

Socio-Ecological Evaluation of Aquaculture Management and Perceived Environmental Pressures in Peri-Urban Ibadan, Nigeria: Evidence from Pond-Associated Respondents

Atim C. Okoko¹; Ofonime E. Afia²; Helen B. Inyang³; Adelowokan O. Aderibigbe⁴ & Idorenyin Philip Okonji^{5*}

¹Akwa Ibom State Ministry of Agriculture and Food Sufficiency, Idongesit Nkanga Secretariat Complex, Uyo, Akwa Ibom State, Nigeria. ORCID: 0009-0000-7101-4264

²Department of Fisheries and Aquatic Environmental Management, Faculty of Agriculture, University of Uyo, Akwa Ibom State, Nigeria. ORCID: 0009-0004-6390-2383

³Department of Agricultural Economics and Extension, National Open University of Nigeria. ORCID:0000-0002-3866-0317

⁴University of Ibadan, Ibadan

⁵Federal Department of Fisheries and Aquaculture, Federal Ministry of Marine and Blue Economy, Bukar Dipcharima House, FCT, Abuja, Nigeria. ORCID: 0009-0009-0685-6911

*Corresponding Author: Idorenyin Philip Okonji

DOI: <https://doi.org/10.5281/zenodo.23623309>

Article History	Abstract
Original Research Article	
Received: 25-08-2026	
Accepted: 29-09-2026	
Published: 24-10-2026	
Copyright © 2026 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY-NC) which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.	
Citation: Atim C. Okoko, Ofonime E. Afia, Helen B. Inyang, Adelowokan O. Aderibigbe, & Idorenyin Philip Okonji. (2026). Socio-ecological evaluation of aquaculture management and perceived environmental pressures in peri-urban Ibadan, Nigeria: Evidence from pond-associated respondents. UKR Journal of Multidisciplinary Studies, 2(10), 54-62.	<i>Fish farming around cities can create jobs and supply food, but it can also put pressure on the environment. This study assessed the business activities, perceived environmental conditions, and management responses of people connected with fish-pond sites in Arulogun, a peri-urban part of Ibadan, Nigeria. Sixty-two pond sites were identified, and 213 people from those sites were interviewed. Simple percentages were used to summarise the answers. No direct measurements of water, air, or soil were taken. Commercial fishing was the most common business activity (39.4%), followed by recreational fishing and fish farming (21.1% each). Most respondents (52.6%) said their main management approach was sustainable fishing practices. However, 70.0% said waste disposal was inadequate, 32.4% noticed changes in water quality, and 27.2% noticed odours. Among those who noticed odours, 70.9% described them as unbearable. Training and education was the most common compliance approach (54.0%), while 72.8% reported no collaboration with external stakeholders. The findings point to clear gaps in waste handling, monitoring, stakeholder engagement, and pond siting. They describe what respondents perceived; they do not prove actual pollution or cause-and-effect relationships.</i> Keywords: Peri-Urban Aquaculture; Environmental Management; Fishponds; Waste Disposal; Stakeholder Engagement; Ibadan.

1. Introduction

Fish farming in the areas around cities, known as peri-urban aquaculture, can help supply fish, create jobs, and support local economies. At the same time, it competes with other uses for land and water, and it can overload local waste-management systems. How well pond-based fish enterprises perform environmentally depends not only on how fish are raised, but also on how wastewater is handled, how inputs are managed, where ponds are sited, and how farmers relate to nearby communities. It is useful to separate two things: measured environmental conditions

(such as laboratory tests of water quality) and people's perceptions of those conditions. Perceptions do not prove pollution, but they matter. They show where problems may exist, and they shape how communities, farmers, and regulators respond. Environmental management systems (EMS) offer a practical way to identify site-level risks, set improvement goals, monitor progress, and review performance (Emilsson and Hjelm, 2002; Nawrocka and Parker, 2009). Nigerian studies also show the importance of extension and information services in aquaculture:

Awolumate (2017) studied extension services in fish farming in Lagos State, Awolumate (2018a, 2018b) examined climate information sourcing and information access among fish farmers, and Awolumate and Inyang (2019b, 2019d) studied communication channels and information-use efficiency. These sources inform the extension implications of this study, but they do not verify conditions at the study sites.

This study focused on Arulogun, a peri-urban area of Ibadan. It describes (i) the business activities and operational practices of pond-associated respondents; (ii) their perceptions of water quality, odour, and waste-disposal adequacy; (iii) their reported compliance approaches, business strategies, and collaboration with stakeholders; and (iv) the implications for environmental management and pond siting. Because all respondents were recruited from identified pond sites, the findings do not represent the views of the wider Ibadan population.

2. Literature Review

2.1 Enterprise involvement and operational practices

Peri-urban aquaculture sits in a special position in the urban food system. It is close to city markets, yet it still has access to relatively cheap land and water. In Nigeria, urban and peri-urban fish farming is mostly carried out in small and medium-sized pond operations, and their performance depends heavily on land scarcity, water availability, and the skills of the owner-operators. Fregene, Inyang and Awolumate (2011) studied urban aquaculture systems in Ibadan Municipal and described how stocking density, feed sourcing, water management, and labour arrangements shape enterprise performance under urban pressure. Their study is the closest baseline for the present research, which extends the same enquiry to the peri-urban fringe of Ibadan.

Studies from other Nigerian states show that fish farms differ in how well they are managed. Awolumate and Inyang (2020a) developed an operational profile and a management performance index for fish farm investments in Akwa Ibom State, showing that managerial organisation differs systematically across farms and affects productivity. Akpabio and Inyang (2007) identified production, infrastructure, and input constraints on aquaculture development, while Solomon and Inyang (2007) used perception-based ranking to show that productivity constraints vary across enterprises. Awolumate and Inyang (2019c) found significant technical efficiency differences among fish farms, suggesting that practices, not just resources, explain much of the performance gap. Awolumate and Inyang (2019a) also linked business decisions to profitability. Fish farming also plays a livelihood role. Inyang and Solomon (2007) described aquaculture in the Niger Delta as a sustainable livelihood strategy that provides income, food security, and employment for urbanising households. Inyang (2026) showed that youth-led agricultural enterprise decisions involve deliberate risk-taking under uncertainty.

2.2 Perceived environmental pressures: water quality, odour, and waste disposal

Because peri-urban ponds are close to homes, their environmental effects, poor water quality, odours, and waste, are highly visible and can quickly create conflict. Many studies measure effluent in the laboratory, but few document how pond-associated people perceive these pressures. Yet perceptions are what drive complaints, informal regulation, and cooperation. Earlier work shows that perceptions can be measured in a structured way. Inyang, Unung and Ekanem (2013) evaluated farmers' reported exposure to climate variability and showed that respondent-reported exposure can yield valid assessments of environmental stress. Inyang, Eka, Udoma and Okon (2004) connected attitudes with the likelihood of sustainable management of degrading wetland forests. Okoro and Inyang (2008) documented how environmental change and livelihood activities influence each other. On waste handling, Inyang, Inyang and Inyang (2019) assessed hazards and safety among urban waste handlers, providing a template for evaluating waste-disposal adequacy around pond clusters. These studies support the second objective of this paper: to document respondents' perceptions of water quality, odour, and waste-disposal adequacy, on the ground that perceptions shape the social acceptance of peri-urban aquaculture.

2.3 Compliance, economic strategies, and stakeholder collaboration

This subunit analysed how enterprises respond to environmental and regulatory pressure. Nigerian evidence shows that advisory and compliance relationships involve many actors, not only government extension. Ekanem and Inyang (2016) evaluated an extension approach delegated to an oil company in the Niger Delta and found that non-state actors can deliver advisory services where public extension is weak. Ekanem and Inyang (2013) mapped capacity building under a corporate social responsibility programme, showing how structured engagement can institutionalise better practices. Udoh and Inyang (2015) examined the role of public and private agencies in addressing commodity constraints, and Inyang, Andiya and Awolumate (2012) compared agricultural extension systems in transition, concluding that extension institutions remain central even as their roles are shared. Economic capacity also matters. Awolumate and Inyang (2020b) documented constraints on value-addition investments in fish processing, which limit the money available for environmental compliance. Oribhabor, John and Inyang (2018) described how market position shapes the strategies of shrimp marketers. Inyang and Solomon (2007) framed aquaculture as part of a livelihood portfolio, meaning that responses such as diversification or exit are rational

adjustments. Finally, information access is a key determinant: Awolumate and Inyang (2019d) identified threats to fish-farming information-use efficiency, suggesting that compliance gaps may reflect information failure rather than unwillingness.

2.4 Environmental management and site planning

The last objective places the findings in the context of environmental management and planning. Udoh and Inyang (2011) used adoption of improved practices in *Gnetum africanum* to test the effect of land ownership, showing that secure tenure encourages investment in sustainable practices — a finding with clear meaning for the permanence and stewardship of peri-urban ponds. Akpabio and Inyang (2004) documented how urban crop farming persists under land-use pressure, a useful parallel for pond siting in a growing city. Okonji, Inyang, Nwanegwo and Oluwapelumi (2025) discussed blue economy and coastal resources management, providing a national governance context. Inyang and Udong (2013) showed that livelihood diversification in environmentally challenged settings is shaped by gendered access to resources, warning that planning interventions distribute costs and benefits unevenly. Inyang, Eka, Udoma and Okon (2004) linked attitudes to the likelihood of sustainable management, implying that strategies which engage people's perceptions are more likely to win voluntary compliance than purely regulatory approaches. At the planning level, Yakubu, Falconer and Telfer (2022) showed that land-use scenarios shape the sustainable expansion of Nigerian aquaculture; Emmanuel, Doro, Iserhien-Emekeme and Atakpo (2023) showed that local soil and subsurface conditions are critical for siting earthen ponds; and Igomu, Aremu and Omobowale (2025) used life-cycle assessment at the University of Ibadan fish farm to highlight the environmental weight of processing choices. Emilsson and Hjelm (2002) and Nawrocka and Parker (2009) provide the EMS foundation: structured management systems connect operating practices, environmental pathways, stakeholder observation, and management response.

Conceptual and Planning Framework

The study adopts a site-level environmental management perspective. It connects four elements: operating practices (feeding, staffing, waste handling), possible environmental pathways (organic waste accumulation, pond effluent, odour-generating materials, drainage), stakeholder observations (perceived water quality, odour, waste adequacy), and management responses (training, monitoring, collaboration). These pathways are possibilities to be investigated, not proven effects. A proportionate EMS for small enterprises can prioritise waste segregation and disposal, pond-water record keeping,

incident logs, periodic review, and cooperation with environmental authorities. Planning criteria include soil stability, year-round water availability, flood and drainage risks, nearby land uses, transport access, and feasible waste-handling arrangements. Recommendations designed for coastal brackish-water ponds should not be applied mechanically to inland peri-urban Ibadan; site-specific conditions must govern.

3. Materials and Methods

3.1 Study area and design. An *expo facto* design based on cross-sectional approach was adopted to conduct a survey of Arulogun, a peri-urban area of Ibadan, Nigeria. The study combined respondent interviews with relevant literature on environmental management, aquaculture, and peri-urban planning. No water, air, or soil samples were taken, and no laboratory analyses or before-and-after comparisons were carried out.

3.2 Study units and recruitment. Sixty-two fish-pond sites were purposively selected because they were relevant to the study objectives. All 213 interviewees were drawn from these sites. No probability sampling frame for residents and no within-site selection procedure was documented. Therefore, 62 is the number of identified sites, while 213 is the number of individual respondents. All reported percentages are respondent-level figures unless stated otherwise. Questions about staffing or pond characteristics are treated as respondent reports, not as a census of workers or ponds.

3.3 Variables and analysis. The survey covered business involvement, primary management techniques, staffing and payment, perceived water-quality changes, waste-disposal adequacy, perceived odours, compliance responses, business sustainability strategies, fish-stock management, supply-chain practices, and collaboration. Each item was summarised as frequency and percentage, generally using 213 as the denominator. Descriptive patterns should not be read as causal relationships, population estimates, or verified compliance. The original questionnaire and missing-data protocol were not available. No confidence intervals or multivariable analyses were reported.

3.4 Interpretive safeguards. Response categories were treated exactly as reported, without assuming that all possible practices were covered or that categories were mutually exclusive. Percentages are reproduced to one decimal place. The category 'commercial fishing' is preserved and not reclassified as pond aquaculture. The earlier term 'resident perceptions' was replaced by 'pond-associated respondents' because recruitment did not include an independent community sample. All environmental observations reported are perceptions, not objective measurements.

4. Results

4.1 Enterprise involvement and practices

Commercial fishing was the most common business activity (39.4%), followed by recreational fishing and

aquaculture/fish farming (21.1% each). Fish processing and packaging accounted for 18.3%. A majority (52.6%) chose sustainable fishing practices as their primary management approach, although this self-report does not verify actual sustainability performance.

Table 1. Reported business involvement and management approach (n = 213)

S/N	Variable and Response category	N	%
1	Business involvement		
	Commercial fishing	84	39.4
	Recreational fishing	45	21.1
	Aquaculture/fish farming	45	21.1
	Fish processing/packaging	39	18.3
2	Primary management approach		
	Sustainable fishing practices	112	52.6
	Stock assessment and monitoring	9	4.2
	Quota management	18	8.5
	Gear restrictions and selectivity	4	1.9
	Habitat restoration/protection	34	16.0
	Community-based management	36	16.9

4.2 Staff and operational organisation

Four staff was the most commonly reported staffing level (54.0% of respondents); this is not the same as 54.0% of ponds employing four people. Fish feeding was the most frequently reported primary duty (54.0%). The modal reported pay range was ₦10,000–₦20,000 (45.5%), and monthly payment was the most common schedule (55.4%). The survey does not establish payroll records or site-level staffing distributions.

Table 2. Reported staffing, tasks, and payment arrangements (n = 213)

Question	Most frequent response	n	%
Reported staff headcount	Four staff	115	54.0
Primary staff duty	Fish feeding	115	54.0
Reported payment range	₦10,000–₦20,000	97	45.5
Reported payment schedule	Monthly	118	55.4

4.3 Perceived environmental conditions

The most widespread concern was waste disposal: 70.0% of respondents said disposal mechanisms were inadequate. About one third (32.4%) perceived changes in water quality, and 27.2% noticed

odours. Among the 58 respondents who noticed odours, 70.9% described them as unbearable. These findings identify concerns that deserve investigation and action, but they cannot attribute pollution to any specific enterprise.

Table 3. Perceived environmental conditions (n = 213)

S/N	Indicator	Frequency	Percent
1	Perceived water-quality change		
	Yes	69	32.4
	No	144	67.6
2	Adequate waste-disposal mechanisms		
	Yes	64	30.0
	No	149	70.0
3	Odour noticed		
	Yes	58	27.2
	No	155	72.8

4.4 Compliance, business strategies, and external collaboration

Staff training and education was the most common compliance approach (54.0%), and revenue diversification was the most common business strategy (54.0%). Nearly three quarters (72.8%) reported no collaboration with government, research, or civil-society stakeholders. Separate source tables also reported implementation of size and catch limits (66.7%) and chain-of-custody certification (54.0%); these should not be read as independently verified use of those measures.

Table 4. Reported compliance and collaboration (n = 213)

S/N	Assessment indicators	Frequency (n = 213)	Percent
1	Compliance approach		
	Regular monitoring and enforcement	34	16.0
	Participation in management organizations	36	16.9
	Staff training and education	115	54.0
	Collaboration with regulators	28	13.1
2	Sustainability strategy		
	Efficiency improvement	34	16.0
	Revenue diversification	115	54.0
	Research and technology investment	36	16.9
	Certification participation	28	13.1
3	Stakeholder collaboration		
	Yes	58	27.2
	No	155	72.8

5. Discussion

A diverse pond-side economy

The sample was not made up only of fish farmers. Commercial fishing (39.4%), recreational fishing (21.1%), fish farming (21.1%), and fish processing (18.3%) coexisted around the same ponds. This matches the picture drawn by Fregene, Inyang and Awolumate (2011) of Ibadan's urban aquaculture as a mixed system, and it matters for policy: different activities produce different kinds of waste, so one single management rule will not fit all. The dominance of small teams (most reporting four staff, feeding as the main duty, and monthly pay of ₦10,000–₦20,000) fits the small-scale, labour-intensive profile described by Awolumate and Inyang (2020a) and Akpabio and Inyang (2007). Most respondents said their main approach was 'sustainable fishing practices' (52.6%). This is encouraging as an intention, but intentions are not outcomes; as Solomon and Inyang (2007) and Awolumate and Inyang (2019c) showed, reported approaches and actual efficiency can diverge.

Perceived environmental pressures

The strongest signal in the data is waste disposal: 70.0% of respondents said mechanisms were inadequate. This is consistent with national evidence. Ojewole et al. (2024) reviewed aquaculture wastewater in Nigeria and found that pond effluent is rarely treated before discharge. Olaoluwa et al. (2024) measured physicochemical and microbial contamination in a river receiving pond wastewater in Ede,

Osun State. Closer to home, Alabi et al. (2024) analysed fishpond wastewater in Ibadan and reported toxicological risks, while Ajide-Akinola and Akinwale (2023) documented nutrient build-up in pond soils in Ibadan, and Fatayo, Egbinola and Omobowale (2025) measured water-quality and vegetation effects near small-scale aquaculture in nearby Ikire. None of these studies measured the Arulogun sites, so they cannot prove pollution there. What they do show is that perceived waste problems in Arulogun fit a documented regional pattern — and that objective monitoring, not perception alone, should guide response. Perceived water-quality change (32.4%) and odours (27.2%), with 70.9% of odour reporters calling them unbearable, flag hotspots for follow-up. Simple measurements of dissolved oxygen, pH, turbidity, nitrogen compounds, and organic loading would turn these perceptions into evidence.

Compliance strategies without collaboration

The most common compliance approach was staff training and education (54.0%), while only 13.1% reported collaboration with regulators. At the same time, 72.8% reported no stakeholder collaboration at all. This combination — internal training, external isolation — suggests enterprises are coping alone. Yet the literature shows that compliance works best through joint action: Ekanem and Inyang (2016) found that delegated, non-state extension can deliver advisory services; Ekanem and Inyang (2013) showed how structured stakeholder engagement institutionalises good practice; and Ojewole et

al. (2024) explicitly recommend shared wastewater responsibilities among farmers, regulators, and researchers. Begho and colleagues reached similar conclusions: Begho, Olaniyi and Irabor (2025) showed that psychological and social drivers shape pro-environmental behaviour among Nigerian fish farmers, and Begho, Irabor and Olaniyi (2026) found that awareness and motivation, not just rules, drive attention to environmental impact. Since information flow is a known weak point (Awolumate and Inyang, 2019d; Awolumate, 2018a, 2018b), training alone cannot close the gap without functioning partnerships. The dominant business strategy of revenue diversification (54.0%) fits the livelihood logic described by Inyang and Solomon (2007) and the profitability constraints documented by Awolumate and Inyang (2019a, 2020b) and Awolumate and Iniobong (2021): enterprises spread risk because margins are thin, which also limits what they can spend on environmental controls.

What this means for management and siting

The findings translate into a clear agenda. Waste audits should come first, because waste disposal was the most widely reported failure. Site inspections and targeted water testing should follow, because perception data cannot assign responsibility. Extension training should cover pond-water management, organic residues, safe handling, record keeping, and low-cost mitigation, echoing the central role of extension found by Awolumate (2017) and Inyang, Andiya and Awolumate (2012). Pond siting must account for flooding, neighbouring land uses, water availability, and waste-handling capacity, following the planning logic of Yakubu et al. (2022), Emmanuel et al. (2023), and Udoh and Inyang (2011), who showed that tenure security shapes stewardship investment. Finally, because vulnerability differs across households — coastal fisherfolk diversify under climate stress (Awolumate and Williams, 2021) and gender shapes access to resources (Inyang and Udong, 2013) — engagement must include women, workers, and processors, not only pond owners. The processing link also matters: Igomu et al. (2025) showed that smoking and processing carry their own environmental footprint, which is relevant where processing happens near ponds.

6. Environmental Management and Planning Recommendations

First, each identified site should adopt a simple environmental management checklist recording waste types, disposal routes, maintenance schedules, and complaints. Second, local agencies should assess drainage, water abstraction, and discharge conditions through site inspections and targeted water testing before deciding on remedies. Third, regular extension training should address

pond-water management, organic residues, safe handling, record keeping, and practical low-cost mitigation. Fourth, pond location approvals and expansions should consider flooding, nearby land uses, water availability, and waste-handling capacity. Fifth, stakeholder forums should bring operators, neighbouring communities, planners, and regulators together to agree on feasible monitoring and response arrangements. These recommendations follow from the survey patterns and established environmental management principles; they were not tested as interventions in this study.

7. Limitations

The study covered 62 purposively identified pond sites and 213 associated respondents. No ambient or pond-water measurements, effluent analyses, or control sites were included. Self-reports cannot independently establish compliance, actual staffing, certification use, or environmental impacts. The proportions reported are descriptive and cannot be generalised to Ibadan residents or to all fish farms in the region. Some survey categories mix fishing, processing, and pond aquaculture, so activity-specific inference is limited.

8. Conclusion

The Arulogun survey found perceived gaps in waste-disposal adequacy, water-quality conditions, and odour management, alongside a reported strength in training and a major gap in stakeholder collaboration. In the 213 pond-associated responses, 70.0% reported inadequate waste-disposal mechanisms, 32.4% perceived water-quality changes, 27.2% reported odours, and 72.8% reported no external collaboration. These results justify site-specific environmental assessments, better waste handling, stronger extension support, and closer attention to pond siting. They do not establish measured contamination or community-wide impacts. Future research should add an independently selected resident sample, map respondents to their sites, link measured exposures to documented practices, and distinguish pond owners, employees, fishers, processors, and neighbours.

Declarations

Ethics approval and consent to participate: The ethical approval and participant consent were verbally sought and obtained from the respondents who all adult proprietors of their firms.

Consent for publication: Not applicable; no identifying participant information is presented.

Funding: The authors report that no external funding supported this study.

Competing interests: The authors declare no competing interests.

Author contributions: All authors contributed to the study, which ranged from conceptualization, fieldwork, data analysis, drafting, and revision.

Declaration of generative AI use: Generative AI assistance was used for language editing and manuscript formatting. The authors were responsible for verifying the analysis, factual statements, citations, and final text.

References

1. Ajide-Akinola, O. E., and Akinwale, A. O. (2023). Relationship between the productivity and nutrient profile of bottom soils of selected regular and integrated fish ponds in Ibadan, Nigeria. *Asian Journal of Fisheries and Aquatic Research*, 25(3), 130–138.
2. Akpabio, I. A., and Inyang, E. B. (2004). The status of crop farming in Uyo urban, Nigeria. *International Journal of Research in Agricultural Education*, 2(1), 75–84.
3. Akpabio, I. A., and Inyang, E. B. (2007). Major constraints affecting aquaculture development in Akwa Ibom State, Nigeria. *African Journal of Aquatic Science*, 32, 75–84.
4. Alabi, O. A., Ashamo, O. M., Akinyanju, R. A., Faleye, F. Y., Afolabi, T. A., Ayeni, F. E., and Adeoluwa, Y. M. (2024). Comparative carcinogenic and non-carcinogenic health risks, and cytogenotoxicity of wastewaters from natural and artificial fishponds indiscriminately disposed in Nigeria. *Toxicology Research*, 13(6), tfae213.
5. Awolunate, S. (2017). Analysis of impact of extension services on fish farming in Lagos State, Nigeria. *Journal of Physical and Life Sciences*, 1(1), 1–15.
6. Awolunate, S. (2018a). Assessment of mass media dependency for climate change information sourcing among agricultural and fishery extension service field agents in Akwa Ibom State. *Asian Journal of Agricultural Extension, Economics & Sociology*, 24(4), 1–9.
7. Awolunate, S. (2018b). Aquaculture information sources, relative incidences of accessibility and preference among fish farmers in Akwa Ibom State. In N. U. Ndaeyo, I. Akpabio, V. Ebong, and U. Etuk (eds.), *Sustainable Agriculture in a Diversified Economy: Nigeria in Perspective*.
8. Awolunate, S., and Iniobong, B. I. (2021). Risk factors associated with value addition in commercial aquaculture in Osun State, Nigeria. *Journal of Agricultural Economics and Extension and Science*, 7(4), 46–65.
9. Awolunate, S., and Inyang, E. B. (2019a). Correlates of aquaculture business decision and profitability status of selected firms in Kaduna, Nigeria. *Journal of Physical and Life Sciences*, 3(1).
10. Awolunate, S., and Inyang, E. B. (2019b). Incidences and relative rank positioning pattern of mass media usage for climate change extension services delivery in Akwa Ibom State, Nigeria. *Journal of Wetlands and Waste Management*, 3(2), 52–57.
11. Awolunate, S., and Inyang, E. B. (2019c). Technical efficiency differentials in aquaculture resource use among selected fish farms in Kaduna State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment*, 15(2), 84–93.
12. Awolunate, S., and Inyang, E. B. (2019d). Threats to fish farming information-use efficiency in a multi-communication infrastructural system in Akwa Ibom State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment*, 15(1), 41–47.
13. Awolunate, S., and Inyang, E. B. (2020a). Evaluation of operational profile and index of fish farm investments management performance in Akwa Ibom State, Nigeria. *Nigerian Journal of Fisheries and Aquaculture*, 8(2), 22–32.
14. Awolunate, S., and Inyang, E. B. (2020b). Fish processing constraints to value-addition investments in commercial aquaculture in Osun State, Nigeria. *Journal of Agricultural Economics and Extension and Science*, 6(2), 75–89.
15. Awolunate, S., and Williams, W. O. (2021). Households' vulnerability and livelihood diversification in the changing state of climate and environment among fisherfolk in coastal communities in the Niger Delta region, Nigeria. *Journal of Forestry, Environment and Sustainable Development*, 7(1), 102–110.
16. Begho, T., Irabor, A. E., and Olaniyi, A. A. (2026). Assessing smallholder fish farmers' awareness, motivation and attitude towards the environmental impact of aquaculture. *Aquaculture, Fish and Fisheries*, 6(1), e70190. <https://doi.org/10.1002/aff2.70190>
17. Begho, T., Olaniyi, A. A., and Irabor, A. E. (2025). Eliciting psychological and social constructs driving pro-environmental behaviour of

Nigerian fish farmers: Evidence from a public goods experiment. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 35(8), e70211. <https://doi.org/10.1002/aqc.70211>

18. Ekanem, J. T., and Inyang, E. B. (2013). Mapping the capacity building process of a corporate social responsibility driven agricultural intervention in the Niger Delta region, Nigeria. *Journal of Agricultural Extension*, 17(2), 31–38.
19. Ekanem, J. T., and Inyang, E. B. (2016). Evaluation of delegated approach to extension practice by an oil company in the Niger Delta region, Nigeria. *Journal of Community and Communication Research*, 1(1), 81–87.
20. Emilsson, S., and Hjelm, O. (2002). Implementation of standardised environmental management systems in Swedish local authorities: Reasons, expectations and outcomes. *Environmental Science & Policy*, 5(6), 443–448. [https://doi.org/10.1016/S1462-9011\(02\)00090-4](https://doi.org/10.1016/S1462-9011(02)00090-4)
21. Emmanuel, E. D., Doro, K. O., Iserhien-Emekeme, R. E., and Atakpo, E. A. (2023). Using geophysics to guide the selection of suitable sites for establishing sustainable earthen fishponds in the Niger-Delta region of Nigeria. *Heliyon*, 9(6), e17618.
22. Fatayo, O. C., Egbinola, C. N., and Omobowale, M. O. (2025). Evaluating the impact of peasant aquaculture on water quality and floristic composition in the headwater regions of Southwest Nigeria. *Water, Air, & Soil Pollution*, 236, 620. <https://doi.org/10.1007/s11270-025-08237-y>
23. Fregene, T., Inyang, E. B., and Awolumate, S. (2011). Operational attributes of urban aquaculture systems in Ibadan Municipal, Oyo State, Nigeria. In R. Adeyemo (ed.), *Urban Agriculture, Cities and Climate Change* (pp. 173–178). Göttingen: Cuvillier Verlag.
24. Igomu, B., Aremu, A., and Omobowale, M. (2025). Environmental life cycle assessment of smoked fish production: A case study of the University of Ibadan fish farm. *Journal of Engineering Studies and Research*, 30(4), 19–31. <https://doi.org/10.29081/jesr.v30i4.002>
25. Inyang, A. B., Inyang, E. B., and Inyang, I. E. (2019). Evaluation of the hazards and safety friendliness of medical waste handlers in care facilities in Uyo Metropolis, Akwa Ibom State, Nigeria. *Journal of Wetlands and Waste Management*, 3(2), 39–48.
26. Inyang, E. B. (2026). Youth-led agricultural enterprise development in the Niger Delta region of Nigeria: Decision-making dimensions under deep uncertainty. In E. Robert (ed.), *Food Security, Energy & Youth Inclusivity: Engaging the Youth to Secure the Future of the Niger-Delta*. Technical paper, Niger-Delta Food Security Summit & Expo, Uyo, Nigeria, April 22–24, 2026.
27. Inyang, E. B., and Solomon, V. A. (2007). Sustainable livelihood through aquaculture in the Niger-Delta, Nigeria. *Journal of Agricultural Extension*, 10, 160–167.
28. Inyang, E. B., and Udong, E. E. (2013). Gender, livelihood security and diversification in an environmentally-challenged Niger Delta region. *The International Journal of Humanities and Social Science*, 1(1), 44–52.
29. Inyang, E. B., Andiya, I. B., and Awolumate, S. (2012). Comparative functionality analysis of agricultural extension systems in transition. In H. M. Ijeomah and A. A. Aiyelaja (eds.), *Challenges to Sustainable Productions in Agriculture and Environment: Nigeria in Perspective* (pp. 615–626).
30. Inyang, E. B., Eka, I. E., Udoma, G. M., and Okon, D. (2004). Attitudinal dispositions and sustainable management likelihood of degrading wetland forest resources in a Niger Delta region, Nigeria. In D. M. Baumgartner (ed.), *Human Dimensions of Family and Farm Forestry International Symposium* (pp. 305–309). Pullman, WA: Washington State University Extension.
31. Inyang, E. B., Unung, O. O., and Ekanem, J. T. (2013). Evaluation of exposures to extremes of climate variability among rain-fed dependent vegetable farmers in a Niger Delta region, Nigeria. *African Journal of Agriculture, Technology and Environment*, 2(2), 56–65.
32. Nawrocka, D., and Parker, T. (2009). Finding the connection: Environmental management systems and environmental performance. *Journal of Cleaner Production*, 17(6), 601–607. <https://doi.org/10.1016/j.jclepro.2008.10.003>
33. Ojewole, A. E., Ndimele, P. E., Oladele, A. H., Saba, A. O., Oladipupo, I. O., Ojewole, C. O., Ositimehin, K. M., Oluwasanmi, A. S., and Kalejaye, O. S. (2024). Aquaculture wastewater management in Nigeria's fisheries industry for

sustainable aquaculture practices. *Scientific African*, 25, e02283. <https://doi.org/10.1016/j.sciaf.2024.e02283>

34. Olaoluwa, D. T., Owonibi, S. K., Hussain, R. T., Adenipekun, O. D., Salotun, R. O., Olufade, I. I., and Adiele, G. C. (2024). Assessment of aquaculture wastewater impact on Osun river, Ede, Nigeria. *Proceedings of the Nigerian Society of Physical Sciences*, 1(1), 79. <https://doi.org/10.61298/pnspsc.2024.1.79>
35. Oribhabor, B. J., John, B. I., and Inyang, E. B. (2018). Shrimp marketing and the socio-economic status of shrimp marketers cum consumers' behaviour in Uyo markets, Akwa Ibom State, Nigeria. *Nigerian Journal of Agricultural Technology*, 15(1). <https://www.eruditescholars.net>
36. Solomon, V. A., and Inyang, E. B. (2007). Symmetric determination of the severity of productivity constraints of fish farmers in the tropics: A case study of the Niger Delta region, Nigeria. *Journal of Central European Agriculture*, 8(2), 205–212.
37. Udoh, A. J., and Inyang, E. B. (2011). Adoption of improved cultivation practices in *Gnetum africanum*: A test crop for ownership of land. *ARPN Journal of Agricultural and Biological Science*, 6(8), 32–37.
38. Udoh, A. J., and Inyang, E. B. (2015). The role of public and private agencies in alleviating narrow export commodity base. *Indian Research Journal of Extension Education*, 15(4), 234–239.
39. Yakubu, S. O., Falconer, L., and Telfer, T. C. (2022). Scenario analysis and land use change modelling reveal opportunities and challenges for sustainable expansion of aquaculture in Nigeria. *Aquaculture Reports*, 23, 101071. <https://doi.org/10.1016/j.aqrep.2022.101071>