical existence of a sufficient quantity of food of appropriate quality, and is determined by domestic food production, domestic stocks, food imports, and/or food aid. Food access can be achieved through adequate income or resources that allow the purchase or acquisition of appropriate food products for a nutritious diet. However, adequate food supply does not necessarily guarantee household or individual level food security, as lack of access to food is often a greater problem than availability, particularly for the most malnourished (Amechi, 2018). As for food utilization, it refers to the process through which the body utilizes various nutrients in the food. It also requires proper food preparation and hygiene practices, sound eating habits, a diverse diet which necessitates availability of all essential nutrients, and

proper intra-household distribution of food. The purchasing ability of individual/household is backed by their human capital potential, malnourished persons are less active/productive which influences their earning capacity. The loss from stunting is calculated as 1.38% reduced productivity for every 1% decrease in height while 1% reduced productivity is estimated for every 1% drop in iron status (Hoddinott, Alderman, Behrman, Haddad, Horton, 2013).

Nutrition discipline is critical to ensuring food security because even if food is available, affordable and accessible but not considered safe or/and nutritious for human consumption, then food security has not been achieved. Thus, nutrition is at the core of the integral components of food security. With regard to food availability, enhancements can be made to improve the quality and quantity of nutrients within foods. Food accessibility can similarly be improved by explicitly focusing on access to nutritious food. Improvements to a farmer's own production, to the purchase of food, or to food received through assistance programs should focus on the provision of safe and nutritious food (Hwalla, 2015). A major pillar of food security with nutrition significance is the utilization pillar. Barrett (2010) explained the importance of the dietary quality of available food. Utilization reflects concerns about whether individuals and households make good use of the food which they have access. Presence of metabolic diseases/infections or the bio-availability of food will affect the absorption and uptake of the nutrients consumed (Ivers et al., 2009). To achieve food security holistically, nutrition cannot be neglected at any form or stage.

2. Improving nutrition: Food security is a necessary but not sufficient condition for optimal nutrition. People also need to have a sanitary environment, adequate health, education and care (including breastfeeding) to have food and nutrition security. Therefore, nutrition security is recognized as the need to secure access to an appropriately nutritious diet, comprising all essential nutrients and water, coupled with a sanitary environment and adequate health services and care practices to ensure a healthy and active life for all household members (FAO, 2012). Concerns have been growing recently over the aspect of over-nutrition in sub-Saharan African: overweight and obesity in addition to existing under-nutrition and micronutrient deficiency burden. This is mainly, due to the over-consumption of energy-dense foods (and especially empty calories) as well as other factors, such as insufficient exercise, lifestyle habits and genetics. Together, these lead to diet-related diseases such as type 2 diabetes and cardiovascular disease.

3. Promoting sustainable Agriculture: Aside from the well-established input, agriculture plays in improving nutrition, it should also be recognized that nutrition is also fundamental to the promotion of sustainable agriculture and food system (Pinstrup-Anderson, 2011). Impaired cognition and reduced work productivity resulting from stunting and iron/iodine deficiency is a proven cause of poor labor input and lowered adoption of improved technology (Pinstrup-Anderson, 2011; Amechi, 2018). Therefore, a well-nourished work-force supports productive agriculture. The nutrition impact on sustainable agriculture is drawn from the need to produce, process, store and distribute agricultural yield which possess optimal quality in terms of nutritional value, bio-availability, functional characteristics. Different systems have different requirements if they are to be nutrition-friendly and sustainable (IFR Industrial systems need to increase fresh food consumption and rebalance protein sources away from certain animals. In addition to applying a nutrition lens to food systems, it is important to understand how they are increasingly threatened by (as well as contribute to) ongoing environmental trends, including

global warming, desertification, and the increasing use of food crops for nonfood purposes. Increasing demands for energy-intensive products also exacerbate environmental impacts of food value chains: industrial agriculture, intensifying production of high-yield starchy staples through monoculture agriculture, leading to significant loss of food biodiversity; excessive use of agricultural chemicals to extract more dietary energy from every hectare while contaminating the very food it produces, along with groundwater and the soil; and the greenhouse gas emissions from livestock industries to feed the ever-increasing demand for meat and dairy products (Pingali et al., 2015).

The effects of malnutrition are long-term and trap generations of individuals and communities in the vicious circle of poverty. Evidence has shown that the mental impairment caused by iodine deficiency is permanent and directly linked to productivity loss. The loss from stunting is calculated as 1.38% reduced productivity for every 1% decrease in height while 1% reduced productivity is estimated for every 1% drop in iron status ((Hoddinott et al., 2013; Amechi, 2018). On the national and global scale, the economic cost of malnutrition is estimated to range from 2-3 percent of Gross Domestic Product to as much as 11% in most sub-Saharan Africa (World Bank, 2006). Furthermore, it is estimated that each dollar invested in nutrition yield about 24.4-26.6 USD in Nigeria (Hoddinott et al., 2013). Under nutrition and non-communicable diseases have been reported to significantly increase health costs in resource constrained health systems which places a huge financial toll on the individuals, families or nation to avoid live above \$1.25 per day. Hence, these evidences are a proof that synergy exists between poor nutrition and poverty. Thus, countries will be unable to break out of poverty and sustain economic advances without ensuring that their populations are adequately nourished on a sustainable basis.

SDG3: “Ensure healthy lives and promote well-being for all at all ages” but can’t be without adequate nutrition input. This goal is translated into 13 targets: three are related to reproductive and child health; three to communicable diseases, non-communicable diseases, and addiction; two to environmental health; and one to achieving universal health coverage (UHC). Four further targets relate to tobacco control, vaccines and medicines, health financing and workforce, and global health risk preparedness. When all these are supported by strong public health policies and with aligned efforts across social, economic, and political domains, primary health care, achievement of sustainable development is ensured. Primary health care programmes include nutrition education that helps to improve the nutritional status and dietary choices of people which are also essential to maintain good health. Health is not achievable without good nutrition. Wellbeing improvements in maternal nutrition help to reduce the frequencies of low birth weight and preterm birth which indirectly reduces the risk of diseases. A malnourished health worker cannot give quality care because of lack of energy, disease frequencies, hospital admissions and expenditure on medics. The Double burden of malnutrition which is characterized by the coexistence of under nutrition along with overweight and obesity or diet related non communicable diseases within individuals, households and populations and across the life course prevent healthy living for all. Evidence has shown nutrition must be fully incorporated into national health planning as it is integral to ensuring healthy lives. About half of all childhood deaths have been associated with under-nutrition (WHO, 2011). It has been further estimated that if optimum nutrition is practised as recommended, up to 19% or 220, 000 of under-5 deaths would be averted each year (Bhutta et al., 2013). Overweight and NCDs account for about 46 percent of the global burden of disease and about 60 percent of total global deaths, 79 percent of which occur in developing countries.

The Global Burden of Disease Study (GBD) which is the most comprehensive worldwide observational epidemiological study showed that childhood malnutrition was identified as the number one risk factor for DALYs (disability-adjusted life years) and years of life lost (YLL) and the number seven cause of death in 1990. In 2010, it dropped to number eight for DALYs and number sixteen cause of death (Lancet, 2010). Suboptimal breastfeeding, once number five burden for DALYs, dropped to number fourteen in 2010. Despite the drop, nutrition still occupies a critical role in understanding the global burden of disease, although factors related to under-nutrition have mostly decreased in importance in the rankings. Many factors related to over-nutrition and malnutrition have arisen through the rankings including high body-mass index and low consumption of fruit and whole grains, the main anthropometric measure used to assess overweight and obesity, rose from 52 million to 94 million DALYs (Lim et al. 2012). Vitamin A deficiency and zinc deficiencies have become less of a risk factor, iron deficiency is still the number one risk factor for YLD (Lancet, 2010). Resolving all forms of under nutrition and obesity would dramatically reduce the social burden of sickness and premature death, and the economic burdens of lost productivity and burgeoning health care costs that face virtually every country in the world (United Nations Sub Committee on Nutrition, 2014). Appropriate investments in the first 1,000 days (from pregnancy through the first two years) will yield benefits not only for that child's lifetime, but across generations (Black et al. 2013). Effective prevention and management of diseases also has food and nutrition security for sustainable eating. Food and nutrition security exist FAO (2010) defined "sustainable diets" as those diets with low environment impacts that contribute to food and nutrition security and to healthy lives for present and future generations sustainable diets are protective and respectful of biochemistry and ecosystems, culturally acceptable, accessible economically fair and affordable are nutritionally adequate, safe and healthy and optimize natural and human resources. Addressing all forms of under-nutrition and obesity would dramatically reduce the social burden of sickness and premature death as well keep people healthy as expected by SDG3. Healthy living also improves early screening for, prevention, diagnosis and treatment of nutrition related disease and general health.

SDG: 4 Ensure inclusive and equitable quality education for all and promote life-long learning: A popular slogan says that 'ignorance is a disease'. Malnutrition affects learning abilities, while lack of awareness may affect healthy and sustainable food choices. Everybody deserves to be educated generally formally (within the four walls of an institution) and informally as education liberates the mind. Nutrition is a discipline for scientific study of how food is utilized in the body. Nutrition education is all about the right nutrition and food practice. It should be taught at all levels of education from primary to tertiary and for everybody (both male and female) in addition to general education to allow responsible eating be part and parcel of every citizen. Public health nutrition programmes done to promote community nutrition education, healthy lifestyles and vaccinations could also reduce the risk of nutrition related deficiency diseases. Education, decent work and economic growth (SDG 8) including social interaction have also been associated with better diet quality. In a study by Okoli in 2011 on assessment of nutritional status among child bearing women, consumption of low-quality foods (energy-dense and nutrient-poor) was also found to be common among lower socio-educational classes and may be driven by poorer accessibility to, and/or non-affordability of higher quality foods, among other factors. To achieve inclusive and equitable quality education for all and promote life-long learning, adequate nutrition is needed.

Nutritional deprivations affect brain development from the last trimester of gestation until the second year of postnatal life (Prado, 2014). Children who are more affected by stunting early in their lives have poorer test scores on cognitive assessments and activity level (Glewwe et al. 2001; Alderman et al. 2006). The negative consequences of iron-deficiency anemia on cognitive and physical development in children and reduced work capacity in adults are well documented (WHO, 2011). Iodine deficiency is associated with mental impairment of students by reducing 13.5 -15points of the intelligent quotient (IQ) of the affected population (WHO, 2013). Resolving iron, iodine and other nutrient deficiencies supports mental capacity (United Nation Subcommittee on Nutrition, 2014). A global prevalence of 2 billion people and 31.5% of school aged children with iodine deficiency emphasizes the inevitable role nutrition has to play (WHO 2013). Apart from the impact of nutrition on academic and cognitive performance, national reports have revealed that school feeding program in Nigeria increased school enrolment by 20% in 31 states between 2016-2018 (Edeh, 20019). Another study laid credence to impact of school feeding program to not only school enrollment but retention, regularity and punctuality in a state in south-western Nigeria (Taylor and Ogbogu, 2016). Good nutrition provides for good studentship, and access to education and learning generates improvements in caring practices, dietary choices and nutrition outcomes (Ruel and Alderman 2013). No nation can afford to waste the latent capabilities of its citizens on a scale. As a result, the benefits of good nutrition for education require that actions to promote good nutrition be taken long before schooling begins. In the words of UNSCN, (2016), improving linear growth for under2s by 1 Standard Deviation adds half a grade to school attainment.

SDG 5: Gender equality, women and girls’ empowerment: The global concern on achieving gender equality stems from the evident marginalized or disadvantaged roles being accorded to women in the society. The recent global nutrition report published in 2020 acknowledged that there are marked differences in nutrition outcomes, or nutrition inequalities, by key socio-demographic characteristics, such as gender, geographic location, age, ethnicity, education etc. and calls for an inclusive approach to ensure that everyone has fair access to the resources and services they need to achieve optimal nutritional health (Global Nutrition Report, 2020). This goal is important to allow women and girls claim their rights to improved quality life. Proper nutrition improves learning performance, which can be translated into better job opportunities. Malnutrition limits powers of individuals by diminishing livelihood skills and options. This makes it harder for individuals to seize new opportunities in a globalizing world (world (United Nation & Sub Committee on Nutrition, 2014). Because of the perceived gender gap in resource allocation in Nigerian household, women and girls are not better equipped to compete without their equipped. On the reproductive potential of women, malnutrition poses a variety of threats to women. It weakens women’s ability to survive childbirth, makes them more susceptible to infections, and leaves them with fewer reserves to recover from illness (Rae et al., 2002). Malnutrition is related to gender in so many ways.

The Sustainable Development SDG5 challenge the global community to build a world where no one is left behind confirming that world must run an all-inclusive government. In Africa and other developing countries of the world, men still take major decisions about women’s health and nutrition (Alamayehu, 2017). Many households in developing countries still do not give women power to decide how food and other resources should be distributed among household members including their children, herself and her father’s place. Positive male role models can enable more equitable distribution of household nutrition, health seeking behaviours, care giving or medicare purchases. Women still lack assertive rights to say ‘NO’ in sexual functions too and

this may affect her health in pregnancy and child bearing (Alamayehu, 2017). Reductions in the numbers of pregnancies and increases in pregnancy spacing that increase mother's health, reduce the incidence of the low birth weight, prematurity and pregnancy-related complications that are all risk factors for malnutrition in women and adolescent girls (Alamayehu, 2017). Men still decide on major issues involving foods among the rural illiterate wives, women and girls. All these are impediments as a result of lack of equality. Addressing gender can also help to end intergenerational malnutrition.

The need to adopt policies that reduce nutritional inequities among women and girls and eliminate discriminatory laws and practices that jeopardize their nutritional status (eg., early marriage, widowhood practices, female genital mutilation, house help, female trafficking, rape etc) can never be over emphasized. Other factors that can negatively impact women and children's nutrition in Nigeria include: heavy work - burden on women , large age difference between the wife and her poor husband, bad role of the mother-in-law, polygamous relationships (e.g. children or the wife who is "less important" , having no suitable substitute caregivers in families (due to low income/pressure to work), cultural norms (e.g. around breastfeeding), making it important to engage men and other members of the household (e.g. mother-in-laws) in nutrition education, gender-based violence (World Health Organization: Global Database on Child Growth and Malnutrition: <https://www.who.int/nutgrowthdb/en/>). On the other hand, factors that can positively impact women and children's nutrition include: older maternal age, higher maternal education, women's exposure over their lifetime to paid employment, women's ability to make decisions for domestic purchases and when to seek health care (World Health Organization: Global Database on Child Growth and Malnutrition: <https://www.who.int/nutgrowthdb/en/>).

Addressing women's malnutrition has a range of positive effects because healthy women can fulfill their multiple roles — generating income, ensuring their families nutrition, and having healthy children — more effectively and thereby help advance countries socioeconomic development (Elder and Ransom, 2003). Undernourished girls and women are often least able to take advantage of development resources on offer (be it microcredit, schooling or paying jobs) because of lower work capacity, sickness (Duflo, 2012) to help have purchasing power and maintain good health. Advancing gender equality and women's empowerment is desirable to improve health on long run by supporting integrating "gender smart" decision-making into their investment processes and operations. If women are empowered, they can attain their potentials in food production, purchasing power of nutritious foods, food preservation, food preparation and caring practices of their household members. The girl child needs education to make life decisions and be able to contribute to national economy and other life strategies, give better care in the families and communities. In communities and households where there is equity, they serve to catalyze and sustain improvements in nutritional activities.

SDG 6: Ensure access to clean water availability and sustainable management of water and sanitation for all: Water is considered as part of food and it is needed at all times. Improved nutrition leads indirectly to improved water and sanitation through increased demand. As all forms of nutrition improve, which leads to the associated benefits of demand for higher food quality, education, preventative health-seeking behaviours, and a voice in development, there is greater household exposure to, and practice of, appropriate hand washing practices, food and personal hygiene, and sanitation. This results in demand for clean water and effective personalized sanitation. As poverty falls, consumers (urban and rural) understand and afford the benefits of private access to hygienic resources and facilities (UNSCN, 2014). Food security

leading to more food preparations lead to requisition of safe drinking water and sanitation. These may lead to reductions in the incidence of food poisoning from contaminated foods. Water borne diseases and diarrheal illnesses that may cause nutrition related deficiency diseases are common in most rural and sub urban areas with poor hygiene.

Adequate and safe adequate food production is essential in attaining water supply and also drought will not be allowed to affect quantity of crop yield. Clean and enough water is needed for general cleaning of machines and utensils.

There is a nexus between water, energy and food security/ adequate nutrition. A lot of women in rural areas spend a lot of energy to fetch water to prepare foods for their family and this also boils down to nutrition. Where women have no other option and have not eating well, they may lack enough energy to traditionally provide or buy (money already spent on foods) safe water to process and cook food. Food availability and good nutritional status help water demand. The knowledge that infectious diseases were caused by harmful bacteria in the environment allowed preventive measures to be developed to exclude them. For example, untreated water supplies were a common source of infection, including cholera, but the treatment of water by sterilizing it before use caused the destruction of all harmful bacteria that could have affected the nutritional status further limiting the resources for provision of safe access to clean water and sustainable management of water and sanitation for all.

SDG 8: Promote inclusive and sustainable economic growth, employment and decent work for all. Adequate nutrition accelerates economic, employment and decent work potentials because it liberates mind and thinking faculties and thus increases public awareness of proper nutritional standards and habits. A well-nourished, healthy workforce is a precondition for sustainable development as nutrition plays a critical role in human resource development. Deficiencies in essential nutrients lead to malnutrition, which affect an individual's mental and physical state, resulting in poor health and poor work performance (www.fao.org). Economic transformation may provide increased nutrition security and sustainable agriculture. Improvements in personal access to health care, dignity and wealth could lead to improvements in the prevention and early treatment of malnutrition and other diseases.

Improvements in the retention of health-care workers could reduce the so-called brain drain and give more access to better of the vulnerable groups. Task shifting in health care could be facilitated leading more people benefiting and becoming healthy. In all these, nutrition programmes are supposed to be facilitated by skilled health workers. Sustainable economic growth, employment and decent work have also been associated with better diet quality. Consumption of low-quality foods (energy-dense and nutrient-poor) are common with lower socio-economic classes, usually caused by poorer accessibility to, and/or non-affordability of, higher quality foods.

A hungry man or country cannot do much to promote inclusive and sustainable economic growth, employment and decent work. Good nutritional status leads to higher individual earnings and mental acuity, which in turn support macroeconomic and societal growth (Webb, 2020). Malnutrition (which includes several forms of under nutrition as well as overweight and obesity) impairs individual productivity which acts as a drag on national growth. In this sense, malnutrition will represent a pernicious, often invisible, impediment to the successful achievement of SDG targets.

SDG 12: Ensure sustainable consumption and production patterns: Falling poverty and improved nutrition raises demand for higher quality and more diverse diets (UNSCN, 2014). It is estimated that one-third of all food produced globally is wasted along the food chain due to poor

harvesting, storage and distribution practices. Also land degradation, declining soil fertility, unsustainable water use, over-fishing and marine environment degradation are all lessening the ability of the natural resource base to supply food. Food production and consumption have major impact on environment-related targets. Meeting the nutritional needs of a growing global population requires sustainable solutions for food production and access to water, as uncontrolled and inefficient food production causes greenhouse gas emissions and soil degradation. Food production leads to the release of nitrogen and phosphorus that is associated with fertilizer use; food production is also responsible for excessive use of both fresh water and farmland, and for biodiversity loss. Policy actions that address not just agricultural productivity but improvements across entire food systems represent a new approach to curbing food insecurity and malnutrition due to high wastage (Global Panel 2014). Nutrition is integral to influencing and advocating for healthy diet and lifestyle habits of individuals/households within the confines of the limited resources and this is a key driver towards the achievement of sustainable production pattern. Promotion of the environmentally friendly and sustainable local production of food crops, tools and food supplies could reduce feeding costs, create jobs and support the local economy, end hunger as in SDG 2 and eventually lead to better feeding. Closely embedded with SDGs 1, 2, and 3, the vision of sustainable patterns of production and consumption is increasingly shared by industrialized and developing countries alike. Many governments are paying more attention to the importance of linking policies and investments. Nutrition and the post-2015 SDGs integrated agriculture and food markets with improved health and nutrition (Webb and Block 2012). The term “nutrition-sensitive agriculture” has been coined to refer to interventions that can have positive nutritional impact by increasing the quantity and availability of agricultural commodities, as well as the quality of foods in terms of diversity, nutrient content and safety (Ruel and Alderman 2013). Enhanced food supply chains can also work for nutrition by reducing or stabilizing food prices, extending the seasonal availability of key nutrient-rich foods, improving information flows or by enforcing food safety standards (United Nation Sub Committee on Nutrition (2014). Reducing both post-harvest food losses and retail as well as consumer food waste, would also play a part in moderating ever-increasing demand for growth in agricultural output (FAO 2013).

SDGs 17: Partnerships for the goals: The SDG 17 seeks to strengthen global partnerships, and calls on national governments, the international community, civil society, the private sector and others, to all work together. In order to achieve the goals, partnership between both diverse sectors and governments is needed and nutrition can form a very big attracting force. There is a special adage that says: “Together we achieve” and nutrition is the motivating force. Nutrition is thus regarded as drivers for business for development. Partnership can also benefit from nutrition in encouraging adequate nutrition of people by nutritionist /dietitians with other professionals and companies to drive home their messages. Nutrition activities bring partnerships for the goals and bringing new private sector partners into the fight against under nutrition will help the world to achieve SDG 17 and especially the targets to mobilize new financing and promote a range of new public private and civil society partnerships. No single organization can transform the society alone without food system. Through partnerships, co-creation and the exchange of ideas, we maximize our collective impact. Only by working together, can adequate nutrition information reach more people, helping millions to eat a nutritious and sustainable diet. Significantly, nutrition is to some extent the new ‘mantra’ in the international development debates. Individuals, donor agencies and international organizations are supporting campaigns on adequate nutrition through food aids and rights of smallholder farmers to ensure access to water,

land, investment etc. Others are multitude of sectoral approach based on an integrated agriculture nutrition health education agenda including social protection and safety nets; a key role for the private sector through production of high quality foods including those fortified with micronutrients and through food production, employment and income generation; a key role for public private partnerships, including national fortification alliance. Many clients and patients are reached for online dietary counseling, food demonstrations etc. Global prioritization of nutrition has never been higher as multi stake holder platforms such as Scaling Up Nutrition and Zero Hunger Initiative offer platforms on which to build renewed interest and investment in nutrition (UNSCN, 2014). Partnership that are driven by nutrition has led companies and industries with like minds tailor programmes to country's needs which eventually will lead achievement of the SDGs.

Conclusion

Nutrition is both a maker and maker of development. The SDGs as a well-articulated policy could assist in focusing the broad international sustainable developments agenda at a practical level and also serve as a tool for countries to measure the progress and cooperation between countries. Improved nutrition is the platform for progress in health, education, employment, empowerment of women and the reduction of poverty and inequality, and can lay foundation for peaceful, secure and stable societies. It promotes sustainable agriculture and is also an essential component for achieving many of the other SDGs. For sustainable impact, it will be essential for us to strive for better nutrition across the globe and feed the growing world population a healthy and sustainable diet to make a change which could lead to correct conclusions out for progress. Every country needs achievement of SDGs as they are critical for development, healthy living and that is what nutrition has a comparative advantage in. The SDGs are attainable, especially if nutrition is put front and center of the sustainable development agenda and linked to all of the ambitious new goals (UNSCN, 2014).

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APPENDIX

Table 1: Illustration of the Linkages between Nutrition and the SDGs

Contributions of nutrition to SDG	Sustainable Development Goals	Contributions of DG to nutrition
Good nutrition results in higher labour productivity, mental capacity, and longer healthy lives. Each added cm of adult height is associated with an almost 5% increase in wage rates.	1. End poverty in all its forms everywhere	Doubling per capita income cuts child stunting by 15 percentage points. This happens as households escape poverty and governments invest more to tackle malnutrition due to reduced GNP losses.
Good maternal nutrition reduces risks of low birth weight and improves care of children. A well-nourished workforce supports productive agriculture and more demand for food, increased food security and reduced hunger.	2. End hunger, achieve food security and improved nutrition and promote sustainable	Nutrition would benefit hugely from zero hunger and full food security. Sustainable agriculture supports appropriate diets, income and resource use.
Nutrient-disease interactions are synergistic. Good nutrition significantly reduces the risks of sickness and mortality in the	3. Ensure healthy lives and promote well-being for all at all ages	Enhancing health, starting with adolescent girls and focusing on the first 1,000 days (including breastfeeding promotion),

context of a host of diseases, as well as maternal health and foetal growth.		supports child nutrition and growth while reducing NCD burdens later in life.
Improving linear growth for under 2s by 1 Standard Deviation adds half a grade to school attainment .Resolving iron, iodine and other nutrient deficiencies supports mental capacity.	4. Ensure inclusive and equitable quality education and promote life-long learning	Access to information, education, schooling and informal knowledge enhances health and food choices, income growth, and nutrition.
Improving the nutrition of girls, adolescents and women increases their ability to perform well at school and in the workforce.	5. Achieve gender equality and empower all women and girls	Gender equality (in education, status, earnings) accounts for 25% of child nutrition gains. Girls' education delays marriage and first birth.
Improved nutrition is associated with enhanced knowledge and behaviours linked to personal and food hygiene and sanitation, raising demand for clean water and quality sanitation.	6. Ensure availability and Sustainable management of water and sanitation for all	Reduction in open defecation and improved access to water cuts bacterial contamination in the food supply and supports hand-washing, which impacts nutrition outcomes.
Improved nutrition in all its forms generates demand for food, goods and services, including electrification in the context of demand for refrigeration and food processing.	7. Ensure access to affordable, reliable, sustainable and modern energy for all	Access to energy reduces time burdens on women seeking wood and charcoal .Reduced indoor pollution directly reduces sickness-mediated nutritional compromise.
Nutrition stimulates economic growth, improving the mental and physical productivity of the labour force. Removing under nutrition would prevent. GNP losses of 8-11% per year.	8. Promote sustained, inclusive and sustainable growth, full and productive employment, decent work for all	Earning opportunities are key to enable households to rise out of poverty and to enhance the adequacy and quality of their diets. Higher GNP allows governments to invest in pro-nutrition policies and programming.
Enhanced nutrition through the lifespan supports learning and later innovation potential. Industrialization and markets only thrive with productivity and growing demand across food systems. Resolving stunting has more impact for the poor, thereby reducing current nutrition inequalities that perpetuate future nutrition and	9. Build resilient infrastructure, promote inclusive industrialization and foster innovation	Innovations in productive technology, value chains and marketing enhance food safety and diet quality. Innovation in communication and marketing among the poor supports nutrition.

income inequalities.		
Resolving stunting has more impact for the poor, thereby reducing current nutrition inequalities that perpetuate future nutrition and income inequalities.	10. Reduce inequality within and among countries	Reduced inequalities in nutrition allows for more balanced productivity and growth across the population. Less inequality across nations promotes balanced dialogue and engagement.
Lower mortality and morbidity due to enhanced nutrition reduces population pressure on natural resources as fertility falls.	11. Make cities and human settlements inclusive, safe, resilient and sustainable	Urban demand for safe quality diets supports growth in rural production and services, enhancing nutrition. Less water waste and pollution support nutrition in urban and rural areas.
Falling poverty and improved nutrition raises demand for higher quality and more diverse diets.	12. Ensure sustainable Production	
Research on nutrient quality as crop traits promoting plant vitality supports climate resilient agriculture research. _ Reduced population pressure on environmental resources comes through better nutrition supporting reduced mortality and lower fertility rates. _ More informed consumer demand for high quality, diverse, safe diets drive attention to sustainability of production and impacts of product choices on entire food systems.	13. Urgent action to combat climate change and its impacts _ Research to enhance crop and animal resistance to agro-ecological shifts linked to climate change will protect food supplies and diet diversity. _ Enhanced resiliency of food production and marketing systems can reduce food price volatility that hurts the poor. _ Production diversity based on sustainable practices lead to lower consumer prices (diversified demand) and hence to diet quality. 14. Conserve and use the oceans, seas and marine resources sustainably 15. Protect, restore and promote sustainable use of terrestrial ecosystems	Research to enhance crop and animal resistance to agro-ecological shifts linked to climate change will protect food supplies and diet diversity. _ Enhanced resiliency of food production and marketing systems can reduce food price volatility that hurts the poor. _ Production diversity based on sustainable practices lead to lower consumer prices (diversified demand) and hence to diet quality.
Moves to strengthen nutrition accountability and governance globally bring attention to the importance of inclusive stakeholder dialogues and cross-sector models for effective policy.	16. Promote peaceful and inclusive societies, access to justice for all, & build effective, accountable institutions	Discrimination of all kinds, inequity, economic penury and injustice are drivers of conflict, destruction and malnutrition. Peace and justice are preconditions for building accountable institutions needed to achieve good nutrition for all.

<p>Global prioritization of nutrition has never been higher. Multi-stakeholder platforms such as Scaling Up Nutrition and Zero Hunger Initiative offer platforms on which to build renewed interest and investment in nutrition.</p>	<p>17. Global prioritization of nutrition has never been higher. Multi-stakeholder platforms such as Scaling Up Nutrition and Zero Hunger Initiative offer platforms on which to build renewed interest and investment in nutrition.</p>	<p>A further strengthening of global partnerships and inter-governmental commitments to sustainability and equality offer a foundation for building peace and effective, open and accountable institutions, and improved multisector and multi-stakeholder Coordination and collaboration.</p>
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Source: *United Nation Sub Committee on Nutrition (2014)*

Chapter 12

Analysing the Impacts of Covid-19 on Water Resources and Household Food Security

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Abstract

Water is needed for the survival of humans, animals and plants for sustainable livelihood. Clean water has been so scarce especially in the rural areas for household consumption and agricultural production, thereby leading to reduction in food production. Recently, water is at the front-line of the fight against Corona Virus (COVID-19) pandemic. Whereas a cure or vaccine is yet to be discovered for the pandemic, therefore, it is essential that we protect ourselves through hand washing and maintaining proper hygiene. This presupposes that there should be reliable and sufficient clean water, which should be accessible and affordable by everyone especially among the rural dwellers and poor urban citizens. There are some crucial questions to consider, such as: is water easily accessible, affordable and adequately utilized? Are there enough community response strategies on water availability? Is there policy in place to eliminate all possible forms of inequality to ensure that no household is left behind? The pandemic has compromised food security living many households hungry. This Chapter considered sustainability and resilient of the rural households in water resource management to protect the health of all and achieve agricultural water demand to attain food security and maintain covid-19 precautionary measure. Conclusion was drawn on water resource preparedness and response plan designed to ensure equitable access to adequate and safe water for the rural dwellers whose water needs stretch beyond washing hands in other to contain the impact of the post pandemic era on food security. It is very necessary to take proactive decisions that will assist on reducing the impact of covid-19 on water security in post pandemic era.

Keywords: Covid-19, adequate water, availability, accessibility, food security

Introduction

The place of water Sustainable Development Goal (SDGs)

As water becomes scarcer, it is fundamentally important to tackle the issue frontal focusing on the principles of SDGs. This is pertinent as the world is facing diverse challenges that need massive utilization of water, and especially for the fact that agenda has been set to achieve sustainability by 2030. It then becomes worrisome that only less than 10 years left for the achievement of all the goals stipulated therein including clean water supply. Food and agriculture lie at the heart of the 2030 agenda and its goals of ending poverty and hunger, responding to climate change and sustaining natural resources (United Nations Department of Economic and Social Affairs (UNDESA) 2015). All food processes including grown, process, trade, transport,

storage, market and consumption, and the role it plays in cultural life presents a fundamental link between people, the planet and the path to inclusive and sustainable development.

The 17 sustainable development goals (SDGs) are geared to transform the world in all ramifications, they including: Goals 1: No Poverty, 2: Zero Hunger, 3: Good Health and Well-being, 4: Quality Education, 5: Gender Equality, 6: Clean Water and Sanitation, 7: Affordable and Clean Energy, 8: Decent Work and Economic Growth, 9: Industry, Innovation and Infrastructure, 10: Reduced Inequality, 11: Sustainable Cities and Communities, 12: Responsible Consumption and Production, 13: Climate Action, 14: Life Below Water, 15: Life on Land, 16: Peace and Justice Strong Institutions, 17: Partnerships to achieve the Goal. These goals are interwoven and the achievement of one lead to the achievement of the order and they are geared towards building on the principle of “leaving no one behind”, which emphasizes a holistic approach to achieving sustainable development for everyone. The adoption of SDG 6 creates an opportunity to systematically engage with key water-scarce countries and to inform and orient national policies towards effective, sustainable models of water management and governance. Target on SDG 6 – “increasing water-use efficiency across all sectors and ensuring sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reducing the number of people suffering from water scarcity” (Global Nutrition Report, 2016). This is apt and relevant especially now with the pandemic challenging the world and requiring increase use of water to maintain sanitation. It is crucial to note that adequate supply of water is needed to achieve some other critical goals such as poverty and zero hunger, good health and wellbeing for a sustainable development.

Sustainable agricultural production will in one way or other lead to achieving all the SDGs whereas agriculture is both a cause and a victim of water scarcity. The excessive use and degradation of water resources is threatening the sustainability of livelihoods dependent on water and agriculture. Inefficient and uncoordinated water use depletes aquifers, reduces river flows and degrades wildlife habitats, and it has caused salinization on 20 percent of the global irrigated land area. The inappropriate use of fertilizers and pesticides translate into water pollution, affecting rivers, lakes and coastal areas. The bulk of production in capture fisheries comes from coastal waters, where both the productivity and quality of fish stocks are severely affected by pollution, a great part of which comes from agricultural crop production, aquaculture and livestock. Achieving the required levels of production from an already seriously depleted natural resource base requires profound changes in our food and agriculture systems, to ensure global food security, providing economic and social opportunities, and protecting the ecosystem services on which agriculture depends (Nwosu, 2012).

Rapid progress in reducing and eliminating hunger and malnutrition will help in achieving all the SDGs. Likewise, progress in all the SDGs will pave the way for ending hunger and extreme poverty. In particular, SDG 1, which is to “end poverty in all its forms everywhere”, includes targets on social protection, land rights and resilience. SDG 2 is dedicated to ending hunger, improving food security and nutrition, and promoting sustainable agriculture. The link between food security and natural resources features prominently in SDG 6 on water, SDG 14 on oceans and marine resources, SDG 15 on ecosystems, biodiversity, forests and land (which provide the foundation of all food and agricultural systems), and in the SDGs on energy, gender, climate, and consumption and production.

Water is crucial and very indispensable for agricultural production and food security for every household. Water is the livewire of ecosystems, including forests, lakes and wetlands, on which the food and nutritional security of present and future generations depends (FAO, 2002a).

Water of appropriate quality and quantity is essential for drinking and sanitary purposes and for food production (fisheries, crops and livestock), processing and preparation. Water is also important for the energy, industry and other economic sectors. Water streams and bodies are often key means of transport (including of inputs, food and feed). Generally, water supports economic growth and income generation and, therefore, economic access to food. The world contains an estimated 1400 million cubic km of water and only 0.003% that is 45,000 cubic km is fresh water resources which can be used for drinking, hygiene, agriculture and industry purposes (FAO, 2020). Almost 69 percent of freshwater resources are tied up in glaciers and ice caps, about 30 percent are groundwater, and a mere 0.27 percent is surface water. Whereas all kinds of water resources are important for the survival of the planet, accessible freshwater is especially important for humans (Corina, 2018). For example, seasonal flooding makes water extremely difficult to capture before it flows into remote rivers. Often, only about 9,000-14,000 cubic km is economically available for human use. The quantity of water available isn't the only concern but the quality of the water supply is also very important. Global water demand is increasing per annum, while between 4.8 and 5.7 billion people are projected to live in areas that are potentially water scarce for one month per year by 2050 (UN-Water, 2019).

The demand for food is increasing in line with population growth, rising incomes, and migration to cities (FAO, 2002b; FAO, 2017). Farmers worldwide need adequate water supplies to reliably produce and trade diversification, micronutrient-rich foods such as fruits, vegetables, animal-source proteins, and dry season crops that might include squash and beans (Umezulike, 2017). Agriculture is by far the biggest user of water, accounting for almost 70 percent of all withdrawals, and up to 95 percent in developing countries. The water needed for crops amounts to 1000-3000 cubic metre per tonne of cereal harvested which means that it takes 1-3 tonnes of water to grow 1kg of cereal. The daily drinking-water requirements per person are 2-4 litres. However, it takes 2000-5000 litres of water to produce a person's daily food. Water is important for food security, which is defined as the regular access of people to enough high-quality food to lead active, healthy lives. If water is a key ingredient to food security, lack of it can be a major cause of famine and under-nourishment, especially in areas where people depend on subsistence agriculture without irrigation for food and income (FAO, 2020).

Categories of water resources

Water resources are supplied in many forms, but the three main categories are saltwater, groundwater and surface water.

Saltwater resources

Majority of the earth water is salty; chloride and sodium are the most abundant ions found in them. There are saltwater resources upon which human beings derive numerous benefits from, apart from beautiful ocean views. Saltwater fish are a staple in much of the world's diet (although overfishing and pollution has put much of the marine life population at risk).

Groundwater resources

Ground water is water beneath the earth surface in soil pore spaces. It is the most abundant of all freshwater resources. As water percolates into the ground through layers of soil, clay, and rock, some of it adheres to the topmost layers to provide water to plants. This water is in what is called the unsaturated zone. Most of the pores in the vadose zone are filled with air, rather than water.

Surface water resources

Surface water is the water that exists in streams and lakes. This water is primarily used for potable water supply, recreation, irrigation, industry, livestock, transportation and hydroelectric

energy. Over 63 percent of the public water supply is withdrawn from surface water. Irrigation uses 58 percent of its water supply from surface water. Industry uses almost 98 percent of its water from surface water systems. Therefore, surface water conservation and quality are of the utmost importance (Corina, 2018).

The global risk perception survey conducted among 900 recognized experts by the World Economic Forum (2015) reports that the highest level of societal impact over the next 10 years will be from water crises. In recent decades the percentage increase in water use on a global scale has exceeded twice that of population growth. This has revealed larger regions of the world being subject to water pressure where the current restricted rates of water use and consumption rates are unsustainable.

Nigerian water resources

Nigeria is so rich in water resources that many of its 36 states are named after rivers but only 67% of the total population had access to "at the smallest amount of basic water supply", this was 82% of the urban population and 54% of the rural population (WASHWATCH (2017)). In addition to surface water found in nearly every part of the country, there's also plenty stored in the ground but with the difficulty of harnessing them adequately to use. The country has 215 cubic kilometres a year of available surface water. This is a lot higher than many African countries, particularly those in the southern and northern regions of the continent (Nelson Odume et al., 2017). In Nigeria, water is widely regarded as the most essential of natural resources, yet freshwater systems are often threatened by human activities and stand to be further affected by anthropogenic climate change. Water systems are affected by intensive agricultural activities; urban development, industrialization and unplanned engineering infrastructures. Unplanned agricultural practices arising from lack of adequate extension workers and largely unmechanised procedures leave farmers with the option of bush burning as the only site clearing method. This practice results in deforestation which translates into land degradation and mass wasting events leading to soil water deficits and sediment loading of surface water. Irrigation practices often affect the wetland hydrology of downstream areas thereby impacting negatively on aquatic ecosystem. It has become common practice in most Nigerian cities to always resort to surface water bodies as a viable receptacle of solid and industrial wastes (Idu, 2015). Water insecurity is increasing, with the poorest and most vulnerable particularly at risk. Water demand, stress and scarcity are increasing due to population growth, urbanization, land use change, climate change and other drivers.

Problems of water supply

In 2015, around 60 million people lacked access to smallest amount of basic water. According to Chichio Aniagolu Okoye (2018), the country Director of Water Aid Nigeria said, with 1 in 3 Nigerians without clean water, and 2 in 3 Nigerians without decent household sanitation, strong political will is what is needed to address the water and sanitation crises in Nigeria. In response to the above, the federal government of Nigeria in 2016 approved a Water Resources Roadmap (2016 – 2030) with the goal of reaching 100% water supply to Nigerian citizens by 2030. The roadmap encompasses several priorities including: the establishment of a policy and regulatory framework for the sector; development and implementation of a National Water Supply and Sanitation Programme to attain the Sustainable Development Goals 6 but in reality, Nigeria is still lacking behind meeting the set target in 2030. When the government of Nigeria fully

implement the above policies and make access to quality water affordable for all, inequality will be eliminated. The challenge of recent is to increase crop productivity and improve agribusiness in a more sustainable way in order to achieve food security. Healthy soil and availability of fresh water are very important aspect towards achieving sustainable food security. It is expected that 90% of the increase in food production will have to come from existing cultivated land and an approximate 10% from new agricultural areas. An increase in water efficiency and water productivity in irrigated agriculture is therefore one of the most important challenges agricultural system is facing (Elswijk, 2020). Water bodies, natural and built environment, and related sociological systems such as policy and governance, have experienced significant impact from the economic lockdown resulting from the Covid-19 pandemic. Preventing or suppressing potential pandemics is likely to increase water demand for domestic and health uses, coupled with the fact that agriculture must feed another 2 to 3 billion people in the next 50 years, putting additional pressure on water resources. More than 70% of the world's 850 million undernourished people live in rural areas, and most depend directly or indirectly on water for their livelihoods. Rain maybe plentiful for some farmers, but in many places, it falls when it is not needed and vanishes during drought (David, Charlotte & Frank, 2007 add current). Water quality is deteriorating across developing countries due to discharges from agriculture, industry, human waste, and wastewater, affecting both surface and groundwater. Climate change will also negatively affect water quality (Solly, 2019). The greatest exposure to pollutants is expected to occur in low-and lower-middle income countries due to high population growth, economic growth and poor waste water management systems (WWAP/UN-Water, 2018). Africa's water towers, which replenish many of the continent's rivers, are under pressure from both climate change and deforestation and encroachment with implications for both water supply and quality (UNEP, 2016).

Possible effect of Covid-19 on water availability

The corona virus, Covid-19, was first confirmed in the Chinese city of Wuhan in late December 2019. COVID-19 is an infectious disease that is caused by severe acute respiratory syndrome corona virus 2. Hand washing is a key preventative measure to suppress transmission of Covid 19 and other infectious diseases (Coates & de Albuquerque, 2020). As the Covid-19 pandemic is still unfolding, it is not clear what the impact on developing countries or their water security will be (Cooper, 2020) and major health organizations advise washing hands more frequently for at least 20 seconds to prevent occurrences .Corona virus (COVID-19) is a respiratory illness caused by a virus that was first identified at the end of 2019. The COVID-19 pandemic is devastating lives, public health systems, livelihoods and economies across the world, populations living in food crisis contexts are particularly exposed to its effects (FAO, 2020). With cases confirmed in scores of countries across the globe, the World Health Organization (WHO) has since declared it a global pandemic. In Africa and indeed in East Africa have since moved from COVID19 preparedness to response since cases were confirmed in the all the six countries. By the start of the second week of April there were, 49 in Tanzania, 208 in Kenya, 127 in Rwanda, 5 in Burundi 4 in Southern Sudan and 54 in Uganda confirmed, though still low compared other countries on the continent, these numbers are still rising and this trend is likely to continue for some time. AS at the start of July 2020, there were more than 1,479,168 confirmed cases, including over 87,987 deaths confirmed world over and still counting world over.

The impact of the COVI-19 outbreak in the Nigeria on jobs and financial transactions could have further negative impact on remittances which forms some percent of the Federal budget.

This will affect livelihood and spending patterns, which in turn could have a negative impact on the economy and wellbeing of the people, therefore equitable access to quality and affordable water supply becomes difficult. It is worthy of note that water is a precious resource, crucial to realizing the Sustainable Development Goals (SDGs), which is aimed to eradicate poverty.

Impact of shortage of water for production and food security

Water is important for food production, preparation and thus food security. Water is crucial in food security because crops and livestock need water to grow. Agriculture requires large quantities of water for irrigation and of good quality for various production processes. Increased demand for domestic water and water for healthcare settings could lead to trade-offs both downstream (in waste water) and upstream (in competing demands for supplies from agriculture and other sectors) (Joshi & Nicol, 2020). Food security could be described as a situation that exist when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2002; Meludu, 2009; Meludu, 2010). Uncertainties in the onset of the farming season, due to changes in rainfall pattern (early rain may not be sustained, and crops planted at their instances may become smothered by heat waves) can lead to a usual sequence of crop failure which results in food shortages due to poor harvests. If water is a key ingredient to food security, lack of it can be a major cause of famine and under-nourishment, especially in areas where people depend on local agriculture for food and income (FAO 2002). African countries that rely solely on natural resources and rain-fed agriculture are more vulnerable to the risks of climate change (International Fund for Agricultural Development (IFAD, 2010). The costs of climate change effects are irreversible, potentially catastrophic to the entire nations most especially the developing and underdeveloped nations of the world. For example, the Intergovernmental Panel on Climate Change estimated that, by 2020, agricultural production would decline by 50% in some countries with rain-fed agriculture (Nanki *et al.*, 2010) and now coupled with COVID-19 pandemic

According to UN projections, the world's population will be 9.7 billion in 2050, and the increasing population will only intensify pressure on the world's resources. In a FAO report 'Towards World Agriculture 2030/2050', projections suggest that there is enough water available globally to sustain the world in 2050 but since the water is not equally distributed, an increasing number of countries will face growing water scarcity, impacting rural livelihoods and food security. Water shortages do not only affect people who live in water scarce areas. According to the Food and Agriculture Organization (FAO 2002b; 2017), future water scarcity and quality will also affect global food production and thereby global food security.

The United Nations (2013) defined water security as: "The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being and socio-economic development; for ensuring protection against water-borne pollution and water related disasters; and for preserving ecosystems in a climate of peace and political stability. Meaning that water insecurity is when the population does not have access to adequate quantities of acceptable quality water when needed and affordable. Water security is when a person is able to obtain a sufficient amount of clean water on a day-to-day basis. People who do not consume enough each day suffer from water insecurity, which is when a person is unable to obtain a sufficient amount of clean water on a day-to-day basis.

Strategies to eliminate all form of inequality on access to water

There is need to take mitigation and adaptation procedures for water resources utilization. Farmers' worldwide embrace experienced solutions to water scarcity (FAO, 2017), but they need to be supported with appropriate policies, the correct combination of public and private investments, and access to knowledge and resources for producing more and better with less water (Solly, 2019). Various adaptation measures that deal with climate variability and build on improved land and water management practices have the potential to create resilience to climate change and address water scarcity. The sustainable intensification of food production with more efficient water management systems adapted to climate variability and local circumstances can help increase water productivity and raise on-farm incomes. Countries in water-scarce regions will increasingly need to devise food security strategies that explicitly consider structural food supply deficits and trade arrangements that will provide protection from food price volatility (FAO, 2012). Therefore, securing access to water is crucial for achieving food security and improving rural and peri-urban livelihoods. Utilization can be limited by physical water scarcity: an excess of water demand over available supply; economic water scarcity: the lack of adequate infrastructure due to financial, technical or other constraints; or institutional water scarcity: the lack of an appropriate institutional framework or capacities for ensuring the reliable, secure and equitable supply of water. Symptoms of physical water scarcity are environmental degradation, declining groundwater levels, and water allocations that favour some groups over others, thereby causing conflicts (frequently among farmers and pastoralists) (FAO, 2017). Physical water scarcity can be exacerbated by human activities that cause pollution and adversely affect ecosystem services. Symptoms of economic water scarcity include a lack of adequate and equitable access to water for agriculture and domestic use. Institutional water scarcity may arise when governments lack accountability to their constituencies, service providers are unaccountable to their users, or institutions are unable to address the management of supply and demand or deal with gender roles, relations and inequalities.

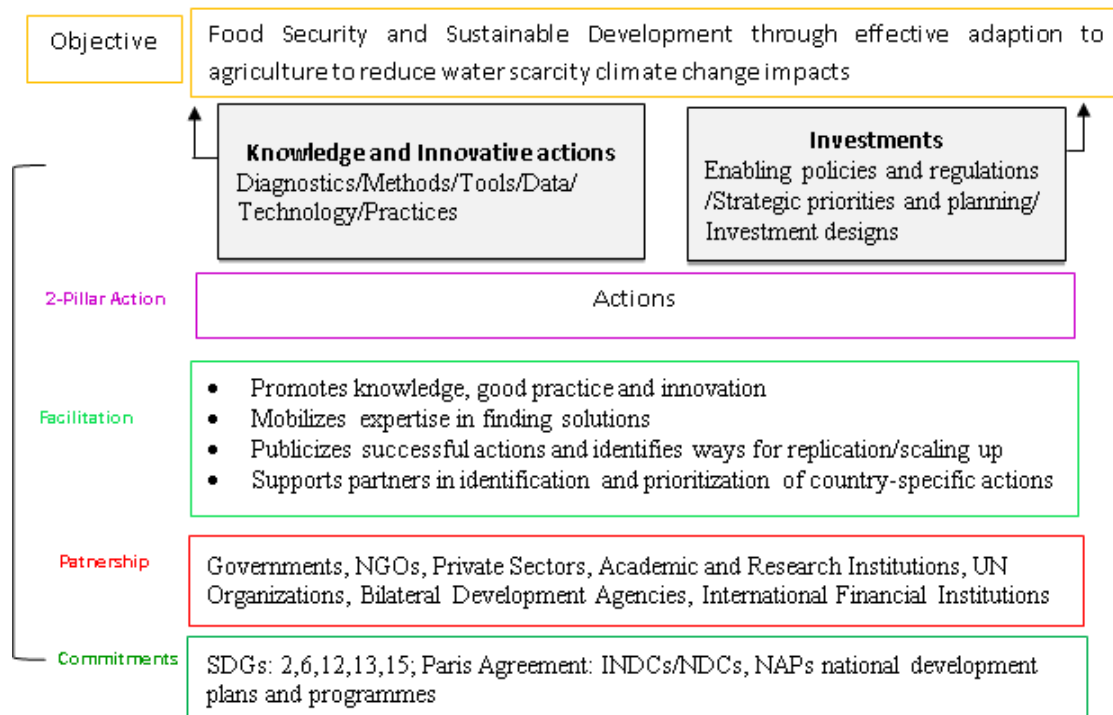


Figure 1: The global framework for action to cope with water scarcity in agriculture in the context of climate change (adopted from FAO, 2017)

Figure 1 showed the action plan for Action-oriented Partnership: knowledge, innovation and investment. Progress towards sustainability is knowledge-intensive; knowledge and innovation are linked to action on the ground through policies and investments. A repository of good development practices and innovative approaches and technologies applicable to water management in agriculture is available for analysis, testing and potential scaling up. Appropriate policies, incentives, regulatory frameworks and institutions are also needed to enable countries to absorb innovation and change. Combined with sound policies and institutional capacities, investments are a main pathway for scaling up the available knowledge and technological and methodological innovations and multiplying their development impact. In this motivation, the Global Framework for Action has a twofold approach that combines knowledge and innovation with effective policies and investment in a unified action chain (FAO, 2017). Such an approach calls for a broad, action-oriented partnership: governments, public-sector and private-sector organizations at the national and local levels, non-governmental organizations, regional collaborative bodies and mechanisms, academic and research institutions; UN organizations, bilateral development agencies, and international financial institutions joined the Global Framework for Action to jointly address water scarcity in agriculture in a changing climate (Figure 1).

Conclusion

Addressing water scarcity in agriculture sector directly contributes to the achievement of the 2030 Agenda for sustainable development especially goals 1, 2 and 6 which will subsequently assist in achieving other goals. It is clear that water is scarce, affecting the achievement of food security and also will be affected the more with covid-19 pandemic. Lack of sustainable access to adequate amounts of acceptable quality water will require strengthening water resources management so that water is available where and when it is needed to suppress and prevent future pandemics and no one will be left behind. Obviously, irrigation is crucial to increasing food production and farm income is requires for improved resilience against weather variability for sustainability and achievement of food security.

Recommendation

In order to confront the challenges linked with water insecurity to enhance food security amidst the COVID-19 pandemic, resilience capacities and activities must involve a set of holistic, multi-sector and multi-scale move towards adaptive agricultural system (drought, heat and flood tolerant crop varieties), improved soil and water management and adaption to droughts and floods. Government should expand irrigated areas by developing more rivers, lakes and aquifers and also expand rain-fed areas by turning more natural area into arable land. To achieve irrigation, government must have good water management policies in place, develop strategies on water eliminating all forms of inequality and equitable access to adequate and safe water to the rural and urban poor whose water needs stretch beyond washing hands, protect the health of all, save lives and meet other water demands from other sectors, facilitate financing for water resources management sufficient to meet the demands for both water sanitation and health services and other development needs. Also, transparent and inclusive sharing of information about COVID 19 and the role of sustainable water resource management amidst COVID 19 should be on track to achieve the targets of SDG 6. Finally, there is a need for strong political will to implement the set goals for water resources roadmap 2030 of the UN to ensure that nobody is left behind for sustainable development.

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Chapter 13

Comparative Analysis of Nigeria's Aquaculture and Capture Fisheries Development across Different Policy Regimes from 1960 to 2016: A Case for an Inclusive and Sustainable Fisheries Development

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Abstract

Government interventions in the Nigerian fisheries sector have mostly focused on aquaculture, largely neglecting the capture fisheries. In this work, the performances of aquaculture and capture fisheries under different policy era from 1960 to 2016 were investigated using the Test of means difference, Analysis of Variance and the Exponential and Quadratic trend functions. Data on aquaculture and capture fish outputs were sourced from the FAO database and publications of the CBN and the NBS. The entire period was split into three policy regimes, namely: the pre SAP era (1960-1985), the SAP era under the military rule (1986-1999) and the era of sustained civilian governance (2000-2016). These sub-periods were designated as sub-period I, sub-period II and sub-period III respectively. Results indicated a positive trend in the proportional contribution of aquaculture to sector total from 2.35% in sub-period I, to 19.5% in sub-period III, and a consistently declining proportional contribution from capture fisheries sector at 97.65% in Sub-period I and 80.5% in sub-period III. However, capture fisheries still determined the trend of fish production as its output was significantly higher than that of aquaculture. Furthermore, aquaculture output grew at 5.02%, 8.9% and 18.2% for the respective sub-periods while the respective growth rates of capture fisheries were 6.82%, 4.15% and 4.18%. Also, the general compound growth rate for aquaculture output (9.6%) stagnated in the entire period while that of capture fisheries (4.02%) decelerated. Finally, the entire sector grew at a decelerating compound growth rate of 4.4%. Thus, by not benefiting commensurately from government support, the capture fisheries performed poorly, leading to stagnation in sector performance. Again, the stagnating growth rate for the aquaculture output indicated sluggish progress. It is recommended that capture fisheries operators be empowered with modern crafts and gears and provision of credit, while not relenting on enhancing aquaculture production.

Key words: Aquaculture, Capture fisheries, policy era, growth rate.

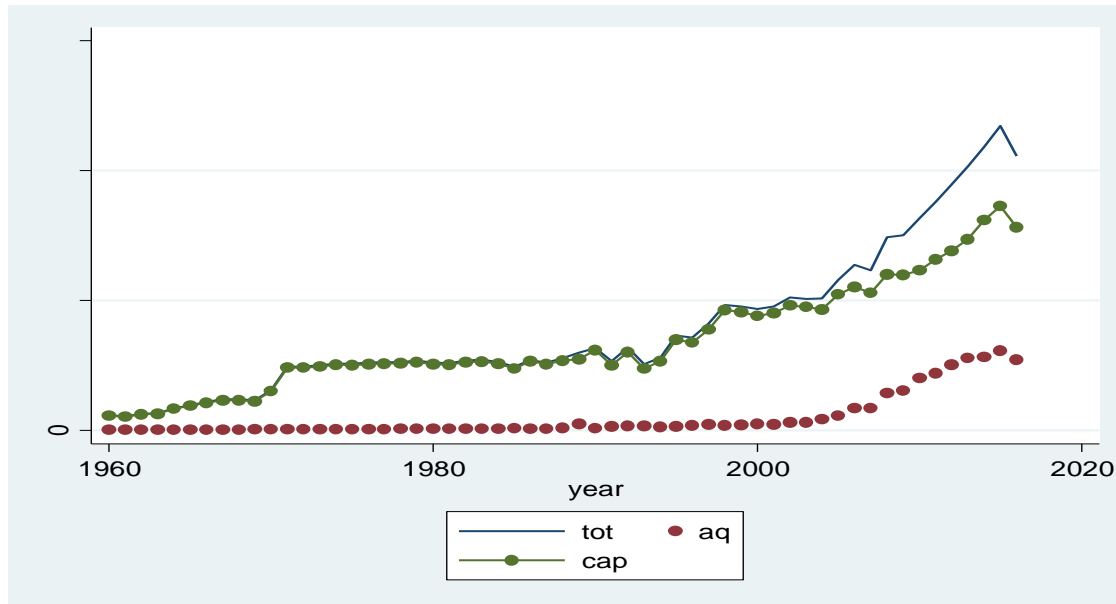
Introduction

The Nigerian fisheries sector exists in a paradox. Nigeria has enormous resources for fish production: a continental shelf area of 37,934 Km², coastal area length of 853Km, an Exclusive Economic Zone of 210,900 Km² (Ibeun, 2006). On the other hand, the inland water surface area of 14 million Hectares (Ha) (Embassy of the Netherlands in Lagos, 2019) and 1.7 million Ha of land available for aquaculture (the Food and Agriculture Organization of the United Nations-

FAO, 2006) with an existing pond area of 60,000 Ha, confers on aquaculture an estimated potential of 2.5 million mt (FDF, 2008). Despite these potentials, the demand-supply gap has persisted leading to a low level of fish consumption (Oluwatayo and Adedeji, 2019), massive importation and the attendant negative consequences on external reserves (Onuche *et al.*, 2020).

The sector, however, makes a modest contribution to the national economy. Nigerian fisheries sector provides employment for 8.23 million in the primary sector and 18.27 million in the secondary sector. Its contribution to entire Gross Domestic Products (GDP) in 2015 was 0.5% (FAO, 2017), while its contribution to the agriculture's component of the GDP is 3-5% (Ebuka 2019). However, the fisheries sector being a foreign exchange earner exists with a lot of trade imbalances, leading to the loss of a huge amount of foreign exchange (Akande *et al.*, 2004). FDF, (2008) reported that while total fish import in 2007 was 0.74 million metric tons valued at United States Dollars (USD) 594.4 million (about 230 billion Naira as at October 2020), the total shrimp export at the same period was 0.005 million metric tons valued at USD38.3 million (about 14.8 billion Naira as at October 2020), quoting the Nigerian Central Bank Governor, the Vanguard newspaper (2019) reported that the import bill had reached 1.2 billion USD (466.8 billion Naira, as at October 2020) in 2018. The consistently increasing trade imbalance has been a matter of policy concern for governments.

Government interventions in agriculture (fisheries sector inclusive), being aimed aside reducing trade imbalances, are generally undertaken to spur the agricultural sector for improved production and productivity. The ultimate goals of such interventions in developing countries bother largely on achieving food security and reducing poverty (Amaechi, 2018). Sometimes, however, agricultural policy attentions are more tilted towards some subsectors thereby, neglecting other sub-sectors. Such biases in narrowing policy attention by governments of developing countries usually create serious implications for sustainable agricultural development. This is the case with the Nigerian fisheries sector comprising of both the aquaculture and capture fisheries subsectors which, during the different era of agricultural policy regimes as mentioned above, priority attentions favoured the aquaculture sub-sector more than the captured fish sector; thereby, leading to the sustained increase in the aquaculture's proportion of total fish production. For instance, such biased policy attention as noted by FAO (2017) and Embassy of the Netherlands in Lagos (2019) have led to increased aquaculture production during the last 2 decades. Within the period of about 2 decades (2000-2016), aquaculture contribution to total sector supply was 18.1%, and within its sub-period of 2011-2016, this contribution to total supply had risen to 28.2% (FAO, 2018, Onuche *et al.*, 2020). Conversely, the proportion of capture fisheries' contribution to total fish supply has been decreasing steadily. In fact, Figure 1 shows the decreasing proportional contribution of the capture fish output to total sector output from around the year 2000, as indicated by the continuously widening gap between sector total and capture fisheries.

Figure 1: Aquaculture, Capture Fisheries and Total Fish Output in Nigeria in tons (1960-2016)**Figure 1:** Aquaculture, Capture Fisheries and Total Fish Output in Nigeria in tons (1960-2016)

Note: tot=Total fish output, aq=aquaculture output, cap=capture fisheries output

Source: Author's construction from miscellaneous data sources

The Nigerian capture fisheries subsector provides the bulk of local supply, and therefore significantly determines the local component of total fish consumed. In comparison, however, Nigeria's local fisheries output account for a total of 30% fish of her consumption, whereas other key African countries such as Cote d'Ivoire, Ghana and Egypt produce 33%, 50% and 70.8% of theirs, respectively (Proshare, 2016, World fish Centre, 2016). Report by the FAO (2018) shows that Nigerian fish consumption and production estimates have been performing poorly when compared with world estimates (FAO, 2018). While average world fish production per caput was recorded to have improved from 22 to 24 kg between 2011 and 2016, the corresponding estimates for Nigeria indicated an increase from 5 to 6.1 Kg (see Figure: 2). Also, while world average consumption has increased to 20.3 kg per caput in recent years, Nigerian average consumption stood at 11 kg (FAO, 2018). Poor policy articulation and implementation have continued to constrain local fish production while poverty has been responsible for low consumption (Onuche, 2015).

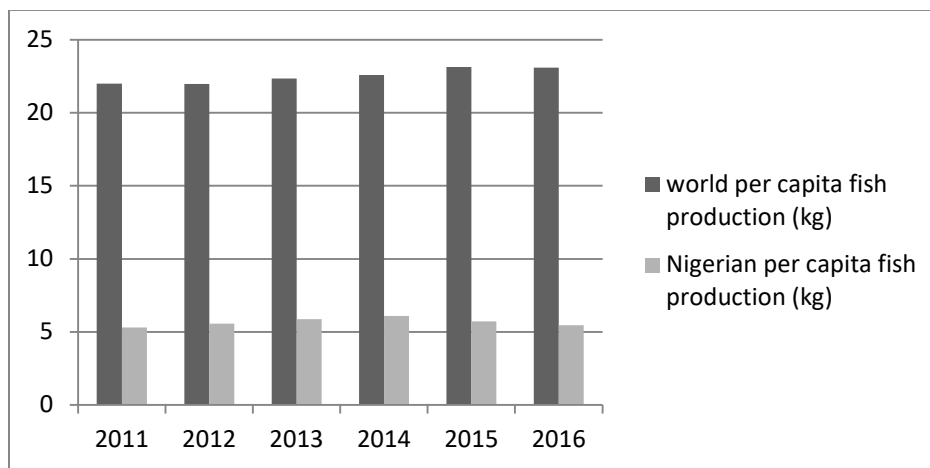
Figure 2: World and Nigeria per capita Fish Production (2011-2016)

Figure 2: World and Nigeria per capita Fish Production (2011-2016)
Source: Adapted from Onuche et al (2020)

Over time, policymakers have tried to spur production. In this regard, the strategies employed were based on the prevailing political climate. Thus, the period from independence in 1960 to 2016 can be split according to macroeconomic policy/administration peculiarities, into three sub-periods or era. The era before the Structural Adjustments Programme (SAP) or sub-period I i.e. (1960-1985) witnessed mild policy intervention like provision of inputs, extension services and loans (Evboumwan et al., 2005). The second era (sub-period II), the SAP era (1986-1999) was, however, characterized by a more ambitious policy initiative aimed at revamping the primary sectors and encouraging competition. This phase of economic development plans which was introduced in 1986 by the Babangida Administration was anchored on trade liberalization (Idachaba, 2006). It, however, had no coherent fish production policies. The third is the sub-period of sustained democratic governance (2000-2016) and was characterised by greater levels of political and macro-economic stability. This era (sub-period III) witnessed serious commitments from political leaders to aquaculture but witnessed no serious attention for capture fisheries. Interestingly, capture fisheries which concern the catching of fishes from the wild contribute over 80% of total fish output in (FAO, 2017).

How the subsectors fared during these periods need to be understood through empirical studies. Hence the need to investigate the performances of the subsectors over the period, with a view to ascertaining whether or not the different policy environments had impacts on their outputs. Thus, in this chapter, sub-periodic Intra and inter sub-sectorial comparisons were undertaken on the performances of the two subsectors. Such comparisons are more common in the crops and livestock sectors (Okoye et al., 2006, Ojiako et al., 2007, Ojiako and Olayode, 2008) than in fisheries and aquaculture. Ogbe and Onuche (2015) had investigated the macro-level performance of the aquaculture subsector over policy sub-periods. Their analysis, which did not consider capture fisheries are based on data for 1971-2010. Although Onuche (2015) had investigated the trend of culture and capture fish production in relation to macroeconomic sub-periods, the data analyzed were from 1971-2010. Thus, available information in the literature on sub sectorial performances of fisheries subsectors in the courses of different macroeconomic era

of the Nigerian entire fisheries economy are void of pre-1971 and post 2010 facts. A study on all available data on the production levels of fish under different policy regimes could bring to lime-light the performances of the different fisheries sub-sectors towards contributing to the attainment of SDG-14 (Aquatic Life) in Nigeria. The performances of the two subsectors will be useful in the projection of consumption and production for policy engendering. The overall objective in this present chapter was to analyse the contribution of both aquaculture and capture fisheries sub-sectors in Nigeria and determining their performances among different policy regimes of the Federal Government for the 1960 to 2016 period. Specifically, comparisons were made on the mean contribution of the 2 subsectors, the periodic contributions within and between the sectors. Also, the growth rates of each subsector in the courses of the sub-periods were analysed.

Methodology

Aquaculture and capture fisheries production data for the 1960 to 2016 period were sourced from the website of Food and Agriculture of Nigeria (FAO), and reports of Central Bank of Nigeria (CBN), National Bureau of Statistics (NBS) and Federal Department of Fisheries (FDF). The entire period of 1960-2016 was divided into 3: 1971-1985 (sub-period I), 1986-1999 (sub-period II), and 2000 to 2016 (sub-period III). The use of means and percentages were employed in the analysis of the subsectors' contribution to the entire fisheries sector during the respective periods and the entire periods. Following Okoye *et al* (2006) and Ojiako *et al* (2007), the test of mean difference, the exponential function and quadratic trend model were used to analyse the performances of the two sectors in the courses of the sub-periods. In addition, the Analysis of Variance (ANOVA) was employed sub-periodic Intra subsector comparisons. The mean difference test (t-test) is specified by

$$t = \frac{Y_1 - Y_2}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}}$$
.....(i)

Where Y_1 is the periodic mean of one subsector's output and while Y_2 is the periodic mean of the other. Furthermore, σ_1^2 is the standard error for a subsector's output, σ_2^2 is the standard error the other. Finally, N_1 and N_2 are the respective sample sizes.

The growth rates were estimated from the exponential trend equation given by

$$\ln Q_T = a + \beta T + e_t$$
..... (ii)

Where \ln represents natural logarithm, Q_T represents Quantity of fish Output measured in tons (t), T is the trend variable with values 1, 2, 3..... N and e_t is the error term

The instantaneous growth rate (r) is easily recovered from the equation by multiplying the β by 100 while the compound growth rate (G) can be recovered from ii thus:

$$G = (e_i\beta - 1)100\%$$
..... (iii)

Where: e_i is the Euler's exponential constant (2.71828) and β is the coefficient of the time (T). Also, the quadratic trend model is specified as; $\ln Q_t = \alpha + \Omega t + \phi t^2 + e_t$ (iv)

Where Q_t is the quantity of fish produced by a sector in a particular year in tons; α , Ω and ϕ are parameters, t is the trend variable and e_t is the error term. The direction of growth is determined by the statistical significance of ϕ . A significantly positive ϕ implies acceleration, a significantly negative ϕ implies a deceleration and an insignificant ϕ , irrespective of the sign, implies stagnation.

Results

Table 1 shows the periodic contributions of aquaculture and capture fisheries to total fish output in Nigeria. The contribution of aquaculture to sector total increased moderately from 115,881t (2.35%) in sub-period I to 222,451t (4.79%) in sub-period II and thereafter leapt to 2,494,372 (19.5%) in period III. In the entire period, aquaculture accounted for 2,832,704t (12.67%) of total fish supply in the country. On the other hand, the contribution of the capture fisheries sector decline from 4,817,709t (97.65%) in Period I to 4,425,724t (95.21%) in the second period. Although its contribution increased thereafter to 10,281,764t in the third period, the proportion of this to total supply declined to 80.5 per cent. The total contribution of capture fisheries to sector total in the entire period was 19,525,197t (87.33%). In all, while aquaculture experienced a steady rise in its proportion of the sector total, the capture fisheries sector's proportional contribution to sector total declined steadily.

Table 1: Periodic Contribution of Aquaculture and Capture Fisheries to Total Fish Production

	Period I		Period II		Period III		Entire period	
	Aqua	Cap	Aqua	Cap	Aqua	Cap	Aqua	Cap
Output (t)	115,881	4,817,709	222,451	4,425,724	2,494,372	10,281,764	2,832,704	19,525,197
	1	9	1	4	2	4	4	7
	(2.35)	(97.65)	(4.79)	(95.21)	(19.5)	(80.5)	(12.67)	(87.33)

Source: Data Analysis, 2020. *Note: Figures in parenthesis represents % of total fish production, Aqua=aquaculture, Cap= capture fisheries*

Table 2 shows the result of the sub-periodic comparisons of mean aquaculture and capture fisheries outputs. The result of the multiple mean comparisons using the ANOVA statistical methodology indicates that average aquaculture production in sub-period II (15889.36t) was not significantly higher than average production in sub-period I (4456.96t). The comparison of average aquaculture outputs of 4456.96t and 146727.56t sub-periods I and III respectively, however, indicates that the later performed better than the former. Average production in sub-period III (146727.56t) was also significantly greater than that of sub-period II (15889.36t). Results on the periodic comparisons of average outputs for capture production also indicate successive sub-periods performed better than previous ones. Generally, finding on the sub-periodic comparisons of mean outputs indicate progress in average periodic production over time for the two subsectors.

Table 2: Periodic Comparisons of mean Aquaculture and Capture Fish Outputs

	Aquaculture		Capture fisheries	
	Mean output (t)	Mean difference	Mean output (t)	Mean difference
Period I	4456.96	11432.40	185296.50	130826.64*
Period II	15889.36		316123.14	

Period I	4456.96	142270.79*	185296.50	419513.16*
Period III	146727.56		604809.66	
Period II	15889.36	130838.4*	316123.14	288686.52*
Period III	146727.56		604809.66	
ANOVA		34.19*		537.80*

Source: Data Analysis, 2020 *= Significant @1%.

Table 3 presents the results of sub-periodic inter-sectorial mean comparisons of outputs from the two subsectors. The t-test results indicate that capture fisheries output was higher than the aquaculture counterpart in all sub-periods. The sub-periodic mean difference between the capture fisheries supply and that of the aquaculture subsector increased over time. These differences increased from 180839.50t in the first period to 300,233t in the second period, and then to 458,081.9t in the last period.

Table 3: Periodic Inter-sectorial mean Comparisons of Aquaculture and Capture Fisheries Outputs

	Sub-period I	Sub-period II	Sub-period III	Entire period
Aquaculture output (t)	4456.96	15889.36	146727.7	49696.56
Capture fisheries output (t)	185296.5	316123.2	604809.7	342546.3
Mean difference (t)	-180,839.50*	-300,233*	-458,081.9*	292,850.8*
t-ratio	11.20	15.90*	48.25	16.15
Aquaculture output as % of Capture fisheries output	2.41	5.02	24.3	14.51
N	26	14	17	57

Source: Data Analysis, 2020 *= Significant @1%.

The growth rate analyses for the outputs for the subsectors and the entire sectors across sub-periods and the entire is presented in Table 4. The instantaneous growth rates recovered from the exponential model for the aquaculture output progressed steadily from 5.02% in sub-period I through 9% in sub-period II to 18.2% in sub-period III. While the positive growth rate in the sub-period I for this subsector was at a decelerating rate, those of the other two periods stagnated. For the capture fisheries sector, the growth rates declined from 6.82% I sub-period one to about 4.2% in the other sub-periods. These growth rates for the capture fisheries sector experienced a deceleration in sub-period I, accelerated in period II stagnated in period III. Total sector supply experienced growth rates of 6.7, 4.3 and 6.2% for sub-periods I, II and III respectively. Furthermore, the compound growth rates of 9.06% and 4.02% were recorded for the aquaculture and capture fisheries respectively. Generally, the aquaculture subsector had higher and steadier instantaneous growth rates than the capture subsector.

Table 4: Periodic Sectorial Growth Rates Analysis of Nigerian Aquaculture and Capture fisheries (1960-2016)

	Aquaculture subsector				Capture fisheries subsector				Entire sector			
	I	II	III	I-III	I	II	III	I-III	I	II	III	I-III
r (%)	5.02	8.99	18.2	8.67	6.82	4.15	4.18	3.94	6.67	4.28	6.2	4.37
Adj R ²	0.99	0.51	0.94	0.90	0.80	0.61	0.96	0.88	0.81	0.66	0.91	0.9
F	1850.9*	14.8*	259.7*	561.4*	101.54*	21.07*	191.3*	400.98	251.0*	25.72*	494.3*	516.24*
G	5.16	9.41	20.01	9.06	7.06	4.32	4.24	4.02	7.00	4.37	6.38	4.47
φ	-0.001*	-0.01	-0.0007	0.0015	-0.004*	0.006*	0.01	-0.0004*	-0.004*	0.00*	0.000	-0.002
N	26	14	17	57	26	14	17	57	26	14	17	57

Source: Data Analysis, 2020 * = Significant @ 1%, ** = Significant @ 5%

Discussion

The steady and sustained rise in the contribution of aquaculture to sector total corroborates the projection of FAO (1999) and United States Agency for International Development SPARE-USAID SPARE (2008) that the future of fish supply will depend greatly on aquaculture. Forecasts by Onuche (2015) had, based on the prevailing macroeconomic situation, estimated that aquaculture will constitute up to 50% and more of local fish production from 2024. The increase in aquaculture's percentage of total output most likely owes to the fact that the capture fisheries subsector had not received the level of and policy investment attention that aquaculture has enjoyed in recent times (Nzewi and Ojiagu, 2017). While aquaculture has received some boost, the capture fisheries continue to be limited to fishermen operating on a small scale with poor crafts and gears, with some low level of modernized fishing. Also, the industrial component of capture fish has been performing poorly as the fleet and infrastructure are ageing (FAO, 2017), undercapitalized and inefficient (USAID WEST AFRICA, 2008). Piracy and militancy have also contained the development of capture fisheries in the Nigerian Niger-Delta region (Nakazawa *et al.*, 2013). The artisanal fishing industry in the Lake Chad basin has also been destabilized by the Boko haram insurgency (Fisheries Committee for West Central Gulf of Guinea –FCWC, 2018).

However, Total capture fisheries output continued to rise over the sub-periods as shown in Table 2. In absolute terms, it also outperformed the aquaculture subsector (Table 3), while this appears indicative of superior performance by the capture fisheries subsector, further analysis of the proportion of the mean periodic capture fisheries supply that could be accounted for by aquaculture alludes to the steadier rise in the proportionate contribution of aquaculture, buttresses the declining proportion of the contribution of capture fisheries to sector total, and invariably, the emerging position of aquaculture as a major supplier of fish food (USAID SPARE, 2008). As indicated in the Table, the proportion of mean capture fish supply that could be accounted for by the aquaculture supply steadily increased from 2.41% in sub-period I through 5.02% in sub-period II to 24.3% in the last sub-period.

Analyses of Growth rate further show the performances of the subsectors over the 1960-2016 period. In the first sub-period, both subsectors experienced deceleration (Table 4). This period was characterized by young nationhood, policy/political instability (Akinyosoye, 2005), the civil war and the reconstruction programme that followed it, while the latter part was of it was characterised by austerity measures owing to decline in oil revenue following the economic crisis that succeeded the boom era. This oil boom period had its attendant consequences. For instance, during the oil boom period, increased revenue led to the neglect of agriculture and fueled massive importation of agricultural commodities while agricultural production declined steadily (Pinto, 1987). During the second and the third sub-periods, aquaculture experienced stagnation in its positive growth rates while the capture fisheries subsector experienced an accelerated growth rate. The stagnation of aquaculture growth rate in the last sub-period may have been caused by the recent downturn in the economy as Onuche (2015) had found an accelerating positive growth rate for the subsector between 2000 and 2011.

The progress made in the aquaculture subsector in the third period especially can be government intervention that has led to expansion aquaculture. During this sub-period, significant private capital and renewed political will to empower private aquaculture farms contributed to the significant progress in Nigerian aquaculture (FAO (2017). In sub-period III, (1999-2016) aquaculture experienced unprecedented policy intervention beginning with the Presidential Initiative on Aquaculture introduced by the Obasanjo Administration and sustained

by the Yar'dua/Jonathan Administration under their Agricultural Transformation Agenda. The supports received in this light were in form of subsidies free fingerling (Nzewi and Ojiagu, 2017), grants, inputs, credits and training for fish farmers. This was undertaken by the federal government without concurrent attention for capture fisheries. It is not in doubt that Government policies do help to improve agricultural production (Olarinde and Abdullahi, 2014) but Nzewi and Ojiagu (2017) have reported that in recent times, government policy interventions are tilted towards aquaculture. For instance, Sun news online (2018) reported that the Federal Government of Nigeria has directed fish importer to undertake backward linkages in aquaculture development. Over time too, the subsector has benefitted from continuous research and resulting innovations which are important to aquaculture (FAO, 2019) and a number of innovations, including those on feed breed and production systems have been shown to be effective in enhancing production. It is however important for the development of capture fisheries sector to be considered in policy issues to as it provides the varieties desired by natives in addition to being a cheaper source of fish (Belton and Thilsted, 2014).

The generally leap experienced by the aquaculture, if replicated for the capture fisheries will be beneficial in reducing the trade deficits and increasing consumption. In all, aside the need to enhance the performance of the capture fisheries subsector, the growth rates of the two subsectors need to be sustained. The scenario Figure 3 shows an unsteady growth pattern of growth rates of the two subsectors, against a steady population's growth rate.

Figure 3: Growth rates of Population, Aquaculture and Capture fisheries outputs (1960-2016)

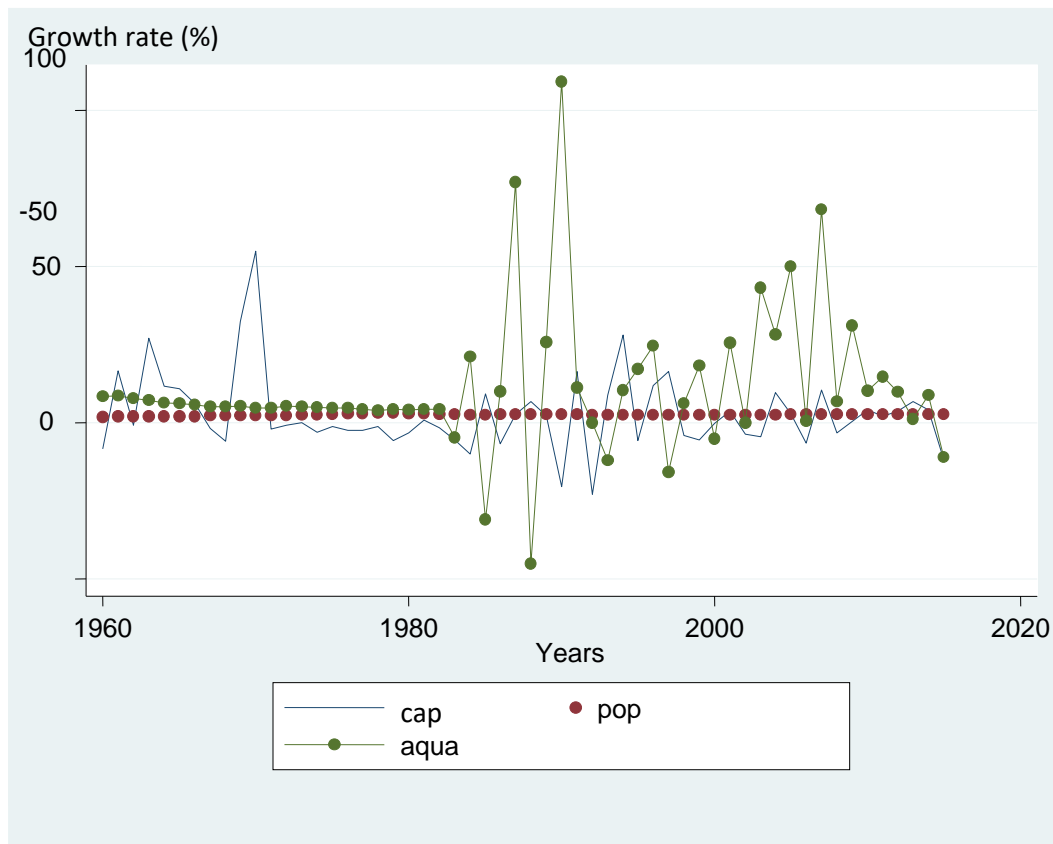


Figure 3: Growth rates of Population, Aquaculture and Capture fisheries outputs (1960-2016)

Source: Author's construction from data obtained from miscellaneous sources

Note: cap = capture fisheries growth rate, aqua=aquaculture growth rate, pop = population growth rate

Conclusion and Policy Recommendations

This Chapter analyzed the empirical processes and performances of aquaculture and capture fisheries sub-sectors in Nigeria from 1960 to 2016 macro-economic policies regimes. The results indicate that the favourable environment provided by the neo democratic era has greatly benefitted the aquaculture sub-sector. Unfortunately, the results also indicate that the negligence of one subsector can cause in balance in the growth of the entire sector. Commensurate government attention for the capture fisheries sector can substantially increase the output of the entire sector, leading to increased consumption and reduction the loss of foreign exchange it stands today, the growing fish import bill is not abating. Thus, increasing fish output in Nigeria will require serious policy attention for the capture fisheries subsector. To this end, a case is made for the empowerment of capture fisheries operatives with modern crafts and gears as well as provision of credit should be embarked upon to facilitate increased production. Substantial investment is also required to resuscitate and reinvigorate the industrial fish component of capture fisheries through an upgrade of the fishing fleet and infrastructure. Furthermore, the issue of piracy in the Niger-Delta and insurgency in the Lake Chad basin needs to be tackled in order to enhance the safety of capture fisheries operators. Sustained and enhanced growth in the aquaculture sub-sector is also canvassed in order to further increase its contribution to sector total. To this end efforts to accelerate the growth rate of the subsector are recommended. This should include the adoption and improvement of the motivation provided by the recent past civilian Administrations. In addition, government should ensure that the directive to fish importers on backward linkages for aquaculture development is strictly complied with.

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Chapter 14

Quality Assurance in Technology Vocational Education Programme in Universities: Imperative for Skill and Sustainable Development in Nigeria

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Abstract

Quality assurance in education, Technology Vocational Education (TVE) in particular as an occupational oriented programme is very essential to ensure that its input and process variables are aligned with the goals to achieve quality of its product. Quality of education has a direct relationship with quality of its graduates. This cannot be achieved if the necessary plans, policies, monitoring, supervising and evaluative measures are not put in place to ensure availability of adequate teaching and learning facilities, the use of effective teaching strategies among teachers and good management of the variables in maintenance of standards. In TVE programmes skill development is very crucial for sustainable development of Nigeria. Quality assurance in TVE programmes therefore becomes imperative to maintain the standards of its input and process mechanisms in other to turn out graduates with saleable skills; for wealth creation, job generation and sustainability of the nation's economy. This paper focuses on quality assurance in TVE programmes in Nigerian universities, with emphasis on the availability of adequate teaching facilities and teachers' use of skill development strategies to achieve sustainable development in Nigeria.

Keywords: Quality assurance, TVE, University, Skill and Sustainable development

Introduction

Provision of quality education has been described as the key to all forms of development and central to the advancement of human capital necessary for sustainability of political, social and economic progress of any nation. It is a critical component and most powerful weapon to bring change in the Human Development Indices (HDI), hence a little wonder as to why it is one of the first groups of the sustainable development goals. It has been proven to be the most powerful vehicle to bring changes in other facets of human existence and crucial in attaining the future.

Education enables people to realize their potentials and improve their quality of life. This is significant if qualitative by providing the learners with the abilities to become economically productive through the development of relevant skills, attitudes and values for sustainable

livelihood. It makes one to be equipped for meaningful contributions to a peaceful and democratic society and for improved wellbeing. Equally, quality education is only feasible where mechanisms are put in place first to determine the needs of the citizens, provide learning experiences tailored towards the satisfaction of the needs and demands identified with measures to maintain standards. These attributes of quality education can only be achieved through quality assurance in our programmes at all educational levels.

Quality assurance in university education has been described as all policies, plans, measures and strategies put in place to ensure that educational programmes in universities are well developed, managed and maintained. It refers to the implementation of a well-defined standard practices and methods to achieve objectives of educational programmes, Technology Vocational Education (TVE) inclusive. TVE is a crucial aspect of education in our tertiary institutions. At universities, TVE programmes study occupations, technology and related sciences. This is aimed at acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various aspects of economic and social life (Federal Republic of Nigeria (FRN), 2013).

Quality assurance in TVE programmes is very crucial and involves a systematic review of programme procedures and standards, in terms of provisions and utilization of educational facilities and human resource to continuously improve the quality of its product. This ensures achievement of objectives by producing competent and skilled industrialists, teachers and entrepreneurs who would contribute significantly to the nation's gross domestic product and improved standard of living through job creation and employability.

Unfortunately, the performance level of technology vocational education graduates seems to be under controversy as some industrial and business managers consider the products of tertiary institutions in Nigeria unusable without further training due to lack of adequate practical experience (FRN, 2013). This has been attributed to such problems as inadequate funding, poor educational administration, monitoring and evaluation procedures, poor motivation among the instructors, poor teaching methodologies, inadequate provision of modern technological equipment to match the increasing rate of technological changes in modern times and poor usage of facilities among instructors even when available (Okoli, 2012; Odu, 2013). These consequently results to many graduates been turned out without possession of adequate skills and competences which are required for employability and sustainable development in the country. Invariably this increases the level of unemployment in the country and its socio-economic consequences such as kidnapping, prostitution and armed robbery that results to insecurity and poverty among Nigerian populace.

Posser (1982) in his Environmental theory of technology education provides the logic of providing individuals on training with an environment that is a replica of the real environment in which they must work after graduation. Learners should be trained with facilities and equipment that they will use in the real work places. Adequate provision and application of these facilities will enable the undergraduates acquire the required skills for effective performance in the world of work. Quality assurance in TVE programmes therefore becomes imperative as pre-determined measures that ensure good programme plans, provision of adequate facilities, adequate and competent instructors with good teaching methodologies and utilization of laboratory and workshop facilities necessary to produce quality graduates with saleable skills.

It is against this backdrop that this paper was conceived, to x-ray the effectiveness of TVE programmes in Nigerian universities in the areas of quality assurance mechanisms put in place to ensure the achievement of the programme objectives; vis-a-vis availability of adequate teaching facilities and use of effective teaching methodologies among its teachers for skill development

among undergraduate. This is for employability and to achieve sustainable development in Nigeria.

Sustainable Development and Quality Education in Nigeria

Todaro and Smith (2006) sees development as a multi-dimensional process that involves changes in social structures, attitudes and institutions as well as economic growth, reduction of inequality and eradication of poverty. It enhances quality of life of people, cutting across positive changes in the economic, social, political, legal and administrative pattern of a national life. National development is the ability of a country to improve the living standard of its citizens through equitable distribution of resources, provision of social amenities as portable water, accessible roads, constant electrical supply, good medical care, quality education, job generation, democracy, good governance and security of life and property (Debeau Vais in Okoli, 2016). This enhanced quality of life is expected to be sustained through sustainable development mechanisms.

Brundtland Commission Report in Schaefer and Crane (2005) defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This entails the ability of the present generation to maintain a non-declining quality of life without posing threat to future generation. Taylor (2016) opined that the goals of sustainable development revolve around the 3Es- Environmental protection, economic growth and social equity. This applies to all we do, ranging from maintaining quality and standard ecological practices in proper disposal of wastes, avoiding pollution and in cutting greenhouse gases to fighting climatic changes and its consequences; sustainable economic practices vis-à-vis increased gross domestic product, equitable distribution of resources, cutting costs and wastes through responsible consumption. Others are building social nurturing communities through social sustainability.

Social sustainability as noted by Everest- Philips (2014) is fostering the development of people, communities and cultures to achieve meaningful life through proper health care, education, gender equality, peace and stability world over. Cultural beliefs of people in a community provokes thought on the manner they live socially and economically, the utilization of their natural resources and management of their environment for improved wellbeing. Everest- Philips believes that social sustainability respects human culture and dignity, thereby preventing people from been subjected to conditions that undermines their ability to meet their needs. It aims at providing every citizen with the enabling environment to have the capacity to realize their needs if they so desire. Education of the citizens therefore becomes imperative to inculcate in them the abilities, values and attitudes for meaningful living necessary to achieving sustainable development. A nations development could be sustained without being sustainable. Sustainability in development of any nation is where the citizens are able to satisfy their human needs and wants at the present, but do not exhaust the productive resources at their disposal. Their manner of living is directed towards achieving quality of life and at the same time performing activities that will make it perpetuity, with reserves for the future generations (Thomas, 2015 & Kolk,2016).

Fafunwa in Okoli (2016) defined education as all man's activities which enable him to acquire, develop and utilize knowledge, skills and attitudes for the benefits of himself and the society. This also entails upgrading, for the purpose of improvement of existing knowledge, skills and values in the light of new socio-economic circumstances obtained in the world over. Education could be general or specific when it is vocationally or occupationally oriented. This

should be done not only through the formal school setting, but also through the non-formal arrangement that will impact on members of the society who are out of school and in the world of work.

Education is of quality if meaningful, worthwhile and responsive to individuals and social needs. It is a functional one when it is used to address or solve societal problems, satisfy the needs of its recipients and the nation at large. It provides the learners with the capabilities they require to become economically productive and independent develop sustainable livelihood, contribute to societal peace and democracy that enhances individual members' wellbeing. Quality education is crucial in empowerment of the citizens, as it strengthens them and the community in general to have more control over their resources and situations, to combat poverty and inequality in the society. Academic programmes are instituted at different education levels and at both formal and non-formal setting, with learning experiences selected, organized and arranged in an orderly manner to achieve objectives directed towards solving these individual and societal problems.

It is in a view to make education in Nigeria functional and of quality that the National Policy on Education was articulated and instituted as the best instrument to achieve the national objectives. which are; To build a free and democratic society, a just and egalitarian society, a united, strong and self-reliant nation, a great and dynamic economy and land of bright and full opportunities for all citizens (FRN, 2013). These national objectives serve as a key to all forms of national development. Quality education therefore provides the access to the door of democracy, economic, social, legal, cultural and technological development in Nigeria.

Quality education, as the 4th among the 17 sustainable development goals in the Post 2015 Development Agenda that succeeded the Millennium Development Goals (MDGs) does not just aim at sustaining a nations development within a sparse of time but makes it sustainable beyond a generation for perpetuity. Quality determines how much and how well children learn and the extent to which their education translates into a range of personal, social and developmental benefits. The learning outcomes required vary according to level of education and programmes instituted. This ranges from the acquisition of basic literacy and numeracy to basic scientific knowledge, occupational and specific life skills for employability, healthy living and management of diseases.

SDG- Education 2030 Steering Committee Secretariat (2019) report on sustainable development Goal 4 noted that despite some progress made, the world is not on track to achieve SDG 4, with the potential to leave hundreds of millions of children, young people and adults behind in every continent in 2030. They noted a continuous progress in decrease of number of out- of- school children, adolescents and youth but on a slow trend, as great number of children and youths aged 6-17 years were still out of school in 2017. Others areas of problem include, lack of basic literacy skills among graduands of primary education. Majority of primary education globally are not free and equitable, majority of women do not acquire skills as a result of gender discrimination and inequality, others include poor quality training in other educational levels such as in secondary and tertiary institutions. This unsatisfactory state of affairs as reported by United Nations undermines the tenets and philosophy behind the 4th sustainable development goal of quality education by 2030.

Sustainable Development Goal 4 (SDG4) aims to ensure inclusive and equitable quality education, and promotion of lifelong learning opportunities for all. Inclusive education is the kind of education that is provided in the formal educational setting to accommodate the interest of individuals with and without special learning needs. McManis (2017) noted that inclusive

education values diversity and the unique contributions each student brings to the classroom. In a truly inclusive setting, every person feels safe and has a sense of belonging. When education is more inclusive, it becomes equitable, providing opportunities for civic participation, employment, and community life. Education that is inclusive also breeds respect and understanding as students of diverse abilities and backgrounds play, socialize, and learn together in a common setting. McManis observed that education that excludes and segregates perpetuates discrimination against traditionally marginalized groups like the disabled and learning challenged. Quality education makes way for inclusiveness and accessibility to all boys and girls at primary and secondary school age and beyond.

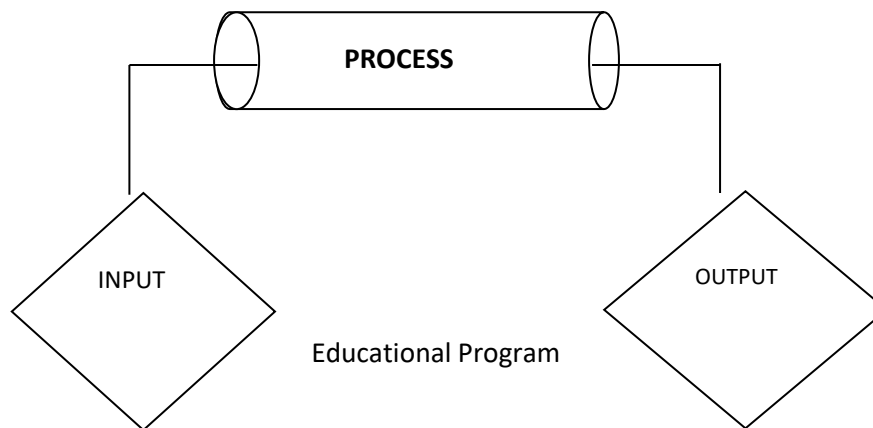
Equal access to affordable technical, vocational and higher education by 2030 is the third target in quality education, SDG 4. This target area emphasizes quality technical and vocational education to all men and women at tertiary level, including university. This area also emphasized the need to reduce barriers to skill development, technical and vocational education training from secondary school level to tertiary education and provision of lifelong learning opportunities for youths and adults (SDG- Education 2030 Steering Committee Secretariat, 2019). Lifelong education permits training beyond the formal school setting, even at non- formal settings to accommodate studies for occupations and skill development for employability in the world of work. In Nigeria as in other countries world over, quality education is used as the most reliable instrument for propelling change, to impart on the human intellect, in development of skills, values and attitudes among the citizens for sustainable development.

TVE as an occupational oriented programme is lifelong and provided beyond formal school setting. It is expected to be of quality, to produce skilled graduates competent to harness the resources available for the wellbeing of the citizens, maintaining good ecological standards with respect to human values and cultural affiliations.

University Education in Nigeria and TVE

University education has been described as the highest level of tertiary education given to persons who are qualified for enrolment for a course after the post primary education; and having fulfilled the admission requirement (Ekpang, 2008). In Nigeria, Public and private universities exist to offer university education under the control, monitoring and supervision of National University Commission (NUC). Public universities are owned and managed by federal and state governments. They were the only universities that operated in Nigeria until the insurgency in enrolment and pressure from students to secure university admission in the recent times. This made the federal government to promulgate Act No 19 of 1993; which encouraged private participation in university ownership (National University Commission, 1999). Prescribed guidelines were mapped out by the government to guide the establishment of these universities. Currently, there are 153 universities registered with National University Commission (NUC) in Nigeria; 40 accredited federal universities, 45 state universities and 68 private universities (Bolaji, 2019).

Traditionally, educational process could be described in terms of input, process and product which can be seen as components of educational programmes.



The inputs of educational programme include the students admitted, the teachers available, the environment/facilities, etc. The process is the complete interaction within and between the inputs. The outputs include the products, attainment of the ultimate programme, objectives among others. At university level, programmes are configured to achieve among others, the ability of individuals to contribute to national development through high level manpower training, develop intellectual capability to understand and appreciate the local and external environments and acquire both physical and intellectual skills to become self-reliant and useful members of the society (FRN, 2013). In universities, degrees are obtained in different academic programmes including technology vocational education.

Status of TVE in Nigerian Universities

Technology Vocational Education (TVE) is a crucial aspect of education that studies occupations, technology and related sciences. United Nations Educational Scientific and Cultural Organization (UNESCO) recommendation of TVE for the 21st century described it as all trainings resulting to the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various aspects of economic and social life (FRN, 2013; Okoli, Ogwa & Okoli, 2018). World over TVE is regarded as an instrument for empowering people especially youths for sustainable livelihood, socio-economic and industrial development. It is education for industry and designed to prepare practically oriented technical and vocational teachers. Rufai, Bin Kamin, Bin Saud & Idris (2013) noted that TVE programme is conceptualized with the following;

- An integral part of general education
- A means of preparing for occupational fields and for effective participation in the world of work
- An aspect of lifelong learning and preparation for responsible citizenship
- An instrument for promoting environmentally sound suitable development
- A method of alleviating poverty.

At university level it is expected to provide individuals with knowledge, skills and competencies for self and paid employment. TVE is designed to acquaint technical oriented personnel with applied skills and basic scientific knowledge required for technological development and sustainability of a country.

Federal Republic of Nigeria (2013) defined technology vocational education as that aspect of education that leads to the acquisition of practical and applied skills as well as basic scientific knowledge. This was ensured into the National Policy on Education with the following aims:

1. To provide trained manpower in applied science, technology, and commerce, particularly at sub professional grades.
2. To provide the technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development
3. To provide an individual who can apply scientific knowledge in the improvement of environmental problems for the use and convenience of man.
4. To give training and impart the necessary skills leading to the production of craftsmen, technicians and other skilled personnel who will be enterprising and self-reliant and
5. To enable our young men and women to have an intelligent understanding of the increasing complexity of technology (FRN, 2013).

The above aims were noted as the general goals of vocational technical education wherever it is taught; whether as basic technology, vocational / technical education at senior secondary level or core technology education at tertiary institutions. At university level, TVE programmes include technology education, business education, Home economics education and Agricultural education. In line with the goals of university education, TVE programme is provided to undergraduates for the acquisition of Bachelor of Science Degree (B.Sc.) and to post graduates for the acquisition of Master of Science (M.Sc.) or Doctor of Philosophy (Ph.D). Undergraduates in TVE programmes in universities are admitted through University Matriculation Examination (UME) and Direct Entry. The programme is for four or five year's duration. Students offering four years are required to pass courses totaling a minimum of 120 credits and 150 credits for students in five-year programme (NUC, 2004).

Technology education has three option areas as; wood/building technology, mechanical/auto mechanics, electrical and electronics technology. As noted by NUC, (2008), BSc technology education programme is expected to;

- Develop high level skill in the design, production, and improvisation of various instructional technology resources.
 - Acquire teaching skills and appropriate methods need in importing knowledge in their field of specialization.
 - Demonstrate competency in the handling of various hardware to achieve maximum result for a wide variety of target audience.
 - Gain insights on maintenance of industrial materials, tools, machines and facility.
 - Develop problem solving and creative thinking abilities.
 - Develop safely consciousness, creativity and good judgment over the use of technology.

Programme components of technology education include; general education, general technology courses, automobile Technology, building technology, metal work Technology, wood work Technology, electrical Electronics Technology, industrial attachment (SIWES) and teaching Practice. It is expected that Technology education should be effective and functional in providing its undergraduate with variety of dynamic and viable learning experiences in skill development and for employability in industrial occupations and technological fields.

National University Commission (NUC), (2008) specifically outlined the goals of undergraduate Technology education as follows:

- To produce competent teachers for secondary schools, technical colleges and trade centers.
- To produce trained manpower in applied science and technology at professional levels.
- To produce people with technology knowledge and skills necessary for industrial occupations and economic development of the nation.
- To produce skilled, self-reliant and enterprising technologists
- Preparation for advanced studies in technical education,

Business education is a programme for and about business, providing its recipients with knowledge, skills, attitudes and values that enable them to be employed (paid or self) and to progress in the world of work. Business education prepares its recipients for the world of business. The programme provides learning experiences in Secretarial education/Office Technology Management (OTM), accounting education, commerce, cooperative economics, marketing and management education. The National Policy on Education provided the objectives of business education at tertiary level of education as; to inculcate the right type of values and attitudes for the survival of the individual in the Nigerian society; and encourage acquisition of appropriate skills, abilities, both mental and physical as requirement for the individual to live and contribute to development of his society, to develop a mature understanding of the general nature of business, to provide the needed background for teaching in business subjects, to provide training for leadership in business and to provide training in specialized phases of business activity (Federal Republic of Nigeria, 2013). The goals of business education are to give training and impart the necessary skills to individuals who shall be economically self-reliant.

Other programmes of TVE include home economics and agriculture that offer special options areas necessary in producing individuals that are also self-reliant. By these, TVE create jobs for Nigerian teeming population, improves the citizens' welfare and sustainability to meet the needs of the next generation.

Historical Development of TVE in Nigeria

In Nigeria, TVE had evolved through the non-formal apprenticeship training in the pre-colonial days, when parents in a bid to ensure continuity of their trades, transmit the required skills to their younger ones. This pride was later lost following the colonization of Nigeria by the British government, who merely introduced literal education into the country, aimed at producing clerks and preachers for evangelization. Little efforts were made by the missionaries at the time to introduce technical/vocational training into the school curriculum but this was not taken serious because of its great costs. This was not also regarded by our people at the time as part of western education

The awareness for the essentials of TVE in national development started gathering momentum in Nigeria after the Phelps Stroke Report of 1920 that recommended its introduction as a necessary skill subject for work preparation. The Educational Policy in British Tropical Africa in 1925 also recommended the adoption of vocational / technical skills to the mentality, aptitude, occupations and traditions of the various people. Technology vocational subjects as brick laying, farming, etc. were therefore included in the curriculum by some mission schools. However, this was relegated to the background by parents who discouraged their children with the notion that it is for drop outs (Ekpenyong in Okoli, Ogwa & Okoli, 2018). TVE was further degraded following the Ashby Review of 1960 that put it below university education, awarding

City and Guilds certificate. At the time training was not giving to TVE teachers at university level and degrees were not awarded

The consequence of TVE neglect in national development was very glaring. There was an over reliance on other country's manpower for local productions, excessive importations and wastes of the country's meager foreign exchange among others. However, measures were taken to promote skill acquisition among Nigerians as Industrial Training Fund (ITF) was legalized and Decree No 41 promulgated in 1971. By this decree, institutions were empowered to promote and encourage skill acquisition among its undergraduates in industrial and commercial fields (Oyedele, 2004). TVE was finally incorporated into the National Policy on Education, which is the working document for the realization of Nigerian educational philosophy at all educational levels, and as a key to achieving the national objectives.

Today TVE is seen as a crucial factor in national development. This emanates from its relevance in providing training in the acquisition of technical and vocational skills required for establishment and effective management of enterprises that leads to national productivity and profitability. This stimulates wealth creation, economic growth, social sustainability through job generation and poverty reduction. Recently, technological developments have altered the nature of workplace thereby exerting great demand on occupational preparation of the TVE graduates. There is also need to go beyond meeting the occupational demands of the present times to inculcation of good social and environmental habits among the recipients to ensure that activities they undertake do not put the future generations in jeopardy. All these expectations call for quality assurance in TVE programme.

Quality Assurance in TVE Programme

Quality assurance in TVE programme refers to all policies, plans, measures and strategies put in place to ensure the effectiveness of the programme in universities. Okogie (2008) noted that performance of programmes in universities is constantly been evaluated, monitored and supervised by National University Commission to maintain set standards. The ability of the Nigerian educational system to provide undergraduates with relevant knowledge, skills and competencies for employability serves as the key to improvement in the nation's standard of living and its sustainability from one generation to another. Quality assurance therefore becomes imperative in our universities, as programmes need to be well-developed, managed and maintained.

Quality assurance in TVE programme of universities describes the degree to which TVE programme objectives are attained vis-a-vis institution of effective teaching and learning measures such as in the provision of facilities, adoption of effective teaching methodologies in skill development with effective monitoring and supervision mechanisms to maintain high performance. The TVE undergraduates need to be exposed to broader areas in technological applications, entrepreneurship and social sustainable practices to enable them cope with new procedures and the emerging technologies posed by the 21st century. Programmes like TVE must be such that will enable learners to understand and apply a wide range of concepts and skills, which they can use for employability purposes. This implies the institution and integration of educational reforms and implementation strategies, with effective monitoring and evaluation activities that are directed towards the achievement of TVE programme objectives of University education. Implementation of a well-defined standard practices and methods is therefore crucial. There are varied approaches to quality assurance in TVE Programme, to determine the programme effectiveness. Hornby (2006) defined effectiveness as the degree to which objectives

are achieved and the extent to which targeted problems are solved. It is the ability of something to produce the intended result that is wanted successfully. Quality assurance in a programme also involves establishing cause-effect relationships about the extent to which a set of policies produces the desired outcome. Rossi, Lipsey and Freeman (2004) outlined the following assessment activities as associated with evaluation of programme effectiveness.

- Assessment of the need of the programme
- Assessment of programme design and logic/theory
- Assessment of how programme is being implemented (i.e if the programme is being implemented according to plan). Is the programme process maximizing possible outcomes?
- Assessment of programme outcome or impact (i.e., what it has actually achieved)
- Assessment of the programme cost and efficiency

Quality assurance in TVE programme therefore entails the above deliberate activities. Finding out the extent the programme objectives are achieved; also, if the implementation process were carried out at a minimum cost. National University Commission (NUC) the body responsible for maintenance of standards of university education conducts accreditation regularly in different programmes, TVE inclusive. Areas monitored and supervised include, adequacy of infrastructures, workshop and teaching facilities, teachers and administrative capacity. This paper will be focused on the effectiveness of TVE in the areas of workshop facilities and teaching methodologies for skill development.

Adequacy of Workshop Facilities in TVE

The performance level of TVE graduates is a function of available instructional facilities to which students are exposed to during training. Workshop facilities are tools, equipment and machines used for practical works which are inevitable in the teaching and learning of TVE subjects. Well-equipped workshops are of paramount importance for effective operation of technology education programme as students are exposed to different equipment, machines and tools, for acquisition of skills; ready for effective performance in industries where the facilities are used in production (Okoli, Uzoagulu ana Okoli, 2018). This is very important because the overall atmosphere in which learning takes place has a direct relationship to the learning one receives. Availability of adequate workshop facilities creates a balance between theory and practical experience in universities for better performance of its graduates in self or paid employment. Owoieye and Yara (2010) also discovered that students in schools with equipped workshops have better academic performance in their final examinations.

The tools, equipment and machines used in TVE may vary based on the programme areas and options. In technology education for instance, NUC (2008) in its Minimum Academic Standard, provided list of tools, machines and other equipment required in the various programme options of mechanical/auto mechanics, electrical/electronic technology, wood work and building technology. The workshop facilities include; hacksaw frame, cold chisel, steel rule (300m) scribe, venire calipers, hammers, try square, benches vices, forging hammers, blow lamps, soldering bits, anvil, flat nose pliers, furnaces for heat treatment, punches, ring spanners, socket spanner, ball pen and grease gums. Others are pliers, assorted file, Allen keys, twist drills, tread cutting taps and dies, rubber mallet, tire levers, welding equipment, electric soldering irons, grinding machine and wheel balancing machine among others. The adequacy of these workshop facilities for technology education programme in the universities depends on the various institutional provisions in meeting the minimum standard of the controlling body.

National University Commission, NUC (2008) also provided a minimum standard to be provided for each of the workshop facilities and upon which the workshop facilities provided in each of the universities could be considered as adequate or inadequate.

Unfortunately, these workshop facilities appear to be lacking in most of the universities or inadequate where available. Okoli (2016) in an evaluation of effectiveness of B.Sc Technology education programme in Universities in South-east Nigeria identified and studied a total of 159 workshop facilities in four universities. Out of the 159 items, 67 were found available in all the universities, representing an availability percentage of 42.1. Also, out of the 159 workshop facilities, only nine items were adequately provided in the universities representing 5.66 percent adequacy. This revealed a state of gross inadequacy in the workshop facilities available for instruction in technology education programme in Universities in South-east Nigeria. Uwaifo (2011) also discovered same problem of inadequate workshop facilities for teaching in technology education from 10 universities studied in Nigeria. It was expected that there should be improvement in facility provision in the universities following the purported claims of Nigerian government in boosting TVE for skill acquisition. However, these recent findings have confirmed that the expectations were not met. This problem was also discovered in other TVE programme areas as in business education (Okoli & Ibeh, 2017).

This problem of inadequacy in facilities for instruction in TVE programmes has been attributed to insurgency in university education and poor funding by the government. Nwaiwu, Dikeocha and Nwagu (2015) observed educational budget appropriated in some African countries in comparison with the 26 percent stipulated by the United Nations Educational Scientific and Cultural Organization (UNESCO) as grossly inadequate. Such include Nigeria, 0.79 percent, South Africa 7.9 percent, Ghana 4.4 percent and Angola 4.2 percent. The full implementation of the 26 percent education budgeting in Nigeria will pave way for adequate funding of TVE programme in our universities for the procurement of relevant workshop tools, equipment, machines and other teaching facilities. This will also pave way for maintenance of the equipment for greater use and effective management and administration of TVE programme in the universities. This inadequate provision of facilities consequently affects the quality of graduates' turnout, as the graduate are been produced without the necessary employability skills. The amount spent on education goes a long way in determining the quality of education offered and quality of its product. No educational programme can be effectively managed and administered without adequate funding (Okoli & Osi, 2018).

This work has implications for all TVE programmes that include technology education, business education among others. Technology Vocational Education as a practical oriented programme cannot achieve its objectives in a situation where facilities required for instruction and skill development amongst undergraduates are grossly inadequate. Students cannot acquire the necessary skills required for gainful employment in the modern age enterprises without proper training that will expose them to technical equipment and maintenance. Technology vocational education undergraduates therefore need to be prepared, exposed and made accessible to facilities used in real life situation. Inability to step up the shortfalls in these workshop facilities in line with NUC minimum standards continue to pose threats to quality of TVE graduates produced in the universities.

Skill Development and Strategies in TVE Programme

The role of TVE in skill development in close relationship with sustainability of national economy and other social sectors is crucial. Skill acquisition programme is the gateway to

sustainable wealth creation in Nigeria, and the inability of educators to use the practical strategies relevant to skill development in the teaching of TVE programme may mar its objectives. Skill development strategies are integrated in TVE programmes to ensure production of self – reliant graduates, entrepreneurs who are job creators and performers even in paid employment. This is important in reducing poverty, social inequality and in increasing the wealth creation of the nation. TVE provides saleable skills for paid employment and upgrading of skills to meet the occupational needs and demands of modern businesses and industries; that results from technological advancements and innovations from the knowledge-driven economy. Technological advancements and innovations bring changes in the manner of production in the work places and these calls for greater commitment in the preparation of TVE undergraduates for skill acquisition.

Okoli, Ogwa & Okoli (2018) noted skill development as training giving to a person for progressing in the ability to perform quality works. Skills are abilities, capabilities, aptitude and expertise acquired through deliberate, systematic and sustained training necessary to adaptively perform job functions effectively. TVE is a skill development programme and help undergraduates in strengthening their abilities and in acquisition of skills necessary to play roles effectively in enterprises as paid and self-employed person. The employability of a person depends on the knowledge, skills, abilities and attitudes possessed and the way such competencies are applied in line with the needs of the labour market. The occupational skills required by undergraduates of VTE include technical skills, managerial skills, leadership skills, accounting skills, professional skills, communication and information processing skills, creativity skills, cooperative skills, credit sourcing skills, home management skills, decision-making skills, civic awareness skills, marketing skills among others (Okoli & Ezenwafor, 2014). The acquisition of these skills has the capacity to augment, inspire productivity and further generate income for life among people. They are also employability skills which transient occupational to include generic skills that are readily transferable across different work settings for effective performance. By teaching these skills, TVE programmes enable an individual to learn, explore and prepare for a trade and to maintain a job.

Strategies for Developing Skills in Technology Vocational Education

The ability of TVE graduates in contributing to success of enterprises, poverty alleviation and economic development of the nation depends on the skill acquisition training received and teaching strategies used by the educators. This imposes a greater demand on TVE educators for the use of appropriate teaching strategies that could fortify the undergraduates with the right skills to face the challenges of the labour market. Okoli, Ogwa & Okoli (2018) explained various strategies that are practical oriented which could be applied in the development of reliable skills among undergraduates in TVE programmes. Such strategies are taught to students, using pragmatic teaching techniques as demonstration, problem solving, lecture, discussion, field trips (excursion), role play and internships.

A. Project Method as a Strategy

This method facilitates skill acquisition through application of knowledge in solving problems with little direction of the educator. Students are allowed to explore their environment and based on their areas of interest embark on projects that aims at showcasing their ingenuity. The projects may be suggested by the teacher, but they are planned and executed by the undergraduates themselves, individually or in groups within the period directed by the educator. Project method

as a strategy improves student involvement and motivation in order to foster independent thinking, self-confidence, and social responsibility.

B. Demonstration

This is teaching by doing as evidence or proof of a claim. It is a planned performance by a teacher on an occupational skill aimed at explaining the steps or facts of an operation and usually a basic strategy for introducing new skills to the learner. It is aimed at showing how a process, procedure or experiment is to be carried out. In TVE programme, the teacher demonstrates as students do same under supervision.

C. Questioning

This strategy makes the students active participants in the learning process especially in acquisition of practical knowledge and skills. It exposes undergraduates to the unknown as a stimulus - respond technique for confirmation of ideas. This is adopted when learners are reluctant to contribute to discussion or are bored as it makes them to participate effectively. The educator could equally raise issues or fact-finding tasks in any of the programme areas and instruct learners to form groups for discussion. These groups later come together again after trashing the issues out, at the expiration of allotted time to give reports. As a skill development strategy, questioning stimulates thinking in students and elicits responses that will lead to the proper solution of problems in technical, business and the field of entrepreneurship.

D. Explanation Strategy

This strategy imparts skills in conjunction with almost all other methods of teaching. Concepts are first explained and followed by practicals. For instance, in impartation of skills on how to start an automobile engine, the concept of automobile engines and how they function is first brought to the knowledge of the undergraduates. The use of explanation as a strategy to impart skills among students start with what the student is familiar with, and then proceed towards the desired goal. This is done by moving from simple to complex concepts. This is further followed by demonstration by driving the engine as practical example. The material to be presented should be properly understood. The instructor should also ensure that explanation giving arouses the interest of students and does not dampen that which already exists. To make the strategy more effective, explanation should be as simple as possible with words that are relevant and simple to understand. Unfamiliar trade or technical jargons should be well explained (Okoli, Ogwa & Okoli, 2018).

E. Lecture Using Buzz Group

Lecturing is the most common method used in teaching, especially when the facilitator has a wide area of knowledge to cover to a large number of people within a short period. Imparting skills with lecturing as a strategy in TVE is very effective when combined with buzz group. The undergraduates are divided into smaller groups and organized to lecture and present shared topics in turns to the entire class. The course content is shared and assigned to member groups with leaders for control. The facilitator directs the activities of each group in terms of objectives and procedure to achieve the desired outcome. The use of buzz groups engages undergraduates in discussion to bring in their own life experiences and to make them active participants in the teaching/ learning process. As adult learners these students have previous knowledge on some issues which they need to bring to the present.

F. Role play Strategy

This is when members of a group, either individually or in smaller groups act a role in given situations to demonstrate ideas. It is very effective for skill acquisition in entrepreneurship and business programmes, as it demonstrates actions necessary for success or failure of given

projects. Role play stimulates active participation of learners and gets them involved in activities required for successful entrepreneurship. To achieve success, the facilitator is expected to effectively direct learners earlier before the role play starts by explaining the objectives of the lesson. This makes learners more interested in the educative aspect of the play than the entertainment. A discussion session is also held at the end of the role play to highlight the major experiences and knowledge required to be acquired.

G. Field trip Strategy

This is equally a powerful strategy in skills acquisition among undergraduates. It entails organizing educative visits to successful establishments, entrepreneurs or institutions for first-hand information. Field trips are made effective when well organized and combined with teachings that are in line with the concrete and direct learning experiences provided. At the end of the trip, students are engaged in group discussion to make sure that the aim of the trip was achieved.

H. Internship Training Strategy

Internship Training in skills development to undergraduates of TVE is a collaboration between schools and industries for real life work experience. This form of collaboration is necessary after exposing students to theories and concepts in TVE programmes. They are attached to industries where they are expected to do the practical aspect of the knowledge acquired. Effectiveness of internship as a strategy for developing skills among TVE undergraduates entails proper planning, timely posting, organization, proper implementation, monitoring and effective supervision. To achieve the objectives of internship and to develop skills taught, students must be fitted in establishments that provide services in their areas of study and with adequate facilities, equipment and machines to work with. This will help them establish such small scale enterprises to become self-reliant or effectively perform in such businesses as workers after graduation.

I. Conferences, Seminars and Workshops

These are training sessions organized for teachers, students and stakeholders in TVE programme. Seminar is a one-day training while conference lasts for days with programmes in problem areas organized for discussions. Important issues that are crucial for better performances in teaching and learning in TVE programmes. Also, for increase knowledge and better practices of participants in businesses, entrepreneurship, technology, agriculture, among other areas; TVE programmes should be a discuss for national development. Exhibitions could also be organized to attract public interest to the programme.

J. Students Teaching Practice

The curriculum of the undergraduate's technology vocational education provides its students with foundational courses in the principles and practices of education, tenets in their major subject areas of specialization and teaching practice for acquisition of practical skills in the actual classroom situation (NUC, 2004). It is assumed that these undergraduates have not taught before, therefore student teaching practice exposes the teacher trainees to the realities of teaching through broad range of activities to acquire skills for future success in teaching performances. Okoli (2016) discovered student teaching practice as a practical teaching activity by which the student teachers are given an opportunity in actual school situation to demonstrate and improve training in pedagogical skill over a period of time.

Okoli and Ibeh (2017) noted that employers are on the demand side of labour and are the key stakeholders who identify the skills which people need to obtain, develop and maintain their jobs in the labour market. The employers of technology vocational education graduates are either

school based or business/industrial based as the recipients are trained either to teach in educational institutions or work in businesses and industries. These employers of labour are also in a better position to assess the performance of TVE graduates regarding the knowledge they acquired in TVE programme, the skills and attitudes they possessed for effective performance in their jobs. Evaluation of skill acquisition among TVE graduates is therefore an approach to quality assurance in TVE programmes.

Nworlu-Elechi (2013) noted that poor performance of TVE graduates is no longer news in Nigeria as projects in the country particularly in the area of construction industry are run by technicians and craftsmen from neighbouring West African countries. This means that our TVE graduates lack the necessary skills demanded by the employers for effective performance, hence the high rate of youth unemployment in the country in the recent times. This has equally increased the nations poverty level to 70 percent as many Nigerians live below less than one dollar per day (Okoye & Anumonu, 2016). TVE in Nigeria could not meet up with the expectations of the founding and successive governments due to some challenges of the programme. Such factors impeding effective skill development among TVE undergraduates include; inadequate funding for provision and maintenance of laboratories and workshop equipment. Aghenta in Okoye & Anumonu, 2016 reported that this results to turning out of half-baked graduates. Others are poor curricular that is based on foreign model and overloaded with academic and intellectual science at the expense of basic engineering and technology that is home based; poor entrepreneurial skill development, poor teaching methods, inadequate staffing, inadequate staff training and development among others (Okoli, Uzoagulu & Okoli, 2018; Ojimba, 2012).

Okoli (2016) findings discovered that four universities studied in South east Nigeria did not have adequate number of technology education lecturers as recommended by National University Commission minimum staff mix (20, 30 and 45 percent for professors, senior lecturers and others respectively). The findings are in line with that of Besmat Digbori (2010) that discovered that institutions are short of technical teachers in adequate number. This is not also far from the discoveries of Igbinoba (2000) in business education programme which is also part of TVE. Skill courses should have a staff/students ratio of 1:30 and the NUC Minimum staff mix must be adhered to. Quality of teachers in terms of rank should be blended and provided in adequate numbers to match students' population for effective instruction. The high quest for university education, TVE inclusive in the present times must be matched with teachers provided in terms of quantity and quality. This is to ensure achievement of objectives in TVE of these universities especially in skill acquisition among the graduates.

In Nigeria value system, there is much emphasis on possession of university qualification and certificates rather than possession of knowledge and skills and this is increasing the problems of TVE. In advanced countries, certificates are deemphasized and more preference given to skill acquisition. World Bank in its 1991 policy emphasized on development of a skilled labour force for development of any nation (Okoye & Anumonu, 2016). The most effective and efficient way to develop required skill among the undergraduates of TVE is to involve private sectors, employers of labour and training institutions. The employers are on the demand side of labour and are the key stakeholders who identify the skills which people need to obtain, develop and to maintain their jobs in the labour market. They are therefore in a better position to help training institutions achieve objectives in TVE programmes as catalyst for economic and social development. Equally, the objectives of the programmes cannot be achieved where the necessary resources are found to be grossly inadequate.

Conclusion

TVE as a competency-based programme remains the gateway to skill and sustainable development in Nigeria. Ensuring quality assurance in TVE programme means having the key to all forms of development and central to the advancement of human capital necessary for sustainability of political, social and economic progress of any nation. Adequate funding must be provided for provision of adequate infrastructural, laboratory and workshop facilities, adequate teachers and effective management in TVE programmes. When these resources are adequately provided, skilled graduates will be produced for industrialization, technology growth, wealth creation and poverty alleviation among Nigerian populace. TVE has also been proved to be the most powerful vehicle to bring changes in other facets of human existence and crucial in attaining the future.

Recommendations

In line with the assertions of this work the following are hereby recommended:

1. Adequate funding should be made available in TVE programmes of universities through public private partnership for provision and maintenance of adequate modern laboratory and workshop facilities for skill development among undergraduates.
2. Federal and state governments should allocate adequate fund to universities and TVE departments for adequate provision of resources, effective maintenance of equipment and management of programme.
3. Adequate provision should be made by the governments and university management to ensure adequate staffing in TVE programme, both quantity and quality for skill development of the undergraduates. Provision of teachers should be made in line with NUC minimum staff mix of 20, 30 and 45 percent for professors, senior lecturers and others respectively.
4. There should be constant training and retraining of TVE staff for upgrade of knowledge and skills in line with innovations in business and industrial work places due to technological changes. This is to ensure imparting of needed skills to the undergraduates.
5. TVE staff should be attached to businesses and industries periodically for field practices, to be conversant with changes in technologies and uses of facilities for better teaching of skills to undergraduates for better job performances.
6. Beyond accreditation TVE programmes in universities should be regularly monitored and supervised to ensure adequate implementation of programmes based on NUC standards.
7. There should be constant review of curricular in TVE programmes to match the learning experiences provided to undergraduates with changes in work environment and skills demanded by employers of labour.
8. Students Industrial Work Experience (SIWES) and Students Teaching Practice (STP) should be adequately administered through proper placement, timing, monitoring and supervised to ensure that the undergraduates acquired the required skills.
9. In addition to university degrees obtained in TVE programmes students should be trained and certified for proficiency in special skill areas in their programme options.
10. Youths in Nigeria should be sensitized by Heads of TVE programmes in universities in collaboration with the Ministry for Youths and Sports on the importance of skill acquisition; and for a change in the societies value orientation and rush for degree certificate acquisition without possession of relevant skills.

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Chapter 15

Framework for the Sustainable Management of the Oil and Gas Environments in Nigeria

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Abstract

The quest for economic growth as enhanced by crude oil and gas discovery in Nigeria as far back as in 1903; has countervailed numerous altruistic crusades which are resulting into incessant environmental degradation in the Niger Delta region. A cursory study into the level of adherence to environmental laws by oil and gas actors is highly imperative for ensuring a safer and healthier environment in the oil producing communities of Nigeria. Therefore, the aim of this present chapter is to x-ray the roles of oil and gas industry in order to ascertain their compliance levels with environmental protection laws towards enhancing salubrious human conditions in oil producing communities of Nigeria. To achieve the above stated objective, the doctrinal method of research was adopted wherein the analytical and historical approaches were employed. Primary and secondary sources of collection of data were resorted to. Here, the result indicates that, some activities of the oil and gas industry greatly negate the principle of sustainable development; thereby, critically endangering the biodiversity and human lives in the oil and gas producing communities of Nigeria. In conclusion, national oil and gas development activities must conform to the principle of sustainable development; which requires that, policies and programmes are executed towards achieving economically viable, socially acceptable and ecologically sound natural resources management. Therefore, to effectively ensure the principle of sustainable development in Oil and Gas Producing communities of Nigeria, it is hereby recommended that, relevant environmental Regulatory Agencies and the Judiciary should strictly enforce compliance with extant environmental laws as well as ensuring strict adherence by both the Regulatory Agencies of government and the private operators; so as to serve as deterrence to would-be defaulters.

Keywords: Doctrinal method of research, Environmental laws, Nigeria, Oil and Gas Industry, Polluter-Pays-Principle, Sustainable Development

Introduction

It is a reality to categorically state that the oil and gas sector in Nigeria has contributed tremendously to Nigeria's economic growth. Regrettably, the unsustainable exploitation of oil and gas resources in the country has placed the lives and environment in the Niger Delta region in jeopardy because, of the increasing dangers posed by environmental degradation and gas flaring. According to Udok and Akpan, (2017), gas-flaring is as old as the discovery of crude oil in Nigeria and it remains a global environmental malaise with its attendant environmental

consequences Adebayo, (2012) such as facilitating global warming occurrence, environmental pollution and marine biodiversity loss (please, cite a relevant source, here). Furthermore, Udok and Akpan, (2017) asserts that, Nigeria accounts for an estimated two billion standard cubic feet of gas flared annually, and which amounts to about 19 percent of gas flared, globally. Meanwhile, Aniefiok et al., (2013) expressed that, Nigeria has over one hundred and twenty-three (123) gas flaring sites within its Niger Delta region. Therefore, the foregoing highlighted environmental situations mostly create climate change related problems because, gas flaring is adjudged as the highest emitter of greenhouse gases in Africa (Aniefiok et al., 2013). The negative impact of gas flaring affects all forms of life existing on the oil and gas communities; thus, worsening social problems stemming from unsustainable and illicit activities perpetuated by some and gas industry and artisanal operators

Hence, there is a clamant need to figure out a holistic approach in the oil and gas sector that will foster global principle of sustainable development in oil producing communities. The 1987 Brundtland Report (as cited in Akpabio & Akpan, Year (2019) defines ‘sustainable development ‘as a development that meets the needs, of the present human generations (particularly, the poor people); without compromising the ability of future human generations to meet their own needs. Therefore, discussing the concept of sustainable development in an aggregate form, it can be termed as improving the quality of human life while operating within the carrying capacity of supporting environmental ecosystems; relating to wise usage of natural resources including surrounding air (1995 Ajai,). Meanwhile, sustainable development goals (SDGs) as a 2015 international agreement encompass the following three (3) key elements (Max 2016): (i) Intergenerational Equity; (ii) Sustainable use of Natural Resources; and (iii) Integration of Environment and Development. The fore-listed three (3) elements of sustainable development can be explained as thus: Firstly, present human generation should responsibly bequeath inheritance of wealth, to their unborn generations, in no less than the quantity they had inherited from older generations. Likewise, the present generations should hold in trust, the inherited natural resources as trustees for their future human generations. Secondly, sustainable exploitations of natural resources should be ensured order to preserve them from indiscriminate explorations. Lastly environmental protection should constitute an integral part of the development process and it must not be considered in isolation from both economic and infrastructural developments. In a nutshell, sustainable development has thus, been described as a global measure to curb ecological problems that emanate from grievous industrial exploitation of resources that can lead to environmental degradation. In the same vein, socio-economic development can imperatively entail the preservation of the physical environment amid growth in the oil and gas industry. Nevertheless, in the case of **Gabcikovo –Nagymarous Project held at the International Court of Justice (ICJ)** in the Netherlands in 1997, the Jury advocated for the inclusiveness of the concept of sustainable development into the development activities of oil and gas industry such that economic development objectives could be achieved together with the goals of environmental protection Okon (2016). The Vice President in an *obiter dictum* opined wherein he reviewed the principle of sustainable development held it to be a well-established principle in international law with normative value and not a mere concept.

i. Brief Historical Background

Early ideas of sustainable development in the twentieth century were rooted in forest management. It gradually shifted towards economic development, social development and environmental protection. Thus, in recent times, this principle of sustainable development gained

widely varied interest across the globe due mainly to the protection and preservation of life as well as its impact on national development.

In 1972 the Stockholm Conference held in Sweden from June 5 – 16 began creating awareness on the need for sustainable development having two key focuses which included institutional framework for sustainable development and green economy in the context of sustainable development and poverty eradication Linner & Selin (2013). The concept of sustainable development became a reality and was introduced in 1980 through a joint report published by United Nations Environment Protection (UNEP), the World Wildlife Fund (WWF) and the International Union for the Conservation of Nature (IUCN 1980;). Sands, 2003). Furthermore, with the publication of the Brundtland Commissions Report of 1987 our common feature subsequently became a household feature in numerous texts of all kinds in addition to the Rio Conference in 1992. Sustainable Development as a concept gained a foundational base from the 1992 United Nations Conference on the Environment (UNCED) also known as the Rio Conference of 1992 which led to the emergence of the Agenda 21 document. The , Rio Conference, declared that, human beings are at the Centre of Sustainable Development, as such, humans are entitled to a healthy and productive life in harmony with nature.

Also, Principle 4 of the Rio Conference states that, in order to achieve sustainable development, environmental protection shall constitute an integral part of the developmental process as it cannot be considered in isolation from it (Ndukwe, 2000).

The fundamental principle of sustainable development is that human wealth and the quality of life of the people is part of and linked to the diversity, productivity and quality of the ecosystem. (Aigbokhaevo, 2010)

In the context of this present chapter, the central aim of sustainable development therefore, is to encourage sustainable explorations of oil and gas resources for national infrastructural development and at the same time, ensure the conservation (otherwise known as wise usage) of both flora and fauna living things on resources on Planet Earth. Consequently, the 17 United Nations Sustainable Development Goals (SDGs) are all hinged on the following three (3) pillars of sustainable development (insert the source here): (i) economic objectives, (ii) social objectives (bothering on ensuring the welfare and equity among human races/tribes) and (iii) ecological objectives (ensuring biodiversity of plants and animals). According to the United Nations Development Program (UNDP), the Sustainable Development Goals which were ratified by the United Nations General Assembly in 2015 to achieve the below listed Global environmentally related goals by Year 2030 (Guterres 2019):

- (a) Clean water and sanitation (SDG - 6)
- (b) Affordable clean energy (SDG-7)
- (c) Climate action (SDG-13)
- (d) Good health and wellbeing (SDG-3)
- (f) Biodiversity preservation on: land (SDG-15) and water (SDG-14)
- (g) Peace, justice and strong institutions (SDG16)
- (h) Partnerships for the goals (SDG-17)

Consequently, the International Law Association Committee on the Legal aspect of Sustainable Development released the 2002 New Delhi Declaration on the Principles of International Law on Sustainable Development. Bernard M This specific International Law Principles, buttressed the need for countries of the World to exert their individual sovereign rights in sustainable management of their respective natural resources in consonance with their national environmental and oil and gas development policies.

Oil and Gas Industry in Nigeria

The history of oil exploration in Nigeria dates back to 1903. At that time, Nigerian Bitumen Corporation conducted an exploratory work in Nigeria. Meanwhile, a major breakthrough in oil discovery by Shell B.P occurred in 1956 in Oloibiri in present day Bayelsa State. Currently, Nigeria is among the leading producers of oil and gas in Africa. The Gross Domestic Products (GDP) of the country is heavily boosted by the oil and gas sector, being a major source of revenue generation Aregbeyen & kolawole (2015).

In agreement with the environmental clause contained in the Principles of International Law, Section 44(3) of the 1999 Constitution (as Amended) of the Federal Republic of Nigeria (FGN) vests exclusive control and management of mineral oils and natural gas on the Federal Government; it provides thus

“Notwithstanding the foregoing provisions of this section, the entire property in and control of all minerals mineral oil and natural gas is under or upon any land in Nigeria or in, under or upon the territorial waters and the exclusive economic zone of Nigeria shall vest in the Government of the federation and shall be managed in such manner to be prescribed by the National Assembly”.

To ensure effective environmental enforcement, the Department of Petroleum Resources (DPR) was established as the Regulatory Agency of Federal Government of Nigeria for the oil and gas industry in Nigeria Faturoti, 2018. DPR’s mission includes but not limited to the following, three (3) environmental sustainability mandates:

1. To ensure safe and environmentally sustainable development of the oil and gas operations activities.
2. Regulation and monitoring of industry activities to ensure compliance with best standards and practices
3. Implementation of all government policies.

Other legal instruments operational in Nigeria for regulation of oil and gas development activities are, the Nigerian Minerals and Mining Act of 2007 and the Nigerian Land Use Act of 1990 also known as Cap 202 Laws of the Federation of Nigeria (LFN 2004). Others are:

1. Petroleum Act 1969 now Cap P10 Laws of the Federation of Nigeria (LFN)
2. 1999 Constitution of Nigeria
3. Mineral Oil (Safety) Regulation of Nigeria 1997
4. EGAPSIN (Environmental Guidelines and Standard for the Petroleum Industry) of Nigeria 2018
5. Land Use Act 1990 now Cap 202 LFN 2004
6. Associated Gas Re-injection Act 1970 now Cap A25 LFN 2004
7. Environmental Impact Assessment Act 1992, Nigeria
8. Harmful Waste (Special Criminal Provision Act 1988, Nigeria)
9. Nigerian Oil and Gas Industry Content Development Act 2010, Nigeria.
10. Nigerian extractive industries transparency initiative Act 2010 2007, Nigeria
11. Oil pipeline Act 07 LFN 2004, Nigeria.
12. Oil in Navigable Waters Act 1968 Cap 06 LFN 2004)

In spite of the oil and gas affirmative contribution, Nigeria's oil and gas industry has created numerous setbacks resulting to environmental degradation from corporations carrying out oil and gas operations in the Niger Delta region. Reason being that, some of these oil companies usually engage in unsustainable exploitation crude oil and production of by-products in total violations of many extant environmental regulations, policies and guidelines Ekhaton, (2016) Nonetheless, the oil and gas industry has been responsible for incessant oil spillages, gas flaring the Niger Delta region of Nigeria; thus, causing devastating effects on the lives of the inhabitants in oil producing communities. As such, associated problems with gas flaring, oil spillages, coastal erosion are examples of anti – sustainable development practices by most oil and gas practitioners.

4. Evaluating the Framework for the Sustainable Management of Oil and Gas Environment

The oil and gas industry has a number of laws regulating the industries and some of the actors take into cognizance sustainable development and environmental objectives when carrying out their activities. For instance, Chapter 8.14 of the **Agenda 21Global** Document empowers countries to operationalize effective legal and regulatory frameworks for achieving sustainable development principles, quote:

“To effectively integrate environment and development in the policies and practices of each country, it is essential to develop and implement integrated, enforceable and effective laws and regulations that are based upon sound social, ecological, economic and scientific principles. It is equally critical to develop workable programmes to review and enforce compliance with the laws, regulations and standards that are adopted...”

In consonance with Agenda 21, Nigeria has operationalised a plethora of legislations in the oil and gas sector towards achieving environmental sustainability in oil and gas development in the country. Some legal frameworks on oil and gas industry having specific focus on environmental sustainability in Nigeria are discussed below:

i. Nigerian Oil and Gas Content Act 2010

The aim of this Act according to Section 2 is to provide a systematic development of the capacity and the capabilities of the Nigerian economy by intentionally employing Nigerian human and material resources and also services in the Nigerian oil and Gas industry. This Act has afforded more Nigerians participation in the Oil and Gas industry and one of the major goals of sustainable development is poverty eradication. Meaning that if more people are gainfully employed the poverty rate drops in the country. In order to encourage technology and infrastructural development, Section 47 of the Act provides for transfer of technology to Nigerians.

ii. The Environmental Impact Assessment Act (EIA) 1992

Prior to the enactment of the Act, communities in Oil and Gas Producing States of Nigeria had no access to basic amenities such as healthcare, food and clean water due substantially to the devastating impact of oil and gas industries which had virtually polluted their arable lands and

water sources. However, with the introduction of the Environmental Impact Assessment (EIA) Act of 1992 by the Federal Government of Nigeria, the oil and gas industry is now mandated to adhere strictly to EIA provisions when carrying out their activities. In the EIA Act, oil and gas operators are to ensure the following:

- i. Preserve the environment and ensure that activities are carried out in an environmentally friendly manner that allows for sustainable development;
- ii. Reduce negative environmental and social impacts of oil exploration activities.
- iii. Prevent pollution and ensure safer health environment for sustainable development.
- iv. Create social and economic benefits from the Oil and Gas industry for host communities through corporate social responsibilities.
- v. Ensure that those companies which fail to meet the environmentally best practices are penalized in line with the provisions of the EIA Act in which imprisonment is the ultimate penalty for gross violations of the Act.

C. The Petroleum Act Cap P 10 LFN (2004) - This is the Principal Act that regulates petroleum operations in Nigeria. The Minister is empowered to ensure that regulations are made on the safe working and prevention of pollution of water courses as well as the atmosphere, See section 9(i) b (ii) and (iii) of the Act. The Petroleum Regulation Cap P10 LFN (2004) is another subsidiary law made under the Petroleum Act. The Regulation prohibits the discharge or escape of petroleum into waters. See Regulation 13. Also, licenses and lessees are expected to apply all practicable precautions, using up to date equipment to prevent pollution in inland waters, rivers, the territorial waters of Nigeria, or the high sea by oil, mud, other fluids or substances which might contaminate the high seas, banks or shoreline or which might cause harm or destruction to fresh water marine life and where any such pollution occurs shall take prompt step to control, and if possible end it. Regulation 25.

D. The Oil in Navigable Waters Act Cap P 10 LFN 2004) was enacted to protect the marine habitat, particularly sea areas within 50 miles from land and outside the territorial waters of Nigeria. Discharge of oil (by a Nigerian ship or any ship whatsoever) or any mixture containing not less than 100 parts of oil into any part of the Sea classified as prohibited sea Area” Section 1 of the Act, is an offence.

E. The Associated Gas Re-Injection Act 1979 provides:

- Schemes for the viable utilization of all associated gas produced from a field or group of fields;
- Projects to re-inject all gas produced in association with oil, which are not being utilized in an industrial project Section 2(1) Associated Gas Re-Injection Act 1979). This Act was amended in 1985. The Associated Gas – Re – Injection (Amendment Act 1985), allowed petroleum production companies to continue to flare gas in certain fields provided the Minister issued certificate subject to certain condition such as where more than seventy five percent of the produced gas is effectively utilized or conserved Section 3(1). Even though gas flaring has not been totally eradicated, positive steps towards reduction and probable elimination are being taken by the various existing legislations. Even though Nigeria continues to extend the flare out deadline (Aladeitan, 2010).

Also, Section 8 of (NESREA) 2007 should be re-assessed. Exclusion of the oil and gas industry activities from the supervision and control of the agency makes it more difficult to insist on sustainable development practices and procedures which the oil and gas industry are expected to adhere to. Checks and balances by the Agency if permitted on the oil and gas industry would foster them into sustainable development practices.

5. The Role of the Judiciary in Ensuring Sustainable Environmental Management

The courts have a huge role to play in ensuring that cases which have the likelihood of emphasizing sustainable development for the benefit of host communities should be properly adjudicated and ensure smooth execution of judgments pronounced. Klaus Toepfer, the Executive Director of the United Nations Environmental Programme UNEP 2005, stated in his message to the UNEP Global Judges Programme that: “The judiciary is also a crucial partner in promoting environmental governance, upholding the rule of law and in ensuring a fair balance between environmental, social and developmental consideration through its judgment’s and declarations”.

The judiciary has a part to play in the interpretation and clarification. As Kaniaru, Kurukulasuriya and Okidi stated: A judiciary, well informed on the contemporary developments in the field of international and national imperatives of environmentally friendly development will be a major force in strengthening national efforts to realize the goals of environmentally-friendly development and, in particular, in vindicating the rights of individuals substantively and in accessing the judicial process (Preston, 2006).

The case of *Gbemere v. Shell Nig. BP suit No, FHC/B/CS/153/05*, if enforced, would have been a golden opportunity to institute the principles of sustainable development in the oil and gas industry, and consequently boost the host communities confidence in the law to the effect that their welfare has been prioritized.

In that case, the plaintiff (on behalf of himself and his community filed a suit against Shell, the Attorney General and the Nigerian National Petroleum Corporation (NNPC) to end the practice of gas flaring. The court granted leave to applicant to apply for an order enforcing or securing the enforcement of fundamental human right to life and dignity, as provided in Articles 33(1), 34(1), Article 4, 16 and 24 African Charter which held that these guaranteed rights inevitably include right to clean, poison and pollution free environment. Also, that the gas flaring laws were inconsistent with the applicants right to life and / or dignity of human person as enshrined in the Nigerian Constitution and the African charter. The court gave an order of injunction restraining the defendants from further flaring of gas. It also instructed the Attorney General of the Federation to collaborate with the Federal Executive Council towards amendment of Section 3(2) (a) and (b) of the Associated Gas Re – Injection Act Regulations which provides to the effect that the flaring of gas ought to be in line with chapter four of the constitution.

For effective implementation and enforcement of sustainable development in the Nigerian environmental law requires incorporating it expressly and directly into the Constitution of the Federal Republic of Nigeria 1999 (Okon, 2016).

Policies of sustainable development should be considered as provided when addressing environmental problems especially in the oil and gas industry in Nigeria. If the courts had successfully enforced the judgment in *Gbemere’s* case, environmental rights would have been entrenched and such enhances sustainable development.

In the case of *NNPC v Sele* (2004) 5NWLR PT 886, the trial judge entered judgment for the respondent whose economic trees, crops, fishing ponds and other facilities were polluted from

Oil spill emanating from the plaintiff in the sum of N15, 329,350.00 as special damages and N3, 000, 000.00 as general damages.

Such judgment encourages the position of sustainable development and act as deterrence to the oil companies forcing them to act in a sustainable manner in their activities and maintenance of their facilities.

The sustainable development principle became more prominent on the detection and response on oil spill with the establishment of National Oil Spill Detection and Response Agency (NOSDRA) Nigeria. Environmental best practices are encouraged in the oil and gas sector which invariable includes sustainable development measures being strictly followed.

Conclusion and recommendations

i. Conclusion

Nothing than a safer, economically sound and environmentally viable energy sector can be more imperative for achieving sustainable development goals relating to the oil and gas industry in Nigeria. As already stated, Oil and gas sector is the Nigeria's economic substratum hence demands a more proactive measures to ensure the sustainability of the developments in the industry and Nigeria at large. The adverse impact on the host communities and the lackadaisical approach toward enforcement of the decisions of the court both by the executive and the judiciary arms of government leaves much. However, there must be willingness on the path of the industry to do more to reduce the adverse impact of oil and gas development which are highlighted in Sustainable Development Goals (SDGs).

ii. Recommendations

Based on the foregoing, the following recommendations are therefore, proffered in this paper so as to strengthen the oil and gas industry:

1. Political will to strictly implement the environmental law and execute decisions of courts.
2. Ability of government to take tough decisions needed to protect the environment, against oil and gas industry when found wanting. Focus should be towards sustainable development in communities hosting the oil and gas industry and beyond.
3. The Oil and Gas Industries as well as the host communities should all take interest in enhancement and conservation as measures to increase their sustainability and productivity.
4. Oil and gas companies can collaborate with stakeholders to broaden their impact and enhance their ability to contribute additional resources to achieve sustainable development goals.
5. Multi – stake dialogue with relevant stakeholders and actors should identify (SDGs) Sustainable Development Goals of joint priorities and collectively define potential co-ordinate contribution to SDGs in the context of the country.
6. Oil and gas industries, government and other investors and insurers should adhere to laws which promote sustainable development and respect human rights by minimizing the negative impact of their operations
7. Tougher sanctions for the oil and gas industry that sideline the principle of sustainable development when carrying out their activities. Civil and criminal actions should be brought against companies that breach the provisions of the law in the oil and gas industry which advocate for Sustainable Development.
8. Host communities in the oil and gas communities should be enlightened to view sustainable development as their right and not mere privileges and should insist on a sustainably developed community alongside exploitation activities of the oil and gas industries.

9. Well strategized and fully committed government's orientation of the populace on the merits of sustainable developments and ways of achieving same.
10. It should form part of the education curricula of all pupils and students in all primary and secondary schools both public and private respectively.
11. Consideration must be taken of effective mechanisms to salvage social and environmental problems which when achieved would be a major boost for sustainable development agenda. For possible achievement, there is need to synergize environmental deliberations with the socio political and economic viewpoints. Resources should be used and sustained in a way to avoid extinction or over exploitation.

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Chapter 16

The Role of Plant Scientists to Achieving SDG-2 and SDG-15

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Abstract

Sustainable development has become a key issue of global interest but its achievement depends on a number of factors including sustainable food supplies and protection of the natural environment. With regards to the roles of plants and agriculture in the achievement of the global Sustainable Development Goals (SDG), this paper explores various roles plant scientist has to play in order to accelerate the achievement of sustainable development Goals, which were set by the UN in 2015 to succeed the Millennium development goals (MDGs). These goals include elimination of poverty, hunger, achieving gender equality and provision of good healthcare, quality education, gender equality etc. The paper draws from a review of existing literature to argue that with the current growing population, meeting the human population need for healthy food, ensuring food insecurity and evading famine is very crucial, which makes plant scientists an indispensable category of professional that should be mobilised to lead the effort to achieve the goals. It recommends government to invest in this field both financially and academically, as a means of empowering youths and saving the nation from food insecurity and famine.

Key Words: Food Security, Millennium Development Goal, Botanist

Introduction

Sustainable development has become a global issue of interest to both developed and developing countries in the 21st century. Sustainable development has been defined as a development that meets the needs of the present without compromising the ability of future generations to meet their own needs (UNDP, 2015). This definition indicates that any development effort that may be described as sustainable should not endanger future development opportunities in effort to address today's needs. The essence of this form of development is a stable relationship between human activities and the natural world, which does not diminish the prospect for future generations to enjoy the quality of life at least as good as our own. Azza (2012) observes that finding a balance between the consumer's demand and the carrying capacity of Earth's natural resources with regards to economic growth is crucial and a key element of sustainable development.

The Sustainable Development Goals (SDGs) were born at the United Nations Conference on Sustainable Development in Rio de Janeiro in 2012 and was adopted on the 15th of September 2015 (Max and Esteban, 2008). The objective was to produce a set of universal goals that meet the urgent environmental, political and economic challenges facing the world. There are

currently 17 of these goals that are listed as part of the Sustainable Development Goals (SDGs) that are intricately connected to each other, among which are reduction of poverty and hunger, which constitute the first and second goals respectively (UNDP, 2015). Details of the Goals are contained in Appendix 1.

The goals of reducing hunger are very important and also constitute a strategy for achieving other strategies (Ofianwa, 2018). Thus while it is a goal, it helps in achieving other goals. As people are living longer and bearing more children, the global population is on the rise. According to (James, 2013), the United Nation projects there will be more than 11.2 billion people living on the earth by the year 2100. This explosion in population is perhaps one of the greatest reasons sustainable development is so important, especially the need to manage food development related issues. A rising population will make use of the bare essential of life such as food, water, and shelter. Agriculture, which is central to food supplies, therefore needs to catch up with that growing population. Also agriculturists and agricultural scientists thus have critical roles to play in figuring out ways to feed around 3 billion more people than the earth currently does. If the same tilling, seeding, watering, spraying and harvesting methods are used into future, they can become very costly as fossil fuel resources run out.

The goals also are also critically related to appropriate management of the earth climate and resources, which are central to plant science (Ofianwa, 2018). Plant science has a measurable impact across the spectrum: increasing yields; providing access to education; and using our natural resources wisely. These particularly links to the SDG's goals of ending poverty and hunger, improving health and education, making cities more sustainable, combating climate change, and protecting oceans and forest. It seeks to answer the question of: how do we bring change to rural communities' agricultural practices around the globe? How do we improve yields, feed more people with fewer resources, and help generate income that leads to greater opportunity? While these questions are not adequately dealt with this paper, the paper seeks to discuss the roles of plant scientists in the whole effort to bring about sustainable development, and particularly poverty reduction, ending of hunger and ensuring enabling environment and climate for human and plant flourishing. It is pertinent to note that plant science, which is also known as botany plant biology or phytology, is a branch of biology that studies the science of plant life. With the current growing population, meeting the human population need for healthy food, ensuring food insecurity and evading famine is very crucial, which makes plant scientists an indispensable category of professional that should be mobilized to lead the effort to achieve the goals. This paper is divided into six sections: introduction, history and concept of plant science, roles and important of plant scientists, specific roles plant scientist play in ensuring sustainable development and conclusion.

History and Concept of Plant Science

Botany is a branch of biology that deals with the study of plants, including their structure properties and biochemical processes. Also included are plant classification and study of plant diseases and of interactions with the environment (William, 2017). This field of study encompasses terrestrial, freshwater and ocean plants as well as algae and some non-plants like fungi (Botany and Botanist, 2010). By this definition, plants include algae, fungi, lichens, mosses, fern and flowering plants (Botanical society of America, 2013).

Botany originated in prehistory as herbalism with the effects of early human to identify and later cultivate edible, medicinal and poisonous plants, making it one of the oldest branches of science (Sumner, 2000). During the 19th century, botany became one of the most popular areas of

European science. This is believed to have been influenced by the ease with which people could get involved in collecting, preserving and identifying plant. It was cheap and involved very few tools (Pols, European Physicians and Botanists, 2009). The Linnaean classification system had been developed by Carl von Linne (Carl Linnaeus) in 1753, who published his species plantarum, a hierarchical classification of plants species that remain the reference point for modern botanical structure nomenclature. This established a standardized binomial or two part naming scheme where the first name represented the genus and the second identified the species within the genus (Capon, 2005), and this helped to make plants easier to identify. In the last two decades of 20th century, botanist exploited the techniques of molecular genetic analysis, including genomics and proteomics and DNA sequence to classify plants more accurately.

Currently, botanist (in the strict sense) study approximately 410,000 species of land plants of which some 391,000 species are vascular plants (including Ca 369000 species of flowering plant) (RBG Kew, 2016) and Ca 20,000 are bryophytes (the plant list, 2013). Among the most important botanical questions of the 21st century as the role of plants as primary produces in the global cycling of life basic ingredients: energy, carbon, oxygen, nitrogen, and water and ways that our plant stewardship can help address the global environment issues of resource management, conservation human food security, biologically invasive organisms, carbon sequestration, climate change and suitability (Botanical Society of America, 2013).

Importance of Plant and Plant Scientists

With a growing world population, making sure that there is enough food for everyone becomes a critical challenge. Population has grown exponentially. Current numbers re estimated around 7.6 million people (Worldometre, 2018) and are expected to rise 9.3 billion in 2050 (World Bank, 2009). The world's population is expected to double in the next 50 years, if the current growth rate of 1.3 percent continues (Kendall and Pimentel 1994: 198). There is need to ensure that plants and agricultural practices result in an abundance of nutritious food in a sustainable and environmentally friendly manner.

Plants are all around us. They underpin all life on earth. In particular, plants provide two of the essentials of human life. They provide all our food (either directly or indirectly), and they provide the oxygen we breathe. Virtually all staple foods come either directly from primary production by plant, or indirectly from animals that eat them (Ben-Menahem, 2009). Plants and other photosynthetic organism are at the base of most food chain because they use the energy from the sun and nutrient from the soil and atmosphere, converting them into a form that can be used by animals. This is what ecologist calls the first trophic level (Butz, 2007). Plants also play a role in many other aspects in our life. They provide many of our medicines are involved in regulating the water cycle and are involved in storing carbon. Plants also provide fibres for our clothes (such as cotton and bamboo) and wood for our building and furniture. They provide industrial products (rubber and cork for example) and are a source of fuel (wood, coal, gas and biodiesel). Plants also create aesthetically pleasing indoor and outdoor environments.

Botanists are plant scientists. A botanist today might be interested in structure, growth, reproduction, metabolism, development, diseases, chemical properties, ecology, biodiversity or the evolutionary relationships between taxonomic groups. A botanist may work in the lab, in the field, for a pharmaceutical company or in a museum or botanical garden. In any enterprise involved with plants whatever their work, what links these scientists is their common interest in and curiosity about plants.

Figure 1 Plant Scientist at Work



With the plant scientists taking the center stage, the plant science industry is already contributing to agricultural development and improvement of food production by:

- conducting experiments to develop new or improved varieties of field crops, focusing on characteristics such as yield, quality, disease resistance, nutritional value, or adaptation to specific soils or climates.
- developing new or improved methods and products for controlling and eliminating weeds, crop diseases, and insect pests.
- conducting research to determine best methods of planting, spraying, cultivating, harvesting, storing, processing, or transporting horticultural products.
- communicating research and project results to other professionals and the public, or teach related courses, seminars, or workshops.
- providing information and recommendations to farmers and other landowners regarding ways in which they can best use land and promote plant growth.
- studying insect distribution and habitat and recommend methods to prevent importation and spread of injurious species.
- identifying and classify species of insects and allied forms, such as mites and spiders.
- conducting experiments regarding causes of bee diseases, and factors affecting yields of nectar pollen.

Roles Plant Scientist Play In Achieving Sustainable Development

Having discussed the important roles of agriculture and plant scientists in human survival, in this section, the roles of plant scientists are discussed in relation to the Sustainable Development Goals (SDGs). In doing this, it is pertinent to reiterate that just as the use of mechanized tools and adoption of crop rotation methods improved outcomes for farmers in past decades, newer innovations from the world of plant science are changing the game for today's farmers. In a world where we must produce more food for a growing population while preserving natural resources in the face of climate change, technology can have a measurable impact. For example, farmer incomes have doubled, and thousands of families have moved over the poverty line as a result of training in good agricultural practices and the responsible use of pesticides.

Likewise, biotech crops are leading the way in the fight against pests, drought and other hardships that can change a farmer's fortunes seemingly overnight. Since 1996, biotech crops have increased production at a value of more than \$130 billion. In March of 2015, a report by ISAAA found that since the first planting in 1996, biotech crops have alleviated poverty for more than 16.5 million small farmers and their families (ISAAA, 2014). Maybe that is why, according to ISAAA estimates, virtually 100 percent of farmers who grow biotech crops grow them again the next year.

The sense of security that farmers feel when they have advanced tools to protect and improve their harvests benefits the whole family – and ultimately the entire community. With more efficient practices, farmers can send their children to school, rather than keep them at home to work on the family farm. And with greater access to education comes exposure to new opportunities.

Out of the 17 goals of the SDG that are aimed at transforming our world by 2030 the role of plant sciences is critically tied to the ending of hunger, achieving food security, improving nutrition, promoting sustainable agriculture and sustaining the earth's environment. With a focus on improving health and nutrition, alleviating poverty, and advancing education and sustainability, the SDGs are part of a revolution that will bring widespread change and opportunity throughout the developing world. The plant science industry, which delivers advanced tools that allow farmers to increase production while protecting natural resources, is key to the international community's efforts and a driving force behind the results we are already seeing.

The appalling picture of how the vast majority of the world's populations are suffering from hunger necessitates immediate attention. According to Goal 2 of SDGs data:

- Globally one in nine people in the world today (795 million) are undernourished or hungry and additional 2 billion people expected by 2050.
- The vast majority of world's hunger people live in developing countries, where 12.9 percent of the population is under nourished
- Asia is the continent with the most hungry people –two third of the total.
- Poor nutrition causes nearly half (45%) of deaths in children under five.
- 66 million primary school age children attend classes hungry across the developing world with 23 million in Africa alone.

These highlight the need for plant sciences and agriculture sector to provide key solutions for eradicating hunger and poverty and help in achieving food security. For thousands of year agriculture has served as the pathway to economic development. Today agriculture is again at the forefront of a movement that will change life and drives economic opportunity worldwide. Our agricultural land is shrinking and population is burgeoning day by day, which is expected to hit

the 8 billion mark in 2025 (Embo report, 2003). There is a limit of land surface being used in crop production also and any increase in this activity in Africa, Asia and Latin America poses a grave threat to worldwide biodiversity. In this regard, there is an immediate need to produce high yield crops that would help to reduce the amount of land being used for cultivation. How do we improve yields and feed more people with fewer resources and help generate income that leads to greater opportunity? The plant science industry is already contributing to these goals around the world and has a central role to play as the International Community commits to SDGs.

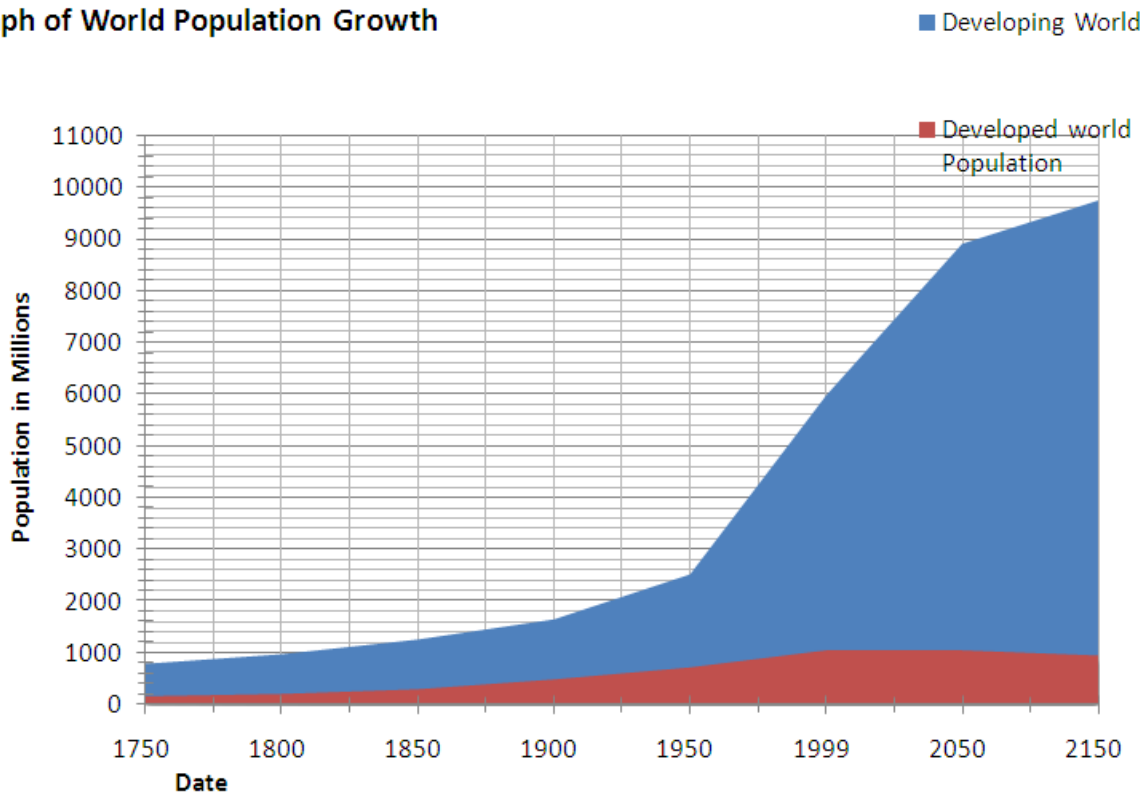
Also, plant scientists play an important role in maintaining the nation's food supply by ensuring agricultural productivity and food safety. These scientists study farm crops and develop ways to improve their quantity and quality. They look for ways to improve crop yield with less labor, control pests and weeds more safely and effectively, and to conserve soil and water. It is pertinent to reiterate that plant scientists study plants in order to help producers of food, animal feed, and fiber crops to feed a growing population and conserve natural resources. Some plant scientists look for ways to use agricultural products for fuels. Thus, plant scientists not only help increase productivity, but also study ways to improve the nutritional value of crops and the quality of seed, often through biotechnology. Some plant scientists study the breeding, physiology, and management of crops and use genetic engineering to develop crops that are resistant to pests and to drought. They also develop new technologies to control or eliminate pests and prevent their spread in ways appropriate to the specific environment.

In developing countries where the brunt of hunger and disease is deeply felt, plant scientists need to find out the solutions for the local problems of the farmers. They need to learn from their counterparts in developed nations. For example, how the research team of Luis Estrella-Herrera from the Plant Genetic Engineering Department at the Irapuato National Polytechnic Institute in Mexico found out the solution for Mexico's poor quality soil in which the high concentration of aluminium ions caused a decline of up to 80% in plant productivity. By genetically modifying the metabolism of maize plants, his research team developed a plant line that releases citric acid into the soil to sequester the aluminium. A combination of agronomic strategies, such as lime applications, together with these genetically modified (GM) plants resulted in dramatically improved productivity (Embo report, 2003). Another example to be discussed comes from Jim Peacock from CSIRO Plant Industry in Canberra, Australia. He showed that through the use of transgenic pest resistant cotton crops, a 60% reduction in the use of pesticides could be achieved. This helped to protect local biodiversity, particularly beneficial insects that were then able to fight off parasitic insect pests. By growing non-GM cotton nearby the insect resistance to this GM plant was kept low (Embo report, 2003).

Recently a research team of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) conducted an experiment trial of sorghum bicolor at Delfarm Project Limited in Igbariam, Anambra State and made some interesting discoveries: differences in climate of the North Nigeria where it is predominately grown and the southeast Nigeria, causes poor grain formation and decline up to 70% in plant productivity. The aim of the experiment was to know the optimum planting date for sorghum in the south east as a means of empowering young farmers at Adani Omor Staple Crop Processing Zone 1. Also, as a new staple being introduced for its industrial and local use. Genetically modified varieties like improved Deko, 12KSV8 and SK 5912 were discovered to be more suitable and disease resistant to the environment (Archibong *et al.*, 2015).

The recent finding of the Scientist at the Cold Spring Harbor Laboratory (CSHL)¹ is worth mentioning here. These scientists have harnessed the still untapped power of Genome Editing to improve agricultural crops. They have mobilized CRISPR/Cas9 technology in tomato to rapidly generate variants of the plants that display a broad continuum of three separate, agriculturally important traits: fruit size, branching architecture and overall plant shape. All these traits are important in determining how much a plant will yield. The method is designed to work in all food, feed and fuel crops including the staples rice, maize, sorghum and wheat. In these regards, it could be argued that in order to achieve sustainable development goals of UN to eradicate poverty, provide food security and improved nutrition, more such research are needed to develop GM crops for disease resistance, drought resistance, and for other agronomic traits.

A Graph of World Population Growth



Agricultural Sector and the Nigerian Economy

One important widely used adage relating to hunger states that a hungry man is an angry man. It portends that any serious nation should be food secured, because, it's a basic need of its people. Therefore, it's a basic economic obligation of the leadership to its people. In our pre-independence (1960) and post-independence (1960-1970's) agriculture was the Nigeria's major economic driver. Key indices of economy; food, security, employment, industrial growth, foreign exchange earnings and gross domestic product (GDP), were manifestly powered by agricultural activities.

Specifically, by time Nigeria got her independence in 1960, agriculture accounted for about 70% of GDP and about 90% of foreign exchange earnings. Oil, contributed meagerly 0.6% to GDP and accounted for about 3% of foreign exchange earnings. Crude oil became dominant in

¹<https://www.cshl.edu>

the Nigerian economy from the 1970's (Iganiga and Unemhilin, 2011; Iyoha Ezirini and Oriakhi 2010). By 1974 precisely, the total share of oil sector impact, on the economy rose to 45.5% and almost doubled that of agriculture which had decreased to 23% (Yakubu, 2008). The decline in agricultural sector performance since the discovery of oil has been dramatic and continuous.

Being realistic, and for the fact that a very large population is engaged in agriculture, Nigerian economic growth will be a mirage without its development, importantly, our national endowment in production factors: extensive arable land; water; human resources; diversified ecology; clement weather; and capital, justifies exploring its production advantage for a sustainable economic growth. Contributing, Chauvin, Mulangu and Porto (2012); and Lipton (2012), states that besides Nigeria's diverse and reach vegetation that can support heavy livestock population, that it has potential for irrigation with surface and underground water of about 267.7 billion cubic meters and 57.9 billion cubic respectively. The implication here is that if our water resources are well harnessed, we can easily have all year season farming with its year-round harvest and agricultural productivity.

Production-Agriculture and Economic Growth

Production Agriculture consist of the physical and/or mechanical activities directed at nurturing our natural endowment of soil, water, sunlight, ecosystem etc to consciously raise crops (food crops , cash crops, tree crops) and animal (livestock, poultry, fishery) for food and fibre. Nigeria as we are aware is largely an agrarian society , with at least 70% (about 103 million) of the estimated population of 148 million in 2008, living in rural and sub-urban area and constituting the major food producers (Philip et al, 2008). According to world trade organization report, although the petroleum sector dominates the economy of Nigeria, agriculture is still more important to most Nigerians because it represents over half of employment and contributed 41.70% of the country experience rich soil, good rainfall and warm temperature all year round. About 80% of the land is cultivated, while 13% is under forest (WTO, 2009). Despite these natural endowment and numeral advantage for agricultural production, our global competitiveness in agriculture as business is abysmal and the most worrisome is the fact that our internal food security is low. In the wake of these challenges, food import continues to rise, our food imports grew from N754.4 million in 1970 to N34.7 billion in 1995 ; N108.9 billion in 1996; N133 billion in 1998 and N162 billion in 1999 (Njoku , 2001). These trends has continued, and what it implies, which is the concern of the presenter, is that there are serious business opportunities in production-agriculture, and the country should leverage on that as means of economic growth.

Conclusion - The Need for a Plant Scientist

The indispensable positions and roles of plant scientists in the realization of the SDG are evident but the number of plant scientists being trained globally remains too little. As the New Zealand Plant Conservation Network (2014) and Alberts et al. (2014) observe, the supply of plant scientists and professional remains far lower than demand. Academia is producing relatively very little and lower number of specialsits in the plant sciences than the number the world needs to solve the crop production challenges facing a rapidly growing population. Given the global agricultural demands and challenges, there is need for an increased campaign for interest, funding and technological innovations to be scaled up in the field. Also, the earth needs to be adequately prepared to support another 1 billion humans in the coming decade, and must do so with less arable land and in an unpredictable climate. This means we must find innovative ways

to produce crops with higher yields and novel traits—a feat that will require the work of trained professionals in agriculture and plant sciences. But at this point we are not producing enough plant scientists to lead us out of this Malthusian dilemma.

The US Coalition for a Sustainable Agricultural Workforce recently completed a confidential survey among agricultural biotech companies to ascertain near-term needs for hiring domestic agricultural scientists. This survey generated an amazing result, given the tone of the *PNAS* perspective, predicting that by 2015, 1,000 new employees will be needed in the half-dozen largest plant-science companies in the US alone (Bayer Crop Science, Dow Agro Sciences, Dupont Pioneer Hybrid, Dupont Crop Protection, Monsanto, and Syngenta) (Jones, A2014). The growing world population needs to eat, and it is past due that we elevate basic, translational, and applied plant research to the priority given to biomedical research, or more boldly, to defense. Stabilizing food supplies in a changing environment is integral not only to the world population's health, as an estimated 50 percent of childhood disease globally is attributed to malnourishment, but also to national security. Moreover, a recent study found that, around the world, the rate of return for investment in agricultural research is ten to one, bringing into question the scaling back of funding for agriculture research and development in many rich countries.

Going forward, we must infuse more resources into plant biology research, to boost research output and to train tomorrow's plant scientists. In the early 1980s, the National Science Foundation (NSF) established an 11-year postdoctoral fellowship program with the primary objective to nurture future leaders of plant biology research. By many accounts, this program was successful; among a cohort of 236 fellows, four are members of the National Academy of Sciences today, and more than 80 percent remained in plant biology. Of those, the majority stayed in academic institutions, while an impressive number (25 percent) went to industry, where many now hold corporate officer positions. Anticipating the need for leaders to alleviate hunger and to prevent global instability, we should reinstate this program to recruit our best talent to plant science and agricultural research.

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Appendix 1: The Sustainable Development Goals



THE GLOBAL GOALS For Sustainable Development



Goal 1. End poverty in all its forms everywhere

1.3 Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable
1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

2.1. By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round
2.2. By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons

Goal 3. Ensure healthy lives and promote well-being for all at all ages

3.1. By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births
3.2 .By 2030, end preventable deaths of new-borns and children under 5 years of age, with all

countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births

3.3. By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases

3.4. By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being

3.5. Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol

3.6. By 2020, halve the number of global deaths and injuries from road traffic accidents

3.7. By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes

3.8. Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all

3.9. By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

3.a. Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate

3.b. Support the research and development of vaccines and medicines for the communicable and noncommunicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all

3.c. Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States

3.d. Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

4.5. By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations

4.a. Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, nonviolent, inclusive and effective learning environments for all

Goal 5. Achieve gender equality and empower all women and girls

5.2. Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation

5.3. Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation

5.6. Ensure universal access to sexual and reproductive health and reproductive rights as agreed

in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences

Goal 6. Ensure availability and sustainable management of water and sanitation for all

- 6.1. By 2030, achieve universal and equitable access to safe and affordable drinking water for all
- 6.2. By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

- 7.1. By 2030, ensure universal access to affordable, reliable and modern energy services

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

- 8.5. By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value
- 8.7. Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms
- 8.8. Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment

Goal 10. Reduce inequality within and among countries

- 10.2. By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status
- 10.7. Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

- 11.1. By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums
- 11.2. By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons
- 11.5. By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
- 11.7. By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities
- 11.b. By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the

Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels

Goal 12. Ensure sustainable consumption and production patterns

12.4. By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

Goal 13. Take urgent action to combat climate change and its impacts*

13.3. Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

16.2. End abuse, exploitation, trafficking and all forms of violence against and torture of children

16.9. By 2030, provide legal identity for all, including birth registration

Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development

17.18. By 2020, enhance capacity-building support to developing countries, including for least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts

Source: <http://www.who.int/mediacentre/events/meetings/2015/un-sustainable-development-summit/en/>

Chapter 17

Modelling the Inter-Links between Human Capital Investments and Inclusive Growth in Nigeria, 1980 to 2018

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Abstract

One of the major macroeconomic objectives of any government is to achieve inclusive growth by reducing unemployment, poverty and inequality. Investment in human capital development is seen as one of the ways of achieving the above-mentioned objective. Despite government efforts on human capital development through budgetary provisions, the rate of poverty and unemployment continues to increase in Nigeria. The aim of this present study is to develop a structural vector autoregressive (SVAR) model to investigate the links between investments in human capital development and inclusive growth towards contributing to achieving the 2030 Sustainable Development Goals (SDGs) in Nigeria using time series data from 1980 to 2018. Secondly, the long-run relationships among the variables were estimated using the Johansen maximum likelihood test. The empirical results show that poverty and per capita income responds negatively to shocks on investment in human capital proxied by government expenditure on education and health while unemployment responds positively to shocks on investment in human capital. This means that investment in human capital has not positively contributed to driving inclusive growth in Nigeria. If the current rate of investment in human capital development is not improved upon, Nigeria will seriously be far from achieving the SDGs relating to poverty reduction and prosperity by Year 2030.

Keywords: Government expenditure, human capital investment, inclusive growth, Nigeria, SDGs
JEL Classification: H20, H50. E62

1. Introduction

The Sustainable Development Goals (SDGs) is an avenue to make countries prosperous and to spur its own development. This can be attained through inclusive growth, gender equality and provision of basic amenities such as health, education, shelter, etc. Presently, increasing inequality and poverty rate are the most significant obstacles limiting progress in achieving the sustainable development goals in Africa (Wright, 2017). Adediran, et al., (2016) had earlier asserted that, an economy that cannot provide jobs for its teeming population cannot sustain itself. Nonetheless, reduction in unemployment can lead to improved livelihood and thus, improvement in the quality of lives of the citizens of any nation. Therefore, investments in human capital can be achieved through investing in education and health sectors that will improve the labour force (Schultz, 1961 cited in Matthew, et al., 2008). For instance, knowledge acquired through education can enhance productivity and further foster economic growth. Similarly, there is strong evidence that investing in health services and facilities contributes to better health outcomes as well as vitality for productive work (Cylus, et al., 2018). Development

of human resources creates an avenue through which peoples' capabilities could give rise to economic opportunities and drive inclusive growth.

The Nigerian economy has undergone different growth trajectories but the positive growth is associated with increasing level of unemployment, inequality, poverty and low per capita income (Metu, 2018). According to Nwokoma et al. (2015) the annual gross domestic product growth of between 6.5% and 7.5% recorded since 2010 has not resulted in addressing the twin problems of worsening inequality and poverty; necessitating the call for inclusive growth. The Nigerian government recognises the importance of human capital development and have introduced different education and health programmes in the country including the Universal Basic Education (UBE) programme, National Primary Healthcare, 100% routine immunisation coverage, etc. The education target was how to achieve quality education for all while the health policy targeted affordable and cost-effective health services for 90% of the population (Amakom, 2013). Government allocation to education has been unstable with highest allocation of 9.9% in 2009; it reduced to 4.8% in 2010 and was increased to 7% in 2018. All these figures are far below at least 26% of the budget recommended by United Nations Education, Scientific and Cultural Organisation (UNESCO) (Odigwe & Owen, 2019). Therefore, the question is, will the current government's allocation to health and education drive inclusive growth and help Nigeria achieve the SDGs of poverty reduction and shared prosperity by the Year 2030?

Several studies have examined the relationship between human capital and economic growth (Shuaibu & Oladayo 2016; Jaiyeola, 2015; Mba, et al., 2013; Ditimi & Nwosa, 2011; Matthew, et al., 2008). For instance, Matthew et al., (2008) examined the relationship between human capital investment and economic growth in Nigeria from 1970 to 2004. The study focused mainly on investment in education leaving out health and social services, and their findings showed that government expenditure on education had a low effect on real GDP. Mba et al. (2013) found that human capital development exerts a positive impact on economic growth. They opined that expenditure made in the development of human capital as well as inclusive growth is crucial in achieving sustainable development.

Amakom (2013) examined how public spending on education and health could reduce poverty and inequality in Nigeria using benefit incidence analysis. The result of the study suggests that healthcare and primary education were more pro-poor than tertiary education. Also, secondary education and health care showed mixed result while there is gender bias in benefits from government spending in both healthcare and education. Jaiyeoba (2015) found a long run link existing between government expenditure in health, education and economic growth. Shuaibu and Oladayo (2016) investigated the determinants of human capital development in 33 Africa countries between 2000 and 2013. Their study found that some factors such as public expenditures on health and education, institutions and economic growth significantly influenced human capital within the study period.

The above highlighted past studies, all concentrated on how investment in human capital could increase the gross domestic product (GDP) without emphasis on the welfare implications of the growth; thereby, creating a research gap. This present paper therefore, attempts to fill in the foregoing identified gap by examining how investment in human capital development could drive inclusive growth in Nigeria toward achieving Agenda 2030 Sustainable Development Goals. This research output will be useful to policy makers to adopt in leveraging the potential of sustainable human capital development in line with the World Economic Forum (WEF). According to WEF (2014) sustainable human capital development is "a human-centric vision of future that recognises people's knowledge, creativity, skills and talents as key drivers of a

prosperous and inclusive economy”. This paper is organized under five Sections: Section 1 is the introduction, Section 2 presents the explanation of basic concepts relating to inclusive growth and human capital, Section 3 outlines the methodology of the study, Section 4 presents the empirical results and discussion. Section 5 states the conclusion and highlights some salient recommendations.

2. Explanation of Basic Concepts Relating to Inclusive Growth and Human Capital

According to Bushan (2013) as cited in Metu (2018) inclusive growth is perceived differently by different people and that inclusive growths seek to achieve the following three (3) elements: outcomes; measurement; and expected results. In other words, inclusive growth involves promoting the welfare of the peoples. The Organisation for Economic Cooperation and Development (OECD) in 2012 reaffirms that inclusive growth requires equal sharing of growth dividends such as health, jobs, skills, clean environment and effective institutions so as to reduce the gap existing between the rich and the poor (OECD, 2012). This means that, for inclusive growth to be achieved in a country; the economic investments must benefit everyone in the society including the poor, through equal access to available economic opportunities. These economic opportunities can be achieved when the government invests in the development of human resources.

According to Todaro and Smith (2015) development of human resources can be known as human capital. Productive investments embodied in human persons, including abilities, skills, locations and health, as a result of expenditures on education, training programmes and medical refers to human capital development (Todaro & Smith, 2015). In other words, human capital development is the process of increasing the skills, education and experience of human resources for improved economic growth and development in a country through expenditure on education, health, social services as well as eliminating all social exclusions. Improved productivity can further result into increase in per capita income if the individuals are employed by the labour markets (Tompa, 2002). Likewise, increase in per capita income provides the labour force with more physical and mental energy to be more productive thereby helping them to be lifted out of the poverty line.

Nwosa (2014) employing time series data from 1981 to 2011 examined the effect of government expenditure on poverty and unemployment rates in Nigeria and their finding showed that government expenditure had a positive and significant relationship with unemployment rate in Nigeria. The study concludes that despite increasing government expenditure unemployment rate continued to increase. In other words, government expenditure has not been able to stimulate the growth activities that may influence improvement in employment opportunities within the study period. Oyinlola, Adedeji, and Bolarinwa (2019) in a study of 14 sub-Saharan African countries, over the period 1995 to 2015, found an insignificant impact of human capital on industrial development. This means that human capital development via spending on education and health does not propel industrial development in SSA. In most African countries, education expenditure has always been a slog on industrial development which is contrary to theory. Without industrial development, unemployment will continue to be on the increase because the graduates will not be gainfully employed. Oluwadamilola et al., (2018) examined the relationship between human capital development and inclusive growth and how it can be used in achieving SDG-4 in Nigeria; they found that human capital through quality education and skill acquisition can be used to achieve inclusive growth.

Most of the empirical literature reviewed concludes that human capital development has impacts on inclusive growth. The problem with some of the previous studies is that they used nominal figures to capture government expenditures which is inappropriate for a country with inflation variability. Also, most of these studies used real GDP to capture inclusive growth without capturing the welfare aspect of inclusive growth. The present study deviates from previous studies and used per capita income growth, unemployment and poverty to capture inclusive growth. Moreover, the issue of investment in human capital and inclusive growth in Nigeria have not received considerable attention from researchers. Therefore, this study fill this gap by modelling the relationship between investing in human capital and inclusive growth and how it can be used in achieving the SDGs of poverty reduction and shared prosperity in Nigeria by 2030 deadline.

3. Methodology

The study employed the structural Vector Autoregressive (SVAR) model for the analysis. Before then, preliminary descriptive analysis was carried out on the series to determine the nature of the data set. The descriptive statistics captures the mean, median, minimum and maximum values, kurtosis, skewness, standard deviation and Jarque-Bera test statistic of each variable.

The time series properties of the variables were tested using Augmented Dickey-Fuller (ADF) test. According to Dickey and Fuller (1991) the rule of thumb is that the null hypothesis of having unit root is rejected if the probability value is less than the level of significance. Having confirmed the stationarity of the variables using ADF test, cointegration test is carried out to examine if the variables are cointegrated, that is, if there is long-run relationships among the variables (Koutsoyiannis, 2003). The Johansen cointegration method is employed on the assumption of a null hypothesis of no cointegrating vectors ($r=0$) in the model.

After determining the long-run association among the variables, the study proceeds with the structural Vector Autoregressive (SVAR) model. The SVAR model enables the estimation of the dynamic interrelationships between variables by applying the impulse response functions (IRFs) and forecast error variance decomposition (FEVD) (Bernanke, 1986, as cited in Metu, 2018). Through IRF analysis, the effect of shocks in human capital on inclusive growth is determined. Similarly, the FEVD measures the comparative importance of the shocks by computing the fraction of movement in a sequence attributed to its shock to distinguish it from movements attributable to other variable shocks.

The inverse roots of AR characteristic polynomial will be estimated to determine if the estimated impulse response function and variance decomposition of VAR are stable for policy analysis. Two lags VAR was used to decompose the innovations of the endogenous variables into portions that can be attributed to its innovations and innovations in the other variables. Therefore, in modelling the relationship between investment in human capital and inclusive growth we assume an infinite vector moving average representation as follows:

$$V_0 Y_t = V(L) Y_{t-1} + \varepsilon_t \tag{1}$$

Where Y_t is an $n \times 1$ data vector of the endogenous variables that includes (PCI, POV, UEM, GEDX, GHTE, GSCE). PCI stands for per capita income; POV is the poverty rate; UEM represents the unemployment rate; GSCE is government expenditure on social services while GEDX and GHTE represents government expenditure on education and health respectively. Matrix V_0 captures the contemporaneous coefficient; Matrix $V(L)$ is a polynomial variance-

covariance matrix in the lag operator L ; $M(L)$ is a matrix representing the relationship between lagged endogenous variables; ε_t is a $K \times 1$ vector of serially uncorrelated and mutually orthogonal white noise disturbances and $\text{var}(\varepsilon_t) = \theta$, where θ is a diagonal matrix, so the structural disturbances are assumed to be mutually uncorrelated (see Bernanke, 1986, cited in Metu, 2018).

The reduced-form of the VAR model is represented as:

$$Y_t = M(L)Y_{t-1} + U_t \tag{2}$$

Where $M(L) = V^{-1} V(L)$ is a matrix of polynomial in the lag operator L and $\text{var}(U_t) = \psi$. Therefore, the SVAR model adopted for the study is identified using a non-recursive structure based on econometric theory that allows contemporaneous simultaneity among the variables. Therefore, the model for the study is expressed as follows:

$$X_t = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 & 0 & 0 \\ b_{41} & b_{42} & b_{43} & 1 & 0 & 0 \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 & 0 \\ b_{61} & b_{62} & b_{63} & b_{64} & b_{65} & 1 \end{pmatrix} \begin{pmatrix} PCI_t \\ POV_t \\ UEM_t \\ GEDX_t \\ GHTE_t \\ GSCE_t \end{pmatrix} \tag{3}$$

The coefficients on the major diagonals are normalised to one, while the zero entries denote coefficients that are restricted to zero. We adopt the approach that investment in human capital can boost the drive for inclusive growth in Nigeria. That is, government expenditure on education and health can facilitate reduction in unemployment and poverty rates based on prior theoretical and empirical information.

Sources of data

The study employed annual time series data from 1980 – 2018 sourced from National Bureau of Statistics (2017), Central Bank of Nigeria (2019) statistical bulletin and World Bank (2019) development indicators. Inclusive growth is captured using per capita income growth rate, poverty and unemployment rates, while investment in human capital is captured using government expenditure on education and health (see Todaro & Smith, 2015). Some of the variables such as government expenditure on education (GEDX), government expenditure on health (GHTE) and government expenditure on social services (GSCE) are transformed into log form. Three lags were included into the VAR model using the Akaike information criterion, Schwarz information criterion and final prediction error (. E-Views version 10 was used for the computation.

Notes: (*) Significant at the 10%; (***) Significant at the 1%. *MacKinnon (1996) one-sided p-values.

The result of the unit root test indicates that the variables PCI, POV, UEM, GEDX, GHTE and GSCE were found to be stationary at first difference; in other words, they are integrated of order 1(1). This leads to the rejection of the null hypothesis of the presence of unit root in the variables. Therefore, we proceed to test for cointegration among the variables.

4.3 Johansen cointegration test result

The Johansen cointegration test was used to determine the nature of the long run relationship between human capital and inclusive growth variables and the result is presented in Table 4.3.

Table 3 Summary of Johansen Cointegration Test Result

Null	Trace Statistic	Critical Value (5%)	Null Hypothesis	Maximum-Eigen Statistic	Critical Values (5%)
$r = 0^*$	199.95	95.75	$r = 0^*$	90.65	40.08
$r \leq 1^*$	109.30	69.88	$r \leq 1^*$	58.04	33.88
$r \leq 2^*$	51.26	47.86	$r \leq 2$	23.84	27.58

Note: r represents the number of cointegrating vectors. Trace test indicates 3 cointegrating equations at 0.05 level while the max-eigenvalue test indicates 2 cointegrating equations. *Denotes rejection of the hypothesis at the 0.05 level.

The result reveals that there are three Trace statistics and two Maximum-Eigen statistic at the 5% level of significance, which is a conflict. The paper made us of the Trace statistic because the Trace statistic takes into account the entire smallest Eigenvalue statistic; moreover, Johansen and Juselius (1990) recommend the use of Trace statistic when there is a conflict. The cointegration test result in Table 3 shows that all the variables are cointegrated driven by at least two factors. This implies that there is a long-run association among the variables. This finding is in line with previous studies such as Mandlebe, (2014); Adediran et al., (2016); Wright, (2017); Oluwadamilola, et al., (2018). Therefore, we proceed to estimate the SVAR model.

4.4 Impulse response functions results

Impulse response functions show the response of an endogenous variable over time to a given shock; the graphical representation is presented in Figure 1.

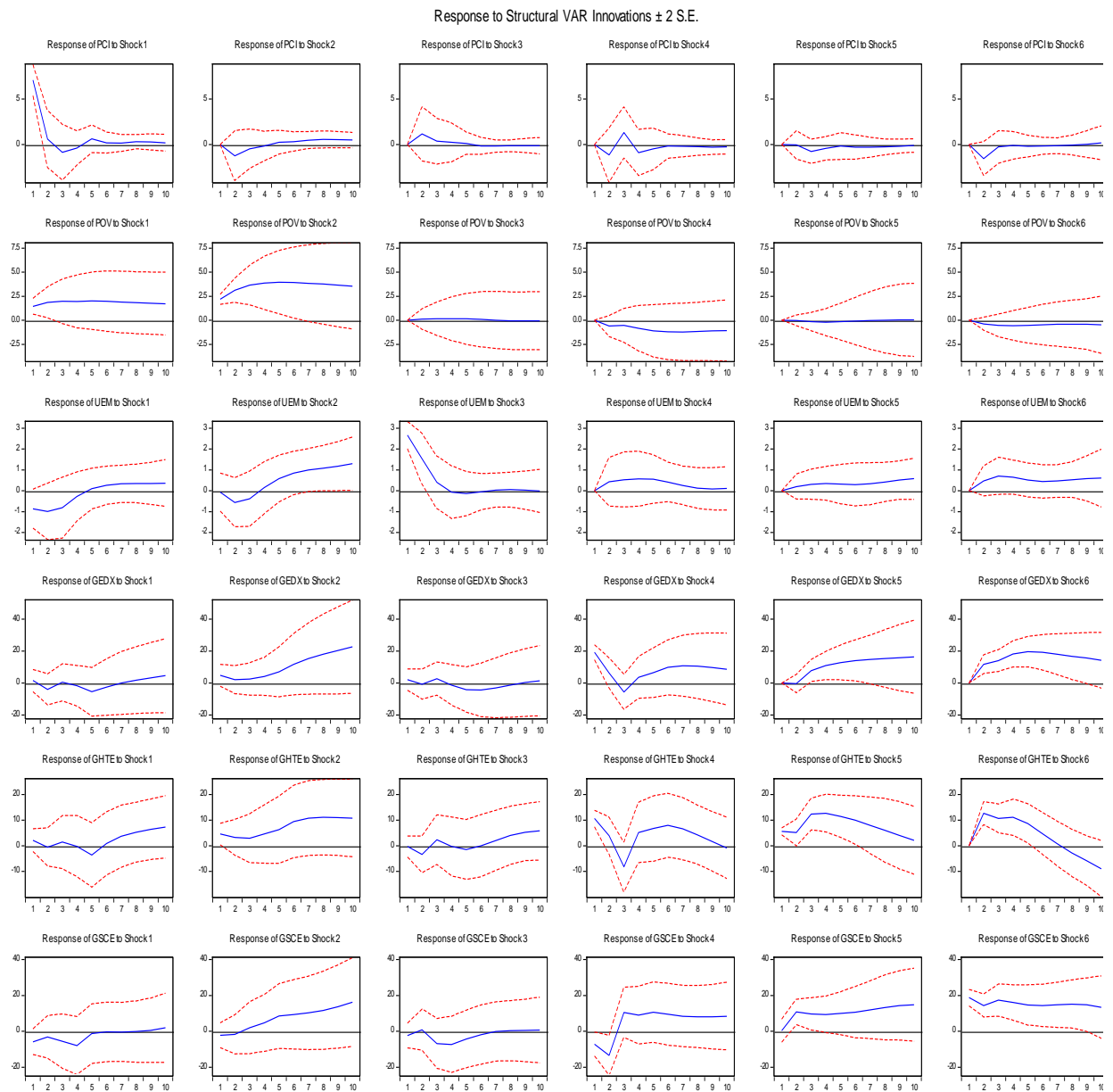


Figure 1: Impulse response result

The result shows the reactions of per capita income growth rate, poverty and unemployment due to shocks in government expenditures on education, health and social services over the ten period horizon. Each variable responds significantly to its one-standard deviation shock, in other words, the variables are largely driven by themselves. The test also reveals that per capita

income growth rate response to education expenditure was negative except in the 3rd and 4th year period where it was positive before becoming neutral from the 6th period. This means that government expenditure on education in Nigeria did not contribute to per capita income except between the 3rd and 4th year period. The IRF shows that per capita income growth rate responds negatively to shock or innovation in health and social services expenditure. This implies that government expenditure on health and social services has not yielded positive impact on per capita income of the citizens. This can be attributed to low funding of both the education and health sectors. According to United States Agency for International Development (USAID, 2016) government expenditure on health in Nigeria is less than 6% of total government expenditure and less than 25% of total health spending in the country. Both health and education are inputs to the aggregate production function and if not well funded, productivity will be adversely affected leading to drop in per capita income. Todaro and Smith (2015) opine that investments in human capital requires quality and efficiency in other to have potential positive effects on income.

Figure 1 shows that the response of poverty to standard innovation in government expenditures on education, health and social services is negative over the ten-period horizon. This means that government expenditure on education, health and social services does not influence the rate of poverty in Nigeria. Although the World Bank classified Nigeria among the poorest countries with majority of the population living on less than \$2 per day (Shuaibu & Lawong, 2015).

The graph also shows the reactions of unemployment due to shocks in government expenditures on education, health and other social services respectively. Unemployment responds positively to shocks in government expenditure on education, health and social services. In essence government expenditure on health and education contributed positively to unemployment. This could be attributed to the fact that as more people graduate, there are no industries to absorb the labour force and hence increasing unemployment rate in the country. The educational system in Nigeria has not been tailored to meet developmental needs of the nation (Shuaibu & Lawong, 2015). Education is expected to make people more skilful, create employment and ensure constant income that will help raise people out of poverty and narrow the rate of inequality.

4.5. Variance decomposition results

Table 4: Variance Decomposition Results

PCI:							
Perio d	S.E.	PCI	POV	UEM	GEDX	GHTE	GSCE
1	7.082197	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	7.551327	88.59915	2.583664	2.484277	2.274652	0.001895	4.056362
3	7.776032	84.74152	2.767241	2.581725	5.059947	0.918896	3.930668
4	7.848096	83.40858	2.756534	2.642891	6.154704	1.168618	3.868671
5	7.897271	83.04348	2.839639	2.647013	6.412038	1.191240	3.866588
6	7.915353	82.73920	3.006511	2.663421	6.422759	1.290633	3.877481
7	7.942021	82.23557	3.374577	2.684345	6.426175	1.406643	3.872694
8	7.976558	81.68063	3.849528	2.686451	6.448988	1.491538	3.842865

9	8.007780	81.18106	4.273708	2.682427	6.517641	1.528365	3.816803
10	8.033558	80.72779	4.637456	2.688568	6.566286	1.530215	3.849681

POV:

Period

d	S.E.	PCI	POV	UEM	GEDX	GHTE	GSCE
1	2.613481	30.53125	69.46875	0.000000	0.000000	0.000000	0.000000
2	4.529350	26.90042	70.58053	0.076897	1.759881	0.001277	0.680990
3	6.202802	24.43720	72.55886	0.106091	1.704991	0.048966	1.143892
4	7.639357	22.55129	73.64189	0.106875	2.311155	0.102827	1.285967
5	8.924542	21.65766	73.61102	0.107218	3.228130	0.104514	1.291451
6	10.03421	21.06576	73.51833	0.093149	3.996464	0.090060	1.236231
7	10.98904	20.52906	73.58721	0.077841	4.555291	0.075749	1.174847
8	11.82530	20.10462	73.71996	0.068539	4.910969	0.065494	1.130418
9	12.56445	19.79897	73.82560	0.063345	5.138163	0.058498	1.115417
10	13.21813	19.59163	73.86563	0.058913	5.296205	0.053225	1.134401

UEM:

Period

d	S.E.	PCI	POV	UEM	GEDX	GHTE	GSCE
1	2.801901	9.463116	0.050376	90.48651	0.000000	0.000000	0.000000
2	3.457621	14.38725	2.640061	79.23641	1.521085	0.337080	1.878117
3	3.716433	17.25732	3.323500	69.75800	3.378103	0.998360	5.284718
4	3.845145	16.62117	3.253736	65.19913	5.390911	1.767000	7.768047
5	3.977916	15.59323	5.187021	61.04581	6.973649	2.286002	8.914294
6	4.132170	14.85507	9.008201	56.59035	7.497875	2.633211	9.415300
7	4.308496	14.25047	13.59480	52.05851	7.233858	3.026037	9.836331
8	4.510322	13.59223	18.21409	47.51902	6.679748	3.623127	10.37179
9	4.741214	12.83530	22.71064	43.00719	6.081356	4.434005	10.93151
10	5.001188	12.06799	27.15164	38.65242	5.514592	5.330407	11.28295

Table 4 shows that each of the variables responds to its own shock more than to shocks in other variables. The variance decomposition of PCI indicates that the effects of exogenous shocks to government education expenditure on per capita income dominates that of the effects of innovations (shocks) in health expenditure on per capita income within the 10-period horizon. Government education expenditure accounts for 2.3% of the forecast error variance of per capita income in the second year, and above 6% in other periods, while government health expenditure accounts for less than 2% within the same period. The predominant source of variation in government education expenditure forecast errors is its own shock. The innovations of health expenditure and expenditure on social services are other important sources of the forecast error variance of government education expenditure. The variable with the least shock on per capita income within the 10-period horizon is government expenditure on health. This implies that though government expenditure on health has a positive impact on per capita income, it only accounts for the least impact on per capita income.

In explaining the forecast error variance decomposition of poverty, it is observed from the study that the innovations on per capita income are next to its own (poverty) shocks within the 10-period horizon. Government expenditure on education accounts for 5.3% shocks to poverty within the period. The least forecast error variance on poverty is the innovations of government expenditure on health with less than 0.02%, while per capita income is the most effective instrument. In explaining the forecast error variance of unemployment, it is observed that innovations on poverty are next to its own shocks. The other important variable for the forecast variance of unemployment is government expenditure on social services followed by innovations of government expenditures on education and health respectively.

4.6 Inverse roots of AR characteristic polynomial

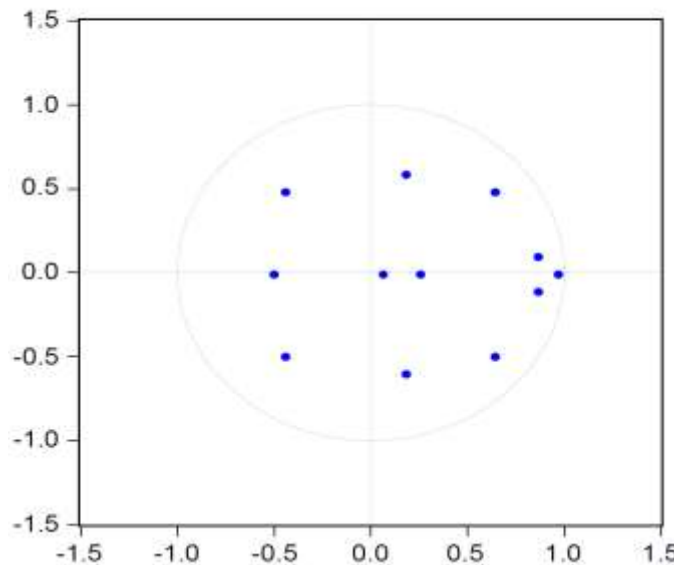


Figure 2: *Inverse roots of AR characteristic polynomial*

Figure 2 shows the inverse roots of AR characteristic polynomial with none of the polynomial roots outside the circle. This means that the estimated SVAR results are stable and can be used for decision making (Brooks, 2014).

5 Conclusion and Recommendations

This paper estimated the relationship between human capital and inclusive growth and how it can be a workable instrument for the realization of 2030 Sustainable Development Goals of poverty reduction and shared prosperity in Nigeria. The study used time series data from 1980 – 2018 which was estimated using an SVAR technique to model the dynamic interrelationships among the variables. The long-run relationship of the variables was tested using the Johansen maximum likelihood test for co-integration. The result shows that poverty, unemployment, per capita income, government expenditure on education, health and social services, are related in the long-run. This means that investment in human capital have an important role to play in achieving inclusive growth in Nigeria. The impulse response functions (IRFs) shows that government expenditure on education and health account for negative shocks on poverty and a positive shock on unemployment in Nigeria. This means that human capital investment does not influence poverty but influences the rate of unemployment in Nigeria due to poor investment in both

education and health sectors. The variance decomposition result reveals that government expenditure on education influences per capita and poverty more than government expenditure on health, although the influence is limited. This is not surprising due to government neglect of education and health sectors in Nigeria. Most education and health expenditures are funded from household out-of-pocket expenditures. To achieve inclusive and sustainable growth, the Nigerian government needs to improve its budget allocation to both the education and health sectors bearing in mind the UNESCO recommended Benchmark for developing countries. The paper also recommends the need for improvements to the financial management of public expenditures to ensue efficiency and effectiveness. In addition, government needs to provide social amenities in order to encourage private partnership in human capital investment for the promotion of inclusive growth in Nigeria.

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Chapter 18

Assessment of Climate Change Impacts on Building Energy Performances in Nigeria

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Abstract

Climate change is characterized by the changes in the usual climate of the planet regarding temperature, precipitation, wind which are triggered by human activities. Climate change is the variations in weather event which last more than a decade. The effects of climate change make the internal environment uncomfortable and harsh. This study aims at analyzing the effect of climate change on building energy need. The study discovered that the trend plot of humidity was found not to be statistically significant with a coefficient of 0.055 at 0.05 level of confidence, this shows the relative humidity reduces annually, the slope of regression coefficient $b = -0.06$, mean relative humidity is 73.7%. The mean annual rainfall for the 47-year period is 1765.4mm. The rainfall pattern of Enugu has exhibited a decreasing trend, 24 out of the years were below normal only 23 years (48.9%) out of the 47 years were above the normal. The overall mean temperature for the 46 year period calculated to be 27.3°C, majority of the years have shown temperatures below the mean. The study generated a regression model showing the mathematical relationship between the independent variables (Rainfall, Sunshine Intensity, Temperature, effective rainfall, wind speed and relative humidity). The model corresponding to this Poisson Regression is $\eta_i = -0.01650X_1 - 0.41782X_2 + 0.02075X_7$. It further recommends that designers, building design and energy provision alike, need adequate tools to help inform decisions.

Introduction

There is a clear evidence of the effect of climate change on the energy need in building. The ever-changing climate, increasing energy consumption and greenhouse are of a great concern. Climate change has strong influence on the environment, in intensity as well as the frequency. Reducing the building energy need and the related greenhouse gas is an issue on everyday global debate, the construction industry and the built environment as a whole is at the receiving end.

The construction industry plays a major role in energy consumption and greenhouse gas, ranging from production of raw materials, transportation, construction, use, rehabilitation, and demolition. To achieve a sustainable design, there should be laid down strategies for accessing building performance (Yassaghi and Hoque, 2019).

The use of electricity either for cooling or heating the internal environment results in increased expenditure and this is one of the impacts of climate change. The net global building

energy consumption increase on the order of 0.1% of global economic output for a 2⁰C increase in global mean surface temperature (Clarke and Zhou, 2018). The effects of changes in climate usually make the internal environment uncomfortable and harsh. As the climate changes there is a danger that current buildings will be not be suitable for the new climate.

However, it is likely that these effects would have to be rapid and severe to require substantial modification of existing buildings (Camilleri, 2000). Climate change has degrees of impact on the building systems. It affects the energy demands of the system in several ways. Climate change determines the energy demand of a building. This study aims at analyzing the effect of climate change on building energy need.

Review of Related Literature

Climate change is characterized by the changes in the usual climate of the planet regarding temperature, precipitation, wind which are triggered by human activities. Climate change is the variations in weather event which last more than a decade. Climate change is caused by anthropogenic activities and some natural events. The anthropogenic activities include fossil fuel combustion, industrial production, construction, urbanization. The natural events include; emission of methane, water vapour, carbon dioxide among others. The effects of climate change include: volcanic activities, solar variability, tectonic activities, orbital variation, green house gases. Climate change affect different sectors of construction, the transportation sector, infrastructure and the economic sector. The building energy demands include: hydropower, wind power, biofuels and solar energy. Energy systems are vulnerable to climate change (Boulahya and Schaeffer, 2012).

The impact of climate change on building energy need can be reduced by using wind power against electricity. This to a great extent can reduce this impact to the barest minimum. To reduce the energy demand in building, the building orientation, thermal mass and envelop insulation should be improved. The building industry contributes to 25% of greenhouse emission gases and 43% of total energy consumption. The thermal comfort is equivalent to obtaining certain indoor conditions that may influence the occupant's thermal state. The research also stated that the building morphology is an important design parameter in the process of finding energy efficiency (Catalina, Virgone and Lordache, 2011). Energy consumption as seen in building amounts to total negative environmental impact. The use of life cycle assessment discovered that gas consumption contributes to a significant measure.

Designers, building design and energy provision alike, need adequate tools to help inform decisions that, although made at present, will have an impact on energy use later within the life cycle of that building. There are numerous risks posed to the built environment by climate change. An attempt to predict such future scenarios is highly subjective. Even if climate model outputs are deemed suitable, making similar assumptions about future energy (generation) and technology (on the demand-side from the built environment) scenarios cannot be generalized.

Frank (2005), investigated the potential impacts of climate change on heating and cooling energy demand were investigated by means of transient building energy simulations and hourly weather data scenarios for the Zurich–Kloten location, which is representative for the climatic situation in the Swiss Central Plateau. A multistory building with varying thermal insulation levels and internal heat gains, and a fixed window area fraction of 30% was considered. For the time horizon 2050–2100, a climatic warm reference year scenario was used that foresees a 4.4 °C rise in mean annual air temperature relative to the 1961– 1990 climatological normal ranges and is thereby roughly in line with the climate change predictions made by the Intergovernmental

Panel on Climate Change (IPCC). Christenson, Manz and Gyalistras (2006), investigated the impact of climate warming on Swiss building energy demand by means of the degree-days method. A procedure to estimate heating degree-days (HDD) and cooling degree-days (CDD) from monthly temperature data was developed, tested and applied to four representative Swiss locations. Past trends were determined from homogenized temperature data for the period 1901–2003. The range of possible future trends for the 21st century was assessed based on 41 regional climate change scenarios derived from 35 simulations with 8 global climate models. During 1901–2003, the HDD were found to have decreased by 11–18%, depending on the threshold temperature (8, 10 or 12 °C) and location. For the period 1975–2085, the scenario calculations suggested a further decrease between 13% and 87%. For CDD, accelerating positive trends were found during the 20th and 21st centuries. The HDD showed the largest absolute and the CDD the largest relative sensitivity to warming (albeit starting from relatively low levels). Accordingly, weather data currently used for building design increasingly result to an over-estimation of heating and under-estimation of cooling demands in buildings; thus, requiring periodic adaptations. Projections were particularly sensitive to the choice of temperature scenario and they suggested that for the next decade's significant, seasonally and regionally variable shifts in the energy consumption of Swiss buildings needs to be studied and properly accommodated by the future designs for buildings.

Ackerman and Stanton (2008), also stated that temperature rise, regional variations in precipitation and humidity are important determinants of local climates. Hot temperatures combined with high humidity levels are often more unpleasant, and worse for human health, than a hot but dry climate. In addition, perceived heat of each local climate will be determined by annual average temperatures, temperature extremes, heat waves and cold snaps and precipitation levels, as well as some ecosystem effects. They assumed that in the business-as-usual case, heat waves will become more frequent and more intense. Changes in precipitation patterns are likely to differ for each region of the United States and all of these have implications with respect to energy need in already existing infrastructures and future ones.

Kevin, Danny, Wenyan and Joseph (2011), investigated the impact of climate change on energy use in office buildings in a city within each of the five major architectural climates across China: Harbin (severe cold), Beijing (cold), Shanghai (hot summer and cold winter), Kunming (mild) and Hong Kong (hot summer and warm winter); were investigated for two emission scenarios. For low forcing, the estimated increase in cooling energy use was 18.5% in Harbin, 20.4% in Beijing, 11.4% in Shanghai, 24.2% in Kunming and 14.1% in Hong Kong; and the reduction in heating 22.3% in Harbin, 26.6% in Beijing, 55.7% in Shanghai, 13.8% in Kunming and 23.6% in Hong Kong. Space heating is usually provided by oil- or gas-fired boiler plants, whereas space cooling mainly relies on electricity.

In their findings, there would certainly be a shift towards electrical power demand. More energy use in buildings would lead to larger emissions, which in turn would exacerbate climate change and global warming. Energy conservation measures were considered to mitigate the impact of climate change on building energy use. These included building envelope, indoor condition, lightening load density and chiller coefficient of performance. It was found that raising the summer indoor design condition by 1–2 °C could result in significant energy savings and have great mitigation potential.

Methodology

The temporal variation in the data set for rainfall, temperature and relative humidity were investigated using time series analysis. The graphs of value for rainfall, temperature and relative humidity revealed so many fluctuations that the general trend of the individual variables may not be easily determined. A smoothing function was applied to the data sets so that the general trend of the values may be easily determined. Other major statistical techniques were principal component analysis (PCA) and correlation analysis. Correlation analysis was used to examine the relationships between the perceptions of the respondents on effects of climate parameters on building energy needs. The PCA was used to collapse the various nine variables indicating the respondent's opinion on effects of climate parameters on building energy needs. The PCA was used as a result of the severe autocorrelations noticed in the data.

Findings and Discussion

The fluctuation in the value of temperature in the study area is of such that, in order to easily determine the general trend of these values, a 5-year moving average was applied to smoothen these fluctuations (figure 1). The general direction of the time series for the 47-year period was determined. While it could be seen that the trend is rising (positive), the correlation coefficient, $r = 0.122$, was found not to be statistically significant

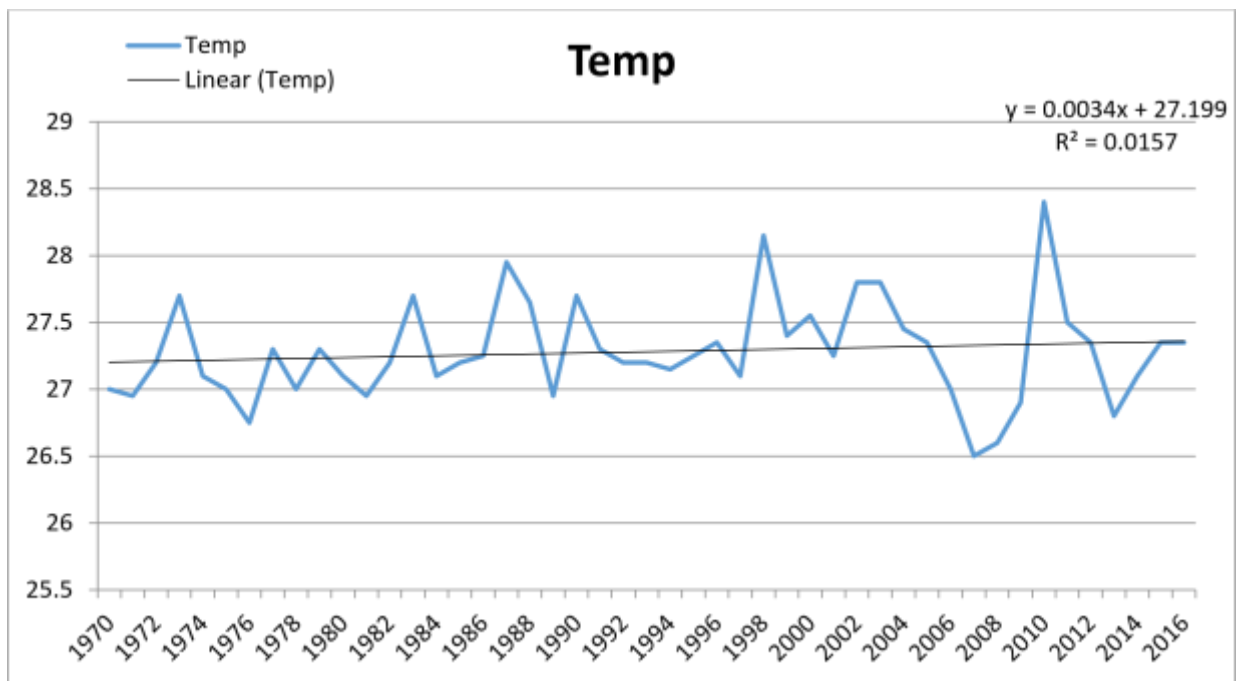


Figure 1: Trend plot of temperature variations between 1970 and 2016

Figure 2 which shows the temperature anomaly of Enugu, indicate temperature is truly increasing at the location. The overall mean temperature for the 46-year period was calculated to be 27.3oC. From 1970 to 1997, majority of the years have temperature values below the mean while in the past two decades most of the years have shown temperatures above the mean temperature for the period.

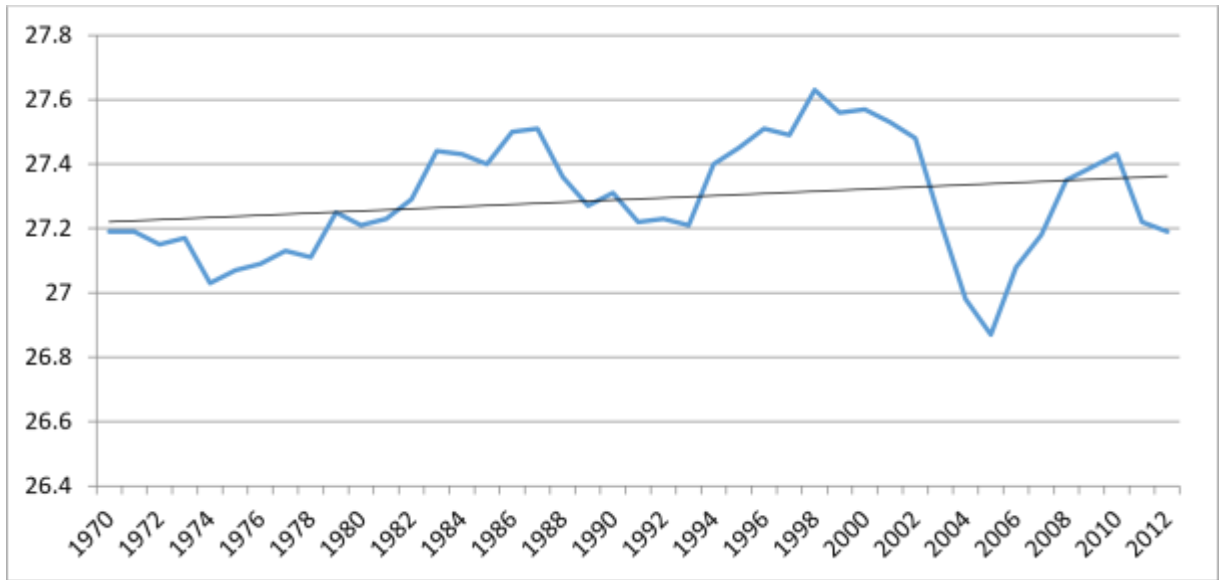


Figure 2: Moving average plot of temperature of the study area

The data were summed annually to generate annual time series of rainfall from 1970 to 2016. The trend plot of rainfall achieved is shown in fig 1.3, indicating that the movement of the time series is sporadic. The least square method was used to determine the trend in the time series of rainfall shown below.

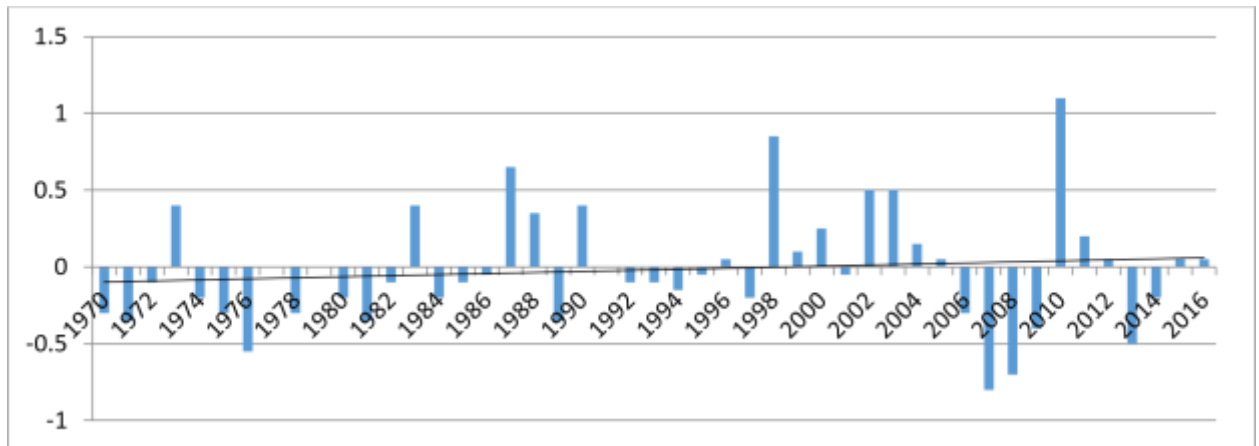


Figure 3: Temperature anomaly in Enugu using 1970 – 2016 normal Rainfall data for Enugu was obtained from the records of the NiMet.

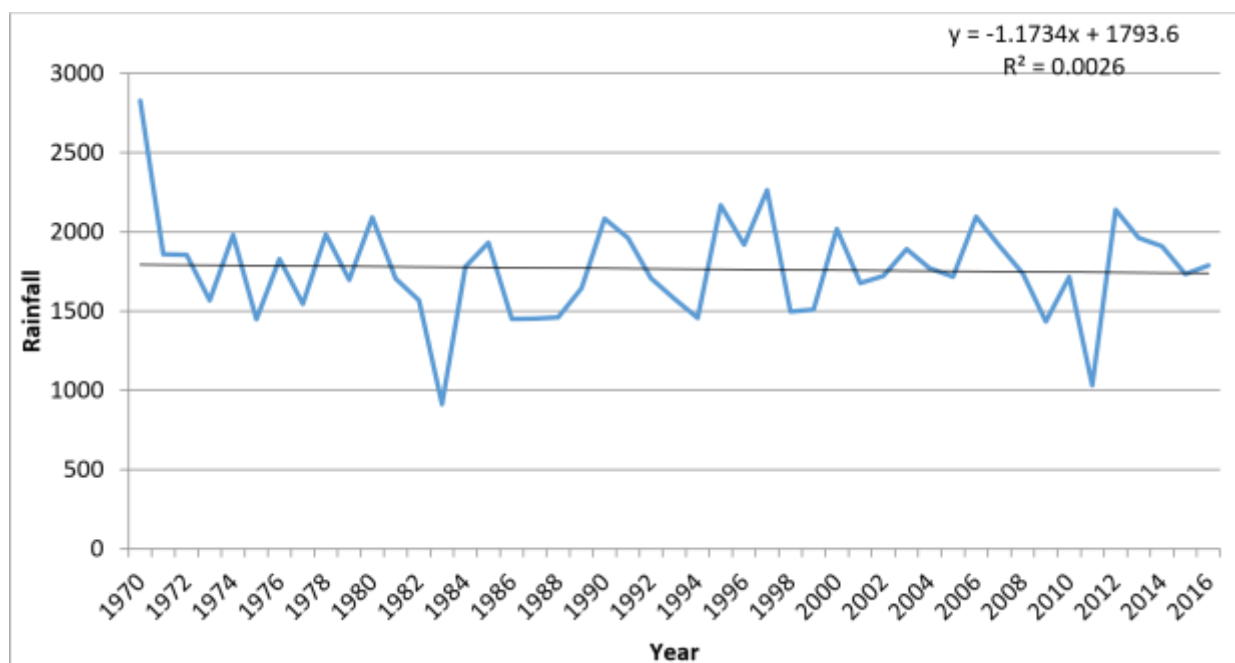


Figure 4: Trend plot of Rainfall variations between 1970 and 2016.

While the trend is not statistically significant with a coefficient of 0.044 at 0.05 level of confidence, it is evident that the rainfall is decreasing at an annual rate shown by the slope of the regression coefficient ($b = -1.173$). The trend plot of rainfall shows that at the start of the climatic period (1970-2016), rainfall increase was recorded for the first decade (1970-1987) after which a decreasing pattern of rainfall has been noticed for the study area with intermittent increase in some years. However, the former was found to be more pronounced from 1980 to 1989 and after 2000s till date than the latter. A similar decreasing trend in rainfall was recorded, but for the northern part of Nigeria, by Odjugo (2010) but an increasing trend in some parts of the south.

The mean annual rainfall for the 47-year period is 1765.4mm. A graph of rainfall anomaly (figure 4) was also shown to give a clearer picture on rainfall condition in the study area. The rainfall anomalies relative to 1970–2016 normal bear evidence to a more recent decrease in the rainfall trend, which was more from the early 2000s. Between 1970 and 1979, mean annual rainfall was above the 1970-2016 normal, between 1980 to 1989, it was below the climatic normal giving a mean decadal rainfall value of 1599.2mm while from 1990 – 1999, the mean annual rainfall for this decade increased to 1814mm. However, from early 2000s till date, the rainfall pattern of Enugu has exhibited a decreasing trend given that the mean annual rainfall for the 2000 to 2009 decade yielded a value of 1797.5mm while the mean annual rainfall recorded for the period 2010 to 2016 was 1754.1mm, a value slightly below the climatic mean of 1765.4mm of rainfall. Furthermore, figure 5 shows that the years with rainfall values above normal are less; 24 out of the 47 years were below normal but only 23 years (48.9%) out of the 47 years were above the normal.

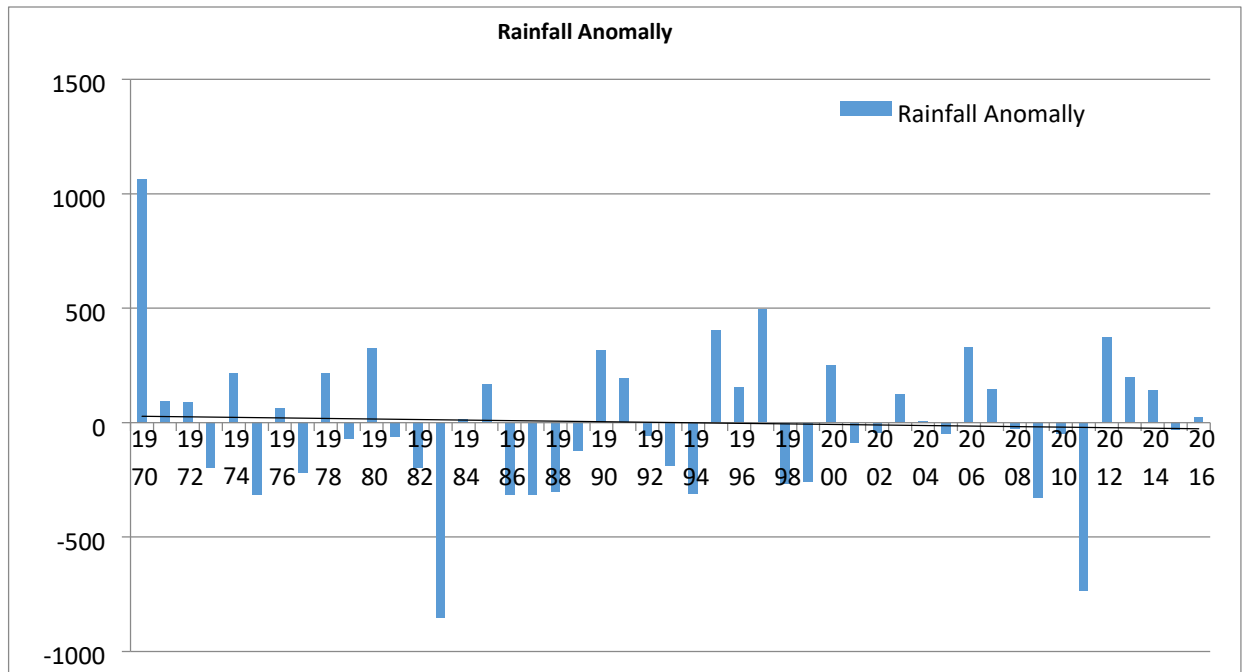


Figure 5: Rainfall anomaly in Enugu using 1970 – 2016 normal

The relative humidity scenario in Enugu is shown clearly in figure 6. The data was obtained from the records of the Nigerian Meteorological Agency. The monthly humidity data were summed annually to generate annual time series of relative humidity from 1970 to 2016. The trend plot of humidity achieved is shown in figure 6 and this was found not to be statistically significant, given a coefficient of 0.055 at 0.05 level of confidence. It is evident that relative humidity is reducing at an annual rate shown by the slope of the regression coefficient ($b = -0.06$). Mean relative humidity of Enugu is 73.7%. Though the rate of reduction of humidity given the slope value is quite insignificant, the negative trend is indicative of the direction of this movement. Relative humidity indicates the degree of saturation of the air i.e., how close to saturation the air is. This is greatly influenced by air temperature because the capacity of air to hold moisture increases with temperature.

However, temperature is generally on the increase in the study area and this appears to be in agreement with the study by Odjugo (2010) where it was reiterated that temperature trend in Nigeria has shown increasing pattern; that since 1970s, there has been a sharp rise in air temperature which continued until 2005. Prior to 1970s, temperature increase was more gradual and this was also emphasized in Ayoade (2012). Although the temperature increase within the study period is statistically the same, the upward trend especially since the 1970s is a worrisome evidence of regional warming (Odjugo, 2010). Similarly, the observed worrisome trend was clearly depicted in the graph of temporal distribution of minimum temperature characteristics of Enugu. As shown in Figure 6, the minimum temperature pattern in Enugu shows a steady increase in mean minimum temperature value for individual years within the 47-year period.

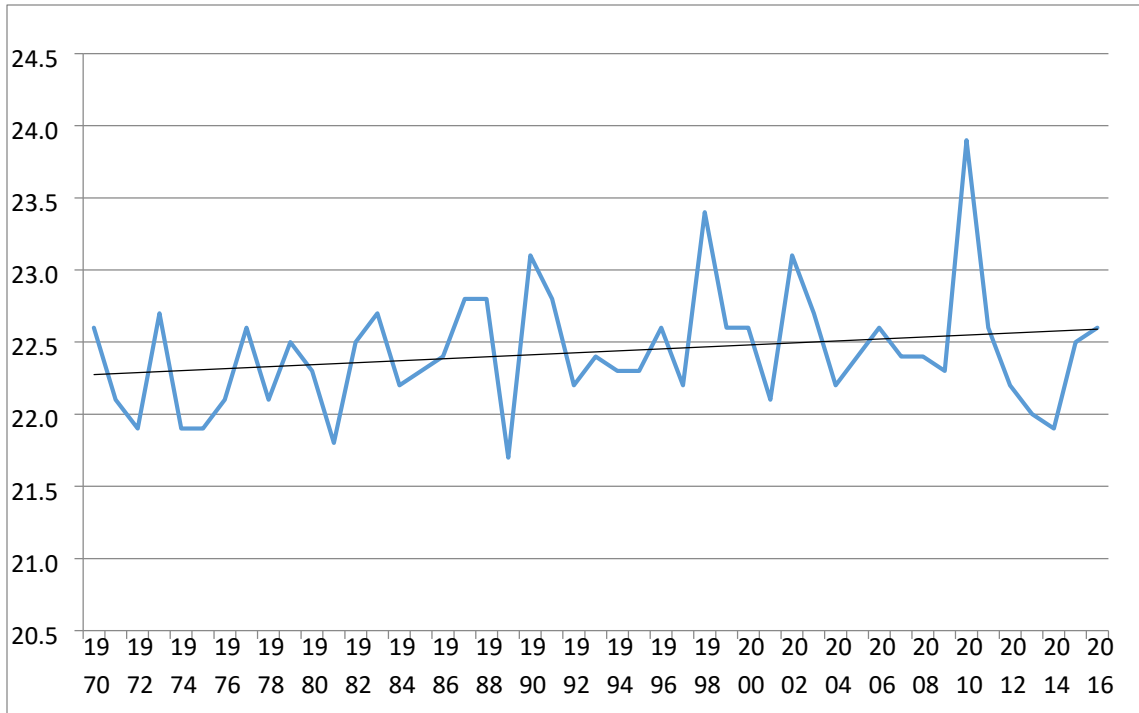


Figure 6: Trend plot of minimum temperature variations between 1970 and 2016

To examine the perceptions of the respondents on the impacts of climate on energy needs. These objectives sought to examine the perceptions of the respondents on the impacts of climate change on energy needs. The result is presented in table 1 and discussed afterwards.

Table 1: Perceptions on Climate impacts on Energy Needs

Question Items SA=5,A=4,UD=3,D=2,SD=1	SA	A	UD	D	SD	Statistics	
						Mean	STD
Energy need in buildings in Enugu metropolis varied over the last three decades.	83	150	58	25	9	3.8	0.56
The variation in energy needs of buildings in Enugu is a product of climate variations	20	120	86	79	20	3.1	0.44
Does temperature change/increase affect the energy need of a building?	142	92	33	33	25	3.9	0.51
Does amount and intensity of rainfall affect the energy need of a building?	111	128	51	26	9	3.9	0.52
Does wind direction affect the energy need of a building?	63	108	72	45	37	3.4	0.28
Does Humidity and Cloud Cover affect the energy need of a building?	83	133	75	17	17	3.8	0.49
Does sunshine intensity affect the energy need of a building?	137	120	51	17	0	4.2	0.61

Heating up of the building increases the energy need in building	108	125	42	42	8	3.9	0.49
Cooling down of the building increases the energy need in building	94	111	60	43	17	3.7	0.38
Cluster Means and Standard Deviation						3.7	0.48

Source: researcher field survey 2017

Table 1 shows the response of the respondents on what they perceived as constraints by climate variability and change on energy needs in buildings. Most of the respondents agreed that the changes in energy needs of buildings are a product of climate variations whereas about 86 of them were indifferent about this assertion while 79 disagreed strongly that changes in energy needs have no relationship with climate variations or change. In addition, the respondents agreed, as about 142 and 92 agreed strongly that temperature is a determinant factor in energy needs in buildings by occupants of these structures. In the same vein, they agreed that wind also determines the level of energy need and rates of energy consumption by buildings in Enugu metropolis. Another effect of climate variation on level of energy needs in buildings that received strong agreement from the respondents is the humidity levels in these buildings and the challenge of maintaining the humidity levels to ensure comfort especially on days with overcast cloud cover. They also agreed that amount of sunshine and sunshine intensity entering buildings determines the level of energy need. More so, 108 and 125 of the respondents agreed at various degrees that the need to heat up of buildings or the reverse of it increases energy cost and consumption.

Cost in energy consumption could be reduced greatly if changing or varying climatic conditions of the concerned sites are put into proper consideration. For instance, when buildings are properly oriented in relation the sunrise and direction of sunrise and sunset, this may lead to energy savings as the sunlight while continuously illuminate the inside of buildings especially throughout the day such that there may not be any need to use electric bulbs to illuminate buildings during the day.

Table 2: Poisson Regression of Cost of Energy (as dependent variable) against Rn, SI, Tmax, Ws, Tmin, Rh and Eff. Rn

Coefficients	Estimate	Std. Error	Z Value	Pr(> z)	
(Intercept)	1.52934	4.33068	0.353	0.72398	
Rn	-0.01650	0.00518	-3.186	0.00144 **	
SI	-0.41782	0.20059	-2.083	0.03725 *	
Tmax	0.20829	0.22989	0.906	0.36491	
Ws	-0.02085	0.27899	-0.075	0.94043	
Tmin	-0.16488	0.22957	-0.718	0.47263	
Rh	0.02126	0.03743	0.568	0.57001	
Eff.Rn	0.02075	0.01050	1.976	0.04815 *	

From this Table 2, we can say that it is only three variables (factors) that significantly affect cost of energy in the study area; they are rainfall, sunshine intensity and effective rainfall. This implies that these three factors do affect the energy cost of building in the study area.

The model corresponding to this Poisson Regression is:

$$\eta_i = -0.01650X_1 - 0.41782X_2 + 0.02075X_7 \tag{1}$$

Hypothesis: The Perceptions of the respondents on impacts of Climate on Energy Needs are not significant

Statistical Tool Used: One Sample T – Test.

Reason for Choice of Tool: One level of observation was compared with a known standard.

Decision Rule: reject the null hypothesis if the p – value is less than 0.05, otherwise accept it.

One Sample T–Test for Perceptions on Climate impacts on Energy Needs

Box 1: One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Perceptions on Climate impacts on Energy Needs	9	3.7444	.32059	.10686

Box 2: One-Sample Test

Test Value = 3.0						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Perceptions on Climate impacts on Energy Needs	6.966	8	.000	.74444	.4980	.9909

Decision and Reason for Decision: The result of the one sample T-Test above showed that the questions asked the respondents are significant climate impacts on energy needs. This is because the p – value is 0.000 which is less than 0.05, the overall (cluster) mean being 3.7444>3.0.

Table 3: Principal Component Analysis of Perceptions of the effects Climate Change on Energy Needs in Buildings (KMO and Bartlett's Test)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.923
Bartlett's Test of Sphericity	Approx. Chi-Square
	6540.059
	Df
	36
	Sig.
	.000

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.923 while the p – value of the Bartlett's Test of Sphericity is 0.000.

Table 4: Communalities Analysis of Perceptions on the Effects of Climate Change on Energy Need

	Initial	Extraction
Energy needs in buildings in Enugu metropolis varied over the last three decades.	1.000	.934
The variation in energy needs of buildings in Enugu is a product of climate variations	1.000	.897
Does temperature change/increase affect the energy need of a building?	1.000	.941
Does amount and intensity of rainfall affect the energy need of a building?	1.000	.948
Does wind direction affect the energy need of a building?	1.000	.922
Does Humidity and Cloud Cover affect the energy need of a building?	1.000	.928
Does sunshine intensity affect the energy need of a building?	1.000	.913
Heating up of the building increases the energy need in building	1.000	.948
Cooling down of the building increases the energy need in building	1.000	.944

Extraction Method: Principal Component Analysis.

Table 5: Component Matrix Analysis of Perceptions on the effects of climate change on the cost of construction and Maintenance

	Component
	1
Energy need in buildings in Enugu metropolis varied over the last three decades.	.967
The variation in energy needs of buildings in Enugu is a product of climate	.947

variations	
Does temperature change/increase affect the energy need of a building?	.970
Does amount and intensity of rainfall affect the energy need of a building?	.973
Does wind direction affect the energy need of a building?	.960
Does Humidity and Cloud Cover affect the energy need of a building?	.963
Does sunshine intensity affect the energy need of a building?	.955
Heating up of the building increases the energy need in building	.974
Cooling down of the building increases the energy need in building	.972

Extraction Method: Principal Component Analysis. a.1 components extracted.

The principal component is strongly correlated with all the original variables. That is, only principal component increases with increasing. This component can be viewed as a measure of the quality of these variables:

- i. Heating up of the building increases the energy need in building?
- ii. Does amount and intensity of rainfall affect the energy need of a building,
- iii. Cooling down of the building increases the energy need in building,
- iv. Does temperature change/increase affect the energy need of a building?
- v. Energy needs in buildings in Enugu metropolis varied over the last three decades,
- vi. Does Humidity and Cloud Cover affect the energy need of a building?
- vii. Does wind direction affect the energy need of a building?
- viii. Does sunshine intensity affect the energy need of a building?
- ix. The variation in energy needs of buildings in Enugu is a product of climate variations.

This component can be viewed as a measure of increases the energy need in building as the heating up in the building takes place. Furthermore, in order to establish a relationship between climate variation over time and variation in building design, construction cost, material and maintenance cost, multiple regression model were developed. Data on majority of the socioeconomic variables capable of defining building designs, cost of construction and maintenance and energy are not easily obtainable and also were not readily available except for building collapse. Building collapse will be used as a surrogate for possible consequence of climatic factors on cost of construction while other remaining surrogate data for energy needs, maintenance and building designs were elicited from the respondents. Data on building collapse were obtained from government agencies such as NEMA and ECTDA. The respondents were asked at what times of the year they think that they spend more to take care of their energy needs. They were also asked to identify the different times during which they think their building performed poorly due its design in protecting them against climatic influences.

Conclusion

The study generated a regression model showing the mathematical relationship between the independent variables (Rainfall, Sunshine Intensity, Temperature, effective rainfall, wind speed and relative humidity. The model corresponding to this Poisson Regression is $\eta_i = -0.01650X_1 - 0.41782X_2 + 0.02075X_7$ It further recommends that designers, building design and energy provision alike, need adequate tools to help inform decisions.

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Chapter 19

Timber as a Material for Multi-Story Constructions: A Review

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Abstract

This research explored the use of timber in the construction of high-rise buildings, and ways they can be harnessed for better acceptability. Timber is one of the building materials which when properly used, will positively benefit plants and human relationship with the ecosystem. This study is to assess the challenges and prospects of timber as a material in the construction of high-rise building, and how to use timber as a structural material especially at the external parts of a building. The study also highlights the sustainability benefits that are attached to the use of timber in the building system, the different types of timber used in construction, the different types of wood generations and the various places where each can be used. From the data collected it was noted that timber can be used for structures above five floors and can stand the test of time if necessary, precautions were taken. Some of the issues that leads to poor performance of timber in construction are; poor seasoning of the wood before use, untreated and unpreserved wood, poor coating, poor technology and other issues which if done right, will see timber construction through the test of time, other issues range from acceptability, approval from the necessary government regulatory agencies to mention but a few. Timber construction has been with us for a very long period, it is still with us now, and the options we take now will determine the fate of timber construction in the next generation.

1. Introduction

1.1. Background Information

For some decades now the building industry has been increasingly looking towards the use of timber as a building material in the construction of high-rise buildings, this interest came up partly as a result of the development of new engineered timber products and the potential economic benefits that can be gotten from prefabricated timber elements and composite building systems, although the primary motivation for a lot of architects, building owners, government and other building stakeholders in wanting to go into the business of constructing with timber is the understanding of the potential sustainability benefits of tall timber building and also the quest for green and sustainable architecture.

Ramage et al, (2017), in their research in renewable and sustainable energy, stated that, there is a sufficient timber supply for the foreseeable future for any type of timber construction,

although there is a worldwide trend towards deforestation, this is basically due to the clearing of land for agriculture, rather than logging for timber, never the less illegal logging of wood remains a huge concern.

How should we use timber? In as much as there are a lot of ways and designs into which timber can be sawn into, but construction of any type is chiefly based on the available engineering and cultural practice, timber has a high strength to weight ratio and it is used most efficiently in structures where it is carrying a lot of its own weight (self-weight).

In a lot of places building codes are made out of the available engineering, so heights are limited well below what is possible in timber, there are other important questions relating to the service life of timber, like how long logs of timber can last as structural elements, the free performance of timber, its fire rating and also its moisture sensitivity and how all these can be extended through the modification of the natural material and using effective design details. Even though such modifications can increase the carbon sequestration (carbon sequestration is a long time removal, capture or sequestration of carbon dioxide from the atmosphere to slow or reverse the atmospheric CO₂ pollution and to mitigate/ reverse global warming.) period due to prolonged life, there may be however detrimental implications to end-of-life scenarios (Noelle, 2019).

1.2. Statement of Problem

With recent observations and studies of various building materials, it has been observed that timber is one of the low-cost materials, this is to say that timber is one of the cheapest building materials in the building industry, this result is gotten when timber is compared with other building materials like aggregates, sand, cement, reinforcement bars and roofing sheets.

Cost comparisons are difficult to make between timber frame and other construction materials. Sometimes the actual construction cost while using timber is oftentimes a few percentages higher for a typical timber frame than in the normal brick and block construction, most architects and builders with less experience in timber frame construction tend to increase their prices to compensate for the extra time needed to ensure that the design is correct. This project is a comprehensive study of timber to ascertain the suitability of timber and usefulness as a building material in the construction of high-rise buildings.

Generally, despite the numerous contributions of timber to the construction companies, there are still lots of problems associated with the use of timber in construction. Some of these problems are lack of knowledge in timber treatment methods, non-availability of standard timber connector. Cost effectiveness in the usage of timber, non-conformity of timber available in market and many other problems associated with the use of timber as an external material in building production in hot climate.

1.3. Aim and Objectives of the Study

The main aim of this study is to assess the problems and prospects of timber as an external material in the construction of high-rise building. This aim is to be achieved through the following objectives:

- i. Analyze the prospects and challenges of timber in the construction of high-rise buildings;
- ii. Examine the challenges of timber in the construction of high rise buildings;
- iii. Discuss the contribution of Timber in building production

2. Prospects of timber in the construction of high-rise buildings

2.1. Source of Timber as Building Materials

Hardwood trees take a long time to grow, around 60 years (sometimes up to 100). Hardwoods include ash, balsa, beech, mahogany, and oak. Softwood trees take around half the time, 25 to 30 years and include larch, pine and spruce. As trees are felled, it is important to plant new ones so that the timber source will be sustainable (Bitesize, 2020). Construction grade timbers and engineered forest products are some of the highest value product from trees. Timber as one of the few natural building materials can boast of a whole lot of advantages generally ranging from being safe to handle, not leaking chemical vapors into the building (Ramage, et al. 2017). For a designer to understand the environmental concerns associated with a particular material, the designer has to first understand where the raw material is sourced from. The Forest Stewardship Council (FSC) is an international organization that promotes responsible forest management. Once a tree has been chopped down, the branches are removed, so only the trunk of the tree remains. The full length of a tree might be too long to transport and work with, so the tree may be cut to a more manageable length. The tree trunks are transported to a sawmill, where the trees are cut to usable planks. This process is known as conversion.



Figure 1: Timber that has been cut into planks

2.2. Reasons for use of timber in building construction

Below are some of reasons for using timber in building construction (Atlantic Cladding, 2018):

- i. Ecology and Sustainability: Timber has been on the construction scene for years now and is truly sustainable and renewable as a building material. Timber is easily replaced because of the standing policy of replanting new trees once any timber is harvested; this procedure makes the continual availability of timber possible.
- ii. Low Production Energy: It takes a very little energy to convert trees into timber for construction; this means the embodied energy in timber is low.
- iii. Offers Great Insulation: Timber as a material is a natural insulator, a timber frame allows more space for insulation than a brick building and wood also has naturally thermal insulating properties.
- iv. Easy to Work: timber is a versatile material and can be used in various ways and it is very easy to install.
- v. No limit to design and size.
- vi. Durable, easy to maintain and quick build time when the timber is treated.
- vii. Fire Retardant: some types of treated timber are fire retardant therefore prolonging the time it takes to catch on fire and slowing down the burning process.

2.3. Sustainability Benefits/Advantages of a Timber Building System

Timber is considered a renewable resource and the forests supplying timber can offer a natural carbon sink; The resource extraction and manufacturing phases of timber products demand a very low amount of energy relative to more conventional structural materials used in construction; and Innovative timber systems designed for prefabrication and disassembly allow for reuse of the material and a more resource-efficient product life cycle than typical demolition and down-cycling. In addition to the sustainability benefits, timber has other positive attributes relative to other building material types: such as, Possibility of offsite prefabrication and minimized onsite work allowing for high-quality certified production, independent from weather and a rapid erecting progress, Reduction of building weight, resulting in savings in foundation works when compared to other construction materials, Ease of alteration onsite, and increased flexibility in architectural design options (Ramage, et al. 2017).

2.4. Types of Timber Construction – The Next Generation in Timber Design

Timber products, assemblies, and methods of construction have evolved over time. Conventional experience with timber buildings is typically limited to low- and mid-rise residential and commercial buildings. These buildings generally utilize light timber frame construction and are limited in size and open area. This is different from heavy timber frame construction that is increasingly being used for mid- to high-rise residential and commercial applications.

While light and heavy timber framing are used for different applications, the primary differentiator between the construction types is the section size of the timber members used in construction. Although there is currently no universally accepted definition of "light" and "heavy" timber, timber can be considered as heavy where its minimum dimension of solid wood exceeds approximately 80 mm.

In general, light timber frame construction is composed of a greater number of small-section stud members to form wall and floor assemblies, typically enclosed within cladding to form wall or floor framing elements. Light timber frame construction is typically used in low- and mid-rise residential buildings and is often used in buildings up to five- and six-stories, typically above a reinforced concrete ground floor. Framing methods include "platform" and "balloon," or stick-framed construction.

Heavy timber frame construction is composed of a lesser number of large-section engineered products to form the building superstructure. While this includes solid sawn lumber sections, modern timber buildings generally use engineered timber products. Relative to solid sawn lumber, engineered timber products offer greater strength and design flexibility and have enabled greater ambitions in architectural and structural design (Barber & Gerald, 2019).

The use of heavy timber frame construction allows for greater design flexibility (relative to light timber frame construction) including longer unsupported spans, open-plan areas, and taller construction. The two predominant forms of heavy timber construction include post and beam construction and panelized construction.

Characteristics of light and heavy timber frames are discussed in a number of design guidance documents (Hodgson, 2015).

2.5. Post and Beam Construction

Post and beam construction utilizes a range of different products. This includes traditional products such as solid sawn lumber, and contemporary engineered products such as glue-laminated wood, laminated veneer lumber and cross-laminated timber.

Solid sawn lumber consists of large-section timber members that are cut down to size. Given the size of the elements, solid sawn lumber is typically used as structural column and beam

framing members. Glue laminated wood (glulam) is an engineered product that consists of smaller pieces of wood, nominally 2 in x 4 in (50 mm x 100 mm), which are adhered, or laminated, together. This produces a structural element that is stronger than solid sawn lumber as it is more homogenous and reduces the impact of knots and other imperfections. Similar in size and structural application as solid sawn lumber, glulam elements are commonly used as structural beams and columns.

Laminated veneer lumber (LVL) is composed of multiple layers of thin wood veneers, approximately 3 mm (1/8") thick, which are laminated parallel to each other under heat and pressure. Slicing the timber into thin veneers and laminating them together reduces the effect of imperfections in the wood, resulting in improved structural performance compared to solid sawn timber members. (Ramage, et al. 2017)

2.6. Panelized Construction

Panelized construction consists of solid timber panels as the primary structural elements. These panels are composed of an engineered product referred to as "cross laminated timber" (CLT). Cross laminated timber is an engineered product that consists of multiple layers of stud members that are laminated perpendicular to each other to achieve strength in multiple directions. Multiple perpendicular layers are built up to create CLT panels for use as structural elements (Barber & Gerard, 2019.). CLT panels can be vertically oriented as load-bearing walls and shear walls, or horizontally as load-bearing floors or roofs. The use of CLT panels for structural wall and floor elements is typically used for mid- and high-rise residential construction as load-bearing walls and floors. Walls typically consist of three- to five-layer panels, whereas floors consist of five or more layers for greater stability. CLT panels can be designed to create internal and external partitions within the structure that makes their use practical for housing units in residential buildings. One of the primary benefits of CLT panels is the use of offsite prefabrication. Holes and notches in panels can be pre-cut prior to arrival to site. This minimizes work onsite, reduces construction time and costs, and increases the accuracy of structural components and quality of workmanship (Schickhofer, 2019.).

3. Evaluating the Challenges of Timber as Tall Building Materials

3.1. The Challenges

The recent emergence of tall timber buildings and its construction presents with it several primary challenges for the design, approval, and construction of these new and innovative structures. Some of these challenges are:

i. Fire Risk

The major challenge for tall timber buildings is a concern that they might present greater fire risks compared to high-rise, non-combustible structures. This assumption was prompted by previous cases of catastrophic fire cases, recent fire incidents in timber structures, or even a general misunderstanding of the fire performance of heavy timber as a building material. Knowing the fire rating of light and heavy timber members is an important distinction. Fire issues with timber could be limited to small section members, characterized by kindling and light timber framing. Research has shown that heavy timber elements exhibit different fire performance compared to light timber. The section size of heavy timber members achieves an inherent fire resistance that protects the element due to the formation of a charring layer. This results in improved fire performance for heavy timber members relative to light timber (Ostman, Brandon, Frantzich, 2017)

ii. Gaps in Knowledge

For over 15 years, research and testing has been performed to better understand the fire performance of timber structures. However, there is still opportunity for further research work. This research however is intended to create better understanding of the fire performance of timber structures and clarify its fire risk. Research and testing could lead to performance benchmarks and design tools that would allow a designer to characterize fire performance, engineer fire protection strategies, and demonstrate safe design (Barber & Gerard, 2019.).

iii. Contribution of Exposed Timber to Room Fires

Previous fire testing has shown that exposed timber has the potential to contribute to the fuel load in compartment fires. Fire tests have shown that delamination can occur in exposed CLT panels. This delamination may result in an increased burning rate for a limited period of time and also can result in an increased char rate for the exposed solid wood as it is instantly exposed to the compartment temperatures. A better understanding of the contribution of exposed timber to room fires has the potential to better account for the contribution, identify if and when delamination might occur, and engineer strategies to meet the specific risks. Further, research also can evaluate the potential for self-extinguishment in exposed timber applications (Schickhofer, 2019.).

iv. Connections between Timber Components and Timber Composite Assemblies

New timber technologies are being developed to meet architectural ambitions and structural demands, it is important to consider the fire performance of these new structural assemblies and, in particular, the connections that transfer load between structural elements. A high level of confidence in structural fire performance will be required to demonstrate that safety is achieved. This could require advanced modeling analysis or fire testing to demonstrate safe design. Design solutions must be balanced by structural-efficiency, cost-effectiveness, aesthetics and, importantly, fire performance (Fernandez-Lavandera et al. 2013.).

v. Penetrations for Services

Understanding penetration behavior is critical to demonstrate that sectional division is achieved for fire safety in timber buildings. The combustible nature of fire-rated structural elements presents unique challenges compared to noncombustible structures. Charring behavior must be considered for appropriate fire-stopping solutions to be developed to meet the fire performance requirements.

Two possibilities to solve this challenge include the development of fire test standards that account for combustible bases or substrates, and proprietary products for walls and floors in timber buildings (Barber & Gerard, 2019.).

vi. Gaining Approval

There is already a growing global precedent for tall timber buildings, most the building regulatory process around the world are yet to approve the design for a high-rise timber building. The current conventional guidance in the International Building Codes restricts flammable construction to approximately five to six stories, well below the practical limit of approximately eight-plus stories for heavy timber buildings. In the current regulatory environment, approval for a high-rise timber structure would require the proposal of an alternative solution to the building code. This requires a designer to provide technical justification that the alternative solution meets the intended level of safety required by the prescriptive code requirement. This is a high burden

of proof that relies on a comprehensive understanding of timber fire performance, an engineered fire protection strategy, and possibly fire testing, to justify safe design (Green, 2012).

3.2. Wood treatments in building construction sector

Wood treatment for increased durability is another important procedure before timber is used for construction. Wood treatment can be described as ‘a procedure that is used in protecting wood from damages caused by insects, moisture, and decay fungi’. Wood, consisting of cellulose, hemicellulose and lignin, is susceptible to biodegradation by fungi and bacteria, especially under high moisture condition. It is undesirable for timber to degrade during service in buildings. In addition to using naturally durable timbers such as larch or tropical hardwood, the durability of wood products can be improved by physical or chemical treatments.

Some of the material properties that need to be enhanced in wood to increase the stability and life cycle of woods include dimensional stability, resistance to biological degradation, thermal stability or fire resistance, UV resistance, mechanical properties etc. Currently, applied physical or chemical treatments usually take effect by:

- i. Reducing the ingress of water in order to minimize changes in wood volume, and inhibit the growth of fungi and bacteria (indirectly), which can be realized by hydrophobic treatment or filling with blocking agents.
- ii. Quenching chemically-active groups such as hydroxyl groups in order to prevent the attack by fungi, bacteria and insects (indirectly), and also increase fire resistance to some extent.
- iii. Impregnating preservatives to kill fungi, bacteria and insects directly, or impregnating fire retardant for thermal stability.
- iv. Coating moisture-, bio-, fire- or UV-resistant agents on the surface of wood.

Therefore, wood treatments normally use one of three strategies: modification of the cell wall, **impregnation**, and **coating**. Modification of the cell wall can be further divided into thermal modification and chemical modification, both of which are active strategies that result in a change to the chemical nature of materials at the molecular level. (Wood Solutions, 2020.).

4. X-raying The Contribution Of Timber In Building Production

4.1. Feasibility Studies – The Future of High-Rise in Construction Using Timber

Timber is becoming an increasingly desirable construction material as many architects and designers understand the potential sustainability and construction benefits of timber buildings. Traditional schemes for timber structures as low-rise (two-stories or less) and mid-rise (three- to five-stories) are now being extended with schemes for new high-rise buildings (six-stories or greater). Innovative technologies, such as the emergence of CLT and other engineered timber products, create the potential for timber buildings to be designed to taller heights and maintain the stability and safety of conventional construction materials, all while reducing the environmental impact.

A 2010 partnership between Arup consulting engineers and Rhomburg, an Austrian architecture firm, undertook a research study for a 20-story office building called Life Cycle Tower (LCT). The study aimed to design and detail a heavy timber commercial office building to demonstrate that high-rise buildings can be constructed in timber without compromising safety. The research project was realized with the construction of an eight-story office building called LCT One in Durbin, Austria in 2012 (Wood Solutions, 2020.).

One of the most well-known cases for tall timber construction was published in 2012. "The Case for Tall Wood" challenges the use of steel and concrete as essential materials in tall building construction. The study demonstrates the environmental benefits of timber buildings,

while highlighting the design challenges and identifying how these can be achieved through science, engineering, and design. "The Case for Tall Wood" promotes the use of a mass timber structural solution that can be competitive with concrete construction for buildings up to 30 stories in height. (Strathern, Varga, Guntchnig, 2017).

5. Conclusion

As stake holders in the building industry learn to expand what they can do with large scale engineered timber, and how they can improve on the already existing rich tradition of centuries of wooden construction while reaching higher to embrace the full potential of innovation and construction with natural material like timber, we can also see from research that a lot of high rise building construction has been done using timber, some of which are (the project "H7-office building" which serves as one of the first prototype of high rise timber buildings in Germany, with an exposed timber frame structure) and also (the "Life cycle tower" LCT which is a high rise building with 100% timber) (World Conference on Timber Engineering, 2016). From the above analyses, it can be concluded that, timber as a construction material has lots of sustainable benefits to the construction industry and the building material also very cost effective and stable.

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Chapter 20

Suitable Blend of Agricultural Waste for Bio-Energy Utilisation and Production in Anambra State of Nigeria

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Abstract:

Environmental pollution from unattended agricultural wastes in the study area is challenging, therefore this study investigated the kinetics of co-digestion of cattle paunch with poultry droppings, the modified version of the logistic function was applied to describe the cumulative biogas production for the bio-digesters, the study also used geospatial technology to map out the spatial density of the waste. The result of the study shows that the first order kinetic model had rate constant that ranged from 0.011 to 0.055 day⁻¹, with R-square value that ranged from 0.9694- 0.9984. The Logistic Function fitted the experimental data. Digester R3 blend had the highest kinetic rate constant of 0.055 day⁻¹. The synergistic effect of co-digestion was observed on biogas production potential and maximum biogas production rate. The geospatial map from the study revealed that poultry waste is available and abundant across the state especial in Idemili North and Njikoka Local Government Areas. The geospatial map can be used as a policy document indicating areas in the state that has comparative advantage of higher availability of agricultural wastes and hence most suitable place for siting bio-waste energy production plant. This study proves the feasibility of bio-energy production from substantial amount (thousands of tons) of these wastes generated daily across the state. For future studies, it is suggested that focus on the seasonal trend of these waste generation and factors that influences them should be examined.

Keywords: Agricultural Waste; Bio-energy; Sustainable Development; Kinetics; Anambra State

1. Introduction

Over the past twenty years, Nigeria has experienced power outages this have obvious negative effect on the economic life of the country. Furthermore, the continuous increase in the Nation's energy needs as a result of rapid growth of technology and population have led to an increase in advocacy for alternative clean energy nationally (Agbo and Oparaku, 2006). Hence, many local populations have resulted to the use of generators to supply an alternative to epileptic public power supply, both in cities and rural areas. If increasing use of generators by larger population of Nigerians is not reduced, then, attaining SDG-13 (Climate Action) by 2030 could be a mirage, because, use of generators can contribute to increasing the greenhouse gases in the atmosphere and further causing environmental pollution and global warming (Suberu et al., 2013). In this regard, innovative solution to power sector of Nigeria could be achieved through the adoption of bio-energy production. Bio-energy is an affordable and alternative clean energy source, the use of this energy aligns perfectly with Sustainable Development Goal (SDG) goal number seven, this aims at ensuring universal access to affordable, reliable and modern energy services to all and to substantially increase the share of renewable energy in the global energy mix.

Large number of poultry and paunch bio-wastes is generated across the state without clear strategies to utilize them for bio-energy production (Umeghalu, 2012). There is need to consider the co-digestion of both wastes for biogas production. Several studies have shown that co-digestion of wastes has synergistic advantages; therefore, this study will consider the synergistic advantage and the kinetics of the anaerobic process. Also, the study by Umeghalu et al., (2012) failed to present spatial resources mapping of the wastes, this is essential in economic analysis and is prerequisite in the siting of biogas plant, this study therefore seeks to bridge the research gaps of previous study by providing spatial density map of the wastes and the kinetic properties of the bio-waste for biogas plant design. Decisions on location for the bio-energy plant may be the most critical and most difficult of the decisions needed to realize an efficient energy system. Since siting of a suitable bio-energy plant is a geospatial problem, the need for the use of state-of-art technology in spatial analysis is inevitable. The focus of this study is to determine biogas kinetics of cattle paunch (a lignocellulose material) co-digested with poultry droppings using first order kinetic model and to geospatial model the availability of the bio-waste. Kinetic parameters assessed include biogas yield potential (P); the maximum biogas production rate (R_{max}); the duration of lag phase (λ) and substrate utilization rate constant (using the first order kinetic model).

2. Agricultural Waste Management Challenges in Anambra State

The capital and the seat of government is Awka. Onitsha and Nnewi are the biggest commercial and industrial cities, respectively. Boundaries are formed by Delta State to the west, Imo State and Rivers State to the south, Enugu State to the East and Kogi State to the North. Municipal and agricultural wastes are generated in large amount across the state, which has three major cities of Awka (State Capital), Onitsha and Nnewi. Anambra State Waste Management Authority (ASWAMA) is the leading government Agency that is saddled with the responsibility of managing all manner of wastes as contained in the revised Anambra State Waste Management Law. Unfortunately, because of poor management practices, the waste products generated during meat processing activities are disposed into these water bodies; leading to serious ecological effects and destabilization of aquatic ecosystem. This indicates that poultry droppings and cattle paunch bio-wastes are poorly managed in the state, hence they constitute moderate to severe

environmental hazards as reported by Chukwuma et al (2020). The challenges posed by agricultural waste mismanagement on the environment, health and social well-being of the people needs to be addressed using appropriate strategy.

3. Renewable Energy and Biogas Technology

Due to the rapid growth in the global energy demand and to the growing concerns regarding energy supply, more attention has been paid to the development of bio-energy, especially the one derived from anaerobic digestion (Dong, and Lu, 2013). Anaerobic digestion is the breakdown of organic material to produce biogas which is a mixture of Methane, Carbon dioxide and other trace compounds (Nyagabona and Olomi, 2009). The first step of the process comprises the disintegration of particulate organic matter into carbohydrates, lipids and proteins, which are further hydrolysed enzymatically (extracellular) to short chained carbohydrates, long chain fatty acids and amino acids (Batstone et al., 2002). Acidogenic microorganisms subsequently convert these soluble components to alcohols and/or organic acids (e.g., acetate, propionate, butyrate, valerate), which are, in turn, converted into acetate and ultimately into Methane and Carbon dioxide by acetoclastic methanogens. The process of anaerobic digestion has the potential of converting biodegradable organics into biogas which comprises Methane (55 to 75%) and Carbon dioxide (25 to 45%) with calorific value of 20 MJ/m³. Biogas production based on animal waste is a cost-effective way to reduce greenhouse gas emissions from agriculture, moreover the establishment of more biogas plants will generate additional income and jobs in the rural areas. Economically, electricity generation from biogas can compete with electricity generation from fossil fuels and other renewable energies such as hydro power. Supporting factors are: Rising prices of fossil fuels; Low reliability of electricity provision from national grids with persistent risk of power cuts and vulnerability of hydro power to drought (Elmar et al., 2010).

Babel et al., (2009) reported that in Thailand, sewage sludge production from the Bangkok metropolitan area can reach up to 63,000 ton/y by 2010. The Beer-Thai Company, Thailand, produces beer and generates lots of sludge as waste. The study reported that for the 1.15×10^6 m³/y of bio-energy is generated annually; this bio-energy production could substitute 918,032 kg/y of coal which is equivalent to 12,089.36 USD/y; with energy replacement of LPG from bio-energy being equal to 315,515.11 USD/y. And on comparison to electricity generation, the bio-energy is equivalent to 1.44x10⁶ kWh and can generate a saving of 140,078.84 USD/y. Bio-energy technology from which bio-energy is derived through anaerobic digestion of biomass, such as agricultural wastes, municipal and Industrial waste (water), is one such appropriate technology that Africa should adopt and precisely Anambra state of Nigeria to ease its energy and environmental problems.

4. Biogas Technology as Appropriate Alternative Energy Mix

Biogas production from organic materials not only produces energy, but preserves the nutrients, which can, in some cases, be recycled back to the land in the form of slurry. The organic digested material also acts as a soil conditioner by contributing humus to the soil. Burning non-commercial fuel sources, such as dung and agricultural residues, in countries where they are used as fuel instead of as fertilizer, leads to a severe ecological imbalance, since the nutrients, nitrogen, phosphorus, potassium and micro-nutrients, are essentially lost from the ecosystem. Nigeria ranks first in Africa in terms of growth rate for electricity and natural gas demand in the past several decades (Chetan 2014).

Fossil fuel and hydroelectricity generation accounts for nearly all of Nigeria's electricity. The availability and accessibility of sufficient amount of energy can accelerate nation's development (Chetan et al., 2014). Fossil energy source fulfills these energy criteria, but lacks in the non-toxic requirement. Since the environment must be preserved for the sustainability of man and animals, alternate energy or energy mix has been advocated for by the global community. Bioenergy, the energy obtained from biomass, is considered to have the potential to supply a significant portion of global primary energy over the next century with associated economic, environmental and socio-technological advantages. On European scale, biomass will potentially contribute 17.2% of the EU heating and cooling mix and 6.5% of electricity consumption in 2020 (European Renewable Energy Council, 2011).

As the global trend is advocating for a transition from fossil energy source to Renewable Energy (RE) based on several socio-economic and environmental justifications, the necessity to embark on a process to capture bio-energy for energy production is inevitable for Anambra state (Chukwuma *et al.*, 2013). Global agitation for sustainable development advocates that both developed and developing countries trench in RE exploitation, since it is not exclusive to any region. The need to adopt bio-energy technology as a critical development strategy for Anambra State considering its attendant benefits cannot be over-emphasized. The adoption and implementation of the biogas technology will provide the state with rich energy source, reduce environmental hazards, provide employment opportunities, and the by-product of the digestion process will be used as bio-fertilizer in farms to mention just a few benefits.

5. Kinetics of Bio-degradability for Plant Design and GIS Analysis

Knowledge about the biodegradability of biomass employed in anaerobic digestion can be useful in selecting suitable biomass for anaerobic process. Some researchers in Nigeria have studied the kinetics of biodegradability of organic material in order to characterize the biodegradability process (Yusuf, et al., 2011). Kinetic studies of anaerobic digestion process are useful to predict the performance of bio-digesters; it is also helpful in understanding inhibitory mechanisms of biodegradation. First order kinetic models are the simplest models applied to the anaerobic digestion of complex substrates as they provide a simple basis for comparing stable process performance under practical conditions (Dhanalakshmi and Ramanujam 2012). Anaerobic bio-digesters often exhibit significant stability problems that may be avoided only through appropriate control strategies. Such strategies require, in general, the development of appropriate mathematical models, which adequately portray the key processes that take place (Lyberatos, and Skiadas, 1999; Adak 2011). Several studies have been carried out for evaluating kinetic parameters and development of models for anaerobic digestion. For the development of cost-efficient technologies, data on optimal mixture ratios, biogas yield, and the kinetics of the degradation process are needed. Increased biogas yield and biodegradation rate will result in more methane generated per unit fed mass and will reduce the size of the reactor required, which makes the process economically more attractive (Kang and Weiland, 1993). Studying the kinetics of methane production from feedstock(s) is important when designing and evaluating anaerobic bio-digesters. However, there are few works (if available) in kinetics of co-digestion of cattle paunch with poultry droppings. Most of the kinetic models proposed earlier focused on the substrate consumption rate, using volatile COD and several input variables as an essential parameters to describe an anaerobic system kinetically (Batstone et al., 2002). However, cumulative biogas production potential has been used here as parameter to evaluate the kinetics of the anaerobic digestion process due to its direct relationship with substrate consumption and

its relative ease of determination (Yusuf et al., 2011). ArcGIS software which is leading software globally was used in this research work. Location modelling which a branch of operation research was strategically integrated with the site suitability model results obtained from GIS analyses and operations for improved decision on the location(s) operations and determination.

6. Experimental Design and Setup

Complete removal of any remaining biodegradable fraction in the form of Volatile Solid was ensured by using cow dung inoculum anaerobically digested for more than 90 days; this is to ensure that the seed slurry does not affect biogas production potential. 2 litres of seed slurry was added to the substrate. The bio-wastes used for the experimentation were randomly collected from nearby farms. 4kg of cattle paunch and poultry droppings were weighed respectively for mono-digestion, also 4kg of both wastes were weighed and blended accordingly (Molinuevo et al., 2009; Chukwuma et al., 2013). The experimental design for the experiment is outlined below:

- Bio-digester R1: 0 kg of Cattle Paunch + 4 kg of Poultry droppings (0% CP + 100% PD)
- Bio-digester R2: 1.4 kg of Cattle Paunch + 2.6 kg of Poultry droppings (25% CP + 75% PD)
- Bio-digester R3: 2 kg of Cattle Paunch + 2 kg of Poultry droppings (50% CP + 50% PD)
- Bio-digester R4: 2.6 kg of Cattle Paunch + 1.4 kg of Poultry droppings (65% CP + 35% PD)
- Bio-digester R5: 3 kg of Cattle Paunch + 1 kg of Poultry droppings (75% CP + 25% PD)
- Bio-digester R6: 4 kg of Cattle Paunch + 0 kg of Poultry droppings (100% CP + 0% PD)

Water to waste ratio of 1:2 was added to the waste, and fed to the batch-type digesters for a period of forty-five days. The experiment was done in replicate. Digester R1 (100 % CP + 0% PD) and R6 (0% CP + 100% PD) are single substrate digestions and were used as control. Gas production was measured by downward water displacement. The temperature range was 22^oC - 28^oC during the period of study. Total Solids (TS) and Volatile Solids (VS) were analyzed for substrates using standard methods. TS was determined gravimetrically after drying in oven overnight at 105^oC, while VS content was determined by igniting dried sample at 550^oC for 2 hours and determining the ash free dry weight (Salminen and Rintala, 2002). The percentage total solid and volatile solid content of the samples was then calculated using the following formulae:

$$\text{Total Solid} = \frac{Wt_d}{Wt_w} \times 100 \quad (1.1)$$

$$\text{Volatile Solid} = Wt_d - \frac{Wt_a}{Wt_d} \times 100 \quad (1.2)$$

Wt_w is the weight of wet sample in gram (g), Wt_d is the weight (g) of oven dried sample; Wt_a is the weight (g) of dry ash left after igniting the sample in a muffle furnace.

pH was measured using pH meter which consists of potentiometer, a glass electrode, a reference electrode and a temperature compensating device. Electrodes were connected to the pH meter and were calibrated using buffer solutions before pH analysis (Lazor et al., 2010). The composition of the various treatments is given in Table 1 below:

Table 1: Compositional analysis of various treatments

Composition	Digester R1	Digester R2	Digester R3	Digester R4	Digester R5	Digester R6	
Volatile Solid (%)	15	18	21	22	23	26	
Total Solid (%)	19	24	30	33	35	40	
pH	7.2	7.2	7.4	6.8	7.1	8.2	

7. Bio-kinetics of Biogas Production

Kinetic studies of anaerobic digestion process are useful in understanding inhibition of intermediates on methanogens of anaerobic digestion of substrates. First order kinetic model is the simplest model that is applied to the anaerobic digestion of complex substrates as they provide a simple basis for comparing stable process performance under practical conditions. A first order kinetic model is considered here based on the availability of substrate as the limiting factor (Abdullahi et al., 2011). The basic equation is:

$$dC / dt = -kC \tag{3}$$

Where ‘k’ is the first order substrate utilization rate constant (time-1) and C (kg/l) represents the biodegradable substrate concentration. On integration, the equation becomes

$$C / C_0 = \exp (-kt) \tag{4}$$

Where C₀ (kg / l) represents initial substrate concentration, substrate concentration can be correlated with biogas production (G):

$$(G_{\alpha} - G) / G_{\alpha} = C / C_0 \tag{5}$$

Where G_α is the maximum biogas production at infinite digestion time, from the above two equations i.e. (2) and (3), the integrated equation for the first order model which gives analytical relation between the volume of biogas produced and digestion time was obtained and used to quantify the extent of process inhibition as follows:

$$G = G_{\alpha} [1 - \exp (-kt)] \tag{6}$$

A nonlinear least-square regression procedure was used in determination of k using MATLAB toolbox software. Logistic function fits global shape of the biogas production kinetics: An initial exponential increase and final stabilization at maximal production level. This model assumes that the rate of biogas production is proportional to the amount of gas already produced, the maximum production rate, and the maximum capacity of biogas production. This model has been used for anaerobic fermentation. A modified version of the logistic function used is given by (Donoso-Bravo et al., 2010):

$$B_P = \frac{P}{(1 + \exp(4R_{max}(\lambda - t)/P + 2))} \tag{7}$$

Where B_p is the cumulative biogas production potential l $(kgVS)^{-1}$ at any time, P is the biogas production potential $(kgVS)^{-1}$, λ is the lag phase period (day), R_{max} is the maximum biogas production rate l $(kgVS)^{-1}d$, t is the time in days. The parameters P , R_{max} and λ were estimated for each of the digester using MATLAB software. These parameters were determined for best fit.

8. Result and Discussion on the Bio-kinetics of the Waste

A plot of cumulative biogas production for the mixture ratios within 45 days retention time is shown in Figure 1 below:

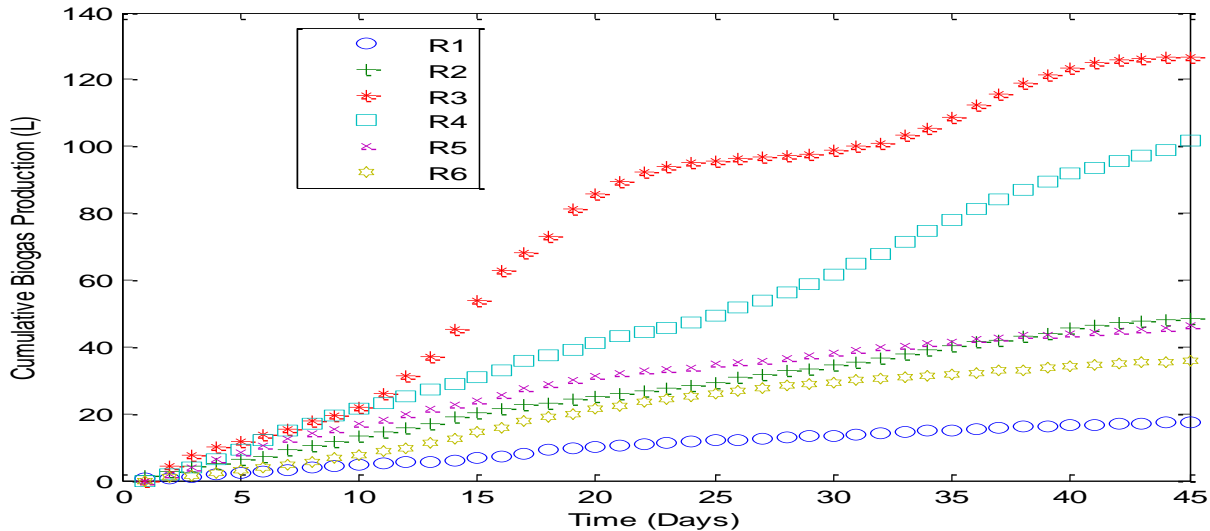


Figure 1: Cumulative biogas yield of cattle paunch blended with poultry droppings

Digester R1 and R6 had the lowest biogas yield as mono or single digestion of both bio-waste respectively due to lack of synergistic properties of mono-digestion of substrates. However, cattle paunch alone (R6) had higher cumulative biogas production; this could be attributed to high concentration of anaerobic bacteria consortium in the cattle paunch and its higher volatile solid content. Digester R2 (25% CP + 75% PD) and Digester R5 (75% CP + 25% PD) had similar cumulative biogas production potential. Digester R4 (65% CP + 35% PD) had higher cumulative biogas production potential than R1, R2, R6 and R5 while Digester R3 (50% CP + 50% PD) had the highest cumulative biogas production potential. It is obvious from Figure 1 that there is a general increase in cumulative biogas production when the paunch content is increased; this general trend is an indicator that cattle paunch is rich in volatile solid content and therefore an important source of bio-energy, Figure 1 shows that above 120 liters volume of gas can be generated from R3 mixture within 45 days, this represent a good output, and indicates the feasibility of substantial amount of bio-energy production, when thousands of tons of these wastes generated daily across the state is utilized.

Kinetics of the anaerobic digestion process of waste was evaluated using the first order kinetic model and the modified logistic function. The first order kinetics model provides information on the rate constant and biogas production potential while the logistic function provides information on the kinetic performance parameters. For the first order kinetics of the substrates, substrate biodegradability was assessed using a mathematical model as stated previously, based on the first order kinetics. The k parameter can be used for process design to determine parameters as reactor size or organic loading, and to predict process performance in

terms of biogas production (Díaz et al., 2011). The experimental data of the reactors simulated using equation (1.6) is shown below for the reactors using Figures 2 to 4.

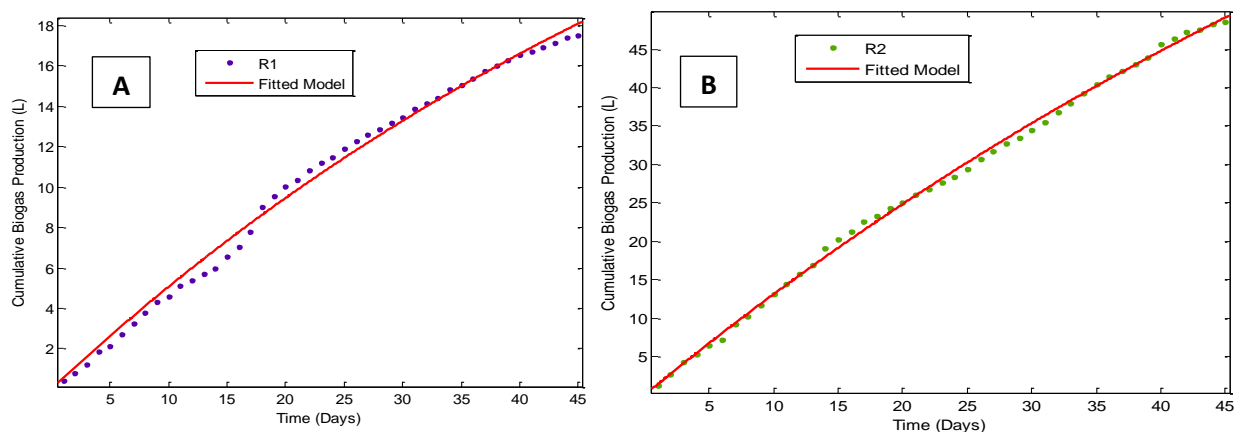


Figure 2: First order kinetic plot for determination of K and G_{α} values for (a) R1 and (b) R2 bio-digester

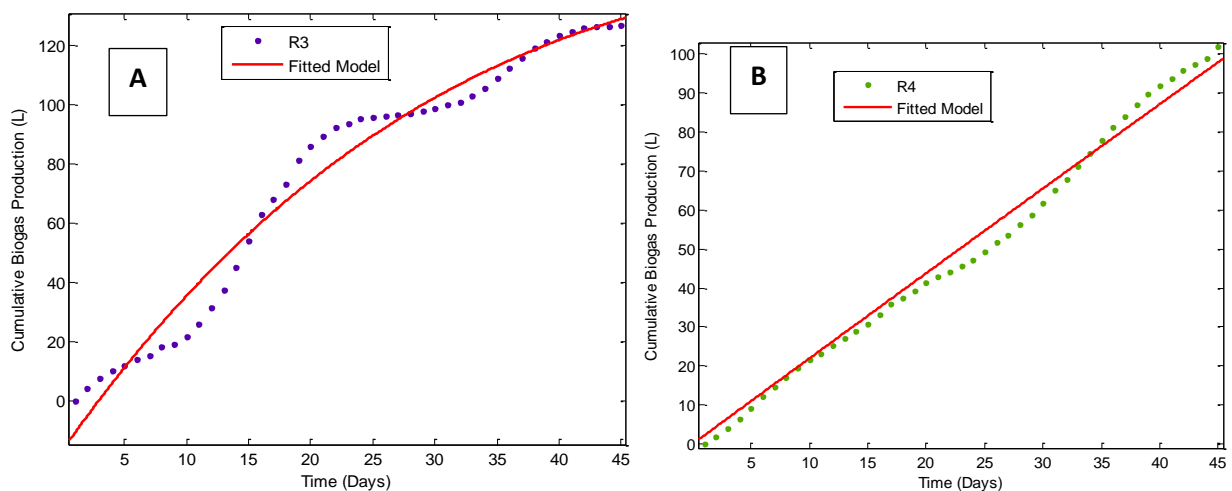


Figure 3: First order kinetic plot for determination of K and G_{α} values for (a) R3 and (b) R4 bio-digester

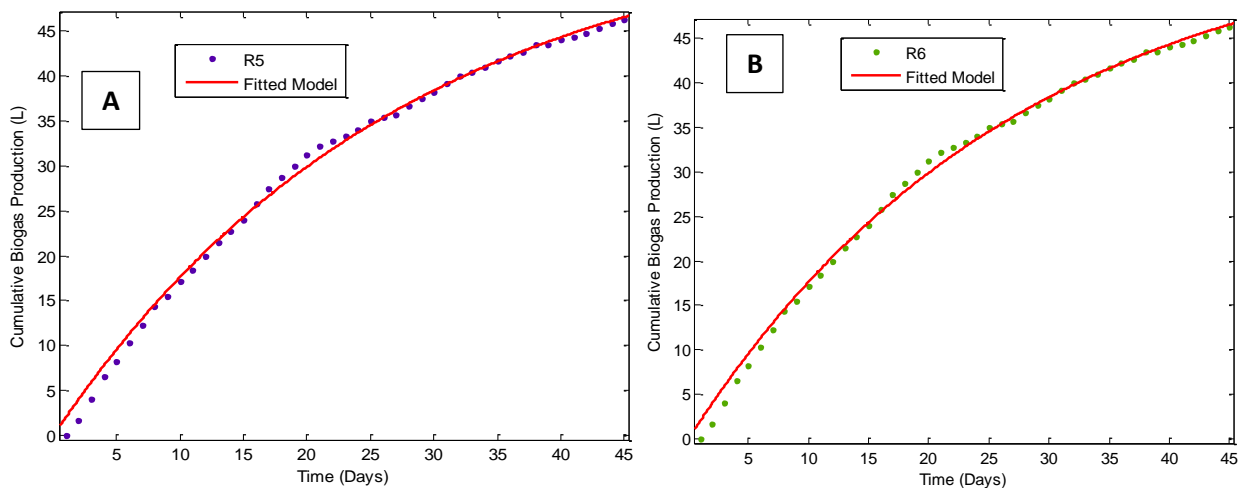


Figure 4: First order kinetic plot for determination of K and G_a values for R5 and R6 Bio-digester

The first order kinetic model, even though it is not a precise model of the process, does give useful description of initial reaction rate and total biogas yield that can be fitted on the data of accumulated biogas production as a function of time. The first order kinetic model slightly over-estimated the start-up biomethanation process of virtually all the bio-digesters, with the exception of bio-digester R3 (50% CP + 50% PD) which was under-estimated by the kinetic model. Similarly, the model overestimated the ending bio-methanation process with the exception of bio-digester R4 (65% CP + 35% PD) which was under-estimated. As can be seen in from Figures 2-4, G was Zero at $t=0$ and the rate of biogas production became zero at $t=\infty$. The slopes of the curves decreased with increasing digestion time. This drop can be attributed to decrease in the concentration of the biodegradable content of the substrates.

The k values increased with co-digestion of substrates, the least values were observed in the mono-digestion of both cattle paunch and poultry droppings, this trend could be attributed to the occurrence of an inhibition properties characterized with mono-digestion of substrates as a result of lack of synergistic nutrient, thus co-digestion of substrates enhanced the synergistic capacity of the substrates as can be seen in the increasing k value during co-digestion of substrates. Comparing the k values of the different batches studied, we can conclude that the anaerobic process displays a better performance during co-digestion in nearly all of the batches. Co-digestion increased the k values from $0.014d^{-1}$ to a maximum of $0.055 d^{-1}$, this maximum k value representing 50% CP + 50% PD indicates that this is the best blend for optimum digester space requirement. Obviously, the 50% CP + 50% PD co-substrate ratio has the highest biodegradability over all the mixtures. Alternatively, the 65% CP + 35% PD blend with k value equal to $0.05 d^{-1}$ may serve as alternative in the absence of availability of 50% CP + 50% PD substrates blend. K value lesser than $0.05 d^{-1}$ for the other experimental co-substrates in this study could be a costly affair, since this will require greater digester space and consequently higher cost of production. The values of the kinetic parameters obtained are listed in Table 2 below.

Table 2: Summary of kinetic data of the anaerobic bio-digesters

	R1	R2	R3	R4	R5	R6
G_a	38.63	125.8	41.6	43.92	57.76	79.15
k	0.014	0.011	0.055	0.050	0.0364	0.0145
R^2	0.9937	0.9984	0.9694	0.9715	0.9963	0.9759
Adj. R^2	0.9936	0.9984	0.9761	0.9694	0.9962	0.9759
SSE	7.992	14.32	1787	2233	29.77	148.2
RMSE	0.4311	0.5772	6.522	7.35	0.8322	1.863

The rate constant according to this study ranged from 0.011 to 0.055d⁻¹, this is similar to the research findings of Tritt and Kang (1991). Tritt, W.P. and Kang, (1999) carried out mesophilic batch tests of cow paunch manure in 5 litre batch reactor operated for 49–63 days at various substrate to inoculum ratios, their result showed that the first-order decay coefficient ranged from 0.044 to 0.064 day⁻¹. They reported that the reaction rate was faster than what is found in plant biomass (e.g., sorghum, napier grass) batch tests, which indicates higher biodegradability of animal wastes in comparison to plant biomass.

The Logistic Function is based on the assumption that biogas produced is a function of the rate of biogas production; and is proportional to the amount of gas already produced; the maximum production rate and the maximum capacity of biogas production. In this study, experimental data obtained from the research was solved numerically using nonlinear regression. To determine the kinetic parameters of P , R_{max} and λ , a modified logistic function equation was fitted to the cumulative biogas production this is shown in Figure 5. In general, there was an overall agreement between all the experimental data and the modified logistic function. The best fit obtained in the regression coefficient in all cases was above 0.96, which means that this model might explain above 96% of total variation in the data. Another important issue is the shape of the modelled curves. Among all the experimental data curves, R3 had the least R-square value (0.9772) and is obviously either overestimated or underestimated by the model. The model underestimated the experimental data during the time intervals of day 0 - 4, 14-23, and 37 till the end of the experiment and over-estimated in the other days. The mono-digested substrates were more accurately simulated by the model (R-square of 0.99). This indicates that co-digestion introduces heterogeneous consortium of micro-organisms which invariably affects methanogenesis leading to fluctuations in the reaction mechanism. This could be seen from the more accurate model prediction of cumulative biogas production potential in the mono-digested substrates than in the co-digested substrates in this study. The values of P , R_{max} and λ , obtained by fitting the modified logistic model (Eq. 7) to the experimental results, are shown in Table 3. The Table shows biogas production started within the lag period of 0.3122- 6.882 days, this is shorter to lag period of 7.3 ± 1.7 days and 14.8 ± 2.9 of cattle manure + rumen fluids (1:1) and cattle manure + water (1:1) respectively reported by Budiyo et al., (2010). The volume of biogas produced per kilogram of VS substrate added (parameter P) significantly increased by 51.13%, 241.8%, 212.7% and 28.8% for R2, R3, R4, and R5 respectively using cattle paunch single digestion as the baseline data. Similarly, (parameter P) significantly increased by 100.3%, 291.07%, 262% and 78% for R2, R3, R4, and R5 respectively using poultry droppings as the baseline data.

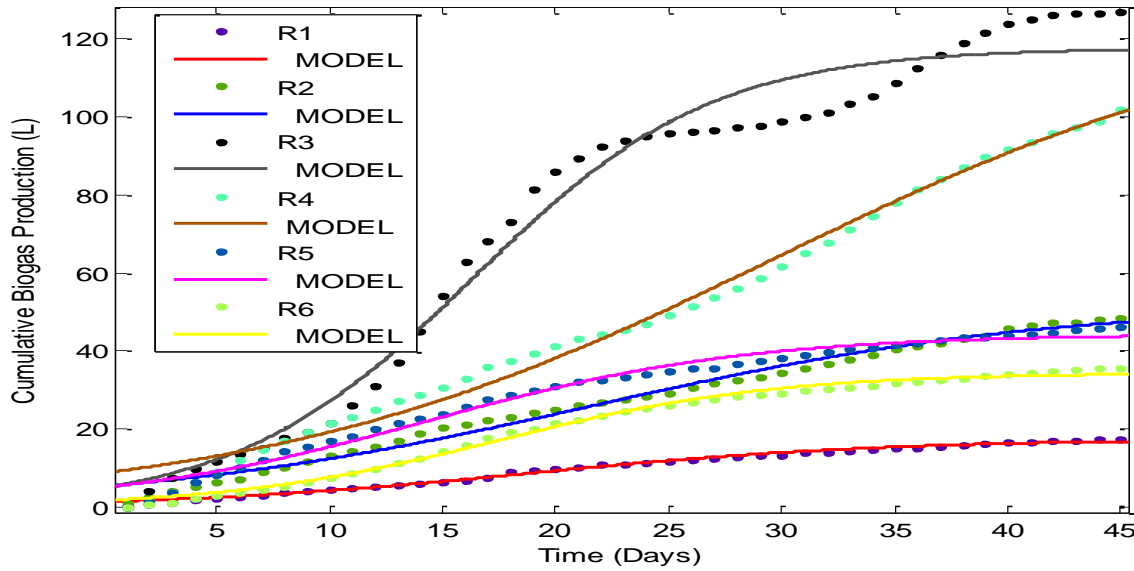


Figure 5: Model fit with cumulative biogas production of anaerobic digestion of substrates

The value of R_{max} indicates that the rate of digestion varied from 0.5518 to 5.571, however R_{max} of 5.571 and 2.79 which are the highest were recorded by co-digested substrates. The low value of R_{max} exhibited by R1 (0.5518) suggests sub-optimum digestion revealing bio-process inhibition, however, co-digestion increased the R_{max} value above 100% (1.291) for R2, this indicates that improved reaction rates is facilitated through co-digestion. This could probably be as a result of the absence of some essential micronutrients for the microorganisms in concentrations below the required amount.

Table 3: Kinetic parameters obtained from the simulation of modified logistic function

	R1	R2	R3	R4	R5	R6
P	17.47	51.99	117.6	107.6	44.31	34.4
R_{max}	0.5518	1.291	5.571	2.79	1.575	1.42
λ	3.012	1.521	5.807	6.882	0.3122	5.419
R^2	0.9923	0.9861	0.9772	0.9888	0.9826	0.9937
Adj. R^2	0.9919	0.9855	0.9761	0.9882	0.9818	0.9934
SSE	9.844	123.1	1787	454.1	139.7	38.86
RMSE	0.4841	1.712	6.522	3.288	1.824	0.9619

In order to evaluate the effects of co-digestion on the biogas production (P) and on the maximum biogas production rate (R_{max}), the increase with respect to the corresponding mono-digestion for poultry droppings (R1) and cattle paunch (R6) respectively was calculated using Eq. (1.8). The results obtained are presented in Figure 6.

$$\text{Percentage Increase} = \frac{(P \text{ or } R_{\max})_{\text{Co-dig.}} - (P \text{ or } R_{\max})_{\text{mono-dig}}}{(P \text{ or } R_{\max})_{\text{mono-dig}}} \times 100 \quad (8)$$

From figure 6, with regard to the effects of co-digestion on biogas production potential and maximum biogas production rate, one peak trend line is observed generally for both biogas production potential P and maximum rate of production. The biogas production potential P increased in all the cases for co-digestion. Comparing the various ratios, R3 (50% CP + 50% PD) had the highest biogas production potential (P) using R1 and R6 as baseline data. With R1 as baseline date precisely, R3 had above 500% improvement, R4 (65% CP + 35% PD) also had similar but slightly lesser improvement in comparison to R3, while R2 and R5 experienced lesser improvement, precisely 197.59% and 153% respectively (See Fig. 6a).

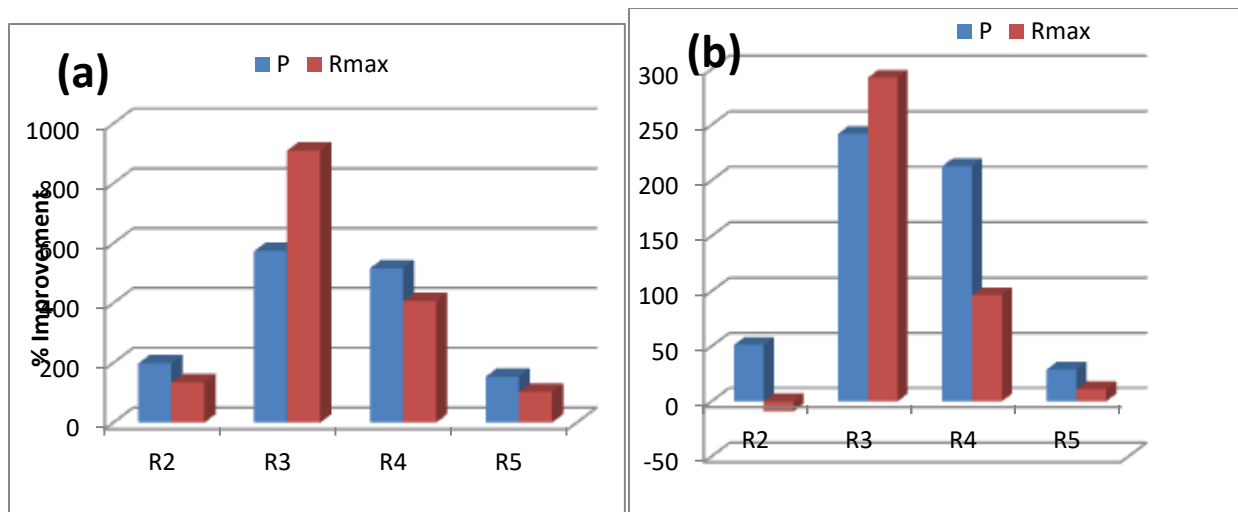


Figure 6: (a) increase in P and R_{max} using R1 as the baseline (b) using R6 as the baseline

For the same reason of cattle paunch containing rich bacteria load for anaerobic digestion, similar trend was observed in the maximum biogas production rate (R_{max}) using R1 as baseline data, the maximum biogas production rate (R_{max}) increased from 102.32% with respect to R2 to 909.605% with respect to R3. Surprisingly the maximum biogas production rate (R_{max}) using R6 as baseline data had a negative value with respect to R2 (-9.188%) indicating that the maximum biogas production rate of the R6 bio-digester had a higher biogas production rate than the co-digested substrate of this particular mixture ratio. It is obvious from the kinetic parameters of this study, that the best blend in this study has good kinetic parameters indicating short lag phase, which is time to produce biogas. The high rate of production also indicates sufficient production of biogas; these factors therefore show that the optimum blend is ideal for biogas production for the study area.

9. GIS-based Substrate Availability and Estimation

Emphasis has been laid on the best blend for maximum production of biogas production for paunch and poultry droppings in the previous section, there is need to provide data on the geospatial variation of the substrates across the state. Data for poultry dropping estimate was

determined using livestock census conducted by Anambra State Veterinary Department in 2015 for all the local governments in the state, the data for the paunch was determined through site visit to all the abattoirs located within the state. The spatial density map of poultry waste generated across the state is shown in Figure 7. The map shows that Idemili North and Njikoka have the highest spatial density of poultry dropping. This is followed by Onitsha North, Orumba South and Idemili South L.G. A. The range of spatial density for ranges from Idemili North and Njikoka is about 65,071 to about 142,967 kg/km², this indicates that these areas have numerous poultry farms and would be suitable for sourcing poultry dropping for biogas plant project for sustainable energy production in the state.

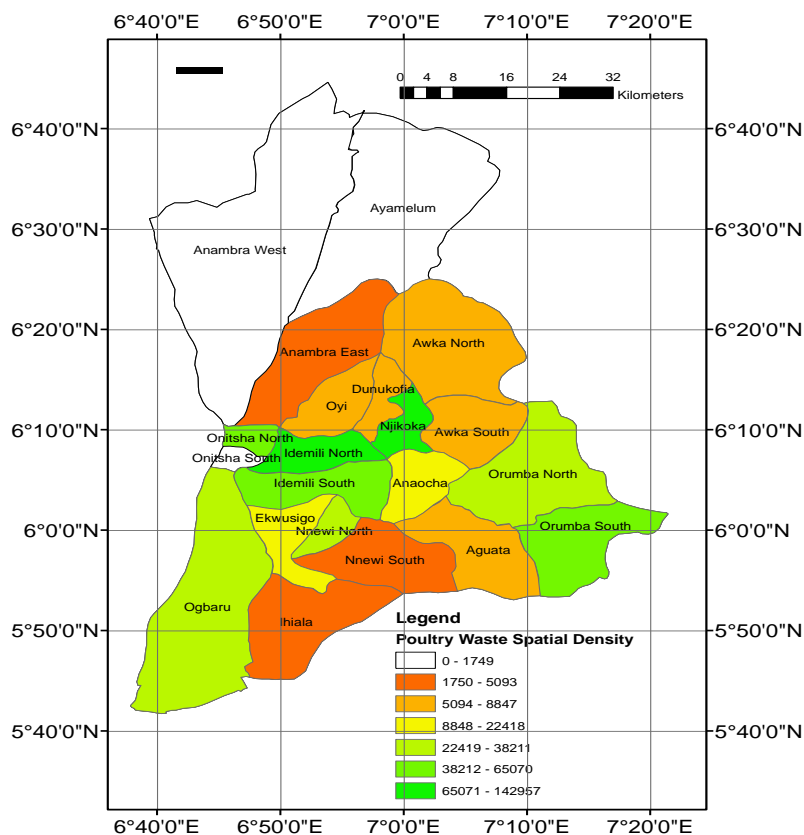


Figure 7: Spatial density map of Poultry waste capacity

It is therefore necessary to site biogas plant(s) in the area of the state with high available of bio-wastes to minimize transportation cost.

10. Conclusion

From the study of kinetics of co-digestion of cattle paunch with poultry droppings, it was noted that the first order kinetic model had rate constant ranged from 0.011 to 0.055 day⁻¹, initial reaction rate and total biogas yield fitted on experimental data using first order kinetic model, the R-square value ranged from 0.9694- 0.9984. The Logistic Function fitted the experimental data, the kinetic parameters of P , R_{max} and λ , obtained ranged from 17.47-117.6l, 0.5518-5.571l/day and 0.3122-6.882day respectively. The modified version of the logistic function was used to adequately describe the cumulative biogas production for the bio-digesters. Digester R3 had the highest kinetic rate constant of 0.055 day⁻¹. The logistic function fitted all the experimental data of the all the bio-digesters adequately with R-square value ranging from 0.9861- 0.9923. The

synergistic effect of co-digestion was observed on biogas production potential and maximum biogas production rate. R3 (50% CP + 50% PD) had the highest biogas production potential (P) using R1 and R6 as baseline data, with above 500% improvement against R1 baseline data. This depicts that digestion of equal amount of both wastes represents that best economic gain for biogas production. The study also revealed that both wastes is available and abundant across the state for development of bioenergy projects. About 6,914,651.65 kg of paunch waste that is generated annually in the state lies waste, there is need to utilized this rich energy source by co-digesting it with poultry droppings, this will translate to numerous benefits to the state. The geospatial map shows the availability of areas in the state that has comparative advantage of higher availability of agricultural wastes and hence most suitable place for bio-waste energy generation.

11. Suggestions for Future Research

Efforts have been made in this study to evaluate the best blend for two predominant agricultural wastes, and estimate on their availability. Future studies should focus on the trend of these waste generation and factors that influences them, also efforts should be made to determine through cost-benefit analysis the expected profit for biogas small, medium and large-scale production plants. In addition to the above stated suggestions for future research, attention should be given to other agricultural wastes, their availability and bio-kinetics.

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Chapter 21

The Role of Early Childhood Education for Sustainable Development in Nigeria

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Abstract

This chapter discusses quality early childhood education for sustainable development. Its aim is increase knowledge of quality early childhood education for sustainability. It looked at Sustainable Development Goal 4 (SDG-4), its target and indicators which strives for quality education. The sustainable development goals forms part of the United Nations (UN) “2030 Agenda for Sustainable Development”, which was unanimously adopted in 2015 by all UN Member States. This chapter also discusses early childhood education within the context of SDG-4 target 2. Early childhood education gears towards laying a sound intellectual, psychological, emotional, social and physical foundation for development and lifelong learning in young children. Building further on this chapter, education for sustainable development, roles of education in sustainable development. roles of early childhood education in education for sustainable development, teaching techniques for education for sustainable development and reorienting early childhood education for sustainable development were also discussed. In conclusion, it is necessary to gear the academic activities of every sector of education towards the SDG-4 targets. This will greatly help to achieve the targets for effective productivity.

Keywords: Education, early childhood education, sustainable development goals, education for sustainable development.

Introduction

Education is fundamental for societal development and success, particularly during times of rapid transition. Education plays a key role in the ability of a developing country to absorb modern technology and to develop the capacity for self-sustaining growth and development (Todaro & Smith, 2009). According to Iechukwu et al, (2014), education holds the master key that unlocks a country’s potentials towards national transformation and sustainable national development. Education is an instrument for self-reliance, social reconstruction and economic development.

Education cannot be separated from human’s life. Johan and Johan (2014), affirmed that education is the only bridge that leads people to their better futures. Education is the medium is

attaining development and achieving sustainability. The value and worth of education in reference to sustainable development in early childhood education cannot be relegated to the background. This contributes to the reason for making education inclusive in the sustainable development goals. The 4th goal in the sustainable development goal (SDG-4) is the goal for education which states thus “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all”. Education and the achievement of SDG-4 plays a central role in building sustainable, inclusive and resilient societies (High level political forum on sustainable development 2019).

Education will see to the making of the young children who are the future generation productive and responsible. It will instill in them the dignity of labour, civic participation, moral duties, citizenship rights and obligations which are the pillars of a peaceful society. If there is a great input to education, there will automatically be a great achievement in all spheres of life. Education has no limitation nor restriction both in content and subjects, it spans through simple to complex phenomenon and from children to adulthood. This is in conjunction with what the Education for All (EFA) stands for, education for all, irrespective of the gender, age, race nor economic status. This is the more reason for the great importance ascribed to Early Childhood Education (ECE), which is the basic of all other forms of education.

Early Childhood Education

Early childhood education which is the education of the early years is of paramount importance because it is the foundation of all other education which will come later in life. According to Sooter (2013), early childhood education refers to the education offered to children who have not yet reached the statutory age of beginning a primary school education. Early childhood education lays the foundation for later learning and development. It is the education meant for young children (aged 0-5 years) to help widen their intellectual horizon in the spheres of basic knowledge needed for their sojourn in the journey of life, of which literacy and numeracy centers on. Aleke (2016), states that early childhood education is the education given to children aged 0-5 years old to develop them morally, socially, intellectually, physically and psychologically for the growth and development of the child in later life. Early Childhood Education, according to Ibiam and Ugwu (2009) is the education designed to develop habits, attitudes and skills needed for primary education. Early childhood education gears towards laying a sound intellectual, psychological, emotional, social and physical foundation for development and lifelong learning in young children. It is in the early childhood period that children develop their basic values, attitudes, skills, behaviours and habits, which may be long lasting (Pramling Samuelsson & Kaga, 2008). Early childhood education which is perceived as the first stage of education is where the foundation for development is laid (UNESCO, 2008). Education of the early years is very crucial. In support of the above, Didonet (2008), states that the first years of every human being’s life are the most favourable ones for developing the attitudes and values that form the basis of their personalities. The structure of values and attitudes built in the early years are the strong and permanent roots for one’s entire life. Everything deeply lived, practiced and felt in the early years of human development remains for the rest of one’s life.

Sustainable Development

Sustainable Development was formally defined for the first time in the Brundtland Report, Published in 1987. It said ‘Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ (Corporate Sustainable Investor Report, 2012). The Organization for Economic Cooperation and

Development (OECD, 2001) as quoted by Ahenkan and Osei-Kojo (2014), also defines sustainable development as the development path along which maximization of human well-being for today's generation does not lead to the decline in the well-being of the future generation. These definitions suggest that sustainable development considers the needs of the future and current generations in tandem, and it is rooted in the pursuit of the well-being and welfare of the people (Ahenkan & Oseikojo, 2014).

Sustainability is a paradigm for thinking about a future in which environmental, social and economic considerations are balanced in the pursuit of development and an improved quality of life (UNESCO, 2012). According to UNESCO (2012), These three spheres which comprises of society, environment and economy are related. For example, a prosperous society depends on a good environment to provide food and natural resources for its citizens. According to Pressoir (2008), the three pillars of sustainable development are:

- Environment and ecology: awareness of natural resources and fragility of the physical environment.
- Economy: sensitivity to the limits and potential of economic growth and its impacts on society and environment.
- Society and culture: understanding of social institutions and their role in change and development. Ways of being, relating, behaving, believing and acting differently according to context and history.

A rapid change is highly needed in the activities of man, so as to make sustainable development achievable. Change is possible through education because education is humanity's best hope and most effective means in the quest to achieve sustainable development (UNESCO, 1997). The importance of life-long learning to the development of sustainable societies is widely recognized, and Early Childhood Education (ECE) relates to the first and most influential stage of the learning life course (Engel et al., 2007).

The Sustainable Development Goals

The United Nations Sustainable Development Goals (SDGs) are not the first set of goals designed to help nations work together to create a cleaner planet and more just global society. The previous agenda's Millennium Development Goals (MDGs) were formulated in 2000 and included eight goals to be achieved by 2015:

1. to eradicate extreme poverty and hunger;
2. to achieve universal primary education;
3. to promote gender equality and empower women;
4. to reduce child mortality;
5. to improve maternal health;
6. to combat HIV/AIDS, malaria, and other diseases;
7. to ensure environmental sustainability; and
8. to develop a global partnership for development (UN 2000; Gabay 2015).

On 1 January 2016, an ambitious new plan was launched, which increased the number of goals from eight to seventeen:

1. to eradicate poverty;
2. to end hunger;
3. to ensure health and well-being for all;
4. to ensure quality education for all;
5. to achieve gender equality;

6. to ensure clean water and sanitation;
7. to ensure affordable and clean energy;
8. to promote decent work and sustainable economic growth;
9. to build resilient and sustainable industry, innovation and infrastructure;
10. to reduce inequalities;
11. to build sustainable cities and communities;
12. to ensure sustainable consumption and production;
13. to take climate action;
14. to protect life below water;
15. to protect life on land;
16. to promote peace, justice and inclusive institutions; and
17. to strengthen the Global Partnership for Sustainable Development (Palmer 2015). The 17 goals address themes of “economic growth, social development [and] environmental protection” (UN 2015, item 9.) and are further specified in 169 targets. While the MDGs mainly targeted developing countries, the SDGs focus on all countries across the globe.

In 2017, UNESCO published *Education for Sustainable Development Goals: Learning Objectives* (UNESCO 2017a). This publication draws a distinction between cognitive, socio-emotional and behavioural learning objectives for all SDGs, refers to the knowledge and skills needed to fulfil these aims, the motivation and attitudes that can underpin them, and the actions needed to achieve them. In the present chapter, the focus on SDG 4, contains 10 specific targets, addressing the needs of children, youth and adults. The idea of “lifelong learning for all” is a key element of SDG 4. The meaning of the SDG 4 targets on quality education.

The SDG4 explicitly stated that not just any type of education will be effective in attaining sustainability but an inclusive and equitable quality education. This simply implies that for an education to be meaningful, appropriate and valuable in achieving development and sustainability; it has to be inclusive, equitable, and of quality. For education to be inclusive, it must embrace inclusion and absolute acceptance of all and sundry irrespective of gender, race, disability, religion, socio-economic status and class. Equitable education refers to the type of education that is fair and just to all in dealing with its participants. It gives everyone equal treatment and equal respect not minding their individual differences and similarities. A quality education is that type of education that gives the best and standard to its learners. The best and standard in quality have to cut across all spheres of learning both material and human. With these in place, promoting lifelong learning opportunities for all will be made much easier.

SDG-4 Targets and Indicators

The European Commission publishes annual monitoring reports as part of its strategic framework entitled “Education and Training 2020”, for which it formulated a set of benchmarks to be achieved by 2020 (European Commission 2017). These relate to the areas of early school leaving; higher education completion; basic skills; early childhood education; lifelong learning; transition to the labour market; and mobility between countries.

The SDG-4 has its set out targets and indicators mapped out by UNESCO to serve as a guide and reference while working towards the attainment and achievement of the SDG-4. According to UNESCO Institute for Statistics (UIS) (2018); a target is a specific, measurable objective which will contribute to achieving one or more of the goals. SDG-4 has ten targets which has its tentacles spread across many different aspects of education. Among them, there are seven targets which are expected outcomes and three targets which are means of achieving these outcomes.

Indicators are markers of change or continuity which enable us to measure the path of development. The SDG-4 indicators are checkmated in reference to its targets. Globally, the various targets and indicators have been placed to be monitored strictly by some organization. This is to ensure that the assessment of its progress or failure is not compromised. According to UIS (2018), tabulated below are the 10 targets and indicators of SDG-4 including the various organization assigned to monitor the global goal 4.

SDG-4 Targets	Indicators	Monitoring unit
a. By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes	a. Proportion of children and young people (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in reading and (ii) mathematics, by sex. b. Completion rate (primary education, lower secondary education, upper secondary education)	UNESCO-UIS
b. By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education	a. Proportion of children aged 24-59 months who are developmentally on track in health, learning and psychosocial well-being, by sex. b. Participation rate in organized learning (one year before the official primary entry age), by sex	UNICEF
c. By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university	Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months, by sex	UNESCO-UIS
d. By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship	Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill	UNESCO-UIS, ITU
e. By 2030, eliminate gender disparities in education and	Parity indices (female/male, rural/urban, bottom/top	UNESCO-UIS

<p>ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations</p>	<p>wealth quintile and others such as disability status, indigenous peoples and conflict-affected, as data become available) for all education indicators on this list that can be disaggregated</p>	
<p>f. By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy</p>	<p>Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment</p>	<p>UNESCO-UIS</p>
<p>g. Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all</p>	<p>Proportion of schools offering basic services, by type of service</p>	<p>UNESCO-UIS</p>
<p>h. Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all</p>	<p>Proportion of schools offering basic services, by type of service</p>	<p>UNESCO-UIS</p>
<p>I. By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and</p>	<p>Volume of official development assistance flows for scholarships by sector and type of study</p>	<p>OECD</p>

scientific programmes, in developed countries and other developing countries		
j. By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States	Proportion of teachers with the minimum required qualifications, by education level.	UNESCO-UIS

Source: UIS (2018), *SDG 4 global indicators*

The above SDG-4 goal and targets are very fascinating and worthy to write home about if they can be implemented. There are great plans and strategies needed to put in place for them to be actualized. All concerned individuals, education sector and government need to put hands on deck for its maximum attainment. Boeren (2019), opined that the idea of reaching the SDG-4 targets is a responsibility shared among individuals, education and training institutions, and regulating governments. Government holds the main responsibility for ensuring the right to quality education, the 2030 Agenda is a universal and collective commitment. It requires political will, global and regional collaboration and the engagement of all governments, civil society, the private sector, youth, UN and other multilateral agencies to tackle educational challenges and build systems that are inclusive, equitable and relevant to all learners.

A special publication written by the Global Education Monitoring Report (2019), under the auspices of the SDG-Education 2030 Steering Committee, outlined ways to monitor progress not just from a quantitative, indicator focused perspective, but also from a qualitative, policy-oriented angle, focused on a framework of six essential transformations that call on countries to look: beyond averages into equity and inclusion; beyond access into quality and learning; beyond basics into content fit for sustainable development; beyond schooling into lifelong learning; beyond education into cross-sectoral collaboration; and beyond countries into regional and global collaboration. Below are the recommendations for achieving the SDG-4 targets given by the Global Education Monitoring Report (2019):

- a. Adopt a definition of inclusive education that encompasses all learners.
- b. Design education and social assistance policies jointly to promote equity.
- c. Ensure that education ministries monitor disparity to help elaborate inclusion policies.
- d. Countries need to develop a national assessment system that provides a robust diagnosis of trends over time and not just a mechanism to manage transition from one level to the next.
- e. elective participation in cross-national assessments is a valuable complementary tool to develop capacity and benchmark a national system.

- f. Information from national monitoring frameworks should be used to inform curricular, textbook and teacher development and drive policy evaluation.
- g. All countries need to respond to the commitments undertaken as part of SDG 4 to promote sustainable development, human rights, gender equality, a culture of peace and non-violence, global citizenship and cultural diversity through their curricula.
- h. Curricular development needs to be participatory for national ownership, from the central to the school level.
- i. Curriculum, teacher preparation, professional development and assessment need to be aligned.
- j. All countries need to define their response to the commitment they made under SDG 4 to provide lifelong learning opportunities for all.
- k. A continuum of approaches is needed to link formal and non-formal education opportunities.
- l. Countries need to address the challenge that the more educated are more likely to receive further education opportunities.
- m. Ministries of education need to engage in stronger partnerships with other sectors, extending beyond planning to implementation.
- n. Partnerships should not be limited to other ministries but extend to other government tiers, NGOs and the private sector.
- o. Education ministries should not only react but also seek to become partners in other sectors' initiatives, removing administrative hurdles.
- p. Regional and international organizations need clear education agendas aligned with SDG 4 and to develop conducive environments for education policy dialogue.
- q. Governments should utilize opportunities for peer learning and informal comparisons.
- r. Peer learning networks for education are a global public good, and their coordination and communication costs need to be funded accordingly.

All children have the right to be educated for sustainable development, and it is in the early years that children have the greatest capacity to learn. It is also in early childhood that the foundations of many fundamental attitudes and values are first put into place. ECE is important because it's the year through which formal learning takes place. It is during these years that children learn a lot and for sustainability to take place, there is need for Education for Sustainable Development (ESD).

Education for Sustainable Development

Education is the surest way to sustainably develop any people or society need. The skills so acquired through education by learners are subsequently applied to sustain present and future generation in their everyday life. Education for Sustainable Development (ESD) gives precedence to the role of global perspectives and participation in addressing worldwide social justice and environmental challenges (Scheunpflug & Asbrand, 2006). Formal education has a significant role to play in ESD. With formal education, establishing beliefs and practices that will promote more sustainable approaches to patterns of living and development in future generations will be attained.

ESD is therefore an approach to teaching and learning which involves the ideals and principles that underlie sustainability. The role of education for sustainable development is to

help people develop the attitudes, values, skills and knowledge to make informed decisions now and in the future for the benefits of themselves and others. UNESCO (2014), defines ESD as it allows human being to acquire the knowledge, skills, attitudes and values necessary to shape a sustainable future.

The goals of the United Nations Decade of Education for Sustainable Development (2005-2014, DESD), cited in Siraj-Blatchford (2009), are therefore to integrate the principles, values, and practices of sustainable development into all aspects of education and learning. Education for Sustainable development provides a vision of education that seeks to balance human and economic well-being with cultural traditions and respect for the environment (Siraj-Blatchford, Smith, & Samuelsson 2009). Pressoir (2008), listed the following as the pillars of education for sustainable development:

- a. Learning to know: acquiring instruments of understanding.
- b. Learning to be: seeing oneself the main actor in defining positive outcomes for the future.
- c. Learning to live together: participate and co-operate with other people in all human activity.
- d. Learning to do: be able to react creatively and responsibly in all environments.
- e. Learning to transform oneself and society: develop respect for the environment, social solidarity and non-discrimination.

Furthermore, education for sustainable development is geared towards the protection and preservation of life and nature. Liu and Liu (2008), are of the opinion that education for sustainable development is fundamentally about values, with respect at the centre, respect for others, including those of present and future generations, for difference and diversity, for the environment, for the resources of the planet individuals inhabit.

Education for Sustainable Development is important to start early in the lives of the individuals. In support of the above, Yoshie (2008), posits that education for sustainability must begin in early childhood. Learning begins at birth (World Declaration on Education for All, 1990, Article 5), and even before. Basic life skills, such as communication (including pre-literacy) skills, co-operation, autonomy, creativity, problem-solving and persistence are acquired, and positive and negative dispositions towards learning (for example, motivation to learn, pleasure in learning) and society are shaped in early years. It is crucial to help young children to understand themselves and others and their links with the wider natural and social environment, to learn how to care about problems concerning sustainable development, and to respect the diversity and difference of cultures and people in the world (Liu and Liu 2008). Early childhood education has an enormous potential in fostering values, attitudes, skills and behaviours that support sustainable development in young children.

ESD must begin in the early childhood years, and requires transformative learning within the common and global constraints of climate change, dwindling ecosystem services and environmental degradation (Feine, 2012). UNESCO states that ESD should be of a quality that provides the values, knowledge, skills, and competencies for sustainable living and participation in society (Eriksen, 2013). Early childhood education has central role to play in achieving those changes required for sustainable development. As a result of this, promoting and improvement of early childhood education recognized that in order to attain sustainable development it requires changes in attitudes and values towards sustainability and development. In order to achieve this, progress must be made toward early childhood education in the areas of infrastructure, quality of education, completion rates and teaching capacity. The necessity of basic education is to

transform and improve the conditions of both the learner and the community towards sustainable development (Association of African Universities, 2009).

Role of Education in Sustainable Development

The role of education in sustainable development according to Itari and Ugbe (2018), can be summarized as follows:

1. Education is regarded as an instrument of social change which could transform the society in significant ways. Education is important in trying to bring about change in values and attitudes towards attaining sustainability. The report of UN's World Commission on Environment and Development (WCED) (1987) recognized that "sustainable development requires changes in values and attitudes towards environment and development" and that education plays a central role in achieving those changes in values and attitudes (Sims & Falkenberg, 2013). Education for Sustainable Development (ESD) is one of the most important tools for raising awareness about the environmental issues within a sustainable development context.
2. Education for sustainable development grows from a variety of sources and it is delivered through casual, informal, non-formal and formal strategies. Topics of sustainable development usually include but not limited to, conflict resolution, human rights, ethics, gender equity, poverty alleviation, peace, human security, citizenship, democracy and governance, energy, health, water, rural and urban development, corporate social responsibility, social and environmental effects of globalization, production and consumption patterns, cultural diversity, biological diversity, ecological principles and eco-systems, natural resources, management, climate change and disaster prevention (Bedawy, 2014).
3. Contemporary sustainable development education is therefore expected to be focused on the above issues and must be oriented on future development, ensuring proper quality of present and future life. In addition, sustainable development concepts/issues should be taught formally and informally so much such that they form part of the core of the people's lives in ways that the people develop skills necessary for sustainable development. Educational providers are also encouraged to provide sustainable training to professionals and practitioners and should encourage research on sustainable development issues.
4. Education for sustainable development involves learning how to make decisions that considers the long-term future of the economy, ecology and equity of all communities. UNESCO argues that education has a special responsibility to generate the knowledge needed as well as communicate this knowledge to decision makers and the public at large. (UNESCO, 2001, 2003). As a result, the body calls on all relevant stakeholders to review the programmes and curricula of schools and universities, in order to better address the challenges and opportunities of sustainable development. Therefore, contemporary sustainable development education is expected to orient on future development, ensuring proper quality of present and future life.
5. Education empowers people for their roles in society. Therefore, formal, non-formal and informal education are key actors in education for sustainable development. Formal education cannot implement education for sustainable development alone. Because education for sustainable development is a life-long process, the formal, non-formal and informal education sectors should work together to accomplish education for sustainable

- development goals and objectives (Ilechukwu et al., 2014). It is important just as the adult for young people to be educated for sustainable development because they are our future. Doing this will provide them with the opportunity to begin to value the world's cultural diversity and appreciate the issues facing our world and of the impact they have on those issues (Davidson, 2003).
6. Education for sustainable development functions to educate, train and undertake research to contribute to the sustainable development of the society. For example, the training of people in monitoring of targets and detection of sustainable concerns and graduates with skills, knowledge and attitudes to make sustainability contribution (Pearson et al 2005, Bedawy, 2014)
 7. In addition, education should provide learners with skills, perspectives, values and knowledge to live sustainably in their communities. Education also produces leaders of the country who manage the affairs of government and private sector industries who constitute the stake holders of sustainable development. By so doing, the educational system creates a “vanguard group” of leaders in each sector of society who will take primary and leading roles in promoting the values for sustainable development (Bedawy 2014).
 8. To enhance learning about sustainable development different teaching methodologies should be adopted throughout all levels of the educational strata. Methods that will help disseminate information quickly and easily to learners should be applied and should be combined with other methods for effectiveness. Doing so will facilitate learners, involvement, communication skills and critical thinking about sustainable development issues.
 9. Educational institutions play a leading role in building more sustainable societies and creating new paradigms as they have the mission to promote development through both teaching and research. But it should be noted that sustainable development can be practiced only through a teacher who himself has been trained on values and perspectives of sustainable development. Therefore, teacher education is seen as an important actor or agent of change in promoting the social, economic and environmental values of sustainable development in the society (Johnson, 2007).

Roles of Early Childhood Education in Education for Sustainable Development

Early childhood education has a great role to play in Education for Sustainable Development; bearing in mind that the partakers of this aspect of education are the future generations that will transform to being the next adults. The UN Convention on the Rights of the Child (1989) affirms that all children have a right to education. Children at the early childhood level often experience the greatest environmental challenges. At this stage also, the foundations of their fundamental attitudes and values are first put into place. Young children are capable of sophisticated thinking in relation to socio-environmental issues and that the earlier education for sustainable development ideas are introduced the greater their impact and influence can be (Siraj-Blatchford, Smith & Samuelsson 2009).

Early childhood education will help create a great sense of belonging, awareness and responsibility in the minds of the children, thereby automatically making them partakers of the education for sustainable development. Pramling Samuelsson and Katz (2008) supported this saying that children need to feel that they are a valued part of the community not invisible, marginal, or worth-less that is, should be viewed as legitimate actors in shaping their

communities now (as well as into the future). This means that each child's meaning and perspective need to be listened to and considered in education (Pramling Samuelsson & Katz, 2008). Early childhood education will help pave way for easy sensitization on education for sustainable development. Children will be instilled with important life and learning skills, and also be equipped with values and basic skills that will allow them to critically reflect and make informed decisions about issues and courses for action related to enhancing the lives of communities on a global scale.

Children will easily connect with nature, embrace and appreciate its resources. A deep sense of respect will be accorded to the lower animals and plants as their importance to mankind will be exposed through early childhood education. Children will also help to regulate its consumption and depletion, through extending their knowledge of education for sustainable development down to their parents and community members. Practically, the culture of protecting the environment and maintaining a tidy and healthy environment will be imbibed in the children. Education for sustainable development will make the children see reasons that will necessitate their trending in the line of environmental protection.

Early childhood education has a great task in sensitizing the teachers of young children on sustainable development; being that children will learn easily through them. Early childhood education plays a great role of imbibing in the children the spirit of social tolerance among themselves and inculcate in them a great sense of respect for their various diversities and individual differences. Through this, they will learn to accept each other as one, and also extend helping hands to one another easily in times of need. With one mind, they will be unified to kick against unsustainable actions.

Economically, early childhood education will help children to comprehend the value of nature and its resources that are been depleted on daily basis. In turn, having understood the economic importance of preserving those natural resources, the knowledge will be shared to their parents and community elders. Early childhood education has a huge task of teaching the children to spontaneously indulge in the etiquettes of keeping clean surroundings in a better and more sustainable way. The children's classroom and the school environment are a good example to begin with.

Early childhood education will provide the opportunity for the teachers of young children to use traditional knowledge, activities and resources to help in the holistic development of children in early childhood. Such development includes physical, conceptual, social and spiritual/emotional development. The holistic development of young children provides a foundation for the development of strong citizenship. Its importance is not only for the present, but also to build the attributes needed for future sustainable societies (Sarathchandra, 2008).

Teaching Techniques for ESD

Teachers help pupils employ and develop different learning processes by using a variety of teaching techniques. With the variety of teaching method and process, pupils have a chance to grow as learners and to enhance their skills and capacity to learn and think effectively. Not all pupils learn in the same way, therefore by using a variety of teaching techniques, the teacher attends to the diverse needs of the pupils in the classroom. Some of the needs of the pupils in the classroom includes those that prefer to listen, those that prefer to read, and those that participate more actively. Meeting the learning needs of all pupils in the classroom is a form of social equity, which is a core concept of sustainability (United Nations Decade of Education for Sustainable Development (2005-2014, DESD).

However, using a variety of teaching techniques to meet the learning needs of pupils can address equity in the classroom. Such practice also demonstrated to the pupils can bring about equity and social sustainability. Teaching techniques used in school, like other educational practices (for example, a whole-school approach to sustainability), can therefore promote principles of sustainability. (United Nations Decade of Education for Sustainable Development (2005-2014, DESD) cited in Legrouri (2014).

Teaching techniques associated with ESD stimulate pupils to ask questions, analyze, think critically and make decisions. Such teaching techniques move from teacher-centered to child-centered lessons and from rote memorization to participatory learning. ESD pedagogies are often place-based or problem/issue based. ESD pedagogies encourage critical thinking, social critique, and analyses of local contexts (UNESCO, 2012). ESD pedagogies involve discussion, analysis and application of values. ESD pedagogies often draw upon the arts using drama, play, music, design, and drawing to stimulate creativity and imagine alternative futures (UNESCO 2012). They work towards positive change and help pupils to develop a sense of social justice and self-efficacy as community members.

The United Nations Decade of Education for Sustainable Development (2005-2014, DESD), sampled four teaching activities techniques to include: simulations, class discussions, issue analysis, and storytelling. Each technique stimulates different learning processes.

Simulations: Simulations are teaching/learning scenarios in which the teacher defines the context in which the pupils interact. The pupils participate in the teaching and learning and gather meaning from what is being taught. For example, pupils imagine they live in a small fishing village and have to learn how to manage the fishing stocks sustainably (that is, without depleting the fishing stocks or starving the people). Often, simulations are simplifications of complex abstract concepts. At the same time, because they are distillations of real-world situations, simulations give a sense of reality and thus engage and motivate learners of all ages.

Simulations give concrete ways to teach abstract concepts. Providing abstract concepts with concrete examples is important for children and adolescents, this is because many of them are still in the concrete stages of cognitive development. Simulations engage pupils with visual, auditory and tactile-kinesthetic learning modalities, thereby promoting equity, address real life problems that face communities and add relevance to the curriculum and promote higher-order thinking skills. According to Katrin (2013), teaching using simulations involves; teaching academic concepts related to the simulation, describing the context of the simulation, explaining the rules of the simulation, Monitoring the activities of the pupils as they engage in the simulation and gently redirecting if necessary, and reflection on the simulation and relating it back to the concepts (UNESCO, 2012).

Class Discussions: Class discussions allow for the transfer of information amongst pupils and from the pupils to the teacher, in addition to the traditional route from teacher to pupils. Pupils come to the classroom with a wide variety of life experiences that can enrich the teaching of the mandated curriculum. With this fore knowledge at hand, pupils can therefore contribute a great deal to discussions of sustainability with observations from the environment about what is sustainable and what is not. Teachers can then incorporate these experiences into their lessons through class discussions that provide pupils with real life applications of concepts (UNESCO, 2012).

One of the skills that ESD develops is the ability to communicate orally and in writing (UNESCO, 2012). Discussions give pupils opportunities to develop oral communication skills (for example, developing focus and purpose before speaking, active listening, building on the

ideas of others, summarizing, and questioning). Pupils with strong auditory learning modalities learn well from discussions, both from listening and expressing their own ideas (UNESCO, 2012). Classroom discussions are student-centered, stimulate pupils to analyze and think critically, and promote participatory learning.

Issue Analysis: Issue analysis is a structured technique for exploring the environmental, social, economic, and political roots of problems that face communities. Issue analysis helps pupils identify major arguments related to a community problem as well as key stakeholders and their perspectives, goals, and assumptions related to that problem (UNESCO, 2012). Issue analysis also looks critically at the proposed solutions and the costs-financial and otherwise and at who will bear those costs. According to UNESCO (2012), issue analysis can be done briefly or in depth. Issue analysis is interdisciplinary, bridging the natural and social sciences. While in school, pupils need to develop the tools and frameworks for thinking in a way that will help them untangle the complexities of sustainability issues that face their communities. They will also need to learn to create solutions that are locally appropriate and at the same time keep in mind global consequences (for example, cleaning up local pollution without shipping toxic and hazardous waste to another country) (Bertoco, 2013). Issue analysis helps pupils through a process that can be used with any issue. It is a generic process that can be applied to a wide range of environmental, social, and economic problems (UNESCO, 2006).

Issue analysis brings relevance to the curriculum, promotes higher order thinking skills and critical thinking skills, promotes decision-making (for example, evaluating which proposed solution is best) and promotes thinking about the future.

Storytelling: Telling stories to convey and illustrate sustainability ideas is an engaging form of teaching (UNESCO, 2006). Stories can be taken from current events, history, television programmes, literature, drama, and personal experience. Storytelling also draws on the oral traditions of indigenous societies and folk art. Storytelling has been practiced for generations as a means of entertainment, education or cultural preservation and to instill moral values among younger generations. Storytelling is an effective ESD pedagogy as the values reflected in traditional stories often contain the wisdom of the elders or stem from creation stories, which helps to impart respect for cultural heritage as well as the environment (UNESCO, 2006).

Storytelling makes ideas, theories, and concepts learned from textbooks come alive. Storytelling gives a better picture to a dry information. This enables teachers to better convey sustainable development information, principles and values to pupils effectively. Storytelling is especially good for pupils whose preferred learning modality is auditory (UNESCO, 2006). Remembering a list of isolated concepts and definitions is difficult, but recalling the flow of a story related to these concepts may be easier for pupils. A story may also provide a non-threatening way to ease pupils into learning UNESCO, 2006). Stories engage people of all ages and abilities.

Storytelling links to traditional and indigenous knowledge and passes wisdom from one generation to the next, engages learners with cultural heritage and the fourth dimension of sustainability, culture, connects with auditory learners, who are not fully engaged in classroom based on learning from textbooks, to address issues of classroom equity and incorporates principles, perspectives, and values related to sustainability (UNESCO, 2006).

Reorienting Early Childhood Education for Sustainable Development

To reorient early childhood education for sustainable development, the curriculum of early childhood education needs to address sustainability. Educational stakeholders need to identify

the knowledge, issues, perspectives, skills, and values central to sustainable development in each of the three components of sustainability-environment, society, and economy-and integrate them into the curriculum. The education stakeholders also need to decide which of the many existing sustainability issues (for example, biodiversity, climate change, equity and poverty) will be part of the curriculum. There is also need to reorient education in line with the national or local sustainability goals. A properly reoriented curriculum for ESD will address local environmental, social, and economic contexts to ensure that it is locally relevant and culturally appropriate. Reorienting early childhood education involves selecting appropriate knowledge, issues, skills, perspectives, and values for the environmental, social, and economic spheres of sustainability.

Reorienting education requires revising education from early childhood care and up through higher education (Joseph, 2014). It requires rethinking what is taught, how it is taught, and what is assessed, with sustainability as the central theme. This process is future-oriented because the pupils will need it to be able to tackle the challenges of tomorrow, which will require creativity, analytical and problem-solving skills. Universal provision of formal early childhood services has also been promoted via international organization who views the early years as formative in terms of later development and learning (UNESCO, 1990). These developments have stimulated global interest in provision of early childhood services and, in particular, the goal of achieving positive outcomes for young children. Kaga (2007), for example, supports UNESCO'S goals in stating that education empowers children and societies "by equipping them with values and basic skills that allow them to critically reflect and make informed decisions about issues and courses of action" (p. 54). By instilling young children with important life and learning skills, early childhood education has the potential to promote change and enhance the lives of communities on a global scale.

Reorienting existing education at all levels involves educational reforms of principle, skills, perspectives and values that are qualitative, quantitative, appropriate and relevant to the socio-cultural and school curricula (Ilechukwu et al., 2014). In doing this, there are three areas of educational processes relevant to these reforms. These are the contents of what is being taught, the method and the education and professional development of those who are responsible for implementing education for sustainable development. Kaga (2007), refers to the key principles of ESD, which include the importance of equity in access to education; the nurturance of learning and life skills that equip children to contribute productively to sustainable societies; positive attitudes towards nature and its preservation, and values such as empathy and tolerance.

Early childhood education is well-placed to adopt these key principles. Despite children's diversity in cultural ideas and learning, there is widespread, shared acknowledgment of the early childhood education as the years for formative learning with regards to establishing life-long attitudes and dispositions. A guiding principle of ESD for early childhood education is that children should be educated and nurtured in achieving skills that will enable them to contribute productively to the sustainability of their social and physical environments (Kaga, 2007). While acknowledging the value of early childhood education, the ESD framework therefore stresses the importance of developing culturally relevant, and therefore, sustainable means of meeting such goals (Pearson, & Degotardi, 2009).

In order to attain a meaningful and successful ESD, it has to be rooted to the local environment of young children. By developing early childhood approaches that remain true to the culture in which they are situated, early childhood educators are not only well placed to empower children to actively contribute towards the development of their own societies and nation, but also to promote the development of culture for sustainability. Re-orientation of early

childhood education towards sustainable development will carefully protect the children's vulnerability to the impact of the unsustainable activities that hampers their livelihood and the survival of nature.

Bringing it home, two major crises which affects education in the country Nigeria is insecurity and corruption. These are deadly cankerworms that have eaten deep the root of quality education. In some parts of the country, insecurity has displaced so many families; it has made some families to shut their doors to social and educational activities in the bid to scamper for safety. It is only when one's heart is safe and peaceful; that he can be able to think of attending school without fear or stress. Tackling corruption will help to ensure that round pegs are put in round holes to ensure quality, equity and just. Everybody should be seen as one and equal without marginalization and discrimination based on gender, disability, race, religion, and ethnicity. With absolute eradication of insecurity and corruption in the system; achieving the SDG-4 targets will easily find its base to spring up. When it springs up, everyone should be responsible in discharging their responsibilities to see to the effective implementation of the SDG-4 targets. Such responsibilities include; government providing sufficient funds for schools, providing a strong and comfortable accommodation for the school, training teachers to be professionals in their fields internationally and locally, training children, youths and adults in skill acquisition, monitoring and supervising schools to ensure that they are following the required standard in their teachings and dealings with children and parents. School administrators should endeavour to employ adequate and qualified staff, follow the given standard in the discharge of their duties without sentiment or bias. Parents as well, should encourage and support their children in their academic and learning activities, they should also assist the teachers in extending learning from school down to home. The children on their own parts are not out, they should always try as much as possible to be serious with thir studies without leaving any stone unturned, they should be obedient and respectful to both their parents and teachers, and always endeavour to give back to the society by becoming useful individuals and helpful member in keeping to the peace and security of the society.

Conclusion

In conclusion, it is necessary to gear the academic activities of every sector of education towards the SDG-4 targets. This will greatly help to achieve the targets for effective productivity. Also, Education for Sustainable Development need not be overlooked at the early childhood level. This is because it is at this level of education that what is taught seems to stick more with the learners. Also, early childhood education has a paramount role to play in achieving the changes that is required for sustainable development. As a result of this, promoting and improvement of early childhood education recognized that in order to attain sustainable development it requires changes in attitudes and values towards sustainability and development. It has become clear that there are moral imperatives for including the youngest children in the work towards sustainable development. In order to achieve this, progress must be made toward early childhood education in the areas of infrastructure, quality of education, completion rates and teaching capacity.

The implementation and maintenance of high-quality education systems across the globe is therefore highly recommended. However, there are still huge differences in how countries approach education. Children, teenagers and adults in low- or middle-income countries tend to have less access to high-quality education, as evidenced by UNESCO's Global Education Monitoring Reports (e.g., UNESCO 2017b). Having looked at the 10 SDG 4 targets, reflecting

quality in early childhood education, a number of suggestions for further discussions are recommended:

1. Bringing education and training opportunities to the people through organizing regular seminar and conferences for head teachers and teachers on quality early childhood education for sustainability.
2. Providing and organizing high-quality teacher training across the world through sponsoring head teachers and teachers in attending international conferences, as it will help widen their intellectual horizon for proper education and guidance of quality early childhood education for sustainable development. Teachers are vital players in the education arena. They facilitate learning by children, teenagers and adults and put education policies into practice.
3. Raise awareness of benefits of learning among citizens. This can be done through encouraging children to develop curious and positive mental attitude, be sensitive to their environment and the things happening within their surroundings. The policy makers especially in the developing countries are not left out. They should perceive investing in certain types of education.
4. Building partnerships with other relevant stakeholders as this will help effective partnerships for increasing educational quality across the globe.

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Chapter 22

National Health Insurance Scheme and Sustainable Development in the Face of 2020 Global Pandemic: The Nigerian Experience

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Abstract

Nigeria has in the past, and recent past, been engraved with various challenges emanating from health-related issues, especially those relating to maternal mortality. On the basis of the exercise conducted by WHO, UNICEF and UNFPA in 2000, the estimated number of maternal deaths globally, was 529,000. Joint report by the three aforementioned international organizations indicated that these deaths were almost equally divided between Africa (251,000) and Asia (253,000), with about 4 percent (22,000) occurring in Latin America and the Caribbean, and less than one per cent (2,500) in the more developed regions of the world. Globally, Maternal Mortality Ratio (MMR), is estimated to be 400 per 100,000 live births. Africa recorded the highest MMR (830), followed by Asia (330), Oceania (240), Latin America and the Caribbean (190). The country with the highest estimated number of maternal deaths is India (136,000), followed by Nigeria (37,000). In this present dispensation, just about the time Nigerians are reaping from the dividends of an affordable health insurance package known as National Health Insurance, the Coronavirus pandemic stroke. The focus of this discourse is to x-ray NHIS as it strives to achieve the purpose for which it was initiated over a decade, even in the face of the present world pandemic.

Keywords: Maternal Mortality Ratio, National Health Insurance, Coronavirus pandemic, Nigeria.

Introduction

Health matters have been one of the major concerns of the Nigerian Government in the twenty-first (21st) century. This is owing to the incessant deaths characterized by poor health which the country has witnessed and which has a drastic effect on her workforce. The fact that Nigeria has recorded numerous deaths which have no health-related undertone but handwork of terrorists is never in dispute, but the truth still remains that over the decades, her citizens have been faced with health challenges, ranging from simple health complications to chronic ones. During the national epidemic, the Nigerian Government made health policies to curb the problem but such policies could only address few health issues, out of the myriad of health complications. It is often stated that a healthy nation is a wealthy nation, but Nigerians were beginning to question their individual minds on the need to still be regarded as the giant by our African brothers, when we cannot boast of merely stable health. It is generally acceptable that every country has her internal conflicts or crises, as the case may be; even though the mode of control differs from

country to country. But accepting the fact that every country is not healthy is an utter illusion and an emotional blackmail.

Most Western, Asian and African countries, were able to sustain stable health of their citizenry through the adoption of and the adaptation to a health insurance policy with a view of offering citizens (both rich and poor) a health coverage over numerous diseases, at affordable rates, thereby endeavouring to uphold the third (3) goal of the United Nation which is 'Good Health' in achieving Sustainable Development by ensuring healthy lives and promoting well-being for all, at all ages. This goal also extends coverage to those with disabilities, it emphasizes 'cutting down on child mortality and increasing life expectancy'. An insight in these countries' efforts over the years toward the attainment of stable health for their citizens was among the major factors which prompted the Nigerian Government to initiate a policy which is health insurance coverage, known as 'National Health Insurance Scheme' (NHIS).

Meaning and Definition of NHIS

NHIS is an acronym for 'National Health Insurance Scheme'. Health Insurance is a health policy initiative by the Federal Government of Nigeria, which was floated in 1999, as a health insurance policy popularly known as the 'National Health Insurance Scheme' (NHIS). The scheme was backed by the NHIS Act no 35 of 1999 but it became operational in 2005. It is a social security system that provides the required health services to the masses who subscribe to it at the payment of a certain token at regular intervals. Such certain token is a contributory exercise, usually every month/year. As a corporate body, the National Health Insurance Scheme (NHIS) was established under the Act no 35 of the 1999 law of the Federal Government of Nigeria. Its main purpose is to enhance the health of all Nigerians at an affordable cost. The NHIS Act is the statutory authorized document which spells out the general rules, regulations and guidelines for the functionality of the health policy. The World Health Organization (WHO) (1948), defines Health as "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity". By the definition, this entails that healthcare infers the provision of conducive health condition for apt psychological, emotional, physical and overall wellbeing and development.

Inyang, Bassey, Igiri, and Ogba, (2018), expressively opined that Health Insurance in Nigeria has undergone a prolonged incubation process over the past decades, with a steady development in the few past years. They further believed that expanding access to health insurance is an important part of an overall strategy to achieve Universal Health Coverage (UHC). They asserted that UHC implies an ensured access to and use of high quality healthcare services by all citizens and projection for all individuals from any catastrophic financial effect of health. Social health insurance in Nigeria went through a tortuous planning process from 1962 until 1999, when it was enacted into law as the National Health Insurance Scheme (NHIS) under NHIS Act no 35 (2005). In the words of Phipps (2018), Health policy is a very broad term encompassing ways in which care is planned in a single setting to national or international guidelines, to improve population health. He argued that Policy guidance may relate to prevention or treatment of a single illness or to environmental changes, which have multiple impacts on various different aspects of health. Health insurance scheme originated in Germany in 1887, as a way of funding healthcare, followed by Austria 1897, Norway 1902 and United Kingdom 1910. In Africa, Nigeria was among the few countries which promulgated a National Health Insurance (NHI) law. Olubunmi (2017) contends that before the advent of the National Health Insurance Scheme (NHIS), health service to government officials, their dependents and students, were supposed to be free, while

the general populace was expected to Pay Out of Pocket (POP) for health service, received at all level of the healthcare system. The initial functioning of NHIS was interrupted and thwarted, owing to the Nigerian civil war. In 1984, the Nigerian Health Council was given the kiss of life to the scheme and a committee was set up to look at the National Health Insurance. In 1988, the then Minister of Health Emma-Eronmi fronted the committee that submitted its report which was approved by the Federal Executive Council in 1989. Being renewed as the “National Health Insurance Scheme” in the fourth republic, the scheme became operational in 2005, under the democratic administration of President Olusegun Obasanjo who ensured its official launch on the 17th of May, 2005. Ever since then, the policy has recorded several flagged offs; the first of which was executed by the first lady, the wife of the then President, Late Mrs. Stella Obasanjo, on the 18th of February, 2003 in a local community known as Ijah in Niger state, North Central Nigeria. Following the flag off “Under-5 Children Health Programme” of the NHIS scheme by the First Lady, in the local community, other flagged offs were witnessed by the residents and dwellers in Aba, Abia State, Nigeria; to mention but a few.

Following its entrenchment in the 1999 Constitution of the Federal Republic of Nigeria, the scheme executes vital operations such as the registration of health maintenance organization and healthcare providers under the scheme, issuing appropriate guidelines to maintain the viability of the scheme, determining the remuneration and allowances of all staff of the scheme, advising the relevant bodies on interrelationship of the scheme with other social security services, among many others. Similarly, Agba (2010) posits that as at September 2009, two/third (2/3) states of the federation, had agreed to partner with NHIS. These states include; Akwa-Ibom, Kebbi, Rivers, Edo, Sokoto, Adamawa, Kaduna, Zamfara, Kastina, Taraba, Nasarawa, Anambra, Jigawa, Imo, Kogi, Bauchi, Ogun, Oyo and Cross-River states. He remarked that these states are at various stages of implementation of the scheme. In line with Agba, Oyedibe et al (2012), contends that statistic from a workshop on Maternal and Child Health/Family Planning (MCH-FP) project by NHIS held between 6th-10th June, 2011, reveals that the number of enrollees and registered subscribers processed by some state in Nigeria as at March, 2011 are: Bayelsa 184,685, Gombe 161,847, Niger 62,408, Imo 90,597, Oyo 158,152, Sokoto 161,847, Kastina 80,272, Jigawa 105,739, Bauchi 158,144, Yobe 102,556 and Cross River 59,910.

The Act backing up the National Health Insurance Scheme which in turns, is being promulgated under the laws of the federation, is classified in parts and sections. The part I of the NHIS Act provides thus:

“(1) There is hereby established a scheme to be known as the National Health Insurance Scheme (in this Decree referred to as "the Scheme") for the purpose of providing health insurance which shall entitled insured persons and their dependents, the benefit of prescribed good quality and cost-effective health services as set out in this Decree. (2) The Scheme – (a) shall be a body corporate with perpetual succession and a common seal: and (b) may sue and be sued in its corporate name.”

From the foregoing, it is crystal clear that NHIS is an artificial person who can sue and be sued. There is also the assurance of longevity characterized by its continuous applicability in the country. By its provision in the Act establishing it, it is expected that it will get to the reach of every dick and harry in Nigeria. It is promulgated to be very affordable, with wide coverage of service delivery. On the contrary, Ampaw et al (2018), argues that the growth of insurance in

Africa is generally low and declining. Swiss Re Sigma Report (2016) identifies a reduction in Africa's insurance penetration rate from 3.65% in 2012 to 2.9% in 2015. Alhassan and Biekpe (2016) posited that Africa's insurance penetration rate of 3.65% in 2012 is lower. In Ghana, the procurement of insurance policies is reported to be discouraging (Inter Alia, National Insurance Commission, 2013). Contending further, Mee-Udon (2014), posits that despite the changes, by 2001, around 30% of Thai people still had no health insurance and had to pay for treatment. He emphasized that rural villagers were often not able to receive timely treatment, owing to the long distance to healthcare centers in the cities, with many individuals dying before they could reach help as it's exactly the case in some rural communities in Nigeria.

The National Health Insurance Scheme (NHIS) under the management of the Act establishing it, is controlled and managed by some number of key persons and medical professionals as provided for, in the scheme. This control is in line with the laws of the federation backing up the Act which establishes the scheme. The Council which is subject to the Act no 35 of 1999, is created to have full control of the health scheme. These medical professionals will in themselves, have a person or persons as the case may be, who will constitute part of the representatives in the council, in accordance with the Act. Similarly, NHIS has initiated several programmes, in order to ensure that every Nigerian has access to good healthcare services. The programmes are developed, so as to cover various sectors of the society. Such programmes comprise formal sector social health insurance programmes (which is a social health security system, geared towards the payment of healthcare of employees from funds created by combining the contributions of employees and employers), informal sector social health insurance programmes (which includes a social health security system for people in the informal sector (NHIS Guideline). It covers employees of companies employing ten (10) or less people, voluntary participants, rural dwellers, artisans and others not included in the formal sector as well as the vulnerable group), and vulnerable group social health insurance programme (involving programmes designed to provide healthcare services to individuals who cannot engage meaningfully in any economic activity owing to their physical status, in addition to age) (NHIS Guideline).

Accordingly, Spaan, Mathijssen, Tromp, McBain, Have and Baltussen (2012), revealed that other groups of Health Insurance system exist in other countries. National or Social Health Insurance (SHI) is one group of the different sets of Health Insurance system. It is based on individuals' mandatory enrolment and it is in operation in numerous countries with low- and middle-income. Such countries are: Thailand, Viet Nam, to mention but a few. Another set of Health Insurance system/scheme is the Private Health Insurance which is based on voluntary mechanism. It is functional in countries like South Africa, Chile, Brazil, among others, on an enormous scale. Community-Based Health Insurance (CBHI), is another set of Health Insurance policy, adopted in countries like Ghana, Senegal, the Democratic Republic of Congo, among others.

Functions of the National Health Insurance Scheme (NHIS)

Following the provisions of Act, no 35 of the 1999 laws of the federation, the functions of NHIS includes:

1. Registration of Health Maintenance Organization and healthcare providers under the scheme.
2. Issuing appropriate guidelines to maintain the viability of the scheme.
3. Approving format of contracts proposed by Health Maintenance Organizations (HMO) for all healthcare providers.

4. Determining the relevant bodies on inter-relationship of the scheme with other social security services.
5. Advising the relevant bodies on interrelationship of the scheme with other social security services.
6. Determining the remuneration and allowances of all staff of the scheme.
7. Advising on the continuous improvement of quality of services provided under the Scheme through guidelines issued by the Standard Committee established under section 45 of the Act
8. Doing such other things as are necessary or expedient for the purpose of achieving the objectives of the scheme under this Act.

Merits of National Health Insurance Scheme (NHIS)

The scheme is advantageous in many diverse ways. First, its benefit to the Nigerian government is quite enormous. The operation of NHIS aids the Nigerian government to cut down her expenditure on health matters which could be quite outrageous. Similarly, the policy through its operations, has created many job opportunities for numerous Nigerians, in the form of medical assistance which are more prevalently open to most graduates, as more of these qualified graduates (medically inclined persons and those that are not medically inclined) are employed from time to time, as a result of increased workload of physicians, nurses, pharmacists and laboratory scientists, in numerous NHIS affiliated institutions which provide healthcare services to their many enrollees. Another benefit of NHIS worthy of mention is that the policy is an important source of revival for the commoners in the society because of its affordable cost of service delivery. Most people in the society now stand better chances to enjoy medical services at very cheaper rates. Another remarkable benefit of NHIS is that Health Insurance subscribers/clients are at liberty to choose any medical institution (hospitals/clinics, maternities, health centres, etc.) of their choice as their healthcare providers (NHIS Act, 1999). Accordingly, NHIS enrollees are at liberty to either add or remove additional dependent (s) in line with the NHIS approval. Other salient merits include the following:

1. It provides great opportunity for the less privileged in the society to have access to drugs which ordinarily, they could not have access to, if the policy was not in operation.
2. A handful of advantage for many families. This implies that with little contributions made monthly or annually (as the case may be), majority of the families are covered under the health insurance package, as the scheme provides for the coverage of couple with four children below the age of eighteen (18) years.
3. Most beneficiaries are children and expectant mothers (pregnant women).
4. The operation of the policy has aided in reducing the high rate of absenteeism witnessed in the Nigerian Federal Civil Service and other Federal Institutions as many federal civil servants and federal public servants who are subscribers to the scheme can now live a healthy life devoid of many health challenges.
5. The operation of NHIS is as well, very beneficial to the elderly from sixty (60) years of age and above.
6. Youths above eighteen (18) years can also be partakers in the package with slightly high contributions than what children under eighteen (18) years contribute monthly or annually via their parents.
7. Every NHIS subscriber is at liberty to switch from the former primary health facility to the recent primary health facility, after the duration of six (6) months, if he/she so desires.

8. NHIS subscribers are at liberty to be treated at the NHIS accredited healthcare institution (facility) nearer to them, in the case of emergency.

Healthcare Service Providers

Healthcare Service Providers are various medical professionals, medical practitioners and medical assistants who serve as clients to the NHIS entity and who render healthcare assistance in various medical dimensions, to NHIS enrollees or subscribers. Most of these healthcare service providers are medical professionals and doctors working in various government hospitals, maternity, health centers and clinics. Some others are employees, employers and owners of private hospitals, maternities, health centers and clinics. Ideally, their duty is to ensure that they render medical services to the NHIS enrollees or subscribers to the extent that the enrollees enjoy satisfaction. Phipps (2018) contends that research informing policy, must move beyond clinical effectiveness to embrace social, psychological, cultural, ethical and political issues. In reality, the reverse seems to be the case as most of these NHIS service providers tend to have attitude problems and poor communication skill. They hardly explain medical terms to patients (enrollees) concerning a particular health issue to the barest minimum of their (patients') understanding,

Enrollees of National Health Insurance Scheme

Enrollees (also referred to as Subscribers) of National Health Insurance Scheme are people, persons or individuals who receive healthcare services from healthcare service providers, having applied, subscribes or enrolled in the NHIS. These people, persons or individuals are either civil or public servants of the Federal Government, and employees or employers of private firms. Ideally, subscribers to this scheme are provided with treatment relating to their various health complications at affordable cost. In real life situation, enrollees encounter delays, emerging from long wait in NHIS medical institutions, communication tends to be barricaded or in most cases not effective between a subscriber and his/her service provider owing to poor attitude display on the part of the service provider. Enrollees are as well faced with the problem of having access to prescribed drugs. Most times, these healthcare service providers often sound convincing and promising about the provision of certain drugs which are never in any of the NHIS pharmaceutical outlets and of which may never be provided for. While the scheme is ideally packaged to be provided at affordable rate, in reality, enrollees are always faced with situations of purchasing most of the prescribed drugs, outside the NHIS pharmacy, at exorbitant prices.

The Concept of Development

This is the continuous process of transformation. Development can take social, economic, political, and religious dimensions. Whichever way, it denotes an improvement in the standard of living. Development often carries an assumption of growth and expansion. During the industrial era, development was strongly connected to increased speed, volume and size. However, many people are currently questioning the concept of growth for numerous reasons – a realization that more isn't always better, or an increasing aspect for reducing outside dependencies and lowering levels of consumerism. So while the term “development” may not always mean growth, it always implies change. The term “Development” connotes different meaning to different people. Goulet (cited in Ejimudo) 2013, opined that the concept of development embraces the major economic and social objectives and values that societies strive for and the three basic and distinguishing

components or core values in the wider meaning of development are life-sustenance, self-esteem and freedom.

Sustainable Development in Nigeria

Sustainable Development is that transformation which recognizes the connection between social, cultural, environmental and economic matters, the diversity of interests within various communities existing in the country and its relationship to building capacity. Sustainable development can be described as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations World Commission on Environment and Development, 1987). In Nigeria, achieving sustainable development is utopia because this can only seem plausible, if the Nigerian Government will support various community development initiatives. This simply implies that there is no sustainable development without community development. Community development is therefore that process of transformation being undergone collectively by a group of persons, originating from the same locality, group of people who have similar interest which is geared toward policy initiation, policy implementation and the overall wellbeing of the populace. Within the Nigerian context, communities in different parts of the country have over the years, strived toward developmental activities for the provision of some basic amenities which would add more value to the lives of their members. They no longer depend solely on their local, state or federal government for provision.

In the recent times, communities have become increasingly interested and concerned about developmental issues. To a large extent, this new orientation is rapidly yielding some good results as most rural communities in recent times, embark on various viable projects that accord them new phase of life. Today, a good number of communities in Nigeria, have in the recent times, especially from the ninety seventies (1970s'), become development-conscious; as various organizations begin to emerge and successfully embarked on several developmental projects in the area.

Community development is a grassroot' process by which communities become more responsible, organize and plan together, develop healthy lifestyle options, empower themselves, reduce poverty and suffering, create employment and economic opportunities, achieve social, economic, cultural and environmental goals. Community development seeks to improve quality of life. Effective community development results in mutual benefit and shared responsibility among community members. Community development helps to build community capacity in order to address issues and take advantage of opportunities, find common ground and balance competing interests. It doesn't just happen – capacity building requires both a conscious and a conscientious effort to do something (or many things) to improve the community. Sustainable Development process takes charge of the conditions and factors that influence a community and changes the quality of life of community members. Community development is about community building, where the process is as important as the results. One of the primary challenges of Sustainable Development is to balance the need for long-term solutions with the day-to-day realities that require immediate decision-making and short-term action. The Nigerian Government has not yielded any positive result in this regard, although there has been some notable evidence that it has empowered some of the various urban and rural communities in striving for a sustainable development, even though the ever-rancorous struggles in the Northern part of the country have posed a big challenge, over the past two (2) decades. Although NHIS is designed and programmed for wide coverage, inaccessibility is still one of the major

cankerworms, eating deep into the policy. Despite its affordable cost, majority of the Nigerians still encounter challenges in taking part in the scheme. One thing is to subscribe to the scheme, another is to become beneficial of it and that is precisely where the real hiccup lies.

The 2020 Global Pandemic: Effects on NHIS and its Implications on Sustainable Development in Nigeria.

From the purview of the global context, strict lockdowns existed all over the world towards end of March 2020 and have lasted for several months. This is as a result of the world most dreadful and fast spreading ailment known as ‘Coronavirus or COVID 19. This terminal ailment is said to have begun from Wuhan, China in 2019 and has claimed thousands of lives, across borders and across continents. An insight into the African economy indicated that economic growth in Sub-Saharan Africa declined from 2.5% in 2017 to 2.3% in 2018. However, it was projected to 2.8% in 2019 and 3.3% in 2020 (World Bank, 2019). In Nigeria, growth was projected to rise from 1.9% in 2018 to 2.1% in 2019 (World Bank, 2019). But with the recent global challenge, the reverse has become the case. Current research has indicated that there will be likely global economic meltdown but our concern is Nigeria, for the purpose of this discussion. Having joined in the global lockdown for barely two (2) to three (3) months, Nigeria has recorded more health complications, other than the ones emanating from the global pandemic. While the COVID 19 seems to be averagely managed and index cases seem to be on the increase daily, a lot of health challenges are evident in the lives of many Nigerians who have been caught up by the lockdown and extended lockdown in some states with high index cases, such as Lagos, Kano and Ogun. To most Nigerians, 2020 first quarter, seems to be an utter waste, economic wise. This is owing to the stagnation (shutdown) of every meaningful economic activity such as churches, schools, industries, boutiques, salon outlets, markets, firms, federal and state civil service; including all government parastatals.

Hunger has taken over many homes and has claimed some lives in the process. Anger has generated rife between neighbours and some notable lives have been claimed through such means. Public stealing by massive number of youths has not ceased to cause dangerous havocs and tensions in some parts of Lagos, Nigeria. Any calculated fellow will also recall that popular song during the eighties (80s), by a musician from the Eastern Nigeria. “Which Way Nigeria? Which Way We Go? I Love My...” Reasonable answers would have been provided for this music-generated questions, if the NHIS was able to hold its feet in the face of this pandemic. Unlike in the Asian, American and European countries where myriads of medical practitioners have died as a result of being frontier healthcare providers, Nigeria has not recorded major deaths of medical practitioners, working as service providers in any of the NHIS’s medical institutions, neither is NHIS’s contribution to the present predicament seen or heard. Other countries of the world, including some of the African countries, have been going through series of health reviews with the health insurance company, operating in their countries, in order to ensure that the COVID-19 team were either engulfed with the former or work alongside with them for efficient, effective and competent outcome.

In Nigeria, while the Nigeria Center for Disease Control (NCDC) deceitfully seems to be working, the NHIS seem to be asleep and this slows operation speed, affects workforce (by claiming their lives), who has been on lockdown and thereby leaving majority of Nigerians rather aggressive, in their hopeless situations. Most countries offered (apart from periodic giving of a certain token), some palliatives, as a way of instituting hopes in the lives of both the infected

and the free ones, and as a way of encouraging them to remain indoors while they are staying safe.

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Chapter 23

Physics Education as a Tool for Achieving Sustainable Development in Nigeria

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Abstract

The study attempted to explore the role of Physics education as a tool for achieving sustainable development in Nigeria. Physics is one of the core science subjects taught in Nigerian schools. Attention was paid to the contributions of Physics education to the society through various sectors. Some of the constraints to achieving sustainable development through physics education in Nigeria were also highlighted. Based on the discussion, recommendations were referred.

Keywords: Physics education, sustainable development, society.

Introduction

Every nation of the world strives towards achieving sustainable development. Each realizes that the only means of doing so is through qualitative education of its citizenry which must be geared towards achieving a better future. Education as viewed by Ada (2016) is the transmission of cultural heritage through systematic change of human behavior that is acceptable to the society. Otor, Kayang & Iyang (2017) further sees education as the process of training in which an individual is actively involved with the view to bringing out latent talents that can be modified for their personal and societal benefits. It is the most singular powerful instrument of life, charged with the responsibility of shaping and refining of life (Adegun, 2003). Hence, education is a systematic process of training aimed at bringing about a lasting positive change in the behavior of an individual for the betterment of the society. The contribution of education, especially science education, in developing a nation cannot be overlooked.

According to Pember and Humbe (2009), science education is described as a process of teaching or training, especially, in school to improve one's knowledge about environment and to develop one's skill of systematic inquiry as well as natural attitudinal characteristics. Nwosu (2015) went further to state that science education is the study of the interrelationship between science as a discipline and the application of educational principles to its understanding, teaching and learning. It involves an in-depth study of both science disciplines and educational disciplines (psychology, philosophy, sociology and curriculum). It is a pre-requisite for technological development which involve an in-depth study of science as well as verified educational knowledge and concepts. Science education therefore owes it as a duty to equip teachers, learners and the society with knowledge, skills and freedom to perform noble tasks useful for improving socio-economic standard by producing capable scientists who contribute meaningfully through the product of their researches to raise the economic level of a nations. One of the branched of science, physics, is particularly of immense value in bringing about developments needed in technological development of any nation. Hence, its effective teaching and learning are crucial issues for consideration.

Concept of Physics Education

Physics is the science subject that deals with the study of matter and energy and their interactions. Physics can be seen as a culture, a way of perceiving and doing things which inevitably affects the problem-solving capabilities of any society and this is what determines the extent of development such a society can attain. Knowledge of physics has contributed immensely to the production of instruments and devices of tremendous benefits to humanity, thus playing a very vital role in the development of any nation. Physics, being one of the core subjects offered in Nigerian secondary schools forms the basis for the nation's technological advancement and human resource development (Abubakar, 2012). Some of the roles played by physics to development are in the areas of electronics, food processing, preservation and storage, information communications and technologies as well as fuel and electricity production. Physics education as defined by Amusa (2015) is the theory and method of teaching physics in the curriculum. The aim of all the intellectual effort dissipated in effective teaching of physics is to improve the learning of physics at all levels of learning especially at the secondary school level. For a sustainable development of any nation to be achieved, sound physics education cannot be neglected.

Despite the importance of physics education to national development, Nigeria lacked sustainable physics education since independence in 1960. This calls for why physics education has not been able to move the country into industrialization and above poverty level. Following the view of Momeke (2007), science (especially physics) education has failed to produce skilled human resources needed for transformation into national prosperity. Hence, Nigeria has been witnessing haphazard type of modernization leading to acquisition of obsolete technology which of course does not lead to sustainable development.

Sustainable Development

Sustainable development is a construct, which envisions development as meeting the need of the present generation without compromising the needs of the future generation (Ugoh, 2008). Nigerian study/action team (NEST, 1991) in Osuji (2004) further stated that sustainable development is an approach that combines the development needs and aspirations of the present without compromising the ability of the future while also maintaining ecological integrity. This later definition stresses sustainable development as the process that is equitable and sensitive to ecological and environmental issues. Hence, any developmental issue must, as a matter of great importance be aimed at preserving ecology and the environment, else, such development cannot be said to be sustainable. The sustainable development goals (SDGs) which is a transformative action plan based on the millennium development goals (MDGs) was officially launched on January 1, 2016. Its purpose was to address urgent global challenges over the next 15 years after the MDGs target (by the year, 2030) so as to consolidate the MDGs and ensure sustainable social and economic progress worldwide. SDGs seek to eradicate extreme poverty and to integrate and balance the three dimensions of sustainable development namely: economy, social and environmental in a comprehensive global vision. According to Ban (2016), the latest data reveals that about 12.5 % of people all over the globe are still living in extreme poverty and nearly 800 million people suffered from hunger while the birth of nearly 25 % of children under five years had not been registered. Ban (2016) further added that about one million people were living without electricity while more than two million still suffer from water scarcity globally. To achieve sustainable development, a lot of issues are to be put in place; namely, human capital through education and technology advances; physical capital like machines, tools and so on.

Educational institutions and their programmes are therefore the tools with which development and its sustainability can be attained.

Borrowing a leaf from UK panel for education for Sustainable development (1998), education for Sustainable development enables people to develop the knowledge, values and skills to participate in decisions about the way we do things, individually, collectively, locally and globally that will improve the quality of life now without damaging the planet in future. Sustainable development, therefore is a process in which the exploitation of resources, the direction of investments, orientation of technological development and institutional changes are all in harmony and enhance both present and future potential to meet human needs and aspirations (UNIlagconsult, 1997). Creative thinking is a sine qua non and a rapidly growing trend that promotes sustainable development projects. Through physics education, efforts are made to foster creative thinking in learners to ginger them to be innovative. The role of creative thinking as a strategy for development of human knowledge and in problem solving is unquestionable.

Human knowledge is the major source of sustainable wealth in that when we apply knowledge to familiar tasks, it results in improved productivity, but when knowledge is applied to tasks that are novel and different, the outcome is innovation.

Strategies for Achieving Sustainable Physics Education

To achieve sustainable physics education, the following strategies will be of great help:

i. **Curriculum review**

The Physics curriculum should be reviewed to make it relevant for the needs of the society and to be in consonance with the signs of the time. Relevant competent skills should be emphasized and inculcated on students at all levels to make them functional contributors to the society on graduation. Such curriculum should also emphasize skills acquisition and development which will make learners competent and creative so as to be able to compete with their counterparts globally. It is in line with this that Eyibe (2009) asserted that what he regards as futuristic curriculum for this millennium should be introduced in the educational system. To Eyibe (2009), futuristic curriculum should ensure that before graduation, every student should be equipped with such skills in science and technology, especially in physics that will be needed for sustainable, technological and socio-economic development agenda of the nation in a period of globalization.

ii. **Training/retraining of more physics teachers**

The impact of the teacher in performance of students in general, but particularly in physics is germane. It has been reported by researchers (Olarenwaju, 1986; Nwagbo, 1995), that most teachers teaching physics are ignorant of the curriculum content of the subject. Some of them do not even have the basic qualification in physics, while some others who have, are without teaching qualifications. For this reason, there is need to train more physics educators and to insist that those who do not qualify should go for in-service training to obtain needed qualification to practice as physics educators. This will make those teachers well-grounded both in the conceptual understanding of the subject as well as being acquitted with the best method of impacting the knowledge on the learners for proper comprehension (Jegade & Adedayo, 2013). This agrees with the submission of Fajonyomi (2007) that the success or failure of any educational programme rests mainly on the adequate availability of well qualified (professional) and dedicated teachers.

iii. Re-orientation of our value system

The present society values more those professions that will generate for people enough income, respect and popularity. Hence, many who are good in and could have opted for physics education, the bedrock of sustainable development, are discouraged on the ground that it will not yield them enough money. Orientation on our value system therefore, should be reversed to give science, technology, engineering and mathematics (STEM) (especially physics) education its pride of place in the society. In similar manner, girls should be encouraged to go for physics to bridge the gender gap since it enables them gain higher status in life and enhanced sense of efficiency. Educated women, especially in physics create more equitable lives for their families, increase their participation in community decision making and work towards achieving sustainable development (Nnabuo & Asodike, 2012).

iv. Motivating physics students

Students who opt to study physics should be properly motivated through scholarship opportunities and other incentives to attract and encourage more students to offer physics. Efforts should also be made to lay solid foundation at the grass root during the basic science days in the junior secondary schools so as to make students love and appreciate the subject at higher levels of education. At this level too, proper orientation if given to students in the career choice will go a long way to developing their interest in the subject. More importantly, while teaching the various concepts in physics, their relationships in, and applications to real life situation should be highlighted.

Contributions of Physics to the Society

Physics is a multidimensional discipline with application in many areas including agriculture, health, water, energy, environment and information and communications technology (ICT). Validiya (2003) realizing this noted the dominant roles played by physics in spearheading technological advancement, promoting national wealth and accelerating industrialization. Through physics education, physicists and science related professionals are produced who make significant contributions in the various areas of life endeavors.

i. Contributions of Physics in Education Sector

In education sector, physicist contribute as resource persons in matters concerning science and technology education, planning and advisory roles. They can work in research institutions. Some physics graduates teach in secondary and tertiary institutions, a job that is highly recommended though unfortunately not highly rewarded especially in Nigeria. Physicists can also establish science schools where they use their expertise knowledge to produce professional in all fields of science related careers. A solid base in physics education enables an individual to master the laws of nature and utilizes them effectively for the welfare of the individual and for social reconstruction; it helps one to utilize one's knowledge for complete and meaningful living in society

ii. Contributions of Physics in the Health Sector

In the area of maintaining human health and the practices of medicine, physics have made tremendous contributions in sustaining development. A lot of inventions in modern medicine are done in the area of physics. Rapid and extensive growth of medical physics is a major health care profession where physics concepts have been significantly applied. Such technologies as X-Ray (discovered by Roentgen in 1895), nuclear medicine, nano medicine and nano pharmacy,

magnetic resonance imaging (MRI), radiation therapy, ultrasound, echocardiography, ECG, particle accelerators and radioisotope tagging and detection technique are introduced into medical domain through researches in physics. The discovery of radioactivity ushers in the era of radiology or medical imaging and radiation. In the words of Freeman (2012), these contributions have revolutionized medical techniques for imaging the human body and treating diseases. Physicists are also pivotal in using radiation and more recently, radiation free nanomaterials as a treatment for cancer. Hence, medical physics have developed cutting-edge technologies in physics laboratories which other health professionals apply in their clinics for both diagnostic and therapeutic purposes, thus alleviating suffering for millions of people. It is therefore noteworthy that just as structures cannot be built in vacuum, a healthy society cannot exist without framework of components, one of which is physics education. All health professional and practitioners require strong foundation in physics education before they could embark on medical or health mission.

iii. Contributions of Physics Education to Development in Electricity and Electronics

Development in electronics have witnessed rapid growth in recent times. Physics has contributed a lot in developing and coupling such items as transistors, diodes and integrated circuits (ICs) which allowed the development of radio transmitters and receivers, televisions, computers and modern tape players. Through advancement in nanotechnology research, these electronic have been highly miniaturized so that they are now very portable and so can easily be moved about with great convenience. Contribution of physics in development of electricity cannot be overlooked in modern time. Knowledge of physics is used for the development of telephones, mobile phones, optics cables, optical fibers and also internet that has reduced the entire universe to a global village.

iv. Contributions of Physics Education to Development in Agriculture

Sustainable food production cannot be achieved without qualitative physics education. For the mass production of food items, mechanized agriculture is an imperative. Consequently, most of the machines and equipment used for mass production of agricultural products were developed, coupled, operated and maintained by physicists. Furthermore, accurate details of quantity and quality of materials to be mixed for a better agricultural yield is best done by physicists.

v. Contributions of Physics Education to Development in Water

Research in water purification is carried out in the Physics laboratories. Physics education at research level equips citizenry with knowledge on how to manage water resources knowing fully well that such knowledge is critical since it addresses the quality and sustainability of water resources. This is a critical factor to the survival of people and the planet as recommended by the SDG number 6, which recognizes the centrality of water resources to sustainable development. Sustainable development goal number 6 also recognizes the vital role that improved drinking water, sanitation and hygiene play in progress in other areas, including health, education and poverty reduction.

vi. Contributions of Physics Education to Development in Energy

Energy is the lifeline of a growing economy since all life on earth depends in some way upon energy. Being primary and of such importance for development, industrial and commercial growth of a nation also depends on the availability of energy. Advancement in renewable energy research which is fast overtaking the use of non-renewable energy sources such as fossil fuels, natural gases and others has been made possible through physics education. Renewable energy sources have tremendous advantages over non-renewable sources. For instance; they are

environmentally friendly, they cannot be depleted over time and they are non-toxic among others. Such researches have given rise to the development of devices like lithium-ion batteries, supercapacitors, dye-sensitized solar cells, perovskites solar cells, sensors and many more which are capable of storing enormous energy and discharging them at a faster rate when needed (Nwankwo, 2019).

vii. Physics Education and Development in Information and Communications Technology (ICT)

Introduction of ICT into education system is the brain-child of physics education. This has made learning both exciting and interesting to students. Through advancement in ICT, the world has been turned into a global village where distance is no longer an obstacle to making any achievement in life. Computers and satellite were also developed by physicists for taking and receiving messages from different parts of the world. Physics has therefore contributed immensely towards making life worth living and boosting the prestige of several nations.

viii. Contributions of Physics Education to Development in transportation

All means of transportation such as vehicles, motorcycles, bicycles, ships, aero planes and trains are all developed from the knowledge of physics. This is because, principles of physics are applied at one point or the other in their constructions and operations. These modern means of transportation have made life easier and more enjoyable to a great extent.

Physics Education for Sustainable Development: the way forward

Physics education for sustainable development promises to make the world a better habitable place for the present and future generations. It entails giving people knowledge and skills in terms of lifelong learning to help them find new solutions on their environment, economic and social issues (Nnabuo & Asodike, (n. d.)). However, the big question is: “does the present physics education programme of Nigerian Universities equip students with adequate skills that will lead to sustainable development?” The performance of the products of the Nigerian Universities in the labour market shows that there is still plenty of gaps to be filled in our physics education programme to fit it for sustainable development.

Physics education for sustainable development is a lifelong process that enables a scientifically informed and involved citizenry to have the creative problem-solving skills, scientific literacy and commitment to engage in responsible individual and cooperative action (Nnabuo & Asodike, n. d). Physics education as a tool for sustainable development sharpens and extends students’ ability to think for themselves and try their hands on novel activities that lead to innovation, discoveries and inventions, To achieve sustainable development through physics education, it is imperative to concur with Maclean (2008) that effective skills development for employability and sustainable livelihood is essential and this also provides a foundation for peace building through contributing to poverty alleviation and raising level of income. It is important to note that the more involved the people are in physics, the stronger the society can be since the lessons and skills have effects that help make for more responsible citizen, a strong economy, a healthy environment for their own children and create a brighter future for every one and provide a better technologically-driven world.

The communication, research, reporting and collaboration skills that science (especially physics) provide can produce generations of individuals who are better prepared for any career and can make greater contribution to the society. According to Okoli, Obiajulu and Ella (2013), students who have solid knowledge base in science (especially in physics) will later be more

open to emerging technologies and ideas that can boost business and stimulate the economy. This is why Nwankwo (2018) asserted that the line of demarcation between developed and developing countries is based on their physics and mathematics attainment and ingenuity to apply the concepts of physics smartly.

Constraints to achieving sustainable development through physics education in Nigeria

So many challenges and constraints to the teaching and learning of physics abound and these are attributable among others to the following:

Physics Education Curriculum

Inadequate Physics education curriculum at all levels of education where physics is offered presents one of the major constraints to the teaching and learning of physics in Nigeria. Since the world is growing rapidly in technology, there is an urgent need to restructure and reform the science, especially the physics curriculum to be in line with the present need. In line with this, Jada (2004) suggested that national physics curriculum would give way to international physics curriculum. Learning would become a universal system. Nationalistic or regional curriculum orientation would be replaced by global focused curriculum.

Physics Teacher Problem

The problem of finding physics teachers that are well equipped with the needed knowledge and are competent to impart such knowledge is one of the major problems experienced in physics education presently. This is why it is difficult to achieve sustainable development through physics education. Most of the available physics educators lack the skills needed for the practical application of physics in technology, a sine qua non for sustainable development

Special Examination Centers

The problem of students migrating en-mass to special centers, also known as miracle centers where examination mal-practices are freely done presents another major constraint to achieving sustainable development through physics education. This is because, these students are neither interested nor ready to go through the stress involved for the acquisition of quality knowledge that will equip them with the necessary skills required for technological development. Hence, they come out of schools with very beautiful certificates, but their brains are devoid of the required knowledge and skills to perform on the field. Instead of helping the society to solve its myriads of problems, they rather constitute nuisance and great problems to be solved by the same society they are supposed to help.

Inadequate Textbooks

Most physics textbooks used both at secondary and tertiary levels of education are not written in line with our culture. They are often beyond the scope and conception of the students for whom they were written. Good textbooks should use demonstrations and illustrations from materials available in the locality and also should be written in simple language understandable to the students for whom they were written. When textbooks are beyond the comprehension of the students, students will naturally be frustrated reading them and hence whatever knowledge it contains cannot be acquired or assimilated by students.

Funding

Another major constraint to achieving sustainable development through physics education is inadequate funding by government. This problem affects every facet of human endeavour including education sector. Fund is needed to train physics educators and physicists; to equip and maintain physics laboratories for meaningful research in physics; for on-going development of physics professionals and for proper remuneration of the serving physics educators and physicist in order to attract more serious-minded persons to study and practice in the area.

Conclusion

This paper attempted to highlight the roles of physics education as a tool for achieving sustainable development in Nigeria. The interrelationship between physics and other science-related careers especially health delivery was also explored. Physics education may therefore provide the country with indispensable avenue through which it could address the myriads of problems it is facing relating to sustainable development. This is because, through physics education, large pool of scientifically literate and skilled workforce could be generated with enabling environment for Nigerian citizens. Effective teaching and learning of physics could doubtlessly influence the sustainability of technological development in Nigeria.

Recommendations

Based on the issues raised in this study, the following recommendations were proffered:

1. The physics education curriculum should be reviewed periodically in line with the technological needs of the present time. Federal government should introduce futuristic curriculum in tertiary institutions.
2. Government should strive to provide in-service training for physics teacher to keep them attuned with the present trend in technology
3. All special centers, otherwise known as miracle centers should be seriously sanctioned and if with enough evidence shut down by examination bodies to enable students work hard for a merited success. In the same vein, all forms of examination malpractices should be severely punished
4. Physics teachers should be recruited based on merit. They should be examined on both content and pedagogical knowledge before recruitment and it should be ensured that they are registered with the teacher registration council (TRCN) for quality assurance.
5. Textbook developers should ensure that physics textbooks are up to the standard and written in simple and understandable language.
6. Government should provide proper incentive to physics teachers and there should be reward to teachers with outstanding performance.
7. Attractive scholarship based on merit as out-judged from students' performance and not political scholarship scheme should be formed and made available for students in science education, especially physics education departments of various institutions.
8. Political deceptions should be avoided in education especially science education sectors by all types of government. Proper funding should be given priority attention to cater for infrastructure, science laboratory equipment and learning materials.
9. Students should be motivated to go for physics by telling them of its importance as a single honour course as well as its interrelatedness with other science related careers like medicine, engineering and pharmacy.
10. Physics educators should be encouraged through adequate funding to engage in academic research towards improving the teaching and learning of physics at post basic level.

11. Students should be provided with more and modern learning aids like computers, internet facilities and accessible websites, overhead projectors to enable them align with their counterparts internationally.
12. Students should be encouraged to take active part in science especially in physics by organizing quiz, science exhibitions and conferences at all levels by government.
13. Physics and other science educators should be adequately remunerated to avoid brain drain.

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Chapter 24

Assessing the Issues of Natural Resources Exploitation on Attaining the Related Sustainable Development Goals

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Abstract

The natural ecosystem has been the basic source of human livelihood, and has enhanced the survival of all living things. The key factor to ensuring that natural resources are continuously harnessed for the benefit of the present and future generations is by promoting the culture of sustainable development. In this chapter, emphases are limited to a review on basic concepts of sustainable development and the relationship with resource exploitation and agriculture. Evidently, natural resources are vulnerable to resource degradation and consequent extinction; following pressures from increasing demands by a fast growing world population, industrial revolution, urbanization and unsustainable agricultural practices. There is thus, a significant nexus between climate change and the way natural resources are being harnessed. Exploitation of natural resources can trigger irreversible climate change issues which are capable of reducing the productive potentials of valuable resources including the soil on which farming is done. On the other hand, agriculture can play a critical role in sustainable development, if practiced in a way to promote it. Thus, traditional agricultural practices and modern farming systems need to be regulated not to intensify ecosystem degradation, but otherwise help the ecosystem regain its resource resilience and productive potentials. Such sustainable practices would not only promote resource productivity and food security, but would also promote environmental health and resource resilience, with regards to sustainable development. Also, there is a need for environmental education, focused government policies and global action as vital elements towards achieving the sustainable development goals (SDGs).

Introduction

The ecosystem is a beautiful piece of creation; adorned with astonishing splendour and wonders of nature; which constitute natural resources. Human beings were born to meet, explore and manage this serene and seemingly inexhaustible natural resources and environment characterised by a productive ecosystem. These resources are naturally widely spread across every nation and continent, against this natural arrangement, was a geometric increase in world's population; which exacerbated an almost uncontrollable resource demand (Ukpog, Ekpebu & Ofem, 2013). The ecosystem also faced the challenge posed by the rising drive for industrialization (or

industrial revolution) which has further mounted pressure on natural resources; as basic raw materials for the industry.

By natural circumstances, the ecosystem had relentless potentials to support resource distribution across the earth; there are also incredible landscapes, green vegetation and forests widely spread across the globe. Up the Arctic, there are also natural wildlife reserves such as those in Alaska, Canada and Russia; which provide a natural serene habitat for valuable rare wildlife species including the Caribou herds, snow geese, falcons, polar bears and wolves (Newman & Furlong, 2020).

There are unique geographically distributed landscapes; including mountains, hills, plains, valleys and deserts, across the continents; which support existence of wildlife species and the ecosystem in general. These critical natural landscapes are also often exploited to support human livelihood as in the case of the country, Israel; where large volumes of vegetables, vines and other fruits are skilfully produced with enough for exports (Walsh, 2000; Michael, 2020).

In Africa, there are unique natural resources that support economic development and with ecological implications. However, there are evident cases of climate change issues that tend to alter the natural face of the original ecosystem; ranging from the growing threat of Sahara Desert encroachment, to issues of flood, drought and coastal erosion (Dodd, 1994; Kalantari & Destouni, 2018). Nevertheless, besides ecological issues, Africa has the fortune for exceptional green vegetation, fertile soils and a favourable agro-ecological climate naturally distributed across the continent; which have enhanced the survival of various cash crops, trees, vegetables and fruits. Also, a few rural areas still enjoy natural, clean and unpolluted marine ecosystem that supports human livelihood, agricultural activities and existence of a variety of aquatic lives and forest reserves (Ekpebu & Ukpong, 2013).

Today, globally, that beautiful, serene natural ecosystem (or environment) has changed as a result of sustainable exploitation of natural resources by human beings. The exploitation has caused almost irreversible distortion of the natural nomenclature of the ecosystem or what could be described as *deconfiguration* of supposed productive characteristics and capabilities of natural (or environmental) resources.

Before these changes and human activities; which aggravated increased unsustainable resource exploitation across the globe, the natural ecosystem was highly resilient and able to promote high productivity of natural resources towards supporting human livelihood, protecting the ozone layer and enhancing survival of wildlife species. The earth was filled with clean unpolluted free flowing natural air for human beings, plants and animals, which today becomes a mirage in most countries. In recent years, the world has witnessed the collapse of the ecosystem ranging from disintegration of ice caps and degradation in the arctic, as observed in the Russian Arctic. There are cases of desert encroachment in Asia and Sub-Saharan Africa; increasing rate of air pollution, water pollution and shortages, drought and other climate change issues as also recorded in most advance nations (Huang & Ukpong, 2019; Jun & Yongyong, 2008).

In the developing countries such as Nigeria, there has been incessant depletion of natural vegetation, deforestation, swamp encroachment, and flood, as well as environmental pollution generated by the oil and gas industry, and in the process of industrialization and urbanization Ekpebu & Ukpong (2013). More so, agriculture also plays a critical role to further intensify environmental degradation and pollution following prevalent adoption of unsustainable farming practices. In view of these concerns, it is a fact that the world is in trouble; faced with numerous challenges; most of which are caused by the continuous unsustainable exploitative activities of

individuals and nations in their pursuit for insatiable appetite for survival, economic recovery, industrialization, military power and political dominance.

It was based on this backdrop that the UN General Assembly in September 2015 adopted the vision 2030 Agenda for sustainable development; that highlighted seventeen (17) major sustainable development goals known as the SDGs. Obviously, achieving the SDGs would depend on a number of factors, and in this chapter, emphases are limited to the basic concepts of sustainable development with regards to resource exploitation and agricultural practices.

Concept of Sustainable Development

The concept of sustainable development is used to describe a development strategy or a development process that meets the needs of the present (or present generation), without compromising the ability of the future generations to meet their own needs (IISD, 2020). In other words, sustainable development emphasizes a development strategy (or process) or a culture of resource use (or exploitation) that would enhance a sustainable use of resources without causing resource degradation or destroying its natural potential to provide the basic ecosystem services for the next generation. As earlier noted, the ecosystem has the natural potential to service every generation of human beings for an inestimable period of time. On the other hand, every natural resource has some levels of inherent resilience and productive capability which are vulnerable to distortion by environmental changes (or conditions) and exploitation by human beings. Such changes could be as a result of climate change, or human activities resulting in environmental pollution, resource exploitation and depletion. Thus, the need to ensure sustainable use of natural resources was the driving motive for the 2015 UN Convention to adopt a sustainable development framework to promote a global consciousness for sustainability. The UN resolution was highlighted under the 17 sustainable development goals (SDGs), listed below.

- | | | | |
|--|-------------------------------|--|--|
| 1. No Poverty | 2. Zero Hunger | 3. Good health and well-being | 4. Quality Education |
| 5. Gender equality | 6. Clean water and sanitation | 7. Affordable and clean energy | 8. Decent work and economic growth |
| 9. Industry, innovation and infrastructure | 10. Reduced inequality | 11. Sustainable cities and communities | 12. Responsible consumption and production |
| 13. Climate action | 14. Life below water | 15. Life on land | 16. Peace and justice strong institutions |
| 17. Partnerships to achieve the goal | | | |

Source: *United Nations (2020)*

Unfortunately, despite adoption of the SDGs, there are still worrisome emerging global issues including global warming, climate change issues, high rate of population growth, environmental pollution, corruption and natural disasters. There are also public health issues

including disease outbreaks such as the HIV-AIDS, Tuberculosis, Cholera, and the most recent devastating Ebola and Corona-virus (Covid-19) pandemics (vanVuuren, 2020).

The world also faces seemingly insurmountable cases of livelihood issues including hunger, malnutrition, food safety and food security issues; arising from complex chains of agricultural and environmental problems (Inyeinyang & Ukpong, 2019). These emerging global trends have raised serious concerns and debates about the possibility of achieving the sustainable development goals in 2030.

Sustainable Development and Resource Exploitation

The ecosystem is the basic index of human survival, and besides ecological implications of a healthy environment, majority of rural population are largely dependent on the natural environment for their livelihood (Adeyemo and Zuofa, 2010).

This section does not intend to dig-deep into economic theories and concepts of consumer behaviour, but attempts to establish a nexus between the implication of 'irrational' consumption culture and excessive demands by humans (consumers), and issues of sustainability. It is interesting to mention among the various categories of consumers to include individuals, organizations and the government. These consumers mount demand pressure on producers who intensify exploitation of resources to meet the various demands. So, while producers are supposed to regulate the way resources are harnessed, consumers are also supposed to take responsible to promote sustainable development by regulating their insatiable and dynamic demands.

It is a fact that the main aim of resource exploitation (or rather a production process); is to create a product to be consumed. In other words, consumption is the endpoint of a production process involving transformation of natural resources into usable or consumable products. Therefore, a given resource could be exploited based on the intent of consumption, and the level of consumption demand would determine the level of exploitation. Thus, the consumption behaviour (or consumption culture) of individuals or organizations, as could be indicated in their dynamic resource or product demands, goes a long way towards influencing the way and extent to which resources are being exploited. Highlighting what could be a *rational consumption behaviour*, or a more sustainable resource use, *David Montgomery*, noted that despite the belief in technology towards solving societal problems, it (technology) cannot 'solve the problem of consuming a resource faster than we generate it'; because someday, it will run out' (Montgomery, 2007). This emphasis further reiterates the need for the consciousness of sustainable development while exploiting or consuming natural resources.

Furthermore, no matter the category of consumers and intent of consumption, every consumer aims at gaining at least an optimum satisfaction (otherwise known as utility), from goods and services consumed, and in a bid to achieve this satisfaction, a consumer might be tempted to over-exploit or over-consume. The issues of sustainability cannot be disconnected from the consumption culture of individuals and groups: thus, the consumption behaviour of individuals or organization would affect the way resources are being exploited. This confirms the basis that the United Nations Assembly advocates 'responsible' consumption and production behaviour and practice, under the SDGs (UN, 2020).

The demand for excess or changing phases of human consumption continues to pose a threat to achieving resource sustainability. Logically, when a given generation tends to consume so much (or irrationally), there is a tendency that available resources would be over-stretched to meet such demands. In the process of meeting rising human demands, those harnessing these

resources (some of which are scarce) might be faced with the options of over-exploitation or over-use. And when resources are over-exploited, there is little or no regards for the next generation, which automatically impedes the realization of sustainable development.

Reiterating the issue of exploitation, it is obvious that environmental resources are under constant threat of degradation and endangered as human beings continue to pursue unlimited and insatiable needs (Ukpong, 2012). For instance, the consequences of sustainable exploitation of natural resources, as in the case of oil and gas extraction, are direct threats to environmental sustainability, food security and human livelihood (Ukpong, Inyeinyang & Omovwohwovie, 2017). As also noted by Wunder (2003), oil and gas extraction impact on natural resources such as the forest which is also a direct threat to the ecosystem. In particular, evident that the oil and gas industry is prone to explosion risks; which result in pollution and fire outbreaks that affect environmental resources (Omodanisi, Eludoyin, & Salami, 2015). According to Ordinioha & Brisibe (2013), besides the environmental issues, crude oil extraction also has human health implications.

In terms of livelihood, Bhau & Ukpong, (2018), reported that the oil and gas industry post a direct threat to the environment and affects agriculture, leaving devastating footprints on the environment and consequent impact on human livelihood. The soil/land also faces the growing impact of unsustainable resource exploitation. The soil is a living entity (and non-renewable resource), which supports the survival of various species of plants and other living things. Montgomery (2007), while emphasizing the need for sustainable use and treatment of the soil; noted that a 'healthy soil has an enticing and wholesome aroma-the smell of life itself'.

It is a fact that the ecosystem cannot be recreated, and with an increasing population of human beings naturally seeking to exploit natural resources for survival, the ecosystem remains on a daily threat of irreversible changes. The world continues to experience the realities of climate change, and so many environmental resources are on high risk of extinction. Therefore, it is needless to overemphasise that human beings are now faced with a choice between not over-exploiting the resource; to promote sustainability and exploiting it to risk resource degradation and subsequent ecosystem collapse. Frankly, for the world to achieve sustainable development, human beings have to address the issue of excessive exploitation of natural resources.

Thus, there is a need to enhance adequate policy decisions on resource management, including the need for appropriate policy that would regulate consumption and exploitation of natural resources, while ensuring suitable environmental valuation, and the need to ensure proper mitigation strategies that would enhance recovery of already degraded resources. These views are also shared by Kant & Lee (2004) and Ukpong *et al.* (2019).

Agriculture and Sustainable Development Issues

Human beings face various options to ensure their survival on the earth. This involves gathering from the wild; exploiting wild fruits and animals, hunting and forestry activities. Thus, the primary aim of human activities on earth is to achieve survival, and food is unarguably a major cardinal for human survival. In other words, human beings engage in various activities geared towards providing the basic needs which include food, shelter and clothing to enhancing its livelihood, satisfaction or survival. These basic activities most times, impact on the natural provisions for environmental resources to produce and the resilience or environmental resources. The concept of sustainable development is therefore important to regulate the use or otherwise, exploitation of natural resources with a view to avoiding perpetual destruction of resources. Thus, human beings face two conflicting endpoints; to continue to exploit the resources for

survival and the need to apply restraint to excessive resource exploitation, or to adopt a more rational consumption culture; to avoid degradation or extinction of natural resources.

Agriculture is the main source of livelihood of rural population who form the largest proportion of the population in most developing countries. For instance, according to Adeyemo and Zuofa, (2010), Nigeria, is an agrarian society with about 80% of its population living in the rural areas, and practicing agriculture as the main source of livelihood. With a large proportion of the population practicing agriculture, there would be relentless pressure on natural resources especially land/soil and vegetation; making agriculture obviously a part of the major threats to resource sustainability. Agriculture (or farming) involves the physical and technical manipulation of natural resources particularly the soil, for the purpose of producing food for human beings, feeds for farm animals and raw materials for the industry (Ekpebu & Ukpong, 2013).

The process of farming may involve land clearing, deforestation which results in vegetation depletion, as well as tillage of the soil which may alter the natural configuration of the soil and enhance soil erosion where valuable soil nutrients and natural features are washed away. One would imagine the ecological impact as a large portion of the earth is continually subjected to farming in different countries. This practice, as already been emphasized, involves inevitable depletion of green vegetation and alteration of natural features of the soil. Thus, the climate faces a greater risk of changes that could worsen the present state of the ecosystem, and by extension risks possible resource degradation and extinction at the expense of future generations.

On the other hand, agriculture if sustainably practiced could play a vital role in protecting the ecosystem or helping it to regain its resilience. Thus, the need to regulate agricultural practices to promote sustainable development through increased adoption and implementation of sustainable farming systems and practices.

Besides unsustainable agricultural practices, oil and gas extraction pose a threat of resource degradation that also affects agricultural development and might influence the course of sustainable farming practice (Eregha & Irughe, 2009). This corroborates with the views of Ekpebu & Ukpong (2013), on the impacts of crude oil extraction on agriculture and environmental resources; that although 'crude oil is a great wealth, it should be properly managed to promote environmental sustainability with regards to agricultural development'.

To further emphasize sustainable development, referring to the SDGs, it is obvious that most of the basic elements of these goals cannot be achieved without sustainable agricultural development. Thus, solving agricultural problems would help in achieving some of the sustainable development goals. Therefore, every nation needs to promote agricultural development through increase investment sustainable agriculture. According to Rashid (2018), sustainable agriculture has the tendency to address most of the world's ecological problems through sustainable and efficient resource management, especially land and water management. Thus, farmers should be encouraged to adopt sustainable agricultural practices to help the world achieve its SDGs, and in solving ravaging climate change and global warming challenges.

More so, despite the agricultural problems and challenges faced by farmers, most developing countries have the potential of attaining sustainable agricultural development, with the consciousness of SDGs. This potential is characterised by availability of fertile soils, a good and compatible agro-ecological environment, and man-power; which need to be sustainably harnessed. On the other hand, farmers, especially those in the developing countries, should take advantage of the global quest for sustainable development to engage in agricultural research, and explore the endless possibilities created by the concepts of globalization to connect with other

nations so as to promote improved skills, sustainable technologies, increased production, increased exports and profitability. Undoubtedly, agriculture (farming) involves several practices that could be deemed unsustainable and a threat to resource sustainability, as briefly highlighted in the next section.

Overview of some unsustainable agricultural practices

In the global quest to enhance food security and sufficiency, the world has engaged in various scientific and technological discoveries to stimulate the soil and other resources to boost food production. Some of these technologies have undeniably turned out to pose environmental problems. Thus, it is important for farmers to promote sustainable traditional practices to enhance resource productivity, rather than invest in unsustainable technologies that are damaging to the ecosystem. Some of the unsustainable farming practices are highlighted below:

(i) Poor Soil/land and water management:

Most crude or traditional agricultural practices do not support sustainable development. For instance, the bush burning practice widely done by rural farmers; negatively affects the environment, particularly the soil and other environment resources. Bush burning becomes an issue especially in this era of growing concerns about global warming and climate change (Ekpebu & Ukpong, 2013). Tillage is another practice that also poses a considerable threat to sustainable soil management, as it tends to alter the natural nomenclature (or properties) of the soil; making it vulnerable to erosion and degradation. As explained by Rashid (2018), damaging the soil and water sources in the process of farming is an unsustainable practice which could result in destroying the resources upon which agriculture is based and their potential to provide other ecosystem services. The soil is the primary index for plant growth, and with regards to ecosystem sustainability, plant or vegetation cover plays a vital role in providing ecosystem services and ecological resilience. According to Montgomery (2007), 'soil is a dynamic system that responds to changes in the environment'. As noted by Rashid (2018), non-sustainable farming practices are among the most considerable factors of land degradation'. Thus, continuous practice of unsustainable farming system could result in severe environmental consequences including resource degradation.

(ii) Abuse of technology and scientific innovation

Poor application or otherwise an abuse of technology could pose a threat to natural resources and the ecosystem. There are issues associated with farmers' abuse of technologies and scientific inventions meant to promote increased agricultural production, for instance the excessive and unsustainable use of agrochemicals could be a big threat to environmental resources and could trigger resource degradation. As emphasized by Rashid (2018), the application of agrochemicals or specifically, an abuse of agrochemicals could lead to human health risk, and environmental problems. In particular, soil/land, water resources and vegetation get contaminated as a result of application of agrochemicals including pesticides, fertilizers and herbicides (Aktar, Sengupta & Chowdhury, 2009). In other words, continuous application of agrochemicals could render soils unproductive and incapable of contributing its own share of the ecosystem services (Rashid, 2018). Technology abuse can also involve the case of inadequate application of mechanized farming system, irrigation irregularities and poor agricultural waste management constitute some of the inefficiencies experienced in the agricultural sector that could result in resource degradation.

(iii) *Poor waste disposal*

As noted above, poor management or inadequate disposal of agricultural wastes is among emerging environmental problems. According to Sabiiti (2011), most agricultural wastes are being disposed into natural water sources, while some are being burnt; releasing pollutants into the atmosphere; which pose both public health and ecological problems. The ecosystem is made up of an interconnected and interdependent component of natural environmental resources, thus an impact on one resource would have implications on the performance and productivity of other resources and the ecosystem at large. This further explains the need to ensure sustainable use and management of every resource, as advocated through the provisions of the SDGs.

Conclusion and Recommendations

The complications associated with farming, leave critical footprints on the fate of the ecosystem, and would have a direct impact on the sustainability of natural resources. Nevertheless, it is needless to overemphasize the critical role of agriculture in addressing sustainable development issues, especially in developing countries where sustainable traditional agricultural systems are still being widely practiced. It is thus, obvious that there are double sided implications associated with agricultural practices toward determining the status and quality of our climate or ecosystem which is already affected by pollution factors. It is beyond a mere argument that the world cannot achieve its global sustainable development goals without first discouraging resource exploitation and achieving sustainable agricultural development. Such a development process should address the issues of unsustainable farming practices which are damaging to the soil and the environment.

In view of this background, it is important to emphasize a widespread implementation of environmental education aimed at sensitizing the general public, especially the farmers on the implications of most of the traditional practices they adopt. To achieve this, it would be also important to engage the services of extension agents and social workers who would have been properly trained by environmental and sustainable development experts. To further narrow down the orientation process, farmers in the developing countries, especially rural farmers who seem to be the majority of farmers' population globally; should be particularly focused on. To buttress this fact, it might not be out of place to note that while modern cities continue to be wrecked by environmental pollution from industrialization, vehicular engines, domestic and industrial plants, as well as poor waste disposal, the rural areas can be managed to play a critical role in reviving the climate with existence of forest, green vegetation and marine ecological environment.

Also, there is a need for collaboration between the agricultural sector and other sectors especially those responsible for development. The government should promote linkages and collaboration with the various sectors to ensure that development processes, such as infrastructural development, farming, urbanization or industrial revolution does not interfere with sustainable development.

In particular, the government in developing countries should promote the campaign for sustainable agricultural practices, which should engage farmers groups and other social organizations. It is also important to emphasize increased investment in the agricultural sector by governments and international investors, to promote sustainable farming practices. We would be helping to save the ecosystem if we invest more in agriculture than there is investment in unsustainable industrialization that would produce increased environmental pollution which is a threat to the resilience and sustainability of natural resources.

On the whole, there is a need for a global action on the implementation of sustainable development goals, and for the government in various countries to focus its policies towards promoting sustainable agricultural development in the drive to achieve the SDGs. The planet belongs to all and sundry, thus every one is a potential stakeholder in the quest to achieve sustainable development; hence everyone must take responsibility and contribute to achieving the sustainable development goals (SDGs).

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Chapter 25

Attaining Sustainable Development in Solid Mineral Industry in Nigeria: The Role of Nanotechnology

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Abstract

The applications of nanotechnology cuts across all sectors, but this paper concentrated on the role of nanotechnology in the development of the solid mineral industry in Nigeria. After a thorough review, it was found that nanotechnology has recently dominated the world market doubling its effects every 5-10years in the world market. It was confirmed that the world dominant producers like China and United States have continued to invest heavily on this technology and are reaping the benefits. While globally the nanotechnology has hit 1trillion USD by 2015, it was projected to hit 3 trillion USD by 2020. It was found that the application of nanotechnology in the solid mineral industry will lead to addition of value to our mineral products, creation of new materials and enhancement of eco-friendly mining. The paper concluded that Nanotechnology is the future that is here with us and should be adopted, embraced and pursued with every enthusiasm to ensure a sustainable growth in our solid mineral industry and the Nigeria economy at large. It also recommended that the Federal Ministry of Solid Minerals should partner with available nanotechnology centres to improve the sector using this technology, the adoption of Nanotechnology in the research and development projects of the nation should be made as a policy, also funds should be made available to procure the necessary equipment for the research and development in this area.

1.0 Background Information

The term nanotechnology was first used in 1974 by the late Norio Taniguchi of University of Tokyo to refer to the ability to engineer materials precisely at the scale of nanometres (Ramsden, 2016). Nanotechnology is the manoeuvring of matter on an infinitesimal, molecular and supra-molecular scale. In fact, 'the engineer materials' was taken to comprise the design, characterization, production and application of materials. But currently the scope has been widened to include devices and systems rather than just materials. Nanotechnology is thus defined as the design and fabrication of materials, devices and systems with control at nanometre dimensions (Ramsden, 2016). The initial general definition of nanotechnology referred to the specific technological objective of accurately manipulating atoms and molecules for production of macro-scale products, also now referred to as molecular nanotechnology (Drexler, 1992 and Kafshgari *et al*,2015). It is plainly the formulation, production, and application of structures, devices, and systems by manipulation of size and shape at the nanometer scale. In recent times, nanotechnology has become a very great area of interest in advanced and emerging economies mainly because of the opportunities and potentials of this technology in providing solutions

through advanced technologies and the prospect of new routes for the mitigation of serious developmental issues (Bhattacharya *et al*, 2012). Many rising economies are considering this technology as a 'window of opportunity' that would help them to grow faster and Nigeria is not an exception.

Nanotechnology is not a discreet technology or an industry sector. It simply refers to a range of technologies that operates at the nano-scale (roughly 1-100 nanometers, one nanometer is 10^{-9} meter). Although 'size' is a convenient way of defining the area; in practice nanotechnology has more to do with the investigation of novel properties that manifests themselves at the size scale, and the ability to manipulate and artificially construct structures at that scale. At nano-scale, some materials gain radically new characteristics and functionalities that can be used for innovative applications in myriad sectors (Roco, 2011 and Ramani *et al*, 2011). For instance, gold, which in bulk form is inert, turns out to be highly effective catalyst when reduced to nanometer range. Infusing carbon atoms into nanotube structures makes the structures stronger than steel, conducts electricity better than copper and becomes virtually impervious to heat. The new scale facilitates manipulation on the cellular level, thus enabling new discoveries in pharmaceuticals, bio-defense and health care. For instance, in cancer research, research is being carried out to use quantum dots to study tumors and locate proteins. These are metallic particles that emit bright light in a color range that varies with their size. Whereas chemotherapy kills cells indiscriminately, nanoparticles once introduced into a tumor and subjected to a specific wavelength of light, target and destroy only the cancer cells. This process requires fewer drugs and is safer for the patient (Bhattacharya *et al*, 2012).

With the present population of Nigeria being about 200million and its growth rate tending towards becoming the third largest population by the next 100years, there is great need to grow the country's economy not on paper but in reality. The country being blessed with a lot of resources still remain import dependent for her goods and services till date, this calls for the intervention of research into a way for improvement through the pathway of scientific and technological innovations as established in the developed countries.

It is no longer news that global trends are currently driven by the Fourth Industrial Revolution which is underway. This revolution is characterized by knowledge based digital economy driven by information and communication technology (ICT), big data, internet of things, robotic, drones, cloud computing, high performance computing (HPC), nanotechnology, Biotechnology, numerical simulation, mobile Apps, softwares, Artificial Intelligence (AI), among others.

For Nigeria to key into and maximize utility of this revolution, all sectors of the economy must be transformed to knowledge-based electronics and smart systems. For example, in health care for the Nigerian economy of the future will be driven by ICT. Doctors will be able to perform surgery remotely with more precision. The frontiers of Medical science will be pushed to new boundaries where surgeries can be performed in non-invasive manner by robots. There will be medical implants using organs printed by 3D printers. Drones will be used to deliver drugs. The factory of the future in this our future Nigerian economy will be run by robots and artificial intelligence. Even agriculture will be knowledge based with big data supplying weather and other input data and drones carrying out surveillance and monitoring of farms. Smart irrigation will be in place making use of satellite and cloud-based data systems.

The Nigerian solid mineral development sector will not be left out, as smart remote sensing systems will be able to carry out resource identification and reserve estimation and mining

equipment will be autonomous articulated vehicles with machine vision and centre. Mineral process and value chain addition will be governed by Nanotechnology.

1.1 Importance and Applications of Nanotechnology

The applications and importance of Nanotechnology are numerous and cannot be over-emphasized. They may include but are not limited to the following:

Water Resources Planning and Management: Water Purification

Nanotechnology offers a prospect for low-cost and effective solution to the challenge of access to clean and safe water for millions of people in developing nations (Ramani, 2011) like Nigeria. The technology holds the potential to radically reduce the number of steps, materials and energy needed to purify water.

Depending on the kind of water to be purified ground, surface or waste water; nano-materials can be tailored with specific pore sizes and large enhanced surface areas to filter out certain unwanted pollutants, such as heavy metals or biological toxins.

For example, titanium oxide at nanoscale can be used to degrade organic pollutants. And silver nano- particles have the ability to degrade biological pollutants such as bacteria (Bhattacharya *et al*, 2011).

Nanofiltration Membranes: They are applied in wastewater treatment, removal of micro pollutants, removal of dissolved salts from saline water and water softening. Nanofiltration membranes selectively reject substances, which enables the removal of harmful pollutants and retention of nutrients present in water that are required for the normal functioning of the body. Nanofilters can be sourced from clays, zeolites, and polymer filters. These can be manoeuvred on the nanoscale to achieve better control over the filter membranes pore sizes. The recent researchers would be developing novel categories of nanoporous polymeric fabrics with greater efficiency than the typical polymer filters (Pendergast & Hoek, 2011).

Nanocatalysts and Magnetic Nanoparticles: Using catalytic particles could chemically degrade pollutants instead of simply moving them somewhere else, including pollutants for which existing technologies are inefficient or cost prohibitive. Magnetic nanoparticles, when coated with different compounds could be used to remove pollutants, including arsenic, from water.

Nanosensors: Researchers will be developing new sensor technologies that combine micro- and nanofabrication technology to create small, portable, and highly accurate sensors to detect chemical and biochemical parameters in water (Bhattacharya and Bhati, 2011).

Health Sector:

In both diagnosis and treatment, nanotechnology holds the key to revolutionise health care, particularly in developing countries where access to effective health care is still a challenge for millions of people living in remote areas.

In the field of diagnostics, nanotechnology promises quick, early and accurate detection of diseases.

Portable, but highly sensitive point-of-care test kits are under development which will offer all the diagnostic functions of a medical laboratory. Depending on how they are designed and the intended application, the hand-held kits could be used to test for viruses, bacteria or hormones. Thus, they will be able to test simply and quickly for infectious diseases such as malaria, cholera, HIV/Aids and other sexually-transmitted infections, and even cancer.

Also known as the “lab-on-a-chip” because of their ability to emulate the services of a complete medical laboratory, these inexpensive, hand-held diagnostic kits can pick up the presence of several pathogens at once and could be used for wide-ranging screening in remote clinics.

Biomedical Imaging: Nanotechnology applications are in development that will radically improve medical imaging techniques. For example, gold and silver nanoparticles have optical properties which make them extremely effective as contrast agents. Quantum dots which are brighter than organic dyes and need only one light source for excitation, when used in conjunction with magnetic resonance imaging, can produce exceptional images of tumour sites (Kafshgari *et al*, 2015). Nanomaterials are also used in Therapeutics or Treatment.

Targeted Drug Delivery Systems: Nano- structures can be used to recognise diseased cells and to deliver drugs to the affected areas to combat cancerous tumours, for example, without harming healthy cells. In obesity, nano-particles can target and inhibit the growth of fat deposits.

Slow-Release Drug Therapy: Research shows that nano-sized biodegradable polymer capsules containing drugs for tuberculosis treatment are effectively taken up by the body’s cells. The effect is a slower release of the drug into the body and a reduction in the frequency with which TB patients need to take his or her medication. In countries where drugs are not readily available and compliance is generally low due to a number of reasons, the technology holds great potential for increased drug compliance and less chance of the development of drug resistance.

Photo-Thermal and Hypothermal Destruction of Cancer: Some nano-particles, such as gold, possess therapeutic properties based on their magnetic wavelength or optical properties. They absorb light and heat up the surrounding area, killing the cancer cells.

Energy Sector:

Another impressive application for nanotechnology is energy production, conversion and storage. Research is well advanced enough to establish that nanotechnology offers a viable alternative to non-renewable fossil-fuel consumption and gives us the means to achieve a “hydrogen economy”. Nano-applications in this area include: solar cells; fuel cells and new energy production, conversion and storage processes. In all cases, the results are energy that is cheaper, cleaner, more efficient and renewable. In future, nanotechnology holds the potential to produce hybrid vehicles with reduced fuel consumption and a lighter motor weight (Kurtoglu *et al*, 2011 and Mashaghi *et al*, 2013)

Applications in the Industrial Sector:

Nanotechnology is set to add value to Nigeria's raw mineral resources through beneficiation of gold, platinum group metals and other minerals which are used as high-performance catalysts, absorbents in polymer nanocomposites and in energy-saving materials. Large Iron ores and silica deposits are big markets for nano materials and nanoparticles.

Nanotechnology can produce cleaner process engineering which will in turn produce value-added chemicals and speciality products, including bio catalytic systems and novel heterogeneous catalysts. Nanotechnology can make catalytic converters more efficient, cheaper and more accurately controlled.

Nanotechnology-based innovations can be designed that will combat air pollution remediation, detect toxic materials and leaks, reduce fossil fuel emissions and separate gases.

Applications in Advanced Materials and Manufacturing Sector:

Nanotechnology can produce smart, functional materials, including lubricants and barrier coatings, ultra-hard and super-strong materials, electro and photo-chromic materials with applications in all manufacturing sectors, industry, medical and domestic markets. Nanoparticles can also improve a wide range of properties shown by engineering plastics, such as biodegradability and improved thermal, mechanical and electrical properties. Thus, plastic bags can be made to bio-degrade and plastic carparts or building materials can be made more fire-resistant. Other areas include the development of nanoparticles for applications in phosphorous paints, printable electronics, inexpensive solar cells and nanotube synthesis for application in sensors and as catalyst support structures (Kurtoglu *et al*, 2011 and Mashaghi *et al*, 2013).

Other Importance of Nanotechnology:

In fact, ground-breaking nanotech products and materials which are of great importance and application, like nanorobotics are prospective. While some predicted it to come after many years, others said it is in few years, but the truth is the time is now. The recent rise in the basic research and development in laboratories world over buttresses the fact that nanotechnology has arrived (Fymat, 2016 and Nicolas, 2012)

Products of nanotechnology are increasingly in the world market today with records of tremendous improvement through evolutionary nanotechnology, where some form of nano-enabled material (like carbon-nanotubes, nanoparticles of a particular substance, nanocomposite structures) or nanotechnology processes (like quantum dots used in medical imaging or nanopatterning) are widely applied in the manufacturing process (Fymat, 2016).

In their ongoing quest to improve existing products by creating smaller components and better performance materials, all at a lower cost, the number of companies that will manufacture "nanoproducts" will eventually grow very fast and soon make up the majority of all companies across many industries.

Evolutionary nanotechnology is certainly considered as a process that gradually will affect most companies and industries. The pervasive potentiality of nanotechnology of being a generic, horizontal, enabling and/or disruptive technology makes it most attractive. Nanotechnology is already addressing key economic sectors and can provide solutions to some of the world's most critical development problems.

Figure 1 shows a summary of the application of nanotechnology in the various sectors of the economy.

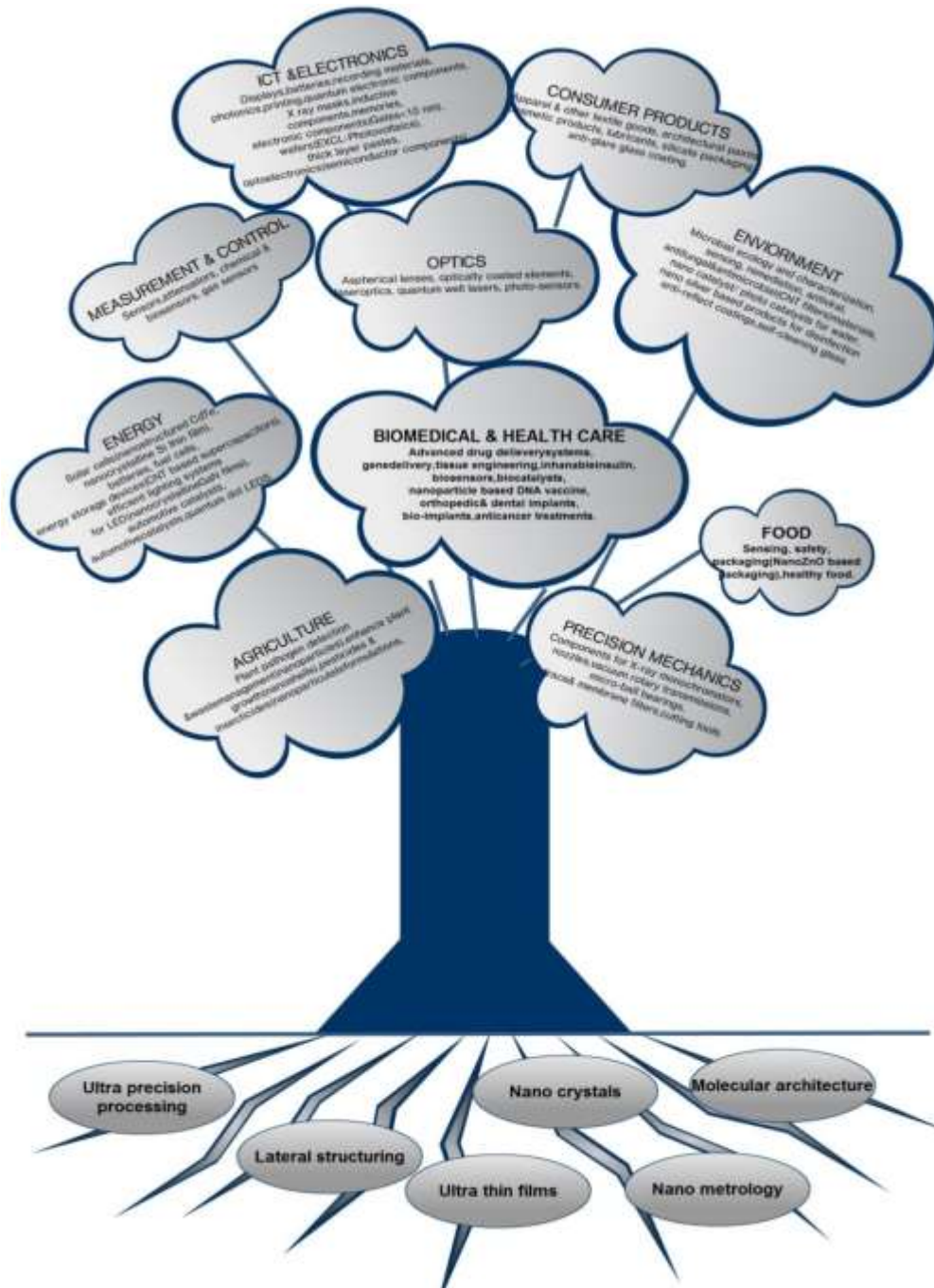


Figure 1: Martin Meyer’s Nano Bonsai Tree, (Source: Meyer, 2003).

This figure 1 has been expanded based on the applications visible in the contemporary period to include applications that address environmental and developmental areas.

2.0 Nanotechnology as a Window of Opportunities for Developing Countries like Nigeria

Nanotechnology – ‘Window of Opportunity’

Different studies forecast that the global market and impact of nanotechnology in key functional components by the year 2015 to be in the range of \$1 to \$2.6 trillion, with requirement of 2 million workers and about three times many jobs in supporting activities. The US National Science Foundation, (2003) confirmed that in 2015, nanotechnology contributed greatly to their nation's economy 33% in new materials, 30% in electronics, 18% in pharmaceuticals, 10 % in chemicals and over 7% in Aerospace.

A forecast of the value of products incorporating nanotechnology was done in 2011 and extended to 2020 as contained in figure 2. Global market of nanotechnology by the year 2015 has been predicted to be in the range of \$1 to \$2.6 trillion and projected to \$3 trillion by 2020. Predictions estimate that the future market will largely be dominated by Nonmaterial followed by nanoelectronics, pharmaceuticals, chemicals and refining, and aerospace. Present market size is largely dominated by nanomaterials followed by nanotools and nanodevices.

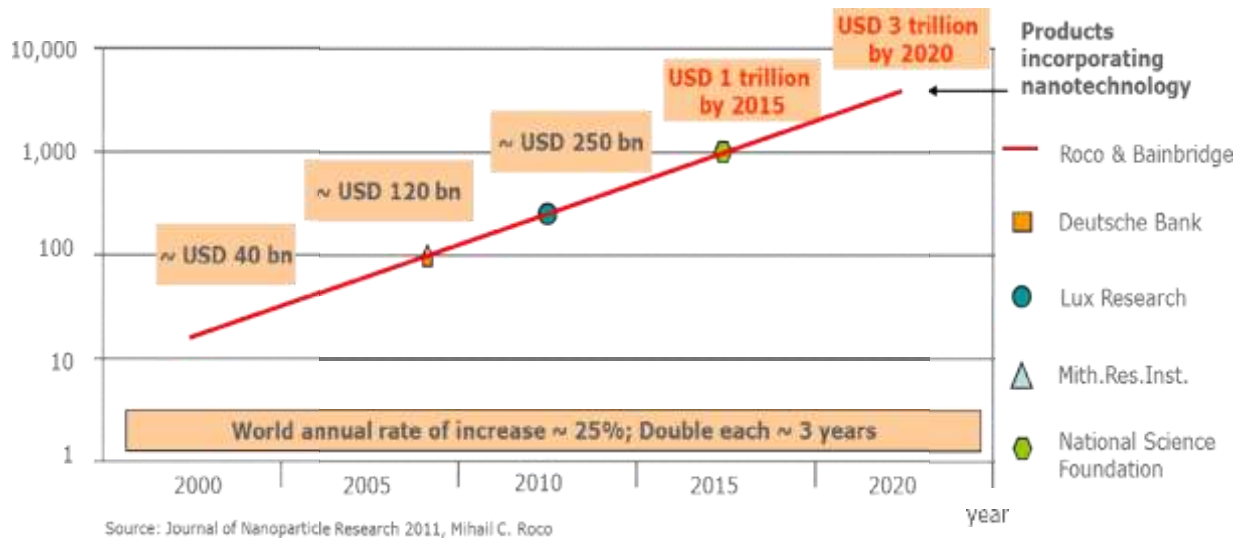


Figure 2: World market incorporating nanotechnology (Billion USD). (Source: Roco, 2011)

These forecasts suffer from difficulties in defining the value-addition of nanotechnology to existing manufacturing processes as well as its role in generating new products. In spite of skepticism of these estimations, products incorporating nanotechnology are entering the marketplace. These products are estimated to have produced \$147 billion in revenues in 2007 (including \$59 billion in the United States, \$47 billion in Europe, \$31 billion in Asia/Pacific, and \$9 billion in other nations). Thus, it is not difficult to see that the country that attains 'first mover advantage' in this technology can derive huge economic benefits. Figure 3 shows the market size estimated for different domains within nanotechnology.

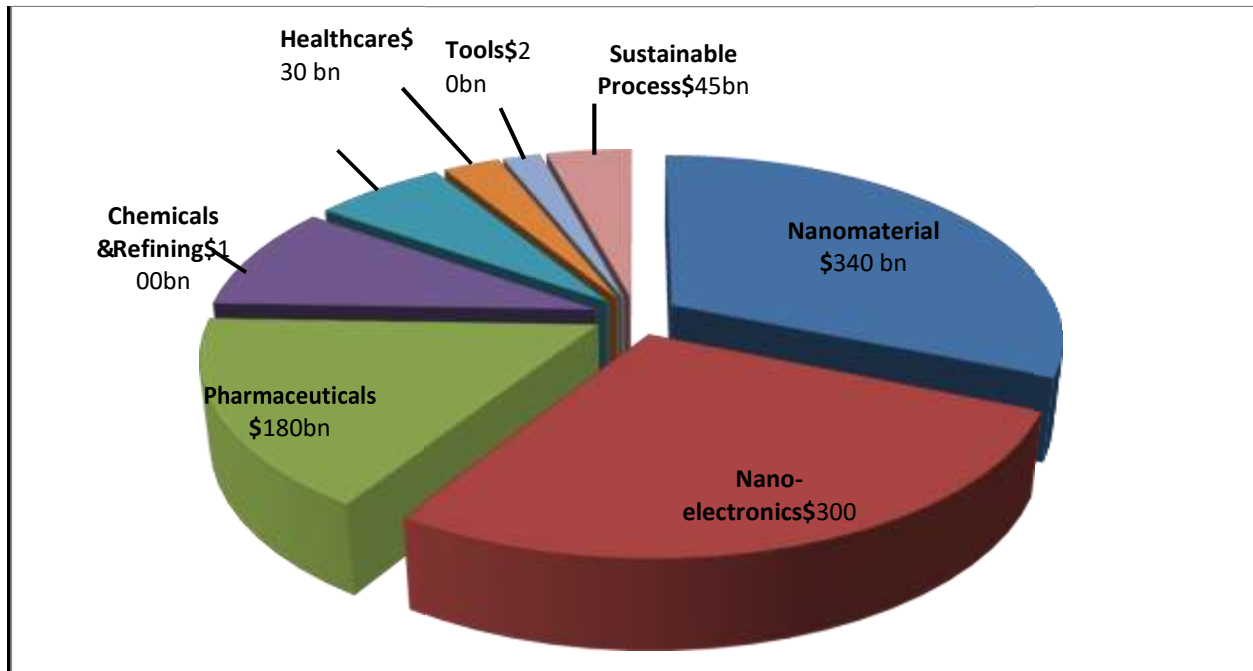


Figure 3: *Estimated Market Size in Various Domains of Nanotechnology (In Billion USD)*
Source: National Science Foundation (Future Estimation)

The large market for nano-materials augers well for countries moving in this high technology area as it is relatively easier to create various types of nanomaterials than in creating nano-enabled products such as nanodevices. Developing various types of nanomaterials (for example ‘carbon nanotubes’, ‘dendrimers’) is useful as they have diverse applications in myriads of sectors. Another characteristic that makes nanotechnology appealing is that not only it can provide solutions in high technology but also in areas that are of pressing concerns in developing and impoverished economies i.e., environment, water purification, agriculture, energy and in a host of other products and services. For example, in water treatment and re-use, engineered nanoparticles can provide a number of opportunities: high absorption that can help remove arsenic and other heavy metals, anti-microbial properties, fouling-resistant, filtration membranes, florescence that can detect pathogens and other primary pollutants. Products are already in the market and more multi-functional water treatment/re-use products are being developed. These demonstrated applications are changing the perception of skepticism towards a realization that if properly addressed nanotechnology can provide a ‘window of opportunity’ for countries to catch up. This has motivated developing countries to channelize their scarce resources for increasing their capacity and capability in nanotechnology. Developing countries also perceive that this technology can help them to ‘leapfrog’ the technology development lifecycle and compete globally through value enhanced products. This has stimulated Organization for Economic Cooperation and Development (OECD) countries as well as emerging economies to channelize huge resources for developing core capabilities in this technology.

Interdisciplinarity of Nanotechnology

Another key attribute of the field of nanotechnology is its interdisciplinarity. Interdisciplinarity implies that development in this field requires cross-fertilization of ideas from different

disciplines (Nicolas, 2012). Developing nanotechnology capability thus requires scientific and technological capacity in material science, applied physics, applied chemistry, etc. Human resource development thus becomes a more challenging exercise. Different skill sets are required for understanding the nuances of this technology as knowledge in this field is changing very rapidly and uncertainty is very high. Nanotechnology is strongly science based wherein 'technological success' increasingly depends on strong scientific capabilities and on the ability to interact with science and scientific institutions. Developing an 'innovation ecosystem' would thus require developing institutional mechanisms that can strengthen the academia-industry linkages.

Nanotechnology promises not only solutions in high technology areas but can also address developmental problems such as water, environment, and energy. This is stimulating both developed and developing countries to devote substantial investment in this area for creating innovation ecosystem. Nanotechnology if properly addressed can help developing countries to 'leapfrog' the development cycle and also provide solutions to key developmental problems. Thus, it provides a 'window of opportunity' for developing nations to 'catch up' with advanced OECD economies. Competency in this area of research is an immense challenge as it is a knowledge intensive area requiring development of advanced R&D infrastructure, significant R&D investment, skilled manpower having inter-disciplinary competence, access/development of sophisticated instruments, entrepreneurship, and synergy among divergent set of stakeholders.

3.0 The Role of Nanotechnology in Solid Mineral Industry in Nigeria

According to Banwo and Ighodalo (2018), it is on record that by a marginal growth of 0.55 percent in gross domestic product ("GDP") in the second quarter of 2017 (driven primarily by improved performance of agriculture, manufacturing and trade sectors of the economy coupled with the gradual rise in global commodity prices and relative stability in domestic crude-oil production), Nigeria crept out of its worst recession in more than two decades; which had been precipitated largely by persistent falls in international oil prices.

Recognizing the precarious nature of an oil-dependent economy, emphasis has thus continued to be laid on diversification through development of the non-oil sector, as a sure way for the country to stay on a steady recovery path in the short term; stabilize the economy in the medium term; and build a formidable economic bulwark against external shocks (such as oil price volatility and future eradication of fossil fuel usage in a bid to save our environment) in the long term. Hence, a critical look at solid minerals as a viable alternative resource to Nigeria's crude oil and an overview of the policies and strategies of the Government for harnessing the potentials in non-oil natural resources, as well as the dynamics of the mining landscape in Nigeria becomes expedient.

Nigeria has about 44 different types of non-oil mineral resources including gold, copper, iron-ore, limestone, bitumen, lignite, coal, lead/zinc, gypsum, kaolin, sapphire, granite, laterite, sand, and clay in abundance across the 36 States of the country and the Federal Capital Territory. In spite of all these deposits, the contribution of the solid mineral sector to overall GDP remains abysmally low and lags behind the figures for major African peers such as Guinea, Botswana, Democratic Republic of Congo (DRC), Ghana, Cote D'Ivoire and South Africa.

The annual Nigeria Extractive Industries Transparency Initiative ("NEITI") Solid Minerals Audit Report put total revenue from the sector in 2013 at N33.86 billion, and in 2014 at N55.82 billion accounting for just 0.11 percent of GDP. In 2015, a marginal growth was recorded in solid minerals mining with accrued revenue hitting N69.2 billion and amounting to 0.33 percent

contribution to GDP. However, figures published by the National Bureau of Statistics ("NBS") showed that the minerals and mining sector contributed 0.55 percent to Nigeria's GDP in 2016 while the corresponding figures were 40 percent, 25 percent and 18 percent respectively for Botswana, DRC and South Africa for the same period. Currently, solid minerals sector contributes averagely about 0.5 percent to GDP, accounts for about 0.3 percent of national employment and 0.02 percent of exports. This contribution is a reversal of historically higher percentages of up to 5 percent in the 1960s–70s, when the economy was largely sustained by agriculture and exploration of solid minerals.

For the solid mineral industry to be relevant in future and sustainably support positive economic growth of the country, then nanotechnology should be adopted. The importance of nanotechnology in the improvement of the Solid Mineral Production in Nigeria in addition to the already enlisted general applications include:

1. Creation of new nano-particles/materials from the already existing minerals which has economic values.
2. Expansion of the usefulness of certain mineral deposits thereby increasing their economic values. Like the beneficiation of silica to get HPA (High Purity Alumina) usable in LED and smart electronics components.
3. The potentials of establishing iron nanomaterials industry in Nigeria exist as Nigeria has numerous iron ore deposits.
4. Enhances the achievement of eco-friendly mining as there is possibility of recovery of abandoned mines where the precipitates are used for the production of nanoparticles.
5. Mineral process and value chain addition governed by Nanotechnology.
6. Maximizing the potentials of the mineral elements.

4.0 Conclusion

From the foregoing, it is apparent that the dynamics of the world has driven every mind to continuously seek for knowledge to understand and solve the emerging and increasing needs of life. Thus, necessitating the quest for nations coming together to re-evaluate, identify and design strategies for immediate palliative solutions that can evolve over time to stabilize and grow the economy to meet life's needs, which is the main reason we are here today.

This paper therefore concludes that the advancement in Nanotechnology is the future that is here with us and should be adopted, embraced and pursued with every enthusiasm to ensure a sustainable growth in our solid mineral industry and the Nigeria economy at large.

5.0 Recommendations

From the conclusion which supported the application of nanotechnology, the following recommendations were necessary:

1. The Ministry of Solid Minerals to partner with available nanotechnology centres (like the NASENI Centre of Excellence in Nanotechnology and Advanced Materials) in preparing their staff for acquiring the knowledge and total embrace of nanotechnology to ensure improved products to support the nation's economy.
2. There should be inclusion of the adoption of Nanotechnology in the research and development projects of the nation.
3. Considering that nanotechnology is capital intensive, funds should be made available to procure the necessary equipment for the research and development in this area.

4. The new Nigerian mineral value chain policy should discourage the exportation of primary / unprocessed minerals as the nanotechnology application processes them to provide more value and opportunities of producing nanoparticles/materials which today are in high demand for production of smart products be it in electronics, health, communication/ICT, etc.

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Chapter 26

The Role of Nomadic Education to Attaining SDG-4 in Nigeria: Reality, Challenges and Way-Forward

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Abstract

In Nigeria, nomads are groups of people who seasonally move from one place to another in search of means of livelihood. These groups of people, particularly the pastoral Fulani nomads, do not have permanent settlement; rather they wander from one location to the other in search of good pasture and water for their animals. Due to their means of livelihood, the literacy rate among pastoralist nomads stood at 0.02 percent while that of migrant fishermen stood at 2 percent. This gave birth to the implementation of National Commission for Nomadic Education (NCNE) whose main aim is to cater for the educational needs of the Nigerian nomads as well as to provide equal educational opportunities to all Nigerians. Despite the establishment of NCNE and its expectations, nomadic education in Nigeria still suffers from multi-dimensional obstacles which include defective policies which have not been able to translate the objectives of the programme in to tangible realities. This paper therefore highlighted that, despite the huge fund invested on Nomadic Education Programme, the realities of attaining quality nomadic education remains low. This means that providing education to nomadic communities is still one of the major challenging issues currently facing education in Nigeria and thus the realization of SDG goal 4 looks unachievable. This paper discusses some challenges nomads face in participating in nomadic education and constructive way-forward were suggested.

Keywords: Literacy, Nomads, Nomadic Education, Sustainable Development

Introduction

In Nigeria, nomads are groups of people who seasonally move from one place to another in search of means of livelihood. These groups of people, particularly the pastoral Fulani nomads, do not have permanent settlement; rather they wander from one location to the other in search of good pasture and water for their animals. There are two major categories of nomads, namely the pastoralists and the migrant fishermen (Maxwell, Iroegbu & Onyenso, 2018). The pastoral category whose population is estimated at about 6.5 million is made up of the Fulani (5.3 million), the Koyam (32,000), the Badawi (20,000) and the Dark Buzzu (15,000) while the rest of the pastoralists are found mainly around Borno Plains and the shores of Lake Chad (National Commission for Nomadic Education, 2019). On the other hand, the migrant fishermen are mainly found in the Atlantic coastline, the riverine, and the river basin areas of the country (Bashar & Sifawa, 2020). Due to their means of livelihood, the literacy rate among pastoralist nomads stood at 0.02 percent while that of migrant fishermen stood at 2 percent (Bashar & Sifawa, 2020; National Commission for Nomadic Education, 2019). This simply implies that the two categories of nomads in Nigeria are educationally disadvantaged. These nomads, even though they are in disadvantaged group, they also contribute meaningfully in national

development through food security, meat, milk and leather production. To get them educated for national security, food availability, nomadic education was introduced.

The Federal Government of Nigeria's National Policy on Education (2013) defined nomadic education as the first six years of Basic Education provided to the disadvantaged nomadic population in the country which include the pastoralists, the migrant fishermen, and the migrant farmers. Nomadic Education Programme in Nigeria commenced officially in 1986 after the Yola National Workshop on Nomadic Education which held on 4th November, 1986. Saidu, Abudu, Odebode and Jejayinfa (2017) stated that the Yola National Workshop on Nomadic Education was a turning point in the development of nomadic education in Nigeria. According to them, the workshop was followed by an active mobilization and enlightenment campaigns for nomadic education in the country. Furthermore, the workshop formed the basis for development of the blueprint on nomadic education which was published in 1989. In order to enhance proper implementation of the programme, the National Commission for Nomadic Education (NCNE) was established by Decree 41 of December 12th, 1989 to cater for the educational needs of Nigerian nomads (Saidu, Abudu, Odebode & Jejayinfa, 2017).

The National Commission for Nomadic Education (NCNE, 2019) further outlined the general objectives of the nomadic education programme in Nigeria to include: "exposing the nomads to the elementary forms of modern education; enabling the nomads take part in the development of their immediate environment, in particular, and society in general; making the nomads self-reliant in improving their living conditions, thus, eliminating the hardships and constraints in their lives; helping them modernize their techniques of herdsman ship on animal management, fishing or farming as the case may be; assisting the nomads develop rapidly and fully, both physically and intellectually, to cope with the demands of the contemporary world; and developing the initiative of the nomads and stimulate in their scientific and analytical modes of thinking" (P. 1).

To achieve the goals of nomadic education in the country, Shagari, Bello and Umar (2013) affirmed that Nomadic Education in Nigeria has been provided to its targeted beneficiaries through different dimensional learning approaches. These include regular school system, on-site school system, mobile school system, adult education programmes, and distance education programmes. The regular school system is an approach that is used in educating the nomads that have a proper settlement unlike other learning approaches (Bashar & Sifawa, 2020).

With the unrealistic learning approaches, nomadic education is faced with numerous challenges that affect its proper conduct and implementation across the country. According to Iro (n.d.), this programme is affected by many problems which hitherto include defective policy, inadequate finance, inadequate learning centres, poor instructional materials, faulty school placement, incessant migration of learners, unreliable and obsolete data, cultural and religious taboos. However, Aliyu (2014) asserted that some nomadic learners attending schools lacks the relevant teaching and learning materials; and in schools where such materials exist, educators do not make adequate use of them. In view of these problems, it becomes necessary to respond to these problems in order to reduce or proffer solution to the problems affecting this group of people especially the Nomadic populace that are found almost in every corner Nigeria today. Addressing these problems makes the realization of sustainable development goals achievable in the nearby future.

Overview of Nomadic Education in Nigeria

In line with the resolution of the federal government of Nigeria to start the nomadic education programme, the Federal Ministry of Education published blueprint on nomadic education in December 1987 after Federal Government had formally launched the programme in Yola, the State capital of then Gongola state. The ministry of education distributed the blueprint to all state ministries of education in the country. Section C of the blueprint highlighted the aims and objectives on Nomadic education as follows:

- i. inculcation of the National consciousness and National unity;
- ii. the inculcation of the right type of values and attitudes for the survival of the individual and the Nigerian society;
- iii. the training of the mind in the understanding of the world around him, (training in scientific and critical thinking); and
- iv. the acquisition of appropriate skills, abilities, and competence, both mental, social and physical, as equipment for the individual to live in his society and to contribute to its development (NCNE, 2017).

In ensuring a successful implementation, provision was made for the setting up of two bodies. Firstly, the National Commission on Nomadic Education (NCNE, 2008) which was empowered with the implementation of the programme nationwide. The commission was made up of 25 members, one of which is the chairman appointed by the president on the recommendation of the Honourable Minister of Education. The second body is the Center for Nomadic Education which was expected to conduct researches on the culture of the nomads, to develop and select curriculum contents for training in Nomadic Education Programme (Aminu, 2014).

The Nomadic Education Programme started officially in November 1986, after the Yola National Workshop on Nomadic Education. The workshop revealed that "... the nomads needed a fair deal through the provision of education and other social amenities to reciprocate their contribution to nation building..." the National Commission for Nomadic Education (NCNE) began to function in January 1990, with 206 centres, 1,500 learners and 499 educators (Abdulrahman, 2016). Ninety-seven of the centres had permanent buildings, while the rest of the centres operated in temporary structures or under the trees. Some schools had furniture; others used mats. The school taught a modified curricular in English, arithmetic, social studies and primary science, developed by the Usmanu Danfodiyo University, Sokoto (Abdulrahman, 2016). To adapt to the work rhythms, nomadic school runs morning and afternoon shifts and learners rotate between herding and schooling (Iro, 2009).

It is with this conviction, the Federal Government via decree 1989 established a National Commission for Nomadic Education (NCNE) to cater for the education of pastoralist and migrant fishermen who were hitherto deprived the access to education. In pursuit of the roles for the provision of basic education to the nomads, the National Commission for Nomadic Education evolved the following strategies in the country

- i. The provision of primary education to nomads by establishment of primary schools with teaching and instructive materials,
- ii. Provision of primary education to the children of the migrant fishermen and provision of instructional materials,
- iii. Provision of adult education and extension service by organizing adult literacy classes for nomadic adult and youths.

- iv. Provision of grants to states, local government and even nomadic communities that started activities and programmes that have direct bearing to the programme in their localities (NCNE, 2019).

Nomadic education programmes are gradually employed by the three tiers of government, thus the establishment of centres all over the country since 1989. As at 1999, there are a total of 1,356 nomadic centres among which 304 are for migrant fishermen children. Similarly, number of participating states is 35 and Abuja. Already, 20,119 had successfully completed their primary education, among which 10,467 learners gain admission into secondary school nationwide.

Sustainable Development Goal 4 and Nomadic Education in Nigeria

The SDG 4-Education 2030 Agenda aims at ensuring inclusive and equitable quality education and to promote lifelong learning opportunities for all. The new agenda represents a paradigm shift in thinking by recognising the underlying and dynamic interlinkages between the three dimensions (social, economic and environmental), driving universal and integrated development across all countries, and promotion of inclusivity, equity, quality and lifelong learning in education. This agenda presents national and international education stakeholders with two critical measurement challenges: learning outcomes and educational equality, broadly conceptualised. In both cases, the challenges are to be addressed through a universal agenda with indicators that are relevant to all countries. The targets look at learning throughout the life-cycle, from early childhood to adulthood. They also go beyond traditional areas of measurement, such as reading and mathematics to reflect a comprehensive and integrated view of the skills needed in relation to society and the environment (UNESCO Institute for Statistics, 2016).

The education goal (SDG 4) is made up of ten targets, including three means of implementation which focuses on how to achieve the outcomes described in the targets. It aims to “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all”. Progress in education is also linked to the achievement of other SDGs. Higher levels of educational attainment have been directly or indirectly associated with individual outcomes such as better livelihoods, healthier behaviours, greater environmental awareness and increased civic participation as well as positive social outcomes, such as economic growth, security and increased social cohesion (Wagner & Castillo, 2014).

A number of actions by both national and international stakeholders are needed to address the risks associated with implementing the indicator frameworks to monitor SDG 4. These include the need to: ensure data quality standards and develop new measurement methodologies; coordinate the new players at the national and international levels; and mobilize sufficient resources (UNESCO Institute for Statistics, 2016).

A need for data quality standards and developing new measurement methodologies:

Statistical standards are central to education statistical systems and directly affect the quality of the data over time and across countries. Statistical standards consist of definitions, concepts, classification systems and methodologies. They are developed to ensure harmonisation and improved comparability of official statistics, whether within a country or across countries. In overall, these standards can serve as guidelines that enable countries to standardise how data are collected and statistics are produced and disseminated. New data sources will be required and existing ones will need to be assessed, extended, improved and integrated with other data sources.

A need for coordination: The challenges associated with the new SDG agenda are markedly greater compared to those of the MDGs. There are many more indicators, many more actors—

both nationally and internationally—and a much wider range of data sources to be used. In order to ensure that efforts are not duplicated but well-targeted and focused, good coordination is needed between organizations and within countries. At the national level, there must also be good coordination between ministries and national statistical offices. In particular, line ministries (such as education, health and agriculture) that may have responsibilities for data collection will need to work closely with national statistical offices to ensure coherence in data collection and reporting across the whole SDG agenda.

A need to mobilize sufficient resources: High-quality statistics are essential for effective education planning and the cost of unreliable or missing data can lead to poorly-informed decisions, misguided policies and a waste of already scarce resources. Without reliable data, the cost of being in a position not to be able to assess whether policies are successful or not and whether the situation is improving can be very inefficient

However, five of the ten SDG-4 education targets focus on the learning outcomes of young children, youths and adults. This is a shift from previous global education targets, such as those in the MDGs, which focused solely on ensuring access, participation and completion in formal primary education and on gender equality in primary, secondary and tertiary education. The Education 2030 targets underscore the extent to which enrolment and participation are the best means to attain good results and learning outcomes at every age and stage, such as learning readiness for young learners; academic competencies for learners in primary and secondary education; functional literacy and numeracy skills; and skills for work, global citizenship and sustainable development for youth and adults. The framework proposes indicators that enable the measurement and comparison of learning outcomes at all levels of education.

Following the statistics that nomads in Nigeria have low literacy level of 0.2% - 2.0%, one could suggest that major constraints to their participation in formal and non-formal education are: i) their constant migrations/ movements in search of water and pasture in the case of pastoralists; and fish in the case of migrant fishermen; ii) the centrality of child labour in the production system, thus making it extremely difficult to allow their children to participate fully in formal schooling; iii) the irrelevance of the school curriculum which is tailored to meet the needs of sedentary groups but however, ignores the functional needs of nomadic people; iv) their physical isolation since they operate in largely inaccessible physical environments; and v) land tenure system that makes it difficult for nomads to acquire land and settle in one place (Ibanga, 2016)

The Federal Government realized that unless a special educational provision is made for the nomads, they would have no access to formal and non-formal education. Thus, in consonance with provisions of the 1979 Constitution and the National Policy on Education, which strongly urge the federal government to provide equal educational opportunities to all Nigerians: and in order to ensure that nomads have an unfettered access to basic education, the Federal Government established the National Commission for Nomadic Education (NCNE) by decree No. 41 of December 1989. The NCNE is charged with the responsibility of implementing the Nomadic Education Programme (NCNE, 2010).

The scope of nomadic education implies specific features of contents of any training programme for nomads. Aminu (2014) gave specific benefits nomads could acquire as a result of training and education. These are outlined here under the scope of nomadic education.

- 1) Education for land acquisition and improvement
- 2) Education for Human and Animal health improvement
- 3) Education for Livestock Breeding improvement

- 4) Education for Commercialization of Animal products
- 5) Education for effective participation in Development.

Despite the establishment of NCNE and its expectations, Bashar and Sifawa (2020) reiterated that nomadic education in Nigeria still suffers from multi-dimensional obstacles which include defective policies which have not been able to translate the objectives of the programme into tangible realities. Poor planning also affects the programme and this implies the inability of the system to incorporate the nomads directly in planning the programme effectively and this resulted in to programme's inability to address the salient needs and aspirations of the target nomads. The next challenge is that of instability of the nomads due to their mobile nature which consequently affects the proper monitoring and planning of both educators and learners of the programme. Other problems include inaccurate data for planning, improper locations of the centres as well as inadequate facilities of logistic supports. This could mean that providing education to nomadic communities is still one of the most challenging issues currently facing education in Nigeria and the realization of SDG goal 4 which is all about providing equal quality education and promoting lifelong opportunities for all.

Assessing the Realities of Quality Nomadic Education in Nigeria

The nomadic education has a multifaceted schooling arrangement to suit the diverse trans-human habits of the Fulanis. Different agencies are involved in the educational process. These agencies include the Ministry of Education, Schools Management Board, and the National Commission for Nomadic Education, the agency for mass literacy, and the Scholarship Board. They work together to offer a mobile school system where the centres and the educators move with the Fulani learners (Aminu, 2014). The approaches to Nomadic education in Nigeria are:

- i. The provision of primary education to Nomadic Children by establishment of Nomadic Primary Schools with teachers and instructional materials.
- ii. Provision of Primary Education to the children of the Migrant Fishermen.
- iii. The provision of adult Education and Extension services by organizing adult literacy for Nomadic adults and youths.
- iv. Provision of grants to States, Local Governments and even nomadic communities that started activities and programmes that have direct bearing to the education of the community. (NCNE, 2008: p88)

In achieving these approaches to Nomadic Education, it indicates that government must have spent funds. Saidu, Abudu, Odebode and Jejayinfa, (2017) remarked that although the government has spent millions of naira in Nomadic Education Programme, the realities of attaining quality nomadic education remains low. The quality of education among them is mediocre at best. The nomadic education is, therefore, yet to fit the literacy and standard of living of the nomads. Many nomads are yet to taking advantage of the educational facilities provided by the government (Na'Allah, 2010). In Plateau state for example, only six of the 100 learners in the Mozat-Ropp nomadic schools are Fulani (Aminu, 2014). Nomadic education in Nigeria is affected by defective policy, inadequate finance, and faulty school placement, incessant migration of learners, unreliable and obsolete data, cultural and religious taboos. While some of these problems are solved by policy and infrastructure interventions, most of the problems are complex and difficult to handle. The persistence of these problems causes the roaming nomads to remain educationally backward (Aminu, 2014).

Nomads' Challenges to participating in Literacy Education in Nigeria

The success as recorded in nomadic education in Nigeria has been said to be impressive. However, this scheme and every other strategy put up by the National Commission for Nomadic (NCNE) are not without their inherent challenges which underscore the purpose of the discussion here. Scholars such as Aminu (2014) and Ekwe (2012) in this field are in agreement that there are many problems confronting nomadic education. They include:

The cultural and religious belief of the nomads: The nomads, like any other groups in the world have their own culture and religion which either retard or encourage them to participate in formal education. Unfortunately, several literatures have shown that nomadic culture and religion in Africa rather discourage their participation in formal education (Aminu, 2014). The culture of nomads encourages migration in search of greener pasture for their cattle and herds. Most of the nomads are pastoralists and as such, pastoral production does not allow the nomads to settle in a place for a very long time but to move about to where grasses are greener. It makes it rather difficult for anyone to educate them at ease.

Teacher Quality, Quantity and Retention: The number of teachers/educators in nomadic schools is grossly inadequate. This inadequacy is most glaring if viewed in the context of the poor quality of the teachers i.e., up to 53.4% of teachers in nomadic schools lack the nationally prescribed minimum teaching qualification as at 1998. Added to this is the indiscriminate transfer of teachers from nomadic to conventional schools without replacement by Local Education Authorities and the difficulty of retaining teachers posted to facilitate their work and nomadic schools (Ekwe, 2012).

Inadequate Instructional Materials: There is a general lack of adequate instructional materials particularly pupils' texts, chalkboards and maps in the nomadic school system. Although the commission has completed the development of pupils' texts for all levels of primary schooling, it lacks funds for the mass production of the texts. Similarly, a specially designed functional literacy primer for adults has been developed but could not be produced due to lack of funds. Other instructional materials such as exercise books and drawing books are also in short supply mainly because state and local governments have been unwilling to provide such materials to nomadic schools as required by law. Thus, it is only the NCNE that provides instructional materials to most nomadic primary schools in the states of the federation where they are situated, which unfortunately they cannot adequately or fairly execute to all schools due to its weak revenue base.

Inadequate Funding: The funds released to the commission are very inadequate vis-à-vis the range of tasks it is expected to accomplish. There is a discernible trend of inconsistency in the pattern of funding nomadic education which is at variance with the commission's plans and budgets. It receives less than 30% of its budget request and has been compelled to spread its lean resources too thinly (Aminu, 2014).

Unconducive Political Climate: Nomadic education like every other educational programme requires peace, law and order if it is to be effective. The incessant violent clashes between nomads and farmers are adversely affecting the programme since the nomads find it difficult to participate in it (Ekwe, 2012) which can be attributed to high priority already placed on taking care of their herds than in learning.

Way-Forward

- i. The major driving force behind this initiative was the realization that one of the challenges to nomadic education is cultural and religious barriers as well as lack of community participation due to non – appreciation of the values of western education among the nomads (Abubarkar, 2015). To overcome this, a more aggressive mobilization and sensitization strategy should be adopted using extension services approach with a view to empowering nomadic communities attitudinally, socially and economically in order to appreciate and support the NEP.
- ii. In order to enhance teacher-quality, the commission should organize refresher courses for educators on an annual basis. The courses should aim at raising their knowledge and update their already acquired skills. Similarly, some incentives such as motorcycles and bicycles should be provided to teachers in order to improve teacher retention levels.
- iii. In order to deal with the problem of inadequate instructional materials such as lack of the specially developed pupils' texts and others, the nomadic schools now use the textbooks produced for conventional schools and the adult literacy primers designed for sedentary people. To ensure that states and local governments carry out their responsibilities in the provision of instructional materials, the NCNE persuaded the National Council on Education at its last meeting in March 1999, to compel state governments to make special financial allocation to nomadic education in their annual budgets (Abubarkar, 2015). When this is implemented, there will be overall improvement in the success stories of nomadic education.
- iv. To overcome the problem of inadequate funding, the nomadic communities should be mobilized to contribute materially to the implementation of the programme by setting up schools, building classrooms, providing teaching-learning materials e.t.c through community self-help strategy. This will go a long way in facilitating their development and acceptance in every community they may find themselves. Assistance should also be sought and received from some national and international agencies such as NAFDAC, cultural department, UNICEF and UNESCO in the funding of some activities.
- v. To overcome the problem of political climate, the commission should use radio and television to sensitize the nomads and farmers on the need for peaceful coexistence. It also set up peace committees for conflict resolution and requests community leaders to assist it. It is equally important to educate the nomads on the importance of safeguarding farmlands and crops by establishing cattle ranges and more also, farmers should be thought on how to accommodate the nomads in the spirit of brotherliness

Conclusion

Learning in any society becomes instrumental when there is adequate provision of quality education to all learners regardless of gender, ethnic group, cultural beliefs and religion. Motivating learners in any society to enroll and remain in school hinges on the provision of education adequate in quality that would make them appreciate and relate such education to the realities of life based on their values, beliefs, needs and aspirations. Therefore, relevant bodies such as NEP and NCNE should utilize adequate and relevant strategies to facilitate the expansion of strengthening of access to nomadic education so as to facilitate sustainable development.

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Chapter 27

Determinants of Adoption of Improved Agricultural Technologies among Fadama Rice Farmer Cooperative Societies in Enugu State, Nigeria

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Abstract

This is an attempt to evaluate factors that drive adoption of improved agricultural technologies among cooperative rice farmers who participated in FADAMA programme. The work was motivated by the need to understand the extent of adoption of improved agricultural technologies as well as measured to quicken uptake of agricultural technologies. The objectives of the study were to determine the extent of adoption; evaluate determinants of adoption; determine the effect of cooperatives on the level of adoption as well as hindrances to adoption. The area of the study was Enugu State and 320 rice farmers were randomly selected from 24 agricultural cooperatives. Questionnaire was the instrument of data collection and data were analyzed using one sample test, regression analysis and one-way ANOVA. Findings revealed that cooperative rice farming farmers have significantly adopted improved agricultural technologies. Significant determinants of adoption include literacy level, farm size, and frequency of contact with extension agents, farming experience, availability of success stories and the number of trainings attended. Cooperative membership had significant effect on level of adoption. Moreover, hindrances to adoption included inadequate extension services, literacy, high cost of adoption and type of media used. It therefore, recommended that extension services should be restructured in terms of personnel and mode of delivery, Cooperatives should also be strengthened in order to contribute effectively to technology adoption.

Introduction

The word FADAMA (in Hausa Local Language) means a low-lying area which the National FADAMA Development programme (NFDP) initiated following the recommendations of the World Bank in its report of 1998 titled "Nigeria-Strategy for Agricultural Growth". It identified the development of small-scale irrigation for the production of off-season high value crops in order to increase the productivity, income, living standard and development capacity of the rural

poor in Nigeria. To that effect, the World Bank funded the National FADAMA Development Project I (NFDP-I) which lasted between 1993 -1999, and was implemented in Bauchi, Gombe, Kano, Jigawa, Sokoto, Zamfar, Ebonyi, and Kebbi State etc. FADAMA farming, therefore, implies cultivation of growing of crop under irrigation or in the river flood plain. This implies that is a farming system that operated in the dry sessions. This is because flood plains are inaccessible during the normal farming season.

Technology means all those methods of production which have been developed or could be developed with the existing state of scientific knowledge, Mgbada, (2002). Technology helps us to do those things needed or want to do better. However, using technology that is inappropriate is at best wasteful and at worst harmful to people to people and the environment. It is appropriate for the task, the environment and the people. For instance, there are three levels of technology. The Nigerian farmer is using a sample hoe (low technology). The plough drawn by animals is more productive but still straight forward (intermediate technology). The tractor is highly complex (high technology) but allows one person to cultivate a larger area. Technology is basically a tool to help create development towards certain agreed overall goals. The choice of technology is important in deciding what type of development, and for whom. It is important people, human needs, in the center of the development of any technology.

Agricultural technology can be defined as any behaviour or practice that involves the interaction of individuals within the agricultural production system. From the time farmers decide what to invest in farming until they sell their product, they perform a series of actions that are the product of what they know and what they think is best. Agricultural professionals are also equipped with knowledge that in turn leads them to believe in the effectiveness of particular farm practices or technology. Consequently, those practices and/or behaviour applied by both farmers and agricultural professionals constitute agricultural technologies Asiabaka (2002). Agricultural technologies include both components (seeds, fertilizers, pesticides and machinery) and the process, that is, element needed by the producer. The later include information on the component and the management and the technical know-how to use the components and its adoption.

Farmers are the ultimate users of the modern or improved agricultural technologies developed through research. Many workers have defined technology transfer in different ways to suit their purpose.

Adoption is a decision made by an individual or group to use an innovation in a continuous manner. Adoption is regarded by Roggers (1995) as a decision to make full use of an innovation or technology as the best course of action available. According to Van den Ban and Hawkins (1996), adoption of innovation is the decision of individual or group to use or apply an innovation.

In Nigeria, a number of institutional and government organs were established to ensure that farmers get to know and adopt agricultural innovations relevant to their situations. These bodies disseminate or facilitate dissemination of agricultural innovation through different methods.

The transfer of information could be done by the use of information media. Such information media include newsletter, radio/television, programme, extension publications/bulletins, field days, field trips, giggles, posters, and leaflets, agricultural how and exhibition. The research is developing appropriate and adoptable technologies and transforming such technology to the farmers. According to Unamma et al (2004), the job of research is to develop technologies and improve their worth to a relatively small number of farmers, using various combinations of upstream and downstream research. The extension service and/or any other similar organization complement this role of research through diffusion of the innovation to as many farmers as

practicable, using appropriate strategies. Consequently, the extension service is responsible for informing, advising and teaching large number of farmers and other input agencies in a timely fashion.

This role of Agricultural Extension has been orchestrated and recognized as crucial to the overall development of agriculture in the country.

Since the inception of Enugu Agricultural Development Programme (AGD), one of its major responsibilities is the dissemination of information on improved modern technologies to the rural farmers in the three agricultural zones namely: Enugu East, Enugu West and Enugu North.

According to Umehali (2004), cooperative organization can be defined as a group of persons who have pooled themselves and their resources on self-help, mutual equitable and democratic basis to form a business enterprise, which seeks to solve the socio-economic problem(s) of its members. This is by directly providing them with good and services in their double capacity as either owners/customers or owner/workers of the cooperative enterprise. It is better to deal with farmers in group (cooperative) than individual basis, hence the need for farmers in rural areas to join or form cooperatives.

Statement of the Problem

A large percentage of small-scale farmers and farmers cooperatives have not progressed beyond. The hoe and cutlass, low inputs agriculture Isife and Madukwe, (2005: Nnadi and Akwikwu (2005). According to Fikru (2009), most farmers are poor and operate at subsistence level and investment for intensification of agriculture is not well developed in the country. This has created a vicious circle of low productivity in agricultural production. Land degradation reduces the production of potential of the land and this in turn makes it difficult for farmers to produce enough and invest in protecting the land.

Agricultural production in developing countries further faces some hindrances and challenges such as poor agricultural practice, inefficiencies in information delivery records, maintenances between farmers and traders, and lack of information on the use of best agricultural practices among farmers Abdul, (2013). The major media system that has a lot to contribute to information dissemination in Nigeria are radio, television and print media, radio being the fastest among them (Egbule and Njoku, 2018). The media system in many States in Nigeria are highly centralized and clustered in urban areas. Consequently, very little of the needed information and reaches rural communities, where more of the population live and actual farming takes place. They went further to identify the problems of wide spread illiteracy. Majority of the farmers cannot read, write and understand the information at their disposal. Most often the few agricultural programmes are not timed to suit farmers. Consequently, most farmers are constrained to rely on the parties for agricultural information which may be biased.

According to Adejare and Arimi (2013) these problems resulted into food insecurity which led various researchers into the development of technologies aimed at increasing food production to meet the needs of the people and improve their living standard. According to Kassal (2000) and Onyemade (2003), technology is used to improve human condition, the natural environment or to carry out their socio-economic activities. Agricultural technology includes, tools, equipment, agro-chemical, management skills and other process that farmers need to increase production of food. Cooperatives provide better platform for farmers to adopt new agricultural innovations. Since they are in group extension agents can easily reach them than individually.

To adopt and successfully use improved technologies, rural farmers and farmer's cooperatives must understand them, and this required effective teaching by agricultural

technologies evolved from research, the productivity of farmers in the agricultural zones in South-Eastern States is still on the decline Ohajianya and Onu (2005). This decline is due to the nature of its production and problems underlying its improvement Adejare and Arinri (2013).

According to Onu (2005), the unavailability or inadequacy of extension message has often been blamed on the poor performance of extension services. The Agricultural Development Program (ADP) since its inception, had been disseminating useful agricultural information to farmers, yet farmers still practice at subsistence levels. In most cases farmers depend on the local knowledge system for production despite the breakthrough by research. Ditto (2007) asserted that there are nuclear signals to whether the FADAMA and rain-fed rice farmers are making efficient use and management of available farm resources.

Since the new millennium, attention of government has shifted to food security with emphasis on commercial farming driven by innovations and modern technologies. Farmers were asked to form cooperatives in order to access different intervention packages and aids rolled out by the government, development partners and donor agencies. FADAMA programme existed to improve farm output through mitigating the constraints facing improved productivity and increased output.

Many extension agents have been released to field and a number of new technologies have been introduced to farmers. Appreciable level of awareness has been created both at community and macro level by cooperatives, FADAMA office and other government agencies. Rice farming has been critical aspect of Nigerian agricultural revolution. Efforts are made at both federal and State government levels to increase rice production as a means of reducing the country's over dependence on foreign rice importation. Apart from the provision of funding and technical assistance to farmers, FADAMA facilitates transfer of technologies. A number of farmers formed and joined agricultural cooperatives in a bid to benefit from these intervention programmes and also due profitability of rice farming

In recent times, attention has shifted from creating awareness about these agricultural technologies to adoption of these technologies. With regards to spacing, varieties, line planting, fertilizer application and limitation, many cooperative rice farmers are not only aware but have also tried using these technologies. However, the extent to which these technologies are adopted is largely undetermined.

Although many studies have been conducted on agricultural technologies adoption, majority of those studies were not on rice farming. To the best of the researchers' knowledge, there is limited evidence that a study on extent of adoption of agricultural technology among rice farmers has been conducted in Enugu State.

In order to encourage uptake of these technologies and achieve food security objective of the country, there is the need to understand the extent of adoption of these agricultural technologies, factors that influence their adoption, as well as roles cooperatives play in the process. This understanding will enable policy makers and analysis to streamline their effort and develop measures to encourage adoption that are effective, efficient and reliable. This study is, therefore, designed not only to determine the extent of adoption of improved agricultural technologies among cooperative rice farmers and factors that influence them but also to examine the significance of agricultural cooperative in the adoption drive.

Objectives of the study

The broad objective of this study is to analyze the determinants of adoption of improved agricultural technologies among FADAMA rice farmers' cooperatives in Enugu State. The specific objectives include to:

1. determine adoption the level of selected improved agricultural technologies among rice farmers in Enugu State.
2. examine the factors that influence adoption of improved agricultural technologies among Enugu State rice farmers.
3. ascertain the effect of Socio-economic characteristics of FADAMA rice farmer's cooperative members on adoption level of improved agricultural technologies among FADAMA rice farmers in Enugu state.
4. identify constraints to adoption of improved technologies by FADAMA rice farmers in Enugu State.

Research hypothesis

H₀₁: FADAMA cooperative rice farmers in Enugu State have not significantly adopted improved agricultural technologies.

H₀₂: Farmer specific and institutional factors do not have significant influence on adoption level of agricultural technologies among FADAMA rice farmers in Enugu State.

H₀₃: Socio-economic characteristic of FADAMA rice farmer's cooperative members do not have significant effect on adoption level of agricultural technologies among FADAMA rice farmers in Enugu State.

H₀₄: Inadequate extension services, cost of adoption, market value of rice, and illiteracy are not significant hindrances to adoption of improved agricultural technologies among FADAMA rice farmers in Enugu State.

Empirical Review

The empirical works that were carried out by different authors from different places was reviewed. Akinnola et al (2011) in their study on determinates of adoption of balanced nutrient management systems technologies in the Northern

Guinea Savana of Nigeria: The project on balanced nutrient management systems (BNMS) has been implemented in the northern Guinea savanna (BGS) of Nigeria since 2000 in order to address soil fertility decline. The project has tested and promoted two major technology packages, a combined application of inorganic fertilizer and manure (BNMS – manure) and soybean/maize rotation practice BNMS-rotation). The study used a multi nominallogist model to examine factors that influence the adoption of BNMS technologies. The result indicated that factors such as farmer's perception of the State of land degradation, and extension services were found significant in determining farmer's adoption decision. As farmers got more perception of the State of their degradation and depletion, the rate of BNMS-manure increased by more than five times, while that of BNMS-rotation was quadruple. In another study by Asibaka and Michelle (2002) on determinants of adoptive behaviour of rural farmers in Nigeria; the major

objective was to assess the effect of information source and the attributes of technology on the adoptive behaviour of rural farmers in Nigeria. It assessed the perception of rural farmers on the availability, credibility and degree of use of information source. The variable tested in technology attributes were complexity, availability and cost and compatibility. Data were collected from 480 farmers from southern eastern Nigeria. Findings indicated that farmer's socio-economic characteristics such as age and education influenced their adoption behaviour.

Also, sources of information were a significant factor in determining farmer's adoption behaviour. Variable such as credibility, availability, interest and usefulness of the information source had positive coefficient and were found to be statistically significant at 0.05 level. Findings also show that technology attributes such as complexity, cost and availability and compatibility were positive and statistically significant 0.05 and 0.01 level.

Bonabana – Webbi (2012) analyzed the socio-economic factors influencing adoption of improved gum Arabic seedlings among farmers in the Sahehan Zone of Borno State. The study analyzed the socio-economic factors influencing adoption of improved gum Arabic seedlings among farmers in the Shedhan Zone, Borno State, Nigeria. The data for the study were mainly generated from farming household through the use of structured and pretested interview schedules. Multi-stage, purposive and random sampling techniques were employed to select 321 representatives of farming households that were used for this study. Both descriptive (frequencies, means and percentages) and inferential (logit regression) statistics were used to analyze the data collected for this study. The result shows that cost of the respondents had farmer's cooperative as their source of gum Arabic seedlings and analysis shows that socio-economic characteristics had influence on the adoption of improved d gum Arabic seedling farmers.

Furthermore, Akinwumi and Jojo (1995) in their study on farmer's perceptions and adoption of new agricultural technology evidence from analysis in Burkina Faso and Guinea, West Africa. This paper tested the hypothesis that farmer's perceptions of technology characteristics significantly affected the adoption decisions. The analysis conducted with Tobit models of modern sorghum and rice varieties technologies in Burkina Faso and Guinea, respectively, strongly supported this hypothesis. The study showed that farmer's perception of technology characteristics significantly affects their adoption decision.

Research Methodology

Area of Study:

The study area for research, Enugu State was created in 1991. Enugu State is situated within the highlands of Awgu, Udi and Nsukka hills and the rolling lowlands of Ebonyi River Basin in the west [ENADEP Report 2008]. The state is bounded in the south by Abia State, Ebonyi State to the east, Benue State to the North West and Anambra to the West. It has entirely within the tropical zone, precisely between latitude 060.00 and 070 .50N and longitude 060.52 and 080.30E [ENADEP Report, 2008]

Enugu state is made of seventeen [17] Local Government areas namely; Enugu North, Enugu South, Udi Ezeagu, Nkanu East, Nkanu West, Isi-uzo, Uzo-Uwani, Igbo-eze North, Igbo-Eze South Nsukka, Udenu and others. The state is also sub-grouped into zones both for agricultural administrative purposes.

These are Enugu East, Enugu west and Enugu North. The settlement structure is still rural with over seventy percent [70%] of the people living in rural areas [ENSGN, 2007]. The people are predominantly farmers as an average family engaged in the production of food crops like

yam, cassava, cocoyam, rice and maize, and livestock like sheep, goat poultry and pig. Cash crops cultivated include palm produce etc. The state is culturally homogenous predominantly, inhabited by the Ibo ethnic group of Nigeria where Igbo language is spoken with minimal differences in dialects. The people are predominantly Christian and English language is the official language.

Population of the Study

Population of the study is made up of all rice farmers’ cooperative societies in Enugu State that participated in FADAMA project. Enugu State is made up of three agricultural zones namely Enugu East, Enugu West and Enugu North. All the local governments that are involved in FADAMA rice production were used for the study. According to State Department of Cooperative, there are 323 registered cooperative societies that participated in FADAMA programme, out of which 48 were into rice farming. These 48 FADAMA rice farmers cooperative with membership strength of 964 constituted the population of the study.

Sample Size Determination and Sampling Procedure

The selection of the sample for the study involved multi- stage random sampling technique which involved three stages. The first Stage involves a purposive selection of two L.G.As that are predominantly rural and agrarian from each of the three agricultural zones in Enugu State. Second stage involved random selection of cooperatives in the selected Local Government Area that participated in FADAMA programme. The third stage involved selecting the cooperative societies that were into rice farming. Therefore, a total of 331 members were selected from 24 rice farmers’ cooperatives who participated in FADAMA programme as sample size.

Table 1 Population of cooperatives in the area of study and selection of sample

Agricultural Zone	No. of functional cooperative	No. of cooperatives in FADAMA	No. of cooperative into rice farming	Membership strength
Enugu East				
Nkanu East	76	21	5	71
Nkanu West	81	24	4	62
Enugu West				
Ani Nri	61	17	3	46
Oji Riverl	81	14	4	52
Enugu North				
Ezeagu	52	20	5	59
uzo uwani	45	17	3	41
Total	364	113	24	331

Field survey, 2017

Instrument for Data Collection

Information obtained were with respect to socio-economic characteristics of the farmers such as age, gender, education farm size, household size, location, membership of cooperative and farm experience. Other information obtained including their relationship and involvement with cooperatives.

Section B of the questionnaire focused on level of adoption of improved technology, factors that influence adoption, contributions of cooperative to adoption and hindrances to adoption. A

point rating scale was employed to capture the extent of agreement and disagreement. Out of the 331 copies of questionnaire distributed, 320 were returned. The respondents were requested to express their opinion by ticking (√) on a five-point likert scale as shown.

SA-	Strongly Agree	5 points
A-	Agree	4points
U-	Undecided	3points
D-	Disagree	2points
SD-	Strongly Disagree	1 point

The levels of agreement or disagreement (High/low) on questions asked were compared to the mean rating threshold of 3.0. Any item in the instrument which has a mean equal to higher than 3.0 was regarded as agree/high, while any item with less than 3.0 was regarded as disagree/low

Method of Data Analysis

Both descriptive and inferential statistics were employed in achieving the objectives of the study. Frequency distribution, percentages and mean score rating were used to achieve objectives one, three and four. A mean score of 3.00 and above was considered significant while less than 3.00 were considered not significant. Hypotheses one, two and four were tested using sample test, one-way ANOVA and sample t-test respectively. Hypotheses three was analyzed using regression equation, while t-test were used to test whether to accept or reject the hypothesis at 5% level of significance.

Model Specification

Hypothesis three which measured the effect of cooperative on adoption of improved agricultural technologies was tested using regression equation. The three (3) functional forms used for the analysis include, liner, semi-log and double log.

1. The linear form is given by

$Y = f(x_1x_2x_3x_4x_5 + \dots \dots \dots \text{ie})$ implicit

$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + \dots \dots \dots \text{ie})$ explicit

2. The semi-log form

$Y = b_0 + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 \dots \dots \dots \text{ie})$

3. The double log form

$\text{Log } y = b_0 + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 \dots \dots \dots + e_i$

Y level of adoption of technologies measured by number of technologies adopted by the farmer cooperative societies.

A = Constant

$B_1 = B_n$ = regression coefficient to be estimated

X_1 – Sex (no)

- X₂ – Age (years)
- X₃ – Level of education (no of years spent in school)
- X₄ – Farm size (ha)
- X₅ – Annual farm income (₦)
- X₆ – Extension contact (no of visit)
- X₇ – Duration in cooperative
- X₈ – Volume of output

The model of best fit was the linear model so it was chosen based on statistical and econometric criteria such as the number of significant variables the signs of the number of the regression coefficient as they conform to apriori expectations and the magnitude of the coefficient of multiple determinations R₂

Table 2 socio-economic characteristics of the FADAMA rice farmers studied

No.	Variables	frequency	Percentage (%)
1.	Sex of the respondents		
	Male	135	42
	Female	185	58
	Total	320	100
2.	Age of the respondents	Less than	
	25	36	11
	26-40	84	26
	41-65	148	46
	Above 65	52	16
	Total	320	100
3.	Marital status		
	Single	70	22
	Married	161	50
	Widowed/divorced	89	28
	Total	320	100
4.	Farm size		
	Less than 1 hectare	135	42
	3 hectare	146	46
	Above 3 hectare	39	12
	Total	320	100
5.	Education qualification		
	No formal education	25	8
	Primary	123	38
	Secondary	143	45
	Tertiary	29	9
	Total	320	100
6.	Household size		

	1-3	32	10	
	4-6	73	23	
	7-9	130	41	
	10-12	63	19	
	Above 12	22	7	
	Total	320	100	
7.	Years of cooperative membership			
	0-5 Years	74	23	
	6-10 Years	146	46	
	11-15 Years	53	17	
	16-20 Years	40	12	
	Above 21 Years	7	2	
	Total	320	100	
8.	Output			
	Less than 1ton	28	8	
	1-3tons	142	44	
	4-10tons	130	41	
	Above 10tons	20	7	
	Total	320	100.00	
9.	Annual income			
	Less than 1ton	31	10	
	500,001-1 million	120	38	
	1m-3million	146	46	
	Above 3million	23	6	100
	Total	320		

Source: *Field survey, 2017*

Table 3 revealed the socio-economic profile of the members of rice farmers cooperatives studied. Majority of them were females (58%) and between the ages 41-65. Thirty seven percent of them were less than forty years while only sixteen percent were above sixty-five years. A large percentage of the farmers cultivated on between 1-3 hectares of land. Only twelve percent exceeded this threshold, while 42% were smallholder farmers cultivating on less than one hectare of land.

Majority of the respondents were literate with 92% of formal schooling interestingly, 54% attempted secondary and tertiary education, whereas only 38% attempted primary education. This implies that the population studied was literate and was able to understand the techniques involved in technology transfer. Table 4.1 showed that majority of the respondents has spent over 5 years as cooperative members (77%).only 23% were relatively new to cooperative . other have spent 11-15years (17). The largest sub- group was those that spent between 6-10 years whereas the least was those that spent above twenty years (2%). A large percentage of the respondents married (50%), while 28% of them were widowed/divorced. Twenty-two percent were still single. In terms of household size, majority had household. over 60% of the respondents had household size that was larger than seven persons. Only 10% had small household size of less four persons. Furthermore, majority of the respondents' annual output was between 1-3 tons. Only 8% produced less than one ton, while 7% produced above 3 tons. In

terms of annual income, the largest category earns between 500,000 to 3 million naira annually. Ten percent earn less than 500,000 whereas 6% earn above 3 million annually.

Table 3 extent of adoption of selected improved agricultural technologies among cooperative rice farmers in Enugu State.

S/N		Mean	Standard deviation	Decision
1	Spacing	2.90	0.895	Low
2	Varieties	3.53	0.675	High
3	Line planting	4.45	0.785	High
4	Fertilizer application	3.62	0.870	High
5	Lime application	2.23	1.065	Low

Field survey, 2017

Test of hypotheses 1

Ho1 FADAMA cooperative rice farmers in Enugu State have not significantly adopted improved agricultural technologies.

Table 4. Test of hypothesis One

One-Sample Statistics

	N	Mean	Std. Deviation	St. Error Mean
Level of adoption	320	3.10	43667	0.5637

One-Sample Test

Test Value =0

	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference.	
					Lower	Upper
Level of adoption	22.174	319	.000	3.25000	1.1372	1.3628

According to the sample test table, level of adoption of improved agricultural technologies was significant at 0 .05 level of significance with t-value of 22.174. Therefore the null hypothesis was rejected, and it was concluded that cooperative rice farmers in Enugu State have significantly adopted improved agricultural technologies.

Table 3: Mean rating of factors that influence adoption of improved agricultural technologies

	Frequency	Mean	SD	Remark
Sex	320	2.8	1.652	Reject
Education	320	3.8	1.873	Accept

Farm size	320	3.9	2.109	Accept
Annual	320	4.4	1.094	Accept
Age	320	2.9	0.425	Reject
Contact frequency with extension agents	320	4.7	2.092	Accept
Cooperative membership	320	4.6	1.983	Accept
Location	320	2.1	2.209	Reject
Farming experience	320	3.7	1.925	Accept
Motive for farming	320	3.3	1.915	Accept
Parents occupation	320	2.2	2.107	Reject
Source of information	320	4.1	2.625	Accept
Status in farmers association	320	1.6	1.328	Reject
Training attendance	320	4.1	2.872	Accept
Source of fund for farming	320	1.9	3.815	Reject
Value of productive assets	320	2.8	0.218	Reject
Availability of success stories	320	4.3	2.761	Accept
Attitude of extension agent	320	4.4	2.902	Accept
Type of farming technology	320	2.4	3.981	Reject
Literacy level of farmers	320	3.8	2.671	Accept

Field survey, 2017

Table 3 revealed that factors that influence adoption of improved agricultural technologies include: education level, farm size, annual income, frequency of contact with extension agents, cooperative membership. Others were motive for farming, number of extension agents. Surprisingly, factor such as age, sex, location, occupation of parents, status in farmers association, source of fund for farming, value of productive assets and type of farming technology in use did not have appreciable influence on adoption of agricultural technologies.

H₀4: Inadequate extension services, cost of adoption, market value of rice, and Illiteracy are not significant hindrances to adoption of improved agricultural technologies among FADAMA rice farmers in Enugu state.

Test of hypotheses 2

H₀2: famer specific and institutional factors do not have significant influence on adoption level of agricultural technologies among FADAMA rice farmers in Enugu state.

Table 4: ANOVA table (One way) showing factors that influence adoption of agricultural technologies

		Sum of squares	df	Mean square	f	sig
Sex	Between Group	1.752	5	.350	1.436	.209
	Within Group	144.873	315	.244		
	Total	146.625	320			
Education	Between Group	35.108	5	7.022	1.088	.366

	Within Group	3832.611	315	6.452		
	Total	3832.718	320			
Farm Size	Between Group	44.960	5	8.992	7.699	.210
	Within Group	693.734	315	1.168		
	Total	738.693	320			
Frequency Of contact	Between Group	7.382	5	1.476	3.082	.009
	Within Group	284.511	315	.479		
	Total	291.893	320			
Age of Respondents	Between Group	15.624	5	3.125	4.257	.031
	Within Group	436.001	315	.734		
	Total	451.625	320			
Membership of Cooperative	Between Group	28.295	5	5.639	8.985	.000
	Within Group	372.803	315	.628		
	Total	400.998	320			
Location of the Farm	Between Group	13.888	5	2.778	1.254	.282
	Within Group	1315.710	315	2.215		
	Total	1229.598	599			
Farm experience	Between Group	16.030	5	3.206	1.569	.027
	Within Group	1213.803	594	2.043		
	Total	1229.833	599			
Type of technology In use	Between Group	195.541	5	39.108	25.490	.100
	Within Group	911.332	594	1.534		
	Total	1106.873	599			
Motive for Farming	Between Group	1.398	5	.280	1.229	.094
	Within Group	135.976	594	.227		
	Total	136.473	599			
Parents occupation	Between Group	4.035	5	.807	2.385	.037
	Within Group	200.950	594	.338		
	Total	204.985	599			
Source of Information	Between Group	11.944	5	2.387	2.111	.033
	Within Group	672.254	594	1.132		
	Total	684.198	599			
Status in farmers Association	Between Group	5.548	5	1.110	1.368	.234
	Within Group	481.645	594	.811		
	Total	487.193	599			
Annual income	Between Group	28.710	5	5.742	3.133	.088
	Within group	1088.783	594	1.833		
	Total	1117.493	599			
Training Attendance	Between Group	18.366	5	3.673	2.171	.046
	Within Group	1004.967	594	1.692		
	Total	1023.333	599			
Source of fund For farming	Between Group	5.920	5	1.184	1.143	.336
	Within Group	615.273	594	1.036		
	Total	621.193	599			
Value of	Between Group	13.003	5	2.601	4.653	.000

Productive	Within Group	331.956	594	.559		
	Total	344.958	599			
Success stories	Between Group	7.330	5	1.466	3.689	.003
	Within Group	236.055	594	.397		
	Total	243.385	599			
Attitude of Extension agents	Between Group	21.271	5	4.254	2.317	.012
	Within Group	1090.794	594	1.836		
	Total	1112.065	599			
Literacy level Of farmers	Between Group	13.646	5	2.729	3.758	.002
	Within Group	431.419	594	.726		
	Total	445.065	599			

Source: Field survey, 2017

In Table 4, the resulted test of hypothesis 2 was presented. Out of the twenty factors presented, only 12 were significant. These twelve factors include education level, farm size, frequency of contract with extension agents, cooperative membership, farming experience, motive for farming, income, number of training attended, availability of success stories, literacy level of farmers and attitude of extension agents. These factors have high f-ratio and significant at 0.05 level of significance. As a result, the null hypothesis is rejected. So, we conclude that farmers. Specific and institutional factors influence adoption of agricultural technologies.

Table 5. Contributions of cooperative to adoption of improved agricultural technologies

	Frequency	Mean(X)	SD	Remark
Awareness creation	320	4.2	2.908	Accept
Sharing of ideas	320	2.7	2.871	Reject
Mitigating hindrances/objections	320	3.9	1.093	Accept
Provision of guarantee	320	3.4	3.983	Accept
Bargaining for cheaper cost of adoption	320	4.1	2.351	Accept
Convincing laggards and late adoption	320	4.7	3.981	Accept
Peer pressure towards adoption	320	4.1	0.378	Accept
Cheaper platform to achieve mechanization/modernization	320	4.4	4.936	Accept
Access to reliable experts	320	2.7	2.187	Reject
Provision of accessible experiment/practical	320	1.8	3.916	Reject
Platform for accessing adoption support services	320	4.2	2.871	Accept
Access to government /donor aids and assistance	320	3.9	3.157	Accept

Source: Field Survey, 2017

Table 6 revealed that agricultural cooperatives contribute to awareness creation, mitigating objections to adoption, providing guarantee and cheaper platform to access adoption service. Respondents also agreed that cooperatives provide access to government aids and assistance, as well as convince laggards on the need to adopt new technologies. However, majority of the

respondents insisted that agricultural cooperatives do not contribute in sharing adoption ideas nor provide access to reliable experts and accessible experiment.

Test of hypothesis 3

H₀₃: Cooperatives do not have significant effect on adoption level of agricultural technologies among FADAMA rice farmers in Enugu state.

Table 6. Regression Estimate (Effects of cooperatives on adoption of improved technologies)

Model	coefficient Estimates	t-Value	Significance
(CONSTANT)	1.187	5.023	0.030
Sex	0.184	1.904	0.274
Marital	0.206	1.860	0.428
Education	2.016	4.121	0.039
Housize	3.099	3.121	0.178
Farmexp	1.713	4.871	0.016
Coopdura	2.205	6.194	0.026
Age	0.421	1.437	0.076
Annual income	3.190	1.87	0.023
Output volume	0.425	1.246	0.149
Contact frequency	2.670	3.761	0.029
R ²	0.782		
Adj R ²	0.767		
F	22.774 (sig.@0.05)		

Source: Field survey, 2017

Dependent variable: Annual Rural farm income

Table 6 Shows that the estimates of coefficient of multiple determinations (R²) and Adj. R² suggest that all the variables in the model collectively accounted for than 78% of the variations farm income. The F ratio value of 22.774 was significant at 5% level. All the variables had expected positive signs suggesting direct relationships with adoption level of agricultural technologies. However, only education, annual income, contact frequency, farm experience, age and cooperative duration were significant. Sex of the farmers, marital status and household size are not significant. This, therefore suggest that some socio-economic characteristics of farmers especially the number of years spent in cooperatives have influence on rural farm income. The null hypothesis that cooperative do not have significant effect on rural income was therefore rejected. So we conclude that cooperatives have effect on adoption level of agricultural technologies.

Table 8: Mean rating of the hindrance to adoption of improved agricultural technologies among FADAMA rice farmers

	Mean(X)	SD	Decision
Inadequate extension services	3.62	2.091	Accept
Market value of rice	2.41	3.892	Reject
Illiteracy	3.90	2.328	Accept
Individualism among farmers	3.46	1.983	Accept
Poor access to information	3.87	1.873	Accept
Cost of adoption	4.00	2.897	Accept
Adverse effects of adoption	2.71	2.875	Reject
Volume of production	1.97	3.011	Reject
Low awareness	4.21	1.983	Accept
Government policies	2.15	0.528	Reject
Farmers general attitude to innovations	3.38	1.7835	Accept
Tasking nature of adopting new technologies	2.14	1.094	Reject
Socio-cultural reasons	2.67	2.863	Reject
Type of media channel in use	3.51	2.330	Accept

Source: Field Survey

Table 7: revealed that major hindrance to adoption of improved agricultural technologies include inadequate extension service, illiteracy, individualism among farmers, high cost of adoption, general society attitude to innovations and the type of media in use. It showed that market value of rice, volume of production, government policies, adverse effect of adoption and socio-cultural reasons do not constitute hindrances to adoption of improved agricultural technologies.

Test of hypotheses 4

Ho: Farmer specific characteristic and society characteristics do not constitute significant hindrance to adoption of improved agricultural technologies.

Table 8

One sample Test on hindrance to adoption of improved agricultural among rice farmers

Test Value=0		95% Confidence interval of the				
t	Df	Sig. (2-tailed)	Mean Difference	Difference	Upper	
21.951	319	.000	1.40000	1.2724	1.5276	
19.565	319	.000	1.85000	1.6608	2.0392	
25.389	319	.000	3.433333	3.1627	3.7039	
27.712	319	.000	2.383333	2.2112	2.5554	
28.626	319	.000	2.50000	2.3252	2.6748	
21.067	319	.000	2.41667	2.1871	2.6462	
28.492	319	.000	2.71667	2.5259	2.9075	

22.984	319	.000	2.97634	2.0804	2.0956
26.983	319	.000	2.89744	2.8075	3.1097
24.9816	319	.000	2.1897	2.4081	2.7862
27.1708	319	.000	2.0987	2.0021	2.6109

Source: Field survey, 2017

According to table 9, seven out of eleven factors were significant at 0.05 level of significant with very high t-ratio. Therefore, the null hypothesis was rejected. So we include that farmers-specific and institutional-specific factors hinder adoption of improved cultural technologies.

Discussion of Findings

This study evaluated the determinants of improved technology adoption among operative rice farmers who participated in the FADAMA programme in Enugu State. Finding revealed that adoption level of these new technologies (spacing, use of varieties, the planting, fertilizer application, time application). This is in line with the views of audiet.al (2011) that there is increasing adoption of line planting and fertilizer application among rice farmers. However, unlike the findings in Ayinde *et.al* (2010) about agricultural technologies adoption, many farmers in the area studied had low rate of adoption for spacing and lime application. This difference can be attributed to cultural and social orientation of the farmers.

Interestingly, most of the determinants of adoption ads revealed in this study are similar to findings made in previous studies, except in the case of age, parents’ occupation and status o the farmers in the farmers association. It is dissimilar with the findings of Adekunle *et.al* (2005), who posited that age and parent’s occupation affect adoption. The findings in this study is similar to Lawal and Oluleye (2008) who agreed that education, annual income, farming experience, cooperative membership and literacy level of farmers effect the level of adoption.

Surprisingly, new factors introduced that are not conventional in adoption literature such as motive of farming, attitude of extension agents, frequency of contact with extension agents, source of information and training attendance were very significant. Some of these factors, however, were mentioned in Laugyin and Nejybuan (2008). The researchers observe that most significant determinants of adoption include education level of the farmers, frequency of contact with extension agents, cooperative membership, training attendance and attitude of extension agents. These findings have important policy implication because they have shed light into why many extension services failed to achieve its objective. It is difficult for farmer to adopt new technologies if they do not trust the source of the information, if the attitude of extension worker is unfriendly, and if the number of contacts is not enough to affect technology transfer. Availability of success stories has merged into an important determinant of adoption. Farmers will be more disposed if they see evidence of adoption. This implies that extension agents and other technology transfer agents should ensure that success stories and evidences are available whenever they interact with farmers.

This study reiterated the critical importance of cooperative in the adoption process. Just like in Magaji (2005), this study found out that cooperative was a significant influence of adoption. They provide platform for information sharing, guarantee services, handling of objections and reducing the cost of adoption new technologies and provider weaker farmers access to information and opportunities to improve their output. Similar study by Akinwunmi and jojo (2000) observed that there was higher adoption rate of agricultural technology among non cooperative farmers than among non cooperative farmers. Cooperatives provide avenue for technology transfer and rural learning especially for less illiterate farmers. This the level of

attention paid to them by government. In recent time, 70% of all government assistance to farmers was delivered through cooperatives, and this policy direction has received overwhelming commendation. The policy implication of his finding is that it justifies increased attention given to cooperatives. This that investing in capacity building of agricultural cooperatives will have significant effect not only on the agricultural sector, but on national development.

In line with the findings of Buhati et, al (2012), illiteracy inadequate extension services, low awareness and cost of adoption stand out as most significant hindrances to adoption of improved agricultural technologies. This is in contrast with Magaji (2005) who observed that volume of production and market value of rice hinder technology uptake. His argument was that if the market value of a produce is high, farmers will be eager to increase yield in order to make more profit. However this study reveals otherwise. Government policies, adverse effects of adoption of improved technologies are noted as hindrances in this study. Apart from the four constraints listed above, this study shows that type of media used in technology transfer, individualism among farmers and general societal attitude towards innovation hinder adoption of improved agricultural technologies. The implication of this finding is that both government, policy makers, analysts and cooperatives leaders have known hindrances facing adoption. This knowledge is critical because it will inform decisions on how to mitigate the constraints.

Conclusively, this study has made valuable contributions to the field of agriculture and cooperative especially as regard adoption. It has expanded the frontiers of knowledge in adoption behavior by focusing on adoption drivers of rice farmers who not only belonged to cooperatives but also participated in FADAMA programme. It has enriched the literate by introducing new determinants such as frequency of contact, source of adoption information, motive for farming, number of training and availability of success stories. These determinants are relatively new in literature unlike educational qualification, age and farming experience. Apart from solidifying the increasing importance of cooperatives in adoption theory, the study also made in-roads identifying new constraints to adoption. The study is therefore, significant because it has filled the gap in literature. It has also generated a lot of policy implication which can help to chart a new course in agricultural technologies adoption.

Summary of findings

- Members of cooperative rice farmers who participated in FADAMA programme have significantly adopted improved agricultural technologies ($t=22.174$; 0.05 level of significance). This adoption was more significant in the area of using varieties, line planting and fertilizer application.
- Major determinants of adoption of improved agricultural technologies among members of rice cooperative farmers included educational qualification, farm size, annual income, and frequency of contact with extension agents, cooperative membership, others are farming experience, source of information on adoption, number of trainings attended, and literacy level of farmers, attitude of extension agents and availability of success stories.
- Cooperative membership had significant effect on adoption of improved agricultural technologies. Cooperative members have high propensity to adopt new agricultural technologies than non-members. Cooperatives contribute to adoption, sharing of information, motivating people towards adoption and providing platform for aid and assistance.

- Significant hindrances to adoption of improved agricultural technologies are inadequate extension services, illiteracy, individualism among farmers, poor access to information, high cost of adoption, low awareness, societal attitude to new innovations and the type of media channel used in the technology transfer.

Conclusion

Government at every level has come to the realization that food security is attained not only with finding alone but improved technology. One of the objectives of the FADAMA programme is technology transfer and cooperatives have played leading role on this aspect. Rice farming is currently receiving attention in Nigeria because of the government effort at reducing importation and increasing local production. Increase in output and revenue can be achieved using the right technology. This study has revealed areas of strength and weaknesses in technology adoption among rice farmers. It has elaborated on factors that drive, encourage or hinder adoption. It has also brought to the limelight the critical role of agricultural cooperatives in achieving the Nigerian rice revolution. Indeed, a lot of improvement has been made in adoption of improved agricultural technology, but there is still need to strive higher. Understanding of significant determinants that propel adoption will help government, policy makers and cooperatives to address objections and increase rate of adoption.

Recommendations

Extension services need to be energized and revitalized by employment and deployment of competent, motivated and well remunerated work force with strong work ethics. There is also the need for effective supervision of extension services and retaining of staff in order to update their skills and keep them at pace with new technologies.

Increased emphasis on capacity building agricultural cooperative through effective linkages and strong apexes. Since studies have established the important roles of agricultural cooperatives in rural development, efforts shall be made to straighten their capacity. The cooperatives in Anambra State are operating as isolated entities and with low volume of business. The presence of an apex body at national and district level to benefit from economies of scale and meet the buyers' required volumes.

- Mode of delivery of agricultural extension services need to be revisited. There is the need to increase the frequency of visits, as well as the media channel employed in the technology transfer. Their curriculum should include influencing farming motives, breaking cultural barriers, first time inertia to adoption and motivating farmers to attend trainings. Success stories that are reliable and accessible should also be used during extension activities.
- Cooperatives should maximize every opportunity they have to get trained and acquire skills. There is growing need for enhancing members' technical skills and regular training in cooperative knowledge to help them gain a better understanding of the cooperative's function. Farming is an occupation that needs improved skills and training is important to reduce individualism and increase large scale farming. This will improve the quality of member's participation and steer the cooperatives towards success.

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Chapter 28

Examining the Dialectics of Cyber-Crimes for Sustainable Cyber-Security in Nigerian Environment

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Abstract

This present chapter assesses cyber-crimes and cyber-attacks issues relating to Ponzi schemes and Ransomwares which confront the cyber-risk management of Nigerian Built Environment Sector towards contributing a sustainable National Security Architecture in Nigeria. Specifically, the dynamics of cyber-risk management approach was discussed in the context of prevention, mitigation and eradication of cybercrime. The findings of this present study show that, a myriad of cyber-security issues including ransomware, Distributed Denial of Service (DDoS), Man-in-the-Cloud (MitC) attacks, among others. Necessary approaches for and effective cyber risks management approaches are anchored on sustainable legal frameworks for achieving timely detection, prevention, mitigation of cybercrimes in Nigeria. The two main conclusions drawn in this present study are: (i) the emergence of crypto-currency being a form of cyber-attacks, and (ii) the quest for cyber-security talents are both counterforces to curbing the menace of cybercrime. With upsurges in the adoption of a novel ICT technology known as the Internet of Things (IoT) by some developed countries, there is therefore imperative for government to partner with relevant stakeholders in developing stringent national regulatory measures that could effectively detect, prevent and mitigate any potential cyber-crimes *cum* cyber-attacks towards achieving an innovative management of cyber-security operations in Nigeria.

Keywords: Cyber-crime, Built environment, Cyber-risk management, Cyber-security, Internet of Things, National Security Architecture

1. Introduction

The proliferation of cybercrimes coupled with their attendant cyber-attacks have become a tremendous concern to both government and private corporate organizations in Nigeria. Historically, the last seven (7) years of 2013 – 2019 have recorded unprecedented cybercriminal cases in the country (Aladenusi, 2018). For instance, one major cause of various cyber-criminalities during the period under review is upsurge in the increase of financial Ponzi

schemes. According to Wilkins, et al., (2012) a Ponzi scheme can be regarded as a fraudulent investment in which financial returns of earlier investors are usually paid from the contributions made by newcomers into the business. Generally, Ponzi schemes are games of frauds where money of newer investors are used to pay increased returns to earlier investors rather than from the profits accrued on the contributions of earlier investors.

Another cybercrime issue bedeviling the Nigerian build environment is a Ransomware. Ransomware is a form of malware that encrypts a victim's files on personal computers (PCs). Usually, the Ransomware attacker often demands a ransom from the victim to restore access to the data upon payment; otherwise, the scammers publish the stolen data of non-paying victims on their own websites. In Year 2017, numerous cases of Ransomware attacks were documented by security Agencies in Nigeria. Wannacry is a major type of Ransomware which seriously affected businesses that are operated with personal computers (PCs) in Nigeria. Literature asserts that Wannacry has already affected more thousands of PCs in more than 150 countries, worldwide (Aladenusi, 2018). Usually, Wannacry attacks result to the loss of both individuals and organizations. In the attacks which happened in 2017 in Nigeria, some IT executives had sleepless nights trying to remove the tragic wannacry attacks; while many others, lost their jobs (Aladenusi, 2018). Brewer, (2016) had asserted that, organisations can suffer lost productivity, loss of business, inconvenience to customers and potentially the permanent loss of data during wannacry ransomware personal computers software attacks. No doubt those cybercriminals are always eager to steal as much money as possible in one go from the cyber space. There, it is imperative for government to take adequate measures in mitigating all forms of ransomware attacks through social engineering techniques. Consequently, curbing future wannacry ransomware software attacks in Nigeria can only be possible through proactive cyber-risk management strategies taken towards ensuring the resilience of Nigeria's National Security Architecture. National Security Architecture can be referred to the physical facilities (equipment and installations in residential, institutional, commercial and industrial domains/settings etc.), including the logistical management for cyber-risk management, regulation, prevention and implementation to ensure cyber-security at local, state and national levels of any country.

No doubt, emerging illicit activities of scammers in the global ICT sector are unfolding and such usually fuel cyber criminalities and weaken effective management of most national cyber-security architectures, especially in developing countries. Meanwhile, Ford (2017), expressed that. Many ICT enabled businesses in Africa are threatened by merging cyber security antics of scammers. Such scenarios therefore, require vibrant and timely proactive approaches in order to effectively detect, control and mitigate cyber-crimes. Therefore, the policy authorities in the ICT sector in Nigeria must determine the right regulatory framework for driving the ICT sector toward a sustainable future while ensuring a sustainable cyber-security including a safer and healthier brown environment in Nigeria.

Hence, aim of this present study is assess cyber-crimes and cyber-attacks issues relating to Ponzi schemes and Ransomware in Built Environment Sector towards contributing to a sustainable National Security Architecture in Nigeria. Specifically, this chapter x-rays the legal and regulatory frameworks required for attaining sustainable national cyber-security in Nigeria amid the global evolution of the novel internet of things (IoT) ICT invention.

2. Legal framework for cyber-security as the regulatory mechanisms in Nigeria

Legal framework for cyber-security are the regulatory mechanisms, legislations and statutes that are aimed at managing cyber-risks through effective detection, control and mitigation of

cybercrimes and cyber-attacks in any country. This Section 2 is organized into five (5) sub-headings as discussed below.

i. Analyzing the Myths and Realities surrounding Ransomware Attacks:

From evidence – based investigations, Ransomware will not fade in anytime soon, because of how lucrative the business of ransomware attacks is to cyber criminals. In Ransomware was the fastest growing security in 2017 as evidenced in several reports (Insert some of the reports, please). Not only were there more attacks on more businesses demanding more money, but the level of sophistication in distributing ransomware expanded. Many victims of ransomware attacks fear for the loss of their vital affected data. As such, victims usually negotiate and give-in to the demands of cyber criminals by paying up the demanded ransoms for their encrypted data to be released. Latest trends in cyber-security were highlighted at the Cyber Security in Banking Conference held in Johannesburg, South Africa in 2017. The Local cloud specialist One Channel addressed delegates at the conference, highlighting the opportunities of using technology in the fight against cybercrime in the banking environment (Van Rensburg, I. (2017).The One Channel Cloud firm at Johannesburg conference termed a set (five or two) of opportunities in their ‘future model of cyber-security’ as highlighted below: .

In a nutshell, It will take concerted efforts from both private and public sectors to fight cyber-crime and improve cyber-security in Africa because, African’s cyber-security architecture can only optimally contend with global standards Likewise, financial institutions in Nigeria need to incorporate a more veritable cyber-security management approaches in order to secure e-banking, mobile payments and the general cyber – operations toward securing the confidences of their customers.

ii. Evaluating the implications associated with Emerging Crypto Currencies businesses

Nowadays, cyber criminals widely adopt the use of crypto currencies in perpetuating their scamming antics on the general public. Since 2017, there has been an increase in the adoption of crypto currency and the combined market shares of online international trade in foreign currencies has outshined value of traditional banking transactions in foreign currency exchange (FOREX), (Aladenusi, 2018). As such, many nationals, including some Nigerians see crypto currency business as a viable lifetime investment opportunity from which huge profits could be made from the comfort of one’s computer system. Regrettably, crypto currency is not left out in cyber-attacks by cyber criminals who are also operators at every phase of the crypto currency ecosystem. Common cyber-attacks on crypto-currency exchanges (operations similar to that of the traditional Stock Exchange) are by flooding the exchanges with fraudulent requests so that it becomes unusable. In order to swing the value of crypto currencies, cyber criminals have adopted a new antic known as the Distributed Denial of Service (DDoS) attacks. Another area of cyber crimes the scammers have divulged into is by compromising user personal computer (PC) systems so as to steal and add to their own mining botnets. A mining botnet is a group of compromised systems that are used for mining data. Simply put, a mining botnet is method of using a computer to solve a mathematical problem as a process required to generate crypto currencies. In summary, as interests in crypto currency trading continues to have wider acceptability among Nigerian citizens, today, government regulatory agencies and crypto currencies trading organizations should collaborate with relevant professionals who have stakes in sector towards strengthening the cyber-security architecture for crypto currency investments in Nigeria

iii. Assessing the implications of the technological quests for Cyber-security entrepreneurship in Nigeria

According to Ford, (2017) billions of people globally, are possibly connected to the internet with their mobile devices in order to satisfy their unlimited knowledge needs thus, leading to proliferations in Artificial Intelligence (AI), robotics, the Internet of Things (IoT), 3-D printing, nanotechnology, autonomous vehicles and quantum computing technologies. Such technological advancements are creating change the ways legal businesses operated and transacted, nowadays. Having the right technology is not just enough to deal with cyber-security challenges; people capacities need to be continuously built and cyber security processes, strengthened. Furthermore, with the increasing shortage of skills and rising cost of technologies, a quick fix for organizations is to look towards outsourcing their cyber security functions. Outsourcing is a common business practice; there has been little traction in cyber-security process in Nigeria (Aladenusi, 2018). Here, organizations can outsource their security functions. As there is an increase in cyber criminalities, there is also higher demand for cyber-security services by cyber businesses. As such, more talents are required to minimize the existing massive shortage of manpower supply. Hence, the few available professionals that are highly skilled should promote entrepreneurial skills development for graduates and undergraduates, so as to boost the sector's service provision in Nigeria.

iv. Assessing the impact of man-in-the-cloud-attacks on national security architecture

It is not a novelty that organizations have progressively migrated to cloud-based environments and an increasing amount of information has been transferred to and stored within many cloud-based storage platforms. Most service providers of cloud storage systems have made their services very affordable to the public, such that anyone that easily obtain a cloud service from an internet search. Some early cloud users have even gone to set up cloud platforms for businesses without consulting skilled cloud professionals. Though cloud platforms are generally secure, the task that it is securely configured lies with each organization or user that enrolls for such a service. Specifically, Year 2017 was marred with several cloud-based security breaches – barely would a week go by without news of a data breach exposing business or customer data. Consequently, an emerging trend is an attack commonly referred to as the Man-in-the-Cloud (MitC) attack, (Aladenusi, 2018). Cybercriminals can have access to victim's cloud environment without running any malicious codes or exploits. What exacerbates this attack is that majority of cloud service users do not have visibility of what is happening inside their cloud infrastructure; hence, the cybercriminals can have unrestricted access and make changes to the environment without the knowledge of the victim. Therefore, organizations are encouraged to take responsibility in securing their cloud environment as well as providing cyber-security trainings for users of their services. Nonetheless, comprehensive service level agreements should be enacted and routine security audits should be conducted in order to track and minimize hackers' activities on the internet.

v. Evolution of internet of things (IoT) technologies?

The recent past few years have witnessed a continuous increase in the use of internet-connected consumer devices; but a similar increase cannot be said of the security of these devices as cost and time-to-market requirements continue to take precedence over security requirements. The challenge is that many IoT devices are not designed or maintained with security considerations

as priority; as they are often sold with old and unpatched operating systems and software. Nigeria is not left out either, as there are proliferations in the use of smart televisions, Apple wrist watches, smart digital projectors and smart whiteboards, etc. As a result, there are an increasing IoT related cyber-attacks on both end-point and cloud-based devices. Businesses need to take special care as they are ripe candidates and more liable to be victims, as these devices are being plugged into their corporate networks without proper security checks. Organizations would need to re-evaluate and set clear policies in order to stay safe.

3. Assessing the strategic role of regulatory agencies for Cyber-security

A Cyber-security regulation can support an effective framework for prohibiting and preventing cybercrimes. Cyber-security regulations took a boost in 2017, by the advent of the Society for Worldwide Interbank Financial Telecommunication (SWIFT), Customer Security Program (CSP) and the European Union General Data Protection Regulation (GDPR). The General Data Protection Regulations (GDPR), European new framework for data protection laws intended to strengthen and unify data protection for all individuals within the European Union, also came into force on 2018. The GDPR is applicable to all companies worldwide that process personal data of European Union (EU) citizens. This means that any company that works with information relating to EU citizens will have to comply with the requirements of the GDPR. SWIFT provides a network that enables financial institutions across the globe to send and receive information about financial transactions. The Customer Security Program (CSP) became a talking point by the end of 2017. SWIFT established the CSP program to ensure its customers take proactive steps to protect their “SWIFT” environment against cyber-attacks. SWIFT identified sixteen (16) mandatory and eleven (11) optional security controls against which all its 11,000 customers worldwide must assess their infrastructure (insert the source to those statistics that you claimed). SWIFT is used by majority of the companies in the Financial Service Industry in Nigeria. Year 2018 witnessed an increase in companies rushing to get their affairs in order as the reality of the implementation imperatives of the GDPR, SWIFT and CSP dawns closer. Hence, Nigerian regulatory organizations such as the National Insurance Commission (NAICOM), Nigeria Communications Commission (NCC) and National Information Technology Development Agency (NITDA) should consider the enforcement of compliance with standards in relation to cyber-security.

4. Conclusion and Recommendations

In this present chapter, effective mechanisms for cyber-risks management within the context of cyber-security regulation were analyzed. The findings of this present study show a myriad of cyber-security issues including ransomware, Distributed Denial of Service (DDoS, Man-in-the-Cloud (MitC) attacks, among others. Also, necessary approaches for and effective cyber risks management approaches are anchored on sustainable legal frameworks for achieving timely detection, prevention, mitigation of cybercrimes in Nigeria. The two main conclusions drawn in this present study are: (i) the emergence of crypto-currency being a form of cyber-attacks, and (ii) the quest for cyber-security talents are both counterforces to curbing the menace of cybercrime.

One salient recommendation needed for curbing any issues arising from the increasing technological quests for cyber-security services is that, the few available professionals that are highly skilled should promote entrepreneurial skills development for graduates and undergraduates, so as to boost the sector’s service provision in Nigeria.

In addition, as interests in crypto currency trading continues to have wider acceptability among Nigerian citizens, today, government regulatory agencies and crypto currencies trading organizations should collaborate with relevant professionals who have stakes in sector towards strengthening the cyber-security architecture for crypto currency investments in Nigeria

Also, cyber service providers are encouraged to take responsibility in securing their cloud environment as well as providing cyber-security trainings for users of their services. Nonetheless, comprehensive service level agreements should be enacted and routine security audits should be conducted in order to track and minimize a hacker's activities on the on the internet. Lastly, with upsurges in the adoption of a novel ICT technology known as the Internet of Things (IoT) by some developed countries, there is therefore imperative for government to partner with relevant stakeholders in developing stringent national regulatory measures that could effectively detect, prevent and mitigate any potential cyber-crimes cum cyber-attacks towards achieving an innovative management of cyber-security operations in Nigeria.

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Chapter 29

Legal Protection of the Unborn Child towards Attaining a Sustainable and Healthy Human Development

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Abstract

Law protects both the weak and the strong without discrimination, so the unborn child is not an exception to that protection. Accordingly, the Target-4 of the third Sustainable Development Goal (SDG 3.4) aims at promoting both the reduction of premature mortality and ensuring mental health and well-being. Despite that, human life is sacred right, right from its formative and development during pregnancy period after birth, the respect for the protection of lives of unborn children is fast eroding, globally. This paper discusses the relevance of guaranteeing the *Right to Life* of the unborn children towards ensuring healthy lives and promotes wellbeing for all at all ages, especially, lives of the unborn. It discusses the need for legal recognition of the right to life of an unborn child which should be central in both domestic and international legal instruments. Such recognition could reduce incessant domestic violence against pregnant women and safeguard the lives of their unborn children under protection law.

Keywords:

Legal Protection instrument, Unborn-Child, Pregnant mothers, Sustainable Healthy Development

1. Introduction

The Sustainable Development Goals (SDGs) are all-inclusive global goals gearing towards achieving a safer, healthier and peaceful world by Year 2030. The 2030 Agenda for sustainable development as adopted by the General Assembly of the United Nations is building on the principle of “leaving no one behind” which emphasizes a holistic approach to achieving sustainable utilizations of natural resources for the overall benefits of both the present and future human generations. Therefore, within the context of sustainable development, the protection of the unborn children who are among future human generations is therefore, sacrosanct.

In the good olden days, nations recognized that the unborn children are central to ensuring sustenance of human life on Earth. Hence, an international fetal treaty known as the American Convention on Human Rights became strictly operational in numerous United Nations member countries (Pact of San Jose,² 1979).² The *Pact of San José* provides legal measures for the protection of human fetus. The same treaty significantly used the term: ‘nationality’ which is adopted as a mark of identity in the World of today. Its³ Article 20 emphasizes that every

² Pact of San José: <https://treaties.un.org/doc/publication/unts/volume%201144/volume-1144-i-17955-english.pdf>

³ <https://www.cidh.oas.org/basicos/english/basic3.american%20convention.htm>

human being has the right to the nationality of the state in whose territory s/he was born if s/he does not have the right to any other nationality. Regrettably, many countries have consciously deviated from moral practice in the old good days. Nowadays, many nations deprive a great number of their unborn children the right to be born alive, and to enjoy their full right to a nationality. Such a scenario if not abated, will limit realization of a peaceful and prosperous world as anchored in the 5Ps (United Nations Foundation, 2019) of Sustainable Development by 2030. It is based on the foregoing premise that this present Chapter entitled: *Legal Protection of an Unborn Child towards a Sustainable and Healthy Development* is conceived.

The unborn children have everything it takes to be accorded legal protection. In the 1929 Act of Parliament in use by Nigeria's colonial master, the United Kingdom, children who are capable of a live birth are protected, thereby making it a serious criminal offense to kill an unborn child who is capable of being born alive (Local Government Act 1929, 2021). Although, a foetus is not yet born, but it represents human life. The Oxford Learners English Dictionary⁴ defines a "foetus" as an unborn offspring situated in the womb of its mother from eight weeks after fertilization until birth. Simply put, at 'eight weeks' of fertilization, the unborn already has the features of human beings. Meanwhile, most abortions usually take place after this period. Therefore, for civil laws to promote the willing termination of pregnancies with the flimsy reason of 'unborn child' not a human being, violates the natural justice of sacred life of the unborn child. It further raises the question as to whether, there would be any future human generations to enjoy the benefits of any achieved sustainable development goals, beyond 2030.

1. Statement of the problem

The Universal Declaration of Human Rights (UDHR) is one "Declaration" that has inspired all of the human rights conventions and subsequent declarations adopted since its proclamation by the General Assembly in 1948. While most International Human Rights instruments lack a universal inclusion of the term '*fetus*' as a living being for the purposes of fulfilling its human rights, it is instructive that the American Convention on Human Rights envisages the right to life of the fetus. Accordingly, the American Convention on

Human Rights also known as the International Fetal Treaty was widely adopted by countries of the World. The International Fetal Treaty provides legal measures for the protection of human fetus under the law (Pact of San Jose, 1979). Furthermore, the treaty guarantees the right to life and to the physical and mental integrity of the life of the unborn child. Consequently, Target-4 of the third Sustainable Development Goal (SDG 3.4)⁵ which is aimed at promoting both the reduction of premature mortality and ensuring mental health and well-being further underscore the sacredness of human life including that of the unborn child right from its formative stages during pregnancy until birth. Despite the foregoing, respect for the full protection of unborn children is widely being eroded, thereby, undermining the Human Rights of the Unborn to Life. Such a scenario would jeopardize future generations from enjoying any achieved benefits of the current Sustainable Development Goals if the heinous crimes that are being perpetuated by the present human generation as enabled by extant national abortion laws, continue unabated. The abortion laws in many countries around the Globe could drastically reduce future human populations, if the Human Rights of the Unborn Child is not upheld by the United Nations.

⁴<https://www.oxfordlearnersdictionaries.com/definition/english/foetus>

⁵ SDG-3.4: <https://indicators.report/targets/3-4/>

Therefore, the overall objective of this study is to ascertain the relevance of guaranteeing the Human Right to Life of the unborn child under international and domestic laws towards ensuring sustainable and healthy human development. Hence, the scope of this present chapter is to attempt answers to the following research questions:

- i. Who is an unborn child under the Common Law?
- ii. What are the legal antecedents for protection of the unborn children prior to World War II?
- iii. What are the historical post World War II situations affecting the unborn children?
- iv. What is the nexus between juristic personality and safeguarding Human Rights of the unborn child?
- v. What are the contemporary international laws guaranteeing the Human Rights of the unborn child?
- vi. How does the Nigerian Criminal Law legally protect the Human Rights of the unborn child?

Hence, Sections 3 - 8 below, provides answers to the foregoing research questions reviews of relevant literature.

2. Who is an unborn child under the Common Law?

Ordinarily, a child is someone other than an adult. However, research has proved that the definition of a child depends on who is defining it (whether male or female, feminist, non- feminist, pro-lifer or an abortionist), the disposition of the definer at the particular time, the purpose of the definition, the gender of the definer, his cultural background and from which perspective the definer is defining, his region or country of origin. A child at common law is a person who has not reached the age of 14(Bryan A. Garner). In *R v Sharp* (1999), Justice Southin of the British Columbia Court of Appeal held:

“In this judgment, when I myself use the word child, in contradistinction to when I am quoting someone else’s words, I mean those below the age of puberty. At common law, these ages were deemed to be twelve for a girl and fourteen for a boy. As, however, fourteen is the age of consent in Canada and has been for girls, for over one hundred years(see the 1892 Criminal Code of Canada, s. 269), I define a child as anyone under the age of Fourteen years.”

An “unborn child” is a child not yet born, in other words he has not completely proceeded in a living state from the body of his mother (Criminal Code Act s.307). The Criminal Code recognises an unborn child as a person but not one capable of being killed. However under section 228 and 229 of the same Code he can be aborted and it is criminal. Article 1 of the United Nations Convention on the Rights of the Child defining a child states: “For the purposes of the present Convention, a child means every human being below the age of eighteen years unless, under the law applicable to the child, majority is attained earlier” UNCRC (1989). Nigerian government ratified this convention on 19 April 1991. It has been domesticated hence Child Right's Act 2003. The Act has been adopted in about 26 states in Nigeria.

Under our various municipal laws too, a child is recognised to be a person within certain age limit. Under the Law of Contract for example, he has the legal incapacity to enter into a contract, to sue or be sued except through his guardian *ad litem*. Under the Actions laws he lacks the legal capacity to sue or be sued except through his guardian *ad litem*. The Children and Young Persons Act (CYPA), Article 2 as enacted in Eastern, Western and Northern regions of Nigeria defines a child as a person under the age of fourteen years, while “young person” means a person who has attained the age of fourteen years and is under the age of seventeen years.

Section 2 of the repealed Criminal Procedure Act (CPA) defined a child as any person who has not attained the age of fourteen years. This definition was given judicial interpretation in *Okon & Ors. v The State* (1988). However, Section 494 (1) of the Administration of Criminal Justice Act (ACJA) 2015 defines a child as a person who has not attained the age of eighteen years. It further defines an infant as a person who has not attained the age of seven years. Furthermore, the Immigration Act (IA) stipulates that any person below 16 years is a minor, whereas the Matrimonial Causes Act (MCA) puts the age of maturity at 21. However, notwithstanding the Matrimonial Causes Act, individual states maintain their various ages for marriage. From the plethora of definitions of who a child “is”, it is obvious that there is yet no one uniform definition of who a child is. However, it is obvious that from the definitions proffered above, childhood starts from age zero to a certain definite age depending on the definer. Furthermore, childhood starts from the womb so that there is an unborn child and child that is already born.

3. Legal Antecedents for Protection of Unborn Children Prior to World War II?

In the early days, an unborn child was mainly protected by restrictions on abortion. Some versions of the Hippocratic oaths indirectly protected unborn child by prohibiting abortion. (Riddle John, 1994). However, philosophical views on the fetus were influenced in part by Aristotelian concept of delayed humanization around the mid-19th century (John Salmond). According to Pythagoreans, fetal life was co-equal in moral worth with adult human life from the moment of conception. Similar views were held by Stoic philosophers (John Salmond). Yet Ancient Athenian law did not recognise unborn child’s right to life before the ritual acknowledgement of the child (Kapparis, 2002). Several Hindu texts on ethics and righteousness (Harold Coward, & Philip Cook, 1996), give fetus a right to life from conception, although in practice such texts are not always followed (Jean Schroedel, 2000). The property Law of the then Roman Empire granted fetus inheritance rights. Thus as long as the fetus was conceived before the father’s death and then born alive, his / her inheritance rights were equal to those of the siblings born before the testator’s death. This is because though under the Roman law the fetus was not a legal subject, it was a “potential person” whose property rights were protected after birth (Schroedel). In (Schroedel) Ulpian, a Roman jurist observed that in the law of the Twelve Tables, he who was in the womb is admitted to the legitimate succession, if he has been born. Another jurist Julius Paulus Prudentissimus also noted, that the ancients provided for the free unborn child in such a way that they preserved for it all legal rights intact until the time of birth. The Roman Digest granted the fetus consanguinity rights and vested the protection of fetal interests in the Praetor i.e a Roman administrative official. The Digest also prohibited the execution of pregnant women until delivery. Under the same Digest if a slave mother had been free for any period between the time of the conception and childbirth, the child would be regarded as born free (Robert Dundonald Melville). Although the mother might have become slave again before the birth of the child, it was considered that the unborn child should not be prejudiced by the mother’s misfortune.

In the Byzantine Empire which is Part of the Eastern Roman Empire, fetus was regarded as a natural person and could inherit alongside other persons including slaves (Nigel Wilson, 2013). Thus the Byzantine Emperor Michael VIII Palaiologos allowed soldiers to transfer their interests to their unborn children and granted unborn royals the right to succession (Mark C. Bartusis, 2013). Also, the King of Scotland Alexander III in 1284, by the act of parliament designated his future unborn children as heirs presumptive to avoid potential squabbles among Royal descendants of his lineage (Monteith Penman). The Scottish king Robert the Bruce allowed the unborn collateral individuals to be in line for the throne beyond his brother Edward and daughter Marjorie Bruce. After the death of Albert II of Germany in 1439, his then-unborn son Ladislaus the Posthumous inherited his father's sovereign rights. In 1536, the British Parliament gave the unborn children of Henry VIII and Jane Seymour precedence in the line of royal succession. Thus in the ancient times before the World War II, legal personality of the unborn child was recognised and protected. The unborn child was then capable of inheritance.

4. Historical Post World War II Situations Affecting Unborn Children?

Fetal rights issues continued to develop in the 20th century and particularly after World War II. The Geneva Declaration of Physicians Oath was adopted in 1948. Prior to the amendments in 1983 and 2005, it urged physicians to maintain the utmost respect for human life from the time of its conception (Tatsuo Kuroyanagi, 2013). The year 1967, witnessed legal decisions that granted every property and personal right to the unborn child, including the right to life itself from conception on (Byrne, 1967). While interpreting the right to life under the Basic Law of Germany, the Federal Constitutional Court in 1975 opined that life in the sense of historical existence of a human individual exists at least from the 14th day after conception and therefore everyone's right to life under the Basic Law of Germany includes the unborn as human beings (Jayawickrama, Nihal, 2002). In the 80s there was clamor for the protection of the unborn child in the workplace, aimed at guarding the health of the unborn child in potentially hazardous working conditions. Sequel to that, in 1983, Ireland became the first country in the world to constitutionalise fetal right to life by passing the Eight Amendment to the constitution (Fiona De Londras, 2015). The Dublin Declaration on Maternal Health was also signed in 2012. Significantly, it notes that there is a fundamental difference between abortion *simpliciter*, and necessary medical treatments that are carried out to save the life of the mother, even if such treatment results in the loss of life of her unborn child (*Dublin Declaration*). This brings to light the clear difference between necessary medical treatment to save life and intentional termination of an unborn child with soul and body. It prioritizes fetal right to life. Consequently, three European Union member states began to grant fetus the constitutional right to life (Douwe Korff). For example Ireland, Hungary and Slovakia, also El Salvador, Czech Republic, Dominican Republic, Guatemala and Paraguay broadly assert that the right to life begins at conception or before birth (Mairead Enright). Similarly, the constitution of Norway grants the unborn royal children the right of succession to the throne. Under its Article 6, it is provided that an unborn child shall also be included among those entitled to the succession and shall immediately take her or his proper place in the line of succession as soon as she or he is born into the world. Nonetheless, the English Common law grants fetus inheritance rights under the born alive rule (AsimKurjak, Frank, & Chervenak, 2006).

However, in recent time, there is a current trend of inconsistency shrouding the legal personality of an unborn child. While some jurisdictions accord legal personality to an unborn child, other jurisdictions deny the fact that an unborn child has any form of personality until

viability period i.e 20 to 21 weeks of pregnancy (Jakob Pichon, 2004). In *Werling v Sandy* (1985), an Ohio court again for other reasons, held that a viable fetus is a “person” under the wrongful death statute even if it dies in uterus. Yet some other jurisdictions wait until after birth and that is if the child is born alive. In some other jurisdictions like Nigeria, the unborn child is indirectly protected as an entity, but not to the extent of according him / her legal personality. Some of these instances are considered hereunder.

5. The Nexus between Juristic Personality and Safeguarding Human Rights of the Unborn Child?

The concept of juristic personality is now central to virtually every legal system. A legal person is any human or non-human entity, in other words, any human being, firm, corporation, body or government agency that is recognised as having legal rights and obligations, such as having the ability to enter into contracts, to sue, and to be sued. Naturally, man is endowed with the quality of volition and action and invariably man is a legal being. This is the fiction-theory also known as the *Romanistic* doctrine which holds that, by principle, only human beings can have legal qualifications. However, it adds that, exceptionally, such qualifications can be extended to artificial, fictitious subjects such as “corporations”, “juridical persons,” namely persons created for juridical purposes. Thus, this theory holds that “juridical” or “juristic” persons, though being fictions and not natural entities, have a legal or juridical reality (Leonidas Pitamic, 1935).

The Supreme Court in *Carlen (Nig.) Ltd. v Unijos* (1994) held that a juristic person has the right to sue or be sued in any law court because he / she is known to law. In law, a party who has a right to commence or defend an action in court must be a person known to law, be it a natural person or a creation of statute. Ogunwumiju, JCA (as she then was), delivering the lead judgment in *Okeke v Nnamdi Azikiwe University Teaching Hospital* (2018) held that it is not the specific name under which a person is sued that determines whether or not the person is a juristic person, but whether or not a natural person exists who bears that name or a similar name or had in fact hitherto bore that name. If it is a creation of statute, it is the recognition of that artificial person under an extant law that is relevant.

In company law for example, the essential feature of a company is that it exists as a separate legal entity distinct from its members. This is the case even if one member owns all the shares. It is known as the separate personality principle. This principle underpins the whole of company law. A legal entity is a body other than a natural person that can function legally, sue or be sued, and make decision through agents. That a company is a legal entity distinct from its members is the fundamental attribute of corporate personality of a corporation from which all the other consequences flow. Consequently, it is capable of enjoying rights. It is also capable of being subject to duties which are not the same as enjoyed or borne by its members. In other word it has legal personality. Such persons in law are rather described as artificial persons different from a natural person (Paul Devies, 1997). The most important consequence of the separate personality principle is that of limited liability. The company is liable without limit for its own debts but, in a limited company, the members, as distinct from the company, have limited liability. It is trite that an action could be brought against a natural or an artificial person, but no action could be brought against a non juristic person because such a person simply does not exist in law. On the proposition

when an action can be brought by or against a party other than a natural person, the English courts per Mocatta, J, in *Knight & Searle v Dove* (1964) held:

"...The proposition was that no action can be brought by or against any party other than a natural person or persons unless such party has been given by statute, expressly or impliedly, or by the common law, either (a) a legal persona under the name by which it sues or is sued or (b) a right to sue or be sued by that name. As to (a), namely, legal personae, this may be divided into (i) corporation sole; (ii) corporations aggregate, incorporated by Royal Charter or special Act of Parliament or under the Companies Acts; (iii) bodies incorporated by foreign law; and (iv) 'quasi-corporations' constituted by Act of Parliament, such as the War Damage Commission: see: Inland Revenue Commissioners v Bew Estate Ltd. As to (b), namely, parties which are not legal personae, but have a right to sue or be sued by a particular name, these may be subdivided into (i) partnerships; see R.S.C. Ord. 81; (ii) trade unions and friendly societies, both of which types have a membership; and (iii) foreign institutions authorised by their own law to sue and be sued, but not incorporated: see, for example, Chaff and Hay Acquisition Committee v Hemhill, a decision of the High Court of Australia, on appeal from New South Wales."

In *Taff Vale Railway Co. v Amalgamated Society of Railway Servants* (1901), it was held that the right to sue may be inferred from statute, but great care must be taken to look very closely at the relevant statutory provisions creating them. A body unincorporated held to possess by implication the capacity to sue or be sued must be either directly established by statute or established pursuant to some enabling statutory provisions. In the American case of *Forest City MFG, et al. v Garment Workers' Union* (1935) it was held that:

"... In the absence of statutory authority, ...a voluntary unincorporated association does not have the legal capacity to sue or be sued in its common or associate name, for the reason that such an association is purely a creature of convention, organized and existing under the common law right of "contract only" and having no legal entity distinct from that of its members".

A juristic person is a bearer of rights and duties *simpliciter* irrespective of whether he is a natural person or an artificial person. Whether this juristic person is a company or a firm or some Governmental Agency or body, what is crucial is that the entity has been given legal personality by law. In other words, juristic persons could be entities other than human beings and on which the law bestows legal personhood. This does not mean that they assume the guise of natural persons, but that the law for the sake of some economic or social expediency, recognises a thing or community or group of persons as having legal personality and therefore the capacity to be the bearer of rights and duties as well as the ability to participate in the life of the law in its own name. As a "juristic person", the law accords the entity a legal status and being an artificial creature of the law, the entity can sue and be sued in its own name (Oho, J C A in *Kwage & Ors v Upper Sharia Court Gwandu & Ors* (2017). Therefore, the unborn child is deserving of legal personality, an opportunity to participate in the legal

life of the law. When accorded legal personality, he/she can be represented by his/her *guardian ad litem* as was held in *Werling v Sandy* (1053).

Perhaps, a classical position of defining the word “person” may highlight the need to accord legal personality to the unborn child. The word “person” is derived from the Latin term “persona”, which means the actor's mask through which his voice must be sounded. The word subsequently came to be used for human beings who could bear rights and duties (Catherine Soanes & Angus Stevenson, 2006). Currently, it has acquired the meaning of denoting a being as one, which is capable of sustaining legal rights and duties. Thus, any person, whether natural or artificial, capable of sustaining legal rights and duties would be a legal person irrespective of the fact that he is not a human being. Thus, a “person” is an entity to which rights and duties may be attributed (Chipman Gray, 1921). Any being, whether a human being or not, whom the law regards as capable of rights and duties is a “person” (John Salmond). Consequently, legal personality is not only accorded to natural persons with the physical body of a human being. It could be accorded to anybody or thing. Whatever entity the law deems fit to be allowed to participate in its noble life, it accords that entity or being or thing legal personality for obvious reasons. It is therefore not an anomaly to say that since the law can appreciate a thing which has no life strictly speaking and accords it legal life, an unborn child who has life in him / her, very vulnerable to attacks and weak to defend himself/herself, deserves much more legal protection for social and economic reasons and for sustainability purpose. Like a company or agency of government which operates through its representatives, the pregnant mother is the functional hand and foot of her unborn child.

6. Contemporary International Legislations Guaranteeing the Human Rights of the Unborn Child

i. The Universal Declaration of Human Rights (UDHR) 1948

The efficacy of the Universal Declaration of Human Rights (UDHR) 1948 cannot be over emphasised. This is one “Declaration” that has inspired all of the human rights conventions and subsequent declarations adopted since its proclamation by the General Assembly in 1948. Its Preamble discusses the equal and inalienable rights of all members of the human family. In its Article 3 it provides that “Everyone” has the right to life. Its Article 6 further provides that “Everyone” has the right to recognition everywhere as a person before the law. Article 7 states that “All” are equal before the law and are entitled without any discrimination to every protection of the law. It is interesting to note that there is no age limit attached to these human right protective declarations and no category of persons is exempted in the protection. Why then would anybody exclude the living- but-not-yet-born from the list of persons to be accorded legal personality? Obviously, the unborn child is a member of the “human family” referred to in the Preamble of the UDHR, he / she is part of the “everyone” referred to in its Articles 3, the “All” referred to in Article 7 of the same UDHR (Patrick J Flood, 2006). Although the drafters of the Declaration did not deal directly with the unborn, they opted for the broadest and most inclusive language possible to describe the subjects of human rights (William A. Schabas, 1997). Schabas reports that “many delegations to the United Nations would have preferred some mention that the right to life began ‘from conception,’ thereby protecting the foetus. Thus, The UDHR Declaration provided a rationale for binding conventions on the general human rights provisions of the UN Charter, which mentions no specific rights.

ii. **The United Nations Convention on the Rights of the Child (CRC) 1989**

The United Nations Convention on the Rights of the Child (CRC) 1989 was preceded by the Declaration of the Rights of the Child 1959. The said declaration in its Preamble includes a significant affirmation of the rights of the unborn child thus:

“Whereas the child, by reason of his physical and mental immaturity, needs special safeguards and care, including appropriate legal protection, before as well as after birth, and whereas the need for such special safeguards has been...recognized in the Universal Declaration of Human Rights and in the statutes of specialized agencies and international organizations concerned with the welfare of children..., the General Assembly...calls upon...national Governments to recognize these rights and strive for their observance by legislative and other measures progressively taken....” (Flood), (Jude Ibegbu, 2000).

Following the 1959 Declaration on the rights of the Child, Paragraph 9 of the preamble to the Convention on the Rights of the Child states: “bearing in mind that, as indicated in the Declaration of the Rights of the Child, “the child”, by reason of his physical and mental immaturity, needs special safeguards and care, **including appropriate legal protection, before as well as after birth**”. Article 6 (1) of the Convention on the Rights of the Child which deals with the right to life of the child, states: “State parties recognise that every child has the inherent right to life.” Paragraph 2 of the same article stipulates that “State parties shall ensure to the maximum extent possible the survival and development of the child.”

It is submitted that by inclusion of the phrase ‘**including appropriate legal protection, before as well as after birth,**’ the CRC envisages some threat of violence on the safety of the unborn child and to peaceful enjoyment of his / her environment and abode in the womb. The convention acting proactively therefore made provision for some legal protection of this weak unborn child in his / her vulnerability. The law is a protector and voice of the weak. It protects persons under threat of violence on their persons and rights and accords them the right of self-defense as well as the right to be defended by another under sections 287 and 288 of the Criminal Code. We further submit that it is proper both in law and equity for all the states in the world to cloth the unborn child with legal personality for meaningful and sustainable legal protection so that where he suffers violence (whether direct violence or indirect violence in the cause of domestic violence, medical violence or road accident violence against the mother), he can sue and enforce his rights through his *guardian ad litem*.

Furthermore, Article 1 of the Convention defines a child as “every human being below the age of eighteen years unless under the laws applicable to the child, majority is attained earlier.” The phrase “every human being below the age of eighteen years” does not exclude the unborn, as it does exclude human beings who have attained the age of eighteen. In legal interpretation, the express mention of one thing is to the exclusion of the other. Article 31 (1) of the Vienna Convention on the Law of Treaties establishes the general rule of interpretation to be followed in ascertaining the meaning of a binding international instrument thus: “A treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose.

Therefore, applying the rules of interpretation of the Vienna Convention on the Law of Treaties concerning the ordinary meaning of the words in their context and the context of the treaty including the preamble, one finds strong grounds for States Parties to the treaty to maintain that the Convention guaranteed protection to the unborn child. As rightly observed by Flood, there is in fact a chain of logic extending from the Preamble through Articles 1 and 6 of the Convention. In the Preamble, it is “the child” that needs appropriate legal protection “before” as well as “after birth”. In Article 1 “the child” is “every human being below the age of eighteen years.” In Article 6 it is “every child” who in paragraph 1 “has the inherent right to life” and in paragraph 2 it is “the child” whose “survival,” State Parties “shall ensure protection to the maximum extent possible” (Flood). We strongly submit that no other category of persons is being referred to here other than the unborn child as well as the born child.

iii. The Convention on the Elimination of All Forms of Discrimination against Women 1979

The Convention on the Elimination of All Forms of Discrimination against Women 1979 has members with functions and responsibilities similar to those of the Human Rights Committee. It is called the Committee on the Convention on the Elimination of All Forms of Discrimination against Women (1979). Like the Human Rights Committee, their main task is to review periodic reports submitted by States Parties on their implementation of the agreement. Their members serve in their individual capacity, not as government representatives. The Convention regards unborn children as worthy of consideration and care. Article 4, paragraph 2 of the Convention says that “adoption by States Parties of measures, including those measures contained in the present Convention, aimed at protecting maternity shall not be considered discriminatory.” Article 11, on the right to work, provides in paragraph 2 that “States Parties shall take appropriate measures (a) to prohibit, subject to the imposition of sanctions, dismissal on the grounds of pregnancy or of maternity leave..., (b) to introduce maternity leave with pay or with comparable social benefits..., and (d) to provide special protection to women during pregnancy in types of work proved to be harmful to them.” Though Article 11(d) on the right to work did not add “or to their unborn children,” it is our submission that the above provisions had in its contemplation the protection of the unborn child while making the provision and as deserving to be protected. The rationale for these protective measures is not just for the benefit of the pregnant mother but for the benefit, safety of the unborn child in the womb and his / her safe arrival, more so in recognition of the unborn child as an entity that deserves adequate protection.

iv. The Declaration on Human Cloning 2005

The United Nations General Assembly (UNGA), in the Declaration on Human Cloning adopted on 3 March 2005, called upon Member States to adopt all measures necessary to protect adequately human life in the application of life sciences and to prohibit all forms of human cloning inasmuch as they are incompatible with human dignity and the protection of human life (Resolution 59/280, paras. a and b). The Declaration is thus a clear affirmation that human life even at its earliest stage deserves legal protection. States are called upon to adopt measures to prohibit the application of genetic engineering techniques that may be contrary to human dignity and to take measures to prevent the exploitation of women in the application of life sciences. However, it has not been possible to achieve consensus on an international convention on the subject, and the General Assembly has called upon all Member States to adopt and

implement without delay the above provisions in their respective national legislations and make it effective (Doc. A/RES/59/280, paragraph (e)).

v. The Geneva Convention for Protection of Civilian Persons in Time of War(GCPCPTW)1949

The Geneva Convention for Protection of Civilian Persons in Time of War (GCPCPTW) 1949, was the fourth Geneva convention held in 1949. Articles 14 and 16 of the Convention included expectant mothers among those who “shall be the object of particular protection and respect, those who shall be included in hospital and safety zones. Article 23 of the same GCPCPTW also included expectant mothers among those who shall be beneficiaries of the free passage to civilians in occupied territory of essential foodstuffs, clothing and tonics intended for children under fifteen, expectant mothers and maternity cases.” Articles 17, 18, and 20-22 also refer to protective and other measures related to maternity cases. Article 70 of Protocol 1 to the Geneva Conventions (1977) mentions expectant mothers among those persons to be given priority in the distribution of relief consignments, as they are among the groups to be accorded privileged treatment or special protection under the Fourth Convention as well as the Protocol. Article 76 of Protocol 1 avoids the pronouncement of death penalty on pregnant women. Furthermore, Article 38 of the Convention guarantees to alien pregnant women any preferential treatment granted to pregnant women who are nationals of an occupied state. While Article 50 prohibits reducing for nationals of an occupied state any preferential measures for pregnant women that pre-existed the occupation. Article 89 provides that expectant and nursing internee mothers and children shall be given additional food. Article 132 includes them among groups of internees whom the Parties are to try to repatriate even while hostilities are still underway. Thus mothers and their unborn as well as new born children are meant to be the beneficiaries of special measures of protection and support at all times especially in times of war.

vi. The Rome Statute of the International Criminal Court (ICC) 1998

The Rome Statute of the International Criminal Court (ICC) which entered into force on 1 July 2002, specifically excludes any interpretation that could provide a basis for asserting an international right to abortion. In the definition of crimes against humanity, ‘forced pregnancy’ means the unlawful confinement of a woman forcibly made pregnant, with the intent of affecting the ethnic composition of any population or carrying out other grave violations of international law. Articles 7(2)(f); 8(2)(b) (xxii) and 8(2)(e)(vi), of the Rome Statute, regarding war crimes, incorporate this definition by reference. The Statute stated clearly that this definition shall not in any way be interpreted as affecting national laws relating to pregnancy.

vii. International Criminal Law

Under International Criminal Law, Article 26 of the Rome Statute adopts the minimum age of eighteen years so that the ICC does not have jurisdiction over any person who was under the age of eighteen at the time of the commission of the alleged crime. The rationale is to treat children as victims, not as perpetrators of international crimes. Hence, children whether born or unborn are victims of crimes and not perpetrators. Even the kick of an unborn child in the womb is a reassuring hope of life, vigor and vitality. His/ her breath gives the “friendly” pregnant mother peace, joy and hope that her baby is alive, active and normal, but not for a hostile mother. Though some international instruments such as The Universal Declaration on Human right (UDHR) in its Article 3, have recognized the right to life as a universal declaration

but strikingly, it is not universally accepted that an unborn child should be accorded some rights including the right to life, to defend himself or answer to claims, to sue and be sued and/or to be represented by his guardian *ad litem*. Worthy of note is that, the International Covenant on Civil and Political Rights (ICCPR) 1966 in its Article 6(5) prohibits the execution of pregnant women until they are delivered of their babies. Article 6 paragraph 1 states that ‘Every human being has the inherent right to life. This right shall be protected by law. No one shall be arbitrarily deprived of his life.’ Paragraph 5 of the same article provides in part that “Sentence of death shall not be carried out on pregnant women. The rationale too, is that the unborn child is not to suffer the effect of the crimes of the mother. From the various statutory provisions discussed in this chapter, there seems to be an inert desire on the side of the international community to accord legal personality on the unborn child but obviously, the courage to take that bold step is lacking. Target-4 of the third Sustainable Development Goal (SDG 3.4) which is aimed at promoting both the reduction of premature mortality and ensuring mental health and well-being is an invitation to various states of the international community in their domestic and international legislations not to leave the unborn child behind as deserving legal personality for a sustainable and healthy development.

7. How does the Nigerian Criminal Law legally protect the Human Rights of the unborn child?

Under the Nigeria Criminal Law, the unborn child is recognised as an entity with life worthy of legal protection but ironically having no legal personality and no right to sue and be sued. The Nigerian criminal law especially sections 228 and 229 frowns at abortion so that abortion, including attempts to procure abortion, is a felony in Nigeria. Yet under section 307 of the same Criminal Code, taking the life of an unborn child is not an act of murder as long as the unborn child has not completely proceeded in a living state from the body of its mother and therefore not yet a person capable of being killed. The unborn child does not have right to be represented in any action through his/her *guardian ad litem* until in the language of the code he/ she completely proceeds in a living state from the body of his/her mother. In *R v Edgal & Ors.* (1938), it is unlawful in Nigeria to destroy the unborn child except for the purpose of preserving the mother’s life. Section 297 of the Criminal Code removes criminal liability for death resulting from reasonable surgical operation to save the life of the mother or the child. However, according to section 307 of the Criminal Code, a child becomes a person capable of being killed when it has completely proceeded in a living state from the body of his/her mother, whether it has breath or not, whether it has an independent circulation or not, and whether the naval-string is severed or not. That notwithstanding, by section 328 of the Criminal Code, any person who when a woman is to be delivered of a child prevents the child from being born alive by any act or omission of such a nature that if the child had been born alive and had then died, he would be deemed to have unlawfully killed the child, is guilty of a felony and is liable for imprisonment for life.

However, it is to be noted that a woman who procures abortion to kill the unborn child can be sued, and another person who unlawfully procures the killing of the unborn child on the woman, can be sued for carrying out that act on the woman not necessarily on the unborn child. Thus, it could be argued that under the Criminal Code and in matters of procuring abortion the law is unconsciously according the unborn child the right to have his / her interest protected and be represented by someone else and that person could be his / her *guardian ad litem*. However, such interpretation will not succeed as a case of murder in the face of section 307 of the Criminal Code which says that a child becomes a person capable of being killed when it has completely

proceeded in a living state from the body of his/her mother. It can only succeed as it is. Furthermore, under section 230 of the code any person who unlawfully supplies to or procures for any person anything whatever, he knows that it is intended to be unlawfully used to procure the miscarriage of a woman, whether the woman is or is not with child is guilty of a felony, and is liable to imprisonment for three years. Thus, mere supply of the substance knowing that it will be used for the unlawful purpose is criminal. It is submitted that the phrase whether “she is or she is not with child” here means that it is immaterial whether the woman is pregnant or not provided the act is done unlawfully with the intention of terminating a pregnancy. In *R v Whitchurch (1886-90)*, a woman who attempts to procure abortion on self could also be charged with conspiracy to commit the offence with another. Thus, procuring abortion is unlawful except for the purpose of preserving the life of the mother. The word “unlawfully” is not defined and it is impossible to find out expressly within the Code the circumstances in which any case of these things may be “unlawfully” done (*R v David Degal*). Thus, the court held in *R v Edgal & Ors* that “unlawfully” within the context of section 230 of the Criminal Code means “except for the purpose of preserving the life of the mother”. In *R v Mills (1963)* “Supplies” has been held to mean supply to another. Under the code, it is not necessary for the prosecution to prove that the thing used to procure the abortion is noxious.

In *R v Edgal & Ors.*, it was held that the word “unlawful” is not a meaningless word in the context of section 230 of the Criminal Code. It necessarily follows that there may be a procurement of abortion which is lawful. In explaining the circumstances where the procurement of abortion may be unlawful the judge said: “my view is that ...it has always been the law that on a charge of procuring abortion the crown has to prove that the act was not done in good faith for the purpose of preserving the life of the mother.” The Judge admitted that the word “unlawfully” is not defined in the Criminal Code, and criticized the indolent style of the draftsman. The judge in his preference to rather base his decision on the meaning of the word at common law held and concluded thus:

“in short the word” unlawfully in section 230 must be taken to have one meaning. It cannot mean “unlawfully” as in the code defined,” for there is no definition. It must therefore be taken to mean “unlawfully according to the law in force in Nigeria by virtue of section 12 of the Protectorate Court Ordinance.”(The Colony and Protectorate of Nigeria. The Supreme Court Ordinance and Rules of Court, 1914) (Nwamara).

It is submitted that the law should boldly, consciously and categorically accord legal personality on the unborn child so that section 228 and 229 of the Criminal Code will be a reality and work towards their sustainability. Section 228 of the Criminal Code provides that any person with intent to procure miscarriage of a woman whether she is or is not with child, unlawfully administers to her or causes her to take any poison or other noxious thing, or uses any force of any kind, or uses any other means whatever, is guilty of a felony and liable to imprisonment for fourteen years. The word “procure” has been defined in *Whelan v FTS (Great Britain) Ltd.* (1961) as “obtain by care and effort.” It can be more simply paraphrased as “see to it.” In other words it means to get possession from another person of something which the person and in this context the “accused” has not already got; it does not cover the case of a person who already has an instrument somewhere and produces it for the purpose of sterilizing it or for some other purpose(*R v Mills*). In order to constitute the offence of procuring or supplying a noxious thing, knowing that the same was intended to be used with intent to procure a miscarriage, the court in

R v Cramp and in R v Henna (1877) held that the substance must be of a noxious character in the quantity in which it was supplied. Whether the thing administered is a noxious thing or not may depend upon the quantity administered. Belief of noxiousness is not sufficient according to *R v Isaac* (1861), if in fact the substance is not noxious under section 228 of the criminal code but such facts, however would, it seems, sustain a charge for attempting, or for inciting to procure abortion as was held in *R v Brown* (1899). To constitute administering poison there need not be a manual delivery. According to *R v Dale* (1852), it is sufficient that the poison is prepared and intentionally left in place where it would likely be taken. The word administer includes conducts which brings the noxious thing into contact with the body, whether directly or indirectly (Nwamara). Furthermore to “cause” has been held *per* Lord Wright in *McLeod (or Houston) v Buchanam*, (1970) to involve some express or positive mandate from the person “causing” to the other person or some authority from the former to the latter, arising in the circumstances of the case.

In Nigeria, the law seems to be more comfortable in calling the unlawful act of terminating the life of an unborn child abortion but not “killing” since the child has not proceeded completely from the body of the mother. Thus, the act of abortion is criminal as long as it was done unlawfully outside the context of preserving the life of the mother. Ironically, abortion and unwarranted miscarriages abound today, the life of the unborn child is always under threat of termination and extinction. There is every need to provide the unborn child with every reasonable thing that will enhance his/her sustainability and healthy development, protect him/her and possibly prosecute direct and indirect threats on him/her including unlawful termination of their lives. The unborn child deserves to be accorded legal personality for sustainable and healthy development. It will accord the unborn child the right to sue for his/her right and/or have guardian ad litem to stand on his behalf.

8. Conclusion and Recommendations

i. Conclusion

Law protects both the weak and the strong without discrimination, so the unborn child is not an exception to that legal protection. The chapter discussed the relevance of guaranteeing the Human Right to Life of the unborn child towards attaining a sustainable and healthy human development. In doing so, six (6) key research questions were formulated and analyzed as headings in this present chapter. This chapter infers the need to uphold the respect for the full protection of unborn children at all time, which could ensure the Human Rights of the Unborn to Life. Otherwise, current global scenarios would jeopardize future generations from enjoying any achieved benefits of the current Sustainable Development Goals if the heinous crimes that are being perpetuated by the present human generation as enabled by extant national abortion laws, are allowed to be continued, unabatedly. This is because, abortion laws in many countries around the Globe could drastically reduce future human populations, if the Human Rights of the Unborn Child is not upheld by the United Nations as infer this present chapter. In conclusion therefore, the outcome of this study underpins the relevance of both international and national legislations that would guarantee the Human Right to Life of the unborn child towards ensuring sustainable human populations that would enjoy the full benefits of any achieved global objectives of Agenda 2030 at their own time.

ii. Recommendations

Therefore, there is the need for a universal legal protection of the rights of the unborn child for its safety, sustainability and healthy development, from pregnancy until after birth in line with the SDG 3.4. Hence, it is hereby recommended that:

- i. The unborn child should be accorded legal personality in Nigeria and internationally so as to enhance adequate protection across all developmental stages of human life and living.
- ii. The legal personality should accord the unborn child the right to sue and be sued and be represented by the guardian ad litem.
- iii. The United Nations Human Rights Council should appoint a Special Rapporteur on the Protection of Unborn Children to monitor observance of the principles contained in relevant international instruments.

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Chapter 30

Assessing the Nexus between Attaining Food Security and Eradicating Poverty in Nigeria

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Abstract

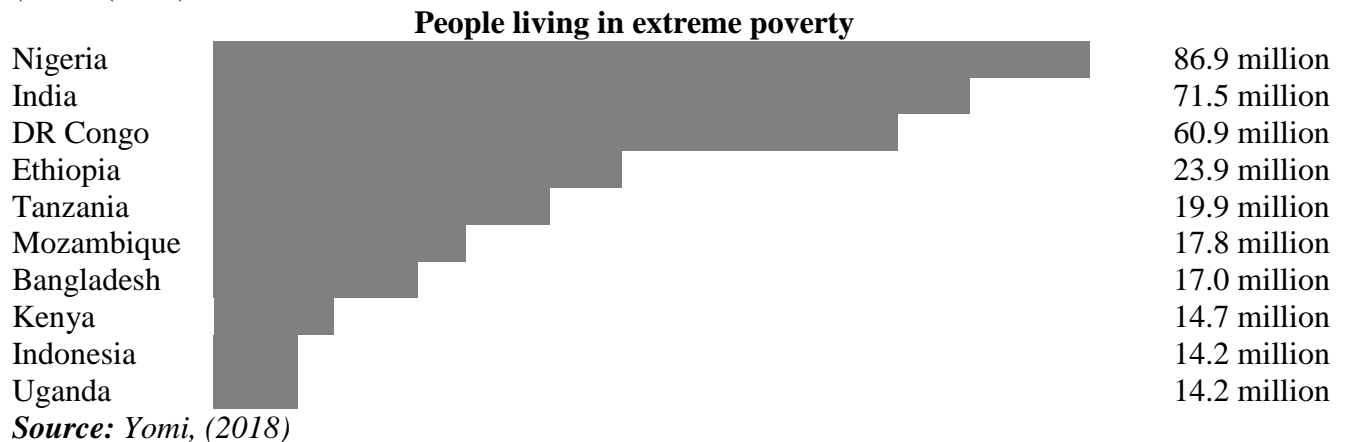
Food insecurity is one of the factors responsible for the increasing poverty rate in Nigeria. On this premise, this present chapter focuses on assessment of the role of food security to poverty eradication in Nigeria. It explores the nexus between the food security and poverty eradication. Climate change, natural disasters, corruption, issues surrounding use of modern farming technologies, poor access to credit facilities by smallholder farmers and policy inconsistencies are identified as some impediments facing the attainment of food security and poverty eradication in Nigeria. It is concluded that food security is one of the mechanisms that could empower people through income generation, provide employment opportunities, improve welfare and living standard of people and thus, reduce hunger and contribute to eradicating poverty in Nigerian communities.

1.0. Introduction

Prior to the oil boom of the 1970s, Nigeria was relying on agricultural sector development for the purpose of achieving self-sufficiency in food production and for foreign exchange earnings (Insert two relevant sources). Attah (2012) noted that at independence in 1960, little was known of petroleum as a source of revenue for the Nigerian economy and there was sustained emphasis on agriculture to the extent that Nigeria was a major exporter of such agricultural products as palm produce, cocoa, groundnut, cotton and rubber. Furthermore, Attah asserted that through the national agricultural sector sufficiently produced both cash crops and food crops like yam, cassava, maize, millet, sorghum and soya beans to the extent that there was almost no need for food importation. However, during the oil boom in early 1970s, the agricultural sector was neglected which resulted to food insecurity in Nigeria. As such, Nwozor, et al., (2019) expresses a worsening status for the Nigeria's food and nutritious insecurity Sector. Nwozor et al., (2019) observed that, between 2016 and 2018, the total number of undernourished Nigerians was 25.6 million. Hence, insufficient food supplies and increasing prices of available food stuff have both made many Nigerian smallholder families to become poor.

Generally, poverty manifests in the form of low income (Source?), unemployment (Source?), hunger and malnutrition (Source?), ill-health (Source?), lack of access to education (Source?) and other basic health services (Source?), increased morbidity and mortality rates in women and children (Source?), unsafe environment (Source?), among other factors. Uma et al., (2013) posited that Nigeria as a country is characterized by low per capita income, highly unequal income/wealth distribution, low standard of living, lack of infrastructure, under utilisation of natural resources, dualistic economic pattern and most importantly, lack of capital as a result of

general poverty. Similarly, Asaju and Adagba (2014) stresses that in Nigeria where about 70 percent of the populace still wallow in poverty; income inequality gap is still widening from 0.429 in 2004 to 0.4471 in 2010, unemployment (54%) and maternal mortality rates are increasing with life expectancy Nigerians now put at 52 years (Asaju & Adagba, 2014). Worse-still, Nigeria, according to the Global ranking rating has 86.9 million poor Nigerians (Yomi (2018):



The 86.9 million Nigerians now living in extreme poverty represent nearly 50% of 180 million national population figure (Source?). In addition, Duke and Okafor (2020) stresses that poverty is a social problem and its eradication has been one of the major issues that occupies a significant place in the scale of preference of national developmental policies. Based on the foregoing premise, how can attaining food security in Nigeria further contribute to eradicating poverty at smallholder families' level in the country? In an attempt to answering the foregoing question, this present chapter therefore, examines the nexus between achieving food security (SDG – 2 and poverty eradication (SDG – 1) in Nigeria.

2.0. Conceptual Clarifications

2.1. Food Security

According to Hyacinth (2020), food security exists when individuals and households in a country have access to sufficient, nutritious and safe food that can keep body and soul together for a healthy life style. Metu, et al., (2016) asserts that, food accessibility depends on two major conditions as follows: economic access and physical access to food. Metu et al., explains economic access to mean one's income which depends on the price of food and the purchasing power of the individuals; whereas physical access depends on the availability and quality of infrastructure needed for the production and distribution of that particular food stuff. Again, Meanwhile, Matemilola and Elegbede (2017) noted that accessibility refers to economic, social and physical access to food by all people at all times, while utilization refers to the pattern in which the body makes use and benefits from the various food nutrients. Eme, Onyishi, et al, (2014) expresses that, food security is not simply having sufficient and adequate quantities of our various staple foodstuffs but also entails access the food items at affordable prices. In the same vein, Ojo and Adebayo (2012) refer to food security as not only to an adequate aggregate supply of food, but also condition in which "all people at all times, have both physical and economic access to basic food."

In a nutshell therefore, food security can be referred to absence of fear of hunger or malnutrition among vulnerable people in a particular nation. Accordingly, Khanam, et al, (2020),

food security is defined as physical and economic access to sufficient food to meet the dietary requirements for a productive and healthy life. Prior to that definition by Khanam et al, Nwozor, et al (2019) conceptualized food security as the availability and adequacy of food supplies to sustain a steady expansion of consumption and accessibility by vulnerable people for active healthy life.

2.2. Poverty

Poverty depicts a condition in which people are unable to acquire the basic necessities of life. According to Akinmulegun (2014), poverty is the economic condition of lacking predictable and stable means of meeting basic life needs. In other words, it is a situation where the means of livelihood of individuals are sufficient to provide for their basic needs. Uddin (2013) defined poverty as deprivation of common necessities that determine the quality of life such as; food, clothing, shelter, lack of access to safe drinking water, etc. In summary, Taiwo and Agwu (2016) an all-encompassing explanation of poverty as: “a condition where an individual is not able to cater adequately for his/her basic needs (such as food, clothing and shelter), and at the same time, meets his/her social and economic obligations; thereby, resulting to a lack of a gainful employment, credible assets and self-esteem.” Poverty is also a situation where individuals have inadequate access to health care and other basic social amenities such as education, potable water and sanitation) because, s/he cannot afford to pay for such basic public services. In general, a poor citizen usually has limited chance of advancing his/her welfare beyond his/her potential and capabilities”. According to Ozoh, Metu et al., (2020), poverty is the lack of income or shortage of assets; the lack of competence, confidence, disempowerment among others.

Poverty in Nigeria has many dimensions and manifestations which relate to: joblessness, over-indebtedness, economic dependence, lack of freedom, inability to provide for one’s basic needs, or own assets (Olarinde, et al., 2020). Poverty can be categorized as: extreme, moderate and relative types. According to Asuquo and Udeme (2017), extreme poverty means the household cannot meet basic needs for survival. Such people are perpetually hungry, lack access to healthcare; they lack amenities for safe drinking water and sanitation. Similarly, the smallholder families experiencing extreme poverty cannot afford to acquire basic education and comfortable shelter for their households. On the other hand, Asuquo and Udeme (2017) refer to moderate poverty as the condition of life in which basic needs barely are met. Lastly, a relative type of poverty is considered when a household income level falls below a given proportion of average national income. According to Agboola and Balcilar (2012), relative poverty involves the lack of or denial of resources, Human Rights, goods and services, and the inability to participate in the normal relationships and activities available to the majority of other people within a particular society, whether in economic, social, cultural, or political arenas.

3.0. Exploring the Nexus Between Food Security and Poverty Eradication in Nigeria

Food security and poverty are inversely related. This means that, an increase in the rate of food security is likely to lead to a decrease in poverty rate (Source?). The direct effect of food security on poverty eradication is improvement of the income of those involved in food production, transportation and distribution. Metu et al., (2016) posited that food security leads to sufficient income needed to meet household basic needs in Nigeria. The income generated by individuals involve in food production can be used to fulfill their basic necessities and also raise the living standard which can eradicate poverty in their lives.

Hence, food is basic necessity for human existence. Eme, Onyishi, et al, (2014) posited that, in Nigeria, food accounts for a large and increasing, share of family budgets for poor and urban families. Attaining food security should ensure that, the prices of staple foods are stable and affordability towards enhancing the purchasing power of sufficient acquisition of food items at all times. According to Andohol (2012), food security sustains a steady expansion of food consumption and consequently, offsets any fluctuations in food production and relative prices. Such a situation could eliminate hunger or malnutrition among vulnerable people in a society. People who are well nourished are usually, more physically and intellectually capable of engaging in productive activities that can enhance their livelihoods; by extension, living above poverty threshold (Oriola, 2009). Likewise, Oriola (2009) noted that if a nation is to escape famine and reduce poverty, food security must be boosted. Therefore, food security is closely linked with poverty eradication and because, accessibility to food items is contingent on having the means to acquire it.

Food security generates more employment opportunities for those who engage in food production, distribution and transportation. Attah (2012) noted that food security strives to create employment opportunities in both the rural and urban areas. Food security results to self-sufficiency and surplus for increase foreign exchange earnings. Foreign exchange earnings enable a country to import goods required to promote industrialization, with a view to further creating employment opportunities.

One example of the contribution of food security to poverty eradication is that posited by Nesengani et al. (2016) which is anchored on the creation of employment opportunities. Also, outcomes of Food security can serve as sources of raw materials for the industrial sector (Source?). Both federal and state governments can generate revenues through taxes from the industrial and agricultural sectors (Source?). Food security improves the welfare of people in the society. Adewuyi and Hayatu (2011) added that the welfare of people can be positively influenced by placing priority on increased food production and regulated prices of foodstuffs.

4.0 Impediments to Food Security and Poverty Eradication in Nigeria

Poverty can be a big impediment to food security and vice versa. Poverty limits the income available to households to engage in food production. Discussed below, are seven (7) impediments relating to attainment of SDG -1 (poverty eradication) and SDG – 2 (Zero Hunger) in Nigeria.

4.1. Climate change and natural disasters: These twin factors are impediments to food security and poverty eradication in Nigeria. Awosusi, et al., (2015) pointed out that, incessant occurrences of the factors of climate changes are leading to shortage of rainfall, persistent drought in Northern part of the country and excessive rainfall and flood in southern and middle belt regions of the country contributed immensely to low food production in Nigeria.

4.2. Drought and Flooding: Matemilola and Elegbede (2017) noted that the impact of climate change and natural disasters such as drought and flood I are more pronounced in regions where agriculture highly depends of rainfall/ In this era of climate change impacts, reoccurring droughts (in northern Nigeria) and floods (across Nigeria) jointly constitute a major threat to food production and availability as, excessive flood can lead a significant loss of farmlands and thus, current hike in food prices. In the same vein, Eme, et al., (2014) asserts that floods are among the

most devastating environmental disasters in the world, claiming more lives and causing destructions to farmlands.

4.3. Issue of Corruption in Nigeria: Corruption has been a serious challenge to food security and poverty eradication in Nigeria. Metu et al., (2016) posited that corruption in Nigeria has been on the increase as money budgeted for agricultural development is always diverted for private uses, thereby, contributing to a decay in agricultural infrastructure needed for food production and for basic social infrastructural; development where majority of smallholder farmers reside. Ojo and Adebayo (2012) also noted that, contracts for developments of river basins, dams, silos and fertilizer are usually siphoned by corrupt public officers. Godson-Ibeji et al., (2016) highlights other areas of corrupt practices in Nigeria to include: farm inputs such as fertilizers, pesticides, herbicides, insecticides rarely get to the targeted audience at the right time and in the right quantity. Another scenario is that farm inputs are mostly diverted from targeted communities by public officers, who later sell such diverted materials at very exorbitant prices to rural smallholder farmers; thereby further impoverishing them.

4.4. Lack of farming technologies and technical knowhow: The use of modern farming technologies and technical know how in Nigeria is very low. The modern farming technologies are very expensive and many smallholder farmers cannot procure and maintain the facilities for their farming activities. Most Nigerian farmers operate with locally made tools such as hoes, cutlasses, rakes, axes, and machetes in cultivating their crops. Adegbola et al., (2011) pointed out that most Nigerian farmers are not well-informed on how to operate modern agricultural inputs and machinery to boost food production. As a result, many farmers in Nigeria use manual tools and labour for their farming activities.

4.5. Poor access to credit facilities: Osabohien et al. (2018) stress that, inaccessibility of credit facility by farmer's affects food production in the sense that, smallholder farmers experiencing capital constraints might tend to use a lower level of farming inputs in the food production process. Most of the credit facilities available are mostly from the Federal Government made accessible through the Bank of Agriculture (BOA). BOA usually subjects interested smallholder farmers to rigorous conditions before accessing credit facilities (Odoh, 2014). As a result, smallholder farmers most times are unable to meet the conditions of BOA for accessing loans

4.6. Insecurity in Nigeria: Increasing insecurity in Nigeria is contributing to increase in the displacement of farmers fertile agricultural lands. Matemilola and Elegbede (2017) expressed that civil insecurity borne out of the Boko Haram insurgencies has persisted in some parts of Borno, Yobe and Kano states, thereby, causing their affected inhabitants to be displaced from their ancestral and farming communities. Such a situation limits production of food below average; restricts market and trade activities; and causes higher food prices in such troubled communities in comparison to other areas of the country. Displacement of farmers and abandonment of farm settlements as a result of insecurity can contribute to food shortages in Nigeria.

4.7. Policy inconsistencies by both federal and state governments: A frequent policy change in agricultural policies is setback to attaining food security in Nigeria. Matemilola and Elegbede (2017) stressed that each time a new government takes power, the previous food and agricultural policies are abandoned and new ones are set-up. In addition, Matemilola and

Elegbede noted that there are, unfortunately, no guarantees that the new policies would be better-off, in fact often times, such policies turn out to be worse.

5.0. Measures Needed to Attain Food Security and Eradicate Poverty in Nigeria

Food security could be attained through policies that encourage mechanization of agriculture. Eme, Onyishi et al, (2014) posited that deliberate government policy of restoring zero duty on agricultural machinery and equipment including fishing boats, agro-chemicals as well as pesticides can encourage food security to eradicate poverty in Nigeria.

Consequently, governments should timely and adequately provide agricultural machines and input such as fertilizer machine, tractors, harvester, grass cutting machine, seeds and seedlings for smallholders' farmer (Amaechi, 2018). Introduction and sustenance of agricultural inputs subsidies by Government on modern agricultural equipment could encourage large a scale food production and thus, contribute to achieving food security and reducing hunger and poverty in Nigeria. Educating of peasant farmers on modern methods of farming could encourage food security and eradicate poverty in Nigeria. Attah (2012) noted that peasant farmers need to be properly informed of the introduction of new improved crops and seedlings, different kinds of fertilizers and their uses as well as timeliness of use, the storage systems under which different post-harvest farm produce can survive over a relatively long period of time, the basic technology that can enhance their farming activities and the marketing to improve food security. Therefore, education of farmers can help to improve farmers' productivity and incomes. Danso-Abbeam et al., (2018) pointed out that education of smallholder farmers and the dissemination of metrological information can enhance farmers' capabilities to developing technical and managerial skills for increasing farm productivity, revenue, minimizing food insecurity and eradicating poverty.

Provision of credit facilities to farmers could encourage food production and food security. Both Osabohien, Afolabiand and Godwin (2018) and Matemilola and Elegbede (2017) averred that agricultural credit facility to farmers in form of making funds available to farmers should be able to enable them buy the required farm inputs such; fertilizer, quality seeds, herbicides, pesticides and working implements as hoes, cutlasses, and water pumps. Osabohien et al., (2018) specifically expressed the need for the provision of credit facilities to farmers during harvest and storage period helps to prevent spoilage and preserve the quality and nutritional value of food.

Attah (2012) pointed that provision of infrastructures, such as linking up the rural areas through new access road, sand grading the old ones, supplying energy through rural electrification, distributing farm inputs like seedlings, fertilizers, insecticides, herbicides, and provision of improved storage facilities to curb the issue of post-harvest losses, easy access to markets for the sale of farm produce when desirable and procurement of farm inputs, would boost agricultural production and further improve incomes smallholder farmers thereby, enhancing their livelihood statuses that can further lead to poverty eradication in communities,

Conclusion

Food security has indisputable impacts on poverty eradication. Food security is one of the mechanisms that can empower smallholder famers through improved income generation, provide employment opportunities, improve welfare and living standard of people and also reduce hunger and poverty in Nigeria. No meaningful national poverty eradication objective can be achieved without strengthening the enabling factors for attaining food security, being an offshoot of agricultural programmes and policies in that country.

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