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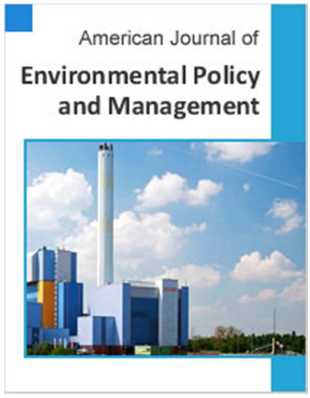

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Genetically Modified Foods (GMOs) and Its Environmental Conflict Situation in Nigeria

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Abstract
Genetically modified foods (GMOs) are economic activities as well as invention. Thus, the increase in population and a corresponding increase in human economic activities with their consequent impact on the environment are visibly retarding the conditions of life on earth. Obviously, there is a cause and effect relationship between human economic activities and the damage done to the environment. Nigeria has adopted the use of biotechnology to enhance food nutritional values. The introduction of genetically modified foods to Nigeria is generating huge debates because of the seemingly the environmental conflicts it will ensue thus raising a number of fundamental questions about its impacts on the environment. In spite of these controversies, GMO has been presented to Nigeria as the ultimate weapon against hunger. This paper will highlight the motivations for introducing genetically modified foods (GMOs) to Nigeria and the controversies generated on the environmental conflicts it could cause in Nigeria. The paper argues that there is an environmental conflict, caused by this human invention which needs to be resolved. Therefore, this paper will identify the potential environmental conflicts that the introduction of GMO could cause in Nigeria and provide conflict management mechanisms for fine tuning of existing policies to de-escalate the conflicts among the stakeholders. The paper concludes with suggestions that will make the country harness the benefits of the technology.

1. Introduction

Genetically Modified Food means any food containing or derived from genetically modified organisms (GMOs) [1]. Genetically Modified Organisms (GMOs) are made through the inserting a gene from an external source such as viruses, bacteria, animals or plants into usually unrelated species of organisms. Through, biotechnology the world has been granted the ability to overcome insurmountable physiological barriers and also to exchange genetic materials among the living organisms. The use of recombinant DNA technology has the prospects or creating an organism which may be desired and designed by a human [1].

The main producers of GM crops include USA, Argentina, Canada, and China [2]. The recent rate of biotechnology crop adoption is greater in developing versus industrialized countries (this is 21% *against* 9%) [3]. Developing countries are fast accepting the technology hoping to lessen hunger and poverty. These countries account for forty percent of the global farmlands used for GM crop cultivation [3].

Genetically modified food (GM food) controversies have disputes over the use of

foods and goods that are derived from the genetically modified crops instead of conventional crops, and the uses of genetic engineering in the production of food [4]. This dispute sometimes involves consumers, biotechnology companies, farmers, governmental regulators, non-governmental organizations, and scientists [5]. While, the key areas of debate related to GMO food are the consequence of genetically modified crops on health and the environment which include the concern on pesticide resistance, the implication of the crops for farmers, and the crops role in feeding the world [4].

In pursuit of sustainable food security in Nigeria, the government has embraced the adoption of genetically modified foods (GMOs) as a product of biotechnology for improvement and increased productivity in the agricultural sector that would lead to improved socioeconomic status of Nigerian farmers and enhanced national economic prosperity to achieve; Foreign investments and earnings from safe modern biotechnology sector, Environmental sustainability, Jobs/wealth creation arising from various modern biotechnology activities, Availability of raw materials for industrial growth, particularly in the Nigerian textile sector, Development of plants/organisms that can reduce the impact of climate change and serve in pollution remediation, Improvement of the medical sector using various organisms that abound in the country.

But Nigeria, like some other countries of the world, has started to battle with environmental conflicts arising from the introduction of genetically engineered foods has shifted focus to the role of agri-business. Discussions and opinions about GM foods which include crops, processing aids, and public policy issues that are related to them have been a product of debate in the last two decades [6].

The debate has generated a lot of heat in the West. Thereby, making the European consumers be wary of GM products, fearing they may impair human health in the future, while the environmentalists also argue that its technology could have devastating consequences on the environment [7]. One of the attractions of introducing GM crops in Nigeria is that they may benefit the environment when crops could be modified to be resistant to the pest in order to remove the need to spray with a pesticide. The technology also holds the opportunity of developing varieties which may flourish in arid conditions [8].

Until this critical moment in Earth's history, slavery, serfdom, war, and colonialism had remained the challenges to peace as well as sources of conflicts that threatened humanity. Nevertheless, the discovered impact of environmental degradation of GMO was not only a credible and serious threat to peace but also represented a basis of conflicts for humankind and, indeed, a powerful global threat to all living organisms [9].

2. Motivations for Genetically Engineered Foods into Nigeria

2.1. Economy

The ambition of Nigeria to diversify its economy from its dependency on crude oil. The country faces a looming food security crisis coupled with a growing population that is increasingly dependent on imported foods. The dominant subsistence-oriented farm economy is at risk due to gradual abandonment. Insecure land tenure, scarcity of funds and credit, labour scarcity despite overall high unemployment and stagnant technology have crippled the further development of subsistence agriculture. Also, a wide range of policies, programmes and projects have had limited impact in ameliorating these problems [10]. Agriculture always provides opportunities to turn rural poverty and stagnation into development [11]. To achieve this, the government is opting for the introduction of genetically engineered foods [12].

The economic value of GM food's to farmers is one of its major benefits in developing nations [13]. The Economics comprehensive study in 2012 concluded that GM crops increased farm incomes all over the world by $14 billion in 2010 and with over half this amount going to farmers in developing countries [14].

Critics have challenged the claimed benefits to farmers over the prevalence of biased observers and the absence of randomized controlled trials. While, environmental activist Mark Lynas alleged that "the complete rejection of genetic engineering might be illogical and potentially detrimental to the interests of the poor and its environment" [15].

2.2. Industrial Agriculture

GM crops have been playing a primary role in intensive crop farming, that involves monoculture, use of herbicides and pesticides, irrigation and use of equipment requiring large amounts of fuel.

The proponents of conventional agriculture are of the opinion that its high yields, wider choices and low prices thereby claiming that technology is essential to feed a growing world population [16].. Commercial GM crops are known to have traits that reduce yield loss from insect pressure or weed interference [17]. Some scientists propose that a second Green Revolution including the use of modified crops is needed to provide sufficient food [18]. The prospect of genetically modified food in assisting the developing nations was acknowledged by the which by the year 2008; they have not found a conclusive evidence of solution [19].

This position had generated some skepticism. Skeptics which include John Avise claim that apparent shortages are caused by problems in food distribution and politics, rather than production [20]. Other critics emphasises that the world is having so many people because the second green revolution embraced unsustainable agricultural practices which at the end left the world with more mouths to feed than the planet can sustain [21]. Pfeiffer affirmed that even if technological farming is going to feed the current population, its dependency on fossil fuels, which was predicted will reach the peak output in 2010 incorrectly in 2006 may lead to a catastrophic rise in energy and food prices [22].

Dr. Borlaug affirms that GM crops are now naturally safe as today's bread wheat and reminding agricultural scientists

of their ethical obligation to stand up to the anti-science crowd and caution policy makers that global food insecurity will not fade away without this new technology and ignore this reality makes future solutions all the more difficult to achieve [23].

2.3. Diversification of Nigerian Economy

Nigeria is having the ambition of diversifying her economy from crude petroleum dependency. The country also faces a looming food security crisis with his growing population which is increasingly dependent on imported foods. The dominant subsistence-oriented farm economy is at risk due to gradual abandonment. Insecure land tenure, scarcity of funds and credit, labour scarcity despite overall high unemployment and stagnant technology have crippled the further development of subsistence agriculture. Also, a wide range of policies, programmes and projects have had limited impact in ameliorating these problems [10]. Agriculture always provides an opportunity to turn rural poverty and stagnation into development [11]. To achieve this, the government is opting for the introduction of genetically engineered foods [12].

In the report of the United Nations Food and Agriculture Organization on biotechnology for resource-poor farm families in developing countries stated that agriculture is confronted with many difficult challenges as the world population increases and agricultural production drops behind consumption for the fourth year in a row.

Drought, inadequate water resources, and poor soils, along with other economic and social pressures, have made food insecurity a problem in Nigeria. Some Nigerians opined that in making this decision, the country considered not the overall implications of GM crops for human and environmental health, but also future directions in agriculture, the implications of private sector-led research, livelihood and development options, ethical issues and rights concerns [24]. Similarly, public concerns are raised about the relationship between GM crops and sustainable agriculture.

As elsewhere, globalization, trade liberalization, and deregulation, and the privatization of agricultural Research & Development lie at the heart of the push for GM technologies into Nigeria. Nigeria's receptiveness is shaped by concerns about food insecurity, growing poverty, and inadequate nutrition as well as declining public agricultural research budgets and capacity. Declining public sector, African agricultural research, combined with the privatization of agricultural research, has led to a focus on providing hi-tech solutions, including transgenics, over other agricultural options. Globally-driven agricultural research and technology development, which defines Nigeria's food security problems as being primarily about yield, poses the "quick fix" of GM crops as particularly attractive [25].

2.4. Hunger and Hunger Reduction Strategies

Hunger is the most extreme display of the multi-dimensional phenomenon of poverty, and the eradication of hunger is therefore instrumental to the eradication of other dimensions of poverty [26]. Persistent widespread hunger impedes progress in other aspects of poverty reduction and weakens the foundation for broad-based economic growth. *Hunger* also represents an extreme instance of *market failure*, because the people who are most in need of food are the least able to express this need in terms of demand.

The right to food was first explicitly stated in the 1940s in the Universal Declaration of Human Rights and the Food and Agricultural Organization (FAO) Constitution [27]. However, there has been little progress towards its implementation. The United Nations (UN) Committee on Economic Social and Cultural Rights has aided the task of implementation of the fundamental human right by adopting, in 1999, the General Comment on the Right to Food, which insist on how states can meet their obligations to respect, protect and fulfill this right.

3. Result / Discussion

3.1. The Environmental Conflict Situation of GMOs in Nigeria

The environmental conflict of GMOs is one of the leading causes of unrest globally in the recent time. The introduction of genetically modified crops (GMOs) to Nigeria as one of the strategies to address food security crisis has gained increasing momentum because it has the potential to improve crops appearance, taste, nutritional quality, drought tolerance, insect and disease resistance [28].

However, there are more reasons, controversies, disagreement, and hesitation about the adoption of genetically modified foods in the country [29]. The GMOs debate illustrates the serious conflict between two groups:

Government, Agri-biotech investors, and their affiliated scientists considered agricultural biotechnology as a solution to food shortage, scarcity or inadequacy of environmental resources and weeds and pests infestations; and

The independent scientists, environmentalists, farmers and consumers who caution that genetically modified food may introduce new risks to food security, the environment and public health such as polluting the environment and also threatening of the biodiversity [30].

Nigeria, such like some other countries of the world, has started to battle with environmental conflicts arising from the introduction of genetically engineered foods has shifted focus to the role of agri-business. Discussions and opinions about genetically modified foods – including crops, processing aids, and the various public policy issues related to them – have been controversial in the recent time.

Of keen interest to researchers as well as environmentalists had been the environmental conflicts associated with GMOs [31]. A school of thought that these could be replicated in Nigeria. For example, the escape of genetically modified seed into neighboring fields, and the mixing of harvested products has been a concern to farmers who sell to countries that do not allow GMO imports [32].

3.2. Genetically Modified Food Controversies in Nigeria

Civil society groups in Nigeria and around the world have engaged in a thorough global assessment of the performance, and the implications of GM crop releases around the world since 1996. These efforts have been aimed at providing an accurate picture of the global spread and implications of these crops and organisms, and also to help separate the hype from reality [33].

Several non-governmental organisations have petitioned the National Assembly over attempts to introduce genetically modified (GM) maize and cotton into Nigeria's food and farming system.

Several non-governmental organisations which include Environmental Rights Action/Friends of the Earth Nigeria (ERA/ FOEN), Health of Mother Foundation (HOMEF), All Nigerian Movement Union (ANCOMU), Women Environmental Programme (WEP, Rice Farmers Association of Nigeria (RIFAN), and Nigerian Women in Agriculture (NAWIA) have made serious objections to introducing genetically modified (GM) maize and cassava into Nigeria's food and farming system [34].

This did not go without response from the National Biosafety Management Agency (NABMA) and Open forum on Agricultural Biotechnology (OFAM) that allayed the fears of Nigerians about alleged attempts to introduce genetically modified (GM) crops, saying every genetically modified organism (GMO) in the country is properly analysed and approved by the agency.

Global anti-GM food campaigns have been influencing public attitudes to GM foods in Nigeria. Consumers International (CI), a worldwide federation of consumer organizations with 38 member organizations in about 22 African countries played an important role in shaping the debates around GM foods. It advocates a legal regime in which all GM foods are subject to rigorous, independent safety testing, labelling and traceability requirements, and in which producers are held liable for the environmental or health damage which their products may cause [35]. There is growing acceptance of this approach globally.

In particular, there are challenges around reconciling the rights of product developers with those of consumers. Many public protests have centered on ethical or ecological grounds, the uncertainty about the impacts of the technology, and the public right-to-know and to have access to information, including through labelling. In several countries, concerns have been raised as to whether "the technology is tantamount to playing God, interfering with nature, contrary to local ethics and also whether gene insertion would play havoc with the totem system that lies at the heart of local cultural association" [24].

3.3. The Potential Environmental Concerns of Genetically Engineered Foods in Nigeria

GM crops are yet to be planted in Nigeria. Hence, we cannot talk about any environmental issues now, but the common environmental concerns are associated with genetically modified crops globally which are likely to be replicated in Nigeria when cultivation takes place are summarized below;

(I). Harm to the Environment and to Biodiversity

GM crops are planted in fields much like regular crops. They interact directly with organisms feeding on the crops and indirectly with other organisms that are in the food chain. In the environment, the pollen from the plants is distributed like that of any other crop leading to concerns over the effects of GM crops on the environment. Potential effects include gene flow, pesticide resistance, and greenhouse gas emissions.

The development of the superior GM strains that gathering others out of the market might decrease the crop genetic diversity. This might indirectly affect other organisms to the level that agrochemicals may have an impact on biodiversity, and also on modifications that encourage their use, also because successful strains will require them or because the accompanying development of resistance will require increased amounts of chemicals to offset increased resistance in target organisms.

In the studies comparing the genetic diversity of cotton found that in the US diversity and that of India, it was foind that there has been either increased or stayed the same, while that of India has declined. These differences were attributed to the larger number of modified varieties in the US compared to India. [36]. When the effects of Bt crops on soil ecology and ecosystems was reviewed, it was discovered that they "appear not to have consistent, significant, and long-term effects on the microbiota and their activities in soil" [37].

For example, in a study in the year 2012, a correlation was found between the reduction of milkweed in farms which grew glyphosate-resistant crops and the decline in adult monarch butterfly populations in Mexico [38]. While, in study designed to simulate the impact of a direct overspray on a wetland with four different agrochemicals (carbaryl (Sevin), malathion, 2,4-dichlorophen-oxyacetic acid, and glyphosate in a Roundup formulation) thereby creating artificial ecosystems in tanks and may then applying "each chemical at the manufacturer's maximum recommended application rates" in the year 2005, it was found that the species richness was reduced by 15% with Sevin, malathion 30%, and Roundup 22%, however 2,4-D had no effect" [39]. The study was used by environmental groups to argue that use of agrochemicals causes unintended damage to the environment and to biodiversity [40].

(II). Gene flow

GMO Genes may pass to another organism just like an endogenous gene. The process outcrossing can occur in any new open-pollinated crop variety. Here introduced traits potentially can cross into neighboring plants of the same or closely related species through three different types of gene flow: crop-to-weedy, crop-to-crop, and crop-to-wild. In crop-to-weedy, genetic information from a genetically modified crop is transferred to a non-genetically modified crop. Crop-

to-crop transfer denotes the transfer of GM material to weed, and crop-to-wild indicates a transfer from a GM crop to a wild, undomesticated plant and/or crop [41].

There is a concern about the spread of genes from modified organisms to unmodified relatives could produce species of weeds resistant to herbicides [42] that could contaminate nearby non-genetically modified crops, or could disrupt the ecosystem [43]. This is on the basis that the transgenic organism has a substantial survival capacity which can increase in incidence and persist in natural populations [44]. The process, whereby genes are transferred from GMOs to wild relatives, is unlike the development of so-called "superweeds" or "superbugs" which develop resistance to pesticides under natural selection.

For example, Chilcutt and Tabashnik (2004) found Bt protein in kernels of a refuge (a conventional crop planted to harbor pests might otherwise become resistant a pesticide associated with the GMO) implying that gene flow had occurred [45]. Also, in 2007, the U.S. Department of Agriculture fined Scotts Miracle-Gro five hundred thousand dollars when modified DNA from GM creeping bentgrass, was found in the families of the same genus (Agrostis) [45] as well as in native grasses up to 13 miles (21 km) from the test sites, released when freshly cut, wind-blown grass [46].

(III). Escape of GM crops

The escape of GM seed into neighboring fields and the mixing of harvested products have been a concern to farmers who sell to countries that do not allow GMO imports [32]. Scientists in Thailand in the year 1999, claimed they had found unapproved glyphosate-resistant GM wheat in a grain shipment, though when it was only grown in test plots with no identification of the mechanism for the escape [47].

Unapproved glyphosate-resistant GM wheat (which had been approved for human consumption was discovered in May 2013 on a farm in Oregon and in a field that had been planted with winter wheat [48]. The strain was developed by Monsanto and was utilized for field-tested from 1998 to 2005. The discovery threatened US wheat exports which totalled $8.1 billion in 2012 which lead the company to withdraw it [49]. Japan, Taiwan, and South Korea suspended winter wheat purchases amid concerns raised by organic food advocates [50].

(IV). Outcrossing

Out-crossing is the unplanned breeding of a domestic crop with a related plant. This has to do with the potential of the presented genes to outcross to weedy relatives as well as the prospects of creating weedy species. A major environmental concern associated with GM crops is their potential to create new weeds through outcrossing with wild relatives and simply by persisting in the wild themselves. The potential for the above to happen is assessed prior to introduction and is monitored after the crop is planted as well.

In 1990, a ten-year study began to demonstrate that there is no increased risk of persistence or invasiveness in wild habitats for GM crops (oilseed rape, potatoes, corn, and sugar beet) and traits (herbicide tolerance, insect protection) were tested when compared to their unmodified counterparts [51]. The researchers affirmed that the results "do not mean that genetic modifications could not increase weediness or invasiveness of crop plants, but indicates that productive crops are not likely to survive for long outside cultivation

(V). Development of insect resistance

Another concern over the use of Bt (Bacillus thuringiensis) crops is that it leads to the development of insect resistance to Bt. Insect resistance management plans was developed by the government, scientists and industry to address this issue. The plans include a requirement that every field of insect-resistant crops will have an associated refuge of non-GM crops in order for the insects to develop without selection to the insect resistant varieties. Additional resistance management practices are also being developed by scientists all over the world. These will be performed in line with post-approval monitoring, when GM crops, as well as their immediate environment, will need to be constantly evaluated for changes even after the crop has been released [52].

(VI). Patenting Life: Intellectual Property Rights

Biotechnology issues that are related to intellectual property rights are concerned with the ethical and moral implications of patenting living organisms. The concerns are linked to fears that biotechnology may transfer resources from the public sphere to private ownership through the enforcement of intellectual property rights. Firms that have invested in the development of genetically modified varieties may want to protect their proprietary knowledge. Nevertheless many farmer groups have protested that enforcing intellectual property rights may disrupt their access to seed. Farmers accustomed to harvesting and replanting their seeds are not willing to pay for GM seeds year after year. These debates draw attention to the controversial TRIPs Article 27.3 (b). (Trips), which exempts certain life forms from patentability but requires countries to establish some form of protection for plant varieties.

Transgenic research is very expensive when compared to more traditional biotechnology techniques. For example, the IRMA project is estimated to have cost US$6 million over 5 years and the transgenic sweet potato research US$2 million, compared to the average funding of tissue culture and marker technology projects costing on average US$300 000 [53]. This will compel Intellectual Property Rights thus depriving farmers' direct access to seeds without recourse to the transgenic firms.

Although IPR standards have been developed through the World Trade Organization's (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), domestic IPR legislation in many African countries remains weak. Many countries struggle with how to reconcile IPRs with farmers' rights and other local interests. There are concerns that strong IPRs will establish global domination of world food production by a few companies and increased dependence on industrialized nations. IPR may place restrictions on farmers, including on their existing rights to store and exchange seed. [54].

In Africa, many communities and consumers express moral concerns about "playing god" as plants are

transformed in unnatural ways and about the implications for traditional beliefs and values. If not properly managed, gene patents could be instrumental in promoting and institutionalizing social inequity [55][56]. Patenting genetic material traditionally accessible to a community, without allowing the community free use of the material or providing any return to the community, affects the fair and equitable distribution of resources, a necessity in the development of a sustainable society [56].

4. Suggestions

In Nigeria, environmental impact assessment/studies should be required before approval is given to any GMO for commercial purposes with a monitoring plan must be presented to identify unanticipated gene flow effects.

GM crops should be evaluated individually on a case-by-case basis, both prior to release and after commercialization.

Nigeria should domesticate the existing international bio safety treaties and protocols to strengthen the national biosafety acts which serve as the regulatory framework for GM foods by the National Biosafety Management Agency (NBMA), Federal Ministry of Environment.

A collaborative meeting should be held comprising the government, academia, research institutes and civil society organisation to make informed decisions on the adoption and cultivation of genetically modified food in Nigeria.

5. Conclusion

This technology has its merits and demerits like other inventions. However, it cannot be dismissed out rightly. No doubt there is a conflict situation in Nigeria on the environmental implications of the introduction of genetically modified foods in the country. This should be a call for attention to re-examine the contentious areas of this technology with a view to enabling Nigerians to benefit from its application.

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