International Journal of Fisheries and Aquatic Research
www.fishjournals.com
ISSN: 2456-7248
Received: 26-12-2025; Accepted: 01-02-2026; Published: 16-02-2026
Volume 11, Issue 1, 2026, Page No. 41-49

Comparative review of tilapia aquaculture in Ghana, Nigeria and Sierra Leone

Samuel Ifeanyi Ogbuagu[1], Obadara Emmanuel Ogundeji[1], Esther Edith Kargbo[1], Jimkuta Chindo[1], Hassan Opeyemi Ogunyejo[2]

[1] Department of Freshwater Fisheries Research Centre, Nanjing Agricultural University, Jiangsu province, China
[2] Department of Aquaculture and Fisheries, University of Ilorin, Nigeria

Abstract

Tilapia aquaculture is a strategic pillar of food security, employment, and economic development in West Africa, with Nigeria and Ghana as dominant producers and Sierra Leone representing a developing but less consolidated sector. Although these countries share broadly similar agroecological conditions and rising demand for fish protein, their aquaculture industries have evolved along divergent trajectories shaped by differences in production systems, governance frameworks, institutional capacity, and value-chain organization. This review comparatively analyses tilapia aquaculture in Ghana, Nigeria and Sierra Leone to identify key drivers of growth, structural constraints, and policy-relevant lessons for sustainable sector development. Based on evidence from peer-reviewed studies, policy documents, and institutional reports, the review reveals marked disparities in production intensity and commercialization. Ghana's tilapia industry is characterized by advanced commercialization, dominated by cage culture on Lake Volta, supported by relatively robust regulatory systems, strong private-sector investment, and more consistent access to quality feed and seed. In contrast, Nigeria's tilapia production remains predominantly small-scale and pond-based, constrained by high feed costs, variable fingerling quality, infrastructure deficits, and uneven policy implementation. Sierra Leone's sector is comparatively nascent, dominated by smallholder pond systems with limited technological adoption, weak hatchery and feed industries, and heavy reliance on external support. Despite abundant freshwater resources and favorable environmental conditions, growth in Sierra Leone is impeded by limited access to finance, weak extension services, and insufficient market integration. Common challenges across the three countries include rising input costs, disease risks, environmental pressures, and increasing vulnerability to climate variability. While Ghana faces ecological concerns associated with intensive cage farming, Nigeria exhibits significant untapped potential due to its extensive inland water resources and large domestic market, and Sierra Leone illustrates both the structural constraints and inclusive development opportunities of emerging aquaculture systems. The review concludes that sustainable expansion of tilapia aquaculture in West Africa will depend on strengthened regulatory enforcement, improved hatchery and feed systems, enhanced farmer capacity, and adoption of environmentally responsible production practices, complemented by regional collaboration and harmonized standards to enhance resilience and long-term productivity.

Keywords: Tilapia aquaculture, ghana tilapia farming, nigeria tilapia farming status, cage farming technology, sierra leone breeding technology

Introduction

Pisciculture translated as aquaculture, is one of the world's leading sectors in food production, represents a critical strategy for enhancing global food security yet promoting sustainable management of aquatic life. Despite being dominated by the Asian continent, aquaculture is experiencing global spread, with Africa demonstrating strong growth potential. This shift demonstrates the expanding role of aquaculture in addressing nutritional deficits, poverty, and livelihood challenges in developing countries (Naylor *et al.,* 2021) [27]. Also, in global context, tilapia farming has emerged as a bedrock of aquaculture development in West Africa, particularly in Nigeria, Ghana, and Sierra Leone, where it stands as pillar of hope in meeting protein needs while confronting diverse structural and operational constraints.

The rapid adoption of tilapia farming in West Africa is largely attributable to the species' biological importance, including rapid growth, high environmental tolerance, and efficient feed conversion, which make it suitable for both small-scale and commercial production systems. In Ghana, Frimpong and Fynn, (2014) [14] asserted that tilapia production dominates the aquaculture sector, with approximately 90% of farmed fish produced through cage culture, primarily in Lake Volta. This growth in production has been sustained through technological innovation, private-sector investment, and relative support in regulatory frameworks. While, in Nigeria tilapia sector despite contributing about 19% of national aquaculture output, remains hindered by catfish production due to cultural preferences and established market structures. Nevertheless, there exist opportunities for expansion and diversification. However, in Sierra Leone inland tilapia fish farming is significantly recognized while the sector is largely subsistence dominated and has yet to attain gainful commercial scale regardless of longstanding interest and favorable environmental conditions (FAO, 2023).

Regardless, the importance of tilapia fish farming is beyond production metrics to basic food security results. In Ghana, where annual per capita fish consumption ranges from 25 to 30 kg, tilapia contributes substantially to animal protein intake. By contrast, Nigeria faces a pronounced fish supply deficit, with domestic production meeting only 38.1% of total demand, underscoring the urgent need to upscale local aquaculture capacity (Odioko and Becer, 2022) [13]. However, Nigeria, Ghana, and Sierra Leone, are faced with common challenges including limited access to quality

fingerlings, high feed costs, disease risks, water quality constraints, and restricted access to finance.

Nonetheless, there persist, strong growth prospects, driven by rising demand, technological advancements, and evolving policy support. Addressing these challenges through improved genetic stock, enhanced feed systems, strengthened extension services, and strategic value-chain investments will be ideal for tapping into the full potential of tilapia aquaculture and promoting sustainable food security and economic resilience in West Africa

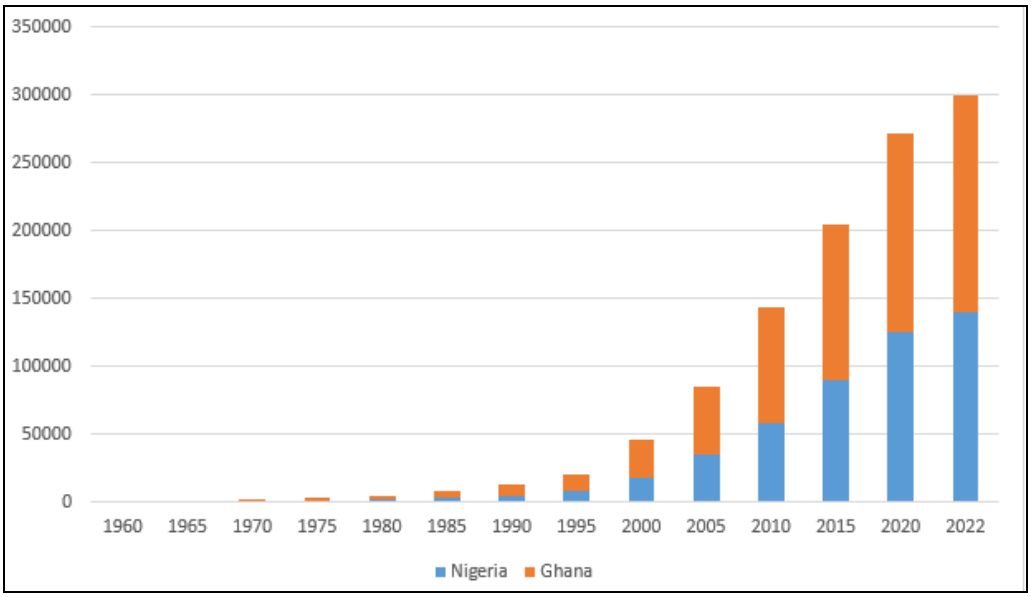
1. Key Aquaculture Species and Production Trends in Ghana, Nigeria and Sierra Leone

Aquaculture currently is a crucial component of food security and economic development in Ghana and Nigeria, Sierra Leone, though with distinct historical origins, production characteristics and species dominance in each country. The sector demonstrates contrasting patterns of species preference, production systems, and growth patterns that reflect varying developmental pathways and market orientations. Tilapia (*Oreochromis niloticus*), African catfish (*Clarias gariepinus*) and *Heterobranchus spp*. are the dominant aquaculture species in these countries. Nigeria's production exceeded 259,000 tonnes in 2022 [30], while Ghana's output is largely tilapia-based. And, in Sierra Leone, the majority of tilapia farming is done by small scale farmers utilising low-input, low-output systems in freshwater pond system. Regardless, aquaculture production in Sierra Leone has increased from almost non-existent levels in the late 20th century to about 115 tonnes in 2021 (FAO, 2023) [32].

2. Historical Origins and Development

The establishment of tilapia farming followed markedly different timelines in these countries. In Ghana, formal tilapia aquaculture began earlier, with initial government-led initiatives dating back to the early 1950s. This effort was significantly advanced by the establishment of the Volta Fisheries Research Station (VFRS) in Akosombo in 1964, which served as a central hub for research and fingerling distribution, mainly acknowledging Nile tilapia (*Oreochromis niloticus*) as the bedrock of the nation's aquaculture strategy (van der Lingen, 1964).In Nigeria's stance, in tilapia farming started later and faced more initial challenges. The first documented introduction occurred between 1959 and 1960, with more organized research beginning at the National Institute for Freshwater Fisheries Research (NIFFR) in New Bussa in the 1970s (Ezenwa, 1981; NIFFR, 1975). However, early efforts were hampered by challenges of uncontrolled reproduction in ponds, which led to stunted growth. This biological challenge, alongside with the concurrent and more successful development of African catfish (*Clarias gariepinus*) culture, caused tilapia to be overshadowed for decades, with relevant commercial growth only seeing the light of the day from the 2000s onwards with the introduction of improved strains and monosex culture techniques (Fagbenro, 2014).

Comparatively, while Nile tilapia stock was introduced and training facilities were established between late 1970s and early 1980s, aquaculture production in Sierra Leone started out as small-scale operations (FAO, 2023). However, international research and development partners, such as USAID and WorldFish, funded these initial initiatives with the goal of addressing food shortages and diversifying rural livelihoods (WorldFish, 2021). Slow sector development resulted from poor infrastructure and technical capacity, hindered production expansion despite initial attempts in Makali village.



Source: FAO database

Fig 1: Estimated Tilapia Aquaculture Production (Metric Tonnes) for Ghana, Nigeria and Sierra Leone (1960-2024)

4. Aquaculture Specialization in Ghana, Nigeria and Sierra Leone.

Ghana shows a dominating model, characterized by the overwhelming presence of Nile tilapia, a trend followed since its pioneering days in the 1960s. Approximately 95% of all domestic aquaculture production is Nile tilapia, with the remainder consisting mostly of African catfish produced in tanks or ponds as polyculture with tilapia (FAO, 2013). This tilapia-centric approach has been aided by the extensive adoption of cage farming systems. Of the total tilapia production, upwards of 90% was from cage systems, with ponds contributing only 1,000 to 1,500 metric tonnes in

2013, demonstrating a clear technological pathway distinct from Nigeria's model.

In 2022, Nigeria's aquaculture sector regains its position as one of Africa's leading producers with an output of 259,106 metric tonnes of fish (FAO, 2024a). The sector is characterized by the dual dominance of two primary species groups, a direct result of its historical development. The African catfish (*Clarias gariepinus*) comprising a substantial 54% of the country's total aquaculture production, a legacy of its earlier and more successful adoption. Tilapia, despite its long presence, accounts for a smaller but growing share of 19% (FAO, 2024a). However, the key tilapia species under cultivation include the Nile tilapia (*Oreochromis niloticus*) and the Blackchin tilapia (*Sarotherodon melanotheron*) (Oboh, 2022) [26]

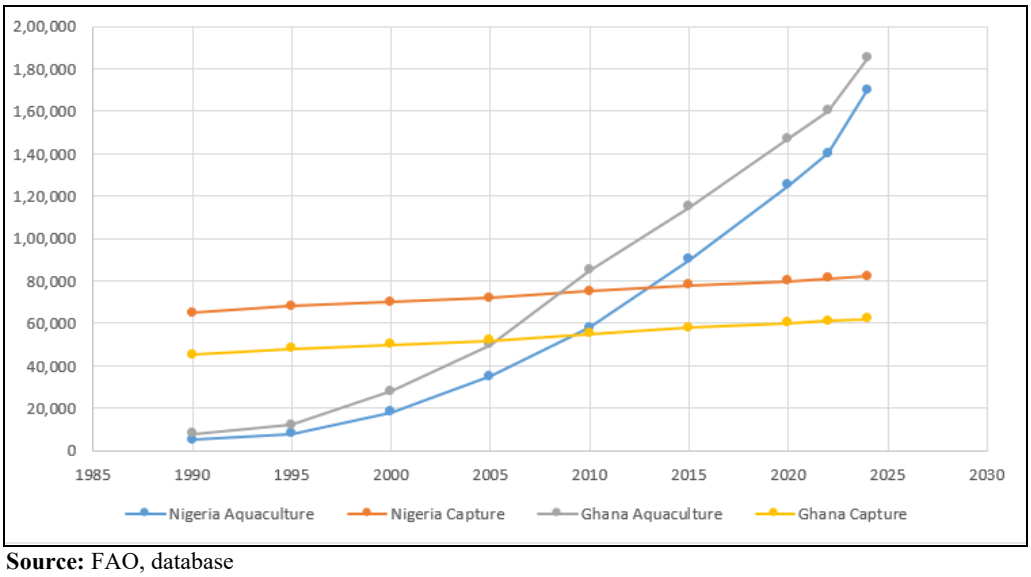
Interestingly, in Sierra Leone the most common species in aquaculture is the Nile tilapia (*Oreochromis niloticus*), and some naturally occurring catfish species including *Clarias gariepinus* and *Heterobranchus spp.* following to a lesser degree (FAO, 2023).

5. Production Trends and Growth Trajectories

Analysis of production trends from 1999 to 2024 as shown in fig.2 reveals significant growth in these countries (especially Ghana and Nigeria driven by their unique historical foundations). Nigeria has demonstrated consistent expansion, with its aquaculture sector growing at an average annual rate of 13.6% since 2000, a growth that now includes a resurgent tilapia segment. Ghana's growth, while also substantial, has been characterized by different phases, including periods of rapid cage culture adoption building on its long-established tilapia farming base and subsequent consolidation.

Furthermore, Future projections to 2030 indicate continued growth for these nations, driven by increasing domestic demand, technological improvements, and policy support. The species composition and production systems are likely to maintain their distinct characteristics, rooted in their separate histories: Nigeria continuing its catfish dominance while further developing its tilapia potential, and Ghana maintaining its long-standing specialized focus on tilapia, particularly through cage culture systems in the Lake Volta region.

However, in Sierra Leon catch fisheries still account for a far larger portion of Sierra Leone's total fish production. Over the past few decades, growth trajectories have shown an incremental tendency; nonetheless, obstacles such limited market pathways, technical skill gaps, and input limits have precluded more substantial expansion (FAO, 2023). according to regional comparisons, superior institutional backing and value chain connections have allowed nations like Ghana and Nigeria to achieve more significant growth in tilapia farming.



Source: FAO, database

Fig 2: Tilapia Production (MT) in Nigeria and Ghana (1990-2024)

The Nile Tilapia

Nile tilapia (*Oreochromis niloticus*) occupies a crucial position in global aquaculture, boasting a cultivation history dating back 3000 years as evidenced by Egyptian tomb illustrations (El-Sayed, 2013) Native to Africa's freshwater systems, this unique fish has achieved worldwide distribution since the mid-20th century due to its exceptional environmental adaptability, tolerance to varying water conditions, and overall hardiness (El-Sayed, 2006). Currently, Tilapia is farmed in over 140 countries, earning the name “the world fish”, as the most cultured fish across continents. Also, global farmed tilapia production has surpassed 6 million tonnes annually, establishing it as the second most important freshwater aquaculture species after carps (Abwao *et al.,* 2023; FAO, 2020a) [1, 3]. China (1.78 MT), Indonesia (1.12 MT), and Egypt (0.88 MT) lead global production, with significant contributions from other nations including the Philippines, Thailand, and increasingly, West African nations like Ghana (FAO, 2017; Yue, 2016) [10, 40]. Projections indicate continued expansion, with global output expected to reach 7.3 million tonnes by 2030 (FAO, 2020b), reflecting its crucial role in meeting growing global protein demand.

Relatively, among approximately 70 identified tilapia species, Nile tilapia has emerged as the most cultured species worldwide. This dominance stems from a combination of biological attributes that make it exceptionally suitable for aquaculture, rapid growth rates and efficient feed conversion, high tolerance to environmental fluctuations and handling stress, resistance to

common aquatic diseases, ability to reproduce successfully in captive conditions, early maturation and short generation time and adaptability to artificial feeds immediately after yolk-sac absorption (Ng, 2013). Regardless, these characteristics have established Nile tilapia as an enviable candidate for both small-scale subsistence farming and large-scale commercial operations.

Recently, the need for systematic efforts to secure and further improve the genetic quality of farmed stocks is widely recognized (Chavan, 2012; Popma, 1999) [18, 37]. Modern tilapia culture, first recorded in Kenya in 1924, has since spread throughout Africa and beyond (Adeleke, 2020; Shrestha, 2019) [3, 38]. The development of Genetically Improved Farmed Tilapia (GIFT) strains and other selective breeding programs has significantly enhanced growth performance and disease resistance, further solidifying its position in global aquaculture. Also, the species' importance is particularly evident in West Africa, though with distinct national patterns. For example, In Nigeria, Nile tilapia is the second most widely cultured species, accounting for 19% of total aquaculture production in 2022 (FAO, 2024b) [13, 33], reflecting the country's strong historical preference for African catfish. While in Ghana, Nile tilapia dominates the aquaculture sector, comprising 80-90% of total production (FAO, 2013) [28] largely driven by successful cage culture operations on Lake Volta. Currently, the continued expansion of Nile tilapia farming worldwide by various agency such as the worldFish and FAO underscores its critical role in sustainable food production, income generation, and poverty alleviation, particularly in developing regions where animal protein demand continues to grow rapidly.

1. Challenges of Tilapia Aquaculture in Ghana, Nigeria and Sierra Leone.

Facing numerous hurdles, tilapia farming worldwide contends with disease outbreaks, poor-quality seed and feed, alongside shifting climate patterns. Though Nigeria holds promise for tilapia production, obstacles persist. A key issue lies in the scarcity of high-performing young fish, slowing progress. Many hatcheries rely on weakened genetic lines, resulting in uneven offspring and slower development. Without a coordinated national effort to improve genetics, the problem deepens (Omitoyin, 2020). Compounding matters, the cost of feeding stocks soars - accounting for between 60 and 70 percent of total operational cost. Imported materials dominate ingredient sourcing, while minimal domestic production capability keeps expenses high. Because many market-ready feeds lack balanced nutrition, fish grow slower than possible - driving up operational spending (Falaye, 2021) [24].

Still, a large number of Nigerian fish farmers operate without key know-how about current farming methods. Without proper control over water quality conditions, feeding routines suffer as well as growth rates. Productivity drops further where illness spreads easily due to weak monitoring systems. Outbreaks like *streptococcosis* often lead to high death counts among stock. In breeding facilities especially, preventive steps against sickness are rarely followed. Rising water heat from shifting weather patterns worsens such risks. Help from animal doctors remains scarce, making early treatment hard to get. Few protective measures exist, leaving farms more exposed when problems arise. Other obstacles include inadequate infrastructure, limited market access, inconsistent government policies, insufficient funding, particularly for small-scale farmers and Inconsistent electricity supply hampers water aeration and management systems, while poor transportation infrastructure increases post-harvest losses and limits market access (Central Bank of Nigeria (CBN), 2019) [16].

Within Ghana, unreliable access to top-grade, genetically enhanced tilapia fry holds back farm output. Because many local hatcheries work with basic breeding stock, offspring often suffer weaker performance; growth slows, physical defects appear, survival drops (Kassam, 2014) [25]. Without broad use of stronger lines like GIFT, progress stalls; gains in yield and efficiency remain out of reach (Arkoosh *et al.,* 2020) [11]. Although, high cost and poor quality of feed among other factors limits Tilapia farming as feed constitutes the largest operational cost, often accounting for 60-70% of total expenses. The reliance on imported feed makes the industry vulnerable to global price shocks and currency fluctuations (Hecht, 2019). While local feed production exists, the quality is often inconsistent and nutritionally incomplete, leading to poor Feed Conversion Ratios (FCR), increased waste, and water pollution (Ragasa, 2019). Also, (Frimpong and Fynn, 2014) report that high feed cost is one of the major challenges of Tilapia aquaculture with an example of a 2011 study comparing Ghana’s tilapia retail prices to those in Egypt, China and the Philippines found prices were four to six times higher in Ghana and concluded that Ghana’s tilapia was not competitive on the international or local markets.

Despite being less widespread, pond-based tilapia farming contrasts with the more localized dominance of cage systems in Ghana. Disease problems have grown alongside the rise of intensive cage setups. Among the most concerning infectious agents are *Streptococcus agalactiae* and Tilapia Lake Virus (TiLV), identified in recent studies. Overcrowding combined with deteriorating water conditions tends to weaken fish immunity. Stress from such environmental factors often leads to severe mortality events. Knowledge gaps remain common because training resources and field guidance reach few producers. Support networks for farmers stay underdeveloped, leaving many without updated methods. Since expertise spreads slowly, outdated approaches persist across much of the sector. Problems pop up regularly when handling water cleanliness, counting fish stocks, or managing disease - research points this out clearly (Anku, 2017) [10]. When support programs fail, it’s usually because travel hurdles exist alongside outdated teaching tools, so those farming miss key advice they need (World Bank, 2013).

Inland waters like Lake Volta see heavy use of cage farming, sparking questions about long-term ecological balance. Beneath these floating enclosures, leftover food and fish waste build up, often triggering nutrient overload and reduced dissolved oxygen levels (Asmah, 2014) [14]. Water demand grows tighter when fish ponds share supplies with farms or communities, especially once rainfall dwindles. Pressure on supply becomes most visible during months without rain.

Investment demands in fish farming, especially within floating cages, create tough entry points. Without assets to back loan requests, small-scale producers find it hard to access funding through official channels - this restricts upgrades to better seed or feed while slowing farm growth (Cobbina, 2015) [19]. Since imported frozen tilapia arrives at lower price levels, domestic growers struggle to compete; evidence from a United Nations agency study confirms market pressure harms local output (FAO, 2018). Oversight gaps in location permits and ecosystem checks add strain - unchecked expansion could threaten ecological balance down the line (Environmental Protection Agency (EPA), 2016).

Facing similar challenges, Sierra Leone's tilapia farming struggles with persistent barriers. Limited access to quality fingerlings slows output - just as poor feed supply worsens inefficiency. Expanding operations becomes harder still when construction costs rise while loans remain scarce, according to findings from Bo City in 2025. Without widespread training programs or field support, best practices rarely take hold on farms. Though intensification could boost yields, progress stalls under overlapping constraints revealed in that same study.

2. Adoption Level of Tilapia Aquaculture in Ghana, Nigeria and Sierra Leone.

Ghana's shift toward tilapia farming ties closely to how easily Nile tilapia (*Oreochromis niloticus*) handles local weather patterns and fluctuates well under different water conditions. Often found on dinner plates across the country, this fish already enjoys deep roots in daily meals - making it easier for farmers to sell without convincing buyers first. Because people know and eat tilapia regularly, stepping into production feels less risky than pushing an unfamiliar type would be (Kassam, 2014) [25].

Over time, wild ocean fishing has weakened, falling at about two percent each year after 1995 - a slow fade that opened space for farmed alternatives like tilapia to step forward. When major fish populations declined, raising profits from local fish farming became more appealing (FAO, 2018). Because some cage farms thrived on Lake Volta, others took notice - imitation followed quickly. Seeing pioneers do well pushed many nearby villages to try it themselves (Frimpong and Fynn, 2014). Though less obvious at first, aid from global groups like the World Bank, FAO, and WorldFish Center played a quiet but deep role - training people, sharing tools, shaping knowledge in tilapia growing (World Bank, 2013).

Even though Nigeria leads African aquaculture output, tilapia makes up just around 19% of that volume because multiple challenges slow its growth. Preference among buyers leans heavily toward catfish - this species takes up roughly 54% of farmed fish output - as a result, room for tilapia shrinks sharply. Rooted deep in local custom, African catfish (*Clarias gariepinus*) enjoys favor thanks to flavor, resilience, plus tolerance for waters low in oxygen (Federal Department of Fisheries (FDF) Nigeria, 2018; FAO, 2020) [4]. When it comes to young stock availability, systems producing healthy tilapia juveniles lag behind those built for catfish. Just under one-quarter of hatcheries release tilapia fry into circulation, whereas more than three out of four concentrates on raising catfish (Fagbenro *et al.,* 2019) [22].

However, many farmers perceive tilapia as more susceptible to handling stress and disease outbreaks compared to catfish. The prolific breeding characteristic of tilapia leads to stunted growth in mixed-size populations, discouraging farmers (Ayinla, 2019) [16]. Most existing aquaculture infrastructure is optimized for catfish production. The lack of dedicated tilapia hatcheries and breeding facilities constrains production capacity (Nwosu *et al.,* 2020) Also, limited extension services specific to tilapia farming techniques. Only 15% of aquaculture extension materials focus on tilapia, while 67% target catfish production (Akinrotimi *et al.,* 2021) [7]. Historical research and development priorities have favored catfish, with 72% of aquaculture research funding allocated to catfish studies between 2010-2020 (Nigerian Institute for Oceanography and Marine Research (NIOMR)., 2021) Limited availability of tilapia-specific feeds and production inputs compared to the well-developed catfish feed industry (Omitoyin, 2022). Although, the low adoption of Tilapia aquaculture in Nigeria which is affected by the predominance of catfish in Nigerian aquaculture reflects complex interactions between cultural preferences, established value chains, and historical development pathways that have collectively constrained tilapia adoption despite its potential for contributing to food security.

Despite some progress, tilapia farming spreads slowly among countryside growers in Sierra Leone. Profit concerns, shifting expenses for supplies, along with inconsistent ways to reach buyers, leave most small-scale operators viewing fish rearing as extra earnings instead of main revenue. Still, more than half manage their ponds without certified instruction or field expert guidance - a gap that limits output while slowing broader uptake across regions (Research in Bo City, 2025).

3. Environmental Sustainability concerns of Tilapia Aquaculture in Ghana, Nigeria and Sierra Leone.

Just like other developing countries, aquaculture can pose environmental risks if not managed responsibly. In Nigeria, the key concern is the water and environmental pollution arising from discharged fish farm wastewater (Ojewole, 2024) [33]. Uneaten feed and fish waste release nitrogen and phosphorus into water bodies, causing eutrophication. In Ghana's Lake Volta, cage farms have shown elevated nutrient levels (up to 45% increase in phosphorus) near farm sites (Asmah *et al.,* 2015) [15]. In Nigeria's Ogun State, pond effluents contained 68% higher ammonia concentrations than permissible limits (Adeogun, 2020) [4] Unregulated antibiotic use in Nigerian tilapia farms has led to detectable residues in 32% of sampled fish, raising concerns about antimicrobial resistance (Okocha, 2018) [34]. In Ghana's Ashanti region, 28% of farmers reported using antibiotics prophylactically (Amoah, 2022) [9].

In Nigeria, escaped Genetically Improved Farmed Tilapia (GIFT) have hybridized with native stocks in the Niger River, reducing genetic diversity by approximately 15% in affected populations (Nwosu *et al.,* 2021) [29] Ghana reports similar concerns in the Volta Basin, where non-native strains compete with indigenous species (Obirikorang, 2019). Furthermore, Coastal aquaculture development in Nigeria's Niger Delta has converted approximately 850 hectares of mangrove forests for pond construction, affecting coastal protection and nursery habitats (Uddin, 2022) [39]. Ghana's coastal zones face similar pressures, though at a smaller scale (Aheto, 2021) [5]. High stocking densities in both countries facilitate disease transmission to

wild fish populations. Tilapia Lake Virus (TiLV) detected in Nigerian farms shows 92% genetic similarity to wild strain variants (Omosowone *et al.,* 2023) [36] Ghana reports increasing prevalence of *streptococcosis* in both farmed and adjacent wild populations (Acquah, 2022) [2].

Although, there are ongoing efforts to address these concerns and promote sustainable aquaculture practices as both countries are exploring integrated multi-trophic aquaculture (IMTA), improved feed management and guidelines from IFAD for small-scale farmers in Nigeria, encourages responsible water use and improved waste management (International Fund for Agricultural Development (IFAD), 2023) [23] Nigeria has seen 40% reduction in nutrient discharge through feed optimization (Ekunwe *et al.,* 2021) [21], while Ghana promotes spatial planning protocols that have reduced mangrove conversion by 60% in designated zones (Aheto *et al.,* 2023) [6].

Despite limited local data, concerns around water degradation persist where tilapia farming occurs. Poor pond upkeep can lead to nutrient buildup from uneaten food and excrement. This runoff might harm surrounding habitats over time. Research worldwide highlights the need for careful oversight in fish production systems. Practices known to lower environmental harm remain underused in parts of Sierra Leone. Evidence specific to the region is sparse, yet global patterns suggest caution. Adjusting farm methods could lessen ecological strain without reducing output.

4. Prospects of Tilapia Aquaculture in Ghana, Nigeria and Sierra Leone.

A nation of more than 200 million people faces a shortfall in fish supply reaching 2.5 million metric tons each year, setting conditions where tilapia may play a key role. Growth in demand for this species continues upward at roughly 8.2 percent every twelve months until 2030, according to data reported by FAO in 2022. While attention turns westward, Ghana maintains an individual intake ranging between 25 and 30 kilograms of fish per person annually - a pattern that supports continuous need. Because pricing remains accessible, widespread adoption becomes likely, possibly lowering import expenses currently measured near $200 million on an annual basis, as noted by WorldFish in 2023. Progress does not stop there; innovation shapes outcomes in both countries through updated methods in science-based farming, including selective gene enhancement such as GIFT variants - these have demonstrated increases in development speed from 15 to 20 percent alongside better food-to-weight performance. Twenty-eight percent marks the rise in yields where Nigeria scaled up adoption during trials led by CGIAR scientists at WorldFish in 2023 (Fagbenro *et al.,* 2023) [23]. In contrast, gains of thirty-five percent appear in Ghana's data following deployment of enhanced fish varieties through its national research hub (Asiedu, 2022) [13].

Success seen where farming combines crops and fish. In Ebonyi State, Nigeria, rice fields hosting fish deliver 28 percent greater total output (Nwosu *et al.,* 2022) [30]. Across borders, Ghana sees results; vegetable plots paired with tilapia ponds in Ashanti cut water waste by 42 percent (Obirikorang *et al.,* 2023) [31]. Government frameworks lend weight here - Abuja aims at half a million metric tons of farmed tilapia before 2025 ends (Federal Department of Fisheries (FDF), 2022) [26]. To match it, Accra commits fifty million U.S. dollars to strengthen how tilapia moves from pond to plate (Ministry of Fisheries and Aquaculture Development (MOFAD), 2023) [1]. Shifting focus toward different aquatic species, raising quality benchmarks, opens doors for Nigerian suppliers overseas (Ogunji and Wuertz, 2023) [32]. Europe becomes reachable when health rules meet strict thresholds. Already, certified producers in Ghana ship fifteen thousand tonnes each year westward (Ghana Export Promotion Authority (GEPA), 2023) [6].

Even so, boosting tilapia production in Sierra Leone hinges on strategic upgrades - better markets, reliable feeds, expanded hatcheries, and stronger advisory support. Once barriers fade, progress often follows, as backers and funders regularly note when discussing aquaculture gains (InvestSalone, 2022; The Fish Site, 2022) [2, 13].

5. Unlocking the Tilapia Aquaculture potential in Ghana, Nigeria and Sierra Leone.

Despite steady growth, long-term development hinges on diverse methods. Genetic enhancement plays a role, as seen when Ghana introduced improved tilapia breeds - trials there recorded output rising by 35 percent (Asiedu *et al.,* 2023) [12]. In Nigeria, room for scaling up exists, especially via linked farming and fish-raising setups; early efforts noted overall gains near 28 percent (Nwosu *et al.,* 2022) [30].

One way to cut expenses involves better handling of animal diets, leading to a drop in output spending by one-quarter alongside fewer ecological effects (WorldFish, 2023). Although less obvious, progress in trade routes matters just as much - evidence from Ghana shows how entry into European markets for farmed tilapia became possible due to organized export efforts (Ghana Export Promotion Authority (GEPA), 2023) [6]

For such possibilities to emerge, alignment among multiple areas becomes necessary. Through stable policies and follow-through - like those detailed in Nigeria's National Aquaculture Development Plan (2021 [21]-2025) and Ghana's Fisheries and Aquaculture Development Plan (2021 [21]-2025) - foundations for expansion are laid (FDF, 2021; Ministry of Fisheries and Aquaculture Development (MOFAD), 2021) [21]. Progress follows where funding flows into study and innovation, especially work focused on illness control and creating feeds from locally available materials (Nigerian Institute for Oceanography and Marine Research (NIOMR), 2023). With stronger outreach systems and skill-based learning opportunities, insight reaches smaller producers more effectively (Akinrotimi *et al.,* 2023) [8].

Favorable biology, rising demand, alongside seasoned fish farming create strong momentum for tilapia expansion across Nigeria, Sierra Leone and Ghana. With careful investment, backed by sound policies plus eco-conscious methods, opportunities open widely - boosting nutrition, livelihoods, even broader stability through smarter water-based agriculture. Growth here does more than fill ponds - it reshapes access, strengthens communities, shifts rural economies toward resilience built on simple, scalable systems that respond quietly yet powerfully to pressing needs.

Fig 3: GIFT Tilapia Farming supported by WorldFish in Ilorin, Kwara state, Nigeria

Fig 4: Nursery Pond for Holding Fingerlings

6. Conclusion and Recommendations

Though tilapia farming supports nutrition, jobs, and income across Ghana, Nigeria, and Sierra Leone, each nation follows a different path. Where one sees steady rules and active business involvement, others face delays in decision-making and patchy execution. Cage systems on Lake Volta give Ghana an edge through reliable supply chains and improved breeding materials. Yet even there, progress depends heavily on location-specific advantages rather than nationwide planning. Meanwhile, most fish farms in Nigeria rely on earthen ponds managed by individual households without consistent support networks. Weak infrastructure slows movement of goods, raising prices for essentials like young stock and formulated feeds. Despite warm weather suited to year-round growth, uneven policies hinder long-term investment in farm upgrades. What works along river basins may fail in drier zones due to mismatched resources. Regulatory gaps leave many producers uncertain about land or water rights. On balance, natural potential does not always translate into stable output when institutional backing lags behind. In Sierra Leone, farming tilapia remains small yet holds strategic importance for improving village economies, diet quality, and access to food. Although Nile tilapia adapts well to local conditions, output struggles due to inconsistent market demand, scarce affordable feed options, limited availability of robust fingerlings, alongside gaps in hands-on knowledge transfer.

Even with obstacles, Nigeria's growth prospects remain strong - thanks to abundant freshwater systems, a broad consumer base, one reason being rising investor attention. Constraints crop up across nations: health threats among stock, cost barriers in feeding practices, strain on ecosystems, along with shifting climates taxing water availability. Productivity must align with ecological care - a point the analysis highlights through combined oversight strategies.

Improving tilapia farming across Sub Saharan Africa could begin with Nigeria and Sierra Leone learning from Ghana’s experience - tighter rules need consistent follow-through, larger farms deserve support, hatcheries require reliable oversight, while collaboration between government and business might fill critical gaps. At the same time, Ghana would benefit from watching its ecosystems more closely, tracking fish illnesses proactively, and expanding away from lake cages to ease strain on Lake Volta. Long-term success hinges on steady funding for science, education for producers, stronger health safeguards, and building robust supply networks; only then will these nations meet rising needs for affordable animal protein through hardy, productive tilapia industries.

References

1. Abwao J, Kyule D, Junga JO, Barasa JE, Sigana DA. On-farm growth performance of different strains of tilapia, *Oreochromis niloticus* reared in earthen ponds. Aquaculture, Fish and Fisheries,2023:3(3).
2. Acquah S, KA OKA, AS. Prevalence and antimicrobial susceptibility of bacterial pathogens in Nile tilapia (*Oreochromis niloticus*) from cage and pond systems in Ghana. Journal of Fish Diseases,2022:45(10):1483-1494.
3. Adeleke B, RA D, MG, TS. Aquaculture in Africa: A review. Reviews in Aquaculture,2020:12(4):2167-2186.
4. Adeogun AO, IO R, AS D, AA. Environmental occurrence and risk assessment of endocrine disrupting compounds in effluents from fish farms in Southwestern Nigeria. Environmental Monitoring and Assessment,2020:192(2):article 126.
5. Aheto DW, AC, OI, AF. Coastal ecosystem management and aquaculture sustainability in Ghana: A geospatial assessment of pressures and policy gaps. Ocean and Coastal Management, 2021, 213.
6. Aheto DW, AC, OI, AF, BI. Effectiveness of marine spatial planning in mitigating coastal aquaculture conflicts and ecosystem degradation in Ghana. Ocean and Coastal Management, 2023, 242.
7. Akinrotimi OA, AOMG, APE. Analysis of aquaculture extension services in Nigeria: Access, quality, and

impact on farmer productivity. Journal of Agricultural Extension,2021:25(3):112-125.
8. Akinrotimi OA, AOMG, OGC. Performance and economic viability of solar-powered aeration systems in small-scale tilapia (*Oreochromis niloticus*) ponds in Kaduna State, Nigeria. Sustainable Aquaculture,2023:5(2):88-102.
9. Amoah KG, AO, FS. Patterns and drivers of antibiotic use in small-scale aquaculture in Ghana: Implications for antimicrobial resistance. Science of the Total Environment, 2022, 803.
10. Anku EK. Technical efficiency of tilapia farming in Ghana: A stochastic frontier approach. Journal of Aquaculture Research and Development,2017:8(2):1-6.
11. Arkoosh B, AI, KD. Genetic improvement and dissemination of tilapia in Africa: Progress, challenges, and future directions. Reviews in Aquaculture,2020:12(3):1445-1462.
12. Asiedu B, AA, OKA. Thermal tolerance and growth performance of Nile tilapia (*Oreochromis niloticus*) under climate change scenarios in West Africa. Climate Change Agriculture,2023:5(1):45-58.
13. Asiedu B, KD, ASK. Adoption and impact of genetically improved tilapia (GIFT) in small-scale aquaculture in Ghana: Evidence from cage and pond systems. Aquaculture Research,2022:53(12):4567-4579.
14. Asmah R, KAY, ANW, ALK, OJK. Environmental impacts of cage aquaculture on Lake Volta, Ghana. International Journal of Fisheries and Aquatic Studies,2014:2(3):56-61.
15. Asmah R, KE, ANW. Nutrient loading and its impacts on water quality in cage aquaculture zones of Lake Volta, Ghana. Aquaculture Research,2015:46(11):2741-2752.
16. Ayinla OA, KOT, NFO. Comparative analysis of tilapia and catfish production systems in Nigeria: Growth performance, economic viability and farmer perceptions. Nigerian Journal of Fisheries and Aquaculture,2019:17(1):22-34.
17. Central Bank of Nigeria. Report on the Assessment of the Agribusiness/Small and Medium Enterprise Investment Scheme (AGSMEIS) and other intervention programmes in the agricultural sector. Central Bank of Nigeria, 2019.
18. Chavan V, YA. Genetic improvement of Nile tilapia (*Oreochromis niloticus*) for aquaculture: A review. Proceedings of the International Conference on Agricultural, 2012.
19. Cobbina J. Financing small and medium-scale aquaculture enterprises in Ghana: Challenges and prospects. International Journal of Fisheries and Aquaculture Sciences,2015:5(2):89-101.
20. Ekunwe PA, ECO. Technical efficiency of small-scale fish farming in Niger State, Nigeria: A stochastic frontier production function approach. African Journal of Agricultural Research,2019:14(11):672-679.
21. Ekunwe PA, ECO, AOT. Optimizing feeding strategies for improved feed conversion ratio and reduced environmental impact in Nile tilapia (*Oreochromis niloticus*) production in Nigeria. Aquaculture Nutrition,2021:27(5):1532-1542.
22. Fagbenro OA, AEO, JWA. Status of fish seed production in Nigeria: A review. African Journal of Aquatic Science,2019:44(3):201-209.
23. Fagbenro OA, AOT, OSA. Growth performance, survival and economic viability of Genetically Improved Farmed Tilapia (GIFT) strain in smallholder pond systems in Nigeria. Aquaculture International,2023:31(4):2155-2170.
24. Falaye AE, OSA, EEO. Evaluation of commercially available aquaculture feeds in Nigeria: Proximate composition, cost implications and farmers' preferences. African Journal of Aquatic Science,2021:46(3):335-344.
25. Kassam D. Assessment of tilapia (*Oreochromis niloticus*) fingerling production and distribution systems in Ghana. Aquaculture Research,2014:45(6):1057-1065.
26. Kwarteng E, ASV, ABT, AEA. Prevalence and molecular characterization of Tilapia Lake Virus (TiLV) and *Streptococcus agalactiae* in farmed Nile tilapia (*Oreochromis niloticus*) in Ghana. Journal of Aquatic Animal Health,2022:34(3):123-134.
27. Naylor RL, Hardy RW, Buschmann AH, Bush SR, Cao L, Klinger DH, *et al*. A 20-year retrospective review of global aquaculture. Nature,2021:591(7851).
28. Ng WK, RN. A review of the nutrition and feeding management of farmed tilapia. Reviews in Aquaculture,2013:5(4):220-254.
29. Nwosu CGC, FO, ZX, ST, MD, IH, *et al*. A systematic review of the effect of dietary supplements on cognitive performance in healthy older adults. Nutritional Neuroscience,2021:24(12):983-1002.
30. Nwosu FM, AOA, EEO. Productivity and economic efficiency of integrated rice-fish farming systems in Ebonyi State, Nigeria. Agricultural Systems, 2022, 203.
31. Obirikorang KA, AC, ADW, ASK. Water and nutrient use efficiency in integrated vegetable-tilapia aquaculture systems in the Ashanti Region, Ghana. Water Resources Management,2023:37(8):3245-3260.
32. Ogunji J, Wuertz S. Aquaculture development in Nigeria: The second biggest aquaculture producer in Africa. Water,2023:15(24).
33. Ojewole TA, OJO, AOA. Economic analysis and constraints of smallholder Nile tilapia (*Oreochromis niloticus*) cage culture in selected reservoirs of Nigeria. Aquaculture Economics and Management,2024:28(1):15-31.
34. Okocha RC, OIO, AOB. Food safety impacts of antimicrobial use and their residues in aquaculture. Public Health Reviews, 2018, 39.
35. Omosowone OO, OOF, AOT, BMO. Prevalence and antimicrobial susceptibility of *Streptococcus agalactiae* and other bacterial pathogens in Nile tilapia (*Oreochromis niloticus*) from selected farms in Southwestern Nigeria. Journal of Fish Diseases,2021:44(10):1567-1577.
36. Omosowone OO, OOF, BMO, AOT. Genetic characterization and phylogenetic analysis of Tilapia Lake Virus (TiLV) strains from farmed Nile tilapia (*Oreochromis niloticus*) in Nigeria. Transboundary and Emerging Diseases,2023:70(2):789-800.
37. Popma T, Masser M. Tilapia: Life history and biology. SRAC Publication No. 283, 1999.

38. Shrestha MK, SS. Tilapia: An excellent candidate species for world aquaculture: A review. Annual Research & Review in Biology,2019:31(3):1-14.
39. Uddin MS, van SEDR, RMM. Assessing mangrove deforestation and its drivers for aquaculture development in the Niger Delta, Nigeria: A remote sensing and GIS approach. Estuarine, Coastal and Shelf Science, 2022, 264.
40. Yue GH, WL, WCM. Recent advances in the genetics and genomics of Nile tilapia (*Oreochromis niloticus*). Aquaculture and Fisheries,2016:1(1):1-6.