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Genetically modified organisms (GMOs) and attached Biosafety and Biosecurity Concerns: Field practitioners' perspective

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ABSTRACT

With an agency established to oversee and regulate GMOs, the extent to which field practitioners align with the biosafety and biosecurity measures of GMOs in Nigeria remains a critical question. This study seeks to explore the perspectives of field practitioners with GMOs concerns with the technology, political and safety aspects within the Nigerian context. This research evaluation was conducted over four months (March to June 2022). It involved the distribution of questionnaires to 234 individuals, encompassing biosafety, biotechnology, and biosecurity practitioners in Abuja, Nigeria. The loadings of items have intrinsic consistency within the range of 0.733 to 0.875. Majority of the respondents expressed the view that Nigeria politicians and public interest groups were concerned about the potential allergenicity and antimicrobial resistance associated with GMOs. Three predictors: Perception on GMOs (Wald=0.031), GMOs safety assessment (Wald=0.674), and Regulation of GMOs (Wald=0.004) at df=1 have no significant effects on attacks related to GMOs as 92.3% of the respondents claimed not to suffer any attack related to GMOs products. Working experience [F (4, 233) =0.228, p=0.923] interaction with perception on GMOs was statistically not significant. The political class and public interest groups worries about GMOs products (Covariance= 5.509) share positive but not significant correlation at p=0.057 with Regulation of GMOs (Covariance= 7.841). Finally, GMOs and their products exist in Nigeria alongside a reliable regulatory body which had put up biosafety and biosecurity guidelines in controlling all GMOs related activities in order to make the environment safer and boost the populace confidence in GMOs.

Keywords: Biosafety, Biosecurity, Biotechnology, GMOs, Regulation

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INTRODUCTION

Cartagena Protocol on Biosafety (CPB) Article 1 objective is set out to bestow in establishing a sufficient level of protection in the domain of securely transferring, managing, and utilizing living modified organisms derived from modern biotechnology that could potentially have negative impacts on the preservation and sustainable utilization of biological diversity, while also considering risks to human health and concentrating specifically on trans frontier manoeuver. (Tsuda, *et al*., 2019). Recombinant DNA technology, which entails merging genes from varying organisms, leads to the creation of organisms referred to as transgenic, genetically modified or engineered (Nayak *et al*., 2011). The utilization of genetic modification can serve various purposes in controlling different plant traits, and the outcomes of one manipulation may differ significantly from another, depending on the modified traits (Kaur, 2016).

According to Terefe (2018), Genetically modified organisms (GMOs) find usage in agriculture, health, biotechnology and various sectors, serving as a potent instrument for development of sustainable task. Genetically engineered crops involve modifications to the genetic makeup of the crop, introducing new traits like herbicide tolerance, resistance to virus, drought, frost and flood, delayed maturation, and augmented crop production. They can be rendered impervious to pests and diseases, leading to a substantial decrease in the need for insecticide application (Mishra and Kumari, 2018). Genetic modification is employed for improvement of crop, addressing both abiotic and biotic tension, enhancing nutritional quality, and resulting in augmented crop production, which has added to world hunger reduction and dwindling malnutrition (Qaim and Kouser, 2013; Terefe, 2018). Furthermore, it minimizes the reliance on agrochemicals, leading to reduced pollution. Some evidence indicates that GM technology has significant potential to enhance agricultural productivity and improve farmers' subsistence in developing countries. Hence in Africa, it is essential to allow the adoption of GM technology to play a role in mitigating hunger and poverty (Adenle, 2011).

The release of GMOs in the environment is associated with difficulty in predicting the danger associated (Prakash *et al.,* 2011). The anticipated and unanticipated risks encompass genetic impacts of transformation, management effects, food safety, ecological consequences, and socio-economic or bioethical concerns (Kaur, 2016).

Biosafety involves confinement concepts, technologies, and practices essential for averting inadvertent exposure to pathogens and toxins, or their unintentional release into the surrounding. As the adoption of genetic engineering (GE) techniques gains prominence in various countries for research in life science and development, biosafety concerns become increasingly important to guarantee the safety of the public and the surrounding (Kumar, 2014). This necessitates awareness among the public, coupled with the implementation of rules, regulations, and observation bodies. Researchers' awareness is crucial to ensure the proper management of biological safety at the grassroots level (James, 2013).

Acknowledging the importance of biosafety in genetic engineering research and development, Cartagena Protocol on Biosafety (CPB) which is an international multilateral agreement on biosafety was embraced by 167 parties, Nigeria inclusive (Kumar, 2014).

Post-release observation plays a crucial role in reducing the danger of genetic erosion associated with the use of GM crops, particularly in countries that boast diverse crop species (Terefe, 2018). In Nigeria, the National Biosafety Management Agency (NBMA) is the agency backed up by law to regulate GMOs inflow and productions in the country. This Agency was set up out of yearning of the stakeholders who were urging the government to reassess the nation's entire biosafety framework to safeguard Nigerians from consuming potentially unsafe foods. With an agency in place to monitor and regularize GMOs to what extent has field practitioners' alignment with the biosafety and biosecurity of the GMOs present in Nigeria as a whole with the modalities put in place. Therefore, this study seeks to investigate the vista of field practitioners' that have engagements with GMOs in the area of the technology, political and safety context in Nigeria.

METHODOLOGY

Study Design

This research assessment was conducted from March to June 2022, spanning four months, involving questionnaires dissemination to 234 workers, including biosafety, biotechnology, and biosecurity practitioners in Abuja, Nigeria.

Sample size

The sample size was ascertained plying the formula proposed in Kish formula as stated by Busienei *et al.* (2019) and Olu *et al.* (2022a):

$$n = Z^2 \times P\,(1-P) / d^2 \qquad \text{Eqn.1}$$

Where n connote size of the sample; Z connote the statistic for a level of interval (at 95%, Z = 1.96); P connote the proportion of population, and 0.75 (the biosafety, biotechnology and biosecurity practitioners' population percentage in the study area); and d connote the precision (0.05). The size of the sample computed for this study was 288.

Study instrument

Data for this assessment were acquired by plying a standardized, self-disseminated questionnaire. The questionnaire was done based on existing literature and in-depth studies; the researchers made certain modifications. The questionnaire was cleaved into five sections namely Socio-Distribution, Perception of respondents on GMOs, GMOs worries by Politicians and the public interest groups in Nigeria, GMOs safety assessment and Regulation of GMOs. The Likert scale was employed to measure the scale using a rating of 1 (IDA- Intensely Disagreed), 2 (UA-Unacceptable), 3 (NS- Not certain), 4 (A- Acceptable), 5 (IA-Intensely Agreed) for the Perception of respondents on GMOs, GMOs worries by Politicians and the public interest groups in Nigeria, GMOs safety assessment and Regulation of GMOs sections.

Data Collection

The questionnaire was administered to members of professional society and staff of organizations that has mandate on biotechnology, biosafety and biosecurity.

Statistical Analysis

Cronbach Alpha was plied to evaluate the response acquired from the disseminated questionnaire internal reliability and factor analysis was plied in getting the rotation required for Average variance extracts (AVE) and composite reliability (CR), The data further underwent both descriptive and inferential statistical analysis. The influence of the perception of respondents on GMOs, GMOs safety assessment and Regulation of GMOs on if the respondents had suffered any attack related to GMOs product in Nigeria was examined plying binary logistic regression at $p<0.05$. in order to determine the relationship between working experience and Perception on GMOs by respondents, one-way (ANOVA) was engaged on at $p<0.05$. Correlation at $p<0.05$ engaged on to evaluate the link between the GMOs worries by Politicians and the public interest groups in Nigeria and Regulation of GMOs relationship in this study.

RESULTS AND DISCUSSION

For this study, 288 questionnaires were generated and disseminated among respondents but 234 of them were optimally filled, 30 of the questionnaires were not filled properly while 24 were was not returned. From Table 1, 38.5% and 30.8% of the research respondents were of the age 30-39 and 20-29 respectively and these symbolize the larger proportions of the participants. The respondents with only first degree appear to be more among the respondents with 69.2%. From Fig.1 there are more respondents with biotechnology background while 92 of them have biosafety background with biosecurity (55) been the least.

From Table 1, 73.1% of the participants in this study had already have contact with GMOs products while 92.3% of them assert that they have not have any attack related to GMOs product in Nigeria

Table 1: Social-distribution of the participants

	Frequency	%	Kurtosis	Skewness
		Age		
20-29	72	30.8		
30-39	90	38.5		
40-49	63	26.9	-0.816 ± 0.317	0.299 ± 0.159
50-59	9	3.8		
60 and above	-	-		
Total	234	100		
		Education		
1st Degree	162	69.2		
2nd Degree	27	11.5	-0.441 ± 0.317	1.149 ± 0.159
3rd Degree	45	19.2		
Total	234	100		
		Working Year Experience		
1-5	86	36.8		
6-10	53	22.6		
11-15	80	34.2	0.147± 0.317	0.683 ± 0.159
16-20	6	2.6		
21 and above	9	3.8		
Total				
		Contact with GMOs products		
Yes	171	73.1		
No	63	26.9	-0.911 ± 0.317	-1.047 ± 0.159
Total	234	100		
		Attack related to GMOs products in Nigeria		
Yes	18	7.7		
No	216	92.3	8.285 ± 0.317	3.196 ± 0.159
Total	234	100		

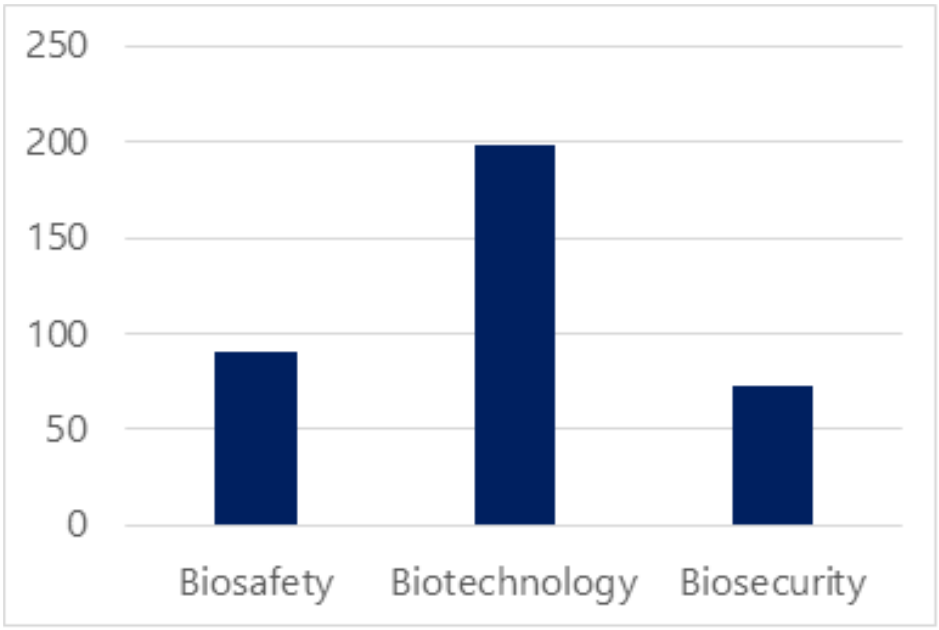

Fig.1: Field acquaintance by the participants in this study

Table 2: Constructs Validity and Reliability

Variables	Number of Indicators	Cronbach's Alpha	Composite reliability Coefficient	Average Variance Extracted
Perception of respondents on GMOs	5	0.733	0.835	0.530
GMOs worries by Politicians and the public interest groups in Nigeria	5	0.865	0.904	0.653
GMOs safety assessment	5	0.804	0.879	0.596
Regulation of GMOs	5	0.875	0.910	0.671

The loadings of all individual items were assessed, and the consistency within the items fell within the range of 0.733 to 0.875 from Table 2. In addition, Composite reliability (CR) is displayed in Table 2 not leaving out average variance extracted (AVE). Both CR and AVE ranged from 0.835 to 0.910 and 0.530 to 0.671 respectively for the variables under investigation.

The lowest acceptable threshold for composite reliability of the constructs is 0.70 (Hair *et al*., 2011). From Table 2, the composite reliability of all individual items ranged between 0.835 and 0.910 which could be ascribed to be satisfactory. Also, according to Hair *et al.* (2011), 0.50 minimum AVE indicate that a minimum of 50% of the variance of the item in question is explained. As shown in Table 2, AVEs range from 0.530 to 0.671 of the constructs were explained.

As stated by Yusuf *et al.* (2022) reliability test in Cronbach alpha if at a value >0.9, > 0.8, > 0.7, >0.6, > 0.5 and < 0.5, is said to be excellent, good, acceptable, questionable, poor, and unacceptable respectively. All the items had a reliability of Cronbach's alpha that are acceptable.

Table 3: GMOs worries by Politicians and the public interest groups in Nigeria

Items	IDA	UA	NC	A	IA
Modern biotechnology is contributing to the development of new species.	-	1(0.4)	6(2.6)	55(23.5)	172(73.5)
Allergenicity and antimicrobial resistance are potential concerns connected with GMOs.	-	-	7(3.0)	68(29.1)	159(67.9)
The validity of risk assessments for GMOs is questionable	-	-	19(8.2)	49(20.9)	166(70.9)
Accidental contamination of conventional food by GM material is a possibility	-	3(1.3)	8(3.4)	55(23.5)	168(71.8)
Adverse chronic effects resulting from the interaction between GMOs and the environment are a concern	-	2(0.9)	6(2.6)	84(35.8)	142(60.7)

IDA- Intensely Disagreed UA- Unacceptable, NS- Not certain, A- Acceptable, IA- Intensely Agreed

Some political authorities, as per Kipp-Sinanis (2011), perceived the genetic modification of organisms as a practice that could result in seed monopolies protected by patents, with intellectual property rights being disregarded. Disputes at the intersection of social, political, and scientific realms among developed nations have impacted the regulation and governing processes related to GMO matters in numerous developing countries (Adenle, 2015). In this study from Table 3, majority of the respondents were of the opinion that politicians and the public interest groups in Nigeria were worried about the allergenicity and antimicrobial resistance that could be prone by GMOs. Furthermore, 20.9 and 70.9% of the respondents accepted and intensely Agreed that the validity of risk assessments for GMOs is questionable as perceived by Nigeria populace and the political figures. According to Dibden *et al.* (2013), there is a divergence in the international regulation of GMOs, where the US aligns its GMO blue-print with the World Trade Organization (WTO), while the EU rigorously adheres to the preventative principle outlined in the Convention on Biological Diversity (CBD). Additionally, Canada, and to some extent the USA, adopts a science-inclined, product-oriented biosafety evaluation with a pre-assessment of each individual new

crops, including conventional novel traits. In contrast, Europe, including the Cartagena Protocol, continues to follow the process-oriented risk assessment of GMOs that is not grounded in prospective science (Ammann, 2014).
From Table 3, 1.3% of the participants in this study did not accept that the possibility of accidental contamination of conventional food by GM material would not put the politicians and the public interest groups in Nigeria on their toes. Due to the absence of well-defined benchmark for establishing what constitutes environmental or health anguish with the existence of scientific data (Kuiper and Davies, 2010; Sanvido *et al.*, 2012), questions arise about the ability of scientists from developing countries, especially those in Africa, to confidently introduce genetically modified (GM) products that offer clear benefits in the future.

Table 4: Binary Logistic Regression Analysis for the interaction between perception on GMOs, GMOs safety assessment, Regulation of GMOs and attack related to GMOs

Predictor	**Coefficients**	**Standard Error**	**Wald**	**Df**	**Significance**	**Odd ratio**	**95% CI**
Constant	-3.674	3.712	0.979	1	0.322	0.025	-
PG	-0.021	0.120	0.031	1	0.859	0.979	0.773-1.239
GSA	0.086	0.105	0.674	1	0.412	1.090	0.887-1.339
RG	-0.005	0.091	0.004	1	0.952	0.995	0.832-1.189
Test							
					χ^2	Df	Significance
Omnibus					0.735	3	0.865
Hosmer and Lemeshow					55.730	8	0.000

Model Summary
2-Log Likelihood- 126.182
Cox and Snell R square- 0.003
Nagelkerke R square- 0.007
Dependent variable overall percentage= 92.3%

PG- perception on GMOs, GSA- GMOs safety assessment, RG-Regulation of GMOs

Plying the enter method, from Table 4, the regression results illustrated that the model explained between 0.003-0.007 of the variances and that the model was not a significant predictor with Omnibus χ^2 (3, N= 234) = 0.735, p= 0.865. The reports from Table 4 also indicate that the contribution of perception on GMOs, GMOs safety assessment, Regulation of GMOs measure were not significant to the model, but the model is not fit with the Hosmer-Lemeshow values χ^2 55.730, df=8, $p<0.05$.

Perception on GMOs, GMOs safety assessment, Regulation of GMOs measure influence on attack related to GMOs = -3.674 + (-0.021* PG) + (0.086*GSA) + (-0.005*RG)

The three predictors namely Perception on GMOs (Wald=0.031, df=1), GMOs safety assessment (Wald=0.674, df=1), and Regulation of GMOs (Wald=0.004, df=1) effects were not significant on attack related to GMOs individually as indicated in Table 4. In addition, 92.3% did not suffer any attack related to GMOs products.
Intense and divisive debates surrounding Genetically Modified Organisms (GMOs) have centered on their probable effects on human and animal health, the environment, plant biodiversity, and the global food chain (Gebretsadik and Kiflu, 2018). From Table 4, 92.3% of the respondents in this study stated that they have not encountered any GMOs product related attack in their field and their opinion was not significantly influenced collectively by their Perception on GMOs, GMOs safety assessment, and Regulation of GMOs with respect to their field.
The genetic modification of crop plants raises concerns about potential hazards to living organisms and the environment and it is essential to carefully assess the probable challenges and opportunities on individual basis. The development of a country-specific regulatory framework requires consideration of the current biosafety contexts and functionality, as well as the implications and

responsibilities outlined in the Convention on Biological Diversity (CBD) and the Cartagena Protocol on Biosafety. In China, there have been reports suggesting that the consumption of GM maize (DEKALB 007/008) from Monsanto inspired a decrease in sperm count among college students (Chen, 2013). In response, Monsanto promptly clarified that DEKALB 007/008 is a non-GM hybrid maize, and there is no association between the observed decrease in sperm counts and the consumption of Monsanto's maize (Chen, 2013).

Table 5: Correlation output between the GMOs worries by Politicians and the public interest groups in Nigeria and Regulation of GMOs relationship

	GMOs worries by Politicians and the public interest groups in Nigeria- r (Sig.)	Regulation of GMOs- r (Sig.)	Sum of Squares and Cross-products	Covariance
GMOs worries by Politicians and the public interest groups in Nigeria	1	0.125 (0.057)	1283.560	5.509
Regulation of GMOs	0.125 (0.057)	1	1826.996	7.841

Biosecurity involves safeguarding, controlling, and ensuring accountability for biological agents and toxins within facilities with the aim of averting loss, diversion, theft, misuse, unauthorized access, or purposeful release, while Biosafety involves the application of containment principles, technologies, and practices aimed at preventing inadvertent contact with biological materials or their unintended release (Olu *et al*., 2022b). In Nigeria, the National Biosafety Management Agency (NBMA) is responsible for the biosafety activities regulation which are needed to be put in place by any laboratory or institute while dealing with anything that has to do with biological agents. The NBMA are highly involved in regulation of GMOs products. In this research from Table 5, the respondents which are purely professional with both laboratory and field practitioner in terms working with GMOs gave feedbacks which show that the worries of the political class and public interest groups about GMOs products (Covariance= 5.509) share positive but not significant correlation at p=0.057 with Regulation of GMOs (Covariance= 7.841). This could simply imply that the more the concerns in Nigeria the more the regulatory body like NBMA steps up their guide on the biosafety and biosecurity attached to GMOs in order to make the nation safe.

Table 6: One way ANOVA output on the relationship between working experience and Perception on GMOs of respondents.

Work Experience	**Mean ± SD**	**Sum square**	**Mean square**	**F (4, 233)**	**P Value**
1-5	22.76 ± 1.93	3.686	0.921	0.228	0.923
6-10	22.49± 2.10				
11-15	22.64 ± 1.99				
16-20	22.17± 2.48				
21 and above	22.67±2.18				

From Table 6, the interaction between working experience [F (4, 233) =0.228, p=0.923] and Perception on GMOs of respondents was not statistically significant. The mean score for working experience in terms of years; 1-5 (M=22.76, SD=1.93), 6-10 (M=22.49, SD=2.10), 11-15 (M=22.64, SD=1.99), 16-20 (M=22.17, SD=2.48) and 21 and above (M=22.67, SD=2.18).

Vecchione *et al.* (2015) carried out an investigation in New Jersey among consumers, revealing knowledge and attitude have a modest correlation ($r = 0.41$, $P < 0.001$). The findings of this research from Table 6 illustrated clearly that the perception of all the respondents about GMOs was not influenced by the number of years that they have been in their profession i.e., work experience with F (4, 233) =0.228, p=0.923. Research by Chen (2008), Grunert *et al.* (2001), Rousu *et al.* (2004) and Zhang *et al.* (2018) has demonstrated that consumers reject GM foods when the perceived risks outweigh those associated with traditional foods. Veeman and Adamowicz (2004) noted that a significant number of consumers perceive higher risks with transgenic food, primarily due to the uncertainty of potential hidden impacts associated with these products.

CONCLUSION

This study has clearly shown from the perspective of the field practitioners in Biosafety, Biosecurity and Biotechnology that truly GMOs and their products exist in Nigeria and that the political class and public group have concerns with the risk that could be associated with the GMOs. Furthermore, this study has shown that Nigeria has a reliable regulatory body that controls all GMOs related activities by putting up both the biosafety and biosecurity guideline in handling GMOs in order to make the environment safer and boost the populace confidence in anything that has to do with GMOs worries. The perception of GMOs and all its attribute by the professionals engaged in this study were independent of their work experience.

AUTHORS' CONTRIBUTION

YUSUF, H.O.: Wrote and edited the submitted manuscript, design the questionnaire and the data analysis.
Oko, V.E.: Distributed and collection of the questionnaires.
Agah, U.A.: Edited the first draft of the manuscript.
Iyelolo, B.O.: Edited the manuscript

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CONFLICT OF INTEREST

None at all.

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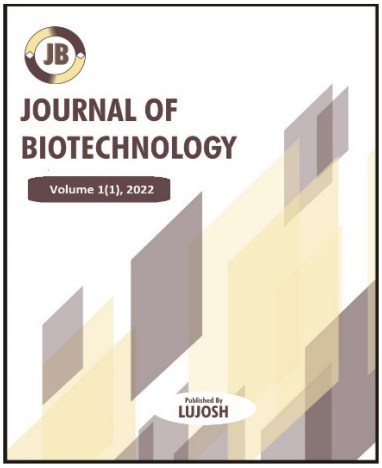

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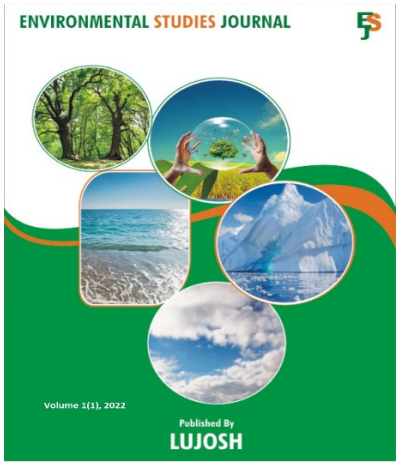

Environmental Studies Journal
https://www.esj.com.ng

International Journal of Biosafety, Biosecurity & Bioscience
https://www.ijbbb.com

Journal of Agricultural Sciences & Technology
https://www.jast.com.ng

Journal of Biochemistry & Molecular Biology
https://www.jbmb.com.ng

Plant Science Journal
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Journal of Parasites Territory
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Microbes World Journal
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Conference Proceedings
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