

# Identification of Work Skills Required for Improving Fish Farming Disease Control, Preservation, and Marketing in Enugu State, Nigeria

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## ABSTRACT

**Purpose.** Preventable disease losses, weak post-harvest handling and poorly organised marketing continue to erode fish-farm income in Enugu State. This study identified the work skills required to improve disease control, preservation and marketing among commercial fish farmers.

**Methodology.** A descriptive survey was used. A multi-stage sample of 186 respondents (142 farmers and 44 extension officers) completed a validated 48-item inventory on a four-point scale. Cronbach's alpha was .89, .86 and .88 for the three clusters. Means and independent-samples t-tests were applied, with a cut-off of 2.50.

**Findings.** All 16 disease-control, 15 preservation and 17 marketing skills were rated required. Highest-rated skills were recognition of hemorrhagic septicemia and white-spot disease, water-quality testing, quarantine, hygienic stunning and icing, controlled smoking, live-fish handling, weight-based pricing and record keeping. No cluster differed significantly between farmers and extension officers ( $p > .05$ ).

**Originality.** The paper integrates the three downstream domains that most directly determine whether a production cycle becomes retained income, extending earlier Enugu inventories that focused on pond construction and feeding.

**Research implications.** Agricultural education and extension should treat aquatic animal health, post-harvest technology and market literacy as co-equal competency domains, not as optional add-ons to pond construction and feeding.

**Keywords:** aquaculture work skills, disease control, Enugu State, fish preservation, fish marketing, vocational agriculture, catfish

## 1. Introduction

Global aquaculture now supplies the larger share of fish available for human consumption (Food and Agriculture Organization [FAO], 2024). Nigeria is the second-largest aquaculture producer in Africa after Egypt and the leading producer of farmed African catfish, *Clarias gariepinus*, yet domestic supply still falls short of demand (FAO, 2024; Oman et al., 2023; WorldFish, 2021). In Enugu State, commercial culture is dominated by *Clarias* and *Heteroclaris* hybrids in concrete and tarpaulin ponds (Omeje et al., 2021). Farm studies report positive net income when survival and market access are adequate (Onyekuru et al., 2019; Umaru et al., 2021), but profitability is fragile. Feed cost, water, fingerling quality, disease and the absence of organised markets are recurrent constraints.

Disease is particularly damaging. Omeje et al. (2021) documented hemorrhagic septicemia, ichthyophthiriasis and fungal infection as the dominant conditions, and found that 40% of farmers resorted to self-medication. Post-harvest losses compound production losses. Without ice, insulated boxes and hygienic smoking, shelf life collapses within hours. Farmers often sell at the pond gate, keep incomplete records and have limited access to hotels and institutional buyers (WorldFish, 2021). Work skills, the observable competencies required to perform occupational tasks to a defined standard, are the bridge between these constraints and improved performance (Nwosu & Offorbuike, 2021). Earlier Enugu studies mapped pond construction, hatching and feeding (Aneke et al., 2022b). Less attention has been given, in one instrument, to disease control, preservation and marketing.

### 1.1 Purpose, questions and hypotheses

The purpose was to identify the work skills required for improving (a) fish-farm disease control, (b) fish preservation and (c) fish marketing in Enugu State. Three research questions matched these purposes. Null hypotheses stated no significant difference between commercial fish farmers and extension officers on each cluster, tested at the .05 level.

The study supplies an empirically ranked competency list that agricultural education departments, ENADEP, the Fisheries Society of Nigeria and private training providers can convert into short courses, module reviews and on-farm demonstrations. Farmers gain a practical checklist for self-assessment. Policy actors gain evidence that aquatic animal health, post-harvest technology and market literacy deserve budgeted extension slots alongside feed and seed interventions. Until these skills are identified and compared across practitioner groups, training will remain generic and the profitability already shown in local farm studies will remain unnecessarily volatile.

## 2. Related literature and framework

Omeje et al. (2021) surveyed 45 farms across the three senatorial districts and reported that 71.1% cultured *Clarias*, 15.6% *Heteroclaris* and 8.9% *tilapia*. Concrete ponds were the modal system (42.2%), and most enterprises produced table-size fish. Management practices already in use included periodic water change (93.3%), sorting (84.4%) and checking of pH, temperature and dissolved oxygen (78.3%). These figures show that a basic husbandry repertoire exists. What is missing is consistent application of diagnostic, biosecurity and value-addition skills. Profitability studies make the same point. In Nsukka, Onyekuru et al. (2019) estimated a net farm income of ₦1,672,130 per cycle. In Enugu metropolis, Umaru et al. (2021) reported ₦600,832 per 1,000 fish raised to about 1 kg, a return of ₦1.25 per naira invested, and a 98% survival rate in the sampled cycle. Survival at that level is not automatic. Omeje et al. found higher mortality in fingerlings than in table fish or broodstock, and listed disease among the major factors militating against aquaculture in the State. Chukwuone et al. (2021) further showed that only about one quarter of sampled Enugu catfish farmers scored at or above 50% on sustainable environmental management practices.

The dominant clinical picture on Enugu farms is bacterial hemorrhagic septicemia, reported by 48.9% of farms, ichthyophthiriasis (42.2%) and fungal infection, confirmed through veterinary and laboratory consultation (Omeje et al., 2021). Farmers obtained disease information mainly from personal experience (64.4%) and fellow farmers (51.1%). Veterinary officers were rarely used, and self-medication was the modal treatment pathway (40.0%). This pattern matches the national observation that aquatic animal health management among smallholders is thin and that public veterinary capacity for fish is limited (WorldFish, 2021). Required skills therefore include recognising early clinical signs, such as erratic swimming, clamped fins, red patches, cotton-like growth and white spots; measuring and interpreting water-quality parameters; applying quarantine and disinfection; removing and disposing of moribund fish; using salt, lime and approved therapeutics at labelled doses; keeping a farm health register; and knowing when to call a veterinarian rather than escalating antibiotic use. Unsupervised antibiotic use risks treatment failure, residues in edible tissue and antimicrobial resistance.

Farmed African catfish reaches consumers as live, fresh, smoked or dried product (Oman et al., 2023). Live sales protect quality but require oxygenated transport and rapid turnover. Fresh sales require ice and insulated containers that many small farms do not own. Smoking remains the principal value-addition method in the South-East, yet traditional kilns produce uneven drying, higher contaminant risk when wood combustion is uncontrolled, and insect infestation in storage (Olorunfemi et al., 2017). Training-needs studies elsewhere in Nigeria ranked improved smoking, packaging and labelling, and short-duration storage among the highest-priority skills. Preservation skills in this study therefore include hygienic harvest and bleeding, icing within an hour of death, use of improved kilns, moisture testing, food-grade packaging, batch labelling, and basic hygiene consistent with hazard thinking even where full certification is not yet feasible.

WorldFish (2021) reported that price and market information systems for Nigerian aquaculture are weak, and that smallholders lack structured access to higher-value outlets. In Enugu, lack of an organised market has sometimes been ranked below feed cost or disease, yet that ranking likely reflects adaptation to pond-gate sales rather than market efficiency (Umaru et al., 2021). Marketing skills include grading by weight, live-fish presentation, break-even and target pricing, cost and sales records, producer groups, negotiation with hotels and retailers, simple promotion, and avoidance of distress sales immediately after a disease scare. These skills convert technical survival into realised income. The study is anchored in competency-based vocational education and human capital theory. Occupations can be decomposed into teachable task clusters, and skills are productive assets that raise the return to physical capital already sunk in ponds, feed and fingerlings. A farmer who cannot recognise white-spot disease, ice a harvest or invoice a hotel is under-using the same ponds that profitability studies show can return more than the naira invested.

### 3. Method

A descriptive survey documented skill requirements as perceived by two practitioner groups. The study covered Enugu State, with nine local government areas drawn from the three senatorial districts: Nsukka, Igbo-Eze South and Udeni; Enugu North, Enugu East and Nkanu West; and Udi, Ezeagu and Oji River. Registered farmers and extension officers were listed with ENADEP and farmer associations. Of 200 questionnaires, 186 were usable (93%): 142 farmers and 44 extension officers. The Work Skills Inventory for Fish Disease Control, Preservation and Marketing had 16, 15 and 17 items, rated Very Highly Required (4) to Not Required (1). Three experts, in veterinary medicine, agricultural education and technology education, established validity. A pilot outside the study area gave alphas of .89, .86 and .88. Means answered the research questions, with a cut-off of 2.50. Independent-samples t-tests tested the hypotheses. Consent was oral, farms were anonymous, and no fish or water was sampled.

### 4. Results

**Table 1. Demographic characteristics of respondents (N = 186)**

| Characteristic                  | Farmers (n = 142) | Extension (n = 44) | Total (%)   |
|---------------------------------|-------------------|--------------------|-------------|
| Male                            | 96 (67.6%)        | 29 (65.9%)         | 125 (67.2%) |
| Female                          | 46 (32.4%)        | 15 (34.1%)         | 61 (32.8%)  |
| Age 21–40 years                 | 78 (54.9%)        | 18 (40.9%)         | 96 (51.6%)  |
| Age 41 years and above          | 64 (45.1%)        | 26 (59.1%)         | 90 (48.4%)  |
| Tertiary education              | 81 (57.0%)        | 44 (100%)          | 125 (67.2%) |
| Secondary education or less     | 61 (43.0%)        | 0 (0.0%)           | 61 (32.8%)  |
| Culture Clarias / Heteroclarias | 129 (90.8%)       | —                  | —           |
| Experience of 5 years or more   | 88 (62.0%)        | 31 (70.5%)         | 119 (64.0%) |

Note. Percentages are column percentages. Extension officers were not classified by species.

The sample is male-majority but not exclusively male, relatively young, and highly educated, consistent with earlier Enugu farm surveys.

#### 4.1 Disease-control skills

Table 2. Work skills required for fish-farm disease control

| Skill item                                                   | Farmers | Ext. | Grand | Dec. |
|--------------------------------------------------------------|---------|------|-------|------|
| Identify early signs of hemorrhagic septicemia               | 3.74    | 3.80 | 3.75  | VHR  |
| Identify white-spot and fungal growth on skin and gills      | 3.71    | 3.77 | 3.72  | VHR  |
| Test pH, temperature, ammonia and dissolved oxygen           | 3.68    | 3.82 | 3.71  | VHR  |
| Quarantine incoming stock for at least 14 days               | 3.61    | 3.75 | 3.64  | VHR  |
| Disinfect nets, boots, baskets and tanks between ponds       | 3.58    | 3.70 | 3.61  | VHR  |
| Maintain stocking density appropriate to volume and aeration | 3.55    | 3.61 | 3.56  | VHR  |
| Remove and safely dispose of dead fish daily                 | 3.52    | 3.66 | 3.55  | VHR  |
| Keep a written health and mortality register                 | 3.41    | 3.59 | 3.45  | HR   |
| Apply lime and salt dips at recommended rates                | 3.44    | 3.50 | 3.45  | HR   |
| Distinguish stress from infectious disease before treating   | 3.38    | 3.55 | 3.42  | HR   |
| Use only labelled therapeutics and observe withdrawal        | 3.36    | 3.61 | 3.42  | HR   |
| Screen inlets and cover ponds against birds and frogs        | 3.40    | 3.43 | 3.41  | HR   |

|                                                               |             |             |             |           |
|---------------------------------------------------------------|-------------|-------------|-------------|-----------|
| Call a veterinarian when mortality exceeds a threshold        | 3.29        | 3.68        | 3.38        | HR        |
| Avoid sharing water and equipment with infected farms         | 3.33        | 3.48        | 3.37        | HR        |
| Cull chronically diseased fish rather than treat indefinitely | 3.27        | 3.41        | 3.30        | HR        |
| Source fingerlings from inspected hatcheries                  | 3.22        | 3.45        | 3.27        | HR        |
| <b>Cluster mean</b>                                           | <b>3.47</b> | <b>3.61</b> | <b>3.50</b> | <b>HR</b> |

Note. VHR = very highly required ( $M \geq 3.50$ ); HR = highly required ( $2.50 \leq M < 3.50$ ).  $n = 142$  farmers, 44 extension officers.

Every disease-control item exceeded 2.50. Clinical recognition, water-quality testing, quarantine and disinfection led the ranking. Sourcing inspected fingerlings, although required, ranked lowest.

## 4.2 Preservation and marketing skills

Table 3. Work skills required for fish preservation

| Skill item                                           | Farmers | Ext. | Grand | Dec. |
|------------------------------------------------------|---------|------|-------|------|
| Stun, bleed and wash fish immediately after harvest  | 3.70    | 3.77 | 3.72  | VHR  |
| Place fish on ice within one hour of death           | 3.66    | 3.80 | 3.69  | VHR  |
| Operate an improved smoking kiln for even drying     | 3.58    | 3.66 | 3.60  | VHR  |
| Package fish in food-grade, labelled containers      | 3.55    | 3.64 | 3.57  | VHR  |
| Keep live fish in clean, aerated holding tanks       | 3.52    | 3.59 | 3.54  | VHR  |
| Estimate moisture of smoked fish before storage      | 3.44    | 3.57 | 3.47  | HR   |
| Prevent insect and rodent infestation of stored fish | 3.46    | 3.50 | 3.47  | HR   |
| Separate processing from mud and feed stores         | 3.41    | 3.55 | 3.44  | HR   |
| Use clean water and sanitizers on surfaces           | 3.39    | 3.52 | 3.42  | HR   |
| Grade by size and quality before processing          | 3.40    | 3.45 | 3.41  | HR   |
| Record batch, date and process on each package       | 3.33    | 3.50 | 3.37  | HR   |
| Transport fresh fish in insulated boxes with ice     | 3.31    | 3.48 | 3.35  | HR   |
| Avoid overloading kilns and burning painted wood     | 3.28    | 3.43 | 3.32  | HR   |
| Store product off the floor in a dry room            | 3.30    | 3.36 | 3.31  | HR   |

|                                              |             |             |             |           |
|----------------------------------------------|-------------|-------------|-------------|-----------|
| Check for off-odour, slime and discoloration | 3.24        | 3.41        | 3.28        | HR        |
| <b>Cluster mean</b>                          | <b>3.44</b> | <b>3.55</b> | <b>3.46</b> | <b>HR</b> |

Note. Decision rule as in Table 2.

**Table 4. Work skills required for fish marketing**

| Skill item                                            | Farmers     | Ext.        | Grand       | Dec.      |
|-------------------------------------------------------|-------------|-------------|-------------|-----------|
| Handle and display live fish without injury           | 3.69        | 3.73        | 3.70        | VHR       |
| Weigh accurately and price by kilogram                | 3.65        | 3.70        | 3.66        | VHR       |
| Keep written records of cost and sales                | 3.58        | 3.75        | 3.62        | VHR       |
| Calculate a break-even price before harvest           | 3.51        | 3.66        | 3.55        | VHR       |
| Join or form a cooperative for bulk sale              | 3.49        | 3.61        | 3.52        | VHR       |
| Identify hotels, restaurants and retailers            | 3.47        | 3.57        | 3.49        | HR        |
| Time harvest to local demand peaks                    | 3.44        | 3.52        | 3.46        | HR        |
| Grade table fish into market weight classes           | 3.42        | 3.50        | 3.44        | HR        |
| Negotiate supply agreements, not only pond-gate sales | 3.38        | 3.55        | 3.42        | HR        |
| Advertise stock by phone and social media             | 3.40        | 3.45        | 3.41        | HR        |
| Avoid distress sales after a disease outbreak         | 3.36        | 3.48        | 3.39        | HR        |
| Differentiate price of live, fresh and smoked fish    | 3.33        | 3.41        | 3.35        | HR        |
| Provide receipts and farm identity                    | 3.28        | 3.50        | 3.33        | HR        |
| Estimate cash flow in the last month of culture       | 3.26        | 3.45        | 3.31        | HR        |
| Comply with market hygiene and levy rules             | 3.24        | 3.36        | 3.27        | HR        |
| Collect buyer feedback on size, taste and off-flavour | 3.21        | 3.34        | 3.24        | HR        |
| Explore smoked-fish branding for urban shops          | 3.18        | 3.32        | 3.21        | HR        |
| <b>Cluster mean</b>                                   | <b>3.41</b> | <b>3.52</b> | <b>3.44</b> | <b>HR</b> |

Note. Decision rule as in Table 2.

All preservation and marketing items were required. Hygienic slaughter, icing, improved smoking and live holding led preservation. Live handling, weighing, records, break-even pricing and cooperatives led marketing. Branding and buyer feedback ranked lowest but remained above the cut-off.

**Table 5. t-test comparison of farmers and extension officers**

| Skill cluster   | Farmers M | Ext. M | t    | p    | Decision       |
|-----------------|-----------|--------|------|------|----------------|
| Disease control | 3.47      | 3.61   | 1.47 | .143 | NS; accept H01 |
| Preservation    | 3.44      | 3.55   | 1.11 | .268 | NS; accept H02 |
| Marketing       | 3.41      | 3.52   | 1.09 | .278 | NS; accept H03 |

Note.  $df = 184$ . Two-tailed. NS = not significant at  $\alpha = .05$ .

None of the cluster comparisons reached significance. Extension officers rated every cluster slightly higher, but not enough to reject the null hypotheses.

## 5. Discussion

Disease control, preservation and marketing are core occupational competencies, not peripheral add-ons. Cluster means of 3.50, 3.46 and 3.44 are comparable to earlier Enugu ratings for pond construction and feeding (Aneke et al., 2022b; Nwosu & Offorbuike, 2021). The disease ranking maps onto the epidemiology reported by Omeje et al. (2021): hemorrhagic septicemia and white-spot disease were the most frequent conditions, and they are the highest-rated skills. Water-quality testing ranked third, consistent with outbreaks precipitated by ammonia, low oxygen or pH drift. Quarantine and disinfection are inexpensive behavioural skills that WorldFish (2021) found practised mainly on larger farms.

Farmers rated veterinary referral lower ( $M = 3.29$ ) than extension officers ( $M = 3.68$ ), reproducing the self-medication pattern in Omeje et al. (2021). Training that only lists drugs will deepen that pattern. Training that pairs symptom recognition with a referral rule is more likely to change practice. Preservation findings follow the live, fresh, smoked and dried value chain (Oman et al., 2023). Process skills were valued more than sensory quality checks, a gap with food-safety implications as smoked fish moves into shops. Marketing findings show that farmers already understand live presentation and weighing. Cooperative marketing was rated highly required, yet pond-gate sale remains the coping routine. Branding ranked last, a frontier skill rather than current practice.

National Board for Technical Education fish-farming practice units already include fish health condition, disease causative agents and basic prevention rules. The competencies are therefore recognised at the vocational qualification level, but they are unevenly translated to commercial farms. Curriculum documents alone do not produce a quarantine habit, a mortality register or a withdrawal-period rule. That translation gap is the practical reason for treating the inventory as a teaching checklist rather than as a literature summary.

Record keeping and break-even calculation ranked immediately after live handling and weighing, which is encouraging where market-information systems are weak (WorldFish, 2021). Cooperative marketing and identification of institutional buyers were rated required, yet earlier constraint rankings in Enugu sometimes placed lack of an organised market low on farmers' complaint lists (Umaru et al., 2021). The apparent contradiction is resolved if pond-gate sale is treated as a coping routine rather than as an efficient market. Farmers know a better market would pay more. They do not yet run the organisations that would create it. The lower rating of sensory quality checks and kiln-fuel discipline points to a residual gap: process skills are valued more than product-quality skills, with food-safety implications as smoked fish moves from open markets into shops that will eventually demand labelling and contaminant control.

The absence of farmer–extension differences means one competency framework can serve pre-service education and in-service extension. Disagreement about what to teach is not the binding constraint. Delivery, the price of test kits, ice, improved kilns and veterinary visits, and the incentive to apply the skills are more likely constraints. Chukwuone et al. (2021) found low use of sustainable environmental practices among Enugu catfish farmers even where education levels were respectable. Skills identification is therefore necessary but not sufficient. Adoption will still depend on whether cooperatives can convert individual skill into collective bargaining power.

Two cautions follow. Mean ratings describe perceived importance, not current competence. An item can be rated very highly required by farmers who do not yet perform it. The instrument also did not measure laboratory diagnostic skill or formal hazard-analysis certification, both of which remain scarce in the State and would require a different training architecture from pond-side short courses. Registered farmers are likely better organised than unregistered backyard

producers, so the sample may overstate current practice even as it validly identifies required skills. Findings are specific to a catfish-dominated inland pond system and should not be generalised to cage culture or brackish-water systems without adaptation.

## 6. Conclusion and recommendations

Farmers and extension officers jointly identified a coherent set of competencies in disease control, preservation and marketing. No statistically significant disagreement separated the groups. Agricultural education and aquaculture extension in Enugu State should treat aquatic animal health, post-harvest technology and market literacy as standing pillars of fish-farmer competence.

Six actions follow. First, departments of agricultural education should embed the 48-item inventory as a teaching and assessment checklist in fisheries and vocational agriculture courses. Second, ENADEP and the Enugu chapter of the Fisheries Society of Nigeria should run short pond-side courses that pair symptom recognition with water-quality testing and a written veterinary-referral rule, rather than courses that only demonstrate drug use. Third, the State Ministry of Agriculture should support shared ice depots, improved smoking kilns and insulated transport through farmer cooperatives in the nine high-density local government areas sampled here. Fourth, farmer associations should adopt standard weight classes, simple farm records and pooled sales to hotels and retailers, using the marketing skills already rated as required. Fifth, veterinary faculties at the University of Nigeria, Nsukka, and related institutions should designate at least one ambulatory fish-health contact point per senatorial district, to reduce the self-medication default documented by Omeje et al. (2021). Sixth, subsequent research should move from importance ratings to performance assessment: observed biosecurity audits, measured post-harvest loss, and farm-gate versus contracted prices before and after training.

The study relied on self-reported importance ratings rather than direct observation of skill performance. Laboratory confirmation of disease on participating farms was not repeated, so epidemiological claims rest on published Enugu evidence. These limits qualify the ranking but do not remove the agreement between farmers and extension officers on all 48 items.

### 6.1 Implications for training

The inventory can be taught as three linked modules rather than as a single survey table. A disease-control module should open with the two conditions already documented on Enugu farms, hemorrhagic septicemia and white-spot disease, then move to a water-quality practical and a written rule for when mortality triggers a veterinary call. A preservation module should run from stunning and bleeding through icing, kiln operation, a moisture check and labelled packaging, using one batch of fish so that students see the sequence rather than isolated techniques. A marketing module should require a break-even price, a weight class, a one-page sales record and a named institutional buyer, so that pond-gate sale is treated as a fallback rather than as the syllabus endpoint.

ENADEP monthly meetings are a feasible delivery point for the first module, because extension officers and farmers already share the same ranking. College demonstration ponds at Enugu State College of Education (Technical) and the University of Nigeria, Nsukka, are the feasible site for the preservation sequence, where ice, a kiln and a packing bench can be shared. Farmer associations are the feasible site for the marketing module, because cooperative sale cannot be practised by a lone trainee. Splitting delivery in this way matches the finding that the constraint is not disagreement about the skill list, but the cost and organisation required to apply it.

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