

ASSESSMENT OF FISH BREEDERS COMPETENCE IN HATCHERY MANAGEMENT IN DELTA CENTER AGRICULTURAL ZONE, DELTA STATE

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Abstract

This study assessed the competence of fish breeders in hatchery management in the Delta Central Agricultural Zone, Delta State, Nigeria, with a focus on socio-economic attributes, technical capacity, and constraints influencing willingness to invest in training. Using a descriptive survey design, data were collected from 80 registered hatchery operators through structured questionnaires and analyzed using descriptive statistics, the Knowledge Attitude Skills (KAS) framework, and binary logistic regression. Results showed that breeders possessed high knowledge (mean score = 3.8) and attitudes (4.0) toward hatchery management, but moderate practical skills (2.9). While essential equipment such as incubation tanks (81.3%) and generators (87.5%) were widely available, advanced monitoring tools like water quality testing kits (37.5%) and filtration systems (31.3%) were scarce. High input costs (81.3%) and unreliable electricity supply (75%) were the most reported constraints. Logistic regression indicated that educational level, farming experience, aquaculture income, and access to credit significantly ($p < 0.05$) influenced willingness to pay for hatchery management training. The findings highlight a critical gap between theoretical competence and applied skills, underscoring the need for targeted, skill-based training, improved access to environmental monitoring tools, and supportive financing mechanisms to enhance hatchery productivity and sustainability in the region.

Keywords: hatchery management, fish breeders, competence assessment, KAS framework, aquaculture training, Delta State

1. Introduction

Hatchery management represents a cornerstone of aquaculture production systems, underpinning the quality, genetic integrity, and survival rate of fish seed that enter grow-out phases. In modern aquaculture, the ability to produce high-quality fry with desirable traits is critical for ensuring sustainable yields, reducing production losses, and meeting the genetic improvement goals of breeding programs (Ogunji and Wuertz, 2023). The process extends beyond the technical act of spawning; it integrates broodstock selection, induced breeding, controlled incubation, larval rearing, and water quality management and

each stage directly influencing seed viability and the long-term performance of cultured stocks (Verma *et al.*, 2024). Within the broader fisheries and aquaculture context, competence in hatchery management is therefore not only a determinant of immediate production outcomes but also a strategic tool for preserving genetic diversity, enhancing disease resistance, and securing the economic viability of aquaculture enterprises.

Globally, breeding and hatchery operations have increasingly aligned with selective breeding programs and genetic management strategies aimed at improving growth rates, feed efficiency, and resilience in cultured fish species (Menezes *et al.*, 2022). Sustainable aquaculture, as envisioned in the International Symposium on Genetics in Aquaculture (ISGA) agenda, emphasizes the integration of genetic improvement with environmental stewardship and socio-economic viability. Seed quality, both in genetic and physiological terms, is the foundation of these objectives, as inferior or genetically compromised fry can undermine the gains achieved through breeding programs. Recent research highlights the role of hatchery operator competence in maintaining genetic integrity, noting that poor handling, inadequate record-keeping, or improper broodstock management can lead to inbreeding, loss of desirable traits, and reduced adaptability to farming conditions (Rossignoli *et al.*, 2023).

In Nigeria, aquaculture has emerged as one of the fastest-growing food production sectors, with hatchery operations concentrated in regions such as the Delta Central Agricultural Zone due to its favorable climatic and hydrological conditions (Ashley *et al.*, 2022). Despite this growth, technical capacity among fish breeders remains uneven. Studies indicate that many operators lack access to modern hatchery infrastructure, such as water quality monitoring systems and advanced filtration technologies, while also exhibiting skill gaps in areas like larval feeding protocols and environmental parameter control (Hashim *et al.*, 2024; Yakubu *et al.*, 2022). This disconnect between knowledge and practice is further compounded by socio-economic barriers, including limited credit access, high input costs, and unreliable electricity supply (Benjamin *et al.*, 2022).

Over the past decade, capacity-building interventions in aquaculture have demonstrated measurable improvements in breeder competence when training combines theoretical instruction with practical application (Essien and Job, 2022). However, these initiatives have not been uniformly implemented, and their uptake is often constrained by financial and logistical challenges (Issa *et al.*, 2022). Comparative studies in countries such as Bangladesh and Kenya reveal that targeted training, coupled with genetic improvement programs, can significantly boost seed quality and farm profitability (Munguti *et al.*, 2022; Siddique *et al.*, 2022). Nevertheless, in Nigeria, systematic evaluations of breeder competence, especially using structured models like the Knowledge Attitude Skills (KAS) framework, remain scarce, limiting the ability to design interventions that address both technical and socio-economic dimensions of hatchery performance.

2. Materials and Methods

2.1 Research Design

This study adopted a descriptive survey research design, which is well-suited for investigating the socio-economic attributes, technical competencies, and operational constraints of a defined population under real-world conditions (Issa *et al.*, 2022). The design facilitated systematic collection of both quantitative and qualitative data on hatchery management competence, specifically structured within the Knowledge Attitude Skills (KAS) framework. The approach also enabled assessment of breeders' willingness to invest in capacity-building initiatives, consistent with methodologies employed in previous aquaculture socio-economic studies (Argade *et al.*, 2023; Sarah *et al.*, 2024).

2.2 Study Area

The research was conducted in the Delta Central Agricultural Zone of Delta State, Nigeria, an area recognized for its significant aquaculture potential and favorable hydrological conditions. This zone comprises multiple local government areas (LGAs) that host both smallholder and commercial hatchery enterprises. The region benefits from proximity to major urban markets, including Warri and Asaba, which enhances opportunities for seed distribution. Nonetheless, the area continues to face challenges such as inconsistent hatchery infrastructure and limited access to advanced breeding technologies (Ashley *et al.*, 2022; Benjamin *et al.*, 2022).

2.3 Target Population

The study population comprised all registered hatchery operators in the Delta Central Agricultural Zone. Eligibility was limited to breeders actively engaged in broodstock selection, induced spawning, egg incubation, fry rearing, and seed sales. Focusing on registered operators ensured that respondents had verifiable operational experience and were directly relevant to the study's objectives (Issa *et al.*, 2022).

2.4 Sampling Procedure and Sample Size Determination

A multi-stage sampling approach was implemented. First, a comprehensive list of hatchery operators was obtained from the Delta State Ministry of Agriculture and relevant aquaculture associations. Second, hatchery clusters within the LGAs were identified, from which respondents were proportionally selected using random sampling techniques to ensure representativeness (Folorunso *et al.*, 2021). The sample size was determined using Yamane's (1967) formula for finite populations, applying a 5% margin of error and a 95% confidence level, as recommended in Nigerian aquaculture research (Sarah *et al.*, 2024).

2.5 Data Collection Instrument

Primary data were collected using a structured questionnaire, designed to address the study's specific objectives. The instrument was organized into five sections:

- Socio-economic characteristics of respondents.
- Knowledge of hatchery management practices.
- Availability and utilization of hatchery equipment.
- Competence assessment based on the KAS framework.
- Constraints and willingness to pay for training.

The KAS framework was selected for its proven effectiveness in evaluating technical capacities in aquaculture and related sectors (Verma *et al.*, 2024; Essien and Job, 2022).

2.6 Validity and Reliability

The questionnaire's content and face validity were established through expert review by aquaculture researchers, hatchery managers, and fisheries extension officers, ensuring alignment with the study's aims (Menezes *et al.*, 2022). A pre-test was conducted with ten hatchery operators outside the study area to refine question clarity and sequencing. Internal consistency was evaluated using Cronbach's alpha, with a reliability threshold of 0.70 deemed acceptable for social science research (Valero *et al.*, 2022).

2.7 Data Collection Procedure

Data were gathered by trained enumerators experienced in aquaculture field surveys, using face-to-face interviews to minimize non-response and ensure accurate interpretation of technical questions. Field observations of hatchery facilities were also conducted to corroborate self-reported information, particularly regarding equipment ownership and operational practices (Benjamin *et al.*, 2022).

2.8 Data Analysis

Descriptive statistics, including frequencies, percentages, and means, were used to summarize socio-economic profiles, competence scores, and equipment availability (Ashley *et al.*, 2022). Weighted indices were calculated to derive KAS scores, a method widely applied in capacity assessment studies (Suhartina *et al.*, 2024). Binary logistic regression was employed to identify socio-economic and operational

factors influencing breeders’ willingness to pay for training, following best practices for analyzing dichotomous outcomes in aquaculture economics (Sarah *et al.*, 2024). Analyses were conducted using SPSS statistical software.

2.9 Ethical Considerations

Ethical approval was obtained from the appropriate institutional review board prior to data collection (Munguti *et al.*, 2022). Participation was voluntary, with informed consent secured from all respondents. Anonymity and confidentiality were maintained throughout the study, and data were used solely for academic purposes (Butcher *et al.*, 2021).

3. Results

3.1 Socio-Economic Characteristics of Respondents

The socio-economic profile of the 80 hatchery operators surveyed is summarized in Table 1.

Respondents were predominantly male (75%), consistent with gender participation patterns reported in Nigerian aquaculture where men frequently dominate commercial breeding enterprises (Uzowulu *et al.*, 2025). The largest age group was 31–40 years (37.5%), indicating a concentration of economically active individuals more likely to adopt improved hatchery practices (Longo, 2024). Educational attainment was generally high, with 47.5% completing secondary school and 35.0% holding tertiary qualifications. Over half (50%) had 5–10 years of hatchery experience, reflecting substantial operational exposure. However, access to credit remained low (27.5%), aligning with prior findings that financial constraints hinder expansion and modernization of hatchery operations in Nigeria (Yakubu *et al.*, 2022).

Table 1
Socio-economic characteristics of hatchery operators in the Delta Central Agricultural Zone, Nigeria

Variable	Frequency (n)	Percentage (%)
Male	60	75.0
Female	20	25.0
21–30 years	15	18.8
31–40 years	30	37.5
41–50 years	25	31.3
Above 50 years	10	12.5
Single	18	22.5
Married	56	70.0
Widowed	6	7.5
No formal education	4	5.0
Primary	10	12.5
Secondary	38	47.5
Tertiary	28	35.0
<5 years’ experience	12	15.0
5–10 years’ experience	40	50.0
>10 years’ experience	28	35.0
Access to credit: Yes	22	27.5
Access to credit: No	58	72.5

Table 2
Knowledge levels of hatchery operators in key hatchery management practices

Practice	Frequency (n)	Percentage (%)
Broodstock selection	68	85.0
Induced spawning techniques	60	75.0
Egg incubation management	55	68.8
Larval feeding regimes	48	60.0
Water quality monitoring	42	52.5

Table 3
Availability of hatchery equipment among operators in the study area

Equipment	Frequency (n)	Percentage (%)
Incubation tanks	65	81.3
Aerators	48	60.0
Water quality testing kits	30	37.5
Filtration systems	25	31.3
Generators	70	87.5

Table 4
Competence scores of hatchery operators based on the Knowledge–Attitude–Skills (KAS) framework

Dimension	Mean Score	Competence Level
Knowledge	3.8	High
Attitude	4.0	High
Skills	2.9	Moderate

Table 5
Major constraints affecting hatchery operations in the study area

Constraint	Frequency (n)	Percentage (%)
High cost of inputs	65	81.3
Unreliable electricity supply	60	75.0
Limited access to broodstock	50	62.5
Disease outbreaks	42	52.5
Lack of technical support	40	50.0

Table 6
Binary logistic regression results for factors influencing willingness to pay for hatchery management training

Variable	Coefficient (B)	Std. Error	Sig. (p-value)
Educational level	0.85	0.32	0.01
Farming experience	0.72	0.28	0.02
Aquaculture income	0.65	0.27	0.03
Access to credit	0.90	0.35	0.01

3.2 Knowledge of Hatchery Management Practices

Table 2 presents knowledge levels across five core hatchery practices. Broodstock selection knowledge was highest (85.0%), followed by induced spawning techniques (75.0%), egg incubation (68.8%), larval feeding (60.0%), and water quality monitoring (52.5%). While high proficiency in broodstock selection reflects breeder awareness of its importance for fry quality (Menezes *et al.*, 2022), lower knowledge of water quality monitoring highlights a persistent gap in environmental management competence (Yakubu *et al.*, 2022).

3.3 Availability of Hatchery Equipment

As shown in Table 3, incubation tanks (81.3%) and generators (87.5%) were widely available, indicating priority investment in core seed production and power reliability. Conversely, only 37.5% of respondents had water quality testing kits, and 31.3% owned filtration systems. This limited access to environmental

monitoring tools mirrors findings in other Nigerian hatchery studies where small-scale operators often operate without essential environmental control equipment (Hashim *et al.*, 2024).

3.4 Competence Assessment Using the KAS Framework

KAS scores (Table 4) reveal high mean scores for knowledge (3.8) and attitude (4.0), but a moderate score for skills (2.9). This suggests a gap between theoretical understanding and practical execution of hatchery tasks, a pattern also reported in livestock production capacity studies (Suhartina *et al.*, 2024). The findings reinforce earlier research indicating that Nigerian fish breeders often require hands-on training to operationalize technical knowledge (Essien and Job, 2022).

3.5 Constraints Affecting Hatchery Management

Table 5 identifies high input costs (81.3%) and unreliable electricity supply (75.0%) as the most

pressing challenges, followed by limited broodstock access (62.5%), disease outbreaks (52.5%), and inadequate technical support (50.0%). These constraints are consistent with national aquaculture bottlenecks linked to infrastructure deficiencies and high operating expenses (Ashley *et al.*, 2022; Yakubu *et al.*, 2022).

3.6 Factors Influencing Willingness to Pay for Training

Binary logistic regression results (Table 6) show that educational level ($p = 0.01$), farming experience ($p = 0.02$), aquaculture income ($p = 0.03$), and access to credit ($p = 0.01$) significantly influence willingness to pay for hatchery management training. These findings parallel Rossignoli *et al.* (2023), who observed that socio-economic capacity strongly determines farmers' investment in skill development initiatives.

3.7 Summary of Findings

Overall, hatchery operators in the Delta Central Agricultural Zone demonstrate strong knowledge and positive attitudes toward hatchery management but lag in practical skills. Equipment ownership patterns indicate adequate investment in basic infrastructure but insufficient access to environmental monitoring tools critical for maintaining seed quality. Persistent operational constraints and low credit access hinder the ability to upgrade facilities or engage in advanced training. The significant role of education, experience, income, and credit access in determining willingness to invest in training underscores the need for targeted interventions that combine skill development with financial support mechanisms.

4. Discussion

The present study provides empirical evidence on the competence of hatchery operators in the Delta Central Agricultural Zone, revealing a nuanced profile where high levels of knowledge and positive attitudes toward hatchery management coexist with moderate practical skills. This disparity between cognitive understanding and applied capacity is a recurrent challenge in aquaculture development, where theoretical awareness of best practices does not automatically translate into operational proficiency (Essien and Job, 2022; Suhartina *et al.*, 2024). For sustainable aquaculture and genetic improvement programs, core priorities of the International Symposium on Genetics in Aquaculture (ISGA) closing this skills gap is imperative, as poor hatchery execution can undermine selective breeding gains, compromise seed quality, and reduce farm profitability (Ogunji and Wuertz, 2023).

The high knowledge scores for broodstock selection and induced spawning observed in this study suggest that operators recognize the critical role of genetic and phenotypic traits in determining fry quality. Proper broodstock management is central to preventing inbreeding depression, maintaining genetic diversity, and ensuring that selected traits such as growth rate, feed efficiency, or disease resistance are successfully

passed to subsequent generations (Menezes *et al.*, 2022; Rossignoli *et al.*, 2023). However, the comparatively lower knowledge and practical capacity in water quality monitoring indicate an area of operational weakness. Given that environmental parameters such as dissolved oxygen, pH, and ammonia concentrations directly influence embryonic development and larval survival (Hashim *et al.*, 2024), insufficient monitoring capability can negate the benefits of high-quality broodstock.

The equipment ownership profile reinforces this concern. While widespread availability of incubation tanks and generators reflects a baseline capacity for seed production, the scarcity of water quality testing kits and filtration systems limits the ability to maintain optimal rearing environments. This pattern aligns with previous Nigerian aquaculture studies that reported underinvestment in environmental control technologies, particularly among small-scale hatcheries (Yakubu *et al.*, 2022). Without these tools, breeders face higher risks of mortality, stunted growth, and disease outbreaks, which in turn reduce the commercial viability of seed production and threaten the genetic integrity of breeding programs.

Operational constraints, most notably high input costs and unreliable electricity supply—further hinder hatchery performance. These constraints are not unique to Delta State; similar patterns have been reported in Sub-Saharan Africa, where infrastructural deficiencies and volatile market prices reduce the competitiveness of aquaculture enterprises (Benjamin *et al.*, 2022). However, their impact in the present context is compounded by limited access to credit, which restricts operators' ability to invest in both training and technology upgrades. This finding is consistent with the regression analysis results, where education, experience, income, and credit access emerged as significant predictors of willingness to pay for training. Such socio-economic determinants of adoption have also been observed in Asia and East Africa, suggesting that technical interventions must be paired with financial inclusion strategies to achieve sustainable capacity building (Rossignoli *et al.*, 2023; Munguti *et al.*, 2022).

From a broader genetic improvement and seed quality perspective, the implications of these findings are substantial. Hatchery operators serve as custodians of genetic resources within aquaculture systems. Inadequate skills, poor environmental control, and suboptimal infrastructure not only reduce immediate production outcomes but also risk propagating genetically inferior or stressed seed into grow-out systems, thereby compromising the long-term gains of selective breeding programs (Ogunji and Wuertz, 2023). Enhancing breeder competence through targeted, hands-on training modules, particularly in water quality management, larval feeding regimes, and disease prevention can directly improve both the genetic and physiological quality of seed produced in the region.

Furthermore, integrating hatchery capacity-building initiatives with policy measures that address infrastructural bottlenecks would strengthen the resilience of the aquaculture sector. For example, subsidies or credit facilities earmarked for acquiring environmental monitoring equipment could accelerate technology adoption. Coupled with cooperative models for broodstock improvement and shared resource management, these measures can contribute to a more robust, genetically secure, and economically viable hatchery network in the Delta Central Agricultural Zone (Walakira *et al.*, 2023).

In sum, the findings underscore the interdependence of technical competence, socio-economic capacity, and genetic resource management in achieving the sustainable aquaculture goals central to ISGA XV. Addressing skill gaps, improving access to environmental monitoring tools, and embedding training within a supportive financial and infrastructural framework are critical steps toward ensuring that hatchery operations contribute effectively to both regional food security and global aquaculture development targets.

5. Conclusion and Recommendations

5.1 Conclusion

This study has demonstrated that hatchery operators in the Delta Central Agricultural Zone possess substantial knowledge and positive attitudes toward hatchery management, particularly in broodstock selection and induced spawning, yet their practical skills remain moderate. While core infrastructure such as incubation tanks and backup power generators is widely available, access to advanced environmental monitoring tools is limited. This gap, combined with persistent operational constraints including high input costs, unreliable electricity supply, and restricted credit access, undermines hatchery efficiency, compromises seed quality, and constrains the realization of genetic improvement goals.

The regression analysis confirmed that socio-economic variables such as educational level, farming experience, aquaculture income, and access to credit, significantly influence willingness to invest in training. These findings underscore the need for interventions that integrate technical capacity building with enabling financial and infrastructural support. From an ISGA XV perspective, strengthening breeder competence and environmental management capacity is not only vital for enhancing seed production and genetic quality but also for safeguarding the sustainability and resilience of Nigeria's aquaculture sector in the face of evolving market and environmental pressures.

5.2 Recommendations

1. Implement skill-focused hatchery management training

- Develop structured training modules that emphasize practical application in water quality

monitoring, larval feeding regimes, and disease prevention.

- Incorporate hands-on sessions in partnership with research institutes and demonstration hatcheries to ensure translation of theoretical knowledge into operational skills.

2. Facilitate access to environmental monitoring equipment

- Establish subsidized procurement schemes or low-interest credit facilities for essential tools such as water quality testing kits and filtration systems.
- Promote cooperative equipment-sharing models within hatchery clusters to reduce individual capital costs.

3. Upgrade hatchery infrastructure and energy reliability

- Invest in renewable energy solutions, such as solar-powered aeration and pumping systems, to mitigate the effects of unreliable grid electricity.
- Expand access to certified, genetically improved broodstock through centralized broodstock banks.

4. Integrate hatchery improvement into policy frameworks

- Advocate for state-level aquaculture development policies that prioritize genetic quality assurance, hatchery certification, and standardized operating protocols.
- Incorporate hatchery management competence assessment into regulatory compliance checks.

5. Enhance financial inclusion for hatchery operators

- Partner with microfinance institutions and agricultural banks to design aquaculture-specific loan products, with repayment schedules aligned to production cycles.
- Link credit access to participation in certified training programs to ensure funds support capacity building and technology adoption.

By addressing both technical and socio-economic barriers, these recommendations aim to create a hatchery sector capable of producing genetically robust, high-quality seed that meets the demands of sustainable aquaculture and the genetic improvement agenda central to ISGA XV. Such integrated interventions will contribute to improved productivity, resilience, and competitiveness of Nigeria's aquaculture industry, while supporting broader goals of food security and rural economic development.

References

- Adame, M. M., and Ameha, N. (2023). Review on egg handling and management of incubation and hatchery environment. *Asian Journal of Biological Sciences*, 16(4), 474–484.
- Argade, S., Syamala, K., and Bhat, N. M. (2023). Evaluating effectiveness of skill development program on fish farming and

- hatchery operation. *Journal of Indian Fisheries Association*, 50(4).
- Ashley-Dejo, S. S., and Adelaja, O. A. (2022). Economics of catfish hatchery farmers and its contribution to household poverty alleviation in Nigeria. *Agricultura Tropica et Subtropica*, 55(1), 19–29.
- Benjamin, E. O., Ola, O., and Buchenrieder, G. R. (2022). Feasibility study of a small-scale recirculating aquaculture system for sustainable (peri-) urban farming in Sub-Saharan Africa: A Nigerian perspective. *Land*, 11(11), 2063.
- Essien, E. N., and Job, I. A. (2022). Skills acquisition in aquaculture for a green economy in Akwa Ibom State. *Journal of Association of Vocational and Technical Educators of Nigeria*, 28(1).
- Hashim, R. G., Aminuddin, Z. M., Mohamed, Z., Ramli, M. H. M., Ismail, Z., Saidon, J., and Chaoqun, W. (2024). Managing complexities in giant freshwater prawn breeding facilities in Perak, Malaysia: A case study. *Information Management and Business Review*, 16(3), 119–129.
- Issa, F. O., Aderinoye-AbdulWahab, S., and Kagbu, J. H. (2022). Assessment of aquaculture development programmes in Nigeria. *Journal of Agricultural Extension*, 26(1), 10–17.
- Menezes, A., Murekezi, P., Martone, E., Badiane, A. A., and Mulonda, B. K. (2022). *Training curriculum and practical manual on sustainable aquaculture*. Food & Agriculture Organization.
- Rossignoli, C. M., Lozano Lazo, D. P., Barman, B. K., Dompok, E. B., Manyise, T., Wang, Q., and Gasparatos, A. (2023). Multi-stakeholder perception analysis of the status, characteristics, and factors affecting small-scale carp aquaculture systems in Bangladesh. *Frontiers in Sustainable Food Systems*, 7, 1121434.
- Suhartina, S., Khaliq, T. D., Said, N. S., Fahrodi, D. U., and Sari, N. N. (2024). Analysis of the level of knowledge, skills and attitude of farmers in handling scabies in goat farming in the Majene district. *Jurnal Nukleus Peternakan*, 11(1), 50–56.
- Uzowulu, C. O., Obiakor, N. J., and Ugwuja, A. A. (2025). Women in aquaculture: A study of the Camp 74 Fish Farm Settlement Anwia, Asaba, Delta State, 2000–2020. *Nigerian Journal of African Studies*, 7(1).
- Walakira, J. K., Hinrichsen, E., Tarus, V., Langi, S., Ibrahim, N. A., Badmus, O., and Baumüller, H. (2023). Scaling aquaculture for food security and employment in Africa – Insights from Egypt, Kenya and Nigeria.
- 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.