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Regulatory Initiatives for Driving Water, Energy and Food Nexus: The Nigerian Episode

Sophia Abiri-Franklin
sophiaabiri@gmail.com
and
Olubukola Olugasa
University School of Law, Babcock University, Nigeria

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Abstract: Water, energy and food are deeply connected and are fundamental to the sustainable development in all societies. This connection is recognized by the United Nation (UN), as part of the 17 Sustainable Development Goals (SDGs) adopted in 2015. Achieving this goal is a major concern to the global community. However, there is limited access to these three essential resources due to incessant growth in population and climate change. As a result, there are growing concerns regarding the future, these three elements and sustainable development. Advanced technology development in the era of artificial intelligence (AI) has proven to be the greatest panacea to the water-energy-food challenge. This paper examined the nexus between the water, energy, and food sectors; identifies the challenges facing them, and proposes legal regimes to promote the use of local technology (taking into consideration the low level of technology in Nigeria in the era of AI) and adequate regulation to ensure food, water, and energy security in Nigeria.
Keywords*: Water-Energy-Food, Regulation, Local technology, Environmental justice, Sustainable development, Nigeria*

Introduction

Water, energy and food (WEF) are fundamental to human development, poverty alleviation, economic and sustainable development of any society. At the heart of the 2030 Agenda for Sustainable Development adopted by all member states of the United Nations in 2015 is the 17 Sustainable Development Goals (SDGs) or Global Goals which provides inter alia, for the security of water, energy and food as strategies to improve health, spur economic growth, reduce inequality and climate change in the world. Worldwide projections demonstrate that there will be significant upsurge in the demand for WEF in the coming years, owing to the weight of population growth, climate change, urbanization, industrialization, cultural and technological advancement, and global/international trade (Vishwakarma, Khare, & Haghighi, 2020).

According to the Food and Agricultural Organization (FAO), 70 percent more food production would be required to meet the nutritional needs of the growing world populace by 2050. The International Energy Agency, predicts that global energy utilization is anticipated to grow by up to 50 percent by 2035 while total worldwide freshwater consumption is projected to rise by 10 percent by 2050 (FAO, 2017). This demands management and adequate WEF policies and regulatory frameworks.

The methodology adapted in this paper is doctrinal. Doctrinal research is a traditional epistemological approach in the legal discipline. It is alternatively known as 'theory-testing' or 'knowledge building. It is concerned with the analytical engagement of laws, relevant cases and for research purposes (Kharel, 2018). The authors made use of library based sources such as Ebscohost and HeinOnline in conducting the research. The paper seeks to explore how technology checked by proper regulatory framework and policies can be effectively employed to ensure WEF security in Nigeria.

Water, Energy and Food: The Nexus

The WEF nexus represents the bedrock of sustainable human, economic and environmental development of any nation. It connotes a structure for investigating the dynamic connections between water, energy and food framework and creating systems for practical and sustainable advancement of the resources. In essence, the nexus refers to the connection between water, energy and food and the interdependence between them. These three resources are so deeply interconnected that they have been identified as the main constituent pillars of any successful society (Rabi and Bassel, 2016). Understanding the nexus and managing them effectively is basic to sustainability in the sectors and achieving the SDGs. Any impact on one affects the other two.

Water Sector of the Nexus

Water is very important in the production of food and energy. For example, energy is produced using hydropower plants which utilizes reservoir of water. Hydropower occupies a large percentage in the energy mix of most countries, including Nigeria. Hydropower is the 2nd largest source of electricity production in Nigeria. For food production, Farmers need access to water for irrigation to grow their crops. Crop cultivation in Nigeria is mostly rain fed as irrigation farming is yet to be fully imbibed by local farmers who make up the bulk of farmers in Nigeria. This has led to low farm output as crop cultivation is seasonal and farming is carried out mostly during the raining season which lasts between 4 to 6 months in Nigeria, hence the need for other water sources to support irrigated agriculture (Kougias, Szabo, Scarlat and Moner-Girona, 2018).

Energy Sector of the Nexus

Agriculture has advanced in the past century into mechanized agriculture leaving behind the era of crude farm implements such as hoe, cutlasses, sickles etc. However, in Nigeria, many farmers still make use of these manual implements in their operations, leading to low farm output. Mechanized farming involves the use of mechanical and electrical energy using advanced technological machines, tools and techniques in the cultivation of plants and animal rearing which results in improved productivity, more farm output and invariably, increase in the economy of the country. Examples of machines and tools used in mechanized farming include: tractors, ploughing machines, boom sprayers, water pumps, etc. The machinery for mechanized farming are mostly fossil fuel energy dependent (Kougias, Szabo, Scarlat and Moner-Girona, 2018).

One of the major effects of poor storage of agricultural products is the loss in both the quality and quantity of the products over time. When viewed in monetary terms, this amount to huge losses for the economy. Energy is also required for the production of fertilizers, pumping of water for irrigation farming, food transportation and distribution services, etc.

Food Sector in the Nexus

The increase in the world population which is exacerbated by the increased income and high standard of living has increased the pressure on the world's resources most especially, water, food and energy leading to over-

exploitation, deforestation and degradation in the ecosystems resulting in climate change. "So, there is increasing risks associated with disasters such as droughts, desertification and floods" (Office of the Senior Special Assistant to the President of Nigeria, 2017).

WEF Challenges

The WEF sectors have been ravaged with challenges not just in Nigeria, but in the global communities. The combined effects of growing population, rising incomes, rural to urban migration, poor regulatory framework and inadequate government policies are but a few of the challenges afflicting the WEF sectors in Nigeria. However, the two most prominent challenges facing the WEF sectors worldwide is the problem of incessant population growth and climate change.

Incessant Population Growth

The global population (which is presently 7.7 billion) is expected to reach 9.7 billion in 2050 and (UN, 2019). This boom in global population is expected to increase the constraints on the availability, accessibility and adequacy of WEF due to expected increase in demand of these resources and decrease in its supply. According to the UN, globally, one in nine people in the world today, that is, 795 million people are undernourished. Oguntegbe, Okoruwa, Ogheneruemeand Olagunju (2018) predicted that there is a tendency for the earth's population to outgrow the capacity to feed it, especially, where there is no political
will by majority of the governments worldwide to legislate on birth control.

Although 70% of the earth's surface is water, 2.5% of it is fresh. Water is relatively scarce. According to WaterAid, 60 million Nigerians lack access to clean water. The Energy sector is not left out, according to USAid (2019), Nigeria current access rate to electricity is 45% and 20 million households are without power in Nigeria. The electricity generated in Nigeria is not sufficient to cater for the energy needs of its almost 200 million occupants.

Population outburst has been attributed to lack of legal and policy initiatives on birth control, religious ignorance, immigration, education, financial incentives, coupled with low mortality rate (Oguntegbe et al. 2018). This has led to a continuous growth in the population of Nigeria putting more pressure on the available WEF resources. In the coming decades, per capital WEF demand will increase tremendously as a result of the fast growing population. This will increase the pressure on the already limited resources, affect food production, and lead to water scarcity and energy depletion.

Climate Change

The world has advanced very far in technological and scientific inventions since the industrial revolution in the latter half of the 18th century. This advancement has greatly impacted not only human life, but also the atmospheric condition and the environment albeit negatively in the latter.

Larry, Swatuk and Corrine attributed the depleted natural capital and ecosystems around the world to agricultural, industrial and household practices. Climate change has very severe impact on WEF security. It can lead to WEF scarcity and shortage. The adverse effects of climate change such as drought, flooding, irregular rainfall pattern and increase in temperature and humidity will have a huge impact on WEF availability and sustainability. Climate change will lead:

> To a reduction in agricultural productivity, increase in crop water requirement, decrease in soil moisture availability, and reductions in hydropower generation. It also reported that there will be significant decrease in surface and subsurface water resources due to climate change which will significantly impact food production and energy generation (Keulertz and Woertz, 2015).

These challenges as discussed above have inhibited global economic growth and sustainable development especially in Nigeria, and have increased the clamor for improved WEF technology and regulations that is environmentally friendly and will lead to environmental justice.

Local Technology

To ensure WEF sustainability, it is imperative that the use of modern technology be adequately utilized to manage these limited resources. From time immemorial, Nigerians have utilized local methods and facilities in the production, storage and preservation of WEF. These traditional methods which have evolved over time have been passed down from one generation to another. These methods include:

i. The use of solar energy in drying farm produce especially grains;
ii. The use of heat energy to preserve animal products such as meat and fish.
iii. The use of adequately aired barns to store root and tuber crops such as yams and potatoes.
iv. The use of clay pots, calabashes and shallow wells to store and preserve water.

v. The use of stones, rocks, dry wood, cloths and oil lamps to produce heat energy.
vi. The utilization of wells, rivers, streams, lakes, ponds, seas and waterbeds as a source of water for
vii. drinking, food and personal hygiene etcetera.

In Nigeria, the prominent structures used by local farmers for food storage are:

granaries, mud rhombus, thatched rhombus, platforms, cribs, earthen pots or baskets, domestic or indoor storage such as plastic containers, gourds, earthen pots and metal containers. Other storage structures include bags, which could be made of jute, hessian, polyethylene or plant fiber (Mobolade, Bunindro, Sahoo and Rajasheka, 2019).

These methods and facilities are not foolproof as they give way to insect, pest infestation and moisture absorption of the stored products. The result is waste of produce agriculture and reduction of the quality and quantity of products, which leads to huge economic losses, illnesses and death in extreme cases.

Nigeria's food insecurity is on the rise, according to World Bank's Development Indicators as cited in Falodun (2019), almost 8 percent of Nigeria's population was found to be undernourished in 2015 as compared to 6 percent in 2007 (Falodun,2019). Nigeria has extensive surface water resources. Odume and Slaughter (2017) reported that Nigeria has 215 cubic kilometres a year of available surface water which is a lot higher than many African countries, particularly those in the southern and northern regions of the continent (Odume & Slaughter, 2017). South Africa, for example, has about 49 cubic kilometres a year. One would imagine that Nigerians have plenty of water to drink. But this is not the case. In fact, only 19% of Nigeria's population has access to safe drinking water. Traditionally, water is sourced from wells, streams, rivers, lakes and rocks. During the rainy season, rain water and water from wells and streams is collected and stored in clay pots, calabashes and shallow wells. However, during the dry season, most rivers, streams and wells dry up resulting to water scarcity. A not rare and unfortunate situation appears when a community that has access to clean source of water cannot extract it due to lack of technological know-how and economic reasons: in such occasions people resort to accessible surface or shallow waters that can be manually collected. It is this time of the year when mechanised equipment is particularly important to secure water supply. Mechanised pumps have a much higher yield than hand ones and more importantly the required capacity to extract water from deep boreholes and larger distances (Odume & Slaughter, 2017).

Due to the geography and climate in Nigeria, some regions are relatively blessed with water while others face drought and scarcity most especially in the dry seasons. The most negatively affected region is Northern Nigeria which is faced with drought and desertification. According to Alhaji Aminu Bello Masari, Governor of Katsina State, there is a need for a strategic plan and implementation framework to address the decline in water in the state (Idris, 2019). This shows that we cannot continue our reliance on Nigerian local technology in its current state in securing the WEF resources. It is therefore imperative that sustainable advanced technology which is environmentally friendly be utilized in managing these resources so as to ensure WEF security.

To adequately address the problem posed by water scarcity in Nigeria, the adoption of new technologies and modernizing infrastructure including the utilization of solar pho-tovoltaic water pumping systems (PVWPS) will have to be installed in communities in the 774 local governments in Nigeria. The Katsina State Government in a bid to curb the challenges faced by water insecurity in the state have provided over 3,500 hand pumps and over 100 solar hand pumps to people of the state (Idris, 2019). Nanotechnology should also be employed to purify drinking water in Nigeria.

Modern technology such as the use of aeroponics farming should be encouraged and the government should allocate more funds to research on both the ethical and health implications of consuming crops produced through aeroponics farming. Aeroponics farming requires minimal water, electricity, and labour, less susceptible to pests yet the crops are more easily realised (Falodun, 2019). PS Nutraceuticals, a Nigerian company founded in 2016 is currently using aeroponics farming in crop cultivation. According to Samson Ogbole, a co-founder of PS Nutraceuticals, aeroponics farming is not meant to replace the soil but to complement it. Using aeroponics, food is produced all year round (Falodun, 2019).

Adopting certain modern technologies such as humidifiers, temperature-controlled containers, modern irrigation, etc. for local farmers would promote food security. The Food Security Portal (FSP), reported that of the available land for agriculture in Nigeria, just about half is currently utilized. Also, Kougias *et al* (2018) recommended that rain fed agriculture should be complimented by solar pho-tovoltaic water pumping systems (PVWPS). However, increasing food production alone will not ensure food security. Access of the food by the populace is the ultimate.

Nigeria is blessed with several energy sources. However, the country's primary energy source is fossil fuels. There cannot be a denial of the effect of pollution which has originated from relying heavily on fossil fuels, however, the Nigerian legal frame work could be strengthened to encompass stringent penalties to force the international oil companies (IOCs) and all other players in the energy sector to comply with corporate governance ESG best practices and limit to the barest minimum if not totally eliminate gas flaring and other resultant causes of pollution. Also, cost-effective and environmental friendly renewable energy technology like solar energy, tidal and wind energy, bio space-based energy, and hydropower, etc. can be adopted in replacing fossil fuel gradually, and thereby reducing environmental pollution, preventing toxic gas emission, mitigate climate change and its effects and foster WEF security.

Regulatory Initiatives Driving Wet in Nigeria

Notwithstanding Nigeria's abundant natural resources, it has remained debased by high percentage of poverty stricken population that could not afford the base US$1.25 per day and lack food. The reason can be easily traced to the failure in WEF management owing to lack of technology-know-how. According to USAID (2019), energy consumption patterns in the world shows that Nigeria and indeed African countries have the lowest rates of consumption. The USAID further placed the energy consumption *per capita* in Nigeria to be about one-sixth of the energy consumed in developed countries while 20 million households in Nigeria lack access to power and just about 19% of Nigeria's population has access to safe drinking water.

In order to achieve WEF security in Nigeria, the Nigerian government adopted the Sustainable Development Goals also known as the Global Goals in September 2015 and has since then put in place regulatory measures to ensure the attainment of these goals. Data from the National Bureau of Statistics as cited by the Office of the Senior Special Assistant to the President (2017), reflects the prevalence of undernourishment in Nigeria. The data shows that:

> 25.5% of the population was lacking adequate and improved nutrition. Also, severe food insecurity within the population based on the Food Insecurity Experience Scale stood at 26.4%. In addition, there was a stunting or delayed growth prevalence of 37.45% among children of kindergarten; 37.4% for school age and 15% severe cases of malnutrition for under 5 children (the Office of the Senior Special Assistant to the President, 2017).

In a bid to tackle hunger and poverty in Nigeria and in a quest to satisfy the 2nd global goal, which is to end hunger, achieve food security and improved nutrition and promote sustainable agriculture, the Federal Government initiated the National Social Investment Programmes (NSIP) in 2016. Under the NSIP, we have the N-power programme; Government Enterprise and Empowerment Programme; the Conditional Cash Transfer Programme and the Home Grown School Feeding Programme which is briefly discussed below.

Home Grown School Feeding Programme

The National Home Grown School Feeding Programme (NHGSFP) is a government led programme which started in 2016, and according to the Federal Government, over 300 million meals have been served to more than 7.5 million pupils in 46,000 Public Primary Schools in 22 states. Among the objectives of the programme is to improve the nutritional and health status of school children and to stimulate local agricultural production and boost the income of farmers by creating a viable and ready market via the school feeding programme.

According to the World Food Programme (WFP), the Home Grown School Feeding initiatives promote nutrition education and better eating habits, and encourage the diversification of production with a special emphasis on local crops. The WFP also noted the contribution of the Home Grown School Feeding Programmes to the achievement of the Sustainable Development Goals (SDGs), particularly SDG 2.

Agriculture Promotion Policy (2016 - 2020)

The Federal Ministry of Agriculture and Rural Development (FMARD, 2016) asserted that the Agriculture Promotion Policy (APP) was enacted to primarily solve the inability of the agricultural sector to meet domestic food requirement and the inability of the sector to export agricultural products at quality levels. The APP aims to achieve its goal between 2016 to 2020. The objectives of the Policy is to ensure seamless access to land to attract investments by small, medium and large scale farmers and processors and 'to ensure national food and nutrition security by ensuring adequate availability of safe and nutritious food at affordable prices for rural and urban population in Nigeria at national and household level' (The Agriculture Promotion Policy, 2016 – 2020).

National Water Policy (NWP)

The NWP was meant to develop potentials of water resources in Nigeria. The policy provides for government goals to provide access to water, however 75 percent of Nigerians don't have safe water (Enyidi,

2017).

Border Closure Policy

The discovery of oil in the Niger-Delta region is the major cause of Nigeria's re-alignment of its focus from the agricultural sector to the oil sector. Nigeria which was once a major exporter of food crops is now heavily dependent on importation of food and other items. As a result, Nigeria closed her borders in October 2019 in an effort to curb smuggling and importation of substandard agricultural products and other products in Nigeria. In July 2015, the Governor of the Central Bank of Nigeria, Mr. Godwin Emefiele had recommended the closure of the borders to avert economic recession, capital flight and to cushion the local producers and farmers from the effects of uneven balance of trade threatening to cripple the Nigerian Economy (Osuntokun, 2019).

So far, the effect of the border closure policy may seem to be successful as local products and farm produce are now being accepted as worthy alternatives to foreign and imported products. However, the implementation has to be strengthened to achieve in the long run the aim of the Government which is to encourage local farmers and manufacturers.

Some Regulatory Agencies

National Agency for Food and Drug Administration and Control (NAFDAC)

The NAFDAC was established to regulate and control the manufacture, importation, exportation, distribution, advertisement, sale and use of regulated products such as food, drugs, cosmetics, medical devices, packaged water, chemicals and detergents (NAFDAC). NAFDAC support food safety programs by ensuring food facilities adhere to good manufacturing practice (GMP) that can sustain quality food product that is safe for human consumption (NAFDAC). In order to properly carry out its functions, NAFDAC is divided into 14 directorates which are further divided into divisions. The Food Safety and Applied Nutrition (FSAN) Directorate of NAFDAC is empowered to take all steps to ensure that food manufactured, imported, exported, distributed, sold, advertised and used in Nigeria meet the highest standard of Food Safety reasonably achievable (NAFDAC). The FSAN is further divided into 7 divisions. NAFDAC whose main objective is to protect the health of Nigerians have been lackadaisical in carrying out their functions. In 2019, contaminated Eva premium table water produced in May 22/23 2019 with expiry date of May 22 2020 were distributed all over Nigeria and this went unchecked until the manufacturers of Eva water voluntarily reported to NAFDAC on June 20, 2019. It however, took NAFDAC over 2 weeks to instruct the Nigerian Bottling Company to recall the said table water until investigations was concluded (Ubong, 2019).

Standards Organisation of Nigeria (SON)

Standards Organisation of Nigeria (SON) is a federal government parastatal, established with the aim of maintaining standard in manufactured products, these products include implements and machines that are largely connected to the WEF nexus. The Standards Organization of Nigeria is known for Meteorology, and Standardization and Testing and Quality control. The responsibility is carried out both at the national and international level, all for the interest of the Nigerian citizens (Athanasius). SON is empowered to seal up premises where substandard products are manufactured or stored (Standard Organisation of Nigeria Act, 1990). The SON is responsible for regulating the standard and quality of all products in Nigeria and has the powers to confiscate and destroy substandard products (Standard Organisation of Nigeria Act, 1990).

Federal Ministry of Agriculture and Rural Development (FMARD)

The FMARD was created in 1966 as the then Federal Ministry of Agriculture and Natural Resources. FMARD has passed through a series of modifications and adjustments with related sectors to suit the prevailing climes in order to enable the Federal Government play a leading role in promoting agricultural activities in the country (FMARD). The ministry regulates agriculture and natural resources, agricultural research, forestry and veterinary research in Nigeria. It aims to organize and manage the agricultural sector and facilitate agricultural business for increased food security and employment along commodity value chains and agro industrial development to earn foreign exchange and contribute to socio-economic development of the country (FMARD). It is also responsible for the formulation and implementation of Agricultural policies and legislations in Nigeria through its several departments and parastatals.

Federal Competition and Consumer Protection Commission Act (FCCPCA)

The FCCPCA established the Federal Competition and Consumer Protection Commission. The Commission was established to monitor and modify behavior of service providers and manufacturers. Some key areas of operation include complaint resolution, surveillance and enforcement, consumer education, as well as research and strategy (FCCPC).

The MacAurthur Foundation reported that it awarded the sum of $300,000 (three hundred thousand dollars) to the FCCPC in 2016. According to the Foundation, the award is expected to provide citizens with a platform for demanding accountability, inform them about their rights and responsibilities, establish a dialogue with electricity distributors and other actors, and, ultimately, contribute to a reduction in corruption in the sector.

Nigerian Electricity Regulatory Commission (NERC)

The Electric Power Sector Reform Act (2005) established the Nigerian Electricity Regulatory Commission (NERC) as a body corporate with perpetual succession which can sue or be sued in its corporate name, and pursuant to the provisions of the Act, performs all acts that bodies corporate may by law perform. The objectives of NERC is to create, promote and preserve efficient industry and market structures to ensure the optimal utilization of resources for the provision of electricity services to ensure the safety, security, reliability and quality of service in the production and delivery of electricity to consumers (Electric Power Sector Reform Act, 2005). The NERC is vested with unrestrained powers to make regulations on electricity where in its opinion such regulatory codes are necessary and permitted to be prescribed, for carrying out matters required or permitted to be done under the Act for giving effects to the provisions of law (Benchmac and Ince, 2018). The budget of the NERC is mainstreamed into that of the Ministry of Power.

Federal Ministry of Water Resources

According to the Federal Ministry of Water Resources, the aim of the Ministry is to develop and implement policies, projects and programmes that will enable sustainable access to safe and sufficient water to meet the social, cultural, environmental and economic development needs of all Nigerians. The Ministry is in charge of the national water fund.

Federal Ministry of Power

The Federal Ministry of Power is the policy making arm of the Federal Government with respect to power provision in the country. In discharging its mandate, the ministry is guided by the provisions of the National Electric Power Policy (NEPP) of 2001, the Electric Power Sector Reform (EPSR) Act of 2005, and the Roadmap for Power Sector Reform of August 2010. The Ministry is responsible for initiating and formulating broad policies and programmes on the development of the power sector (electricity) in general (Federal Ministry of Power).

Recommendation/Conclusion

The paper has shown the connection in the WEF nexus and identifying the WEF challenge to be majorly two, i.e., population growth and climate change. It reviewed the local technology currently adapted by the majority of Nigerian farmers from history to include the use of; solar energy in drying farm produce especially grains; the use of heat energy to preserve animal products such as meat and fish; the use of adequately aired barns to store root and tuber crops such as yams and potatoes; the use of clay pots, calabashes and shallow wells to store and preserve water; the use of stones, rocks, dry wood, cloths and oil lamps to produce heat energy and the utilization of wells, rivers, streams, lakes, ponds, seas and waterbeds as a source of water for drinking, food and personal hygiene etc. It showed that the common means of water, energy and food storage, preservation and generation currently adopted is not environmentally sustainable to sustain Nigerian citizens and neighboring countries in light of the projected geometric growth in Nigerian population. The paper also suggested the adoption of the use of modern advanced technologies where they are environmentally friendly and sustainable are to be utilized in managing the resources to ensure WEF Security. An example for instance, would be the Government's encouragement of the use of aeroponics farming all over the Country, in at least the six geopolitical zones for starters. Also, the paper suggested that the Government should allocate more funds to research on both the ethical and health implications of consuming crops produced through aeroponics farming. The government may partner with private sector individuals, companies and educational institutions via public private partnership schemes to research, develop and invest in new technologies in the various geopolitical zones of the country.

The use of advanced modern technology which may involve the use of Artificial Intelligence (AI) where it does not have any adverse repercussion is also suggested for generation of energy, cultivation and processing of food crops and ensuring adequate water supply all year round to every part of the country. The government and concerned stakeholders like non-state actors can also subsidize and actually monitor the commercial activities of local players in the WEF sectors, for example, aiding the farmers with modern environmentally friendly technological tools/equipment and machines to enhance production and output of each season.

In order to ensure the WEF security and sustainability, the following recommendations are also proposed; a

robust review of the legal frame work/regulatory initiatives of the WEF sector is urgently recommended. The current legal framework and the roles being played by the various government agencies would have better effect if implementation drive is strengthened by the integrative laws and policies that would create sustainable synergy between the agencies. For Instance, NAFDAC and NERC have veritable roles to play in the WEF nexus as NAFDAC's terms of reference touches directly on Food and Water, production and consumption and NERC deals with the regulation of Energy distribution.

Like in most agencies in Nigeria, where regulations are replete, the strategies of implementation need to be urgently reviewed and strengthened for greater impact and results in the WEF sectors to ensure better planning for WEF resource allocation; adoption of incentives to increase efficiency; investment in infrastructure for more secure WEF supplies and availability. With daily advancement in civilization and growth in population, these sectors need more flexible, adaptive and responsible institutions.

It also requires a quality monitoring network and data base. These data base would store physical, chemical, biological and ecological information. It is also important to raise public awareness about the value of the connection in the WEF nexus, especially in the sectors of all stakeholders at all level of government as getting people involved would foster sustainability. The use of electricity-powered water pumps in irrigation farming in Nigeria should be encouraged by the government by subsidizing the cost of electric water pumps in rural communities. Achieving higher agricultural yields requires additional water extraction and correspondingly extra energy.

To enhance the developmental trend in the country, there is every need to support the existing unreliable energy sector with a sustainable source of power supply through solar energy. The Government should encourage the use of Rooftop solar panel by households and commercial businesses by subsidizing the price of solar panels and providing solar panels to indigent's homes and rural areas free of payment. The annual average of total solar radiation varies from about 12.6mj/m2-day (megajoule per square metre per day) in the coastal latitudes to about 25.2mj/m2-day in the far north.

Advanced Technology, particularly AI, can be applied to aid the global monitoring information system on water, as well as provide the information needed for water management, renewable energy and food security. Carbon Capture and Storage (CCS) technology with renewable biomass which can capture up to 90% of the carbon dioxide emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the carbon dioxide from entering the atmosphere can be used in achieving WEF security by abating environmental degradation. Biotechnology (genetic engineering like Genetically Modified Organisms/Food (GMO/GMF) can help cater for WEF needs of the growing population and save endangered species. The above recommendations though not exhaustive if implemented with adequate regulation of the legal frame work can ensure food, water, and energy security in Nigeria. All these recommendations must be provided for in the suggested integrated legal regime that can drive a synergized WEF production in Nigeria.

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