Media coverage and framing of genetically modified crops: A case study of science journalism in Nigeria

by

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Declaration

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Abstract

This study examines and analyses the media coverage and framing of Genetically Modified (GM) crops in Nigeria in view of the controversy surrounding the deployment of agricultural biotechnology. The objective is to examine the quality of media reporting on this contested science and the state of science journalism in the country. Agenda-setting and social constructionism are used to establish the theoretical framework for the study. The study employed both a qualitative and quantitative approach to data collection: content analysed four leading newspapers, 37 science journalists responded to an online questionnaire and eight in-depth interviews were conducted with science journalists. The main findings were that the frequency of reporting on GM crops was low; the tone of the headlines and articles was more negative; there were more articles with perceived risks of GM crops than perceived benefits; and the articles were mostly news stories about the comments of government officials and anti-GM activists. GM crops were framed in four prominent ways: agriculture, controversy, regulation, and safety with the regulation and safety frames dominating the media coverage. The media framing of GM crops was greatly influenced by the sources, predominated by government officials and anti-GM groups. Overall, the quality of media coverage of GM crops was very poor because of the poor state of science journalism in Nigeria. The journalists lacked the capacity and resources to cover science accurately, especially controversial science like GMO. This study recommends that scientists and research institutions should proactively engage the media and advocate in shaping public perception on scientific outcomes. It also recommends for newsrooms to specifically hire science journalists to generate locally relevant science stories, rather than filling their science pages with articles from foreign media.

Key words

Biotechnology, framing, genetically modified organisms, GM crops, GM, GMOs, Nigeria, Premium Times, science journalism, scientists, The Guardian, The Punch, and Vanguard.

Contents

Chapter one: Background of study

1.1   Introduction

The National Biosafety Management Agency was established after Nigeria passed its first biosafety law in April 2015. Subsequently, the agency issued two permits for the introduction of genetically modified (GM) cotton, and the confined field trial of maize in 2016. The licences were given to Monsanto Agriculture Nigeria Limited, an affiliate of the US agricultural company that has been one of the main players in the global effort for the adoption of Genetically Modified Organisms (GMOs). Also in September 2017, Nigeria approved confined field trial of GM cassava, one of the staple crops in the country. These approvals indicate that Nigeria will not stop the introduction of GM crops in spite of the strong opposition against it by certain interest groups in the country.

To produce GM crop, its DNA (genetic material) must have been altered through the unnatural method and it is achieved through recombinant DNA technology (Khan, Ullah, Siddique, Nabi, Manan, Yousaf, & Hou, 2016). This alteration produces crops that have characteristics that are more desirable than the original crops. Such characteristics include having more nutritional value or being able to resist pests and even withstand drought. This genetic modification of original crop results in better crop yield. This, perhaps, accounted for the introduction of GM crops in many countries. Across the world by 2014, an estimated 8 out of 10 total crops areas of soybeans, 7 out of 10 crop areas of cotton, 3 out of 10 crop areas of maize and 3 out of 10 crop areas of oilseed rape were planted with GM strains (James, 2014). Also, 9 out of 10 farmers in Brazil, Argentina, and the USA, would prefer to plant GM cotton, maize, soybean or oilseed rape (James, 2014). By planting GM crops, farmers increased their profits up to 68 per cent as the yield of crops increased by 22 per cent while expenditure on pesticides decreased by 39 per cent (Klumper & Qaim, 2014).

Despite the perceived advantages of GM crops over traditional crops, their introduction in Nigeria was resisted by interest groups. Pressure group that included a coalition of civil society groups, faith-based organizations, farmers, students, among others protested against the permits given to Monsanto for confined field trials of GM crops and commercial production of GM cotton in the country. Globally, people are skeptical of GM crops because of concerns about their safety for human consumption. Some of the common concerns exhibited by the opposition against GM crops include increased allergenicity, gene

transfer and outcrossing (World Health Organisation, 2014). These concerns have led to evaluations of GM crops before licensing them for commercial production and public consumption (Center for Disease Control, 2000). Therefore, many countries have put in place rigorous systems to evaluate the risks of GM crops on humans and the environment before introducing them for public consumption (Buiatti, Christou, & Pastore, 2013). United States passed a law in 2016 that mandates the U.S. Department of Agriculture to establish a national disclosure standard for genetically engineered foods (Bovay & Alston 2018). In South Africa, the implementation of policy on mandatory GM food labelling has "faced divergent interpretations, and thus high levels of ambiguity; an inefficient National Consumer Commission; a lack of recourse for non-compliance; and the absence of a government-enforcement agency" (De Beer & Wynberg, 2018). Thus, the researchers conclude that lower capacity in developing countries underscores the need for inclusive and participatory process in the formulation of GM food labelling policy. As more countries move to have mandatory GM food labelling policy, crops that are grown naturally with conventional agricultural methods do not go through these rigorous evaluations (Buiatti *et al*., 2013).

The controversy associated with GM crops indicates that consumers are yet to fully understand how to interpret the benefits and risks associated with the use of GMO (Lucht, 2015). This misunderstanding on the part of consumers has generated robust scientific discourse. Despite the fact that GM crops have potential to increase crop yield and reduce food prices, consumers have shown concern about the negative consequences of consuming food with the unclear nutritional advantage which they fear might introduce foreign DNA and cause health challenges (Lucht, 2015). A study has shown that one of the major concerns of consumers is the perceived lack of benefits associated with GM crops (Gaskell, Allum, Wagner, Kronberger, Torgersen, Hampel, & Bardes, 2004). However, consumers might potentially show interest in GM crops if they are shown to be more nutritious and have tangible benefits like less cholesterol (Gaskell, *et al*. 2004). Therefore, providing unbiased and accurate information to consumers is vital to the adoption and reception of GM crops in Nigeria.

The need for accurate information on GMOs draws attention to the role of the media in shaping public opinion. This study will analyse how the news media in Nigeria covered and framed GM crops between 2015 and 2017. In a case of a contested scientific topic like GMOs, the media play an influential role in shaping public understanding and perception because the public largely depends on the media for information. The media are one of the

key enablers and hindrances to the adoption of GM crops in Africa (Mabaya, Fulton, Simiyu-Wafukho, & Nang'ayo, 2015).

There have been a number of studies on the media reporting on GMOs. Frewer, Miles, & Marsh (2002) studied the effect of increased media coverage on the perceived risk associated with GM foods among consumers from 1998 to 2000 in the United Kingdom. Utilising 300 participants, Frewer *et al*. (2002) found that changes in reporting of hazards about GM foods influenced perception of risks and benefits as perception of risks increased during the peak of reporting while the perception of risks decreased during the levels of lowest reporting. Another study conducted in the USA investigated the effect of different mass media sources on the perception of GM food (Fishman, 2002). This study which used self-administered questionnaires among 105 participants found that 6 out of 10 of the consumers consulted mass media sources on information about GM food. Augoustinos, Crabb, and Shepherd (2010) in their analysis of articles in six British newspapers show that the media framed the public to be unreceptive of GM crops while British policymakers were framed to have only political and economic interests that did not include concerns about the wellbeing of the citizens.

Most studies on media coverage and framing of GM crops have been carried out in Western countries (Vicsek, (2013). In employing both quantitative and qualitative methods, Vicsek (2013) found that Hungarian tabloids and political papers had low salience on reporting GM crops as compared with Western countries. The study also discovered that anti-GM crops coverage was dominant compared to what has been found in some other countries. Similarly, a framing analysis of newspaper coverage of GM crops in Kenya showed that only 34 percent of the articles were neutral in tone while the safety and regulatory frames dominated coverage in some of the newspapers (Lore, Imungi & Mubuu, 2013). A study of the role of media in the GMO debates in Uganda shows that journalists were caught in a conflict of interest between reporting scientific evidence and providing a voice to all stakeholders (Lukanda, 2018). The study indicates that there was an outright bias as journalists took sides.

So far, there is no available or published study on the media coverage of GMOs in Nigeria. This makes this study imperative not only in understanding the framing of GM crops but also the quality of science reporting in Nigeria. Science journalism in Nigeria and Africa is still performing below expectation due to certain challenges. These challenges include the capacity to cover science and interact with scientists, unfavourable newsroom environments for science reporting, and lack of resources for science coverage (Lublinski, Reichert, Denis,

Fleury, Labassi & Spurk, 2014). Generally, the media are often accused of misrepresenting science through inaccuracy, distortion, and sensationalism in reporting scientific findings (Haran & Kitzinger, 2009). Claassen (2011: 355) states that "complex research findings are reduced to misleading headlines and reports that present deductions which are either exaggerated or blatantly wrong."

To a very large extent, the quality of science reporting in Nigeria will determine how the introduction of GM crops was covered by the news media. Therefore, this study aims to achieve two main objectives: the analysis of media coverage that influenced public perception of GM crops and the examination of quality of science reporting. The outcome of this study will hopefully be useful in improving science journalism in Nigeria and elsewhere on the continent.

1.2   Theoretical approach

The agenda-setting function of the media and social constructionism will make up the theoretical framework for this study. McCombs and Shaw (1972) originally suggested that the media determine the public agenda in such a way that they may not exactly tell people what to think, but they may tell the people what to think about.

> "In choosing and displaying news, editors, newsroom staff, and broadcasters play an important part in shaping political reality. Readers learn not only about a given issue, but also how much importance to attach to that issue from the amount of information in a news story and its position" (McCombs & Shaw, 1972: 176).

More than 40 years after the conceptualisation of the agenda-setting of media function in society, it continues to be applied in research seeking to determine the media's role in influencing public opinion. In revisiting the theory of agenda-setting, the original theorists identify seven distinct facets it has evolved into which include the followings: basic agenda-setting, attribute agenda-setting, network agenda setting, concept of need for orientation, consequences of agenda-setting effects, origins of the media agenda, and agendamelding (see McCombs, Shaw & Weaver, 2014). The first three in the seven facets of the agenda-building theoretical perspective has been categorised into three levels of the object, attribute, and network connections (see Kiousis, Kim, Ragas, Wheat, Kochhar, Svensson, & Miles, 2015).

Out of the seven facets of agenda-setting theory, the one that is particularly imperative to this study is the origins of the media agenda. This aspect of the theory examines the norms and routines of journalism, and the individual characteristics of journalists, prevailing cultural and ideological environment as well as news sources and the influence of the media on each other. However, McCombs *et al.* (2015) contend that the need for orientation, network agenda setting, and agendamelding are the most active theoretical areas of contemporary research. This perspective of contemporary application of agenda-setting function notwithstanding, the origin of the media agenda is equally significant in examining the role of the media, rather than just the media influence. To understand how the media covered and framed GM crops, it is important to understand the sociology of news environment and the characteristics of the science journalists in terms of capacity and qualification. This aspect of the agenda-setting theory closely aligns with the second theory anchored in this study.

Social constructionism posits that social reality is constructed (given meaning) by individuals in society. Considering the role of the media as a major source of information in society, the media influence people's understanding of reality. McQuail (2010: 101) defines social constructionism as "the processes, by which events, persons, values, and ideas are first defined or interpreted in a certain way and given value and priority, largely by mass media, leading to the (personal) construction of larger pictures of reality." The media use framing to construct reality by choosing to present certain aspects of a phenomenon. Framing answers the questions of selection, emphasis, and presentation of media content. Cacciatore, Scheufele, and Iyengar (2016: 11) state that:

"Frames are embedded in culture, inside people's minds, and within the agendas of the media. Frames are found in all types of media, from print to broadcast news, and they convey meaning through the interaction between the reader and the text. Frames are socially shared, and therefore must have resonance for both those producing a message and those receiving it."

In covering GMOs, frames can manifest in the use of certain sources or certain words and phrases as well as pictures and symbols. In most cases, media frame events or issues to fit into a particular context. Therefore, the framing aspect of social constructionism gives an insight that the reality of the media presentation may be subjective. In this regard, the media framing of GM crops is vital in drawing a conclusion about public understanding of the issue.

1.3   Problem statement

This study examines and analyses the coverage and framing of GM crops by the news media in Nigeria from January 2015 to December 2017 within the context of science journalism.

1.4   Research questions

This study aims to answer the following research questions:
- Which sources did the news media in Nigeria use in reporting GM crops?
- How did the news media in Nigeria frame GM crops?
- What were the tones of coverage in the reporting of GM crops by the news media in Nigeria?
- What factors accounted for the framing of GM crops by the news media in Nigeria?

1.5   Conceptual definition

Genetically Modified Organisms (GMOs) are plants, animals or micro-organisms of which the DNA (genetic materials) have been altered through unnatural method or untraditional breeding techniques achieved through a biotechnology known as recombinant DNA technology (Khan *et al*., 2016). GM foods are foods derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally, that is through the introduction of a gene from a different organism (World Health Organisation, 2014). In all the ramifications of GMOs, the distinguishing word is "nature". While traditional organisms are considered natural, GMOs are not.

Within the scope of this study, the concept of GMO will refer to an organism whose existence did not follow the natural process but was made possible through genetic engineering. While this study is focused on GM crops, GMOs will be used to refer to the broader concept of genetic engineering through biotechnology which will include crops, plants, animals, and micro-organisms.

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Chapter two: Literature review

2.1   Introduction

The relevant literature was identified through keywords searches on databases such as Web of Science, Google Scholar, Science Direct, Taylor and Francis and SAGE Journals. The searches were mainly restricted to studies that were carried out within the past seven years. Although, GM crops were first commercialised in the 1990s, extending the literature search to such a long period was cumbersome. Hence, the decision to limit the search to newer studies as well as the minimal inclusion of studies conducted before 2010.

A combination of keywords was used to search for studies related to GM crops, media coverage of biotechnology and science journalism. Key terms such as "genetically modified", "genetically modified crops" or "GM crops", were used in variation with words like "media", "Africa" and "Nigeria". Another key term was "science journalism" with a combination of the words like "Africa" and "Nigeria". The search terms yielded more than 1200 results. Each study was screened by reading the abstract and subsequently the findings and the conclusion.

The selection criteria focused on studies that dealt with the introduction of GM crops, the debates and controversies, media coverage or framing of GM crops, and science journalism. Eventually, 131 publications were selected for this review. Majority of the publications were peer-reviewed journal articles. Others were book pages, working papers, conference papers, and reports of research institutions. This literature review is grouped into headings for clear presentation and easy understanding.

2.2   Development of biotech crops

The saying that nothing is new under the surface of the Earth applies to GMOs. Through the ages, human beings had practiced genetic engineering through cross-breeding of animals or cross selection to develop new crop varieties (Okigbo, Iwube, & Putheti, 2011; Key, Ma & Drake, 2008). The difference between the traditional and the modern techniques of genetic improvement is that with the former, thousands of traits from two crops are combined while the advent of biotechnology facilitated the manipulation of the genes in such a way that only the desired characteristics are added to a plant (Okigbo *et al.*, 2011: 25). GM revolves around

the insertion or deletion of genes in which specific changes are introduced into the DNA of an organism through genetic engineering techniques (Ibiam & Okoi, 2012: 24). GM crops are plants that have been genetically engineered through recombinant DNA technology which means that a gene that is not native to the crop has been inserted into it (Key *et al*., 2008: 290).

Modern biotechnology is being applied to areas like agriculture, medicine, and industry. Though, the first commercial GM crops were planted in 1994 (tomatoes), 1996 was the first year in which a significant area of crops containing GM traits was planted worldwide in 1.66 million hectares (Brookes & Barfoot, 2014: 65). According to Brookes and Barfoot, (2014), there has been a substantial increase in the number of farmers planting GM crops globally. The number of countries growing GM crops has also increased from six in 1996 to 18 in 2003 and 25 in 2008 (James, 2010: 8).   By 2008, GM crops were planted in 125 million hectares of land and have continued to grow since then (James, 2010: 8). The planting of GM crops increased to over 160 million hectares in 2012 (Brookes & Barfoot, 2014: 65). The global production of GM maize and soybeans added 122 million tonnes and 230 million tonnes respectively in 2012 and the production of GM cotton, corn, soybeans, and canola has resulted in a significant net economic benefits at the farm level amounting to $18.8 billion in 2012 alone and $116.6 billion for the 17-year period (Brookes & Barfoot, 2014: 65). The result of a meta-analysis of the impact of GM crops shows that:

> "On average, GM technology adoption has reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%. Yield gains and pesticide reductions are larger for insect-resistant crops than for herbicide-tolerant crops. Yield and profit gains are higher in developing countries than in developed countries" (Klumper & Qaim, 2014: 1).

Pattern of approval of GM crops shows that by 2014, "there was an accumulative increase in the number of countries granting approvals at 29 (79% developing countries) for commercial cultivation and 31 (70% developing countries) for food and 19 (80% developing countries) for feed" (Aldemita, Reaño, Solis, & Hautea, 2015: 150). Maize has been the most widely approved GM crop as well as herbicide tolerance trait of GM crops being the most approved globally (Aldemita *et al*., 2015: 150).

According to James (2010: 8), the growing acceptance of biotech crops can contribute to solving certain challenges facing global society, such as food insecurity, the high cost of

food, food sustainability, hunger, and poverty as well as reducing the impact of climate change. Biotechnology is attractive to agriculture because it can be used to "engineer resistance, such as drought, extreme temperature or salinity, and biotic stresses, such as insects and pathogens that would normally prove detrimental to plant growth or survival" (Key *et al*., 2008: 290). In addition, biotechnology is not only very useful in offering resistance to insects, viruses, and herbicides but also in improving the nutritional content of crops (Wang, Chang, Lu, Fray, Grierson, & Han, 2017: 5). Therefore, GM crops provide an opportunity for food security, safety and improvement of the quality of food in a rapidly growing global population.

While many scientists (Tsatsakis, Nawaz, Tutelyan, Golokhvast, Kalantzi, Chung, Kang, Coleman, Tyshko, Yang, & Chung, 2017: 108) believe that GM crops have the potential to meet the rising global food demand, others do not think that GM crops have advantage over other available options for food security and sustainability. The claim that GM crops are the most realistic pathway of meeting global food security in the future has insufficient scientific proof but rather a reflection of corporate interests (Jacobsen, Sørensen, Pedersen, & Weiner, 2013: 652). Jacobsen *et al*. argue that "objective review of current knowledge places GM crops far down the list of potential solutions in the coming decades." They suggest that rather than devoting so much money into GM crops research, money should be spent on other areas of crop research, such as governance, policy research, nutrition and "solutions close to local market conditions if the goal is to provide sufficient food for the world's growing population in a sustainable way."

Although the contribution of GM crops to agricultural productivity is obvious in certain regions, their contributions to agricultural development and sustainability remain uncertain (Azadi, Ghanian, Ghoochani, Rafiaani, Taning, Hajivand, & Dogot, 2015: 195). Guraua and Ranchhod (2016: 35) argue whether GM crops represent panacea or threat to food security, the right approach is to take whatever decision on good understanding of the science because proper understanding has been lacking in the controversy over GM crops.

Since the first introduction of GM crops, their risk to health and the environment have been the major concerns (Key *et al*., 2008: 290). There has been a scientific consensus on the safety of GM crops but a study published in the journal Food and Chemical Toxicology actually claims that a GM maize caused a tumour in rats (see Arjo, Portero, Pin, Vin, Matias-Guiu, Capell, Bartholomaeus, Parrott, & Christou, 2013). Arjo *et al*. (2013), however, found that the study that linked RoundupTM ready corn or the herbicide RoundupTM to cancer in rats "appeared to sweep aside all known benchmarks of scientific good practice and, more

importantly, to ignore the minimal standards of scientific and ethical conduct in particular concerning the humane treatment of experimental animals." Sanchez and Parrott (2017) state that the reports that have shown adverse effects of GM crops are about 5 percent of all safety studies, despite GM crops being the most studied crops in history. Those minor reports often come from less important journals because there has not been an authoritative scientific report of adverse effects of GM crops after more than two decades of production (Sanchez & Parrott, 2017: 1227).

The potential impact of GM crops on biodiversity has also been a topic of general interest, specifically in the context of the Convention on Biological Diversity. A review (see Carpenter, 2011: 7) finds that currently commercialized GM crops have reduced the impacts of agriculture on biodiversity, through enhanced adoption of conservation tillage practices, reduction of insecticide use and use of more environmentally benign herbicides and increasing yields to alleviate pressure to convert additional land into agricultural use. However, another review (Tsatsakis *et al*., 2017: 108) shows that "although the consequences of gene flow and risks to biodiversity are debatable, risks to the environment and ecosystems can exist, such as the evolution of weed herbicide resistance during GM cultivation".

2.3   Regulation and opposition to GM crops

The discovery of DNA and the subsequent practice that facilitated the separation and transfer of genes from one organism to another have enabled scientists to create an innovative and novel means of solving many old challenges. However, the disruptive nature of biotechnology has also created new challenges for scientists because of the ethical concerns and uncertainty around the technology. The effect of biotechnology on agricultural, industrial or socio-economic changes in the society demands regulation in the face of ethical concerns around GM crops. In examination of the ethical consideration of transgenic crops, Ricroch, Guillaume-Hofnung, and Kuntz (2018: 803) state that ethical concerns about GMOs are approached more holistically when they are shifted from the technology and its use to the issues of morality or amorality of various stakeholders of the debate because there are various ethical viewpoints about biotechnology.

In an examination of the first 11 mega-GM crops growing countries each with an area of more than one million hectares in 2014, Sinebo and Maredia (2016: 1) found that only five out of the 11 countries had smooth and orderly adoption of these crops in terms of the

regulatory requirement of each country. Others, mainly from developing countries, lacked workable biosafety regulatory systems and political will to support GM crops. The study shows that the desire of the farmers to plant GM crops in those countries led to unauthorized access to GM crops and the consequent adoption of substandard biotechnology which undermined performance and productivity.

The perceived risks to agriculture and environment have led to different countries enacting different regulatory frameworks for GM crops in certain ways that do not apply to conventional crops. The regulation of GM crops is more efficient and predictable in North America, with numerous countries in Latin and South America, Asia and Australia following in a more scientific way than in Europe where the regulation is more political than scientific (Smyth & Phillips, 2014: 170). As European countries disagree on the commercial production of GM crops, this division is affecting international grain trade and creating challenges for meeting global food demand through GM crops (Smyth & Phillips, 2014: 170). Ammann (2014) faults the regulation of GM crops in Europe as well as the Cartagena Biosafety Protocol which were anchored on the false premise that GM crops are different from conventional crops. Ammann suggests that the legislation should rather be based on the scientific ground than any other consideration.

Despite the increasing scientific evidence that GM crops are as good as conventional crops for human consumption, sustained negative campaigns against GM crops have led many countries to introduce regulations that require the labelling of GM crops. The United States passed a law in 2016 that mandates the U.S. Department of Agriculture to establish a national disclosure standard for genetically engineered foods (Bovaya and Alstonb, 2018). Bovaya and Alstonb argue that the law is worse than a complete absence of mandatory labelling laws but it is better than other policies that will hinder the development of biotechnology crops. Compulsory labelling of GM products is not supported by science and such laws can inhibit the development of agricultural biotechnology, thereby exacerbating the misconception that GMOs endanger the environment and consumers' health (Yanga & Chenb, 2016: 1851).

Opponents of GM have won a victory because after two decades that the first commercial GM crop was planted, it is still not approved anywhere to plant GM wheat or rice and most of the GM crops are for animal feed such as soybean meal and yellow corn or for industrial application like yellow corn for ethanol or cotton for fabric (Paarlberg 2014: 223). Paarlberg points out that the "the only GMO food staple crop planted anywhere is white maize, and only in one country – the Republic of South Africa". Negative campaigns against

GMOs by NGOs have serious consequences for food security in poor countries where farmers actually need GM crops to increase yield (Paarlberg (2014: 228).

Public opposition to GM crops has been sustained despite the avalanche of scientific evidence that GM crops have no adverse effect (Ventura, Frisio, Ferrazzi & Siletti, 2017: 548). This rejection of scientific evidence shows that "intuitive expectations about the world render the human mind vulnerable to particular misrepresentations of GMOs" (Blancke, Breusegem, Jaeger, Braeckman, & Montagu, 2015: 414). Strong anti-GM sentiment has not stopped farmers from using GM for animal feed or industrial use in developed countries. Citizens in Europe and North America where farming is productive and population of farmers may be less than 2 per cent of the population may not be attracted to biotechnology but their campaigns against GM crops deprive farmers in poor countries where they constitute about 60 percent of the population from gaining from biotechnology (Paarlberg, 2014: 228). For example, the GM crops debate and controversy in Uganda were influenced by events in other countries (Lukanda, 2018).

Empirical findings indicate that the pro-GMO coalition in the European Union is made up of biotechnology companies as well as representatives of Canada, Argentina, the United States, the United Kingdom, and the World Trade Organization while the anti-GMO coalition consists of environmental NGOs and representatives from most of the EU member states (Tosun & Schaub, 2017: 310). This study states that the anti-GMO coalition has been more coherent in the concepts they use to mobilise the public against GM crops in recent years. Moreover, the acceptance of GM crops and the genetic engineering, in general, may have a connection with age as Rousselière & Rousselière (2017: 664-665) found that the support for biotechnology decreases with age. The findings show that the perception of biotechnologies "as risky is not compensated for older Europeans by an increased perceived utility." Although the study did not establish any generation effect on the acceptance of GMOs in European society and was unable to make a prediction on whether there will be a change of attitude toward GMOs in the continent with the increasing application in other parts of the world. Europeans are more sceptical about the application of biotechnology to human foods. There is also the effect of political ideology on biotech with leftists becoming more hostile to GMOs in specific countries in the continent (Rousselière & Rousselière, 2017). However, in Uganda, the youth are more likely to oppose GMOs than older people (Lukanda, 2018).

Contrary to Europe, there is appreciable of level public acceptance of GM in China. China has planted transgenic Bt cotton since 1997 and approved biosafety certificates for the

commercial production of Bt rice and phytase corn in 2009 (Han, Zhou, Liu, Cheng, Zhang, Shelton, 2015). Using interview surveys of consumer households, farmer households and scientists, Han *et al*. (2015) found that Bt cotton farmers had a very positive attitude towards Bt cotton because it provided them with better economic benefits while Chinese consumers from developed regions had a higher acceptance and willingness to pay for GM foods than consumers in other regions. The study also found that the positive attitude towards GM foods by the scientific community will help to promote biotechnology in China in the future, adding that educational efforts made by the media, government officials, and scientists can facilitate wider acceptance of GM technology in the country.

2.4   Introduction of GM crops in Africa and Nigeria

The introduction of GM crops in Africa has been controversial with the debate centred on the potential of biotechnology in solving the wide-spread food insecurity, malnutrition, and poverty. Despite the benefits of GM crops, only South Africa, Egypt, Burkina Faso, and Sudan have commercialised GM crops (Adenle, Morris & Parayil, and 2013: 159). Other countries, such as Kenya, Uganda, and Nigeria have approved field trials of GM crops with their governments showing support for the commercial production of GM crops (Okeno, Wolt, Misra, & Rodriguez, 2013: 125). South Africa approved its National Biotechnology Strategy in 2001 and Kenya in 2006. Nigeria just approved its policy in 2017. Introduction of GM crops is based on regulations that outline the conditions for research, field trials, and commercialization. Okeno *et al.* (2013: 125) state that:

> "Africa took a long time to embrace GM technology, primarily due to lack of
> political support or 'political will', lack of access to proprietary technologies,
> scientific uncertainties and anti-GMO activism. However, increasing food
> insecurity, rapid scientific and technological advances and increasing
> commercialization of GM crops elsewhere has led to a paradigm shift, moving
> the debate on GMOs from the confines of scientific and environmental groups
> to the centre of public policy and politics in Africa."

Most countries have taken a concrete position on GM crops but Africa still remains largely undecided on biotechnology as there is a wide gap in GM policy across the continent.

Though globally, GM policy and adoption are often guided by political consideration rather than science as the vested interest groups and media play a key role in the whole arrangement (Mabaya, Fulton, Simiyu-Wafukho, & Nang'ayo, 2015: 577). Mabaya *et al*. (2015) identify the key factors that enable and hinder the adoption of GM crops in Africa to include peer country influence, stage of seed sector development, ministerial control of biosafety, advocacy by key political figures, activism, media, technical capacity and food security. International conventions have also contributed to the slow pace of adoption of biotechnology in Africa.

> "Adhering to internationally binding agreements is useful, but maybe an obstacle to science-based decision-making. The Cartagena Protocol's 'precautionary' principle of articles 10, 11 and 26 have lead some nations to put more emphasis on the potential risks of GMOs to biological diversity, human health and socio-economic status of the indigenous and local communities, even if there is no scientific certainty to that effect. The politics surrounding the way these provisions are interpreted and implemented has significant repercussions regarding research and commercialization of genetically engineered indigenous crops/landraces, which form the bulk of rural staples in Africa" (Okeno *et al*., 2013: 125).

Africa needs GM crops more than other continents because many of the diseases that affect crops on the continent are not present in other parts of the world (Thomson, 2015: 152). These tropical crop diseases which limit crop yield can be tackled through the planting of GM crops. The GM crops that will tackle these diseases include cassava resistant to cassava mosaic virus, maize resistant to the endemic African maize streak virus, and bananas resistant to bacterial wilt (Thomson, 2015: 152). Thomson states further GM crops that will facilitate greater crop production to include maize resistant to insects, drought-tolerant maize, vitamin-enriched crops, GM crops resistant to post-harvest fungi and weeds. Some of the benefits that the continent will gain by embracing GM crops include increased food production, improved economic benefits, improved nutritional and health benefits, improved food storage and improved environmental condition (Okigbo *et al*., 2011: 25)

Concerns about the safety of GM crops and the conspiracy theories around biotechnology as well as lack of biosafety measures have delayed the commercialisation of GM crops in Africa. The suspicion and mistrust of GM crops in some European countries

have impacted negatively on GM debates in Africa (Paarlberg, 2014). Though, South Africa has shown better appreciation of GM food than Europe. A nationally representative survey of the South African public's perceptions of biotechnology shows that "compared to Europeans, South Africans are more positive about the health implications of GM food, less critical about the environmental impact of GM food, and more positive about the economic consequences of GM food," (Gastrow, Roberts, Reddy, & Ismail, 2018). Other results of the study show that knowledge about biotechnology was higher in groups like younger people, educated people and people with high standard of living.

NGOs have repeatedly accused government and scientists of being biased to multilateral corporations which have patents to the GM crops. A narrative policy analysis of GM debate in Ghana (see Kangmennaanga, Oseia, Armaha,& Luginaaha, 2016: 37) shows that civil groups made exaggerated claims against GM crops being harmful to the environment and health. They maintained that GM crops represented a threat to the survival of smallholder farming because farmers would be required to buy the seedlings for planting from corporations that developed them. Efforts by the government and scientists to counter such claims resulted in counterclaims that confused the public. "Civil society adapted the counter-rhetoric of insincerity, claiming that scientists had some kind of hidden agenda behind their claim, such as eagerness to just earn money from their patents on GMOs" (Kangmennaanga *et al*., 2016: 37).

Burkina Faso that adopted GM cotton in 2008 suspended it after almost ten years during the 2016–2017 agricultural campaign (Sanoua, Gheysenb, Koulibaly, Roelofsd, & Speelmana, 2018: 33). Snoua *et al*. (2018) state that despite the fact that the adoption rate grew rapidly reaching around 70% in 2014, the GM cotton was suspended following persistent criticisms over the suitability of the application of biotechnology to farming in the country. A survey of 324 cotton farmers, both GM and conventional cotton growers in Burkina Faso, shows that the farmers had a poor knowledge of biotechnology but there was also the poor biotech regulation which led to the substandard utilisation of the technology (Sanoua *et al*., 2018:33). The study, however, indicates that in spite of the suspension, farmers had positive views of GM cotton, especially on improvement in production and income as well as in the reduction in the use of pesticide.

Farmers in Africa are not as opposed to GM crops as other interest groups. A study of cowpea farmers in Northern Nigeria and Republic of Benin shows that they preferred GM cowpea to conventional cowpea (Gbegbelegbea, Lowenberg-DeBoera, Adeotia, Luskb, &

Coulibalyc, 2015: 563). The results of the study indicate that social welfare in Benin, Niger, and northern Nigeria would increase by at least estimated US$11.82 per capita annually with GM cowpea production if the introduction of GM cowpea is successfully managed. A different study (see Oparinde, Abdoulaye, Mignouna, Bamire, 2017: 125) that relied on a state-level sample of smallholder cassava farmers in Nigeria identified three distinct types of attitude to GM crops comprising low opposition, medium opposition, and high opposition farmers. The study estimated that only 25% of the surveyed population of farmers was highly opposed to the cultivation of Provitamin A GM cassava.

A survey of public perception of GM foods in Tanzania (Mnaranara, Zhang & Wang, 2017: 589) shows that general awareness level was 49.1 percent with regulatory authorities having the highest level of awareness at 88.9% per cent and the academic field had 62.7 per cent while the media had 60 per cent and farmers occupied the bottom at 24 percent. Expectedly, the study shows that the regulatory authorities and academic had a more favourable view of GM foods while the media and farmers expressed worry over the perceived health risks and ethical consideration of GM foods.

While there is still strong public opposition to GM crops in Nigeria, Yusuf, Amasiora and Ashanu (2010: 8906) argue that the use of biotechnology is not new because it has been applied for centuries in the production of fermented foods such as gari, bread, beer, yoghurt, cheese and beverages like wine. A survey of policy makers and scientists in Ghana suggests that the participants were in support of the introduction of GM crops but lack of trained personnel, lack of appropriate regulatory framework, poorly equipped laboratories and weak institutions are the major impediments (Adenle, 2014: 241). A survey of agricultural scientists in southwestern Nigeria also shows that the majority of the respondents were in support of the introduction of GM foods in Nigeria (Alarima, 2011: 77).

So far Bt Cotton, Bt Cowpea, Africa Bio-fortified Sorghum and Nitrogen Use Efficient, Water Use Efficient and Salt Tolerant (NEWEST) Rice are already at different stages of the field and confined field trials in Nigeria (Olaito & Akhidenor 2017). As agriculture provides employment to about 70 percent of Nigerians, GM crops are expected to increase food production. However, the journey to full commercialisation of GM crops has been very slow. The National Biotechnology Development Agency (NABDA) was established as far back as 2001 to promote, commercialise and regulate biotechnology products but operated for almost 15 years without the necessary legislative backing. The biosafety bill stayed in the country's parliament until it was signed into law in April 2015. With the law in place, the National Biosafety Management Agency (NBMA) was established

which is now regulating and granting permits for field trials of different GM crops. Government officials have publicly indicated interests in commercialising Bt maize, Bt cotton, and Herbicide Tolerant (HT) soybeans, which are already approved commercially in South Africa (Olaito & Akhidenor 2017).

There is no official approval for commercialisation of GM crops in Nigeria but there is an indication that the commercialisation will come soon because of the on-going trials of different GM crops. Public opposition to GM crops seems to be misplaced because Nigeria imports foods from countries that have commercialised production of GM crops and Nigeria also receives food aid that may have GM content from countries like the US (Olaniyan, Bakare, Morenikeji, 2007: 191).

2.5   Media reporting of GMOs

Biotechnology has remained in active public discussion and debate since the first commercialisation of GM plants in the mid-1990s but consumer knowledge about GMOs has not increased at the same rate as the adoption of GMO crops (Wunderlich & Gatto 2015: 42). Globally, consumers are showing limited knowledge and misconceptions of biotechnology and many consumers have reported that they got information about GMO food products from the media, Internet, and other news sources (Wunderlich & Gatto 2015). Therefore, these sources of information may not be as reliable as the available scientific evidence. In making a distinction between GMO familiarity and scientific understanding, Wunderlich and Gatto (2015) found that those who were not familiar with biotechnology seem to be more resistant to the technology while those with higher scientific knowledge scores tend to have more favourable attitudes toward GMOs.

Existing measures of science literacy tend to focus on textbook knowledge of science but there is the need to bring science closer to people who are not scientists by making science a part of the everyday culture (Priest, 2013: 138). As a measure of designing and evaluating new approaches to building critical science literacy, Priest (2013: 144) suggests that "people need to know something about the sociology of science, as well as something about the philosophy of science, to navigate a world full of competing truth claims about science."

Having a scientific background is not a guarantee of positive perception of GM crops. In a survey of 200 medical doctors in Turkey about their GM food risk perceptions, attitudes,

behaviours, and knowledge, the study shows that 80.5% of the doctors perceived GM foods to be harmful (Savas, Gultekin, Doguc, Oren, Guler, Demiralay, & Demirel, 2016: 172). Other results of the study show that 22% of the doctors said they had good knowledge of GM foods while 38% of the participants used the internet and 23.5% of the participants used media as sources of information on GM foods. It was only 4.5% of the participants who acknowledged to have used medical schools as a source of sufficient information about GM foods. The study concluded that although the risk perception of medical doctors about GM foods was high, their knowledge of GM foods was poor.

The selective exposure that stems from cognitive dissonance applies to peoples' perception of GM crops. Studies have shown that people seek information that is consistent with their attitudes and avoid information which can disrupt them. Findings from a multiple-mediation model (Bardin, Perrissol, Facca, & Smeding, 2017: 10) show that in the case of GMOs, people actually exposed themselves selectively to information that confirmed their bias. The study reports that "the higher the level of general risk perception they reported, the higher the perceived threat, the more negative their attitude towards GMOs and the greater their inclination to expose themselves to information on the harmful effects of GM food".

In confirmation bias as regarding media exposure, individuals seek to read stories that reinforce their beliefs and attitudes. However, in a study of how individuals select science information online based on four contested science issues, Jang (2014: 143) found that "participants tended to choose science information that challenged rather than supported their views concerning stem cell and genetically modified foods." But the study also found that the participants who perceived that they had sufficient science knowledge and were religious showed confirmation-bias by preferring congruent to incongruent information. Similarly, in their examination of how political partisans consume and process media reports about nanotechnology, Yeo, Xenos, Brossard, and Scheufele (2015: 172) found that "when cues clarifying the political stakes of nanotechnology are made available, individuals are willing to read information from countervailing sources. When such cues are lacking, however, individuals avoid incongruent information and opt for headlines from attitude consistent sources." Based on this study, confirmation bias and defensive avoidance occur under certain circumstances.

In politicised science debate like the GM crops, Nisbet and Fahy (2015: 223) recommend that knowledge-based journalism should be the best approach to dispel misconceptions. In this instance, knowledge-based journalism should be anchored on how "journalists and their news organizations can contextualize and critically evaluate expert

knowledge; facilitate discussion that bridges entrenched ideological divisions, and promote consideration of a menu of policy options and technologies" (Nisbet and Fahy, 2015: 223). Knowledge-based journalism has not been comprehensively used in the debates and controversies over GM crops.

Gerasimova (2018: 455) suggests that scientists and science communicators should practise "advocacy science". In this regard, science communication should go beyond simply reporting scientific findings but should adopt advocacy science strategy to counter the increasing engagement of civil society organizations in interpreting scientific evidence for their campaign. Gerasimova argues that though it is now difficult to separate science and advocacy, it has become imperative for scientists to use advocacy to engage the political and institutional context for science. Mindful of the fact the role of civil society in the discussion of bioscience has brought positive and negative results with regards to public policy, advocacy science can address the issue of misrepresentation of science and increase public engagement (Gerasimova, 2018: 472). Civil society organisations have emerged as critical players in the GM debate and have played the role of alternative science communicators (Maeseele, 2009: 55). NGOs are increasingly found to contest and redefine scientific knowledge in a way that influences public opinion and public policy. Therefore, advocacy science will be a veritable way of countering NGOs meddling with scientific evidence.

An analysis of newspaper reporting of GM crop varieties around the world between 1996 and 2013 shows that increase in reporting has been paralleled with an increase in GM crop area and the pattern over time was similar in Africa, Asia, Europe, Latin America, North America and Oceania (Morse, 2016: 7). Morse found that articles with the negative representation of GM were lower when compared with those that had a good vision of GM. Overall, the study suggests that media reporting of GM was mildly positive. In another study that explored the trend over time in the global reporting of Bt maize and Bt cotton between 1996 and 2015 in Asia, Europe, and North America, Morse (2016b: 206) found that increase in press coverage also resulted in an increase in the adoption of GM cotton and maize. According to the study, an increase in media reporting of Bt maize between 1998 and 2001 was largely associated with North America and Europe which was the period shortly after the first commercialisation of GM crops. Similarly, a sudden rise in media reporting in Asia around 2008/2009 witnessed a sharp increase in the area of Bt cotton in India.

Framing and discourse analysis have been used widely to study media coverage of GMOs across countries. A critical discourse analysis of two Belgian elite newspapers reporting of GM debate identifies two different ideological cultures which are driven by the

idea of scientific consensus and status quo (Maeseele, 2015:278).   The study found that while one ideological culture defended the status quo and advocated for processes that gave legitimacy to authorities than yielding to democratic debate, the other facilitated democratic debate by often challenging the status and emphasising the opposing responses to scientific uncertainty.

An analysis of widely read national newspapers in Canada from 2000 to 2015 shows that the media coverage of GMOs was not biased because both sides of the debate were represented in the media reporting (Galata, 2017: 1). The study, however, points out that the representation of all sides of the debate could be "artificial balance" as the sources were found to have expressed biased statements. Galata (2017) concludes that the media exposure could have a cultivation effect where the public act on what they found in the press rather than the real scientific evidence. This kind of media representation in an effort to create balanced coverage leads to polarized public perceptions on GMOs. Although controversial scientific stories attract the audience and highlight important issues, covering multiple sides of a controversial scientific issue may constitute a disservice to the audience (Kohl, Kim, Peng, Akin, Koh, Howell, & Dunwoody, 2016: 976). Kohl *et al*. argue that "counterbalancing a truth claim backed by strong scientific support with a poorly backed argument can unnecessarily heighten audience perceptions of uncertainty." This is where the journalistic norms of "get both sides of the story" becomes a problem in covering GM crops with a lot of non-science actors in the debate trying to win the argument without solid evidence.

False balance in a controversial topic like GM crops mixes unsubstantial claims against scientific consensus. Thomas, Tandoc, and Hinnant (2017, 152) state that "much of the prior scholarship on false balance has examined instances where journalists brought scientifically questionable claims, fringe science, or unscientific opinion into their reportage as a 'balance' against scientific consensus". In reporting science, the ethics of balance in media reporting should be applied with caution because no two sides of contested science have the same quantity of evidence (Clarke, 2008, 87). In an effort to maintain balance in reporting GM crops, the media fail to accurately project the scientific evidence that has found no adverse effect of GM crops. Clarke (2008, 103) argues that "journalists must negotiate various norms when reporting controversial stories. The balance norm may appear to conflict with a commitment to accuracy, a situation in which a perspective with little supporting evidence receives prominent attention compared to an established consensus." Similarly, Clarke, Dixon, Holton & McKeever (2015, 461) argue that "in situations where a

preponderance of evidence points to a particular conclusion, balanced coverage reduces confidence in such a consensus and heightens uncertainty about whether a risk exists".

An analysis of a set of 517 images collected through Google to study the effect of exposure of the Italian population to scary GM-related images (see Ventura, Frisio, Ferrazzi & Siletti, 2017: 548), shows that the most viewed Google result images contained the most frightful contents. The study indicates that the agri-food sector in Italy was strongly disposed towards the negative representation of GMOs which exposure to scary images could be a factor that contributed to the negative perception of GMOs in Italy. A study of media framing of GMOs in China (Yanga, Xu & Rodriguez, 2014: 339) found that in spite of only one-third of the articles showing negative reporting of golden rice and GM foods, the articles contained analogies and strident metaphors that arouse audiences' concerns and fears about GM crops. The study identifies conspiracy theory frames, such as the view that the Western countries were using biotechnology to secure global control of agriculture and that GM products were weapons for genocide. However, pro-GMOs articles emphasised the scientific evidence about GM but they appeared less appealing to the readers.

Coverage of GMOs may differ in terms of the target audience of a particular media. In a quantitative framing analysis of genetic discourse in 12 national newspapers, Carver, Rødland, and Breivik (2012: 449) found that elite and tabloid newspapers use different frames when reporting the GM concept. The differences had to do with the choice of topics and use of expert sources. A content analysis of community newspapers in Northern California and Missouri between 1992 and 2004 found that some community newspapers framed the GM stories in more complex and diverse ways that included a wider range of voices that had been reported in studies of coverage in the national or elite press (Crawley, 2007: 314). However, the study found that opposing viewpoints were more in some local newspapers than probably so in the elite newspapers.

Using discourse analysis to study the GM debate in 2004 in the UK, Augoustinos, Crabb and Shepherd (2010: 98) found that the media constructed GM crops as a battle ground of competing interests and framed the public as being opposed to GM but the British government was undemocratic by yielding to vested political and economic interests. Meanwhile, in Hungary, there has been little public debate about GM crops when compared with the Western countries (Vicsek, 2014: 344). Vicsek, however, found that the media in the country conveyed general impressions of a negative framing of the issue. The media framed GM crops as an uncertain risk with a focus on health risk. Another framing has to do

with foreign companies perceived as the source of the problem and trying to make a profit by pushing for unhealthy biotech crops.

In Africa like the rest of the world, the media play an important role in disseminating information about GM crops. A survey of food consumers' awareness of GM foods in Enugu, one of the cities in Nigeria, shows that the awareness levels of the respondents about GM foods were high (Eneh, Eneh & Chiemela 2016: 76). The result of the survey indicates percentages of the participants got the information about GM crops through newspaper (21.67 per cent), television (38.33 per cent), radio (33.33 per cent), Internet (11.33 per cent) reports (3.33 per cent), books (10 per cent), journals/articles (3.33 per cent), institutions (13.34 per cent), family/friends (30 per cent), and seminars/conferences (10 per cent).

A study of the role of media in the GM debates in Uganda shows that journalists were caught in a conflict of interest between reporting scientific evidence and providing a voice to all stakeholders (Lukanda, 2018). The study shows there was outright bias as journalists took sides. Freelance journalists covered the topic more than staff journalists. Journalists also depended on scientists and non-scientists or pseudo-scientists as major sources. Some other key findings of the study show that "both coverage and perceptions are shaped by the contours of capitalism, mistrust and outright misinformation meshed in personal and society myths: newspaper editors consider biotechnology a fringe subject; legislation dominates coverage, and the debate is influenced by events in other countries."

A comparative analysis of media reporting of perceived benefits and risks of biotechnology (DeRosier, Sulemana, James, Valdivia, Folk, & Smith 2015: 563) found that in Kenyan media, more articles mentioned perceived benefits of GM crops than risks. However, the study points out that when risks are mentioned, new articles contain more references to risks than to benefits. The researchers also found that the sources influence the reporting of perceived risks and benefits while the perceived risks were more reported in Kenyan newspapers than the international newspapers. Another analysis of media framing of GM crops in three mainstream Kenyan newspapers shows that only 34.7% of articles were neutral in tone (Lore, Imungi, & Mubuu, 2013). The study found that boosting agricultural productivity through GM crops was predominant in two of the newspapers while the safety and regulation frames dominated coverage in the other newspaper. The most quoted sources were government officials and scientists who generally spoke in favour of GM crops.

The findings in Kenya were similar to another study in Ghana which analysed news media reporting of agricultural biotechnology (see Rodriguez & Lee, 2016: 91). The findings show that government officials and representatives of the food industry were the most quoted

sources in the media stories. Overall, the media coverage of GM crops was dominated by food safety and food security and was mostly negative reporting.

2.6   The state of science journalism

As the name implies, science journalism has to do with journalism that covers science. Murcott and Williams (2012: 152) describe a science journalist as a specialist whose role is to report scientific developments to a wider audience than that reached by the academic journals. In addition, a science journalist will provide the context of research, provide analysis and carry out journalistic investigations into the certainty and reliability of research as well question the integrity of researchers. Sometimes, a science journalist breaks stories of major scientific findings to the public. Science journalists are regarded as the link between the scientists and the public through their task of interpreting scientific results in less complex ways than scientific journals or scientists.

In a study to investigate what science journalism actually means in Germany, Summ and Volpers (2016: 775) analysed two forms of science coverage in German newspapers. The results show a significant difference between a narrow and a broad definition of science journalism. In the classic understanding, science journalism is prompted by scientific events and is rather noncritical. Science coverage in a broad sense is defined by a wider range of journalistic styles, driven by non-scientific events, and with a focus on the statements of scientific experts (Summ and Volpers, 2016: 775).

Many of the journalism studies and science communication literature have continued to criticise science journalists for sensationalism, oversimplification, inaccuracy, and failing to engage audiences in meaningful debate about scientific issues (Secko, Amend, & Friday, 2013: 62). Secko *et al*. (2013), however, argue that theories of science journalism have not actually given practical solutions to journalists to overcome these criticisms. In response to this gap, they suggest four models which involve science literacy, contextual, lay-expertise and public participation to represent how science journalism can be produced from within different theoretical frameworks. "These models are clear representations of how science journalism can be produced from within different theoretical frameworks and thereby provide a theoretically-informed but practical guide for nuanced evaluations of the quality of science journalism," (Secko *et al*. 2013). Hansen (2016: 770) recommends that the focus of research on science communication should go beyond the traditional media genres to include the

mediated communication systems where various voices have emerged in shaping opinions through digital media. The scientific journal *Nature* has a useful framework for science communication by which science communicators and science journalists can study the model to improve the quality of their reporting. Krause (2016: 16) summarises the *Nature*'s framework for visual communication into three categories:

> "The first category, level 1, is for peer-reviewed research; the second category, level 2, is for summaries of research or science policy pieces created by external experts in conjunction with Nature editors (such as News and Views or Comment); and the final category, level 3, is for original science journalism created internally by Nature staff (such as News in Focus or News Features)."

In effort to increase the visibility of research output, public relations departments of research institutions often send out press releases of scientific breakthroughs to journalists. These press releases, however, are more appealing to internal scientific audience than journalistic audience (Lynch, Bennett, Luntz, Toy, & Benschoten, 2014). The journalists in attempts to make these press releases more appealing to their audience sometimes run the risk of not accurately interpreting the outcome of the research. Due to the dwindling resources to traditional journalism in the face of disruptive digital media platforms, science journalists, many a time, reproduce these press releases. Murcott and Williams (2012: 152) state that such dependence on public relations to communicate science undermines the critical role of journalists in holding the scientists to account.

The internet has presented peculiar challenges to science journalism as more science journalists rely on online sources to write science stories. In a survey of science journalists in 14 European countries, Granado (2011: 798) found that science journalists were not only becoming more dependent on scientific journals in their daily reporting but also, they were spending so much time on the internet. Granado argues that the consequence of this overdependence on internet sources is that readers are receiving a distorted image of science as a series of "breakthroughs", or "discoveries" distant from the real daily world of the scientific process and scientists. Granado further argues that the overreliance on the internet and "ready-to-write" press releases from research institutions and scientific journals is threatening science journalism in such a way that science journalists are using the same sources and visiting the same sites regardless of the country they are working in. This trend

means that professional journalists are controlled by the same embargoes that often accompany press releases.

The norms of traditional media are also changing to reflect the new realities of online publishing. Online content is often updated to effect new information or criticisms or corrections. Riesch (2011: 771) found that this "poses a problem to researchers who analyse newspaper coverage of science, health and risk topics, because it is no longer clear who has read and written what version, and what impact they potentially had on the national debates on these topics". The advent of social media and other digital communication platforms have altered the historically dominant role of journalists as purveyors of information. The evolving media environment has become more social, pluralistic, and participatory. In a study of how journalists in US and Europe were responding to this changing media ecosystem, Fahy and Nisbet (2011: 778) found that in comparison to a decade ago, science journalists, who are now driven by economic imperatives and technological changes, are performing multiple roles. These roles include those of convener, curator, civic educator, and public intellectual, in addition to their traditional journalistic roles as conduits, reporters, watchdogs and agenda-setters. Fahy and Nisbet (2011: 778) state that "online science journalists have a more collaborative relationship with their audiences and sources and are generally adopting a more critical and interpretative stance towards the scientific community, industry, and policy-oriented organizations".

Parts of the changes taking place in the media landscape is that scientists are now using digital platforms to communicate and engage with the public without the help of journalists. Jia, Wang, Miao and Zhu (2017: 1-2) found that social media have enabled Chinese scientists to avoid depending on traditional media to disseminate scientific findings to the public. By choosing different social media platforms, the scientists tended to avoid the bureaucratic practice of science communication and promote certain level of audience engagement through mutual interactions.

Twitter has become a veritable means of communicating science to the public by providing additional voices and contextualisation of science issues (Bücchi, 2017: 953). Thus, Twitter plays an important role in the communication of science as a recommender by linking to web resources, directing users' attention, and connecting users. Another important source of science news is blog. In a survey of 2,955 readers of 40 randomly selected science blogs, Jarreau and Porter (2018: 142) found that science news consumers read science blogs for various reasons, such as for ambiance and entertainment while some read the blogs for specific information not found elsewhere.

One of the greatest impediments to science journalism is that many of the science journalists are not often grounded in science. In a survey and interview of scientists and journalists in Spain, Cassany, Cortiñas and Elduque (2018: 9) found not only that most science journalists did not have any scientific training, but also that they did not even consider it to be necessary to execute their job as science reporters. The ethnographic study shows that the science journalists even criticised the system of training journalists and believed that the best approach to science reporting or the profession is by acquiring the skills through experience.

Scientists have often criticised journalists for being inaccurate and often misrepresenting science. A study in New Zealand that employed semi-structured interviews with scientists, science communication advisors and journalists, found that scientists and communication advisors believed that most media outlets, excluding public service media, reported science poorly (Ashwell, 2016: 379). The study shows that dwindling revenue has resulted to smaller newsroom staff thereby putting journalists under constant pressure. In some cases, press releases are published verbatim because there are not enough hands.

In a study of how scientific evidence was represented in science reporting in German print and online media, the results show that scientific evidence was rarely part of science articles, and scientific findings were predominantly depicted as scientifically certain (Guenther, Bischoff, Löwe, Marzinkowski & Voigt, 2017). Guenther and Ruhrmann (2016: 927) investigated the predictors of the journalistic intention to represent scientific uncertainty by using computer-assisted telephone interviews with a representative sample of German science journalists. The results of this study show that:

> "Beliefs about the coverage of other media, perceptions regarding scientific uncertainty of the main field of coverage, perceived expectations of the audience, past behaviour, and gender were the predictors that most strongly affected the journalists' intention to represent life sciences as more scientifically uncertain."

When journalists make news judgement on science reporting, factors like perceived importance to their audience and influence of their organizations often guide their decisions (Rosen, Guenther & Froehlich, 2016: 328). This was the finding of a study that analysed and compared how three groups of journalists in Germany, France, and Argentina selected their news, and explored some motivations behind their decisions. A set of common news factors,

personal interests and sources were also some of the factors that guided the journalists in deciding what science story to write. This sort of journalistic approach to science news may differ from the perspective of scientists on what should be reported. A comparative analysis of British and Danish newspaper science news observe that Danish science news more often than British science news included more coverage of social sciences and humanities, gave priority to national stories and the science news was often triggered by political events (Vestergaard & Nielsen, 2016: 661). British science news, however, favoured stories on the natural sciences and health often triggered by a journal article and also appeared more traditional. The researchers attributed these differences to pattern of the media, scientific, public, and political atmospheres in Denmark partly being a more closed media market in comparison to the liberal market in Britain.

While journalists and scientists acknowledge that objectivity in reporting science is desirable and attainable, they differ on their approach to objectivity. In a comparative survey of 134 German journalists and 163 academics, Post (2014: 730) found that:

> "Journalists think objectivity demands 'trying to let the facts speak for themselves', and academics think it requires systematic methods and transparent accounts. In other words, respondents' attitudes toward objectivity depend on the subjects they deal with, while their understandings of objectivity depend on their professional belonging."

2.7   Science journalism in Africa and Nigeria

Science journalism in Africa faces peculiar challenges such as lack of capacity of journalists to cover science, lack of basic resources for journalistic research, lack of newsroom support for specialised science reporting and challenges in interaction between journalists and scientists (Appiah, Gastel, Burdine & Russell, 2015; Lublinski, Reichert, Denis, Fleury, Labassi & Spurk, 2014). In further explanation, journalists in Africa found it very difficult in getting to interview local scientists and many of them lack professional qualifications. Newsrooms usually have a small number of staff who cover other beats in addition to science. The newsroom managers show little or no support for science and usually favour politics and sports. A combination of these factors and others has created mistrust between journalists and scientists in the region (Outram, 2010: 341). Outram points that local experts

tend to talk to journalists from outside Africa rather than with journalists in the continent. This kind of relationship blurs the opportunity for journalists and scientists to interact on relevant development in science

A survey of 151 general reporters in Ghana (see Appiah *et al*., 2015: 23) shows that there was an inverse correlation between the numbers of science feature stories reported in the past 12 months and journalism experience. The respondents also perceived scientists and health professionals as very important sources for reporting science. Other findings indicate that most of the respondents believed that science journalism training would motivate them to report science and getting easier access to research findings would help them to intensify their science reporting. An initiative by the World Federation of Science Journalists on science journalism cooperation suggests that "capacity building activities based on peer-to-peer support, in the form of different types of mentoring, networking and joint reporting projects in a virtual newsroom" will be part of the solution to improving science reporting in Africa (Lublinski *et al.*, 2014).

Claassen (2011: 351) suggests that: "The media should give serious attention to raise the standards of science reporting by establishing science desks headed by properly trained science editors and well-trained science reporters while scientists should be trained to communicate better with the media and, therefore, the public." Getting scientists to communicate better will involve taking seriously writing courses for undergraduate science students because they are the future scientists and researchers (Smith, 2016).

2.8   Summary of literature review

The development of biotechnology has revolutionised agriculture. With genetic engineering, scientists have been able to produce crops that are resistant to weeds, pests, plant diseases and adaptable to climate change. GM crops have reduced the use of pesticides and herbicides and have enabled farmers to increase their production as well as make more income. GM crops are a potential solution to the global food insecurity in ever-growing world's population. Biotechnology also enhances the nutritional content of crops which is effective in reducing malnutrition. Despite these huge benefits, the introduction of the GM crops has been resisted in several countries since the first commercialisation in the mid-1990s. The Majority of the cultivated GM crops area is for animal feeds and industrial use.

There is no evidence of the adverse effect of GM crops; they are not different from conventional crops. But despite the assurance of scientific consensus that GM crops are the same as traditional crops, there is still widespread uncertainty and fears about the negative impact of GM crops on consumers' health and environment. The regulations of GM crops in many countries are based on potential risks to health and biodiversity. Most of these regulatory decisions are not based on scientific evidence, especially the European Union's regulations which have been severely criticised by scientists. The introduction of GM crops in Africa has been very slow in spite of the fact that the continent stands to benefit more from the technology in solving food insecurity and malnutrition which are pervasive in the continent. Only four countries, South Africa, Egypt, Burkina Faso and Sudan have commercialised GM crops while countries like Kenya, Uganda, and Nigeria are at various stages towards the commercialisation of GM crops. Burkina Faso commercialised GM cotton in 2008 but later suspended it in 2017.

The introduction of GM crops is highly controversial and the media have been playing a pivotal role in providing information to the public. The anti-GM group has been substantially led by civil society organisations while scientists, food industry, and government officials have been the major supporters of GM crops in many countries. Generally, the media have reported all sides of the divide in the GM debate. However, the normative media ethics of providing balanced reporting has contributed to the negative perception of GM crops by the public because unsubstantiated claims by non-scientists and pseudo-scientists are reported alongside solid scientific evidence. In a contested science like the GMOs, the media have been found wanting in representing science. Scientists accuse the media of inaccuracy and sensation, particularly in reporting uncertainty in contested science.

Science journalism continues to face old and new challenges. Many of the journalists who cover science do not have a science background or are not familiar with the scientific processes and methodologies. In an effort to make their science stories appealing to their audience, the journalists run the risk of misrepresenting scientific findings. Also, the disruption of media ecosystems by the digital communication platforms and the dwindling resources for traditional media has affected science journalism. Social media and other new media have created new channels of communicating science. Science journalists are no longer the sole purveyors of science news. In Africa, science journalism is still in a very poor shape because journalists lack resources and capacity to cover science. They also face the challenge where they have to cover science and other beats which denies them the opportunity to specialise in science reporting. Suggestions to improve science journalism in

Africa include retraining of journalists and creation of science desk in the newsroom. In addition, scientists should also be trained on how to communicate better and that can start by training undergraduate science students in the art of better communication.

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Chapter three: Research design and methodology

3.1   Introduction

This study will employ both the quantitative and qualitative approach to data collection. This combined approach will answer the research questions better than using either quantitative or qualitative method. Some of the studies on the media coverage of GMOs have utilised multiple research methods to investigate the phenomenon (Lukanda 2018).

Triangulation refers to the use of more than one method of data collection in a study. Du Plooy (2009: 41) states that "the main reasons for applying triangulation are to test theoretical assumptions in more than one way and to increase the reliability and validity of observations, analyses and findings". The application of multi-methods in a single study has the advantage of reducing uncertainty (Ogbuoshi, 2005: 79). While the quantitative method is more objective, the qualitative approach has a subjective view of reality. Despite these differences, researchers employ both methods to examine the phenomena that they are studying (Wimmer & Dominick, 2003: 110).

Both research methods have their strengths and weaknesses but researchers are using integration of the methods to compensate for their weaknesses. Kelle (2006: 293) argues that integration "can serve for the mutual validation of data and findings as well as for the production of a more coherent and complete picture of the investigated domain than monomethod research can yield". Although there are still disagreements among scholars on the analysis of both quantitative and qualitative data in the same study, mixed research can be promoted as a distinctive methodology (Onwuegbuzie, Johnson & Collins, 2009).

Triangulation tends to produce different outcomes across the methodologies. This limitation will be minimised in this study because not all the research questions will be addressed with both methods. Another limitation of a multiple methodological approach is the consumption of more resources than a single research method. Despite these limitations, the research questions in chapter one of this study will be better approached with the mixed methodologies. While the questions on media coverage of GM crops can be quantified through content analysis and survey, it is imperative to use a qualitative approach like

interviews to answer the research question relating to the factors that influence the media coverage. Therefore, the adoption of triangulation is based on the research questions.

3.2   Content analysis

The content analysis will provide quantifiable data on the coverage and framing of GM crops in Nigeria to answer the research questions on how the Nigerian media covered GM crops. In this regard, newspapers have been found to have an advantage over other types of media in content analysis because of its archival format and accessibility. Therefore, this study will content analyse only newspapers. The sampling frame will include all the articles on GM crops in the selected Nigerian newspapers. Also, the sample size will be defined as the selected newspapers while the units of analysis will include each article on GM crops in the selected newspapers.

All the national newspapers in Nigeria publish both print and online while there are respected solely online publications. A purposive sampling will be used to select the four most popular newspapers in Nigeria for analysis over a three-year period from 2015 to 2017. This period is highly significant to this study because the national biosafety law and the first approvals of field trials of GM crops happened during this period.

In Nigeria, newspaper circulation is self-reported by each newspaper outfit with no independent body that assesses the strength of circulation of the newspapers.   The figures quoted by the newspapers may not accurately reflect the reach of the newspapers. Therefore, Alexa, a web ranking platform is used to select the most widely read newspapers. Although, a newspaper may be performing poorly online but has very wide circulation. To avoid focusing on online presence to determine the readership of a newspaper, two of the most popular newspapers will be picked through Alexa ranking while the remaining two will be chosen based on their track records and perceived circulation strength.

All the articles on GM crops between 2015 and 2017 will be included in the content analysis. Since there is no identified electronic database that indexes newspaper content in Nigeria, the online databases of the newspapers will be searched for articles on GM crops. The online search will be complemented with a physical search of the newspapers in the public library to ensure that all GM crop articles during the study are included. An exception will be *Premium Times* which publishes just online.

Boolean searches will be used to sample the articles associated with genetic modification and agricultural biotechnology. The search terms will include genetically modified organism, genetically modified crops, GMO, GM, GM crops and their variations. Each selected article must have at least one word relating to GM crops or GM food or biotechnology in the headline or lead paragraph. The results of all the searches will be examined and only relevant articles will be included in the analysis. The selected articles will be identified as news, editorial, opinion, and feature.

Using the procedure for content analysis (see Du Plooy, 2009: 213-219), various possible categories will be developed. Phrases, metaphors, symbols, keywords will be used to identify each frame. Already, the literature review has yielded possible categories such as frequency, sources, and tone for the coding. Other possible frames will be identified based on a random sample of 10% of the selected articles. The frequency will refer to the number of times articles on GM crops published in the newspapers during the sample period. The sources will be identified as government, scientist, business, and NGO. The sources that do not fit into these identified sources will be coded as others. The tone will be coded as either positive or negative or neutral depending on how an article presented the impact of GM crops. The headlines will also be categorised as positive, negative, and neutral.

The variable data will be entered into a Microsoft Excel spread sheet, upon which the analysis will be carried out. The analysis will be done and presented based on quantitative descriptive statistics, containing counts and percentages.

3.3   Selected newspapers

The four selected newspapers are *Vanguard, The Punch, The Guardian,* and *Premium Times*.

Vanguard: The newspaper is one of the leading newspapers in Nigeria with nationwide circulation which has its headquarters in Lagos. It was established in 1984 by a veteran journalist, Sam Amuka. He was the editor of *Sunday Times* and the first managing director of *The Punch* (see about section of *Vanguard*). The paper's self-reported 120,000 daily circulation is not verified by an independent body. However, its website is among the top websites in Nigeria and it is the top news website in the country, according to Alexa ranking. The newspaper's Facebook page has 3.1 million likes and 1.85 million followers on Twitter.

The Punch: The paper is one of the oldest surviving newspapers in Nigeria. A family-owned business, it was founded in 1971. It has self-reported daily circulation of 80, 000 copies and claims to be the most widely read newspaper in Nigeria (see about section). The paper covers the entire country and has its headquarters in Lagos. *The Punch* website ranks among the 10 most popular websites in Nigeria and ranks second to *Vanguard* on Alexa. *The Punch* has 2.19 million followers on Twitter and 1.4 million likes on Facebook page.

The Guardian: The newspaper is a family-owned business established in 1983 with headquarters in Lagos. It has national coverage but its circulation is not self-stated and there is no independent body that assesses the newspaper circulation in the country. *The Guardian* is regarded as the most elitist newspaper in Nigeria, though *The Punch* circulates more copies than *The Guardian*. *The Guardian* is not among the first 50 top websites in Nigeria on Alexa ranking. It has 735,525 likes on its Facebook page and 1.14 million followers on Twitter.

Premium Times: *Premium Times* is an independent online news website with an impressive record on investigative journalism. It won the 2017 Global Shining Light Award of the Global Investigative Journalism Network and it was the only Nigeria media outfit that participated in the Panama Paper leak and investigation. *Premium Times* was founded in 2011. It is ranked among the 50 top websites in Nigeria on Alexa. Premium Times has 752, 000 followers on Twitter and 1.2 million likes on its Facebook page.

3.4   Online survey

An online survey will be conducted on science journalists to complement the findings from the content analysis. The essence of this survey is in recognition that the quality of reporting on GM crops to a large extent will be influenced by the quality of science reporting in general. Therefore, this survey will assess the state of science reporting in Nigeria from the point view of reporting GM crops.

The online survey will be sent to journalists in mainstream media, covering subjects of science. From the literature review in chapter two of this study, it is obvious that newsrooms in Africa and developing countries like Nigeria lack science desks. In Nigeria, journalists who cover science also cover other beats. With this lack of specialisation in core science reporting, this survey will target journalists that cover science related subjects, such as agriculture, the environment, health, science and technology in general.

This survey will target 50 journalists and they will be identified through beat associations. In Nigeria, journalists have beat associations with a leadership structure that has chairperson and secretary. The researcher will reach out to the leaders of these beat associations to encourage their members to participate in the survey.

Many of the questions in this survey are adapted from a survey of science journalists in Australia between 2010 and 2011 (Expert Working Group Report 2011). The survey assessed the state of science journalism in Australia and how the field has changed in recent years. Many of the questions in the Australian survey are relevant to this study in ascertaining the state of science journalism in Nigeria.

The survey will consist mainly of closed-ended questions with a few of open-ended questions to elicit the trend and challenges in covering science in Nigeria. The survey will be designed in a Survey Monkey, an online tool that is widely used to carry out surveys. Thereafter, it will be sent to the e-mails of the respondents with one month duration to respond to the survey. The responses will be exported directly into spread sheet upon which the responses will be presented in simple charts and graphs.

3.5   Interview

In addition to the content analysis and online survey, a face to face interview will be conducted with science journalists. The interview will make up for the details that are not captured in the survey. It will be semi-structured questions that will probe the views, attitude and perception of the journalists to GM crops and science journalism. Although the questions are predetermined, the respondents will be asked follow-up questions depending on their responses to each question.

The interview will target 10 science journalists and will be designed to yield more detailed information than the survey. Each interview will last not more than 20 minutes. Also, each interview will be recorded and the researcher will write down key points during the interview. After the interview, the recording will be played again by the researcher to summarise and transcribe major highlights of the interview.

3.6   Summary of methods

This study employs three methods of data collection: content analysis, online survey and interviews. Four leading newspapers that are purposively selected will be analysed for their coverage of GM crops from 2015 to 2017. Also, an online survey will be designed and sent to journalists who cover science related beats to elicit their responses on the quality of reporting on GM crops and the state of science journalism in the country. A qualitative approach of in-depth interviews will be used to probe science journalists on factors that influence the coverage of GM crops. The essence of the triangulation is to collect adequate data that will satisfactorily answer the research questions.

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Chapter four: Presentation of findings

Three methods of data collection – content analysis, survey and interview – were employed. The essence of the triangulation is to ensure that the research questions are adequately answered.

4.1   Content analysis results

Three Nigerian newspapers and one online news publication were content analysed. They were purposively sampled based on their circulation and track records. The selected newspapers were *The Guardian, The Punch, Vanguard,* and *Premium Times*. The papers were analysed over a three-year period between January 2015 and December 2017.

Boolean searches were conducted on the online database of the selected media. The search terms included "genetically modified crops", "genetically modified organism", "GMOs", "GM", "GM crops", "GM foods", "biotechnology", "agro-biotech" and their variations. Physical search of the three newspapers were also carried out at the Area 2 National Library Branch, Abuja, to complement the online search.

The results of the searches were coded directly into Microsoft Excel spread sheets. Before an article was coded, it was screened to meet the criteria for selection. For an article to be selected, it must have GM-related words in its headline or substantially addressed GMOs in its body. Each article was read up before inclusion. In coding the articles, names of the authors, date of publication and headlines of the articles were included. All published items, such as news, features, opinions, editorials and interviews that addressed GMOs were included. The selected articles were coded into categories, such as frequency, tone of headlines and articles, framing as well as benefit and risk perception. In all, 181 articles were selected and analysed. A breakdown of the articles showed that 86 were from *The Guardian*, *Premium Times* 24, *The Punch* 21 and 50 articles from *Vanguard*. In this content analysis, every piece is referred to as article.

- **Frequency of coverage of GM crops**

Almost a half of the analysed articles (47 per cent) were published by *The Guardian*. *Vanguard* followed with 50 articles, representing 27.6 per cent of the total articles on GM crops. *The Punch* and *Premium Times* had the least number of articles with 21 and 24 respectively, representing 11.6 per cent and 13.3 per cent of the analysed articles. A half of all the articles (50 per cent) were published in 2016, the year that Nigeria first granted permits for commercial GM cotton and confined field trials of GM maize to the United States agricultural and agrochemical company, Monsanto. Only 15 per cent of the total articles were published in 2015, the year that the biosafety bill was signed into law while 35 per cent of the articles were published in 2017.

Frequency	Guardian	Premium Times	Punch	Vanguard	Total	Percentage
2015	17	0	0	10	27	15%
2016	47	14	13	16	90	50%
2017	22	10	8	24	64	35%
Total	86	24	21	50	181	
Percentage	47.5%	13.3%	11.6%	27.6%		

- **Tone of headlines**

The headline of an article was identified as positive, negative and neutral. It was coded into the positive category if the headline suggested the benefits of GM crops but identified as negative if it suggested the risks of GM crops. When the headline addressed neither the positive and negative aspects of GM, it was coded into the neutral category.

Headline Tone	Guardian	Premium Times	Punch	Vanguard	Total	Percentage
Positive	13	1	5	16	35	19%
Neutral	42	8	6	16	72	40%
Negative	31	15	10	18	74	41%
Total	86	24	21	50	181	

Of the all the analysed articles, only 19 per cent had positive a tone. *Vanguard* had the most headlines with a positive tone while *Premium Times* had the least. Only one headline, out of the 24 articles published by *Premium Times*, had a positive tone. Examples of headlines with a positive tone include:

> "Genetically modified crops designed to enhance productivity, farm efficiency — NABDA" (*The Guardian*).
>
> "Cassava engineered to 'cure' vitamin B6 deficiency" (*The Guardian*).
>
> "Adopt bio-solutions for food security, experts tell FG" (*The Punch*).
>
> "Experts call for investment in biotechnology" (*The Punch*).
>
> "Nigeria to generate N48bn from PBR Cowpea annually-IAR" (*Vanguard*).
>
> "How biotechnology can optimize agriculture in Nigeria" (*Vanguard*).
>
> "Textile manufacturers back genetically modified cotton production in Nigeria" (*Premium Times*).

However, the majority (41 per cent) of the article headlines were negative in tone. Examples of the headlines with negative tone include:

> "Nigeria deploys genetically modified cotton, maize despite safety concerns" (*Premium Times*).
>
> "Groups reject planned introduction of genetically modified maize, cotton in Nigeria" (*Premium Times*).
>
> "The Growing Menace of the Monsanto-induced Pro-GMO Lobby in Nigeria" (*Premium Times*).
>
> "Group seeks to nullify permits on genetically modified maize, cotton" (T*he Guardian*).
>
> "Use GMO for electricity and gas not food" (*The Punch*).
>
> "GMO foods: FG may shut Shoprite, Next superstores" (*The Punch*).
>
> "Farmers raise alarm over Western introduction of deadly organisms in Nigeria" (*Vanguard*).
>
> "HOMEF, scientists call for repeal of National Biosafety Act" (*Vanguard*).

Of the total articles, 40 per cent of the headlines had a neutral tone. These headlines did not specifically refer to either the benefits or risks associated with GM crops. Examples of these headlines are:

"NAFDAC, NBMA sign MoU on regulation of GMOs (*Vanguard*).

"What new biotechnology law means to Buhari's administration" (*Vanguard*).

"Do we need GM cotton?" (*The Punch*).

"Biotechnology and food security in Nigeria" (*The Punch*).

"Climate change, agriculture and biotechnology" (*The Guardian*).

"On the genetically modified rice" (*The Guardian*).

"Nigeria approves new policy for GMO regulator" (*Premium Times*).

- **Tone of articles**

Similar to the tone of headlines is the overall tone of the articles. In some cases, the tone of headline could be neutral but the body of the article would be either positive or negative. If the body of the article conveyed the impression that GM crops were harmful and unsafe, it would be recorded as negative. But if it was framed in such way that suggested the benefits of the GM crops like boosting agricultural production and nutrition, it would be recorded as positive. When the article either emphasised the negative or positive, it was recorded as neutral. Only 31 per cent of the articles conveyed a positive impression of GM crops while as much as 40 per cent of the articles framed GMOs as negative. *Vanguard* had the most positive articles with 50 per cent of the GMOs articles in the newspaper being positive in tone. While *Premium Times* had the least positive articles on GM, just two out of the 24 articles in *Premium Times* had a positive tone.

Article Tone	Guardian	Premium Times	Punch	Vanguard	Total	Percentage
Positive	22	2	8	25	57	31%
Neutral	30	7	5	10	52	29%
Negative	34	15	8	15	72	40%
Total	86	24	21	50	181	

- **Type of articles**

The majority of the articles (66 per cent) were news stories while opinion pieces followed distantly with 18 per cent. Only 10 per cent of the articles were features. There were just four editorials, representing 2 per cent of the total articles. *The Guardian* published three editorials on GMOs while *Premium Times* had one editorial. *The Punch* and *Vanguard* did not have any identified editorial on GMOs.

Article Type	Guardian	Premium Times	Punch	Vanguard	Total	Percentage
Editorial	3	1	0	0	4	2%
Feature	12	1	0	5	18	10%
Interview	7	0	0	0	7	4%
News	44	22	13	40	119	66%
Opinion	20	0	8	5	33	18%
Total	86	24	21	50	181	

- **Source of the articles**

Some of the articles had more than one source. Government officials were the most prominent sources in the articles with 42.8 per cent. Civil society or non-governmental organisations (NGO) activists were the second most cited sources with 20 per cent while 14 per cent of the analysed articles had scientists as sources. Only three articles used journals as sources and these articles came only from *The Guardian*. The rest of the analysed papers did not quote any specific journal or specific journal articles as sources.   Other sources that did not fall into the category of companies or businesses, farmers, government officials, NGO activists, scientists, and journal were categorised as "Others". For example, opinions by public affairs analysts, journalists and regular newspaper columnists that did not use a particular source were identified as others.

Source	Guardian	Premium Times	Punch	Vanguard	Total	Percentage
Company	2	2	1	2	7	3.3%
Govt	34	12	10	36	92	42.8%

official						
NGO	27	10	2	6	45	20.9%
Scientist	15	3	5	7	30	14.0%
Farmer	2	0	0	3	5	2.3%
Journal	3	0	0	0	3	1.4%
Other	14	4	7	8	33	15.3%
Total	97	31	25	62	215	

- **Frame of articles**

Some of the articles contained more than one frame. Four main frames were identified in the coverage of GM crops by the media. They were the agriculture, controversy, regulation, safety frames. The agriculture frame had to do with articles that highlighted the gains of GM crops, such as boosting food production, ending hunger, increasing crop yields, reducing cost by decreased use of pesticides, offering better nutritious crops, adapting to climate change, resistant to pests and improving the economy through adequate food production. *Vanguard* had the highest articles on the agriculture frame, just as it had the most articles with a positive tone. *Premium Times* had the least agriculture frame articles, just as it had the least articles whose headlines and body had a positive tone. In all, 20.9 per cent of the articles framed GMOs and biotechnology in the agricultural considerations.

Regulation and safety frames appeared more in all the articles with 32.3 per cent and 30.5 per cent respectively. The regulation frame had articles that addressed the activities of biosafety agency and usually had government officials as sources. A half of the articles (50 per cent) in the *Premium Times* had safety frame, especially concerns about how unsafe the GM crops were to health and environment. Also, the majority of articles in *The Guardian* were framed on safety. Controversy was the least frame in the coverage of GM crops with only 16.4 per cent of the total articles.

Frame	Guardian	Premium Times	Punch	Vanguard	Total	Percentage
Agriculture	14	3	7	22	46	20.9%
Regulation	29	11	5	26	71	32.3%
Safety	41	12	3	11	67	30.5%

|						
Controversy	17	4	8	7	36	16.4%
Total	101	30	23	66	220	

- **Benefit and risk perception**

The articles were analysed based on overall perception of benefits and risks of GM crops. The articles were categorised as "benefit" if they made reference to increased yields and reduced cost of farming, as well as being safe to both health and environment. If the articles made reference to harm, contamination and safety, they were categorised into "risk". The articles that did not specifically made reference to benefits and risks were identified as neutral. 16 of 24 GM crop articles on *Premium Times* were framed with perceived risks of GMOs. *Vanguard* had the most articles with perceived benefits of GM crops. Overall, articles with perceived risks of GM crops were higher with 39 per cent.

Perception	Guardian	Premium Times	Punch	Vanguard	Total	Percentage
Benefit	23	3	8	22	56	31%
Risk	34	16	7	14	71	39%
Neutral	29	5	6	14	54	30%
Total	86	24	21	50	181	

4.2   Survey results

Survey Monkey, a popular online survey platform was used to design the survey and collect responses. The survey was sent to journalists who cover GM and science-related beats like agriculture, environment, health, and science and technology. These beats had associations in which the online links of the survey were sent to the journalists through the leaders of these beats. Some of the beat association leaders made available the email addresses of their members to the researcher who then sent the links to the journalists. The science and technology did not have any identified beat association. In all, 37 journalists responded to the survey. However, one respondent did not complete the survey. Here are the responses to the survey questions:

- **What is your gender?**
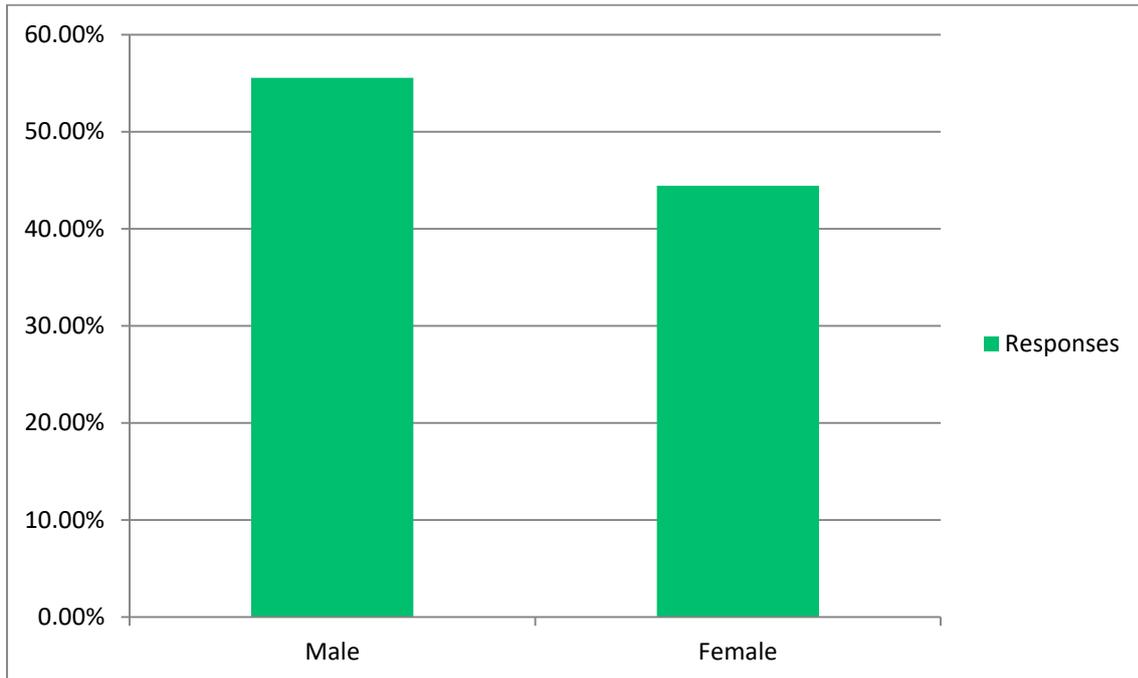
- **How old are you?**
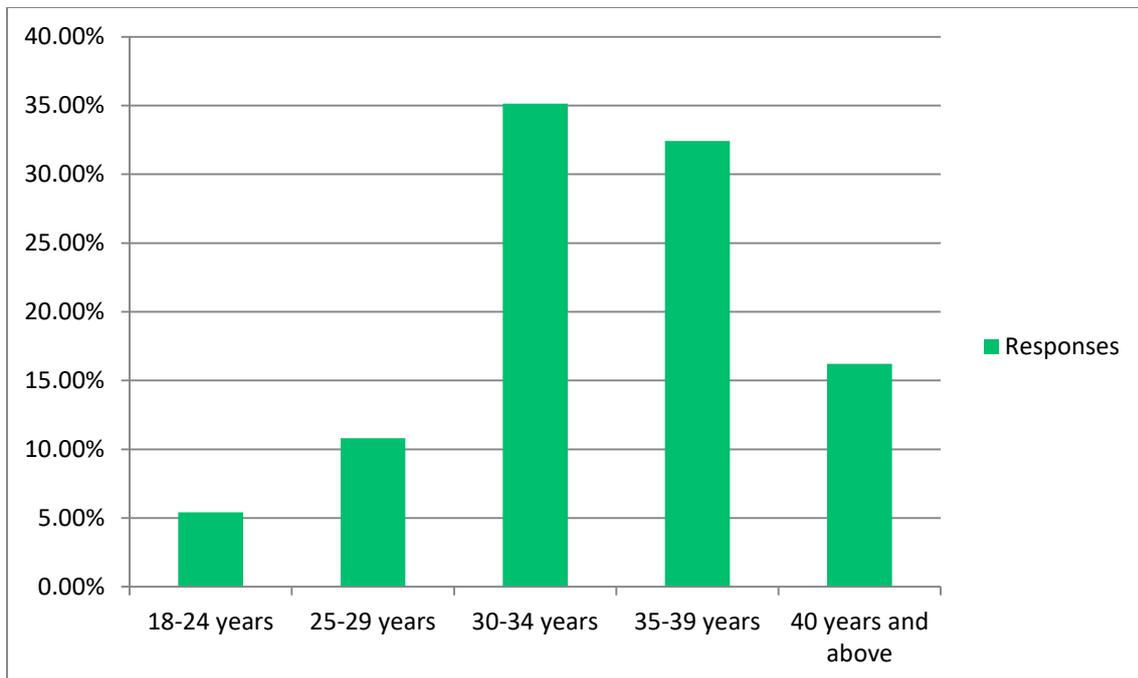
- **What type of media do you work in?**
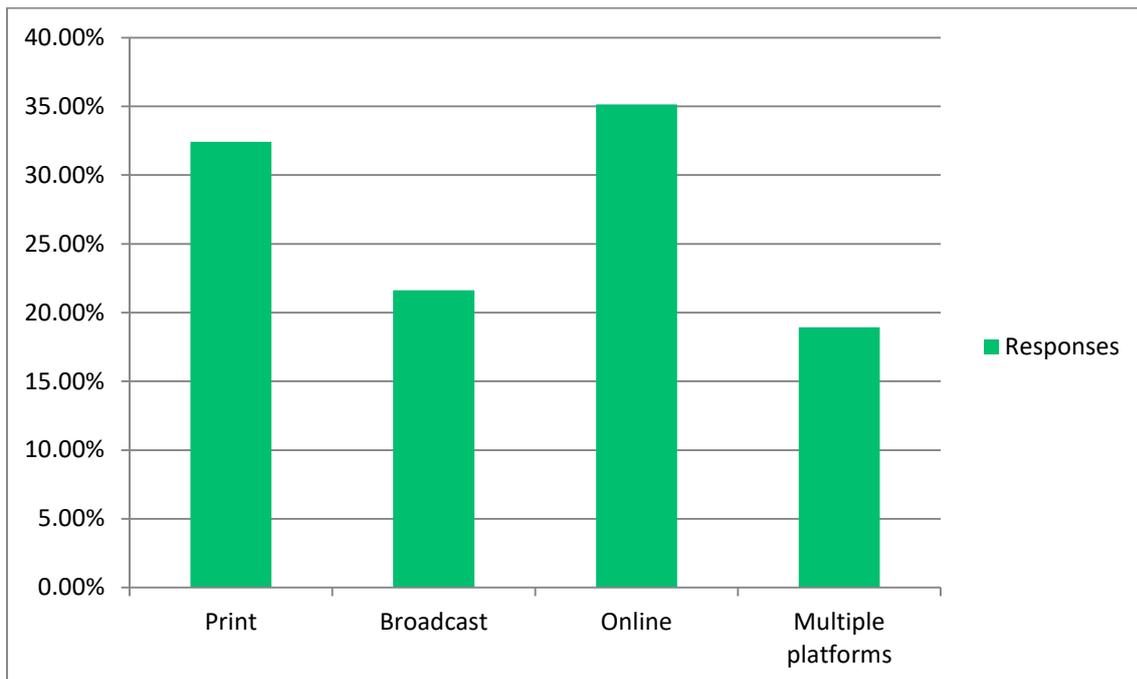
- **What is your job title?**

Seven of the respondents were editors, especially health page editors. Three of the respondents were freelance journalists. One was a blogger and the rest were either correspondents or reporters, with some adding the title of senior reporter.

- **Which media company do you work for?**

Some of the responses came from notable media organisations such as *News Agency of Nigeria, Core TV News, New Telegraph newspaper, Thisday newspaper, Nigerian Pilot newspaper, Daily Independent newspaper, Business Day newspaper, Daily Trust newspaper, The Authority newspaper, Vanguard newspaper, Leadership newspaper, The Nation newspaper, Premium Times, The Cable, Radio Nigeria, Kiss FM, Aso Radio*, and *Vision FM*.

- **Are you a science journalist?**
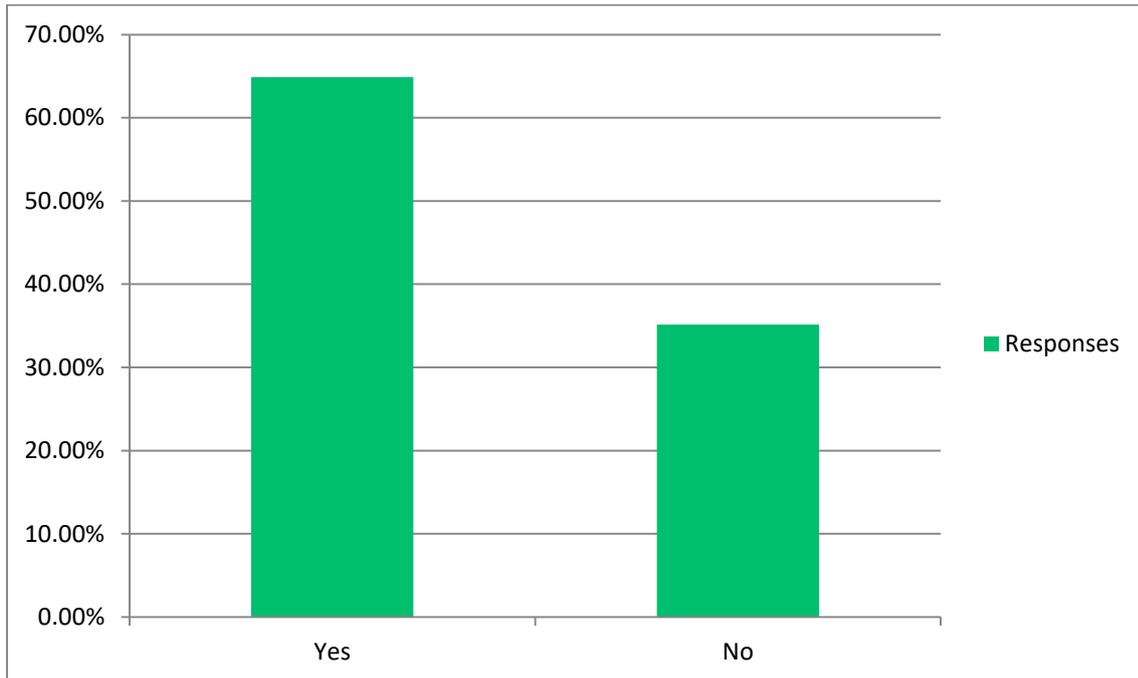
- **Which fields of science do you cover?**

Five respondents skipped this question.
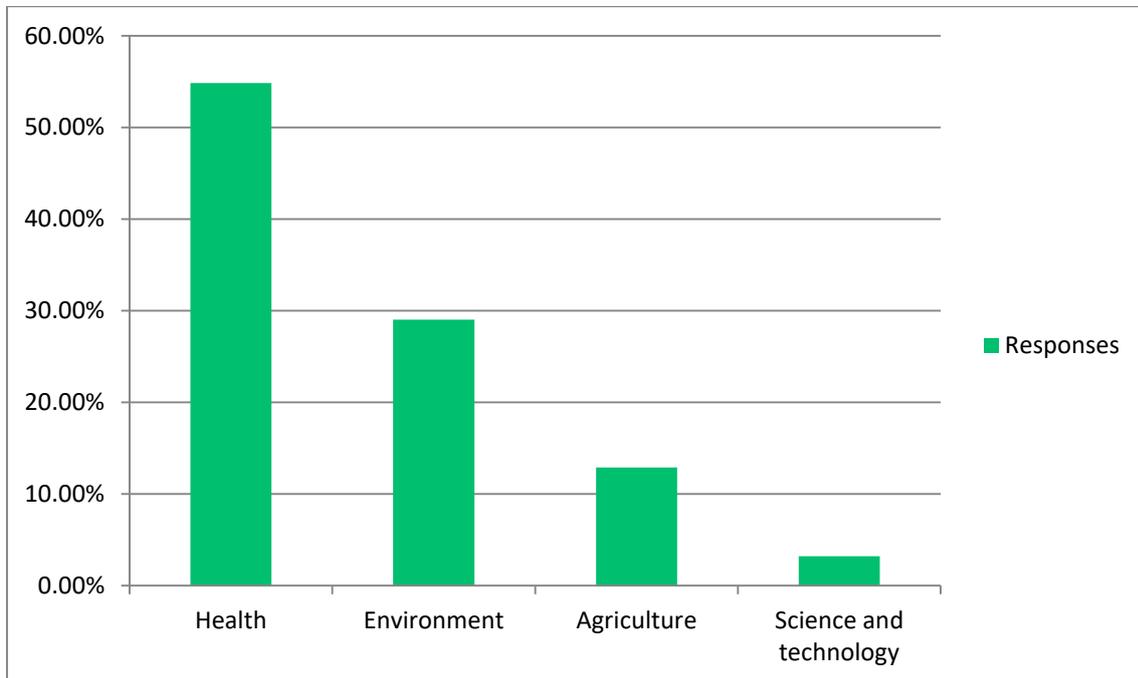
- **What is your educational background?**
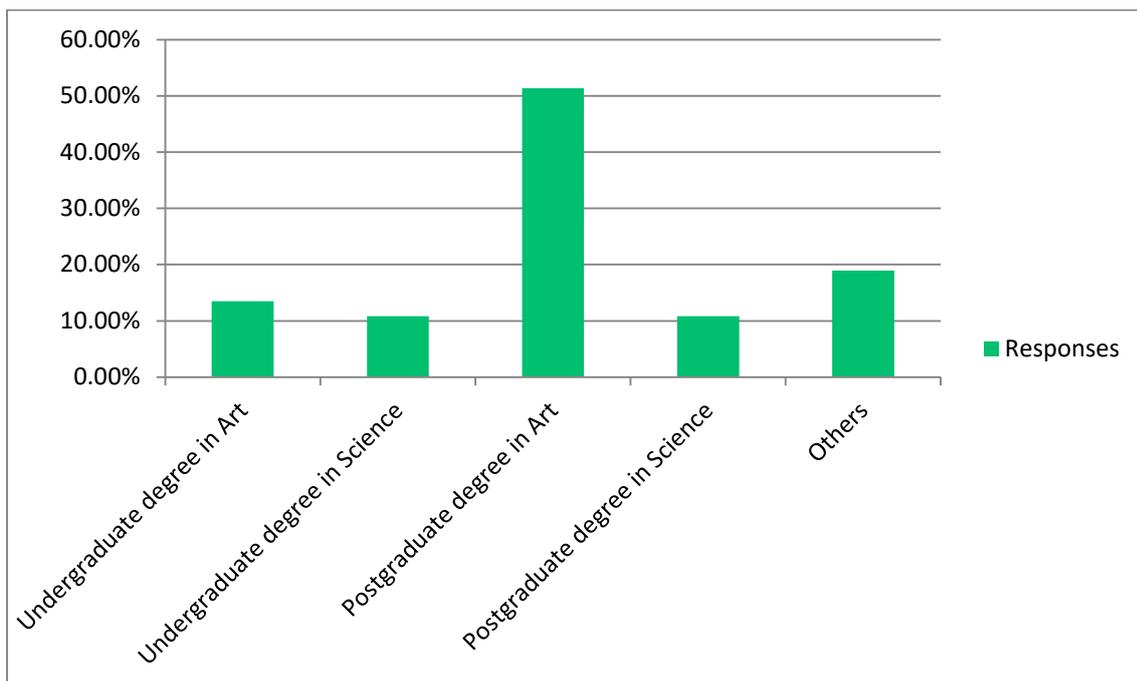
- **How long have you been covering science related topics?**

Five respondents skipped this question
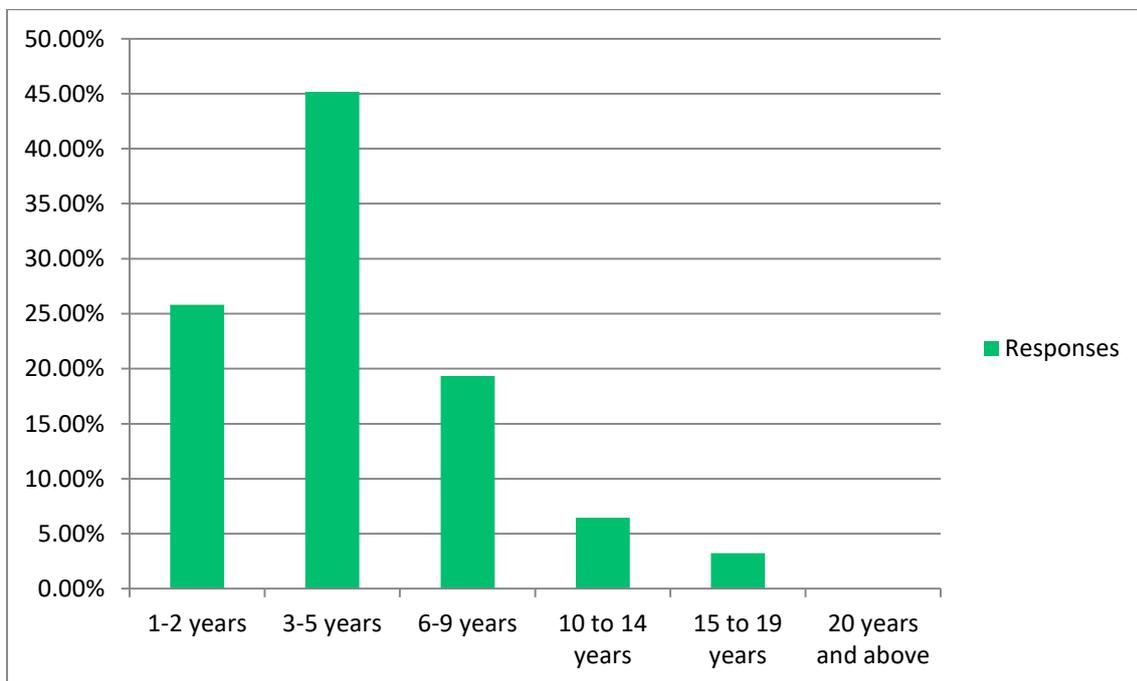
- **Do you cover other beats apart from science?**
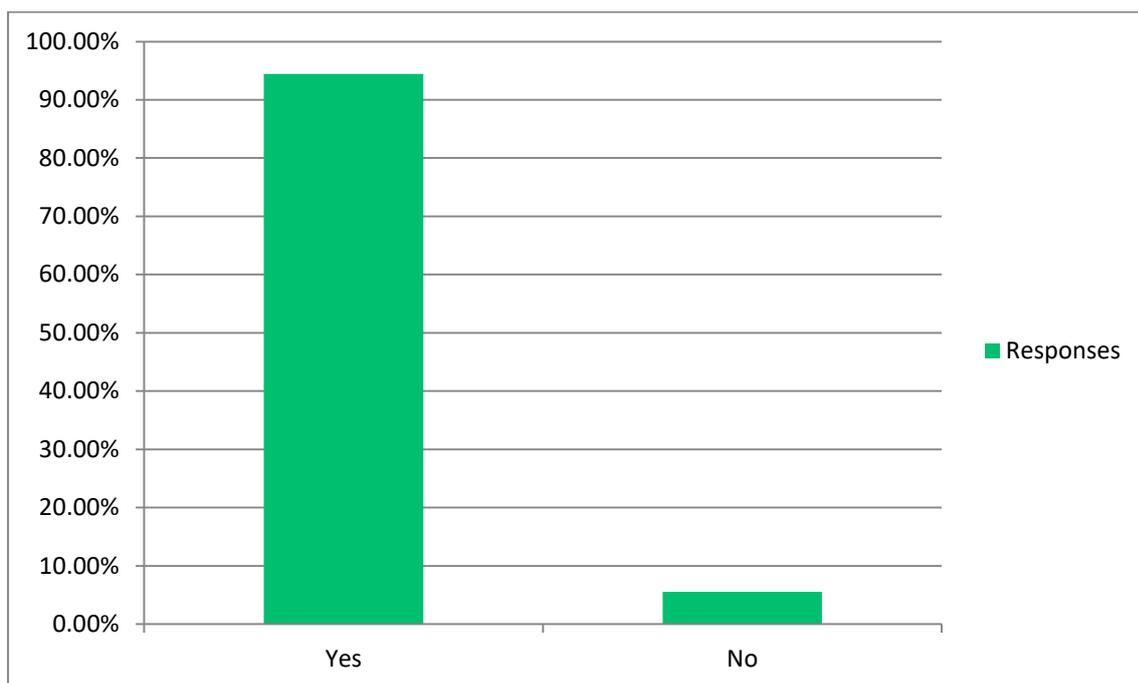
- **Is your role as a science journalist permanent or will you be moving on to other beats?**
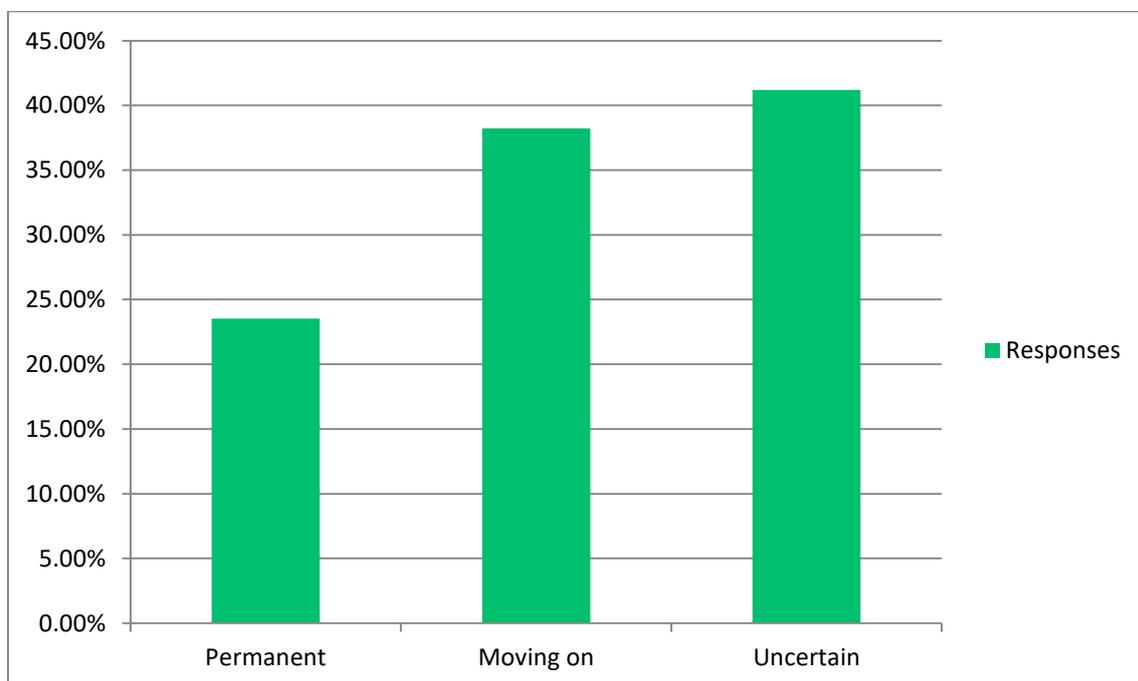
- **Are you required to produce general stories as well as science stories?**
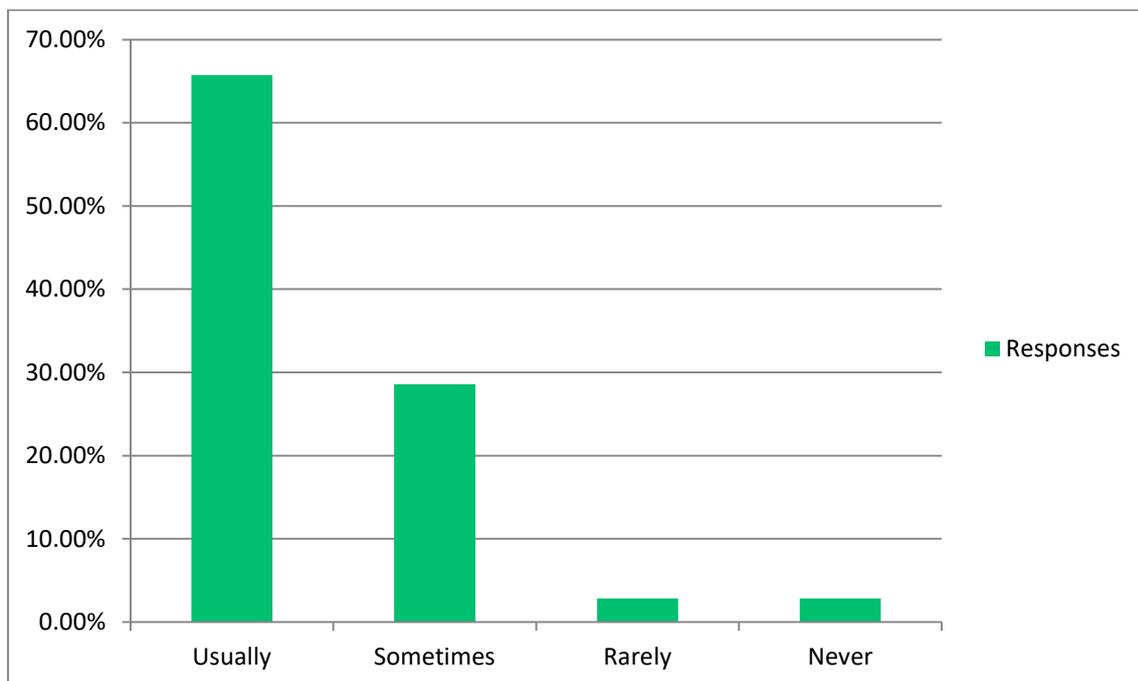
- **Do you feel that the role of the science journalist is considered important by your media outlet?**
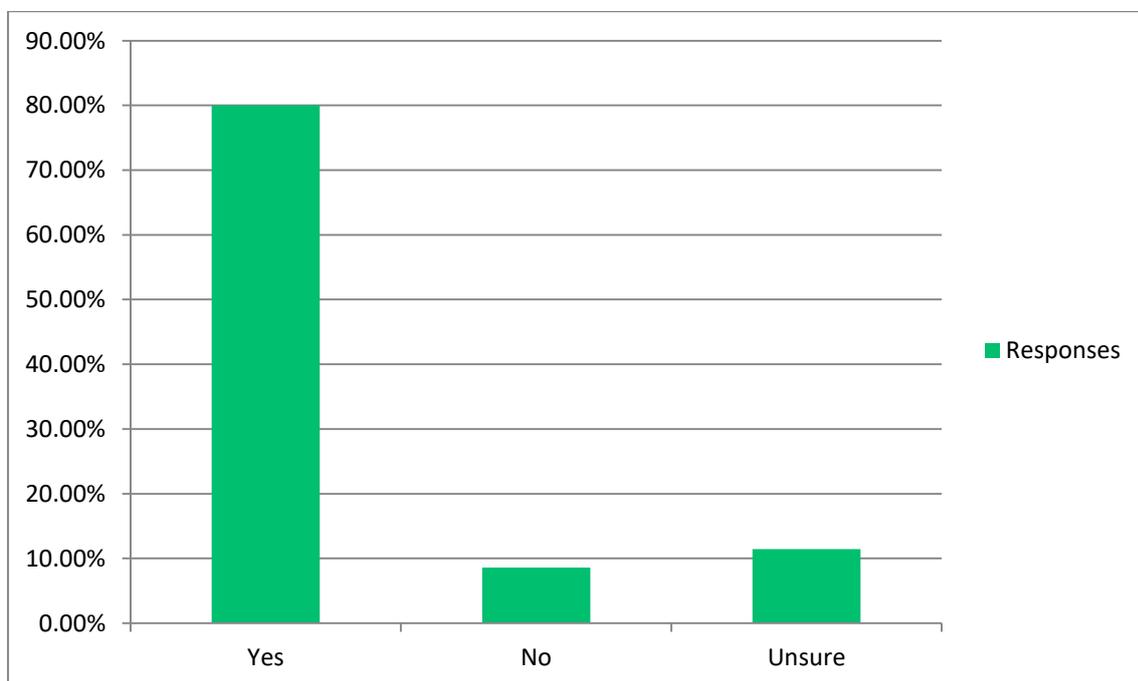
- **Have you ever written a story on genetically modified (GM) organisms or crops?**
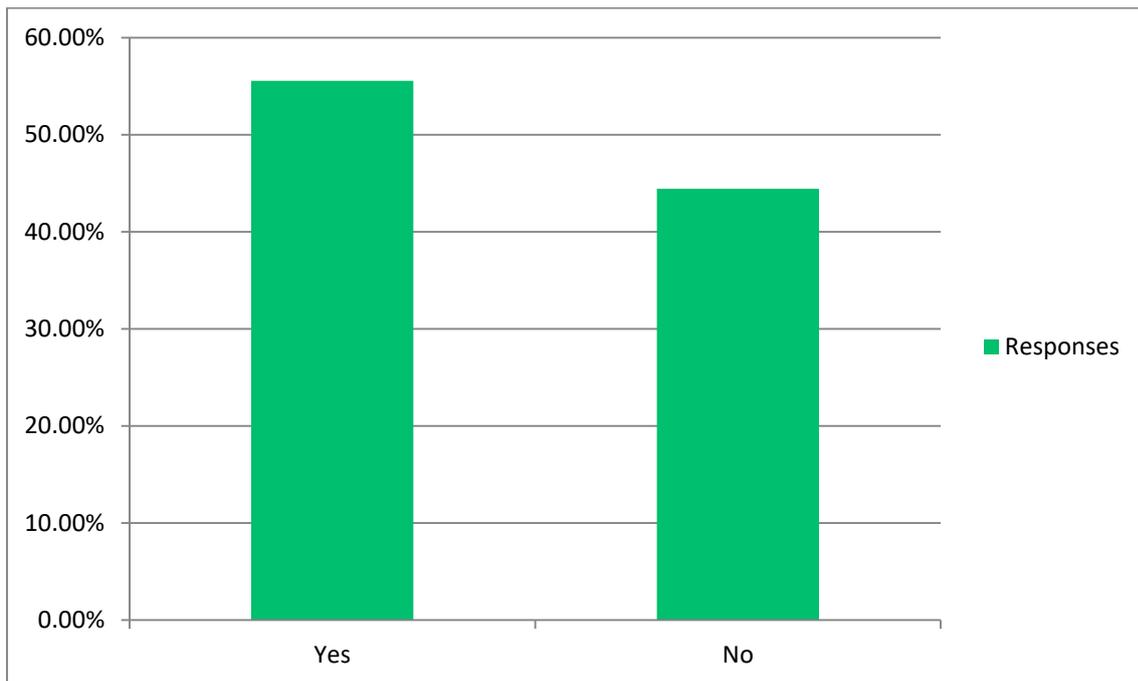

- **What source do you use mostly in your GM crop stories and other science related topics?**

Seven respondents skipped the question. Some of the respondents clicked more than one choice answer
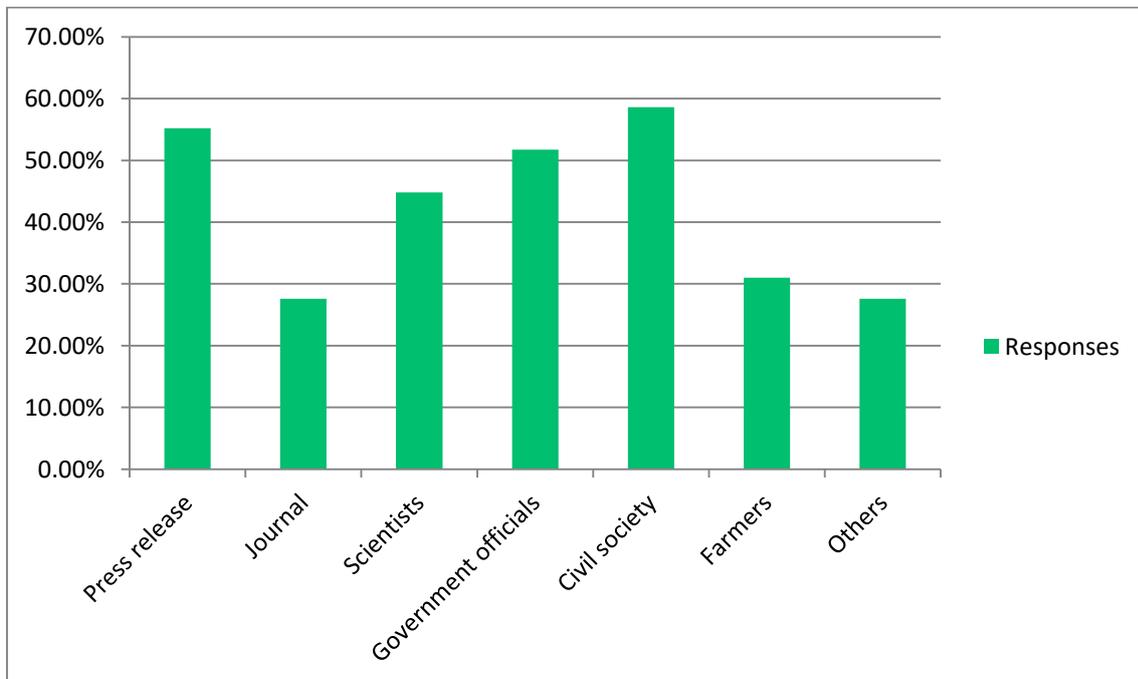
- **Do you think Nigeria should not have introduced GM crops?**
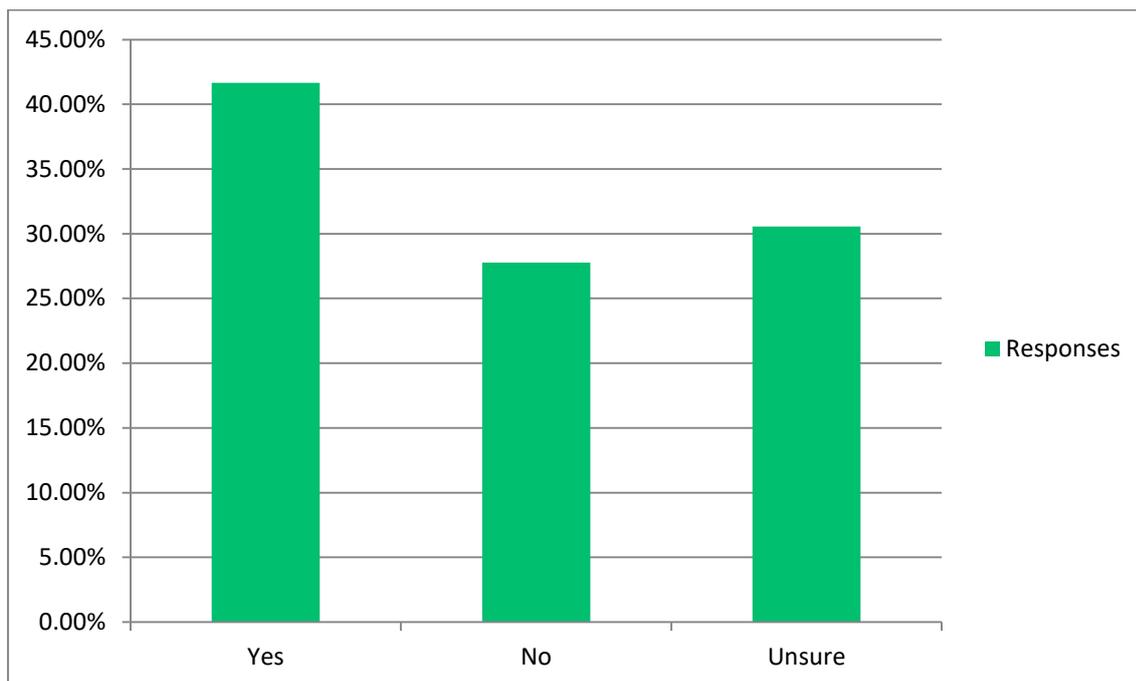
- **What are the reasons for your answer on the introduction of GM crops?**

Respondents who believed that Nigeria should not have introduced GM crops raised the issues of health and environmental concerns of GM crops. They also believed that Nigeria did not have the capacity to regulate the deployment of biotechnology to agriculture. Examples of the responses of those who were against GM crops include:

"Nigeria lack the capacity to contain any eventualities. Nigeria also lack standard GM laboratory as the current one is inside a container. Moreover, there are several improved seeds produced by over 17 research institutes in Nigeria but yet to be adopted, so GM should be last of the last resort. "

"I don't think Nigeria should introduce Genetically Modified into its system because of the disadvantages attached to consuming such crops. Nigeria may not be able to cope with the vagaries of consuming GM crops. It may need some time to understand the nitty-gritty of the issue, and then work out the modalities on how to cope with the consumption of GM crops."

"Nigeria does not have a regulated market for its crops generally unlike the developed countries where consumers can easily decide to choose between a GM crop and an organically grown corps"

"Arguments about the total safety of GMO products are inconclusive yet. Several cases abound where the usage of GMO products had been related to several ailments such as Cancer."

"1. hidden health implications 2. GM seeds can only be used once, this meant that it could spell doom for a nation who feeds only on GM crops, increasing the risk of famine or creating too much dependency and economic wastage by countries who will have to buy from other countries."

"Nigeria is already blessed with fertile soil and bountiful harvests so there is no need to introduce GM crops, it would only pollute our soil. Also it would increase diseases"

"I believe they are unnatural."

"I believe in nature and believe in its superiority to artificiality."

The respondents who believed that Nigeria should introduce GM crops pointed out that GMOs could improve yield and reduce malnutrition. Some wrote responses such as:

"Because I believe it holds the key to food security and that consumption of GM crops should be a personal choice."

"There is a huge benefit in GMOs but poor sensitisation has been a problem."

"I believe GM crops are the answers to malnutrition, and hunger in Nigeria."

"It will boost agriculture development in Nigeria."

"Because I believe introducing that would help improve the agricultural sector and improve yield."

Others who were unsure about GM crops pointed out that they had little knowledge about GMOs. Examples of such responses include:

"It is new to us."

"I do not have adequate information on GM crops."

"Level of awareness by public is still low."

"It is not fully understood yet."

- **Do you think the Nigerian media have covered GM crops accurately?**
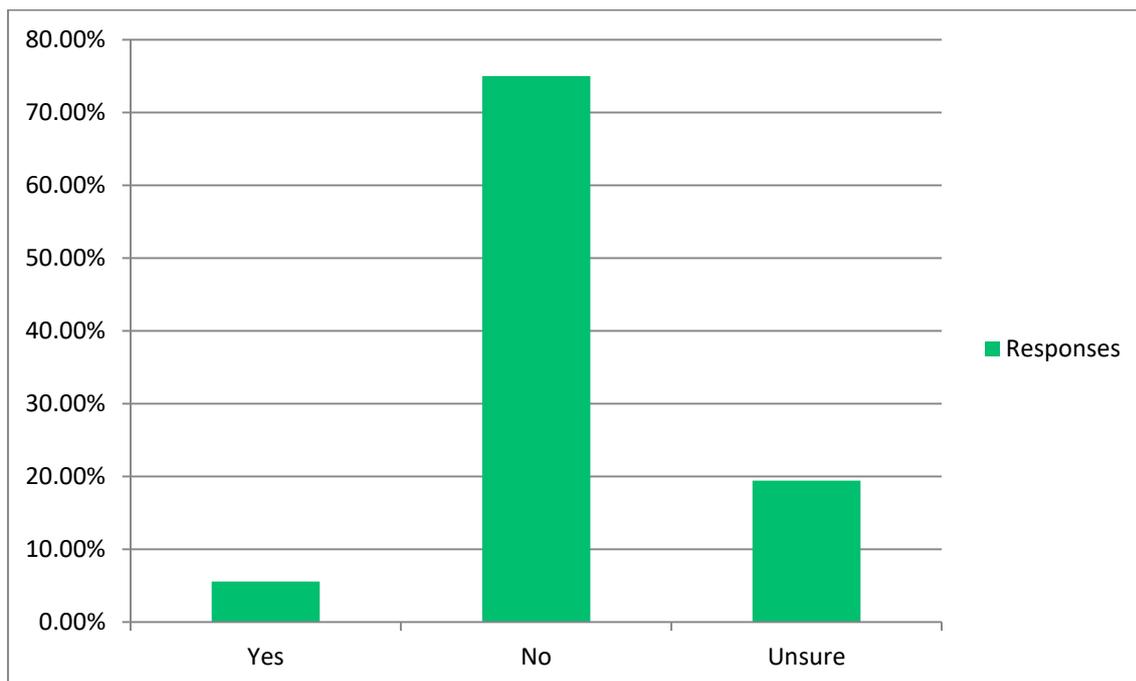
- **What is your reason for your answer on media coverage of GM crops?**

Reasons for the poor media coverage ranged from poor knowledge and awareness to poor capacity of the journalists to cover controversial scientific topics like GMOs as well as lack of funding to research and travel to do science stories. The respondents also pointed out lack of newsroom enthusiasm in science stories and lack of specialisation in science journalism as the factors responsible for poor coverage of GMOs and science. Responses include the following:

"A lot of journalists don't have the capacity, particularly the requisite knowledge, to report on GM crops."

"Only a few have talked about it and most of them that cover GMOs lack understanding of the subject."

"Most media organisations in Nigeria don't have agriculture as a beat. So a few journalists covering health don't have time to divide their roles as a health reporter and as a agriculture reporter. "

"I hardly see stories on GM. I have also not written anything on it."

"It is still too sensational to allow journalists unpack the science"

"They have not been able to provide needed information about GM crops that would explain to the ordinary citizens what it is all about. They have also not engaged scientists to get more insights into GM crops"

"There are few reports on GM in Nigeria"

"Over time, contents and issues on genetically modified crops have not been a major issue that could bring about a national debate on GM crops. So I feel because of this reason, the media hasn't done much on it."

"There's not been seriously researched stories into GMOs; the dangers or otherwise. All that's being reported are what's being reported by foreign media."

"They have not been able to inform the public about GM, the gains and the challenges. Good numbers of Nigerians know little or none about GM"

"The media sensationalism on GM crops haven't helped to truly educate Nigerians on what it entails"

"There aren't many stories on the issue in the media."

"I feel that science journalists have not been properly capacitated. There is need for effective capacity building."

However, one of the respondents believed that the media had covered the topic satisfactorily by saying that "a number of investigation and research have been conducted by journalists in Nigeria". Other respondents said they did not have enough information to draw a conclusion on how the media had covered the topic. "Am not really sure because I cannot ascertain the level of importance given to GM crops in other media," one of the respondents wrote.

- **Have you ever experienced hostility, bully, harassment or threat by activists in writing about GM crops?**
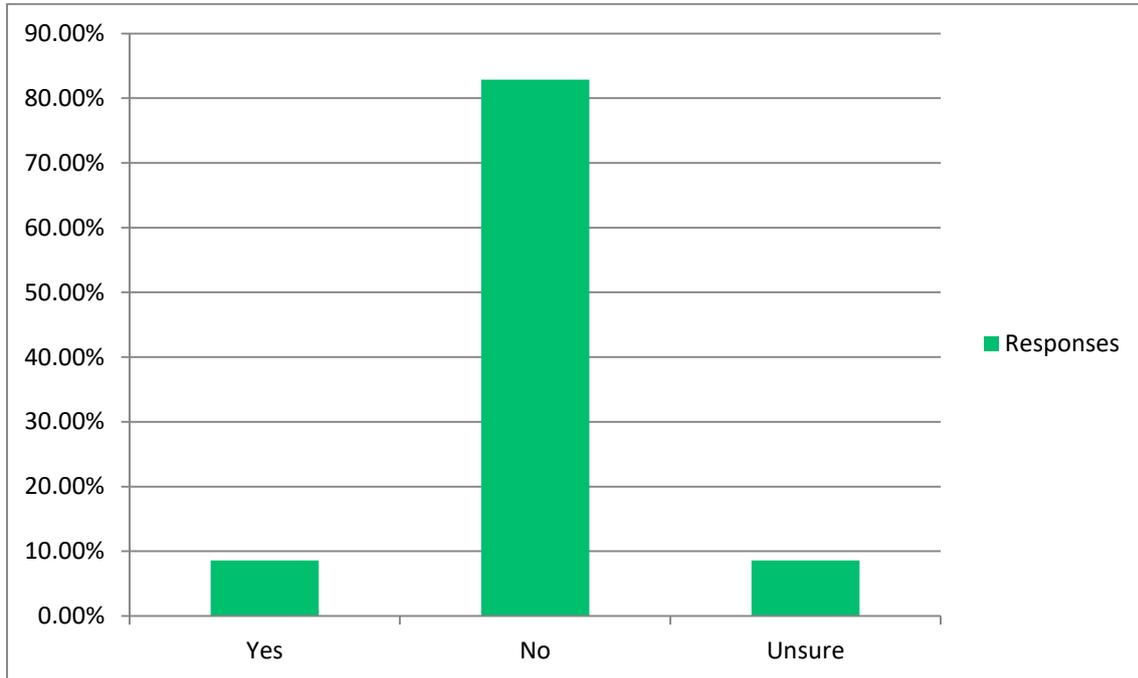
- **If your answer is "yes", please, briefly explain the nature of the hostility or threat.**

One respondent acknowledged to have been harassed: "I hosted some activists on a radio show and who almost bit me up for saying GMO has huge economic benefit and on Facebook, a lot of followers have expressed disappointment in me." Another respondent however had been attacked by the pro-GMO group "For not being Pro GM, there are harsh words and a bit of dislike. There is also a shaped mindset of one being so backward."

- **Do you feel that the role of the science journalist is considered important by your media outlet?**
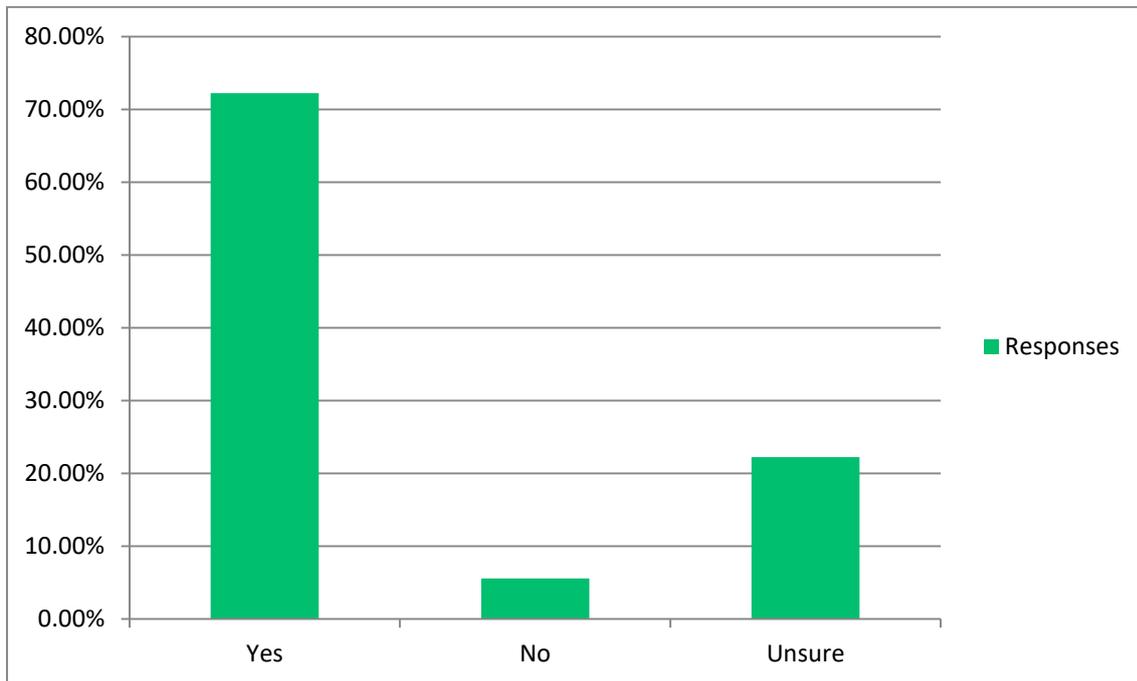
- **Do you have more or less time and resources to research complex science stories**?

Two respondents skipped this question
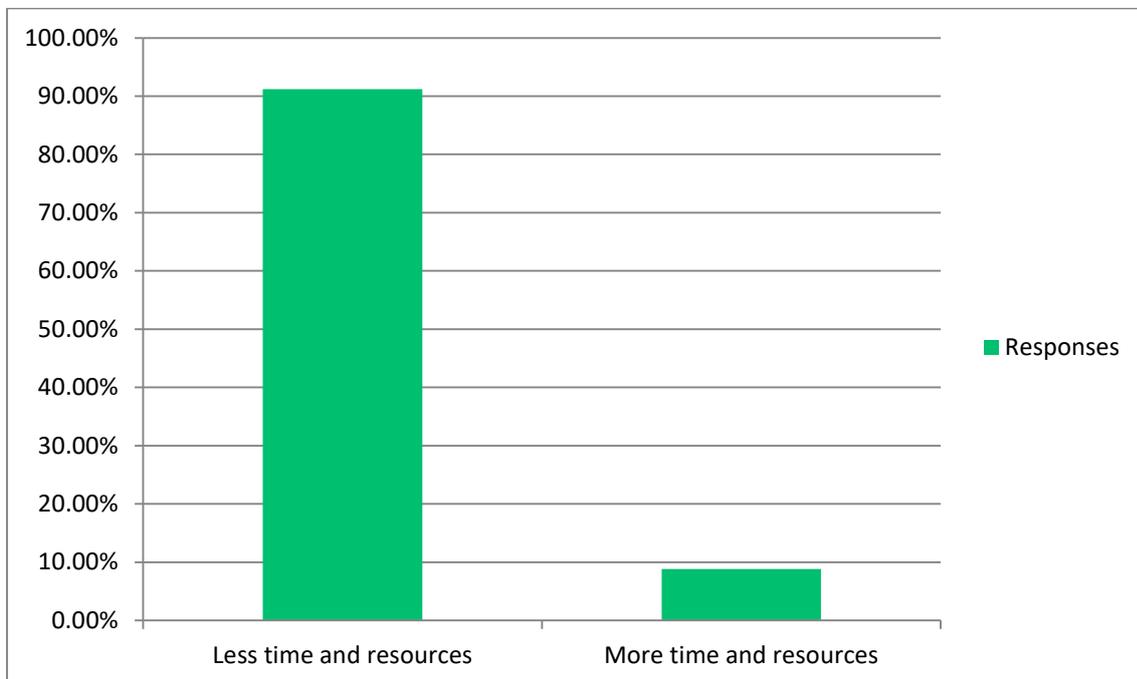
- **Are there any factors which you feel threaten science journalism in Nigeria?**

Many of the respondents cited poor remuneration, lack of interest in science, poor funding of media and lack of capacity as the major impediments of science journalism. Some of the responses include:

"Unpaid salaries/poor salaries.”

“Lack of training for the journalists.”

“Poorly equipped journalists."

“Inadequate funds, editorial policy, nose for news.”

“Media ownership, advertisers influence, religion background of reporters.”

“Mediocrity, apathy toward research, lack of avenues to meet willing experts.”

“Finance to follow and pursue such stories.”

“Science journalism is still being regarded as not having the interest of the public in its content."

"Yes. The chief factor is funding. A serious, well-researched story into GMOs will require some serious funding, this is lacking in majority of the newsrooms in Nigeria.”

“Paucity of data; lack of indepth research in the academia; government's non-challance [nonchalant] to academic research.”

“Funding in order to do research, inability of people to speak at times.”

“Not all media outfits are eager to have such stories published. Preference for other stories is a threat.”

“Poor research skills, lack of motivation in journalism in Nigeria and near lack of knowledge and understanding of science journalism.”

- **Do you see any trends occurring in the media that have an impact on science journalism?**

Some of the respondents believed that sensationalism and click bait could have enormous negative impact on science journalism in Nigeria. Some also believed that the preference of political stories would have impact on science journalism because most newsrooms would rather focus on other stories than science. Here are some of the responses:

"Yes. The more time that is presently being devoted to covering the environment and environmental-related issues will definitely influence positively science journalism. The much time that is also being devoted to the discourse on global warming will also do a world of good to science journalism."

"Sensational stories taking the place of truth, fake news and misinformation by journalists who lack understanding of science topics to report on."

"I feel science reporters are mostly put in the pool of special assignments reporters that they have less time to do an extensive story that science reports needs."

"Sensationalism and the need to sell papers and get clicks allows a lot of unverified claims into circulation."

"Yes, the media is now mostly tilted towards political reportage."

"Well, of late, the argument on whether GMOs should be introduced into the country is getting more serious. Perhaps this could make journalists to begin to rechannel their concentration to the subject matter."

"The Award series by OFAB & AATF in Africa is a step that can boost the morale of journalists in this sector."

- **What do you think are the main impediments to strong science coverage?**

Most of the respondents pointed out lack of skills, funding and motivation as the major impediments to proper coverage of science in Nigeria. Here are some of the responses:

"Poor knowledge of the issues."

"Poor understanding, sentimental reportage and no budget for research by media houses."

"Time, grants, unavailability of resource persons or experts resources for research ,experience or knowledge of science reporters on the GM."

"Funding, editorial preference for political stories as against science stories."

"Deadline by editors."

"Research, funding, political will in media, apathy."

"Capacity gaps, finance and lack of interest by most newsrooms."

"Inadequate science journalists."

"Finance and lack of enough experts on the field."

"Lack of training, lack of expertise, continuous moving of reporters from one beat to another, thereby not giving the opportunity for mastery."

"Lack of motivation by publishers to finance good story."

"Competition in breaking news story."

"No major encouragement, inadequate resources, poor working condition, too much concentration on politics and corruption reporting."

"Firm understanding of Science."

"Lack of motivation, sponsorship, skills and knowledge."

- **Do you have any recommendations on how science journalism can be supported further?**

Many of the respondents suggested for better funding, better remuneration, training of journalists on science reporting and the need for newsrooms to start giving science reporting serious attention. Here are some of the responses:

"Let capital be invested into enhancing the job of covering science, and let those who are already into the field be supported in every way possible."

"Training and retraining of science reporters."

"Science journalists need more exposure and training to be grounded in science journalism." "Increased funding and capacity building."

"Initiatives to support or encourage media scholarship in support of science, fellowships to pick and make examples of good practice."

"There should be frequent capacity building for journalists, funding to cover investigative science stories and recognition of its importance in most news rooms."

"More institutions across the globe should take up research's as well as funding science journalists for research and evidence base reporting."

"There should be grants to support journalists that want to delve into science journalism so they can function better and go all out to get their stories."

"Journalists interested in doing science stories should be given the necessary and adequate support."

"Funding is a critical issue, organisation should support individuals with necessary moral and financial support."

"International donors, government and other stakeholders should come up with special programmes that will enhance adequate reporting of science and technology issues."

"More funding and resource persons as well as trainings and retraining to better equip the journalists."

"Adequate funding and specialized journalists on the beat."

"Public knowledge on science needs to improve, also Journalists should be empowered and well equipped to write on science."

"More resources to report science and media outfits should reduce moving reporters on other beats when they are not yet conversant with the science beat."

4.3   Interview results

An in-depth interview was conducted with eight senior journalists who have reported about GM crops and who cover one science related beats like agriculture, environment, health and science and technology. The interviewees worked for *Premium Times*, *The Guardian*, *Daily Trust*, *Leadership newspaper*, *TV Continental*, *Digital Sense magazine*, *Vision FM*, and *Aso Radio*. One of the interviewees is an assistant managing editor at *Premium Times* and another is the editor and publisher of online magazine on technology related news. One is a host of environment programme on TV. They were between the ages of 34 and 47 years. The interviewees have had an average of nine years of media experience. They were all university graduates. Five of the interviewees possessed postgraduate qualifications and three had undergraduate degrees in science. Three of the interviewees were female while the rest were male.

The interview was semi-structured with each interview lasting no more than 25 minutes. Each interview was recorded. While the interview was going on, the interviewer jotted down key points in the responses. Each interview was later replayed and summarised with a full transcription of quotable parts. After asking background information, the following main questions were asked with follow up questions for clarification and further details:

- What sources do you use mostly in your GM crops stories and other science related topics?

- What determines the sources you select?

- How do you ensure accuracy and balance in a controversial scientific issue like GM crops?

- Aside your journalistic responsibility, what is your perception of GM crops and their introduction in Nigeria?

- How would you describe the media coverage of GM crops in the country?

- What do you think are the main impediments to strong science coverage?

- Do you have any recommendations on how science journalism could be supported further?

- Do you have any other comments on science reporting in Nigeria?

The journalists mostly depended on proactive sources. That is, sources who sought them. In this regard, government officials and anti-GM activists from civil society organisations or NGOs were the most proactive sources. In most cases, the journalists wrote stories on GM crops from press releases and when they were invited for events. They hardly used peer review science journals as a direct source because they did not have access to many reputable international journals. Therefore, they sourced most of their latest research and scientific breakthroughs from foreign media. Local and independent scientists were not readily available to the journalists as sources because the scientists were not as eager as NGO activists and government officials to speak on GMOs. The journalists rarely used farmers as sources because the journalists were all urban-based (Lagos and Abuja) and rarely got funding from their media organisations to research and travel to do their stories. Also, business or company interests were not sources as much in GM crop stories because they did not seek the journalists. In all, the journalists mostly used convenient and available sources, especially those who intentionally reached out to them through press releases and invitation to cover events.

In maintaining balance and accuracy in their GM crop reporting, one of the interviewees responded that "I report the facts as presented by experts from either of the divide: pro and anti-GMOs". This was the experience of other interviewees as they just reported what the so-called experts said. According to one of the interviewees:

"Journalists have not been writing accurate, fair and balanced reports. They have failed to undertake extensive research to write the untold stories of GMOs, starting from getting first hand unbiased reports from farmers in countries where it had been introduced. The civil society organisations who are anti-GM foes not have so much money and so, nobody seems to give a damn about what they are saying. Whether they are saying the truth or not. Both sides needs [need] to be heard, brought to the public and scrutinized to find out what GMOs really are? Who benefits what when introduced? What are the effects adverse or positive?"

Many of the interviewees expressed reservations about GM crops. They pointed out that Nigeria did not have the capacity to regulate GMOs. They also raised concerns about the perceived health and environmental risks of GM. One of the respondents said:

"It's not certain that GMOs in the long run, won't have a gross negative effect on the health of its consumers since it has not been declared totally non-cancerous. So far, developed nations of the world including the UN have rejected it why force it down our throat? Countries such as Burkina Faso where it was earlier introduced, their farmers have raised an alarm over the negative effects of GMOs. Organic agriculture is still the best, not chemically induced plants with propensity to do more harm than good to the unsuspecting populace."

However, some of the interviewees believed that GM crops were crucial to tackling hunger and malnutrition. They believed that GM crops should be properly regulated for Nigeria to join other countries to enjoy the benefits therein. The interviewees noted that in the face of desertification in the northern part of the country which is the food basket of the nation, GM crops could revitalise agriculture and make the country self-sufficient in food production.

All the interviewees rated media coverage of GM crops poorly. They believed the media did not have the means to report on GM crops, as they made reference to the low skills of the journalists in covering science, poor funding, and newsroom attitude to science stories and lack of specialisation of the journalists in science reporting. One of the interviewees said "Again, because science journalism requires some sort of specialization, there are very few journalists that specialize in this area in Nigeria. So, lack of personnel is a limiting factor."

They pointed out that journalists were not allowed to specialise as they had been moved from one beat to another, often every three to five years. The journalists noted that they were given a target of number of stories to contribute in a week or month and such practice did not give them the chance to research and wrote GM crops stories as it should be done. Again, the interviewees noted that the editors were not interested in science stories as they were in other stories like politics, corruption and sports.

The reoccurring impediments to strong science reporting in all the interviews were lack of skills of journalists to report science, poor funding and poor remuneration of journalists, newsroom attitude to science stories, poor public understanding of science and lack of local research and scientists willing to talk about their works. One of the interviewees said "Our country has not given preference to research, innovation and development which is the bedrock of science. Also researches are going on silos which are under reported because everyone wants an independent research work". Also another interviewee said "Emphasis on political stories which editors think sell better than science; lack of adequate training opportunities for science journalists, poor funding of science stories etc." Another pointed out thus:

> "Among the impediments are societal perception of science based news stories which reflect in the attitude of editors to such stories, the lack of incentive and support to strengthen science journalism and the fact that the audience has a high level of illiteracy which impedes their ability to comprehend."

The interviewees suggested that science journalism should be enhanced by building capacity of journalists, funding for story research, changing newsroom's attitude towards science stories, and allowing reporters to specialise in science reporting. Some of the interviews also noted that improving local scientific research and scientific activities would stimulate science coverage rather the overwhelming dependence on foreign information resources.

4.4   Summary of findings

The three methods employed in the data collection yielded relatable significant findings. Here are the key findings:

- The frequency of coverage of GM crops was low, especially in *Premium Times* and *The Punch*, despite being a controversial scientific topic.

- The risks of GM crops were emphasised more in the coverage than the benefits. The majority of the articles on GMOs tilted towards a negative tone both in the headlines and body of the articles. *Premium Times* led in the negative coverage of GMOs while *Vanguard* had more positive and neutral coverage of GM crops.

- Four prominent frames were identified in the media coverage of GM crops. They were the agriculture, controversy, regulation, and safety frames. Regulation and safety frames were more prominent in the reporting of GM crops in all the analysed articles except *Vanguard* which had more of regulation and agriculture frames.

- The most used sources were government officials and anti-GM activists from NGOs. The newspapers rarely cited sources such as journal and farmers. The journalists who have covered GMO and other science subjects depended more on press releases for the sources of their stories.

- The majority of the articles (66 per cent) were news stories. Only three editorials were identified in the analysed articles. News and opinions made up 84 per cent of all the articles on GMOs.

- Many of the science journalists surveyed were against the introduction of GM crops in Nigeria, mainly because of the health and environmental concerns as well as the capacity of Nigerian authorities to regulate biotechnology application to agriculture.

- The media did not cover GM crops properly because of certain limitations. These were low skills of journalists in science reporting, lack of funding for research, newsroom nonchalant disposition to science stories, and lack of specialisation in science reporting as well as lack of local scientific activities.

- In covering controversial topics like GMOs, the journalists amplified the voices of available and convenient sources. They maintained balance and accuracy by citing both anti and pro GMOs groups.

- For better science coverage, there should be capacity building of the journalists, proper funding, prioritisation of science stories by newsrooms and specialisation in science reporting by the journalists.

Chapter five: Discussion and conclusion

5.1   Discussion

This study has shown that the quality of media coverage of GM crops cannot be effectively established without looking at the overall quality of science journalism. This stems from the fact that GMO is a controversial scientific topic and non-scientists have become involved in the campaigns for either adoption or rejection of GM crops.   As the issue becomes politicised, the scientific underpinnings of GM crops are not amplified as much as the concerns over the safety of GM crops. With sharply divided pro- and anti-GM groups, the media become a platform for these groups to contest their ideas and pass on their message to the public.

If somebody says that a particular colour is white and another person says the colour is black, it is the responsibility of the media to find out the actual colour. This was not the case in the coverage of the GM crops in Nigeria as the media reported the opinions of the opposing groups without actually emphasising the evidence and scientific consensus. The media's reliance on maintaining balanced coverage by giving each side the opportunity to be heard undermines the scientific integrity of GM crops. The media rather gave a false balance by underrepresenting solid scientific evidence. The content analysis of the newspapers shows that the media gave false equivalence between established scientific evidence and unsubstantiated claims by the anti-GM activists.   These unsubstantiated claims even overshadowed the scientific consensus on the safety of GM crops.

The tendency of the media to apply its normative ethics of balance in covering contested science is a global phenomenon. After years of amplifying climate change denials in the name of maintaining balance, the BBC finally acknowledged that it made mistakes in such coverage and urged its reporters that they did not need climate change deniers to balance the debate in their reporting (Carrington, 2018). The BBC, thereafter, warned its entire staff to be conscious of false balance. The organisation followed it up with training on how to report climate change. Clarke, Dixon, Holton and McKeever (2015) state that in "situations where a preponderance of evidence points to a particular conclusion, balanced coverage reduces confidence in such a consensus and heightens uncertainty about whether a risk exists." False balance is often noticeable in media coverage of contested science because the claims do not usually have the same degree of evidence. The Nigerian media equated

unsubstantiated risks of GM crops against scientific consensus that have established that GM crops have no adverse effect on health and environment. Therefore, the perspective with little evidence receives even higher media attention than solid scientific evidence. Hence, it distorts the accuracy of media reporting of GM crops.

Lukanda (2018) found that in Uganda, the media were caught in a conflict of interest between reporting scientific evidence and providing a voice to all stakeholders. False balance is compounded when the media do not have the capacity to report science accurately. The overall quality of science reporting is very poor in Nigeria. Newsrooms' attitude to science stories affected the coverage of GM crops because the editors gave preference to politics and other stories. The impression is that the public has low science literacy and as such, the audience will not be interested in science stories. This attitude is reflected across the newsrooms as there are no designated science journalists. What are obtainable in the newsrooms are journalists who cover science related beats, like agriculture, environment, and health. *The Punch* has a daily one page on science, known as *Science World*, but the page is always filled with curated articles originally published by foreign media. *The Guardian* also has a weekly two-page on science, known as *Science Guardian* and published every Thursday, but the pages are also filled with articles from foreign media. This practice clearly indicates that the local journalists lack the capacity to generate content for these science pages.

In view of the overall quality of science journalism in Nigeria, the introduction of GM crops was under-covered and poorly reported. In a three-year period which covered the period from when the biosafety bill was signed into law to when the first GM crops permits were issued, only 181 articles on GMOs were identified in the four analysed papers. These articles comprise the news stories, features, interviews, opinions and others. If all the four media organisations could publish in three years were 181 articles despite the controversy around the subject, it means that the media failed to set the public agenda on GM crops. The agenda-setting function credits the media with the powers to determine the direction of public discussion and debate. One of the ways the media achieve this is by giving salience to an issue. This can be done through emphasis and repetition, like capturing the issue in the front pages. Only once did the issue of GM crops make a cover page in *The Guardian* and it did not appear on the front in all other newspapers. Similarly, *The Guardian* had three editorials on GMOs and *Premium Times* had one editorial. *The Punch* and *Vanguard* did not have any identified editorial over the analysed period. Editorial is a means whereby a newspaper weighs in on issues of pubic importance and take a stand on such issues.

In the case of the media coverage of GM crops in Nigeria, it is important to point out that the agenda-setting function of the media does not exist in isolation to social constructionism. The media's representation of an issue is often a social construct. The Nigerian media operate in a social environment where there are few scientific activities in terms of research and breakthrough. Of all the analysed articles, less than 5 articles made reference to any specific local research on GMOs. The scientific information about GM crops was coming from abroad. Even when the Nigeria Academy of Sciences endorsed GM crops, the body did not carry out independent assessment but rather pointed out that GM crops have been found to be safe in many studies carried out in developed countries. Based on the lack of local research activities, Nigerian journalists did not have access to local scientific materials to write about GMOs. It also happened that local scientists did not normally talk to journalists about their research. As meanings are socially constructed, the media framed GM crops from the perspectives of those who are mostly proactive in pushing their agenda, such as the regulatory agencies and the anti-GM activists.

Meanwhile, this study formulated four research questions which were stated in chapter one of this thesis. The findings of this research will further be discussed in relations to the research questions, with each question having a subheading.

- **Which sources did the news media in Nigeria use in reporting GM crops?**

Apart from overreliance on press releases for sources of stories on GM crops, the most cited sources were government officials and anti-GM activists from NGOs. The newspapers rarely cited sources like peer reviewed journals and farmers. Scientists who are in a better position to give informed opinions on GM crops were not used as much. And when scientists were sources in the articles, they were more of anti-GM scientists. For example, one of the stories on *Premium Times* proclaimed in its headline that: "UK-based Nigerian scientist lambasts Nigeria's Academy of Science over GMOs endorsement" (Ezeamalu, 2017). Then the news website quoted the scientist on the perceived risks of GM crops and how they were rejected in Europe.

A study in Ghana which analysed news media reporting of agricultural biotechnology (Rodriguez & Lee, 2016) found that government officials and representatives of the food industry were the most quoted sources in the media stories on GMOs in Ghana. Also, a similar study in Kenya found that government officials and scientists were the most quoted

sources (see Lore, Imungi, & Mubuu, 2013). However, in this study, government officials and NGOs are rather the most quoted sources.

The findings in this study show that sources influenced the tone of media coverage and framing of GM crops. Likewise, a comparative analysis of media reporting of perceived benefits and risks of biotechnology in Kenya (see DeRosier, Sulemana, James, Valdivia, Folk, & Smith, 2015) found that sources influenced the reporting of perceived risks and benefits. The normative practice in journalism is that news should be attributed to external sources of information and journalists merely play the role of facilitator, not the creator of the news. In this regard, sources are essential elements of news production. Without sources, news stories will not be possible. News content and the agenda of the media are influenced by sources (Messner & Distaso, 2008). Malaolu (2014) points out that the type of sources the media use is very important in determining the representation of people, events or issues as well as creation of stereotypes through the media.

Ordinarily, journalists select their sources based on their news value and orientation. But in the case of media coverage of GM crops in Nigeria, it is obvious that the journalists did not select most of their sources. The sources actively reached out to the journalists through press releases and invitation to cover events or participate in workshops. The most proactive sources ended being the most represented sources in the media articles on GM crops.

Studies have shown that the audience tend to believe sources that are knowledgeable about a subject being reported or official sources. Journalists, therefore, ensure the credibility of their stories by reporting elite sources (Atton & Wickenden, 2005). This could have been the case in the media coverage of GM crops as government officials were the leading sources but this happened because the regulatory agencies were active in countering anti-GM activists by issuing press releases and inviting the journalists to cover their events. The anti-GM NGOs also issued press statements and invited journalists to cover their events, thereby constituting a major source of GM articles. Scientists and farmers who could have been the most knowledgeable about GMOs were rarely sources in the stories because they were not proactive in issuing releases and inviting journalists for event coverage as government officials and NGOs did. As much as 66 per cent of 181 articles on GM crops were news stories, concerned with the comments and statements of mainly government officials and anti-GM activists. Evidently, the media did not independently seek to generate stories on GM crops. The official and anti-GM sources originated from events and press releases.

Professional standards or news value did not determine source selection in the coverage of GM crops in Nigeria. The implication of this that for the public to appreciate scientific consensus in contested science like GMO, scientists have to engage the media proactively as NGOs do. The findings of this study indicate that those who engage the media get their views represented in the media content. In this regard, the NGOs are far ahead of scientists. An example of how NGOs were proactive in their anti-GM campaigns was when one activist went to Brekete Family, one of the most popular radio programmes in Nigeria which uses Pidgin English, to talk about the risks of GM crops and why Nigerians should protest the introduction by the government (see Odogwu, 2016). Such outreach is significant in influencing public opinion and shaping individuals' understanding of GM crops.

To counter the increasing roles that NGOs play in the interpretation of scientific evidence, Gerasimova (2018: 455) suggests for "advocacy science" to be used. That is deploying the tools of advocacy to engage the media and public on contested science. This strategy will help to address the misrepresentation of science and increase public understanding of the nature of science. As suggested by Claassen (2011), scientists should get involved in communicating science to the public, beyond the journal articles which the public rarely has access to. As the findings of this research have established, sources on GM crops determined not just the tone of the media coverage but also the framing of GM crops. This is why scientists need to step up engagement with the public in the scientific enterprise.

- **How did the news media in Nigeria frame GM crops?**

GM crops were framed in four major ways: agriculture, controversy, regulation and safety. Issues around the regulation and safety of GM crops dominated media coverage more than the need for biotechnology in agriculture. The regulation frame was 32.3 per cent of the analysed articles mainly because the media reported about the events or the press releases of government officials, especially the National Biosafety Management Agency. With the sustained campaigns against GM crops led by NGO activists, 30.5 per cent of the articles were framed on safety, especially how the GM crops were unsafe to the consumers and the environment. Then 20.9 per cent and 16.4 per cent of the articles were framed on agriculture and controversy respectively.

While other media had more stories on the regulation and safety of GM crops, *Vanguard* stood out by having more of agriculture and regulation related articles. Close to 50 per cent of articles in the *Vanguard* addressed the agricultural benefits of biotechnology, such

as boosting yield, improving nutrition and reducing the cost of farming as well as making more money from farming and becoming food sufficient. In a related study in Kenya (see Lore et *al*., 2013) agriculture and safety frames were the most predominant while the regulation followed closely.   Also related to the findings of this research is that most sources on agriculture frame quoted government officials and mostly talked about how GMO would boost agricultural production and reduce hunger (Lore *et al*., 2013).

Most of the articles on regulation were general news stories, often citing officials from the biosafety agency. Other articles on regulation frame were concerned with the capacity of the agency to regulate GM crops and protect Nigerians from the influence of foreign agricultural companies. For example, *Premium Times* in its editorial accused the biosafety agency of being susceptible to the manipulation of Monsanto to the detriment of Nigerians. *Premium Times* (2016) proclaims that:

 "*PREMIUM TIMES* is very concerned about the determined march by the US-based multinational, Monsanto, to impose Genetically Modified Organisms (GMOs) into agricultural production in Nigeria. They have found willing accomplices in two government agencies – the National Biotechnology Development Agency and the National Biosafety Management Agency – that are taking the lead in opening doors to GMOs… We cannot allow the National Biosafety Management Agency (NBMA) to sell our future for whatever temporary inducement it might have received from Monsanto. How can we as a nation allow Monsanto Agriculture Nigeria Ltd to register in the country and start production without explicit approval from the Federal Executive Council and the National Assembly?"

The sources for safety frame were mainly anti-GM activists. These articles did not only mention the perceived harm of GMOs but also stated that GMO crops have been found to be responsible for cancer and infertility. There was the tendency of the media to quote the anti-GM lobbyists as experts who were conversant with the scientific implication of GM crops. For example, Ibrahim (2017) reported in the *Premium Times* that "Gbadebo Rhodes-Vivour, the convener of Nigerians against GMOs, said the group had outlined the scientific studies that prove consuming GMO's leads to endocrine destruction as well as affects the growth of cells that eventually lead to cancer."

The most striking anti-GM activist is Dr. Ify Aniebo who was described as a Nigerian molecular geneticist from Oxford University. She was not only quoted in the news stories but she wrote a series of opinion articles and a letter to the President claiming that GM crops had been found to be extremely harmful and have been banned in Europe. In one of her opinion articles, Aniebo (2016) claims that:

"Despite several empirical evidence and calls from the world's leading scientists linking GMOs to diseases such as cancer, reproductive failure, stunted growth, and birth defects as seen in Argentina and many other places, Nigerian Ministry of Agriculture in tandem with NABDA have labeled these calls 'anti-science' and 'uninformed' because the producers of these products have told them that their products are safe."

The findings of this research show that more articles focused on the perceived risks of GM crops than the benefits. These were contrary to the findings of a related study in Kenya where more articles mentioned perceived benefits of GM crops than risks (DeRosier *et al.*, 2015). The spikes in potential risks were mainly caused by the media reporting of unsubstantiated claims of activists on the harmful nature of GM crops.

As sources influenced the framing of GM crops, the agriculture frame was mainly amplified by government officials and scientists while the controversy was predominated with anti-GM activists. The agriculture frame was positive on how GM crops will boost crop yield, increase the farmers' income, reduce malnutrition and ensure a food secured future. However, the controversy frame, constructed GM crops as having no advantage over traditional crops but rather harmful to health and environment and have been rejected in many countries. Most of the articles on controversy cited the instances in European countries where GM crops had been banned and also the example of how GM cotton failed in Burkina Faso that first adopted it in Africa. The controversy frame made references to events in other countries and why Nigeria should learn from those countries. As the biosafety agency moved ahead with the granting of permits, the anti-GM activists organised street protests as well as wrote a petition to those in authorities to stop the introduction of GM crops. The anti-GM group went as far as asking for the repeal of biosafety law.

- **What were the tones of coverage in the reporting of GM crops by the news media in Nigeria?**

Generally, GM crops were framed negatively both in the headlines and the articles. As much as 41 per cent of the headlines and 40 per cent of the articles were negative in tone. Only 19 per cent of the headlines and 31 per cent of the articles had a positive tone. The headlines and articles that had a neutral tone were 40 per cent and 29 per cent respectively. Again only *Vanguard* had more articles with positive headlines and positive articles. Overall, some of the articles were neutral in tone but the entirety of articles was negative. In their analysis of newspaper coverage of GM crops in Kenya, Lore *et al*. (2013) found that 37.9 per cent of the analysed articles had a negative tone, compared to 27.4 per cent with a positive tone and 34.7 per cent with a neutral tone.

The tone of the articles is an indication of the level of media bias in the coverage of GM crops. *Premium Times* took an outright negative stance against GM crops both in its editorial and overall coverage. In the editorial, *Premium Times* rejected GM crops and maintained that GM crops were being imposed on Nigerians by US multinational company Monsanto, despite the supposedly risks associated with GM crops. Out of the 24 articles on GM crops by the *Premium Times*, only 2 articles had a positive tone and 7 had a neutral tone. However, the three editorials on GMOs in *The Guardian* were neutral on the subjects – biosafety law, GM rice and GM soybeans oil. *The Punch* and *Vanguard* did not have any identified editorials. Editorials are useful in gauging the official stance of a media organisation on issues of public importance, especially controversial issues. While *The Guardian* covered GMOs more than other media houses and took a neutral position in its editorial, the newspaper opened its pages for anti-GM opinion pieces with spurious and unsubstantiated claims. A high number of news stories in *The Guardian* also had anti-GM sources that made unsubstantiated claims against GM crops. *Vanguard* had more positive coverage. As much as a half of the articles in *Vanguard* were positive in tone. This positive coverage of GM crops in *Vanguard* was influenced by official sources from the regulatory agencies and other government officials.

Except the *Premium Times*, it is not obvious that the media bias in the coverage of GM crops in Nigeria was deliberate. Sources influenced the coverage to a large extent and it has been clearly established that the sources were proactive in engaging the media. It happened that the most proactive sources were biased sources like government officials and anti-GM activists. While government officials showed positive bias, anti-GM activists

displayed negative bias. These two predominant sources made it impossible for the media to be neutral in the overall coverage of GM crops.

- **What factors accounted for the coverage and framing of GM crops by the news media in Nigeria?**

As much as 75 per cent of science journalists surveyed believed that the media did not cover GM crops accurately. Many of the journalists lack the skills to cover science. Reporting science is a specialised field but the journalists are not even allowed to specialise by their newsrooms. They are often moved from one beat to another. The newsrooms did not have designated science journalists. What they rather had were journalists who covered science-related subjects like agriculture, environment, health and science and technology. The newsrooms never specifically hired science journalists and some of the journalists who covered science subjects did not see themselves as science journalists.

The skill-gap was so noticeable that anti-GM NGOs organised a number of workshops for the journalists on how to cover GM crops. As a counter measure, regulatory agencies also organised skill-building workshops for the journalists. As the two predominant sources took the responsibility of teaching the journalists on how to report on this controversial topic, the science of GMO was neglected in the media coverage. What took hold in the majority of the reporting were the perspectives of the anti-GM NGOs and the government officials.

In addition to a skills gap and lack of specialisation in science journalism, the newsrooms showed poor attitude towards science stories. Science stories hardly made front page stories and the editors would rather prefer political or sports stories to science stories. Therefore, those journalists who cover science subjects are not motivated to pursue critical reporting of science. Although *The Punch* has a daily science page and *The Guardian* a weekly science page, these pages are often filled with stories from foreign media. Simply reproducing foreign science articles shows that the Nigerian media lack the capacity to produce top-notch science articles. This limitation influences the quality of GM crops coverage as the media just reported the comments and opinions of the sources without independently ascertaining the veracity of their claims.

Poor funding is also a major factor that influenced the media coverage of GM crops. The journalists did not have money to research and undertake critical reporting of GM crops outside their locations. The journalists are mainly urban-based in Lagos and Abuja. They

hardly ventured outside their locations to research and investigate the issues of GM crops except when they were sponsored by either the NGO or governmental agency. And this sponsorship often comes in form of workshops. In this case, important voices like farmers and scientists were not given adequate representation like the anti-GM activists and government officials. This imbalance in sourcing also affected the quality of the media articles because the majority of the articles were news stories of the comments and opinions of government officials and activists. Journalists are also poorly remunerated and motivated to do their job. Poor remuneration affects the retention of talented and skilled journalists as they will rather move to better paying jobs than doing the work of journalism which render them poor.

Also, Nigerian scientists are not proactive in engaging the journalists. The scientists hardly send press releases or organise press briefings. Overall, the relationship between journalists and scientists is very poor in Nigeria. Universities and research institutions hardly engage the media on the outcomes of their research or scientific breakthroughs. Also, the journalists do not usually have access to locally generated research material when they are writing on GM crops. When these journalists search on the internet for content on GM crops, they usually do not have access to reputable journals. Therefore, they get freely available information online which may not be the best representation of the scientific evidence of GMOs.

These factors that limited the coverage of GM crops in Nigeria are similar to other findings on the state of science journalism in Africa. Most media houses in Africa have small newsrooms and science is often covered by general assignment reporters. In their assessment of an initiative by the World Federation of Science Journalists on science journalism cooperation in Africa and Arab countries, (Lublinski, Reichert, Denis, Fleury, Labassi & Spurk, 2014) identified lack of interaction between scientists and journalists, lack of newsroom environment for science reporting and lack of capacity as the major impediments to science journalism in Africa and Arab countries. In a survey, Claassen (2011) found that journalists in South Africa were ignorant about certain scientific evidence to the extent that as much as:

"65 per cent believed that science had established that cold fusion is possible, 49 per cent did not know or had no opinion on whether lead causes mental impairment, 11 per cent did not know cholesterol causes heart attacks, as many as nine per cent of respondents said HIV does not cause Aids, 41 per cent did

not believe evolution as a scientific theory is based on solid and convincing evidence, whereas 47 per cent of journalists believed there is enough solid and convincing scientific evidence that an Intelligent Designer created Earth and the universe."

For science to be covered appropriately, journalists have to be knowledgeable about the nature of science and the scientific method. This is what is lacking among many journalists that cover science in Africa. In a survey of journalists in Ghana, Appiah, Gastel, Burdine and Russell (2015) found that lack of capacity was a major barrier in reporting science. Also, as this research found, the majority of the journalists do not have a science background as most of them possess art-related degrees. However, the state of science coverage in Nigeria is a reflection of the general state of science literacy in the country. The newsrooms do not pay attention to science stories because they perceive their readers as lacking interest in science.

5.2   Conclusion

This study's analysis of the media coverage of GM crops has established that the issues of GM crops were underreported and poorly covered in Nigeria. The availability of sources greatly influenced the framing of GM crops. Curiously, the selection of sources in the GM stories was not determined by news value or judgement. Rather, the articles were predominated with proactive sources who engaged the media. The anti-GM civil society activists did not only issue press releases, write opinion articles, invite journalists to cover their events but also organised workshops for journalists to teach them how to cover GM crops. The regulatory agencies also organised similar activities for journalists. With this kind of media engagement, anti-GM activists and government officials dominated the coverage of GM crops. Vital sources like the farmers, journals and scientists were scanty in the media coverage because they were not proactive in engaging the media as the predominant two sources.

In addition to passive selection of sources, the media lacked the capacity to cover GM crops accurately. This failure is a reflection of the state of science journalism in Nigeria. The newsrooms do not specifically hire science journalists nor have designated science journalists. In addition to covering science-related beats like health and the environment, the journalists also cover other general assignments. Therefore, the journalists who sometimes

cover GM crops and other contested science, report these issues like general assignments. The media coverage of GM crops was dominated with "he said, she said" without the media independently evaluating claims made by the anti- and pro-GM groups. The media ended up equating unsubstantiated claims with scientific consensus and distorting solid scientific evidence.

Science journalism is not given due attention in Nigeria. Even the science pages of the newspapers are often filled with articles from foreign media. This stems from the attitude of newsrooms towards science stories which are perceived not to attract readership. This could be true, judging by the overall science activities in the country and the relationship between the media and scientists. There are hardly local scientific content for the journalists to source their stories and the local institutions hardly issue press releases about their research and scientific breakthroughs. Therefore, science is perceived as the culture of developed countries and this perhaps explains why the newspapers' science pages are filled with articles from foreign media. In all the articles, none specifically quoted local research that determines the risks and safety of GM crops, despite the opposition against the introduction focusing on these issues. All the references to evidence of safety or risks of GM crops were studies done in other countries. In this atmosphere of science development in the country, the media have to go the extra mile to set the public agenda on GM crops.

It is beyond the scope of this study to determine how the media framing of GM crops influence audience perception. However, media theories have established that the media have the power to influence public opinion and shape individuals' understanding of issue. This opens up opportunity for further study on how Nigerians who exposed themselves to media messages on GMOs perceive GM crops.

For better representation of GM crops and science in general, this study is recommending that scientists and local scientific institutions should proactively engage the media by means of press releases, press conferences and invitation to cover their research activities and outcomes. In short, scientists should learn how to communicate better since non-scientists now play an increasing role on shaping public policy and public opinion on the products of science. Scientists should also write opinion pieces about science, especially contested science.

Until newsrooms recognise the importance of strong science coverage and stop seeing it as an afterthought, science will continue to be poorly covered in Nigerian. First, the newsrooms have to begin by hiring science journalists and giving them the resources to do their job. Dedicated science editors and reporters will increase the quality of science reporting

in the country. This will ensure that the newspapers do not fill their science pages with foreign articles. Generating local science stories will help to rekindle public interest in science and increase public understanding of science.

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Appendix

Online survey

1. What is your gender? (a) Male (b) Female.

2. How old are you? (a) 18-24 years (b) 25-29 years (c) 30-34 years (d) 35-39 years (e) 40 years and above.

3. What type of media do you work in? (a) Print (b) TV (c) Radio (d) Online (e) Multiple platforms.

4. What is your job title?

5. Which media company do you work for?

6. Are you a science journalist? (a) Yes (b) No.

7. Which fields of science do you cover? Tick all that apply (a) Health (b) Environment (c) Agriculture (d) Science and technology.

8. What is your educational background? (a) Bachelor of Art (b) Bachelor of Science (c) Postgraduate degree in Art (d) Postgraduate degree in Science (e) Others.

9. How long have you been covering science related topics? (a) 1-2 years (b) 3-5 years (c) 6-9 years (d) 10 to 14 years (e) 15 to 19 years (f) 20 years and above.

10. Do you cover other beats apart from science? (a) Yes (b) No.

11. Is your role as a science journalist permanent or will you be moving on to other beats? (a) Permanent (b) Moving on (c) Uncertain.

12. Are you required to produce general stories as well as science stories? (a) Always (b) Occasionally (c) Never.

13. Do you feel that the role of the science journalist is considered important by your media outlet? (a) Yes (b) No (c) Unsure.

14. Have you ever written a story on genetically modified (GM) organisms or crops? (a) Yes (b) No.

15. What source do you use mostly in your GM crop stories and other science related topics? (a) Press release (b) Journal (c) Scientists (d) Government officials (e) Civil society (f) Farmers (g)Others.

16. Do you think Nigeria should not have introduced GM crops? (a) Yes (b) No (c) Unsure.

17. What are the reasons for your position on GM crops?

18. Do think the Nigerian media have covered GM organisms or crops accurately? (a) Yes (b) No (c) Unsure.

19. What is your reason for your answer on media coverage of GM crops?

20. Have you ever experienced hostility, bully, harassment or threat by activists in writing about GM crops? (a) Yes (b) No (c) Unsure.

21. If your answer is "yes", please, briefly explain the nature of the hostility or threat.

22. Do you feel that the role of the science journalist is considered important by your media outlet? (a) Yes (b) No (c) Unsure.

23. Do you have more or less time and resources to research complex science stories? (a) Less time and resources (b) More time and resources.

24. Are there any factors which you feel threaten science journalism in Nigeria?

25. Do you see any trends occurring in the media that have an impact on science journalism?

26. What do you think are the main impediments to strong science coverage?

27. Do you have any recommendations on how science journalism could be supported further?

Interview guide

This is a semi-structured interview that will not last more than 25 minutes. I would like to ask you some questions about your background, your education, some experiences you have had in science journalism.

1. What source do you use mostly in your GM crops stories and other science related topics?
2. What determines the sources you select?
3. How do you ensure accuracy and balance in a controversial scientific issue like GM crops?
4. Aside your journalistic responsibility, what is your perception of GM crops and their introduction in Nigeria?
5. How would you describe the media coverage of GM crops in the country?
6. What do you think are the main impediments to strong science coverage?
7. Do you have any recommendations on how science journalism could be supported further?
8. Do you have any other comments on science reporting in Nigeria?