Impact of Environmental Pollution from Industrial Agriculture on the Quality of Human Life in Nigeria: Concern for GMOs and Agri-Business

Maria Chinecherem Uzonwanne*, Uju Regina Ezenekwe, Geraldine Ejiaka Nzeribe

Department of Economics, Faculty of Social Sciences Nnamdi Azikiwe University, Awka, Anambra State, Nigeria

***Corresponding Author**

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ABSTRACT

Food is life, and it can become an instrument of control in national and international power polity. It is not enough to aspire to be sufficient in food production; however the system of production that ensures the production of healthy and safe food in a safe environment is equally crucial for the quality of human life. The pertinent concern of this study is to investigate the possible implications of the present quest to introduce the Genetically Modified Organisms (GMOs) into the agricultural sector in an effort to ensure food security vis-à-vis the quality of life of the citizenry and the impact on the environment of Nigeria. The study adopted the Diffusion Theory of Rural Development, employed Vector Autoregressive (VAR) Model Approach using annual time series data spanning from 1981-2017. The plausibility of the results lies with the positive relationship between food supply and life expectancy. The study found that the environmental effect of industrial food production which is usually associated with gaseous emissions was not significant. This shows that with any improvement in food security, Co_2 emissions are reduced. This reduction in Co_2 emission by these industries further has chain reactions as it improves food security. The results also shows that there is a negative relationship but with significant impact of industrial emission into the environment on life expectancy of Nigerians. The study therefore recommends that there is need to revitalize public sector agricultural research, Small farmer-oriented, low-input agro-ecology and reform trade-related rules.

Key Words: Food Security, Quality of Human life, Environment, Agri-Business, GMO's

JEL: Q13, Q51, Q18, I15

INTRODUCTION

The growing concerns that the current system of industrial food production promoted in Nigeria might create more harmful conditions for the present and future generation and undermine the problem of food insecurity in the country prompted the researchers to empirically investigate the impart of environmental pollution from Industrial Agriculture on the Quality of Human Life and food security in Nigeria.

Several studies have found the dangers of environmental pollution caused by GMOs. One of such is the Greenpeace European Unit (2011) which through empirical evidence revealed that GMOs are polluting the environment in a way that is outside the control of society or the companies that have released these GMOs. Also Microbiologists have come up with an important point that if genetic modification is carried out extensively, new viruses with greater potential to harm mankind may evolve anytime, and the probability of this occurring can be quite high.

The study adopted Diffusion theory of rural development propounded in 1962 by Everett Rogers. The

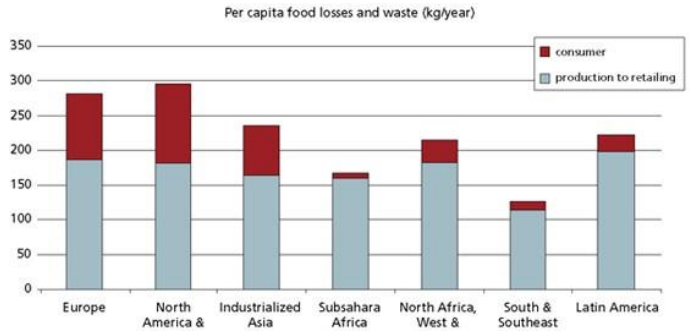
theory emphasized on the need for farmers to embrace modern techniques of farming in order to correct the structural impediments hampering improved agricultural productivity and also guarantees food security. Furthermore, Drimie and Ruysenaar (2010, p.316-337) maintains the diffusion model theory has gained considerable acceptance in Nigeria where it was highlighted as a solution to the problem of low productivity of the average rural farmers leading to national food insecurity. Specifying under the multiple regression analysis framework, the study employed the VAR model approach using time series data spanning from 1981 to 2017.

The empirical result reveals that environmental pollution from industrial agriculture has negative but insignificant impact on quality of life in Nigeria. This therefore implies that in the long run, the introduction of GMOs into agricultural sector will lead to reduction in life expectancy in Nigeria. Also pollution from industrial agriculture had negative impact on food security in Nigeria. The implication of this result is that, the activities of the GMOs will further lead to increase food insecurity in Nigeria. Based on the findings, the study recommends that mechanized agriculture should be promoted in Nigeria since it promotes food sovereignty, autonomy and respect for human rights.

Overview

World Food Summit (2016) states that food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. It is the right of people to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems. There is a desperate struggle especially among the populations of the third world countries to have even the minimum food requirement. It is not surprising then that the circumstances of their food intake do not come near the globally accepted minimum standard. In addition, there are insinuations that climate change will affect sub-Saharan Africa more than any other region in the world and that dryness will make agricultural production impossible in some areas. Foley et al. (2011) cited in Meemken and Qaim (2018) posed that agricultural production contributes to various environmental problems such as climate change, biodiversity loss, soil degradation, and water pollution. These factors combined with the endless herders/farmers conflict will further complicate the Nigerian food security challenges. The graph below depicts that.

Figure 1: per capital food losses and waste in the world



Source: http://www.fao.org/save-food/resources/keyfindings/en/

Nigeria, blessed as it is, with abundant agricultural resources and diversity is very far from self-sufficiency in food production. According to Atinmo and Adeniran (1999), Nigeria is one of the food-deficit countries in Sub-Saharan Africa .One major reason for this largesse is the fact that our system of agriculture has not evolved significantly beyond the pre-colonial era. Nevertheless, there are growing concerns that the current system of industrial food production promoted in Nigeria might create more harmful conditions for the

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present and future generation; and further undermine the problem of food insecurity in the country. The negative health consequences of the chemicals used for industrial agriculture has for long remained a subject of controversy but the recent land mark US court decision against the industrial agriculture chemical giants Monsanto lends credence to the argument that GMOs is rather cog on the wheel of Nigeria food security and quality of life of her citizens

In the early 60s, Nigeria did not have to contend with the problem of food insecurity. The system was able to feed her relative smaller population and at the same time export the surplus food items. At that time, Agriculture was the main contributor of Nigerian GDP. But things fell apart and started changing gradually at the discovery of oil. It was like declaring holiday for hoes and machetes as oil prices went up. Nigeria's interest in agriculture completely waned as oil became the main stay of the economy.

The renewed effort to boost both the quality and quantity of agricultural production and reverse the *status quo* has not been very successful. There are indications that the quality of some locally produced food may not be healthy for human consumption. Precisely in July 2017, the CNN announced that a great quantity of beans produced in Nigeria and exported to United Kingdom was rejected and deported on the ground that it contains harmful chemical far above the internationally acceptable tolerable maximum. The said chemicals were introduced during the process of production and preservation of the beans. If the beans produced and marketed for human consumption contain such chemical at an intolerable level, it casts a shadow on the safety of the industrially produced food with its enormous use of chemicals. Not only that, it raises a deep concern on the impact of long term use of the chemicals on the environment and the entire ecosystem.

According to World Health Organization (WHO) (2005), the application of modern biotechnology to food production presents new opportunities and challenges for human health and development. The recombinant gene technology which is the most well-known modern biotechnology enables plants, animals and micro-organisms to be genetically modified (GM) with novel traits beyond what is possible through traditional breeding and selection technologies.

An ecosystem is a complex web of relationships between the biotic and abiotic members. An ecosystem is sustainable under certain conditions: (1) when there is synergy within the system or fluctuations within an acceptable range. (2) There are species diversity and population levels of organisms within the ecosystem. (3) The habitats of the species and connections are sufficient to allow organisms to carry out their life cycles. (4) Toxic materials are not accumulating in the soil, air or water. However, scientists have shown that human activities have brought about major changes in the different components of the ecosystem. As a matter of fact, industrial agriculture with its excessive use of chemicals has been fingered as the biggest culprit. The excessive use of fertilizers and pesticides have resulted in the upsetting of N,P,C,S,K balance in the ecosystem and it is found to be responsible for the bio-accumulation of these elements in animal tissues. According to Leopold, (1940) the chemicals are also not merciful to the micro-organisms living in the ecosystem.

Micro-organisms are very crucial but they are neglected members of the ecosystem while promoting industrial agriculture. The environmental burden of agricultural chemical fertilizers and pesticides are enormous. There is no doubt that chemical fertilizers and pesticides have contributed to food production especially since Second World War, but clear warnings have been raised against over-reliance on them. The run-off of nitrogen and phosphates from excess use of fertilizer damages water resources, and such damage is spreading. Its overuse threatens the health of human and the lives of other species. Also, long term exposure to pesticide and chemical residues in food, water, and even in the air is hazardous, particularly to children. According to Szabolcs (1985,p.30-47), a 1983 study estimated that approximately 10,000 people died each year in developing countries from pesticide poisoning and about 400,000 suffered acutely. The effects are not limited to the area where pesticides are used but travel through the food chain. Commercial fisheries have been depleted, bird species endangered, and insects that prey on pests wiped out. The number

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of pesticide resistant insect pest species in Nigeria has increased and many resist even newest chemicals. The variety and severity of pest infestation multiply, threatening the productivity of agriculture in Nigeria.

The excessive use of all these chemicals has affected and created a negative impact in the environment and the quality of life of the people. It has contributed to the decline of indigenous knowledge in food production; affordable and organic solutions ignored in favor of expensive genetically modified foods (GMOs) and questionable hybrids. Local agriculture is also at risk; for example, farmers lose right to save or share seeds, thus it contributes to the promotion of monoculture. It is known that Industrial agriculture contaminates local agricultural systems and contributes to climate change such as shifting rainfall patterns, droughts/floods. The shrinking Lake Chad resulting from climate change has adversely affected the life of pastoralist and farmers; and has largely contributed to the farmers/herders conflicts in Nigeria. It means that with people being displaced and confined to the Internally Displaced Persons camps (IDPs) and farmers not able to return to farms, the Nigeria Food security and quality of life is further undermined.

Forests are important for maintaining cultural food diversity, quality of air and quality of the environment. However, according to Egbejule (2017) industrial mono-cropping is taking a big toll on the forests and livelihood of Nigeria communities. In Edo State, Uhiele, Odighi and Odiguetue, communities lament over the devastation of their environment, deforestation and loss of livelihoods occasioned by industrial agriculture. Obviously, the Nigerian agricultural sector requires more investments and the participation of the private sector but it must be a participation that prices inclusivity over corporate control; Human Right to food over profit and food merchandise; protection and development of indigenous knowledge over quick fix introduction of the GMOs in the Nigerian agricultural sector.

In October 2015, an agri-business company named Monsanto Agriculture Nigeria Limited submitted applications to the Nigerian National Bio-safety Management Agency (NBMA) for two permits. One permit, requests for the commercial release and placing on the market, the genetically modified BT cotton and the other for the confined field trial of two maize varieties. There were objections from the Civil Society to the application of Monsanto for various reasons. First, the application did not follow the laid down procedures. Second, there is a conflict of interest in the constitution of the membership of the Nigerian Bio-safety Management Agency that approves the application. Third, the Nigerian bio-safety law does not contain adequate provisions to safe-guard Human and Environmental Rights as required by international best practices. Fourth, while some European Union Nations have banned the distribution of GMOs with all their sophisticated monitoring mechanisms, is there any wisdom for an African country to be granting permission to Monsanto taking into consideration their antecedents in some African Countries likes Burkina Faso? Fifth, the Civil Society reasoned that since the Bio-Tech industry have had history of covering up the negative human and environmental effects of their products, granting permit to Monsanto exposes the Nigerian population and environment to yet to be determined impact assessment. Sixth, Industrial mono-cropping is known to be a major contributor to climate change.

Already, the climate change and ecological disasters in Nigeria are taking a big toll on her Food security effort. According to Nzeribe et al (2013), in 2012, the flooding in Nigeria, took some lives and most of the agricultural products that would have contributed extensively to the GDP of the country were lost. Premium Times, (2013) also reported that in June 2014, 15 people were said to be dead in the flooding in Southern Nigeria. In September 2015, floods killed 53, displaced 100,420 people across Nigeria. Drought and desertification now threaten in a more severe way eleven out of thirty-six states in Nigeria: Adamawa, Borno, Bauchi, Gombe, Jigawa, Kano, Kastina, Kebbi, Sokoto, Yobe and Zamfara; while in 2018, about 52 people were killed by flood in Katsina state. According to GlobalChange.Gov, Ongoing acidification of the oceans linked to chemicals from industrial agriculture is putting at risk the food chains connected with the oceans. Phytoplankton is at the bottom of the food chain. The decrease in pH decreases the bioavailability of essential algal nutrients, including essential trace metals such as zinc and iron needed by Phytoplankton. It is

also very likely that rising CO_2 will alter the relative proportions of major macronutrients in many crops by increasing carbohydrate content (starch and sugars) while at the same time decreasing protein content. An increase in dietary carbohydrates-to-protein ratio can have unhealthy effects on human metabolism and body mass.

In this vein, it is argued that, the promotion of chemical industrial agriculture and GMOs without adequate impact assessment and the appropriate safeguard mechanisms to mitigate the impact will further undermine the Food Security of Nigeria, deteriorate her environment and the quality of life of citizens since according to Vermeulen, Campbell & Ingram (2012, p.195-222) future food security for all will ultimately depend on management of the interacting trajectories of socioeconomic and environmental changes.

Having introduced this study and explained the problem of the study, it is pertinent that we explain most of the key concepts of this study for its better understanding.

(a) Food security

The definition of food security adopted at the 1996 World Food Summit held in Rome sees food security as a situation that 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 . Lack of sufficient human food requirement leads to low productivity, hunger and malnutrition, poor physical and cognitive development of the people in that nation. United Nation world food conference in 1974 defines food security as the availability, at all times, of adequate world supplies of basic food stuffs, to sustain a steady expansion of food consumption globally and to offset fluctuations in production prices. For Sen, (1981), food security and food insecurity are linked as they are two halves of the same problem. Firstly, the scale of food security varies greatly spatially whereas food insecurity changes depending on the economic and political situation of the nations, it also depends on the vulnerability to effects, both physical and humans in the area concern. According to Abdullahi (2008, p.4-6) food security is defined 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. According to Pretty, Morisson and Hine (2003) increased household food production can be achieved through increased water use efficiency, improvements to soil health and fertility, and pest control with minimal or zero pesticide use.

According to FAO and WHO (1992, p.13-14), the concept of food security has been used in various ways. Food security in its most basic form is defined as the access to all people to the food needed for a healthy life at all times. Though, in a simple language, a country is food-secure when majority of its population have access to food of adequate quantity and quality consistent with decent existence at all times. What is implied in this definition is that food must be available to the people to an extent that will meet some acceptable level of nutritional standards in terms of calorie, protein and minerals which the body needs; the possession of the means by the people to acquire (i.e. access) and reasonable continuity and consistency in its supply. In other words, food security can be taken to mean access by all people at all times to sufficient food for an active, healthy life.

For Ojo and Adebayo, (2012, p.199-222), food security should be seen only in the perspective of its hygiene and safety. They should be given priority in order to protect the health of the people. Hence, the chemical substances used to produce or preserve the food may constitute a health hazard. Food security according to World Bank (1986) is defined as access by all people at all times to enough food for active, healthy life. Its essential elements are the availability of food and the ability to acquire it. Egbuna (2001, p.307-325) suggests that a food secured situation is said to exist when the demand side is balanced with the supply side, anything contrary suggests food insecurity.

Eckert (2015, p.191-192) in a book review stressed that the dysfunctional food system includes

environmental and public health concerns of large-scale intensive agriculture and biotechnology.

Sinha (1976) in Ojo & Adebayo (2012, p.199-222) maintains that health and safety consideration are important in food production. However, given the likely general misuse of chemicals due to illiteracy and ignorance, particularly in developing countries; some chemicals used for treating livestock diseases, the indiscriminate application of pesticides to treat crops diseases or control pest and other agricultural parasites, may be harmful to humans much later after the consumption of the agricultural products.

Davies (2009, p.186-202) argues that in essence, a country should be considered as food-secure when food is not only available in the quantity needed by the population consistent with decent living, but also when the consumption of the food should not pose any health hazard to the citizens. Food sovereignty is therefore defined by Food Secure Canada (n.d) as the rights of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable method and their right to define their own food and agriculture system.

(b) Quality of Human Life (QoHL)

Despite the difficulties and controversies encountered in understanding this concept, Quality of human life has proved to be an indispensable term. Generally, to make a scientific enquiry into people's life more feasible and to determine its movement (increasing or decreasing) four valuations are considered important. The four factors seen as human specific cardinal valuations are: 'survival of species, security in the life span of individuals, material prosperity to ensure survival and security and attaining a wholesome life, and mental progress to unfold the potentials of respective humans'. Put simply, quality of human life has to do with survival, security, prosperity and progress of the people. These can be seen in connection to the basic human needs. These needs have been expressed variously by experts as including innumerable things. In fact, no one can boast of a comprehensive list. Some of the things that make the lists often are food, clothing, health, education, leisure, security, etc, which are seen in one form or the other in the four cardinal valuations we presented earlier. Human life cannot be examined without involving its quality. We examine life in order to improve it.

WHO (2012) defined Quality of Life as individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. Quality of human life (QoHL) as a concept is ambiguous involving on the one hand an investigation into how well individuals' lives are going and on the other that of the community where individual's live. Megone (1994, p.24-41) observed that it may well be that the two notion intersect, "that the quality of an individuals' life is affected by the quality of his environment and culture, and that these are in part a function of how lives of agents in the society go." When we talk about quality of human life what comes to mind immediately are the basic needs of humans. For Prescott-Allen (2001), quality of human life includes the conditions in which people are able to determine and meet their needs and have a large range of choices and opportunities to meet their potentials. This should not be confused with standard of living that has its bases on income.

Zhanna (2014, p.103-112) opines that quality of life is the category that characterizes the essential circumstances of life, defining a level of dignity and freedom for each individual person.

Santosh and Krishna (2016, p.47-49) emphasized that quality of life has included several domains related to health, but the concept also originally included many other non-health-related issues such as work and environment. QoHL consists of both medical and psychosocial aspects, including activities of daily living, instrumental activities, psychological well-being, social functioning, and perception of health status, pain, and overall satisfaction with life.

In the context of this study, quality of life is related to people's heath in connection with food intake in the country.

(c) Environment

According to Victoria (2013, p.159-167), Environment is a broad concept. It refers to all or part of an object's or a living beings surrounding. It becomes everything that surrounds man hence, everything that is used by man including man himself. She went further to describe the environment as "as a residual, but an entity which incorporates attitudes, values, institution economic, science and technology and ideology, furthermore it is life itself". Life is the environment and the environment is life she maintains.

Environment is the surrounding in which a person, animal, or plant lives or operates. It is sum of all surrounding of a living organism, including natural forces and other living things, which provide conditions for development and growth as well as of danger and damage. It is a place where people, things and nature that surround any living organism live. It is our basic life support system. It provides the air we breathe, the water we drink, the food we eat and the land where we live. It is a combination of natural and human made phenomena.

The term environment simply means 'nature', in other words, the natural landscape together with all of its non- human features, characteristics and processes. It is the total of all surroundings of living organisms, including natural forces and other living things, which provide conditions for the growth and development as well as of danger and damage. Environment is everything that is around us. It can be living or non-living things. It includes physical, chemical and other natural forces. Living things live in their environment. They constantly interact with it and change in response to conditions in their environment. In the environment there are interactions between animals, plan, soil, water and other living and non-living things.

According to Peach and Petach (2015, p.32-45), environment is applied to encompass both the natural world and humanity's use of space. They maintain that one of the unfortunate side effects of economic activity is pollution and that increased amounts of air pollution are associated with numerous adverse health consequences such as increased risk of heart disease and respiratory ailments.

Environment includes everything on this earth but in a healthy manner. It is everything that makes up our surroundings and affects our ability to live on earth. When we talk about environment, we are talking about the ecosystem that supports life on the planet. Although, the urban industrial environment is technically part of our environment, it is not necessary to support life on the planet and in some cases it is quite destructive towards humanity and the ecosystems on which the human depend. In other words, we can say that environment means understanding of natural system combined with how they insert with human social systems.

Tribhuwan (2017, p.1359-1365) Stead and Stead (1996) emphasized that for individuals, the idea of environment promotes the practice of environmental protection which involves the need to make different kinds of sacrifices, such as giving up the driving of private cars and paying higher price for eco-friendly products, instead of simply raising slogans. The objective of environmental protection cannot be achieved without active and concerted efforts by the entire society. Hence, for the purpose of this study, environment is everything that makes up our surrounding and affects our ability to live a healthy life on the earth.

(d) Agri-business

This is the business of agricultural production and transformation of the value chain. It includes manufacturing of agrichemicals, breeding, crop production; distribution, farm machinery, processing and

seed supply as well as marketing of agricultural products and retail sales, all agents of the food and fibber value chain and those that influence it are part of agribusiness system. Agribusiness tends to be a large scale business operation and may dabble into farming, processing and manufacturing and packaging and distribution of products.

For Davis and Goldberg (1957), it is the sum total of all operations involved in the manufacture and distribution of farm supplies; production operations on the farm; and the storage, processing, and distribution of farm commodities and items made from them. For Downey & Erickson (1987), it includes all those business and management activities performed by firms that provide inputs to the farm sector, produce farm products, and/or process, transport, finance, handle or market farm products. It is commercialization of agriculture, which refers to market orientation of agricultural production process, transition from subsistence to commercial agriculture, from production orientation approach to market oriented approach. It is an activity which is involved in the managed exploitation of natural resources including production, transformation and trade of natural resources

(e) Genetically Modified Organism (GMO)

It is the removal of one or more genes from the DNA of another organism, such as a bacterium, virus, and recombine them into the DNA of the plant they want to alter. By adding these new genes, genetic engineers hope the plant will express the traits associated with the genes. For example when Bacillus thuringiensis genes which express a protein that kills insect is recombine into the DNA of corn. The new gene allows the corn to produce its own pesticide. It is a way of disrupting the functioning of other genes and creates novel proteins that have never been in the food supply and could create toxins and allergens in foods.

FAO currently defined GMO as uncontrolled spread of genetic information (frequently referring to (trans-genes) into the genomes of organisms in which such genes are not present in nature. There are no safety assessment standards for GMOs. GM food regulatory systems worldwide vary from voluntary industry self-regulation (in the US) to weak (in Europe). None are adequate to protect consumers' health.

According to James (2008) cited in Qaim(2009, p.665-694) a genetically modified (GM) crop is a plant used for agricultural purposes into which one or several genes coding for desirable traits have been inserted through the process of genetic engineering. These genes may stem not only from the same or other plant species, but also from organisms totally unrelated to the recipient crop. The basic techniques of plant genetic engineering were developed in the early 1980s, and the first GM crops became commercially available in the mid-1990s. Since then, GM crop adoption has increased rapidly. In 2008, GM crops were being grown on 9% of the global arable land.

FAO (2004) has it that agricultural biotechnology encompasses a range of research tools scientists use to understand and manipulate the genetic make-up of organisms for use in agriculture: crops, livestock, forestry and fisheries. Genetic engineering has made it possible to make genetically modified organisms and plants. In other words new genes from another source have been inserted into the organism and as a result organism shows changes in it according to the gene's function in the body. These inserted genes are called as trans-genes and scientists can take them from other sources or species to see certain changes in the organism. In some cases the genes which are already present in the organism can be taken out and desirable changes can be made in them. Scientists make all these changes just to see the different traits or characteristics of genes in an organism. When the genetically modified organisms are allowed to breed with the organisms which are not genetically engineered, then these organisms will pollute the gene of the non-genetically engineered organisms. Due to this reason the whole ecological system will get affected.

There are few possibilities if GM organisms are bred with non-GM organisms. (1) Genetically modified might lead the non-GM organisms to extinction. (2) Their genetics will change and they will not be able to

show their characteristics. (3) There are chances that these organisms might develop resistance against pesticides or herbicides and it will be a nightmare for the farmers. This gene flow is undesirable according to some environmentalists and conservationists, including groups such as Greenpeace, TRAFFIC, and Gene Watch whom for a number of years, have used the term to describe gene flow from domestic, feral, non-native and invasive species into wild indigenous species, which they consider undesirable.

The United States Department of Agriculture (2012) described the genetically modified organisms (GMOs) as organisms that are produced when selected individual genes are transferred from a given donor organism into another target organism, typically conferring desired properties to the new organism. GMOs can include plants, animals, and enzymes. Some GMOs have been approved by regulatory agencies for commercial production and consumption, while others are currently undergoing regulatory evaluation. Still other GMOs are in experimental stages and confined to scientific laboratory research. According the United States Department of Agriculture (USDA) by 2012, 93% of soybeans, 94% of cotton, and 88% of corn grown in the U.S. were genetically modified and they might be harmful to the human body.

This study adopted the Diffusion Theory of Rural Development. The theory was propounded in 1962 by a United States Rural Sociologist, Everett Rogers. The diffusion theory of rural development is an attempt to explain the existence of substantial productivity difference among farmers in the same economic and geographical regions. According to the model, such differences arise due to differences in farmers' adoption of innovations such as new varieties of seeds, mechanical and chemical inputs within the same environment. Some farmers would embrace modern techniques such as mechanical equipment, improved seeds and chemical inputs, thus guaranteeing food security and oppose the adoption of these modern techniques, as such continue to have poor harvest thereby, causing food insecurity. The diffusion model theory emphasize that to correct the structural impediment to improved agricultural productivity, the farmers need to embrace modern techniques of farming to guarantee food security. The diffusion of innovations to farmers requires re-orientation and rehabilitation which is possible through communication and other support services. Drimie & Ruysenaar(2010, p. 316-337) opines that the benefits of the modern techniques have to be explained to farmers in rural areas for their understanding and application of some it to reduce the incidence of food insecurity and poverty.

The choice of this theory was based on the fact that the theory has been graciously applied by many developing nations and has contributed to the fame recorded by agricultural extension services, demonstration farm or experimental farm (local innovation). Through these channels, the rural farmers who are still unaware of the modern innovation and its implication are brought face to face with the concepts and their applications. According to Drimie & Ruysenaar(2010, p. 316-337), the diffusion model theory has gained considerable acceptance in Nigeria where it is emphasized as a solution to the problem of low productivity of the average rural farmers leading to national food insecurity.

The empirical literature of this study is divided in two sections. The first section looks at the Impact of GMOs on the human life while the second section takes a look at its impact on the enviroment.

Impact of GMOs on the human life

Alexander & Mellor (2005, p. 179-204) discovered another potential risk of GMOs; that they are toxic to humans and animals. One of the most recent GM crops to be suspected of causing toxicity is the GM maize line known as MON 863 (Yield Gard Rootworm Corn), which received approval in the US in 2003 and specifically targets the corn rootworm. MON 863 contains less Bt toxin than most Bt maize varieties, producing the toxin primarily in the roots, which is the site of entry for the western corn rootworm. For Smith, (2006) there is also a possibility that if foreign gene integrate into human DNA, they could switch on random genes inside of humans, leading to an overproduction of a toxin, allergen or carcinogen.

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Árpád (2009) carried out a research in Scotland on the relationship that exists between feeding rat with GMOs. The result of his research which was ten (10) days of testing showed that feeding genetically modified potatoes to rats had negative effects on their stomach lining and immune system. Specifically, Rats fed GM potatoes had smaller livers, hearts, testicles and brains, damaged immune systems.Consequently, they are more vulnerable to infection and disease compared to other rats fed non-GM potatoes.It also shows that the stomach and intestines cells proliferation that could be a sign of greater future risk of cancer.Thus he recommends that genetically modified foods should not be eaten by human beings since it is detrimental to their health.

Hayes (2004, p.1138-1149) carried out a research on the impact of herbicide atrazine which is used on the farm product on the Male Frog. The research found out that herbicide atrazine is an endocrine disruptor that de-masculinizes and feminizes male frogs, hence, he concludes that if they are harmful to male frogs it could also be harmful to male humans' organs and therefore recommends that herbicide atrazine should not be used to control weeds because they have direct connection with the food produced.

In a book written by Mike Adams (2016) on the foods that harm and those that heal, it reveals that GMO foods alter the human organ function and pose a very real health threat to humans especially during fertilization. It went further to say that it particularly alters the human liver functions and causes cancer and makes the cells in the body never to remember what it is meant for hence the more GMO food you consume the less human you become. As a result of that; the research recommends that human beings should not eat GMO foods since they could be detrimental to their health. Another study of Monsanto's high-lysine corn showed it contained toxins and other potentially harmful substances that may retard growth. In addition, when this product is cooked, it produces toxins associated with Alzheimer's, diabetes, allergies, and kidney disease, cancer and aging symptoms. Inserted genes have been found in the bacteria in the human gut after digestion and in peripheral blood circulation. Inserted genes may move from food into gut bacteria or internal organs, causing these organs to potentially become cancerous. If corn genes with Bt-toxin get into gut bacteria, our intestinal flora may become pesticide factories.

For Godheja (2013, p. 26-29), GMO causes allergenicity. According to him, the potential of GM crops to be allergenic is one of the main suspected adverse health effects. They discovered that soy bean plants engineered with a gene from Brazil nuts produced beans that caused an allergic reaction in some people. In the same vein, according to Bernstein et al (2003) as cited in Greenpeace (2011), GM crops do have the potential to cause allergenic reactions more so than conventional crops.

Seralini et al, (2007, p.596-602) carried out a research on long term toxicity of a roundup herbicide and roundup tolerant genetically modified maize adverse health effects in human. They found out very significant chronic kidney deficiency in both sexes. Females developed large mammary tumours, hence they recommend long-term (2 year) feeding trials need to be conducted to thoroughly evaluate the safety of GM foods.

Impact on the Environment

According to Greenpeace organization (2011), there is also more evidence that GMOs are polluting the environment in a way that is outside the control of society or the companies that have released these GMOs, and we are outraged. Godheja (2013, p.26-29), the International Federation of OrganicAgriculture Movement has made stringent efforts to keep GMOs (genetically engineered /modified organisms) out of organic production, however, some US organic farmers have found their corn (maize) crops, including seeds to contain detectable levels of genetically engineered DNA. It means that organic farmers cannot prevent their crops from being contaminated by GMOs.

Microbiologists have come up with an important point that if genetic modification is carried out extensively, new viruses with greater potential to harm mankind may evolve anytime, and the probability of this occurring can be quite high.

A research paper commissioned by the British government in 2013 supports the above point. It concludes that crops genetically altered to be resistant to common plant viruses' cold risk are creating mutant strains that could wipe out the entire forms. The resurgence of the pests from primary pest outbreak to a more destructive secondary outbreak may occur. After a pest has been virtually eliminated by any means, the pest population not only recovers, but also explodes to higher and more severe levels. This phenomenon is known as resurgence. To make matters worse, small populations of pests that used to be of no concern due to their significant numbers may suddenly rocket, creating new problems. This phenomenon is known as secondary pest outbreak. Abnormalities, mutation, and extinction of species may become widespread and cause a biological havoc that either takes ages to return back to equilibrium or enters a stage of no return. Genes produce proteins in the cells that they are programmed to work in, but when transferred into another system, the proteins may act differently, thus resulting in the outbreak of allergies and the disasters mentioned above. This will be a great blow to Gaia, as the harmony that the Earth's closely-linked ecosystems that have settled down to vanish, leaving the Earth's inhabitants to reorganize themselves to build up the balanced structures. And this might take a few centuries, or even forever .Evaluating human health risk Gardening job will be tougher as the weeds acquire the modified genes to become super competitive weeds that rampage through the countryside and destroy other life forms in the process.

According to Godheja (2013, p.26-29), the transfer of modified genes by wind-borne pollen might wipe out countless species of organisms. New viruses with greater potential to harm mankind may evolve anytime, and the probability of this occurring can be quite high. This form of dangerous biotechnology will only benefit largely towards the GM crop farmers in form of monetary gain. According to relevant statistics, farmers would spend more than US$3.3 billion annually on herbicides, insecticides, and fungicides.

METHODOLOGY

This study adopts multiple regression analysis where the food supply (FOOD) serves as the independent variable which is used to capture food security, while life expectancy (LIFE) is used to capture the quality of life, and CO_2 emissions from manufacturing industries during the production of chemical inputs that is used for the production of improved seedlings is representing environment (ENV). Thus industries that produce genetically modified foods will be used to capture the environmental effect. The study employs Vector Autoregressive (VAR) Model Approach using annual time series data spanning from 1981-2017 obtained from the Central Bank of Nigeria (CBN) 2015 and World Data Bank (World Economic Indicators).

Model Specification

From the theoretical and empirical underpinning of this study, the examination of the impact of environmental pollution from industrial agriculture on quality of life and food security in Nigeria is explicitly specified in our VAR model as:

$$FOOD_t = f\,(FOOD_{t-1,}\ LIFEt\text{-}_1, ENV_{t-1}) \quad - \quad - \quad - \quad - \quad -1$$

$$LIFE_t = f\,(FOOD_{t-1} + LIFEt\text{-}_1 + ENV_{t-1}) \quad - \quad - \quad - \quad - \quad -2$$

$$ENV_t = f\,(FOOD_{t-1} + LIFEt\text{-}_1 + ENV_{t-1}) \quad - \quad - \quad - \quad - \quad -3$$

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Where:

FOOD = Food, beverages and tobacco supply (proxy for food security),

LIFE = Life expectancy of Nigerians (proxy for quality of life) and

ENV = CO_2 emissions from manufacturing industries (used to capture the environmental effect of industries producing genetically modified food).

These can specifically be expressed in explicitly econometric models as:

$$FOOD_t = \alpha_1 + \beta_1 FOOD_{t-1} + \delta_1 LIFEt_{-1} + \lambda_1 ENV_{t-1} + \varepsilon_1 \quad - - -4$$

$$LIFE_t = \alpha_2 + \beta_2 FOOD_{t-1} + \delta_2 LIFEt_{-1} + \lambda_2 ENV_{t-1} + \varepsilon_2 \quad - - - -5$$

$$ENV_t = \alpha_3 + \beta_3 FOOD_{t-1} + \delta_3 LIFEt_{-1} + \lambda_3 ENV_{t-1} + \varepsilon_3 \quad - - - -6$$

Where:

$\alpha_1 – \alpha 3$ = constant intercept term,

$\delta_1 – \delta_3$, $\beta 1 – \beta 4$ and $\lambda_1 – \lambda_3$ = parameters,

$\varepsilon_1 – \varepsilon_3$ = stochastic error terms.

Adopting a semi-log specification, taking natural logarithm of variables in millions to obtain realistic results, we have:

$$LFOOD_t = \alpha_1 + \beta_1 LFOOD_{t-1} + \delta_1 LLIFEt_{-1} + \lambda_1 LENV_{t-1} + \varepsilon_1 \quad - - - -7$$

$$LLIFE_t = \alpha_2 + \beta_2 LFOOD_{t-1} + \delta_2 LLIFEt_{-1} + \lambda_2 LENV_{t-1} + \varepsilon_2 - \quad - - -8$$

$$LENV_t = \alpha_3 + \beta_3 LFOOD_{t-1} + \delta_3 LLIFEt_{-1} + \lambda_3 LENV_{t-1} + \varepsilon_3 \quad - - - -9$$

Where

L = natural logarithm.

A priori Specification: $\beta 1 > 0$, $\beta 2 > 0$, $\beta 3 < 0$; $\delta_1 > 0$, $\delta_2 > 0$, $\delta_3 < 0$; $\lambda_1 < 0$, $\lambda_2 < 0$, $\lambda_3 > 0$

RESULTS

One of the basic issues to address when using VAR is the ordering of the variables. In ordering our variables, we assumed that the CO_2 emission into the environment during the production of these foods (ENV) and food security (FOOD) would transmit into the quality of life (LIFE) while food security is the most exogenous variable in the model. For the selection of lag length, a lag length of one is selected based on Schwarz information criteria because it takes into consideration the parsimoniousness of the model and has stringer theoretical backing (Serrate, 2006, p.1-23).

Roots of characteristic Polynomial Test

The result of the test in Table 1 shows that LFOOD, LLIFE and LENV are endogenous variables while the

exogenous which is constant variables shows that no root lies outside the unit circle.

The VAR satisfies the stability condition. The result is shown in table 1.

Table 1: Roots of Characteristic Polynomial

Root	Modulus
0.026058	0.026058
0.923551 – 0.185703i	0.942036
0.923551 + 0.185703i	0.942036
0.214081 – 0.512300i	0.555231
0.214081 + 0.512300i	0.555231
0.103975	0.103975

Source: Author's compilation using Eviews 9

Roots of Characteristic Polynomial, Endogenous variables: LFOOD LLIFE LENV, Exogenous variables: C , Lag specification: 1 2

From the root of polynomial test above, it can be observed that all of the modules are less than one and implying that No root lies outside of the unit circle drawn for the variables and as such, Vector Auto Regression (VAR) satisfies the stability condition necessary to carry out a VAR model on the study.

Block Exogeneity Test

Block exogeneity tests are to determine how these variables enter the model. It has as its null hypothesis that the lags of a set of variables do not enter the equation of the other variables, and, thus, it is exogenous to the model.

Table 2: VAR Granger Causality/Block Exogeneity Wald Tests

Sample: 1986 2017			
Included observations: 30			
Dependent variable: LFOOD			
Excluded	Chi-sq	Df	Prob.
LLIFE	2.424512	2	0.2975
LENV	0.038029	2	0.9812
All	3.742632	4	0.4420
Dependent variable: LLIFE			
Excluded	Chi-sq	Df	Prob.
LFOOD	63.09017	2	0.0000
LENV	8.175153	2	0.0168
All	83.81707	4	0.0000
Dependent variable: LENV			

Excluded	Chi-sq	Df	Prob.
LFOOD	1.082394	2	0.5821
LLIFE	5.817266	2	0.0546
All	9.426991	4	0.0513

Source: Author's compilation 2018 using Eviews 9.

The block exogeneity test result in table 2 indicates that none of the variables at lag one should enter the equation of LFOOD as an exogenous variable at 5 percent significant level. The values of their various probabilities are greater than the 5 percent significant level thereby accepting the null hypothesis. There is no indication of LLIFE and LENV granger cause LFOOD. This opposes the innovation theory of rural development which accounts for variations of food supply as a result of environmental differences.

The block exogeneity test of LLIFE equation indicates that two of the variables at lag one should enter the equation of LLIFE as an exogenous variable at 5 percent significant level. The values of their various probabilities are lesser than the 5 percent significant level thereby accepting the null hypothesis. This is in line with the innovation theory as it conforms to the influence which modern techniques of food production has on the reduction of incidence of food insecurity and poverty that is capable of endangering the quality of life of the populace.

The block exogeneity test of LENV equation indicates that none of the variables at lag one should enter the equation of LENV as an exogenous variable at 5 percent significant level. The values of their various probabilities are greater than the 5 percent significant level thereby accepting the null hypothesis. This supports the famous Sen's Entitlement Approach to food supply which shifted the focus of food from national food availability to people's access to food**.** Thus the environment is not the focal point of call rather, ensuring food availability to individuals of the society at all cost (whether genetically modified or naturally produced).

VAR Lag Order Criteria

To determine the optimum lag length, we began with a lag of twenty but finally selected an optimum lag of one. We employed the sequential modified LR test, the final prediction error (FPE) test, Akaike information criterion (AIC) test, Schwarz information criterion (SIC) test and Hannan Quinn (HQ) information criterion at 5 percent level of significance to carry out the selection. All the test results in Table 3 indicate a lag order of one.

Table 3: VAR lag order selection criteria

Endogenous variables: LFOOD LLIFE LENV						
Exogenous variables: C						
Sample: 1986 2017						
Included observations: 31						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	56.39842	NA	1.03e-05	-2.966579	-2.834619	-2.920521
1	189.8758	237.2931*	1.03e-08*	-9.881987*	-9.354148*	-9.697757*

Source: Author's compilation using Eviews 9

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

SC: Schwarz information criterion

AIC: Akaike information criterion

HQ: Hannan-Quinn information criterion

Table 4: Unrestricted Vector Autoregression Estimates

Sample (adjusted): 1987 2017			
Included observations: 30 after adjustments			
Standard errors in ( )& t-statistics in [ ]			
	LFOOD	LLIFE	LENV
LFOOD(-1)	0.969706	0.007273	-0.036318
	(0.05003)	(0.00188)	(0.13007)
	[19.3838]	[3.86940]	[-0.27921]
LLIFE(-1)	0.443393	0.908351	-3.290759
	(0.63187)	(0.02374)	(1.64293)
	[0.70171]	[38.2584]	[-2.00299]
LENV(-1)	-0.017993	– 0.002831	0.337212
	(0.06263)	(0.00235)	(0.16285)
	[-0.28728]	[1.20284]	[2.07071]
C	-1.408641	0.296315	14.29150
	(2.30441)	(0.08659)	(5.99168)
	[-0.61128]	[3.42213]	[2.38523]
R-squared	0.957699	0.991352	0.464582
Adj. R-squared	0.953733	0.990541	0.414387
Sum sq. resids	0.300911	0.000425	2.034293
S.E. equation	0.096971	0.003644	0.252134
F-statistic	241.4938	1222.748	9.255466
Log likelihood	35.03849	153.1697	0.638881
Akaike AIC	-1.724361	-8.287207	0.186729
Schwarz SC	-1.548414	-8.111261	0.362675
Mean dependent	7.206160	3.823113	2.223303

S.D. dependent	0.450826	0.037465	0.329478
Determinant resid covariance (dof adj.)		7.50E-09	
Determinant resid covariance		5.26E-09	
Log likelihood		189.8758	
Akaike information criterion		-9.881987	
Schwarz criterion		-9.354148	

Source: Author's compilation using Eviews 9

The results of the VAR analysis in table at lag one indicates that the variables are dynamically interacted. Starting with the equation of food security/supply (equation 1), a 1% increase in the previous values of food security/supply, life expectancy, and Co_2 emission into the environment lead to a 97% increase, 44% increase, and 30% decrease in current food security respectively. The plausibility of the results lies with the positive relationship between food supply and life expectancy, which has made the result consistent with the famous Malthusian Theory of population and food supply, as the population will not starve to death (longevity) following the increase in quality food availability.

Followed by the equation of life expectancy (equation 2), a 1% increase in the previous values of food security/supply, life expectancy, and Co_2 emission into the environment lead to a 0.7% increase, 91% increase, and 46% decrease in current life expectancy respectively. Here again the direct relationship between life expectancy and food security has shown that with food security, there is bound to be improvement in the quality of human life in the country.

On the equation of the Co_2 emission into the environment (equation 3), a 1% increase in the previous values of food security/supply, life expectancy, and Co_2 emission into the environment lead to a 3.6% decrease, 32.9% decrease, and 34% increase in current Co_2 emission respectively. Here, food security and Co_2 emission into the environment are negatively related. This implies that when the environment is less polluted, food security is enhanced.

The overall goodness of fit shows that 96% variation in food security/supply is caused by the variations in the previous values of food supply, life expectancy and emissions into the environment while 99% variation in life expectancy is caused by the joint variation in the previous values of food supply, life expectancy and emissions into the environment. And 46% variation in emissions into the environment is caused by the joint variation in the previous values of food security/supply, life expectancy, and Co_2 emission into the environment.

DISCUSSION OF FINDINGS

Several reasons account to why food security has been seen to significantly improve the quality of life of Nigerians. This can be attributed to the increased consumption propensity of average Nigerians. Indeed, among the factors is the postulation from the basic need theory by Streeten et al (1981) that food is very important to the survival and improvement of the quality of life of the populace.

The environmental effect of industrial food production which are usually associated with gaseous emissions (from the industries producing chemical foods, genetically modified foods, etc) has been observed not to be significant. This follows that any improvement in food security, Co_2 emissions are reduced. This reduction in Co_2 emission by these industries further has chain reactions as it improves food supply (security). This can be attributed to environmental pollution which these emissions are liable to cause when increased. This

is capable of reducing quality and quantity of agricultural yield and food security/supply suffers.

The results presented also shows that there is a negative but insignificant relationship between industrial emission into the environment and life expectancy of Nigerians. Therefore, Nigerians will suffer life threatening and hazardous environmental pollution emanating from these food producing industries in the long run. This has ensured that the quality of life (especially life expectancy) of the citizens is comparatively abased.

In sum, the entire test results of the VAR analysis in table 4 at lag one indicates that the variables are dynamically interacted. Starting with the equation of food security (equation 1), a 1% increase in the previous values of food supply, life expectancy and environment lead to a 97% increase, 44% increase and 2% decrease in current food security respectively.

Followed by the equation of life expectancy (equation 2), a 1% increase in the previous values of food supply, life expectancy and environment lead to a 0.7% increase, 91% increase and 0.3% decrease in current life expectancy respectively.

From the study also, equation 3 on environment shows that, a 1% increase in the previous values of food supply, life expectancy and environment lead to a 3.6% decrease, 32.9% decrease and 34% increase in current value of the emission in the environment.

CONCLUSION AND POLICY RECOMMENDATIONS

Despite Nigeria's rich arable land that could guarantee food sovereignty and social security, this study has observed that Nigeria is still plagued by hunger, social insecurity and climate change. Industrial agriculture is a major cause of ecological destruction. These interconnected issues impact heavily on the situation of human rights of the citizens of Nigeria.Nigeria needs Independent and rigorous scientific investigation before ever GMO product is accepted. The Nigerian Government needs to invest in independent science research that puts the health and welfare of Nigerian citizens first. Regulators should look into the bio-safety laws of Europe as well as the work of independent scientist.Finally Nigerians can feed Nigerians, protect our soils and protect our seeds from seed colonialism, block toxic chemicals, Farm to Markets Bridges, increased social investments (education, etc.).

Finally, we conclude by saying that it is important to underline that mechanization of agriculture to improve productivity is different from industrialization of agriculture for business purposes. The former retains the indigenous food cultures and systems, indigenous food sovereignty and autonomy; and respects their Human Rights while the later erode them. Besides, the real and potential negative environmental impacts of industrial agriculture are well documented.

For this reason, this study has filled important gaps such as official scientific knowledge gap on biotechnologies, public knowledge gap of science and holistic assessment of Foods: cultural, social, ethical and environmental.

1. Though our people are hungry, the introduction of genetically modified organisms (GMOs) and the distribution of GM seeds are not options considering the vast and fertile lands for organic agriculture in Nigeria. However, the Government will need to invest more in agriculture and support local farmers and researchers to develop indigenous agricultural systems.
2. Nigeria should not be in a hurry to accept GMOs. It is important that the country indigenizes the " *precautionary principle"* of the African Union regarding GMOs.
3. Agro-ecology offers more cost-effective solutions to environmental protection. Additionally, it protects biodiversity, seed varieties, food cultures and farmers right to seeds. There is need for

agricultural policy guide that will take these values into consideration.

4. There is also need to revitalize public sector agricultural research, Small farmer-oriented, low-input agro-ecology, reform unfair trade-related rules.
5. The Nigerian government must evolve an original agro-economic policy that suits her local economic and social contexts.
6. There is an urgent need to develop practical policies that will promote value addition to Nigeria's agricultural produce. As a matter of fact, much of the foods produced in Nigeria are wasted.

Limitations

This study does not claim to be exhaustive regarding the issue of the implication of industrial agriculture on the quality of human life and environment in Nigeria especially when it concerns GM foods and agri-business. Apart from this, our study has also the limitation of investigating the impact of GM foods and Agri-business on other living creatures that are not human in the Nigerian environment.

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