AQUACULTURE RISK FINANCING STRATEGIES AND FOOD SAFETY AMONG SELECTED FISH FARMERS IN LAGOS METROPOLIC: A RANK-ORDER ANALYSIS

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Abstract
This study examines aquaculture risk financing strategies and food safety practices among selected fish farmers in Lagos Metropolis, Nigeria. The study investigated the ranking of financing strategies and food safety practices using a quantitative survey approach. A descriptive survey design was adopted with a sample of 141 respondents selected through multistage sampling. Data were collected using structured questionnaires and analyzed with descriptive statistics and Friedman rank test in SPSS version 25. Results showed significant differences in risk financing strategies with $\chi^2 = 18.545$, df = 4, $p < .001$. Personal savings and cooperative societies ranked highest (mean rank = 3.11), while credit facilities ranked lowest (2.66). Food safety practices also showed significant variation $\chi^2 = 16.315$, $p < .001$, with HACCP ranking highest. The study concludes that informal financing dominates while food safety compliance is generally high. It recommends financial inclusion policies, insurance awareness, and strengthened extension services. The study contributes by applying Friedman ranking to link financing preferences and food safety priorities. Future research should extend to other regions and use longitudinal and mixed methods to enhance generalizability and policy relevance in aquaculture development and food security frameworks in Nigeria for sustainable sectoral growth and resilience policy implementation improvement.

Keywords: Aquaculture risk, food safety, Lagos, rank-order, risk financing.

1.0 Introduction

Aquaculture has become an increasingly important component of food production systems, particularly in rapidly growing urban centers such as Lagos. With rising demand for affordable animal protein and declining yields from capture fisheries, fish farming is widely seen as a practical solution to improve food supply (Adamu & Kawugana, 2025; Ogunji & Wuertz, 2023). In Nigeria, the sector contributes significantly to local economies through employment generation and income creation. Small- and medium-scale farmers dominate production, often

operating under resource constraints. Despite its potential, aquaculture remains vulnerable to several risks that can disrupt production cycles. These include disease outbreaks, water quality challenges, fluctuating feed prices, and environmental uncertainties (Nwuba et al., 2022; Olugbire et al., 2021). Market-related risks such as price instability and limited access to buyers further complicate operations. As a result, sustaining productivity and profitability in aquaculture requires effective management of these risks (Luna et al., 2023).

To cope with these uncertainties, fish farmers employ a variety of risk financing strategies aimed at minimizing losses and ensuring business continuity. Common approaches include reliance on personal savings, borrowing from informal lenders, participation in cooperative societies, and access to microcredit facilities. In some cases, farmers may adopt insurance schemes, although awareness and utilization remain relatively low (Ogunleye et al., 2024; Pomeroy et al., 2020). These financing strategies play a crucial role in determining the scale and efficiency of aquaculture operations. The choice of strategy often depends on factors such as income level, education, and access to financial institutions. Importantly, the availability of financial resources influences farmers' ability to invest in improved technologies and best management practices. This, in turn, affects productivity, operational sustainability, and resilience to shocks (Enwa et al., 2024; Nelima et al., 2024). Therefore, understanding how farmers prioritize these strategies is essential for sector development.

Food safety is another critical aspect of aquaculture that directly affects consumer health and market acceptance of fish products. Safe handling, proper feeding practices, and maintenance of clean production environments are necessary to prevent contamination. However, many fish farmers face challenges in adhering to recommended food safety standards due to limited resources and inadequate knowledge (Al-Mizan et al., 2024; Cortes-Sanchez et al., 2025). Poor water management, improper use of chemicals, and unhygienic processing conditions can compromise fish quality. As consumer awareness increases, demand for safe and high-quality fish products continues to grow. Failure to meet these expectations can result in reduced market access and economic losses for farmers. Moreover, food safety issues in aquaculture may have broader public health implications if not properly addressed (Bukachi et al., 2021; Cudjoe et al., 2022). Thus, improving food safety practices remains a priority within the sector.

Despite the recognised importance of risk financing and food safety, there is insufficient information on how these factors are prioritized among fish farmers in Lagos metropolis. Many farmers operate without structured financial support, limiting their ability to effectively manage risks and maintain high food safety standards. The absence of clear data on the most commonly used financing strategies and key food safety concerns creates a gap in policy and intervention design (Ogisi & Enwa, 2024; Okon et al., 2024). Access to adequate risk financing mechanisms is closely associated with the capacity of aquaculture operators to implement effective food safety practices. Financially constrained fish farmers may struggle to invest in essential safety requirements such as water quality monitoring systems, certified feed, hygienic storage facilities, biosecurity measures, and Hazard Analysis and Critical Control Point (HACCP) compliance procedures. Conversely, improved access to financing enhances farmers' ability to adopt preventive safety measures, maintain operational standards, and respond effectively to contamination risks. Thus, aquaculture financing and food safety are conceptually interconnected through resource availability, operational capacity, and compliance behaviour within aquaculture

production systems.The study aims to assess the food safety practices adopted in fish production and handling processes. The study objectives investigate if there is a significant difference in the ranking of aquaculture risk financing strategies among fish farmers in Lagos metropolis; and a significant difference in the ranking of aquaculture food safety practices among fish farmers in Lagos metropolis.

2.0 Literature Review

Aquaculture risk financing strategies refer to the range of financial mechanisms employed by fish farmers to manage, absorb, or transfer the economic consequences of production-related risks. In Lagos environs, these risks often include disease outbreaks, feed price volatility, environmental shocks, and market fluctuations that can significantly affect farm profitability. Conceptually, risk financing is distinguished from risk prevention because it focuses on coping with losses after they occur rather than eliminating the risk itself (Nimako-Boateng, 2024; Ruben et al., 2025). Common strategies include the use of personal savings, access to credit facilities, participation in cooperative societies, government financial assistance, and insurance coverage. Each of these mechanisms represents different levels of formality and institutional involvement in cushioning financial shocks. Personal savings and informal borrowing are typically self-managed approaches, while credit, government support, and insurance involve external financial systems (Mrema & Kinyondo, 2024; Ntamwaga et al., 2020). Together, these strategies form a framework through which aquaculture operators stabilize income and sustain production continuity.

From a conceptual standpoint, the effectiveness of aquaculture risk financing strategies is influenced by accessibility, affordability, awareness, and institutional support. Farmers with better access to formal financial institutions are more likely to adopt structured mechanisms such as credit schemes and insurance, whereas those with limited access rely heavily on informal networks and savings. Cooperative societies also play a significant role by pooling resources and enhancing members' financial resilience during crises. Government interventions, when effectively implemented, provide a safety net that strengthens sectoral stability and encourages investment in aquaculture (Putri et al., 2026; Sinha & Banerjee, 2025). However, low insurance penetration in developing aquaculture systems reflects gaps in awareness, trust, and cost affordability. Conceptually, these strategies are interrelated, as farmers often combine multiple approaches to diversify risk exposure (Ravisankar et al., 2025). Therefore, aquaculture risk financing is best understood as a multidimensional system of financial coping mechanisms that collectively enhance resilience and sustainability in fish farming operations.

Aquaculture Food Safety

Aquaculture food safety refers to the set of practices, standards, and conditions applied during fish production, handling, processing, and distribution to ensure that fish and fish products are safe for human consumption. It focuses on preventing contamination from biological, chemical, and physical hazards that may arise during aquaculture operations. In systems such as those in Lagos, food safety is influenced by water quality management, feed quality, disease control measures, and hygiene practices on fish farms (Carlino-Costa & Belo, 2025; Vergis et al., 2021). Poor management practices, such as the use of contaminated water sources or inappropriate chemicals, can introduce harmful substances into fish products (Aslam et al., 2025). Therefore,

maintaining proper biosecurity measures and adhering to recommended production standards are essential components of aquaculture food safety.

Conceptually, aquaculture food safety is closely linked to public health, consumer confidence, and market sustainability. It ensures that fish products meet acceptable standards that protect consumers from foodborne illnesses and toxic exposure. Effective food safety management involves proper handling of fish from pond to market, including harvesting, storage, transportation, and processing practices. It also requires compliance with regulatory frameworks and awareness among fish farmers regarding best practices (Hoque & Myrland, 2022; Martins, 2025). Inadequate food safety measures can lead to product rejection, economic losses, and health risks for consumers. As demand for fish continues to rise, particularly in urban markets, ensuring food safety becomes increasingly critical for both producers and regulators (Wang et al., 2026). Thus, aquaculture food safety represents a key pillar in achieving sustainable and healthy food systems.

Theoretical Review

Expected Utility Theory

The Expected Utility Theory was formally developed by John von Neumann and Oskar Morgenstern in their seminal work Theory of Games and Economic Behavior (1944). The theory was later refined and popularized in decision economics as a framework for understanding how individuals make choices under uncertainty. Its core essence is that rational decision-makers evaluate risky alternatives by comparing the expected utility rather than just expected monetary value of different options and then choose the one that maximizes their satisfaction or benefit (Kocasian, 2019; Murphy, 2025). In other words, individuals are assumed to be rational agents who weigh probabilities and outcomes to arrive at optimal decisions when faced with uncertainty. The theory has been widely applied in economics, finance, insurance, and agricultural decision-making, where outcomes are uncertain and risk is inherent (Liu, 2023; Quiggin, 2022).

The Expected Utility Theory explains decision-making under uncertainty based on rational evaluation of expected outcomes. Despite its wide acceptance, the theory has been criticized for assuming perfect rationality, stable preferences, and complete information, which do not always reflect real human behavior. Behavioral economists argue that individuals often rely on heuristics, emotions, and biases rather than strict utility maximization (Hou, 2025; Vladimir, 2022). It has also been challenged for its limited capacity to explain inconsistent risk-averse or risk-seeking behavior across different situations. In relation to aquaculture risk financing strategies among fish farmers in Lagos, the theory provides a useful framework for understanding financial decision-making under risk and uncertainty. It assumes that farmers choose among options such as savings, credit, insurance, cooperative support, and government assistance based on expected benefits. These choices are made by weighing potential costs against the perceived protection each strategy offers against production shocks like disease outbreaks and price fluctuations (Herfeld, 2018). The theory is relevant because aquaculture financing decisions involve trade-offs under uncertain conditions. However, farmers' choices are also influenced by access to financial services, awareness levels, and socio-economic factors. These practical realities highlight the limitations of the theory in fully capturing actual decision-making behavior in aquaculture systems.

Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) was developed by Icek Ajzen in 1985 as an extension of the earlier Theory of Reasoned Action. Its central essence is that human behaviour is directly influenced by behavioural intention, which in turn is shaped by three key factors: attitudes toward the behaviour, subjective norms, and perceived behavioural control. Attitude refers to an individual's positive or negative evaluation of performing a behaviour, subjective norms involve perceived social pressure from others, and perceived behavioural control reflects the individual's belief in their ability to perform the behaviour (Barbera & Ajzen, 2020; Bosnjak et al., 2020). The theory assumes that individuals make rational decisions by considering available information and potential outcomes before acting. TPB has been widely applied in health, environmental, and agricultural studies to explain and predict behavioural intentions and actual behaviour.

Despite its usefulness, the Theory of Planned Behaviour has been criticized for overemphasizing rational decision-making while underestimating emotional, habitual, and unconscious influences on behaviour. Critics also argue that the relationship between intention and actual behaviour is not always strong, especially when external constraints such as limited resources or institutional barriers exist Alhamad & Donyai, 2021; Syed et al., 2024). Additionally, the theory may not fully capture complex social and cultural factors that shape behaviour in real-world settings. In relation to aquaculture food safety among fish farmers in Lagos, the theory helps explain why farmers adopt or fail to adopt safe production and handling practices (Kurniawati et al., 2024; Kushwah, 2025). Farmers are more likely to implement food safety measures such as proper hygiene, clean water management, and safe chemical use if they have positive attitudes toward food safety, perceive social approval from peers and regulators, and believe they have the capacity and resources to do so. However, constraints such as lack of training, inadequate infrastructure, and limited awareness may weaken the translation of intention into actual safe practices, highlighting both the relevance and limitations of the theory in aquaculture food safety behaviour.

The integration of Expected Utility Theory and the Theory of Planned Behaviour provide a broader explanation of how aquaculture operators make decisions regarding financing and food safety practices under uncertain production conditions. While Expected Utility Theory explains farmers' preference for financing mechanisms that maximise expected economic protection against production risks, the Theory of Planned Behaviour explains behavioural intentions toward food safety compliance based on attitudes, subjective norms, and perceived behavioural control. Together, both theories suggest that financing capacity and behavioural orientation jointly shape farmers' ability and willingness to implement effective food safety practices in aquaculture systems.

Empirical Review

Aminu et al. (2021) evaluated the aquaculture risk management coping strategies among catfish farmers in Nigeria. The research aimed to identify major production risks, assess coping strategies, and determine socio-economic factors influencing their adoption. A descriptive survey design was used, with data collected from 100 fish farmers through structured questionnaires and analyzed using descriptive statistics and multivariate probit regression. Findings revealed that price fluctuation, feed cost, and quality of fingerlings were major risks, while farmers mainly

adopted personal savings, pond treatment, and improved feed quality as coping strategies. The study concluded that farmers rely more on informal than formal financial mechanisms due to limited access to institutional support. It recommended strengthening agricultural credit schemes, cooperative societies, and subsidy programs to enhance farmers' resilience. The study contributes to knowledge by providing empirical evidence on risk coping behaviour in aquaculture and highlighting socio-economic determinants influencing strategy adoption, which is relevant for improving risk financing systems and productivity in the sector.

Jimoh and Ajemunigbohun (2023)investigated factors influencing farmers' uptake of insurance as a risk management tool in aquaculture. The introduction highlighted aquaculture insurance as a financial mechanism for cushioning income losses, protecting farm assets, and ensuring production stability. The objectives were to identify barriers affecting aquaculture insurance demand and determine key factors influencing farmers' willingness to adopt insurance services. A survey research design was adopted using a multiphase sampling technique to select fish farmers, and data were collected through structured questionnaires. Descriptive statistics and Friedman's rank test were used for analysis. Findings revealed that high premium costs, poor access to insurance services, low awareness, weak regulatory structures, poor claims settlement, and low financial literacy significantly reduced demand. The study concluded that aquaculture insurance adoption remains low despite its potential benefits due to structural and informational constraints. It recommended policy support through subsidies, improved awareness, and simplified insurance products. The study contributes to knowledge by empirically ranking barriers and determinants influencing aquaculture insurance demand among fish farmers, providing evidence for improved policy and insurance design.

Agbabiaka and Okeke (2024) examined the socio-economic profile and production challenges of fish farmers in Owerri, Orlu, and Okigwe zones. The introduction emphasized aquaculture as an important livelihood activity constrained by economic and infrastructural limitations. The objectives were to assess the socio-economic characteristics of fish farmers and identify major constraints affecting aquaculture production. A descriptive survey design was adopted, using structured questionnaires administered to 120 randomly selected fish farmers across the three zones, with data analyzed using SPSS version 22.0. Findings revealed that most respondents were male, within the active age bracket of 40-49 years, and relatively well educated. Major constraints included high cost of feed, inadequate capital, poor power supply, limited access to credit facilities, and lack of storage infrastructure. The study concluded that aquaculture productivity is significantly hindered by financial and infrastructural challenges. It recommended government intervention through subsidies, improved credit access, and strengthened extension services. The study contributes to knowledge by providing empirical evidence on the socio-economic conditions and key constraints limiting fish farmingdevelopment in southeastern Nigeria.

Owoeye et al. (2025) examined the role of risk financing in enhancing food security among rural farmers. The study introduced agricultural risk financing as a mechanism for managing production uncertainties and improving livelihood outcomes. The objectives were to identify prevalent agricultural risks, examine the effectiveness of risk financing strategies on food security, assess their influence on farmers' decision-making, and determine barriers to adoption. A multi-stage sampling technique was employed to select 450 smallholder farmers, while

structured questionnaires were used for data collection. Data were analyzed using descriptive statistics, linear regression, and logistic regression models. Findings revealed that weather-related risks, crop failure, price volatility, and pests and diseases were most prevalent, while education, extension services, insurance use, and crop diversification significantly influenced food security. Major barriers included limited financial access, poor infrastructure, and low financial literacy. The study concluded that risk financing significantly enhances food security and farmers' decision-making capacity. It recommended improved access to financial services and agricultural insurance. The study contributes to knowledge by empirically linking risk financing strategies with food security outcomes among smallholder farmers.

3.0 Methodology

This study adopted a descriptive survey research design with a quantitative approach. The design is appropriate because it allows for systematic collection and analysis of data on aquaculture risk financing strategies and food safety practices among fish farmers without manipulating variables. The study was conducted among fish farmers operating within the Lagos metropolis, Nigeria, where aquaculture activities are highly concentrated due to urban demand for fish protein.

The population of the study comprised registered and active fish farmers in Lagos State, estimated to be drawn from aquaculture clusters, cooperative associations, and fish farming settlements across the metropolis. Given the absence of a unified database, the study focused on accessible farmers registered under cooperative societies and aquaculture associations. A multistage sampling procedure was adopted to enhance coverage of active aquaculture clusters within Lagos metropolis. Purposive sampling was initially used to identify major aquaculture-producing clusters due to their strategic importance and concentration of fish farming activities. Subsequently, simple random sampling was applied within the selected clusters to improve representativeness and reduce sampling bias. Convenience sampling was only employed at the final stage where accessibility constraints and respondent availability limited complete randomization. Although this may introduce some degree of selection bias, the approach was considered appropriate given the absence of a comprehensive sampling frame for fish farmers within the study area.A sample size of 141 respondents was determined and considered adequate for statistical analysis based on Krejcie and Morgan sample size determination.

The data collection instrument was a structured questionnaire designed in Likert-scale format (5-point scale) to capture information on risk financing strategies and food safety practices. The instrument was divided into sections covering demographic characteristics, financing mechanisms, and food safety indicators. To ensure validity, the instrument was subjected to face and content validation by experts in aquaculture economics and agricultural extension, who reviewed it for clarity, relevance, and coverage of research objectives (Sallies et al., 2021). Reliability was established using Cronbach's Alpha coefficient, which yielded acceptable internal consistency values above 0.70 for all constructs. Data were analyzed using descriptive statistics (mean and standard deviation) and Friedman rank test to determine the relative importance of variables and test differences in ranking. The analysis was conducted using SPSS version 25, with statistical significance set at 0.05.Ethical approval was obtained from the relevant departmental research committee, while informed consent was obtained from all respondents prior to questionnaire administration.The suitability of the data for factor-related analysis was confirmed through Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity

4.0 Results and Discussion of Findings

Descriptive Analysis of Demographic Profile

Table 1:

Demographic Information of Participants

Variable	Category	Frequency (%)
Gender	Male	97 (68.8%)
	Female	44 (31.2%)
Age	18 but less than 30	57 (40.4%)
	30 but less than 40	68 (48.3%)
	40 but less than 50	16 (11.3%)
	50 but less than 60	0(0%)
	60 & above	0 (0%)
Marital Status	Single	07 (5%)
	Married	134 (95%)
	Separated	0 (0%)
	Widow	0 (0%)
Educational Qualification	SSCE/GCE/OND	56 (39.7%)
	HND/BSc	85 (60.3%)
	Postgraduate	0 (0%)
	Professional Certificate	0 (0%)
	Others	0 (0%)

Source: Field Survey, 2026.

Table 1 revealed significant insights into the composition of the studied population. The gender distributionshowed a wider representation, with 68.8 percent identified as male and 31.2 percent as female. Concerning age distribution, the data reflected a diverse age range within the sample. The majority of participants fall within the age brackets of 30 to less than 40 years, 18 to less than 30years, and 40 but less than 50 years; accounting for 48.3 percent, 40.4 percent, and 11.3 percent respectively. This distribution indicates a relatively younger cohort dominating the sample. The marital status presented an interesting aspect of the demographic profile. The majority, constituting 95 percent, are identified as married, while 5 percent are single. Educational qualifications within the sample population exhibit varying levels of attainment. A considerable portion, accounting for 60.3 percent, holds a HND/BSc, followed by 39.7 percent possessing SSCE/GCE/OND qualification.

Table 2:

Participants' Demographic Information

Variable	Response Label	Frequency	Percentages (%)
Years of experience	1 -10 years	138	97.9
	10 - 20 years	03	2.1
	20 years above	0	0
What is your primary source of financing?	Bank loan	0	0
	Insurance	03	2.1
	Personal savings	130	92.2
	Others	08	5.7
Do you implement regular water quality checks?	Yes, always	71	50.4
	Sometimes	67	47.5

	Rarely	03	2.1
	No	0	0
How do you manage disease outbreaks?	Use of antibiotics	73	51.8
	Improved biosecurity measure	47	33.3
	Vaccination	21	14.9
	Others	0	0
Have you experienced significant financial losses?	Yes, significant losses	49	34.8
	Some losses	90	63.8
	Minimal losses	02	1.4
	No losses	0	0
How often do you assess risks?	Regularly	55	39.0
	Occasionally	86	61.0
	Rarely	0	0
	Never	0	0
Do you have insurance coverage?	Yes, comprehensive cover	09	6.4
	Partial cover	0	0
	No, but planning to	78	55.3
	No	54	38.3
Have you received training?	Yes, recently	18	12.8
	Yes, but over a year	76	53.9
	No, but interested	38	27.0
	No	09	6.4
Do food safety practices influence your access	Significantly	77	54.6
	Somewhat	03	2.1
	Minimally	25	17.7
	Not at all	36	25.5
Do you have an emergency response plan	Yes, documented plan	06	4.3
	Informal plan	49	34.8
	No plan, but planning to	26	18.4
	No plan	60	42.6

Source: field survey, 2026

The data presented in Table 2 provides further insights into other demographic variables. For investigation regarding the participants years of experience, 97.9 percent responded 1 – 10 years and the remaining 2.1 percent implied '10-20 years'. For the primary source of financing, majority representing 92.2 percent were from personal savings. For implement regular water quality checks, 50.4 percent expressed the yes always. While 47.5 percent were sometimes, 2.1 percent showed rarely quality check. For the manage disease outbreaks by the participants, majority representing 51.8 percent expressed use of antibiotics while 33.3 percent implied improved biosecurity measure. For the experienced significant financial losses due to aquaculture risks by the participants, majority representing 63.8 percent expressed some losses while 34.8 percent implied yes, significant losses. For how often do you assess risks by the participants, majority representing 61.0 percent expressed occasionally while 39.0 percent implied regularly. For the insurance coverage for fish farm against major risks by the participants, majority representing 55.3 percent expressed no, but planning to while 38.3 percent implied 'No'. For received training on aquaculture food safety practices by the participants, majority representing 53.9 percent expressed yes, but over a year while 27.0 percent implied no, but interested. For food safety practices influence by the participants, majority representing 54.6 percent expressed significantly while 25.5 percent implied not at all. As for emergency response

plan for aquaculture risks, 42.6 percent claimed 'No plan', while 34.8 percent showcased 'Informal plan'.

Descriptive Analysis of Research Variables

Table 3:
Descriptive Statistics of Aquaculture Risk Financing Strategies among Fish Farmers

Variable	M	SD	Interpretation
Cooperative societies	3.83	1.36	High agreement
Personal savings	3.80	1.41	High agreement
Access to credit facilities	3.59	1.09	Moderate agreement
Government financial support	3.57	1.47	Moderate agreement
Insurance subscription	3.57	1.53	Moderate agreement

Source: Researchers' Computations, 2026.

Table 3 presents the descriptive statistics of aquaculture risk financing strategies among fish farmers, showing that all variables recorded mean values above the neutral midpoint of 3.0, which indicates a general agreement on the relevance of these mechanisms in managing production risks. Among the strategies, participation in cooperative societies recorded the highest mean score (Mean = 3.83, SD = 1.36), closely followed by personal savings (Mean = 3.80, SD = 1.41). This suggests that farmers predominantly rely on informal and semi-formal financial arrangements to cushion the effects of financial shocks. The relatively high standard deviations for these variables indicate variability in responses, implying differences in farmers' access to cooperative networks and their capacity to accumulate savings.

Access to credit facilities (Mean = 3.59, SD = 1.09), government financial support (Mean = 3.57, SD = 1.47), and insurance subscription (Mean = 3.57, SD = 1.53) all exhibited moderate levels of agreement, but with varying degrees of dispersion. The lower variability in credit access suggests relatively more consistent experiences among farmers, although not necessarily widespread usage. In contrast, the higher standard deviations for government support and insurance indicate uneven access and adoption, likely reflecting structural barriers such as limited awareness, affordability constraints, and institutional inefficiencies. Overall, the results reveal a financing structure dominated by informal mechanisms, with limited reliance on formal financial instruments, highlighting gaps in financial inclusion within the aquaculture sector.

The equal mean ranks observed between government financial supprot and insurance subscription suggest that respondents perceive these financing mechanisms as similarly important in managing aquaculture risks. This may indicate overlapping functional roles among these strategies in enhancing financial resilience. However, equal ranking does not necessarily imply equal utilization intensity, but rather comparable perceived relevance among respondents.

Table 4:
Descriptive Statistics of Aquaculture Food Safety Practices among Fish Farmers

Variable	M	SD	Interpretation
Compliance with chemical use guidelines in fish production	3.98	0.58	High agreement
Regular monitoring of water quality to prevent contamination	4.28	0.64	High agreement
Hygienic handling and storage of harvested fish	4.36	0.63	Very high agreement
Use of certified feed to reduce food safety risks	4.30	0.65	Very high agreement
Proper record keeping for traceability and compliance (HACCP)	4.19	0.68	High agreement

Source: Researchers' Computations, 2026.

Table 4 presents the descriptive statistics of aquaculture food safety practices among fish farmers, with all variables recording mean values well above the neutral midpoint of 3.0. This indicates a high level of agreement and suggests strong compliance with recommended food safety standards. Among the practices, hygienic handling and storage of harvested fish recorded the highest mean (Mean = 4.36, SD = 0.63), followed by the use of certified feed (Mean = 4.30, SD = 0.65) and regular monitoring of water quality (Mean = 4.28, SD = 0.64). These high mean scores reflect that farmers place considerable emphasis on operational practices that directly influence fish quality and contamination prevention. The relatively low standard deviations across these variables indicate consistency in responses, suggesting that these practices are widely adopted among the respondents.

Furthermore, adherence to recommended guidelines on chemical usage (Mean = 3.98, SD = 0.58) and proper record-keeping for traceability and compliance (Mean = 4.19, SD = 0.68) also demonstrate strong levels of agreement, although chemical management shows a slightly lower mean compared to other practices. The low dispersion observed across all variables implies minimal variation in responses, indicating a uniform pattern of food safety behaviour among fish farmers. Overall, the results suggest that aquaculture operators exhibit a high level of awareness and implementation of key food safety practices, particularly in areas related to hygiene, water quality, and feed management, which are essential for ensuring product safety and enhancing market acceptance.

Test of Hypotheses

Table 5:
Friedman Rank Test for Aquaculture Risk Financing Strategies among Fish Farmers

Strategy	Mean Rank
Credit Facilities	2.66
Personal Savings	3.11
Cooperative Societies	3.11
Government Support	3.01

Strategy	**Mean Rank**
Insurance Subscription	3.11

Source: Researchers' Computations, 2026.

Table 6:

Test Statistics	**Value**
N	141
Chi-Square (χ^2)	18.545
Df	4
Asymp. Sig. (p)	.001

Source: Researchers' Computations, 2026. **Note:** The Friedman test is a non-parametric test used to determine whether there are statistcally significant differences in the ranks of related groups.

A Friedman rank test was conducted to examine differences in the importance of aquaculture risk financing strategies among fish farmers. The results revealed a statistically significant difference in the ranking of the financing strategies, $\chi^2(4) = 18.545$, $p = .001$. This indicates that respondents did not assign equal importance to all the risk financing mechanisms considered in the study.Based on the mean rank scores, personal savings (Mean Rank = 3.11), cooperative societies (Mean Rank = 3.11), and insurance subscription (Mean Rank = 3.11) emerged as the most highly ranked strategies, suggesting that these mechanisms are relatively more important in managing aquaculture risks. Government support followed closely (Mean Rank = 3.01), while credit facilities ranked lowest (Mean Rank = 2.66), indicating that it is the least preferred or least accessible option among respondents. The equal mean ranks observed among personal savings, cooperative societies, and insurance subscription suggest that respondents perceive these financing mechanisms as similarly important in managing aquaculture risks. This may indicate overlapping functional roles among these strategies in enhancing financial resilience. However, equal ranking does not necessarily imply equal utilization intensity, but rather comparable perceived relevance among respondents.These findings suggest a greater reliance on informal and semi-formal financial mechanisms compared to formal credit systems, highlighting potential constraints in access to institutional financing within the aquaculture sector.

Table 7:
Friedman Mean Ranks of Aquaculture Food Safety Practices among Fish Farmers

Food Safety Practice	Mean Rank
Chemical residues (use of chemicals in fish production)	2.20
Water quality parameters (monitoring of water quality)	3.21
Physical contaminants (hygienic handling and storage)	3.01
Bacteria count (use of certified feed)	3.16
Hazard Analysis and Critical Control Points (record keeping and traceability)	3.42

Note: Higher mean ranks indicate stronger relative emphasis or compliance among fish farmers.
Source: Researchers' Computations, 2026.

Table 8:

Test Statistics	Value
N	141
Chi-Square (χ^2)	18.545
Df	4
Asymp. Sig. (p)	.001

Note. The Friedman test was used to determine differences in ranking among aquaculture food safety practices
Source: Researchers' Computations, 2026.

A Friedman rank test was conducted to examine differences in the ranking of aquaculture food safety practices among fish farmers. The results revealed a statistically significant difference in the relative importance of the practices, $\chi^2(4, N = 141) = 16.315$, $p = .001$. This indicates that the identified food safety practices are not equally prioritized by fish farmers.Further examination of the mean ranks shows that Hazard Analysis and Critical Control Points (HACCP) ranked highest (Mean Rank = 3.42), followed by water quality parameters (Mean Rank = 3.21), and bacteria count (Mean Rank = 3.16). Physical contaminants (Mean Rank = 3.01) ranked lower, while chemical residues recorded the lowest mean rank (Mean Rank = 2.20), suggesting it is the least emphasized food safety practice among respondents.Overall, the results highlight a significant variation in food safety priorities, with stronger emphasis placed on monitoring and compliance-related practices compared to preventive chemical control measures.

Discussion of Findings

The findings of this study on aquaculture risk financing strategies indicate that fish farmers in Lagos metropolis predominantly rely on informal mechanisms, especially personal savings and cooperative societies, while formal financing options such as credit facilities and insurance are less utilized. This aligns with Aminu et al. (2021), who reported that Nigerian fish farmers largely depend on informal coping strategies due to limited access to institutional finance. Ogunleye et al. (2024) similarly found that credit constraints significantly reduce the adoption of formal risk management tools, reinforcing self-financing behaviour. Owoeye et al. (2025) also

observed that smallholder farmers rely heavily on savings and community-based systems for risk management. In addition, Mrema and Kinyondo (2024) emphasized that cooperative societies enhance financial resilience through pooled resources and mutual support, although Jimoh and Ajemunigbohun (2023) highlighted that weak institutional frameworks and low awareness continue to limit access to formal financial instruments such as insurance and credit.

The findings on aquaculture food safety practices show generally high compliance among fish farmers, particularly in hygiene, water quality monitoring, feed management, and HACCP-based practices, with HACCP ranked highest. This is supported by Carlino-Costa and Belo (2025), who emphasized biosecurity and sustainable aquaculture practices as essential for ensuring fish safety. Vergis et al. (2021) also highlighted hygienic handling and environmental control as key in reducing contamination risks. Cortes-Sanchez et al. (2025) noted the importance of HACCP systems and traceability in modern food safety management, while Aslam et al. (2025) reinforced that structured hazard analysis improves compliance and product integrity. However, Al-Mizan et al. (2024) reported gaps in chemical safety knowledge among fish handlers, and Martin (2025) observed persistent risks of contamination from improper chemical and antibiotic use, indicating weaknesses in preventive chemical residue control practices.

5.0 Conclusion and Recommendations

This study concludes that aquaculture risk financing strategies and food safety practices among fish farmers in Lagos metropolis are characterized by distinct but interrelated patterns of adoption and prioritization. The findings reveal a strong dependence on informal and semi-formal financing mechanisms, particularly personal savings and cooperative societies, while formal instruments such as credit facilities and insurance remain less utilized due to accessibility and institutional constraints. The Friedman rank analysis confirmed significant differences in the prioritization of financing strategies, indicating a preference hierarchy shaped by convenience and perceived reliability. In terms of food safety, farmers demonstrate generally high compliance with hygiene, water quality monitoring, feed management, and HACCP-based practices, although variations exist in their emphasis, with chemical residue control receiving the least attention. Overall, the study concludes that while food safety awareness is relatively high, aquaculture risk financing remains structurally constrained, highlighting the need for improved financial inclusion and stronger regulatory support systems.

Based on the findings of this study, it is recommended that government and relevant financial institutions strengthen financial inclusion in the aquaculture sector by developing tailored credit schemes that are accessible, affordable, and responsive to the specific needs of fish farmers in Lagos metropolis. Loan conditions should be simplified, with reduced collateral requirements to encourage greater participation in formal financing systems. In addition, aquaculture-specific insurance products should be promoted through targeted awareness campaigns and subsidies to improve farmers' understanding and uptake of risk transfer mechanisms. Cooperative societies should also be strengthened through capacity-building, improved governance structures, and access to institutional support, as they currently serve as a key source of financial resilience for farmers. Furthermore, extension services should be intensified to provide continuous training on food safety practices, particularly in areas such as chemical use, HACCP implementation, and hygiene management. Finally, regulatory agencies should enforce stricter monitoring of chemical

and antibiotic use to ensure compliance with food safety standards and reduce contamination risks in aquaculture production.

Contribution to knowledge and Directions for Further Studies

This study contributes to knowledge by providing empirical evidence on the ranking of aquaculture risk financing strategies and food safety practices using Friedman analysis. It highlights dominance of informal financing and prioritization of HACCP-based food safety, while integrating Expected Utility Theory and Theory of Planned Behaviour to explain farmers' decisions.

Future studies should extend this research beyond Lagos metropolis to other aquaculture-producing regions in Nigeria and similar developing contexts to enhance comparability and generalisability. Longitudinal studies are recommended to examine how risk financing strategies and food safety practices evolve over time in response to policy changes, climate variability, and market dynamics. Mixed-method approaches should also be adopted to capture deeper behavioural and institutional factors influencing farmers' decisions.

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