The Perception of Fish Farmers on the Use of Genetically Modified Organisms in Oyo State

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Abstract

Nigeria's aquaculture sector holds great potential for improving food security, yet it remains underutilised due to persistent production challenges such as low yields, disease outbreaks, and poor feed efficiency. As global demand for fish intensifies and wild capture fisheries decline, biotechnology; particularly the use of genetically modified organisms (GMOs) offers a promising avenue to enhance aquaculture productivity. However, the adoption of GMOs remains limited in Nigeria, partly due to poor awareness, uncertain perceptions, and weak regulatory frameworks. This study investigates the awareness, perception, and willingness to adopt GMOs among fish farmers in Oyo State, Nigeria, to understand the socio-economic and informational factors influencing adoption decisions. Using a purposive sampling technique, 120 fish farmers were surveyed across four Agricultural Development Project (ADP) zones using structured questionnaires. Data were analysed using descriptive statistics, Likert-scale measures, and chi-square tests. Findings revealed that while over 65% of farmers had heard of GMOs; mainly through mass media; only 55% understood their implications. A significant proportion of respondents remained undecided on key issues related to GMO safety, benefits, and environmental impacts. Although factors such as affordability, high yield, and faster growth cycles were cited as adoption incentives, widespread uncertainty persisted. The study recommends targeted policy support, farmer education, demonstration trials, and aquaculture-specific biosafety regulations to bridge awareness gaps and enable informed, inclusive adoption of biotechnology in Nigeria's aquaculture sector.

Keywords: Aquaculture, Genetically Modified Organisms, Biotechnology Adoption, Farmer Perception, GMO Awareness

Introduction

Aquaculture has emerged as the fastest-growing food production sector globally, contributing significantly to food security, rural livelihoods, and economic development (Garlock et al, 2019). Over the past two decades, global aquaculture output has expanded fourfold, a trend projected to continue as capture fisheries approach ecological limits and the global demand for cultured fish intensifies (FAO, 2018). In Nigeria, however, the sector remains underutilized, despite its potential to bridge the widening gap between domestic fish supply and national demand.

As of 2015, Nigeria's total domestic fish production was approximately 1.03 million metric tonnes, with aquaculture contributing 316,727 tonnes (30.8%) (Olaoye and Ojebiyi, 2018). By 2018, national demand had surged to an estimated 3.61 million metric tonnes, resulting in a production shortfall exceeding 2.5 million tonnes (Giwa et al., 2018). This gap has necessitated annual fish imports valued at over US $1 billion (Oladimeji, 2017), underscoring Nigeria's heavy dependence on foreign supply chains. Despite being Sub-Saharan Africa's leading aquaculture producer (CGIAR, 2018), the country faces systemic challenges, ranging from low-quality broodstock and high input costs to disease outbreaks and climate variability, that constrain local fish production. These figures illustrate not only the country's food security vulnerability but also the untapped potential within its aquaculture sector.

To address these constraints, biotechnology, particularly genetic modification, has been proposed as a viable strategy for boosting aquaculture productivity. Innovations such as transgenic breeding, hormonal manipulation, vaccine development, and selective strain improvement have demonstrated the capacity to enhance fish growth rates, feed efficiency, disease resistance, and environmental tolerance (FAO, 2000; Maclean and Laight, 2000; El-Zaeem and Assem, 2004). These technologies could significantly increase production efficiency, reduce import dependence, and accelerate the sector's contribution to Nigeria's protein supply.

However, despite the promise of genetic modification, its application in aquaculture remains controversial. Concerns persist over ecological risks, such as the escape of transgenic fish into natural ecosystems, alongside potential health hazards, biodiversity loss, ethical dilemmas, and regulatory inadequacies in developing contexts. In Nigeria, limited public awareness, cultural and religious beliefs, misinformation, and weak scientific communication have further complicated public acceptance of genetically modified organisms (GMOs).

The perception of farmers; the end-users of these technologies; is a critical determinant of adoption. Studies have shown that willingness to adopt GMOs is shaped by a combination of knowledge and awareness levels, perceived risks and benefits, access to extension services, and socio-economic characteristics. In Nigeria, where access to biotechnology education and outreach remains low, it is vital to understand how fish farmers perceive the integration of GMOs into aquaculture systems.

This study therefore investigates the awareness, perception, and willingness to adopt genetically modified organisms among fish farmers in Oyo State, Nigeria. The specific objectives are to; Examine the socio-economic profile of fish farmers in the study area; assess their level of awareness and knowledge of GMOs in aquaculture; explore their perceptions, both favorable and unfavorable, regarding GMO use; identify the key factors influencing their willingness to adopt GMO technologies.

By generating empirical insights into the attitudes and knowledge gaps of fish farmers, the study aims to suggest policy interventions, extension strategies, and regulatory frameworks that can guide the responsible and inclusive adoption of biotechnology in Nigeria's aquaculture sector.

Materials and Methods

Study Area

The study was conducted in Oyo State (Figure 1), Nigeria, a region well-suited for examining aquaculture development and biotechnology adoption. Oyo State is situated in the rainforest agro-ecological zone of southwestern Nigeria, lying between latitudes 2°38.661'N and 4°38.251'N and longitudes 9°08.741'E and 7°01.681'E. It shares boundaries with Ogun State to the south, Kwara State to the north, Osun State to the east, and the Republic of Benin to the west. With an estimated population of over 5.59 million people (NPC, 2006), the state represents a significant agricultural and demographic hub.

Oyo State's tropical climate is characterised by two distinct seasons: a rainy season spanning from March to October and a dry season from November to February. The state experiences mean temperatures of approximately 28°C, peaking at the end of the Harmattan period (January to March). Annual rainfall varies from about 1,200 mm at the onset of the rainy season to 1,800 mm at its peak in the southern regions, while the northern parts receive between 800 mm and 1,500 mm annually (Olagunju *et al*., 2007). This climatic variability supports year-round aquaculture activities, making the state an ecologically favourable location for fish farming.

The state is administratively structured into four Agricultural Development Project (ADP) zones: Ibadan/Ibarapa, Ogbomoso, Oyo, and Saki, which cover all its local government areas. This division facilitates targeted agricultural outreach, extension services, and data collection for research purposes. Oyo State is particularly suitable for this study for several reasons. Firstly, it has a vibrant and growing aquaculture sector, with numerous small- and medium-scale fish farmers operating in both urban and peri-urban settings. Secondly, the state benefits from relatively good infrastructure, access to research institutions (such as the University of Ibadan), and agricultural extension services, which influence awareness and technology dissemination. Thirdly, Oyo State presents a socio-economic and cultural diversity reflective of wider trends in southwestern Nigeria, making it a useful case for generalising findings on GMO awareness, perception, and adoption in aquaculture. Lastly, the presence of existing agricultural policies and stakeholder networks such catfish farmers associations and cooperatives, provides a functional platform for assessing the practical feasibility of integrating modern biotechnology into fish farming systems.

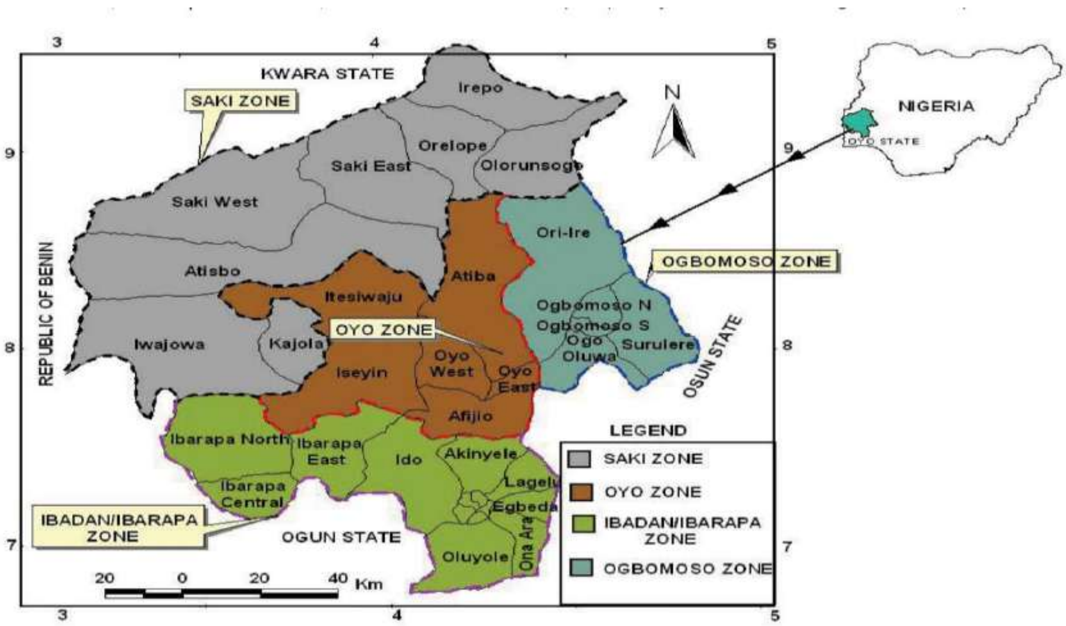

Figure 1: Map of Oyo State highlighting the study area.

Sampling Procedure

The study adopted a non-experimental survey design using a purposive sampling technique to select respondents; fish farmers with active involvement in aquaculture across the four Agricultural Development Project (ADP) operational zones of Oyo State: Ibadan/Ibarapa, Oyo, Ogbomoso, and Saki. These zones were chosen to ensure geographical coverage and represent the diversity of aquaculture practices across the state.

A total of 120 respondents were selected, with 30 fish farmers interviewed in each zone using a semi-structured questionnaire. The purposive sample size was determined based on practical field constraints, available resources, and the need to ensure balanced representation from each zone. Although the sample is not statistically randomised, it is adequate for generating exploratory insights into farmer perceptions, particularly given the homogeneous nature of aquaculture systems in the study area. The questionnaire was designed to capture both quantitative and qualitative data, with sections addressing socio-economic characteristics, awareness and knowledge of genetically modified organisms (GMOs), perceived risks and benefits, and willingness to adopt GMOs in aquaculture.

In addition, a Likert scale was employed to measure the intensity of respondents' perceptions on GMO-related statements. A five-point scale was used, where: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree. These scores were aggregated and analysed using mean scores and standard deviations to determine overall perception levels. A mean score of ≥3.00 was interpreted as a generally positive perception, while a mean below 3.00 indicated negative or uncertain views.

Furthermore, inferential statistics examined associations between socio-economic factors (such as education, years of experience, and access to extension services) and willingness to adopt GMOs. This helped to identify which factors significantly influenced perception and adoption intentions.

Data Analysis

For data analysis, descriptive statistics such as frequencies, percentages and standard deviation were used to summarise respondents' demographic profiles and response patterns. Furthermore, inferential statistics were used to test relationships between key variables. Specifically, Chi-square tests were conducted at the 0.05 level of significance to examine associations between socio-economic factors All statistical analyses were conducted using SPSS (Version XX) or a similar statistical software package to ensure accuracy and reproducibility of results.

Results

Socio-Demographic Profile of Respondents

The socio-demographic characteristics of respondents are summarized in Table 1. The age distribution shows that the majority of fish farmers (66.7%) fell within the 40–59 years age range, with a mean age of 45.6 years (SD = 8.7). The gender distribution revealed a strong male dominance (96%). Education levels were relatively high, with 86% of respondents having at least secondary education. Marital status revealed that 78% of respondents were married. Respondents had substantial farming experience, with 35% having farmed for 6–10 years and an average experience of 9.3 years. Catfish was the dominant species cultured (96%), and most farmers (78%) used earthen ponds, followed by concrete tanks (11.7%) and mixed systems (10%).

Awareness and Knowledge of GMOs

Table 2 presents the farmers' awareness of genetically modified organisms. A substantial portion (65%) had heard about GMOs, and most of these had become aware of them within the past 1–5 years (46.7%). The main sources of information were mass media (30.8%), particularly radio and the internet, as well as interpersonal sources such as friends (16.7%).

Despite moderate awareness, only 55% of respondents claimed to understand the meaning of GMOs. Furthermore, only 46.7% had ever used or experimented with GMOs, while 53.3% had not.

Table 1: Socio-Demographic Profile of Respondents (n = 120)

Variable	Freq	Percentage (%)
Age (years)		
20–29	7	5.8
30–39	24	20.0
40–49	41	34.2
50–59	39	32.5
60–69	9	7.5
Mean ± SD		45.6 ± 8.7
Gender		
Male	115	96.0
Female	5	4.0
Education Level		
No formal education	2	1.7
Primary	14	12.0
Secondary	52	43.0
Tertiary	52	43.0
Marital Status		
Single	26	22.0
Married	94	78.0
Farming Experience		
1–5 years	35	29.0
6–10 years	42	35.0
11–15 years	31	26.0
>15 years	12	10.0
Mean ± SD	8.7 ± 4.6	
Species Cultured		
Catfish	115	96.0
Tilapia	5	4.0
Culture System		
Earthen ponds	94	78.3
Concrete tanks	14	11.7
Mixed systems	12	10.0

Source: Field survey, 2018

Farmers' Perception of GMOs

Farmers' perception of GMOs was measured using a 5-point Likert scale across several belief statements (Table 3). The overall trend showed a high rate of indecision, with over 50% of respondents selecting "Undecided" on most statements. For instance, 45.8% were undecided on whether GMOs reduce the quality of organisms, 53.3% were undecided on whether GMOs contribute to the popularity of today's products, and 44.2% were undecided on whether GMOs pose risks to human health. There was stronger agreement on the need for more research (23.3% strongly agreed) and more education by researchers and extension agents (19.2% strongly agreed). Only a very small proportion of respondents (2.5%) strongly agreed that GMO technology contradicts their religious beliefs.

Factors Influencing Willingness to Adopt GMOs

Table 4 summarises respondents' perceptions of factors influencing their willingness to adopt GMOs in aquaculture. A high proportion of respondents remained undecided on most items—47.5% for cost, 48.3% for marketability, and 54.2% for nutritional benefits. Nevertheless, some expressed agreement with potential motivators: affordability (43.3% agreed/strongly agreed), higher yields (29.1%), and faster growth cycles (33.3%).

Chi-Square Test Results- Demographic Determinants of GMO Awareness and Perception in Aquaculture

The chi-square tests presented in Table 5 examined two associations: awareness of GMOs and education level, and perception of GMOs and gender. The test between awareness and education yielded $\chi^2 = 7.61$ with 3 degrees of freedom and $p = 0.055$. The test between perception and gender yielded $\chi^2 = 0.00$, $df = 1$, and $p = 1.000$.

Table 2: Awareness and knowledge of GMOs among Respondents

Indicator	Response Categories	Frequency	Percentage (%)
Heard about GMOs	Yes	78	65.0
	No	42	35.0
Duration of Awareness	1–5 years	56	46.7
	6–10 years	13	10.8
	>10 years	9	7.5
Source of Information	Friend	20	16.7
	Internet	13	10.8
	Multiple Sources	37	30.8
Understanding of GMOs	Yes	66	55.0
	No idea	54	45.0
Ever used or produced GMOs	Yes	56	46.7
	No	64	53.3

Field Survey, 2018

Table 3: Perceptions of Farmers on the Use of GMOs in Aquaculture (Likert Scale)

Statement	Strongly Agree	Agree	Undecided	Strongly Disagree	Disagree
GMOs reduce the quality of organisms	7.5%	5.0%	45.8%	28.3%	13.3%
Products today would remain popular without GMOs	10.0%	36.7%	53.3%	–	–
GMOs in food imply no risk to human health	9.2%	23.3%	44.2%	15.0%	8.3%
GMOs in fish feed imply no risk to human health	7.5%	33.3%	40.0%	17.5%	1.7%
Use of GMOs has no environmental impact	7.5%	22.5%	50.0%	20.0%	–
More research is needed on GMOs before widespread adoption	23.3%	5.0%	63.3%	8.3%	–
Researchers/Extension agents should educate us on GMO risks	19.2%	7.5%	70.0%	3.3%	–
The consequences of GMOs are too complex	1.7%	13.3%	57.5%	26.7%	0.8%
GM technology contradicts my beliefs/religion	0.8%	1.7%	56.7%	30.8%	10.0%
I cannot gain enough knowledge to reduce all possible risks	3.3%	1.7%	78.3%	16.7%	–
GMOs reduce pesticide use	6.7%	20.0%	55.8%	17.5%	–

Field Survey, 2018

Table 4: Factors Influencing Willingness to Adopt GMOs

Factor	Strongly Agree	Agree	Undecided	Strongly Disagree	Disagree
Cost of GMOs	18.3%	25.0%	47.5%	8.3%	0.8%
Marketability of GMO products	8.3%	24.2%	48.3%	18.3%	0.8%
Higher yields from GMO production	8.3%	20.8%	55.8%	13.3%	1.7%
Faster growth cycle	12.5%	20.8%	45.8%	16.7%	4.2%
Improved nutritional quality	6.7%	17.5%	54.2%	19.2%	2.5%

Field Survey, 2018

Table 5: Chi-Square Tests of Association

Test	χ^2 Statistic	df	p-value
Awareness of GMOs × Education	7.61	3	0.055
Perception of GMOs × Gender	0.00	1	1.000

Discussion

The results show that fish farmers in Oyo State fall predominantly within the economically active age group, a stage where decision-making and adoption of innovations are more likely. This aligns with Onwumere (2018), who noted that farmers within this age bracket are more open to adopting new agricultural technologies. The strong male dominance observed supports findings by Adenle *et al*. (2013) and Oladele and Akinsorotan (2007) that aquaculture is largely male-driven in Nigeria. The relatively high education level is significant, as education improves the ability to process and adopt new technologies, including biotechnology (Ani, 2007). Similarly, the high proportion of married respondents resonates with Lavison (2013), who emphasized that marital status often correlates with greater responsibility and motivation to adopt income-enhancing technologies. The dominance of catfish culture reflects market demand and profitability, echoing FAO (2000). The prevalence of earthen ponds underlines their affordability and accessibility in extensive systems.

Awareness of GMOs, though moderate (65%), does not translate into deep understanding, as only 55% claimed to understand GMOs. This gap between awareness and comprehension mirrors the findings of Azadi et al. (2015), highlighting that exposure alone is insufficient without institutional support and education. The media's role as a key information source supports observations by Ojanji and Otunge (2018). Farmers' perceptions show widespread uncertainty, with many undecideds on health, environmental, and quality implications. This suggests that misinformation or lack of reliable information limits confidence in biotechnology. However, the expressed demand for research and extension education reflects a desire for engagement, consistent with Massarani and De Castro Moreira (2015). Interestingly, religious or moral objections were minimal, challenging assumptions that these form major barriers in African rural communities (Paarlberg, 2008; Adenle *et al.,* 2013).

The indecision observed in willingness to adopt GMOs underlines the role of poor access to credible information and weak extension systems. Similar challenges have been reported in sub-Saharan Africa (Zakaria *et al*., 2014; Adenle *et al.,* 2013). Where opinions were expressed, affordability, yield performance, and faster growth cycles were recognised as motivators, in line with Langyintuo and Mungoma (2008), Qaim and Zilberman (2003), and El-Zaeem and Assem (2004). However, the lack of consensus highlights the need for risk communication and participatory extension, as emphasized by Juma (2015) and Massarani *et al.* (2013).

The chi-square tests underscore education as a critical determinant of GMO awareness, consistent with Feder *et al.* (1985) and Mwangi and Kariuki (2015). Although the p-value was slightly above significance, the trend suggests educational attainment enhances access to and understanding of biotechnology. Conversely, perception of GMOs was not influenced by gender, echoing Adenle *et al.* (2013), who argued that practical factors like cost and productivity often outweigh gender or cultural differences in shaping attitudes toward biotechnology. Overall, the findings highlight that enhancing education, building trust through transparent communication, and improving extension services are essential to drive informed adoption of GMOs in aquaculture.

Interestingly, religious and moral objections were minimal, challenging the widespread assumption that cultural resistance constitutes a major obstacle to biotechnology in African rural communities. Instead, farmers' attitudes were shaped primarily by practical livelihood concerns such as cost, yield, and productivity, underscoring the importance of addressing economic viability rather than ideological resistance. Education also emerged as a borderline but pivotal factor in shaping awareness, indicating that with larger samples or more refined educational categories, it may prove to be a critical determinant of biotechnology uptake.

Conclusion

In conclusion, this study makes a novel contribution by showing that indecision, not opposition, defines farmers' perceptions of GMOs in aquaculture. Practical concerns clearly outweigh moral or religious objections, shifting the focus of interventions from overcoming cultural barriers to addressing uncertainty through education, demonstration-based learning, and transparent regulatory frameworks. By closing gaps in knowledge, perception, and institutional support, Nigeria can create an enabling environment for the informed and sustainable adoption of GMOs in aquaculture, thereby enhancing productivity, food security, and technological innovation.

To enable responsible and effective integration of GMOs into Nigeria's aquaculture sector, the following measures are essential:

- **Policy Interventions:** Develop a dedicated national aquaculture biotechnology policy aligned with food security, youth employment, and embedding biotechnology into existing agricultural policies such as the National Agricultural Technology and Innovation Policy (NATIP).
- **Extension and Capacity Building**: Strengthen extension systems by establishing participatory demonstration farms and launching culturally sensitive biotechnology literacy campaigns via radio, visual aids, and social media. Retrain extension agents with evidence-based tools and resources, and provide inclusive training programmes targeting women and youth to ensure equitable access to innovations.
- **Regulatory and Institutional Frameworks:** Enhance the technical and financial capacity of the National Biosafety Management Agency (NBMA) to regulate aquaculture biotechnology. Develop aquaculture-specific biosafety guidelines, mandate

product labelling and institutionalise a multi-stakeholder advisory panel to address ethical and cultural concerns.

- **Cross-Cutting Enablers**: Strengthen data and monitoring systems using digital tools track awareness, adoption, and performance. Incorporate biotechnology education and bioethics into aquaculture and agricultural curricula at tertiary and vocational institutions.

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