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Development, adoption and commercialization of GM crops: A needed commodity in Nigeria

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Abstract

Food has been recognized globally as a necessity of life and organization such as World Health Organization (WHO) have made attempts at addressing the global food scarcity crisis. One of the attempts is the introduction of Genetically Modified crops (GM crops). Agricultural productivity is low in Nigeria due to reliance on rainfall and other related factors like poor agronomic practices and crop losses from pest and disease. The benefits of GM crops include increase or improved yield, adoptability to specific abiotic and biotic stresses such as drought, pest and disease among others. Nigeria as a nation is slow in adopting GM crops due to the political debate and public opinion and concerns over public health and safety. The Nigeria National Assembly and Nigerian Academy of Science (NAS) has since declared that GM crop is safe for consumption. However, the commercialization of GM crops in Nigeria still remains to be the challenged. There is need to convince the population on the safety of GM crops based on evidence of success stories of empirical studies for the formulation of regulations and policy guidelines that will promote the development, adoption and commercialization of GM crops for food sufficiency and sustainable development.

Keywords: *GM crops, Nigeria, Herbicide, Tolerance, Resistance, Fortification, Commercialization.*

1. Introduction

Food has been recognized globally as a basic necessity of life. Its basic function is to supply the energy needed for human activity and sustenance of life. The importance of food has also made it an instrument of national power and development worldwide. Thus, developed nations place much emphasis and allocate substantial budgets to food security of their populace (Ojo and Adebayo, 2012). Despite these efforts, climate change, population growth, disease outbreak, environmental degradation and human activity have made food security a global concern. Hence, governments and non-governmental organizations such as the WHO have made

several attempts at addressing the global food scarcity crisis. One of the attempts at addressing the crisis that has proven to be promising is the introduction of Genetically Modified (GM) crops (Qaim, 2010).

According to the World Health Organization (WHO), "GM foods are foods derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally" (WHO, 2014). Some of these attributes include resistance to diseases and environmental conditions, reduction and or delay of spoilage, resistance to chemical treatments as well as improvement of nutrient profile. GM crops have the potential of raising agricultural productivity as evident in areas where they have been adopted. Although, concerns have been raised on possible human health hazards due to GM crops, appropriate safety regulations could address these concerns (Qaim, 2010).

Although better in terms of production, Nigeria is one of the food-deficit countries in sub-Saharan Africa (FAO, 2015). Her population among other factors makes food security a major challenge. In June 2016, the National Biosafety Management Agency (NBMA) issued two (2) permits for the commercialization of GM cotton and confined field trial of maize in Nigeria. NBMA has also granted permits for field trials of other GM crops (Ezeamalu, 2016). These efforts have been laudable, however GM crops are yet to be fully commercialized in Nigeria especially due to safety concerns. Another impeding factor is that stakeholder groups in Nigeria assert a challenge of integrating GM crops into Nigeria's local economy owing to the limited involvement of local scientists and farmers (Adenle et al., 2013). Considering increase population growth rate (indicate the rate of annual population growth), security challenges and her prevailing food production decline, it is imperative that GM crops production in Nigeria be given due attention. It is against this backdrop that this review seeks to justify the need for GM crops and proffer ways of fast tracking its development, adoption and commercialization in Nigeria within adequate safety regulations and policy guidelines to promote food security and national development.

2. Development of GM crops

Agriculture is the major economic sector in Africa employing about 65% of the total labour force and contributing about 32% of the continent's gross domestic product (Asenso-Okyere and Jemaneh, 2012). However, agricultural productivity still remain low due to reliance on rainfall as opposed to irrigation, minimal use of input fertilizer on depleted soils, lack improve crop cultivars couple with poor agronomic practices, crop losses from pests and diseases (Asenso-Okyere and Jemaneh, 2012). So far, four African countries are growing genetically engineered crops: South Africa, Burkina Faso, Egypt and Sudan (Adenle et al., 2013). Countries like Kenya, Nigeria and Uganda have conducted field trials (ISAAA, 2016). According to Apps (2015), a handful of other African countries including Nigeria and Tanzania are looking at creating a new law to allow planting of Genetically Modified Organism (GMO) crops. The reverse is the case in many other African countries where there is ban and strict control of importation of GM crops.

In Nigeria, the IITA has developed parasite resistant maize (Ngandwe, 2005). This variety tolerate heavy striga infestation without suffering crop losses. More so when the insect *Maruca vitrata* destroys nearly $300 mn worth of black-eyed peas—major staple crop in Nigeria. Farmers were force to import pesticides worth $500 mn yearly. To solve the problem, scientists at the Institute for Agricultural Research at Nigeria's Ahmadu Bello University have developed pest-resistant, transgenic black-eyed pea variety using genes from *Bacillus thuringiensis* (Bt) which highlights the need to fast track the development and adoption of GM crops in Nigeria.

3. Why Nigeria need GM crops

3.1. Benefits of improved crop varieties

The Green Revolution in agriculture largely passed unnoticed in Africa. While in Asia and Latin America the introduction of improved crop varieties and adoption of improved farming methods has enabled food production to outstrip population growth, in Africa agricultural productivity actually declined.

Jennifer and Richard (2010) stated that global population stood around seven billion was predicted to rise to nine billion by 2050. The recent Foresight (2011) report suggested that global demand for food could rise by 70% by 2050 and most of this demand is likely to come from developing countries. Nigeria has fast population growth rates, and the high number of people living with chronic hunger (Cohen et al., 2003). The optimal places to improve crop yields are areas such as sub-Saharan Africa, where 96% of farms are rain-fed (Hazell et al., 2007) with low inputs in terms of soil improvements or fertilizer (Crawford et al, 2003). Agricultural development in sub-Saharan Africa particularly in Nigeria faces the daunting challenge of climate change and increasing climate variability in most vulnerable areas (Thornton et al., 2014).

Presently, Nigerian agricultural system is facing the growing encroachment of urbanization, industrial expansion, and an expanding transport infrastructure (Oluwatuyi, 2004). Low food production has also constantly been ascribed to such factors as climate (drought or inadequate rainfall), soil fertility, soil erosion and desertification; poor farming practices; crop losses due to weed and insect attack; inappropriate post-harvest technology; poor farm inputs and natural disasters. In addition to these factors, the situation is increasingly being made worse by the global warming phenomenon, the decrease in farm labor due to rapid rural urban migration, widespread poverty and conflicts (Academic of Science of South Africa, 2010). Consequent upon these challenges on agriculture, Nigeria imports a lot of commodities especially food from other countries. GM crops improved crop varieties with enhance desired traits such as increased resistance to herbicides, improved nutritional content, Insect/pest-resistant, disease resistance, and increased storage life can serve as the country's lifeline to finally tackling its agricultural problems and subsequently attaining food sufficiency (Oluwatuyi, 2004).

Herbicide tolerant crops are engineered to survive the application of a powerful herbicide that would kill a non-engineered crop, making it easier for farmers to use more herbicide to control nearby weeds. Insect-resistant crops are engineered with an insecticidal protein from a soil bacterium, *Bacillus thuringiensis* that kills certain insect pests when they eat the leaves or grain of the plant. Insect resistance GM crops will provide Nigerian farmers a lasting solution to insect pest infestation and reduced productivity. Improved crop varieties have also been developed to thrive in regions with very little rainfall (Drought resistance GM crops). Crops under development include soybeans with higher protein content; potatoes with more nutritionally available starch and with improved amino acid content; pulses such as beans which have been altered to produce essential amino acids; crops which produce beta-carotene; and crops with a modified fatty acid profile (Okonko *et al.*, 2006). Different types of peppers and melons with improved flavors are currently in field trials. Flavor can also be improved by enhancing the activity of plant enzymes which transform aroma precursors into flavoring compounds (Tietyen *et al.*, 2000).

3.2. GM crops are environmentally friendly

The introduction of GM crops has greatly altered the amount of insecticide and herbicides used globally and thus reducing the negative impacts on the environment, human and animal health (Brookes and Barfoot, 2010). The analysis from a study conducted in 2010 by Graham Brookes and Peter Barfoot where the environmental Impact Quotient indicator was used to assessed the impact of insecticide and herbicides on conventional and GM production systems reveals that GM crops traits to a large extent reduce significantly the environmental impact associated with the use of insecticide and herbicides. It has been observed that since 1996, the use of pesticides and herbicides in Biotech traits farms has decline by 352 million kg of active ingredient which equates to 8.4% reduction in the use of pesticides (Brookes and Barfoot, 2010).

This huge reduction in the use of pesticides and herbicides has translated into a 16.3% drop on environmental pollution (Brookes and Barfoot, 2010). According to Graham and Peter, the highest environmental gain was associated with the introduction of GM IR cotton compare with the use of traditional cotton which rely heavily on the use of insecticides. A survey conducted to monitor the volume of herbicides use in soybean from 1996 to 2008 reveals a significant decline by 50 million kg of herbicides used (3% reduction) translating to 16.6% decrease on environmental impact (Brookes and Barfoot, 2010). These trends were also recorded in GM maize with 141.5 million kg in herbicides and insecticides translating to 8.5% and of GM Canola crop decrease of herbicide application by 13.7 million translating to 24.3% reduction in environmental impact (Brookes and Barfoot, 2010). The adoption of no-till/reduce till farming system for the GM HT crops in North and South America has save 25,909 million kg of carbon dioxide that has not been released into the atmosphere (Brookes and Barfoot, 2010). The survey reveals that the amount of carbon dioxide save from emission into the atmosphere in 2013 as a result of reduce in amount of fuel used in the GM HT farming system is equivalent to removing 0.93 million cars from the road. Environmental protection against pollution is a concern for all nations. Nigeria as a nation will not compromised in maintaining a pollution free environment. The use of insecticides and herbicides as well as the fuel use in spraying and tilling the land can to an extend leads to pollution. In an effort to reduce the use of insecticides, herbicides and fuel, GM crop farming system is recommended. These crops do not need insecticides and herbicides since most have in their genome insecticide and herbicide resistant genes. In addition, not much tilling is needed thereby reducing the amount of fuel needed in the cultivation process.

4. Use of genetically modified crops to solve the issue of food security in Nigeria

Food security refers to a situation when all people at all-time have physical and economic ability to enough, safe and nutritious food for a healthy and active life (FAO, 1996). Another definition states that, food security involves producing food that will go round every citizen both in quality and quantity (Adegbola *et al.*, 2011). According to (FAO, 2015), sub-Saharan Africa countries have shown limited progress in reducing both undernourishment and child underweight, in Nigeria about 13 million people are report to be undernourished between 2014 -2016 and therefore it was suggested that all aspects of food security needs to be tackled in other to attain significant progress towards achieving food self-sufficiency. The population of Nigeria is a challenge to meeting food security requirements of the nation as Nigeria's population as at 2011 stands at 162 million people and it is expected to be between 230 and 430 million people by 2050 (Towobola *et al.*, 2014).

The prevalence of food insecurity and malnutrition is expected to be significantly higher in 2017 in northern Nigeria especially in the areas affected by the insurgency. On the other hand, food insecurity refers to the effects posed by inadequate consumption of nutritious food, looking at the physiological use of food by the body as being within the domain of nutrition and health (FAO, 2010). The neglect of agriculture in Nigeria due to oil boom created disillusionment in the agricultural sector of the nation which has manifested in massive rural-urban migration and this has also reduced the output of food per capital, thus making Nigeria as one of the least in the sub-Saharan Africa in terms of agricultural production. Therefore, there is the threat of hunger and poverty as 70% of the population lives on less than N100.00 ($0.7) per day and youth unemployment is very high (Oni, 2008) in (Towobola *et al.*, 2014). Nigeria is a country which is highly blessed with numerous natural and human resources and if properly utilize can feed its populace and export the surpluses to other countries, but yet still it is experiencing persistent food crisis both in terms of quantity and quality (Otaha, 2013).

Even though, Nigeria has as abundant agroecological resources and diversity, it has undoubtedly become one of the largest food importers in sub-Saharan Africa (Idachaba, 2009) in (Ojo and Adebayo, 2012). Agricultural biotechnology has the ability to eradicate malnutrition, hunger and provide food self-sufficiency through the production of resistant crops to pests and diseases, having longer shelf-lives, higher nutritional and palatability, higher yields and maturity period, tolerant to adverse weather and soil conditions, and generate employment among other benefits (Tonukar and Omotor, 2010). Nigeria needs to invest heavily in the cultivation and usage of GM crops in order to be able to overcome the issue of food insecurity, malnutrition, starvation and fight hunger in the country. Even though, critic of the use of GM crops argued that, its usage has detrimental effects on the health of the human populace and the ecosystem in general, hence there are substantial reasons why much research needs to be carried out to properly address and prevent any possible risks that may be associated with the consumption of GM crops (Olaniyan *et al.*, 2007).

4.1. Economic gains of GM crops in Nigeria

Nigeria will gain financially from investing in GM crops productions and help in boosting or curbing the current economy slow growth rate. It has been reported that countries around the world has gained financially for investing in GM crops.

For example, GM crops increased farm incomes globally by $12.9 bn during 2007 and have cumulatively placed $56.5 bn in farmer pockets since 1996. Also, globally, the report found that farmers received an average of $3.59 for each dollar invested in GM crop seeds in 2014. However, in developing countries that number was even higher, as farmers in places like South and Latin America, some countries in Africa and Asia received an average of $4.42 for every dollar invested in GM crops (Genetic Literary Society, 2016). From 1996-2014, farmers saw significant increases in yields due to reduced pest infestations from insect resistant cotton and corn. Corn farmers experienced a 13% increase in yields just from IR technology, while cotton farmers experienced 17% yield gains as compared to conventional farming.

In 2005, GM crops were grown by 8.2 million farmers in 21 countries, Of the GM crops grown, 90% of the beneficiary farmers were resource poor farmers from developing counties whose increased income from GM crops contributes to the alleviation of their poverty (James, 2005).

4.2. Ensuring of food security and agricultural production in Nigeria can boost economic gain

In Africa many have died of hunger due to the scarcity of food, increase in food production through GM technology will help in tackling the problems. It has been reported around the world, that Africa faces a fundamental food security challenge (UNEP, 2008). Cowpea is an essential source of protein for millions of

Nigerians and others in Africa. Farmers in Africa typically apply pesticides several times within a planting season in an effort to control the destructive pod borer (*Maruca vitrata*) pest. It is for this reasons among others that, the Government of Nigeria has taken the bold step to approve the production and commercialization of GM cowpea in country. This product would provide built-in resistance to the insect and it will considerably decrease pesticide usage by local farmers in Nigeria. It would in no doubt reduce the reliance on the import of cowpea and it would as well help the nation to achieve food security drive (Nkechi and Conrow, 2019).

4.3. Improved nutritional and health benefit of GM crops can boost economic gain

Nigeria has recorded dead rate among children due to malnourished foods, fortification of these foods crops through GM technology will help curb this problem. It has been reported according to (Yamin, 2003), crops can be GM to improve appearance, taste, nutritional quality, drought tolerance, insect and disease resistance. GM crop can thus often help up as the solution to yield deficit. The biotechnology of gene splicing allows for the opportunity of creating crops that will produce food that is more nutrient dense (Anonymous, 2009a). FAO (2005) reports underscores the importance of nutrient dense food as it tends to reduce the large proportion of undernourished people. These GM crops produced can be exported to other parts of the world and thus boost the economic gains.

4.4. Adoption of GM crops in Nigeria

Nigeria as a nation is slow in adopting GM crops due to the political debate and public opinion that have been tailored by fear of the unknown which is exacerbated by the social media. However, those who have the understanding of GM crops are proponent of the technology. Although, this technology is relatively new in Nigeria, it has natural raised concern on public health and safety. The Assistant Director with the National Biotechnology Development Agency (NABDA) Ms. Gadado, described the controversies on GMOs as "war of word", where she further stated that no research had proven that GMOs had adverse effect on human health and the environment (Premium Times, 2016). Nigeria, now poised to cultivate GM crops alongside its Africa counter-part which include Burkina Faso, Egypt, South Africa and Sudan since the passage of a biosafety law by the Nigerian National Assembly and its signing by the former president Goodluck Jonathan in 2015. The Nigerian Academy of Science (NAS) also declared in November 2016 that, GM foods are safe for consumption although no GM crops are presently grown commercially. According to *Premium Times* Nigerian newspaper, the Nigerian government has been campaigning to reassure the public about the safety of GM crops and to promote their benefit to the agricultural section and it has sanctioned several field trials which if successful could result in green lighting of insect-resistant Bt cotton, cowpea and corn; disease resistant and vitamin A cassava, and nitrogen and water efficient rice. The Director General of the National Biosafety Management Agency (NABMA) also made pronouncement that he expects the first GM crop; Bt cotton to be commercialized in 2018.

Despite anti-GMO campaign by some NGOs to scare Africa nation from voluntarily accepting this technology, Arch. Kabiru Ibrahim the President of All Farmers Association of Nigeria (AFN) disclosed to *Vanguard* newspaper that there is strong and growing support in the farming community for the use of GMOs. A vibrant and well-established seed sector can be a key factor for GM crop adoption using a five-phase classification system for GM crop application stages, Nigeria falls under the contained field trials group (Mabaya *et al.,* 2015) which is a strong positive correlation between a country's progress towards adopting GM crops.

4.5. Commercialization of GM crops in Nigeria

GM crops have the capability of influencing the economic and social situation of farmers, and Nigerian citizens thus improving their economic access to food, good health and productivity. This is an estimated 50% of all undernourished people worldwide are small-scale farmers in developing countries (Borlaug, 2007). It will also attract foreign investments and earnings from a safe modern biotechnology sector, leading to environmental sustainability, jobs or wealth creation. How to commercialize these GM crops in Nigeria is the challenge we are faced with at present. In order to successfully commercialized GM crops in Nigeria, three target groups have to be involved; the farmers, the biotechnology industry and consumers. This was the approach that was adopted in Australia when they discovered they were left behind in the commercialization of GM crops (Harrera-Estrella and Alvarez-Morales, 2002). China also embarked on some these strategies for fast commercialization of GM crops (Huang *et al.,* 2005). It is already a way forward that national biosafety management agency has been put in place and the administration of the past government had signed for the

reading of the biosafety laws. Involving peasant and commercial farmers by educating them even in their local dialect will quickened and fastened GM crops commercialization in Nigeria. No country is independent of herself, therefore we must depend on one another in one way or the other for growth and development. China when they were to commercialize their GM products, the biotechnology industry was greatly involved. Funding from national and international research agency should be sourced for the establishment of several biotechnology laboratories that can even test even ready-to-use GM crops across the country. NABDA is not sufficient. It may also need to collaborate with National Agency for Food and Drug Administration and Control (NAFDAC). Production and commercialization of GM crops must not necessarily start on a large scale. Small scale production is sufficient because it is result that stops arguments and the journey to the mountain top must always start from the valley. At present, only three institutes are currently carrying out confined trials researches on-going on cowpea at ABU, Zaria, rice at the National Cereal Research Institute, Badegi, cassava at the National Root Crop Research Institute, Umudike and cotton. Apart from these confined trials, no GM product is available in Nigeria. Although it has been noticed that some farmers go out of the country and come back with suspected GM seeds but officially, the first GM crop in Nigeria will be cotton which is expected to be made available to farmers by 2018, when the research and issues relating to its release would have been completed. According to daily trust news, the country coordinator for Open Forum on Agricultural Biotechnology (OFAB) said 'there is no going back on the commercialization of GM products in Nigeria. The coordinator added that all had been set to begin full commercialization of GM products in Nigeria soon. Some of the crops that will first be commercialized in large quantities include cotton, cowpea, and bio-fortified sorghum. Policy makers and practitioners should be guided by these recommendations for a fast commercialization of GM crops in Nigeria;

a) Institutions should collaborate to form intensive and centralize GM crop research group with focus on potential to commercialize varieties.

b) Increase awareness and knowledge about the product through educational programs and media (television and radio program, text book syllabus, seminar etc.).

c) Increase the awareness to commercialize the product by promoting the university research and focus towards production.

d) Heavily enforced the establishment and collaboration of institutions, unit and bodies to coordinate the regulation and activities.

e) Improve funding allocation for capacity building to minimize the distraction of resource limitations.

Finally, in most developed countries where the production and consumption of GM crops have permitted, the crops are mostly labeled. Therefore separate GM crops supermarkets can be built or GM crops labeled in mixed supermarkets since the GM crops does not stop the production of natural and local crops.

With this in mind, once the senate house finally passed the bill on production and consumption of GM crops the insight here presented will go a long way in commercializing GM crops in Nigeria.

5. Conclusion

The benefits and the need of GM crops have the potential of solving: food insecurity, create economic gains, produce high yielding crops among other benefits in Nigeria. Nigerians have for long being using GM pharmaceutical products but have been rejecting GM crops. This is probably because, health challenges are placed as a priority over food production and consumption. However, what we eat is what we are. Although field trials have been granted to cotton, we need to act fast, in fast tracking, adopting and commercializing GM crops and products that are of enormous benefits to the average Nigerian. The faster we accept this fact and put policies on ground that will facilitate GM crop production, consumption and commercialization the better for us as a nation.

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