

MEDIA AND THE ADOPTION OF GENETICALLY MODIFIED ORGANISMS IN NIGERIA'S AGRICULTURAL SYSTEM IN THE CONTEXT OF FOOD SECURITY

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Abstract

Food occupies a central position in development discourse. Part of the efforts to maximise the advantages of nature for food security is the innovation of genetically modified organisms (GMOs). This article examines GMOs in Nigeria's agricultural system in the context of food security through the media prism. Its objectives were to find out if GMOs should be adopted to combat food insecurity in Nigeria; to determine the extent of farmers' awareness about GMOs through the media, and to ascertain the level of Nigeria's farmers' use of GMO seedlings in their agricultural practices. The study was anchored in Everest Rogers' Diffusion of Innovation Theory. Qualitative and quantitative research methods were employed. Findings showed that there is confusion and controversy surrounding the GMO discourse. The study concluded that there is a need for an open and transparent dialogue among stakeholders to find a dynamic nexus between indigenous knowledge and scientific inventions that ensures the sustainability of such interventions as GMOs. The article recommends, among others, that the government should implement policies that afford stakeholders in agricultural services unhindered access to GMO crops and the technology, to facilitate immediate and large-scale adoption and production of food to combat food insecurity in Nigeria.

Keywords: media, food security, GMOs, development communication, agricultural services, Nigerian populace

Introduction

One of the most critical issues that countries around the world, including Nigeria, are contending with in the 21st century is how to meet the growing food needs of the ever-increasing population. Food is a compulsory need for all living things, including human beings who need it to exist. On the other hand, food security is referred to as "the situation that exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food to meet dietary needs and food preferences for an active and healthy life" (Food and Agriculture Organization of the United Nations [FAO], 2009). Food insecurity is the opposite of FAO's definition. The second Sustainable Development Goal (SDG 2) formally seeks to end hunger, achieve food security and better nutrition, and advance sustainable agriculture by 2030 (FAO, 2017, p. 6). The United Nations (UN) Sustainable Development Goal to end world hunger taxed governments at all levels to concentrate on ensuring food security for all in the face of rising population and a wide range of issues that hinder food production (Turnbull et al., 2021).

Food insecurity is a problem worldwide. Around 697 million people, or 9% of the world's population, experienced extreme food insecurity as of 2019, while one in four people (1.9 billion) experienced moderate to severe food insecurity globally (Roser & Ritchie, 2019). Up to 811 million people go to bed hungry every night (United Nations World Food Programme [WFP], 2022). The number of people experiencing severe food insecurity has more than doubled. In 45 different nations, 50 million people are reportedly suffering from emergency levels of hunger. According to WFP (2022), the number of people who are extremely food insecure has surged by more than 200 million in just two years, from 135 million (in 53 countries before the Covid-19 pandemic) to 345 million in 82 countries (Ratasuk & Gajesanand, 2023). Conflict is the primary cause of hunger, accounting for 60% of the world's hungry, while climate shocks also contribute to the crisis by destroying lives, livelihoods, and crops while

uprooting 30 million people from their homes globally by 2020. The Covid-19 pandemic's economic effects are also a major factor in the seismic rise in hunger, pushing it to previously unheard-of levels, as the price the World Food Programme (WFP) currently pays for food is up 44% compared to 2019, adding US\$73 million per month to the cost of reaching people in need. This is an increase from the US\$42 million at the start of the year, before the Ukraine conflict (WFP, 2022).

According to Livinus (2022), 11 international organisations that work in partnership with the European Union on food emergencies found the food crisis in West Africa has not only remain unabated over the past ten years, but has become worse in Burkina Faso, Niger, Chad, Mali, and Nigeria. The number of people in need of emergency food assistance quadrupled between 2015 and 2022, going from 7 to 27 million. Furthermore, Babatunde-Lawal (2022) claims that Nigeria, which ranks 103rd out of 135 nations with an index of 28.3, is comparable to Afghanistan in terms of pricing, availability, quality, and safety of food as well as natural resources and resilience. Nigeria is on the cusp of a food catastrophe having been called the poverty capital of the world (among the least developed countries of the world). The lack of food supply in the nation is a concern, and where food is accessible, the cost is increasingly prohibitive. Accordingly, between 2018 and 2020, an average of 21.4% of Nigeria's population was food insecure and suffered from hunger (Sasu, 2022). Plus, the National Bureau of Statistics (NBS) of Nigeria claims that Nigeria's food inflation increased to 18.37 per cent in April 2022 from the 17.2 per cent recorded in March (Olawoyin, 2022). The country could experience a food upheaval if immediate action is not taken to alleviate the food shortfall. Apostle Johnson Suleman, a televangelist from Nigeria and a Senior Pastor of Omega Fire Ministries International, which has its headquarters in Auchi, Edo State, Nigeria, started a free-food restaurant where people are fed for free for twelve hours each day to alleviate the plight of hungry Nigerians who are suffering from food insecurity. Regardless of their race, religion, or ethnicity, people go to the free meal restaurant to consume the day's menu (Wesley-Metibogun, 2022).

The demand for food in Nigeria continues to surge because of the increase in population, terrorism, banditry, and kidnapping that have made a large number of farmers abandon their farms, thus reducing the number of farmers actively producing food. All these make the future of Nigeria food insecure, if drastic measures are not taken to address the issue of food shortage or inadequacy. To meet the challenge of meeting up with an adequate food supply to mitigate food insecurity, suggestions have been made that GMO technology is massively deployed. GMOs were first introduced in the 1990s into the human food supply chain in the United States of America (Gaille, 2017). An organism that has had its DNA altered through the use of genetic engineering is known as a 'GMO.' Gaille (2017) claims that a GMO is produced when genes from one species are forcibly inserted into the gene structures of unrelated plants or animals in a lab setting. These genes can come from any living thing, including humans, and can be inserted forcibly into the genetic makeup of any other living thing. GMOs are also known as transgenic products in some contexts (Hudson et al., 2015). This is due to the genetic transfer that takes place during current GMO research. The procedure may also be known as genetic engineering or genetic modification, however, both words refer to the same method of altering an organism (Hudson et al., 2015).

Food products are usually mentioned while discussing GMOs because they contain the majority of them. However, several countries are still hesitant to adopt GMOs because of some unknowns and potential drawbacks, particularly health issues. According to Pinduoduo Global (2021), the use of GMOs is known to expose consumers to a wide range of health hazards, including high levels of toxicity, cancer, nutrient loss, and allergic reactions. To many in sub-Saharan Africa, particularly Nigeria where there is a food shortage, the issue of GMOs is like choosing between the devil and the deep blue sea. That is, give it (GMO) a try with the supposed dangers associated with it and survive with an abundance of food if it works out, or live with the consequences, and, on the other hand, avoid it completely to escape the supposed backlash of its negative effects, and continue to live in hunger and food insufficiency. The furore and resentments that characterise this innovation appear to be the fallout of ineffective communication strategies and a lack of meaningful engagement of stakeholders, particularly the rural farmers or agro businessmen and women who are the primary target audience. At this critical point of decision-making, education and enlightenment are needed to put the issue of GMOs in the right perspective. The burden arguably falls on the media. They have to elucidate on it having carried out immense investigations and research to enable them adequately analyse the issues involved.

The cure to ignorance, which is harmful to a human being's life, is knowledge since knowledge is power. Relevant information at one's disposal is a significant source of knowledge, and the media are the primary suppliers of information. Hence, the media are a key part of development communication. Since access to knowledge through the media is vital to combat ignorance, Guanah and Udo (2022) contend that the information provided by the media aids people, organisations, and the government in making decisions about a variety of issues. There are now specialised television and radio channels, and the print media have also developed unique columns and sections for their readers to meet society's demand for knowledge. People are sometimes confused about issues. They, therefore, depend on the media to interpret and explain things to them so they could form their opinions based on the enlightenment they receive from the media. The media must help the public in understanding the dynamics of issues that arise in society by presenting different views and angles for them to choose from in the language and terms that the public would comprehend. Mistakes made due to ignorance can be very costly, "likewise, ignorance or mistake of political leaders can become the sorrow of millions" (Kwakpovwe, 2022a, 130). The situation has thrown up several puzzles, which are: Is the adoption of GMOs a solution to food insecurity in Nigeria's future? Are Nigerians in general, and particularly Nigerian farmers, aware or knowledgeable about GMOs to the extent of using them? Should Nigeria and Nigerians worry less about food insecurity because GMOs will take care of it? These are some of the bases of concern for this article.

The problem of food insufficiency is a worldwide phenomenon. However, it tends to be more prevalent in sub-Saharan Africa. Many reasons are adjudged as the causes of food shortage, and these include extremes of climate change that phase out millions of hectares annually due to drought, heat, super storms, weather volatility, shifting seasons, insect infestation and other signals of a warming planet (Little, 2019). Coupled with these are conflicts, economic consequences of the Covid-19 pandemic, poverty, environmental degradation, and lack of usage of modern agricultural technologies and artificial intelligence, among others (Zhang et al., 2016). These factors inhibit a large supply of food to citizens of nations. The compounded effects of these factors can push Nigeria towards a food crisis, which may culminate in a high cost of living as a result of skyrocketing food prices. No doubt, agricultural technologies like GMOs can help to produce food massively to mitigate hunger and food shortage, but the challenge is that much is not known by many people in Nigeria and elsewhere about GMOs in terms of their safety or potential risks (Bawa & Anilakumar, 2013).

Moreover, this type of genetic engineering is quite controversial. Agricultural stakeholders have been tussling with the question of whether or not to adopt GMOs to tackle food insecurity. This has nurtured intense debates and created an impasse among policy actors. Proponents from both sides avow that their respective suggestions offer the most appropriate solution to food inadequacy in the land (Okwu & Iorkaa, 2011; Isaac & Conrow, 2019). While there have been studies on GMOs in Nigeria, none of those focused on food insecurity and farmers' reception of GMOs. By implication, scholarship on the role the media can play in enlightening the public about GMOs when it comes to Nigeria's agricultural system, is scanty. It is this gap that this study seeks to fill. The objectives of this study, therefore, are to:

- a. find out if GMOs should be adopted to combat food insecurity in Nigeria;
- b. determine the extent of farmers' awareness about GMOs through the media; and
- c. ascertain the level of Nigeria's farmers' use of GMO seedlings in their agricultural practices.

Theoretical Grounding

This study is founded on the Diffusion of Innovation Theory (DOI). Everett Rogers proposed this theory in 1962 (Wogu, 2008). Rogers is reported to have integrated information flow research findings with information flow and individualised impact in domains such as anthropology, sociology, and rural agricultural extension work. Rogers (2003, p. 5) defines diffusion as "the process by which an invention is shared over time among members of a social system through specified routes." He claims that "an innovation is an idea, practice, or undertaking that is seen as novel by an individual or other unit of adoption" (Rogers 2003, p. 12). The dissemination and adaptation of an invention or new concept by members of a social system is known as diffusion. Ali and Miraz (2015) cite Rogers as stating that "diffusion is the process of how the news and adoption of innovation are conveyed through social connections and networks concerning time." Rogers recognised innovations, communication channels,

time, and the social system or environment as the four aspects of diffusion, namely, an aim or idea; ideas must travel via a medium; time; and dissemination of innovation proceeds through certain processes within the sequence of society members. This means that an invention can only have an impact if it is conveyed to the individuals it is intended for, over time. Put simply, the theory explains how, why and at what rate new ideas and technology spread (Guanah, 2021).

After reviewing over 500 empirical investigations in the 1960s, Everett Rogers proposed that knowledge passes through five phases before being adopted by an individual and having its full influence on the intended audience. The phases are mass media (for awareness); early adopters (first users); opinion leaders (from early adopters); opinion followers (from friends); and laggards (late users), which may be summarised as awareness, knowledge and interest, decision trial, and adoption/rejection. This theory is relevant to this study because it emphasises the critical function of the media in informing people about new ideas and initiatives, as well as how such ideas can be incorporated into their daily lives. In this case, the media can be used to inform and enlighten Nigerians and farmers in particular, about GMOs and their offerings. The theory emphasises the media communicating innovations or ideas, distributed it and absorbed by people, organisations, institutions, and communities in far and near areas, recognising the media as powerful forces for transmitting innovations.

Agriculture and Food Security in Nigeria

Food is a vital part of every human's life, and its insufficiency concerns people all around the world. The major source of food is agriculture. Lim (2022) claims that industrialization over the past two centuries has propelled the increase from 1 billion to approximately 7.7 billion people. Agriculture has enabled this tremendous growth. Nigeria's agricultural imports continue to rise, reaching N2.7 trillion in 2021 alone, according to data from the National Bureau of Statistics (NBS), which was cited in a recent report (Ikpot, 2022). This is true despite spending no less than N N129.084 billion on loans to farmers for agricultural purposes. According to data taken from four quarterly foreign trade reports by the NBS, Nigeria only managed to export goods worth N504.4 billion throughout the review period, leaving a trade balance of N2.2 trillion despite investing billions of dollars in the agriculture sector. Meanwhile, Nigeria, like other African countries, has enough arable land that can make the continent the food basket of the world, as attested to by Vladimir Putin, who was quoted as saying that African soil can feed the whole of Europe, America, and Asia, but their problem is just one, 'their leaders' (Misso, 2020, p. 2).

Nigeria is the most populous nation in sub-Saharan Africa, but water scarcity, biodiversity decline, kidnapping, drought, floods, tropical deforestation, desertification, terrorism, faulty soil management techniques, conflict, banditry, and the impacts of Covid-19, together with climate change and global uncertainties, threaten its food security. The unavailability of adequate amounts of micro and macro nutrients due to food insecurity can have long-term effects on broader human capital development (HCD), which affects cognitive function and learning (Salaam-Blyther & Hanrahan, 2009; World Bank, 2018). In Nigeria, the Lagos State Governor Babajide Sanwo-Olu claims that the state's citizens consume 50% of the nation's beef production and around N4.5 billion worth of food each day, reiterating that "history has shown that any society that is unable to provide food guarantee, its security is open to abuse and utmost danger" (Oyibo, 2021). In a deliberate effort to address the issue of food shortage, the federal and state governments in Nigeria are putting in place, a variety of agricultural roadmaps. Investing more in agriculture is one of the crucial priority actions that must be addressed at all levels to achieve food security and reduce malnutrition among Nigeria's most vulnerable and at-risk populations. Also, higher investments in and use of technology that increases productivity as well as the full participation of all types of farmers involved in the agricultural sector are necessary to adequately feed the burgeoning population. As a result, many states in Nigeria have introduced and implemented a variety of strategies, one of which is the use of GMOs to increase food production globally (Okwu & Iorkaa, 2011; Isaac & Conrow, 2019). However, due to the lack of clarity about GMOs' effects on the human body, certain countries are yet to adopt them. Even in Nigeria, where only a small number of farmers plant them, this doubt has persisted for a very long period. Nevertheless, biological innovations such as the use of GMOs in agriculture, aquaculture, and food production, could enhance the availability of food and produce significant long-term economic gains.

The National Biotechnology Policy was endorsed by Nigeria's Federal Executive Council on April 23, 2001, in acknowledgement of the value of biotechnology to the growth of the country. As a result, the National Biotechnology Development Agency (NABDA) was founded in November 2001. The organisation was created to carry out the strategy for promoting, coordinating, and prioritizing research and development, particularly in biotechnology, for Nigeria (OyozeBaje, 2022). In 2018, the Nigerian government approved the commercialization of a significant cash crop, the pest-resistant *Bacillus thuringiensis* (Bt) cotton, through its top regulatory authority, the National Varietal Release Committee. Nigeria authorised its first genetically modified (GM) food crop, pest-resistant cowpea, in January 2019 following nearly ten years of study by its scientists. Also, it opens the door for the sale of GM cowpea and the distribution of the seeds to farmers (Isaac & Conrow, 2019). Field confinement trials on the VIRCA Plus project, which produces resistant cassava that has been nutritionally improved with iron and zinc, are among the ongoing initiatives. The crops include the African Biofortified Sorghum (ABS), Bt Maize, Herbicide Tolerant Soybeans, and Genetically Modified (GM) Cassava Improved for Shelf Life Extension of Root Starch.

GMO adoption in Nigeria's agricultural services is undoubtedly a sure-fire approach to increasing food production, but GMOs must be properly supervised, tracked, and monitored. The government must make sure that genetically modified seeds and grains for food and feed processing undergo laboratory testing before any type of GMO is permitted for usage or importation into Nigeria. The European Union (EU), where high-quality products are valued for more than just their flavour, should serve as a model. From the farm to the table, the EU places an unshakable priority on food safety. Along the entire production and supply chain, strict health and safety regulations are implemented, regulating everything from pesticides to packaging, illness prevention to hygiene, and more. All food and beverage items must have labels that are clear and legible for customers to know what is in them, trust European foods without fear of surprises, and be able to trace components back to their sources within the EU (European Union, n.d.).

Genetically Modified Organisms (GMOs)

GMOs are manufactured in ways that are very similar to genetic engineering and are reported to have been around since 1994. Regoli (2018) delineates genetically modified (GM) food as an organism that has received new genes from other organisms. He explains that the method utilised in this form of crop management has been developed to make sure that farmers and merchants may more effectively improve the quality of their crops or foods (Regoli, 2018). Techniques used to manufacture GMOs are vital for making some medicines in addition to food. In reality, the production of human insulin, a drug used to treat diabetes, was the first application of genetic engineering. Additionally, the textile sector makes use of GMOs. Utilising some GMO cotton plants, cotton fibre is produced, which is then used to make fabric for garments and other items (United States Food and Drug Administration [US FDA], 2022).

A species of bacteria, plant, or animal that has had its genetic composition altered in a way that does not happen normally, either by recombination or mating, is referred to as a 'genetically modified organism.' Either transgenic technology or genetic engineering is used to modify this (Pinduoduo Global, 2021). To National Human Genome Research Institute (NHGRI, n.d.), genetic engineering, often known as genetic modification, is a procedure that uses lab-based technologies to change an organism's DNA composition. This could entail altering a single base pair (A-T or C-G), erasing a section of DNA, or incorporating new DNA. For instance, in genetic engineering, transferring a gene from one species to an organism from a different species may result in the desired characteristic. In Nigeria, the argument over whether or not GMOs are safe has remained divisive. Due to worries over their effects on human life, agriculture and the ecosystem, some groups have called for their ban, while others are clamouring for their approval in Nigeria. Genetically modified foods have many advantages, but they are also thought to have a lot of drawbacks for people, animals, and plants that come into contact with them.

Advocacy for the Use of GMOs

Nigerian government tends to be in support of the introduction of GMOs to aid food security. According to the Director-General/Chief Executive Officer of the National Biosafety Management Agency (NBMA), Rufus Ebegba, embracing GMOs will be very beneficial if Nigeria is to meet its set goals of attaining food security and reducing import dependency (Eludini, 2021). Those who favour and promote the use of GMOs tend to focus more on their benefits. Some of the key advantages are: GMOs can be designed to provide their full nutritional worth in terms of health. According to Gaille (2017), by modifying the genetic profile of the plant, multiple vitamins and minerals can be incorporated into the crops as they grow, allowing individuals to obtain what they need from fewer foods at a reduced cost. Simple modifications to some crops can increase their nutritious content, whether it be in the form of vitamins or minerals. The importance of this is ensuring that individuals receive the nutrients they require as well as preventing malnutrition in developing nations has been noted (Regoli, 2018; Miller, n.d.).

GMO crops have a propensity to be genetically modified (GMO) to have a longer shelf life after harvest than organic crops. According to Regoli (2018), this will enable farmers and agro entrepreneurs to more effectively retain the high quality of foods by using certain materials. Gaille (2017) continues by saying that it will enable the provision of affordable, healthy foods to locations where shortages happen, by using the infrastructure already in place for food distribution. Higher yields can be achieved with GMO crops on a smaller amount of land. When local farmers successfully make the switch from conventional to GMO crops, crop yields have the potential to quadruple in some cases. As a result, it will be possible to meet the food needs of many people. Additionally, because GMO crops have a higher tolerance generally, no-till farming techniques are possible, allowing farmers to adopt superior ground-care techniques. Less tilling may be necessary if it is necessary for a crop to be planted successfully. Less irrigation may, therefore, be required. There may be less runoff of nutrients, and reduction of soil erosion is possible. At the same time, the safety and nutritional value of the crops are not placed at risk (Gaille, 2017).

Producing GM crops also uses less water, soil, and energy resources. According to Zhang et al. (2016), with the right genetic alterations, food can be cultivated in locations with little soil, minimal rainfall, and no irrigation. This is achievable because of their enhanced resistance to weeds, diseases, and pests. These aid farmers in growing larger quantities of crops or food (Regoli, 2018). Since they will not need to spray toxic pesticides or herbicides on their crops, farmers can save money. Due to the higher yields of GMO crops, they also profit more from their current croplands. Even sustainability advantages, like drought resilience, can keep yields stable so that fewer loans and subsidies are needed (Gaille, 2017; Regoli, 2018). GMOs have the potential to save important crops. Many of the foods we eat today, according to Gaille (2017), are the by-products of a single starting resource. For instance, the navel orange is essentially a clone of a single original tree from which more trees were grafted. Due to its lack of genetic diversity, the crop is vulnerable to attack by bacteria or viruses that can damage its fundamental DNA. Also, GMOs can be developed to endure weather extremes and swings and still produce crops with sufficient yields and high quality, even in unfavourable or adverse weather conditions. Additionally, genetically modified animals and plants may grow more resistant to unanticipated illness issues ((Zhang et al., 2016; Regoli, 2018).

Although some people do have food allergies, the goal of food science in the era of GMOs is to find a way to eradicate food allergies. Gaille (2017) points out that the goal of contemporary genetic engineering research is to eliminate allergy triggers that are present in everyday foods like peanuts. GMO crops might have a favourable environmental effect. As a result, the general well-being and aesthetics of the area surrounding farms will be enhanced, helping to protect cleaner water and air, which can also indirectly improve everyone's health. This is possible because GMO crops require fewer in-field treatments and procedures to preserve the yield's quality. As a result, fewer passes over the field are necessary. A study from Oklahoma State University claims that the proliferation of genetically modified (GM) animals and crops often takes less effort, equipment, and chemicals and may contribute to a decrease in greenhouse gas emissions, soil erosion, and environmental degradation (Regoli, 2018). Fewer passes indicate less of a release happens in the soil because carbon dioxide is also trapped there (Gaille, 2017).

Products made from GMOs are safe and uphold the same requirements as conventional foods. GMOs and other related items have undergone thorough testing and review and have been determined to be safe for human consumption. Purely nutritionally speaking, GMO foods are on par with or better than those bought at the typical supermarket. Research demonstrates that they are even safer than conventional crops. Even Stanford University discovered that consuming organic or GMO foods posed no significant health hazards (Miller, n.d.). The adoption of GMOs results in increased agricultural output, which lowers food prices and makes it feasible for more people to get affordable food thus, reducing hunger and poverty. Many people in developing nations spend more than half of their income on food alone, and some families cannot afford to purchase supplies for daily consumption (Regoli, 2018; Miller, n.d.). Because these organisms are created to be pest-resistant, which eliminates the need for pesticides and results in greater savings, farmers will also benefit from GMOs and spend less time on resources (Miller, n.d.; Regoli, 2018). Through the use of GMOs, new crop varieties can be created and produced in harsh climates, such as those found in arid or icy regions (Regoli, 2018).

Bias Against the Utilisation of GMOs

In Nigeria, those who call for the prohibition of GMOs want the stoppage of the spread of these seeds because Africa must not be turned into a dumping ground for risky technologies. Hence, Nnimmo Bassey emphasises that GM seeds reduce soil fertility, degrade biodiversity, and encourage land grabs for monocultures (Onyesi, 2022). Those who oppose the adoption of GMOs push their argument concerning some critical disadvantages of GMOs. The risk of allergies or food intolerances can be brought on by GMOs. Genetic mutations can cause gastric intolerance in people. Gaille (2017) asserts that studies on GMO foods in animals have discovered organ effects in almost every situation and that plants are poisonous by definition when they manufacture pesticides inside the plant to kill insects. Genetic modification frequently adds or combines proteins that were not native to the original animal or plant, according to a study from Brown University, as reported by (Regoli, 2018), which could result in new allergy reactions in human beings.

Other fields may become contaminated by GMO crops. Gaille (2017) informs that pollination is necessary for the crop to generate the 'fruit' that is being developed because genetically modified plants still grow in the same manner as any other crop. Bees do a large portion of the pollination effort, which exposes them to the plant's genetic alterations. In many cases, these GMO crops also produce seeds, which can contaminate adjacent fields when they are spread there. If cross-pollination takes place, neither field's outcome can be predicted. This can make it impossible to tell which crop fields are organic and which are not, making it difficult to correctly identify food products that do not include genetically modified organisms. Miller (n.d.) argues that if crop diversity does decline, this will have a significant effect on the population dynamics of other creatures and the ecosystem as a whole.

Animal proteins could be affected by GMO crops. In a place like the United States of America (USA), the vast majority of the core crops grown are GMO crops. These crops are then fed to livestock, aquaculture, and apiculture, which impact groceries that are based on animal proteins. GMO ingredients can be found in milk, seafood, eggs, and animal muscle tissues. Even honey can have GMO ingredients when bees are pollinating genetically modified crops to produce it (Gaille, 2017). Concerning this, GMOs may potentially harm beneficial insects. Bt proteins are used in genetic engineering to target a specific group of insect pests that are damaging to that specific crop. A wide pesticide preserves other beneficial insects that would otherwise be killed when used (Bawa & Anilakumar, 2013; Gaille, 2017). GMOs may increase the growth of weeds that endanger animals' life and promote the use of more herbicides. According to Miller (n.d.), artificial plants are discovered to serve as intermediaries for gene transfer to wild plants and the emergence of weeds. Scientists are developing new herbicides to control them that were unnecessary for non-GMO weeds and are hazardous to many animals that eat GMO crops, such as cows. Accordingly, more than 80% of GMO crops planted globally are engineered to be herbicide-tolerant. Since the introduction of the first GMO crops, farmers have used more than 1500% more harmful herbicides as a result (Gaille, 2017). According to various tests carried out, the uptake of these herbicides has hazardous effects on a variety of creatures as well as the ecosystem as a whole.

A handful of the pesticide-treated insects that pose a hazard to crops often survive and develop into superbugs. Gaille (2017) contends that each succeeding generation gets increasingly resistant to pesticides. Furthermore, a continual risk of eating genetically modified food is that an organism's

changed genes could get loose and infect other organisms (Regoli, 2018). He quotes specialists who express concern that genes from herbicide-resistant commercial crops may contaminate the population of wild weeds, resulting in the development of super-weeds that are impossible to eradicate (Regoli, 2018). Likewise, genetically modified plants and animals may develop into super-organisms that can outcompete native ones, putting them out of existence. GMO foods are also feared to contribute to the development of antibiotic resistance. According to Iowa State University research, some genetically modified foods have antibiotic properties incorporated into them that render them resistant to viruses (Regoli, 2018). These antibiotic indicators remain in our bodies after consumption, making true antibiotic treatments less effective. Gaille (2017) claims that there is evidence to show that continued exposure to an antibiotic can result in disease resistance; efforts to establish a safer food supply through the use of GMOs may also be a factor in the rise of 'super germs,' such as MRSA.

Media and Awareness Creation in the Society

One of the media's fundamental responsibilities is to inform the public as soon as possible about events taking place throughout the world. They have long served as platforms for spreading, fostering, and encouraging awareness on a variety of topics, particularly those that are unfamiliar to the general public. They are taxed with enlightening the populace on issues that are thought to be complex and ambiguous by expertly analysing them for the benefit of the populace. Humanity is the target of every piece of information that emanates from the media. Therefore, it must be taken into consideration when any information is being processed to be disseminated. The media must evaluate the characteristics of the target audience of their messages as per location, culture, age, sex, religion, and race, among others. A media report is useless, for it is just occupying space, if it does not convey any message, or if it fails to pass specific information. The quality determines the value of decisions and opinions that ensues from it. The quality of information from the media also determines the choice of media the public patronises. The media have to be circumspect while discharging their duties because the vast majority of the masses tend to build their lives around what they get from the media (Omoera, 2010). Hence, Abel Damina asserts that "the only thing that controls all of us is the media, particularly social media. The media have complete control over all of us, not one man" (News Hub Creator, 2022).

The media possess the power of knowledge, and information given by the media starts the awareness creation process for the public. As the public is inundated with knowledge via the media, people expressively get involved in the development process of the community or society. When the media give the populace the necessary knowledge about a thing, the people will now know how to take precautions if such a thing portends danger to them. Knowledge is the initial step in the innovation-decision process (Rogers & Shoemaker, as cited in Asemah & Tsegay, 2013). Knowledge is a part of the cognitive domain of the human mind. For agricultural development, farmers must get knowledge and information at the appropriate moment on crucial farm technology, methods, and practices. The media serve as the disseminators and analysts of information to bring about enlightenment for the public and rescue them from ignorance through the knowledge they impact on them because the repercussion of ignorance is costly.

By their functions, the media act as counsellors as well as advisers to the public, for they help citizens to form opinions on diverse issues. Hence, the quality of their contents, reportage and analyses is crucial. Asemah and Tsegay (2013) affirm that communication makes technical know-how available to expand understanding of the production, transformation, organization, and marketing components of agriculture. Therefore, when the media tracks food security indicators, or more specifically, food access indicators, over time and space concerning GMOs, it can give stakeholders crucial information about the benefits and drawbacks of GMOs that may help Nigerians decide whether or not to use GMOs in their agricultural activities as farmers or consume GMO products as Nigerians. Farmers must be given the proper knowledge, training, and skills concerning GMOs by the media for them to successfully begin growing GMO crops throughout all farming seasons, should they be accepted. This would support efforts to combat food insecurity in Nigeria by enhancing the capacity of farmers across the nation.

Methodology

The researchers adopted quantitative and qualitative research methods where a survey was conducted on farmers in Delta State, Nigeria. According to the Delta State Ministry of Agriculture and Rural Development (as cited in Guanah et al., 2018), the population of registered farmers in Delta State is 25,000. The sample size of the study was 379, and it was derived through the use of the Creative Research System (1982) at a 95% level of acceptance (confidence level) and 5% confidence interval (margin of error), and a population proportion of 50%. The researchers employed a multistage sampling technique for the study. Nine (9), out of the 25 local government areas (LGAs) of Delta State that form the three senatorial districts of the State (North Senatorial District, Central Senatorial District, and South Senatorial District) were purposively selected. Through simple random sampling without replacement, the researchers selected three local governments from each senatorial district. From Delta North Senatorial District, Aniocha North LGA, Ndokwa East LGA, and Oshimili North LGA were selected; from Delta Central Senatorial District, Ughelli North LGA, Okpe LGA, and Sapele LGA were selected while Warri North LGA, Patani LGA, and Isoko South LGA were selected from Delta South Senatorial District.

The researchers further used the purposive sampling technique to select an equal number of farmers from the nine local government areas. It implies that 42 respondents were selected from each of the nine local government areas. For the oral in-depth interview, out of the 42 respondents, three were randomly selected from Delta South and Central Senatorial districts while four were selected from Delta North Senatorial district because the latter is made up of nine LGAs while the formers are made up of eight LGAs each. This brings the total number of those interviewed to ten. Therefore, 41 respondents (giving a total of 369) from each of the local government areas were administered the questionnaire. An in-depth oral interview was used to collect qualitative data with a question guide serving as the instrument for data collection. The quantitative data were also gathered from respondents using the questionnaire as an instrument for data collection. Content validity was employed to authenticate the effectiveness of the research instruments while the reliability was determined at 0.58 coefficient using Parson Movement Correlation. From the 369 copies of the questionnaire given out, only 348 (94.31%) copies were completely filled and returned successfully. The data were analysed quantitatively using simple percentages and tables.

Data Presentation and Analysis

Table 1: GMOs should be adopted to combat food insecurity in Nigeria

Responses	Frequency	%
Strongly Agree	87	25
Agree	85	24.43
Undecided	4	1.14
Disagree	84	24.14
Strongly Disagree	88	25.29
Total	348	100

Source: Field Survey, 2022

Table 1 revealed that half of the respondents want GMOs to be adopted to curb food insecurity while half of them do not support. This data imply that a decision is yet to be taken, either for, or against the adoption of GMOs in Nigeria.

Table 2: Extent of farmers' awareness about GMOs through the media

Responses	Frequency	%
To a great extent	29	8.33
To a minimal extent	53	15.23
Difficult to say	20	5.75
To a little extent	127	36.49
To a very little extent	119	34.20
Total	348	100

Source: Field Survey, 2022

Table 2 indicates that the awareness level of the farmers about GMOs is low. This may imply that the media have not done enough to create awareness as well as creating sufficient discourses around the issues about GMOs in Nigeria.

Table 3: Level of Nigeria's farmers' use of GMO seedlings in their agricultural practices

Responses	Frequency	%
Very High	19	5.46
Minimal	17	4.89
Difficult to say	27	7.76
Low	86	24.71
Very Low	199	57.18
Total	348	100

Source: Field Survey, 2022

Table 3 shows that Nigeria's farmers' use of GMOs seedlings in their agricultural practices is quite low. This is based on the fact that the majority of the respondents may not be aware of the existence of GMO seedlings, or may not know how to get them.

Discussion of Findings

The first finding of this study revealed that 49.43% of the respondents support the adoption of GMOs to combat food insecurity in Nigeria while, equally, 49.43% are against such a move, and 1.14% are undecided. This finding further strengthens the existence of confusion and controversy surrounding the GMO discourse. Hence, the media need to intensify their enlightenment of the public about the issue of GMOs. OyozeBaje (2022) is of the view that since GM foods are gradually becoming part and parcel of the Nigerian food security landscape, and with the wave of globalisation sweeping across continents, Nigeria needs well-coordinated activities for Nigerian-researched and approved foods that are safe, nutritious, and affordable to the consumers. During an oral interview, Henry Odiete of the Delta Central Senatorial district backed the use of GMOs to lower food insecurity in Nigeria. He suggested that Nigeria should test GMOs since its farmers are unable to meet the nation's need for food, which has caused food prices to rise. He believed it will lead to a significant rise in the nation's food output, some of which may be exported to nearby African countries and earn some foreign exchange for Nigeria's development initiatives. However, he did express worry that GMOs might harm people's health considering how little or nothing most people know about them.

This fear is substantiated by Regoli (2018) who posits that GMOs could result in the emergence of new diseases. There is concern that this will undoubtedly occur given that they were altered utilising viruses and bacteria. This worrying aspect of the threat to human health has generated a lot of discussion. Gaille (2017, p. 4) submits that with this technology, "we have the potential to maximize our resources. Of course, maximizing those resources while creating health problems for future generations may not be the right answer either." Pinduoduo Global (2021) concurs that the existing standard of technology has several adverse side effects for plants, animals, and humans who come into contact with them. Therefore, people should avoid being exposed "to these dangerous chemicals and instead seek out purely organic substitutes." From the data gleaned while investigating the second objective of this study, which had to do with determining the extent of farmers' awareness about GMOs through the media, it was discovered that the media have not done enough in the area of creating awareness as well as creating sufficient discourses about GMOs in Nigeria. OyozeBaje (2022) aligns himself with the position while noting that insufficient knowledge of their benefits has hampered their acceptance in Nigeria, which has led to ongoing worries being voiced about the health effects of GMOs on consumers. However, this finding is contrary to the report of Mahmood and Sheikh (2005) that the media play a very significant role in creating awareness and knowledge about the latest agriculture technology information among farmers, asserting that the media are one of the best sources for disseminating information about new technologies and innovations of agriculture among farmers much faster than personal contacts.

There should be a massive deployment of conventional, traditional, alternative and social media to bring about a pyramid of enlightenment on GMOs. These should include entertainment via radio,

television, storytelling, festivals, cinemas, magazines, drama, public announcements, folk poetry, advertisement, dance, music, carnivals, news, current affairs, folk music, and folk dance. McBean (2005) as cited in Okwu and Iorkaa (2011) also suggested newsletters, books, journals, leaflets, photographs, sketches, and posters, and new technologies such as the Internet, websites, online discussion groups, weblogs, e-mails, databases, mobile phones or webcams. Such intense engagement of the media is necessary because "...until the media are involved, no matter or issue revolves; every issue remains docile until the media choose to activate it and cause it to be matters of national discourse" (Guanah, 2017, p. 8). In an oral interview, Chukwuemeka Anosike of the Delta North Senatorial District said that the media should treat GMOs as part of their duties to society so that people can get more familiar with GMOs' advantages and disadvantages. The populace will be well-informed about these foods and how they may impact their life as a result. Citizens will be able to distinguish between the potential advantages and risks of GMOs thanks to the media's education.

The third objective of this study sought to ascertain the level of Nigeria's farmers' use of GMO seedlings in their agricultural practices. The finding from the field indicated that Nigeria's farmers' use of GMO seedlings in their agricultural practices has been very low. The reason may be because a majority of the farmers may not be aware of the existence of GMO seedlings, or may not know how to get them. This is evident in the controversy that ensued when the National Biotechnology Development Agency (NABDA) distributed GMO seeds to some farmers to plant without informing or training them about them before they were given. This made Nnimmo Bassey, an environmental activist and the convener of the Home of Mother Earth Foundation, accuse the government of deceiving farmers to plant, harvest, consume and sell GMO cowpeas to the unsuspecting public without them knowing they were GMO products (Onyesi, 2022). In an oral interview, one of the farmers from Delta South Senatorial District, Madam Alaere Ebikebena, stated that to ensure that farmers have a clearer understanding of GMOs, there need to be adequate public sensitisation and key stakeholders' engagement. This is because the issue of GMOs has generated a great deal of intense public interest, heated debates, and controversies. She claimed that while the government was looking for ways to increase food production, it also needed to make sure that all parties, including farmers, were kept in the loop.

Conclusion

Since the Nigerian government, through the National Varietal Release Committee, has introduced some GMO crops like the pest-resistant *Bacillus thuringiensis* (Bt) cotton and pest-resistant cowpea, citizens should be given some time to sample them so that they can form their own opinions about them. The study argued that the media have a significant role to play here in educating people about GMOs. The media, including social media, should shoot and broadcast documentaries to enlighten people, especially as it can show countries that have successful implementation of GMOs. This may remove the scepticism most people have that GMOs are location origin-specific and that the same cannot work for all countries without the research of its adaptability being locally carried out to ensure it aligns with local needs. This article advances the argument for an open and transparent dialogue among stakeholders, intending to find a dynamic nexus between indigenous knowledge and scientific inventions that will go a long way in ensuring the sustainability of such interventions as GMOs, and ultimately, food security and healthier living by the Nigerian populace. No doubt, GMOs can tackle food insecurity in a country like Nigeria alongside their other attendant benefits and advantages. However, relying on Socrates' postulation that the person who is aware of their ignorance is indeed wise (Kwakpovwe, 2022b), conscious efforts must be taken to learn more about GMOs, become knowledgeable in using them to improve and attain food security and sufficiency or be cautious enough to avoid the negative effects they have on the environment and human health, given the potential of genetic engineering technology.

Recommendations

The following recommendations are made based on the findings of this study: 1. Government should put in place policy measures that will provide agricultural system stakeholders' unhindered access to GMO crops and the technology in order to facilitate immediate and large-scale adoption and production of food to combat food insecurity. 2. Media awareness creation and pyramid of enlightenment on GMOs should be geared towards throwing more light on the advantages and disadvantages of GMOs so that the public will have balanced information on where to decide on whether to patronise GMO crops/products or not. 3. Since some genetically modified foods like cowpea are already on sale in Nigeria, their bags and packages should be labelled to make it easier for consumers to know if the foods they eat contain GMO ingredients. For instance, the EU organic logo can only be used on products that have fulfilled strict conditions on how they must be produced, processed, transported and stored. Products carrying the EU organic logo contain at least 95% of organic ingredients and additionally respect further strict conditions for the remaining 5% (European Union, n.d.). 4. All food regulatory bodies should make sure that all food/animals meant for consumption, notably those with GMOs, are safe for human consumption before being authorised to be marketed to the general public.

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