FISH FARMING: ASSESSING THE PROCESS AND ECONOMIC BENEFITS OF ESTABLISHING SUBSISTENT AND COMMERCIAL FARMING

By

Dr. Rosemary Collins Piate
DEPARTMENT OF Home Economics,
College of Education
Afaha Nsit
Akwa Ibom State

And

Ubong Ndueso Orok
Department of Agricultural Science Education,
College of Education,
Afaha Nsit
Akwa Ibom State

ABSTRACT

This study examined fish farming, highlighting the processes and economic benefits of establishing both subsistence and commercial fish farms. It emphasized that fish farming is among the fastest-growing food production sectors, addressing global protein demand. Key topics included the concepts of subsistence and commercial fish farming, along with their establishment processes. For persistent farming, the steps involve site selection, pond construction, stocking, and nutrition management, while commercial farming requires additional infrastructure, species breeding, and water quality management. Economic benefits of subsistence fish farming include employment generation, income diversification, and support for the local economy. Commercial fish farming adds large-scale employment, revenue generation, export potential, and support for allied industries. Key components for subsistent farming are resource accessibility and pond management, whereas commercial farming focuses on stocking density, species optimization, and intensive water quality control. Challenges such as financial constraints and limited technical skills were identified, with solutions proposed including financial support and capacity-building for farmers. For disease control, the study recommended quarantining new stock and regular inspections; if an infection occurs, immediate isolation of infected fish is advised. Conventional feeds like fishmeal and soybean meal, along with locally produced feeds like Olam Feeds, were mentioned. The study concluded that fish farming plays a crucial role in food security, recommending that persistent farmers adopt sustainable aquaculture practices to balance yields with environmental responsibility. One of the recommendations made was that subsistence fish farmers should prioritize sustainable aquaculture techniques that minimize environmental impact while maximizing yields.

KEYWORDS: Fish, Farming, Economic, Benefits, Subsistent, Commercial and Farming

INTRODUCTION

Fish farming, also known as aquaculture, has emerged as one of the fastest-growing food production sectors globally, revolutionizing the way aquatic species are cultivated to meet ever-rising demands for protein. As global populations burgeon, traditional fishing practices are insufficient to satisfy nutritional needs, making sustainable aquaculture a critical necessity (Beveridge, Thilsted, Phillips, Metian, Troell& Hall, 2013). This growth has not only transformed food security but has also highlighted environmental, economic, and social factors associated with fish farming. Today, understanding the intricacies of fish farming, from subsistence models to large-scale commercial enterprises, has become vital for food policy planning and rural economic development (Pinstrup-Andersen, Rahmanian, Allahoury, Gitz 2014).

The essence of fish farming lies in optimizing the rearing conditions to achieve healthy and productive yields while minimizing ecological impact. From managing water quality, feed supply, and stocking densities to mitigating disease outbreaks and waste disposal, the process demands precision and expertise (Yusoff, Umi, Ramli, and Harun, 2024). Subsistence farming models are often employed in developing regions where fish provide essential protein and micronutrients, significantly reducing malnutrition rates and improving overall community health. Conversely, commercial fish farming focuses on profit maximization and economies of scale, leveraging advanced technologies and logistics to supply global markets. The contrast between these two models underpins broader discussions about sustainability and resource allocation in aquaculture.

One of the most captivating aspects of fish farming is its economic potential. For rural communities, subsistence aquaculture creates livelihood opportunities that can uplift entire regions by generating income, supporting local markets, and providing a reliable food source (Olaganathan and Mun, 2017). This economic empowerment fosters resilience against poverty and unemployment, transforming once-neglected fishing villages into bustling hubs of productivity. Commercially, aquaculture enterprises contribute significantly to national GDPs and global trade. In 2023, for instance, the global aquaculture market was valued at $316 billion and is projected to keep growing, driven by both consumer preferences for healthier protein sources and advancements in aquaculture technology (FAO, 2023).

Nevertheless, challenges remain that could hinder the full realization of aquaculture's economic benefits. Environmental degradation, resource competition, and susceptibility to disease outbreaks threaten the long-term sustainability of fish farming (Irwin et al., 2024). High-density fish farms can lead to pollution, disrupting aquatic ecosystems, and causing biodiversity loss. Balancing economic incentives with environmental responsibility is essential, necessitating research into low-impact farming techniques and improved regulatory frameworks. Moreover, understanding the broader implications of aquaculture, such as its impact on food sovereignty and global trade dynamics, is crucial for fostering sustainable development (Zreik, 2024).

In light of these complexities, this paper explores the comprehensive process and economic implications of establishing both subsistence and commercial fish farms. The

analysis will not only cover the technical aspects of aquaculture but will also address the socioeconomic impact on global food systems and rural livelihoods. By examining case studies and recent industry developments, the discussion aims to provide an informed perspective on how fish farming can be optimized to benefit communities and ecosystems. Ultimately, understanding aquaculture's dual role as a solution for food scarcity and a potential environmental risk highlights the urgency of developing responsible and innovative practices in the field (Boyd, 2020; FAO, 2023).

CONCEPT OF FISH FARMING

The commercial breeding of fish, usually for food, in fish tanks, artificial enclosures like fish ponds, or in a section of fresh or marine water that is isolated from the surrounding water by cages or open nets is known as fish farming or pisciculture. Udoh and Offiong (2017) mentioned that fish farming can be carried out with different techniques, including using concrete ponds, earthen ponds, plastic tanks, Gee-Pee tanks, etc. According to Saad and Udoh (2023), fish is an important source of animal protein in many nations. Fish farming is basically the commercial cultivation of aquatic organisms in a regulated or semi-controlled environment with the goal of increasing productivity.

Udoh, Offiong, and Iwatt (2022) defined fish farming as the cultivation of fish. It is a composite and budding field that offers considerable opportunities for sustainable food production (Nikejah, Udoh, and Kolawole, 2021). Fish farming creates various income opportunities, particularly for individuals who live below the poverty line. Azari and Udo (2023) and Offiong, Udoh, and Akpan (2024) mentioned that fish farming plays a crucial role in improving the socioeconomic conditions of rural communities. The ecological footprint of fish farming can be reduced, local economies can be supported, and individuals can help create a more sustainable aquaculture production by adopting sustainable practices like integrated multi-trophic aquaculture and responsible feed sourcing, as well as by understanding the various systems, species, and practices involved. Fish farming includes fish seed production, pond construction, rearing of fish, fish processing, marketing of fish and the accessories, among others (Udoh, Ekanem, and Offiong, 2019).

CONCEPT OF SUBSISTENT FISH FARMING

A type of aquaculture known as "subsistence fish farming" aims to provide for the immediate dietary and financial needs of nearby populations rather than for extensive commercial production. Practiced primarily in rural and low-income areas, this farming approach focuses on cultivating fish species that are easy to maintain and resilient to local conditions, often utilizing low-cost and sustainable techniques (Ahmed & Garnett, 2020).

Fishing that is done primarily to provide food for the fisherman's family and other relatives is referred to as subsistence fishing, excluding sport fishing. It is typically done by extremely impoverished individuals and also suggests the use of low-tech "artisanal" fishing methods. Producing fish for the farmer's own consumption or the local community as opposed to selling them on larger markets is the main goal of subsistence fish farming. By providing a consistent supply of protein and vital nutrients, this strategy tackles food

poverty head-on. Often, fish such as tilapia, catfish, or carp are selected due to their adaptability and lower cost of maintenance (Ahmed et al., 2018).

According to Jamu & Ayinla (2020), Utilizing repurposed materials, locally acquired feed, and frequently natural water sources or tiny, man-made ponds, subsistence fish farms run on tight budgets. Farmers with limited funds can use this low-input strategy since it eliminates the need for costly industrial feeds or equipment. Furthermore, fish waste is used to support agricultural output in a sustainable cycle that is created when farmers combine fish farming with crop or livestock systems. To catch enough fish to support oneself or one's family with a minimal danger of fish population depletion, subsistence fishing is mostly small-scale, inshore, local activities. This additional income stream is particularly impactful for rural women and smallholder farmers, promoting financial independence and empowerment (Jahan et al., 2019).

A livelihood safety net that keeps people out of poverty and starvation is subsistence fish farming. For vulnerable households and local economies impacted by climate change, it is particularly crucial. Commercial fish farming, when the primary objective is to generate a profit by selling fish, is not the same as subsistence fish farming. Because subsistence fish farming depends on natural resources, it is frequently adjusted to local climate fluctuation and environmental conditions. Farmers may use traditional knowledge to adjust practices based on seasonal changes or water availability, making this form of aquaculture resilient and adaptable to shifts in climate (Yazdanpanah et al., 2020).

CONCEPT OF COMMERCIAL FISH FARMING

In order to increase fish production and satisfy the world's expanding food needs, commercial fish farming has become an essential technique. For market sale, fish are cultivated in ponds, tanks, and marine cages, among other regulated settings. Fish farming attempts to enhance food security, boost the economy, and lessen the burden on wild fisheries by producing fish especially for commercial use.

Commercial fish farming is defined as the intentional cultivation of fish and other aquatic species under controlled or semi-controlled conditions for economic gain. This system is typically characterized by efforts to optimize conditions such as water quality, temperature, feed, and space to ensure optimal fish growth and survival rates (FAO, 2020). Commercial fish farms are built for efficiency, predictability, and profitability with the goal of producing high-quality fish for the consumer market, in contrast to traditional fishing, which depends on the erratic availability of wild fish. Fish are raised primarily for market sale rather than for personal or subsistence consumption, which is why the technique is referred to be "commercial." Large-scale fish production is made possible by commercial fish farming, which enables fish farms to satisfy the demand for well-known species like catfish, salmon, and tilapia, which are mainstays in many diets across the world. (Froehlich et al., 2018).

Making money (profit) by actively participating in the market through the sale of various fish products and other related farm produce is the main economic activity of commercial fish farming. Large-scale, intensive, and expensive commercial fish farming is

the norm. It is focused on the market and might involve export processing. There are two types of commercial fish farming: cage aquaculture and land-based (using tanks and ponds with or without recirculatory systems).

These practices involve higher stocking densities of mono-sex species, reliance on feed, and oxygen supplementation in some cases (Musuka & Musonda, 2012).

PROCESS OF ESTABLISHING SUBSISTENT FISH FARMING

Establishing subsistent fish farming entails multiple phases, from setup and management of aquaculture systems to ensuring sustainable practices that benefit local communities. Research has shown that in regions where aquaculture has been introduced, it enhances food security, provides economic benefits, and contributes to poverty alleviation.

- **Site Selection and Design:** Choosing an appropriate site is a critical first step in setting up a fish farm, as it determines the success of subsequent operations. Optimal sites are selected based on water quality, soil type, and climate conditions favourable for fish production. Rosa da Silva et al. (2020) underscore that smallholder farmers often rely on accessible water sources and nutrient-rich soils to support fish growth naturally. The location must also have minimal environmental hazards to protect both the fish and the ecosystem.
- **Pond Construction and Preparation:** Proper Pond construction is essential to controlling the quality of water and other environmental factors affecting fish. In regions like Assam, India, diversified farming methods are employed where ponds are strategically built to manage water flow and nutrients (Duarah& Mall, 2020). This includes digging to appropriate depths and setting up drainage systems to prevent flooding, which can be detrimental to fish farming.
- **Stocking of Fish Species:** The choice of fish species for subsistence farming varies depending on the local market demand, climate adaptability, and the farmer's resources. Small-scale farmers often select hardy species that are resilient to local conditions and can thrive on available feed resources. According to Kaminski et al. (2020), selecting locally adapted species is crucial for enhancing production while reducing reliance on high-cost inputs.
- **Feed and Nutrition Management:** Sustainable feed management is another key aspect of subsistence fish farming, especially given the cost implications. Farmers are encouraged to integrate natural feed sources, such as insects or plant-based feeds, as an affordable and nutrient-rich option. Ssepuuya et al. (2019) highlight the role of alternative proteins, such as insect meal, in sustaining fish growth while minimizing feed costs for smallholders.
- **Water Quality Control:** Maintaining water quality is essential for fish health and growth and involves regular monitoring of parameters like pH, dissolved oxygen, and ammonia levels. Studies by Chrispin and Ananthan (2022) emphasize that in developing contexts, low-cost methods such as natural filtration and routine pond cleaning are widely used to preserve water quality.

PROCESS OF ESTABLISHING COMMERCIAL FISH FARMING

Establishing a commercial fish farming operation is a multifaceted process, requiring a detailed understanding of ecological, financial, and technical aspects. Each phase must be approached strategically to optimize productivity and sustainability.

- **Site Selection and Infrastructure Development:** Selecting an ideal site is crucial for commercial fish farming, as it directly impacts water quality, temperature, and access to resources. The site should have a reliable water source and optimal soil type to support large-scale aquaculture operations. Considerations include accessibility to markets, logistical infrastructure, and regulatory compliance, particularly for recirculating aquaculture systems.
- **Species Selection and Breeding:** Commercial fish farms benefit from selecting species that are robust, fast-growing, and meet market demand. New breeding techniques, including selective breeding and genetic improvements, allow for species-specific optimization to increase yield. Species selection must align with environmental compatibility and potential profitability.
- **Feed and Nutrition Management:** An efficient feeding strategy is critical in commercial fish farming. Chu et al. (2020) emphasizes the importance of balancing high-quality feeds with cost-effective alternatives, such as plant-based proteins or bio floc technology, which supports sustainable production by recycling nutrients within the system.
- **Water Quality and Waste Management:** Monitoring and controlling water quality is paramount, especially in closed systems where nutrient buildup can harm fish health. Valenti et al. (2018) recommend integrating waste management practices, including biofilters and sedimentation systems, to remove organic waste efficiently and maintain optimal water conditions.
- **Marketing and Distribution:** Successful commercial fish farming requires strong market linkages and distribution networks to ensure profitability. Khan et al. (2022) highlights the role of direct-to-consumer strategies, value-added processing, and export options, which are critical for maximizing returns and reaching broader markets.

ECONOMIC BENEFITS OF ESTABLISHING SUBSISTENT FISH FARMING

As mentioned by Asuquo, Joe William, &Ekpo (2022), fish are an important resource for humans worldwide, especially as food. Commercial and subsistence fishers hunt fish in wild fisheries or farm them in ponds or in cages in the ocean (in aquaculture). Its economic benefits in the establishment of subsistence fish are thoroughly discussed below:

- **Employment Generation:** Subsistent fish farming can significantly reduce unemployment by creating job opportunities for individuals within the community. The work involved in pond maintenance, feeding, harvesting, and selling fish provides income for local residents, thus reducing poverty. For small-scale farmers, this type of employment may be part-time or seasonal, but it still contributes to enhancing local livelihoods and stability within the rural economy.

- **Income Diversification:** For households involved in agricultural or other forms of subsistence farming, adding fish farming as a secondary source of income can mitigate risks associated with crop failures or other agricultural challenges. This diversified approach helps households manage fluctuations in income, enhancing their economic resilience. By having another income stream, families have more resources to reinvest in their farms, support their children's education, or improve their quality of life.
- **Boost to Local Economy:** The need for fish has increased significantly over the past few decades, and aquaculture has emerged as a critical component in supplying this demand (Etim & Afia, 2024). Subsistent fish farming stimulates the local economy by keeping profits within the community. Farmers sell their fish at local markets, creating a flow of money within the area. This local trading loop can create additional benefits as it encourages the development of small businesses like equipment shops, feed suppliers, and transport services that support fish farming activities, fostering economic growth and self-sufficiency.
- **Reduced Dependency on Imported Fish:** Establishing subsistence fish farms decreases the community's reliance on imported fish, which can be costly and inconsistent in supply. By producing fish locally, communities can enjoy a more affordable and readily available source of protein. The money that would have been spent on imports can instead be reinvested within the community, improving the economic stability of the region and reducing the overall trade deficit at the national level.
- **Enhanced Food Security and Nutrition:** Fish farming contributes to food security by providing a reliable source of food for local communities. Fish is a highly nutritious protein source, containing essential vitamins and minerals that improve health outcomes. With steady access to affordable and nutritious food, households spend less on external food sources, and healthier individuals are more likely to contribute positively to the local economy, creating a cycle of health and productivity that boosts long-term economic development.

ECONOMIC BENEFITS OF ESTABLISHING COMMERCIAL FISH FARMING

The following are the economic benefits of establishing commercial fish farming.

- **Large-Scale Employment Opportunities:** Commercial fish farming offers extensive employment opportunities beyond subsistence levels, providing jobs in areas such as farm management, hatchery operations, processing, and distribution. This sector often requires both skilled and unskilled labour, creating jobs across different skill levels and benefiting various demographics. By expanding employment within the region, commercial fish farming helps reduce unemployment rates, contributing to regional economic stability and growth.
- **Increased Revenue Generation:** Commercial fish farming is typically a profitable venture, generating significant revenue for investors and the community. As fish farms scale up, they can produce a high volume of fish for domestic and international markets, resulting in substantial profits. Taxes and export revenues from commercial operations benefit the local government, increasing funds available for public

infrastructure, education, and healthcare, which further bolsters economic development.

- **Export and Foreign Exchange Earnings:** With an increasing global demand for fish, commercial fish farming allows a country to tap into international markets, enhancing export earnings. This generates foreign exchange income, which is vital for a country's economy as it strengthens currency reserves and supports a favourable balance of trade. The export of farm-raised fish can also attract foreign investments, leading to new partnerships, technologies, and resources that further stimulate economic growth.
- **Development of Allied Industries:** Commercial fish farming stimulates the growth of related industries, such as feed production, equipment manufacturing, and cold storage facilities. The demand for fish farming inputs and services creates opportunities for businesses to supply fish feed, equipment, and logistics services. This network of allied industries diversifies the local economy and creates even more job opportunities, further enhancing the economic benefits of fish farming.
- **Enhanced Food Security and Reduction of Fish Imports:** Commercial fish farming helps reduce the dependency on imported fish by meeting local demand through domestic production. This not only strengthens food security but also reduces the need to spend valuable foreign currency on imports. With affordable, locally produced fish, communities can enjoy a consistent and accessible protein source, benefiting both the economy and public health, as healthier populations are more economically productive.

COMPONENTS OF SUBSISTENCE FISH FARMING

Subsistence fish farming, primarily practiced for personal consumption and local trade, contributes significantly to food security in many communities, especially in rural settings. The primary components of subsistence fish farming involve resource accessibility, species selection, pond management, feed and nutrient provision, disease control, and sustainability. These components are essential for ensuring the successful, sustainable production of fish for household needs. Subsistence fish farming typically involves a few small ponds and the following components:

- **Resource Accessibility:** Access to natural resources like water bodies, land, and starter stock is essential for subsistence fish farming (FAO, 2020). Small-scale farmers often rely on locally available materials and inputs due to limited financial resources. This accessibility to resources directly impacts the feasibility and productivity of fish farming.
- **Species Selection:** Choosing appropriate fish species is crucial for the success of subsistence fish farming. Common species like tilapia, catfish, and carp are often selected because of their hardiness, fast growth, and adaptability to diverse environments. Species selection also depends on the farmer's goals, environmental conditions, and local market preferences.
- **Pond Management:** Efficient pond management practices include site preparation, regular water quality checks, and appropriate stocking density. Proper pond maintenance helps control algae growth, aeration, and temperature, which are vital

for fish health and growth. Regular monitoring of these factors minimizes fish mortality and enhances yield.

- **Feed and Nutrient Provision:** Adequate feed and nutrients are essential for fish growth. Subsistence farmers often rely on agricultural by-products and locally produced feeds to reduce costs. Research shows that balanced nutrient input, even in small-scale settings, significantly influences fish development and overall productivity.
- **Disease Control:** Maintaining fish health through disease prevention is crucial for sustainability. Subsistence fish farmers commonly use natural disease control methods like the removal of sick fish, keeping pond water clean, and using herbal remedies, which are cost-effective and accessible. Good management practices and early detection reduce the risk of disease outbreaks that could devastate small fish stocks.
- **Sustainability:** Sustainable practices in subsistence fish farming include using eco-friendly resources, minimizing environmental impact, and maintaining a balance between fish production and resource availability. Sustainability ensures long-term benefits and aligns with food security goals in rural communities.
- **Monitoring:** Subsistence fish farmers should check their ponds at least once a day to ensure the water supply is adequate, the pond dikes are in good condition, and the water quality is good.

COMPONENTS OF COMMERCIAL FISH FARMING

Commercial fish farming is an advanced aquaculture practice aimed at high-yield production for profit and market distribution. Its primary components include intensive stocking, species optimization, advanced water quality management, efficient feed systems, disease control measures, and sustainable practices. These elements are crucial in enhancing productivity and ensuring long-term profitability.

- **Intensive Stocking and Density Control:** Commercial fish farming typically involves higher stocking densities to maximize yield. This requires careful control of stocking rates to balance fish growth and water quality, ensuring optimal biomass production. Proper stocking practices prevent overcrowding, which can lead to stress and increased susceptibility to disease.
- **Species Optimization:** Selecting suitable fish species based on market demand, growth rate, and adaptability to local conditions is crucial for commercial operations. Species like tilapia, carp, and catfish are common due to their fast growth and resilience. Optimization ensures maximum productivity while aligning with specific market requirements.
- **Water Quality Management:** Water quality management, including monitoring pH, dissolved oxygen, and ammonia levels, is essential for fish health and growth. Advanced filtration and aeration systems help maintain optimal conditions and reduce mortality rates. The integration of technology like automated sensors enhances water quality management efficiency.

- **Efficient Feed Systems:** High-quality feeds and automated feeding systems are critical in commercial fish farming. Nutritionally balanced feeds that provide essential proteins, fats, and vitamins improve growth rates and feed conversion ratios. Automated feeders allow for consistent and timely feeding, reducing waste and improving efficiency (FAO, 2020).
- **Disease Control and Biosecurity:** Commercial operations emphasize biosecurity and disease prevention through the use of vaccines, antibiotics, and regular health monitoring. Quarantine measures, water treatment, and vaccination programs help manage disease risks, ensuring healthier stock and minimizing financial loss. Biosecurity measures are essential for preventing the spread of pathogens, which can quickly escalate in high-density environments.
- **Sustainability and Environmental Management:** Commercial fish farming integrates sustainability practices like eco-friendly feed, waste management, and energy-efficient systems to minimize environmental impact. Sustainable practices, such as recirculating aquaculture systems (RAS), allow water reuse and reduce the need for freshwater, which is vital in water-scarce regions (Torrans et al., 2018). These efforts help align commercial fish farming with environmental and economic goals.

CHALLENGES OF ESTABLISHING FISH FARMING

Establishing fish farming involves numerous challenges, particularly in areas with limited resources, inadequate infrastructure, and varying regulatory environments. Major challenges include financial barriers, technical constraints, environmental concerns, supply chain issues, and regulatory complexities. Addressing these challenges is essential to fostering sustainable and profitable fish farming operations.

- **Financial Constraints:** Initial investment costs, such as those for building ponds, purchasing high-quality feed, and securing high-standard equipment, are major financial challenges for aspiring fish farmers. Many struggle to access sufficient capital and financing options. This limitation restricts their ability to adopt efficient technologies and grow production capacity, often relying on high-interest loans that add financial pressure. Additionally, rural farmers face limited access to credit facilities, creating a barrier to entry.
- **Technical Expertise and Skills Deficiency:** The knowledge and skills required to manage fish farming operations efficiently are often lacking, especially among small-scale farmers. Mismanagement of fish stock, inadequate feeding practices, and ineffective disease management are common issues due to limited training. Without access to modern aquaculture techniques and practices, farmers risk reduced yields and poor stock health.
- **Environmental and Sustainability Issues:** Fish farming can negatively impact the environment, particularly in regions where natural water sources are affected by pollution from aquaculture waste. Over-reliance on traditional practices increases waste and risks habitat degradation. Concerns regarding water resource usage and pollution pose long-term sustainability challenges and can lead to conflicts with local communities and regulators.

- **Supply Chain Challenges:** Access to high-quality fish seeds, reliable feed, and modern equipment is limited in many regions. High-quality inputs are critical for fish growth, yet supply chain issues, including high prices and limited availability, make it difficult for new farmers to acquire necessary resources. The lack of access to certified hatcheries and affordable feed further hinders production and profitability.
- **Regulatory and Licensing Barriers:** Navigating the regulatory environment can be complex, particularly for small-scale farmers unfamiliar with licensing requirements. Long and expensive permitting processes discourage new entrants. Regulations regarding water use, environmental impact, and food safety add to the administrative burden, often requiring expertise and resources to comply fully. These barriers can deter potential fish farmers from formalizing their operations and expanding production.

HOW TO MITIGATE THE CHALLENGES OF ESTABLISHING FISH FARMING

Establishing fish farming faces challenges such as financial constraints, technical expertise, environmental sustainability, and regulatory issues. Effective mitigation strategies are essential for addressing these obstacles and ensuring sustainable and profitable operations.

- **Financial Access and Support:** A major barrier in fish farming establishments is access to financing for infrastructure and operating costs. Governments and financial institutions can support new farmers by providing access to credit, subsidies, and grants. Programs offering low-interest loans or microfinance, particularly for rural communities, have proven effective in encouraging aquaculture startups. Additionally, collaboration with NGOs and aquaculture development agencies can help secure funds for small-scale farmers.
- **Capacity Building and Training:** The lack of technical expertise in fish farming can lead to mismanagement and low productivity. Regular training programs focused on modern aquaculture techniques, disease management, and feeding strategies are critical for equipping farmers with the knowledge required for efficient operations. Training in financial and resource management can also empower farmers to maximize productivity and profitability (Nyandat & Munguti, 2021).
- **Environmental Management and Sustainability:** Aquaculture operations can have environmental impacts, such as water pollution and habitat degradation. To mitigate these, farmers can implement sustainable practices, including recirculating aquaculture systems (RAS) that reduce water usage and waste discharge. Integrated aquaculture practices, such as polyculture and bio floc technology, offer eco-friendly alternatives for managing waste and enhancing sustainability (Avnimelech, 2018).
- **Access to Quality Inputs:** Establishing reliable supply chains for high-quality fish seed, feed, and equipment is critical. Ensuring access to certified hatcheries, efficient feeds, and affordable equipment reduces initial startup challenges. Farmers' cooperatives and partnerships with suppliers can also improve input accessibility and reduce costs. Government regulation of feed and seed quality helps address supply chain issues and prevent loss (FAO, 2020).

- **Navigating Regulatory Frameworks:** Navigating complex regulatory requirements can deter fish farming startups. Simplifying aquaculture licensing and reducing bureaucratic delays can facilitate farm establishment. Additionally, governments should create policies that promote aquaculture-friendly zoning, support sustainable practices, and offer guidelines for managing environmental impacts. Engaging stakeholders in policy discussions can ensure that regulations balance development needs with ecological preservation.

HOW TO PREVENT DISEASES INFECTION IN FISH FARMING

Fish farming, or aquaculture, is susceptible to various diseases caused by pathogens such as bacteria, viruses, and parasites. Effective disease prevention is crucial for maintaining fish health and ensuring sustainable production. Here are key strategies to prevent disease infections in fish farming:

- **Quarantine New Stock:** New or returned fish should be quarantined away from the main population to prevent the introduction of pathogens. This period should last until the fish have been exposed to seasonal water temperatures relevant to potential diseases.
- **Regular Health Inspections:** Inspect fish for diseases before introducing them to the farm. Health certificates from reputable suppliers can help ensure that new stock is disease-free.
- **Vaccination:** Implement vaccination programs for fish stocks to enhance immunity against common diseases. Vaccines are crucial as they do not contribute to antibiotic resistance and can protect both vaccinated and unvaccinated populations through herd immunity.
- **Equipment Sanitation:** Clean and disinfect all equipment thoroughly before use. This includes drying equipment after washing to kill pathogens, as wet or contaminated gear can facilitate disease transmission.
- **Water Quality Management:** Use clean water sources, preferably well water, and avoid river water unless properly treated. Water should be filtered and held in fish-free ponds for a minimum of 21 days to disrupt parasite life cycles.

HOW TO CONTROL DISEASE INFECTION IN FISH FARMING

If disease infection has already infected the pond, the following are measures to control the outbreak:

- **Isolate and Remove Infected Fish:** Quickly isolate infected fish in a quarantine tank to prevent the spread of the disease to healthy individuals. In cases where fish are critically infected, humane removal and disposal of those fish may be necessary to limit further spread. Regularly observe the remaining fish for any signs of infection to determine if further isolation is needed.
- **Water Quality Management and Partial Water Change:** Replacing a portion of the pond water can help dilute harmful pathogens and improve overall water quality. Ensure that water parameters (e.g., oxygen levels, pH, ammonia, and nitrite levels) are

Dr. Rosemary Collins Piate
&
Ubong Ndueso Orok

optimized, as poor water quality can exacerbate the outbreak and hinder fish recovery. Boost aeration to maintain adequate oxygen levels, which helps reduce fish stress and aids recovery.

- **Use Medicated Treatments:** In consultation with a fish health specialist, administer medicated feeds to infected fish populations if the disease is treatable with antibiotics. This method is effective in delivering medicine directly to the fish. For parasitic or bacterial infections that affect the external body of fish, adding suitable treatments (like salt, potassium permanganate, or formalin, depending on the pathogen) to the water can help. Use these chemicals carefully, following recommended dosages and observing fish reactions. Always consult a fish health professional before applying any treatments, especially antibiotics, to avoid resistance issues and ensure proper dosage. Clean and disinfect all equipment, including nets, feeders, and tanks, to prevent cross-contamination. For severe outbreaks, consider draining and disinfecting the pond entirely, especially if the pathogen is resilient. After disinfecting, let the pond dry completely before refilling.
- **Enhance Fish Immune Response with Supportive Care:** Adding immunostimulants (such as beta-glucans or vitamin C) to fish diets can strengthen the immune system, making it easier for fish to fight off the infection. Ensure the fish receive nutritionally rich feeds that are easy to digest, which supports faster recovery.
- **Monitor and Record Outbreak Progress:** Record fish behaviour, mortality rates, and water quality parameters to monitor the outbreak's progress and determine the effectiveness of the treatments. If possible, identify the pathogen responsible for the outbreak. This helps tailor the response and improve prevention strategies for the future.
- **Evaluate the Cause of the Outbreak:** Identify any lapses in biosecurity, water quality, or stocking density that may have led to the outbreak. Revise farm protocols to prevent future outbreaks, such as stricter quarantine measures, improved sanitation, and regular health monitoring.

CONVENTIONAL FEEDS FOR FISHES

Conventional feeds for fish are primarily composed of a variety of ingredients that provide essential nutrients necessary for growth and health. Here are some common types of conventional feeds used in aquaculture, as mentioned by numerous scholars, including Audu and Yola (2020):

- **Fishmeal:** A key protein source, fishmeal is made from processed fish and is highly valued for its complete amino acid profile, which is crucial for the growth of many fish species.
- **Soybean Meal:** This plant-based protein source is widely used in aquaculture diets due to its high protein content (approximately 47–50%) and availability. However, it may lack certain essential amino acids, making it less effective as a sole protein source.

- **Groundnut Cake:** Derived from peanuts, groundnut cake is another protein-rich ingredient often included in fish feed formulations. It provides a good balance of nutrients but can also have anti-nutritional factors that need to be managed.

Wheat Gluten: This ingredient is used for its high protein content and binding properties, making it suitable for pelleted feeds. It is often combined with other ingredients to meet the nutritional requirements of fish.

- **Rice Bran:** A byproduct of rice milling, rice bran serves as an energy source and contains some protein. It is commonly used in aquaculture due to its low cost and availability.
- **Corn and Other Grains:** Grains like corn are often included in fish feeds as energy sources, providing carbohydrates necessary for fish metabolism.
- **Animal Byproducts:** Ingredients such as poultry byproducts and meat meals are sometimes included in fish diets to enhance protein levels while utilizing waste products from other industries.
- **Rice Bran:** A byproduct of rice milling, rice bran serves as an energy source and contains some protein. It is commonly used in aquaculture due to its low cost and availability.
- **Corn and Other Grains:** Grains like corn are often included in fish feeds as energy sources, providing carbohydrates necessary for fish metabolism.
- **Animal Byproducts:** Ingredients such as poultry byproducts and meat meals are sometimes included in fish diets to enhance protein levels while utilizing waste products from other industries.

LOCALLY PRODUCED FEED FOR FISHES

The following are locally produced fish feed brands available in Nigeria:

- **Olam Feeds:** This is a major player in the Nigerian feed market, offering a range of fish feeds under brands like Blue Crown and Aqualis.
- **Grand Cereals:** They produce a variety of livestock feeds, including fish feed.
- **Livestock Feeds:** Another significant player in the Nigerian feed industry, offering a range of fish feed products.

CONCLUSION

Fish farming has rapidly emerged as a vital food production sector, revolutionizing how aquatic species are cultivated to meet increasing protein demands. As global populations grow, traditional fishing practices fall short, making sustainable aquaculture essential for food security. This sector encompasses both subsistence models that provide vital nutrition in developing regions and commercial operations focused on profit maximization. While aquaculture offers significant economic potential and job creation, challenges like environmental degradation and disease outbreaks threaten its sustainability. Understanding these dynamics is crucial for developing innovative practices that balance economic growth with ecological responsibility in fish farming.

RECOMMENDATIONS

- Subsistence fish farmers should prioritize sustainable aquaculture techniques that minimize environmental impact while maximizing yields. Practices such as integrated multi-trophic aquaculture (IMTA) can enhance productivity by utilizing waste from fish as nutrients for other species, such as shellfish or seaweed
- Commercial fish farmers should invest in advanced aquaculture technologies and provide ongoing training for their workforce. Technologies such as automated feeding systems, water quality monitoring sensors, and recirculating aquaculture systems can enhance operational efficiency and reduce resource use.
- All fish farmers, regardless of scale, should engage in collaborative efforts to share knowledge, resources, and best practices. Establishing local cooperatives or associations can facilitate access to shared services such as marketing, distribution, and training.

REFERENCES

Alam G. M., Sarker M. N., Gatto M., Bhandari H. &Naziri D. (2022). Impacts of COVID-19 on the Fisheries and Aquaculture Sector in Developing Countries and Ways Forward. Sustainability, 14(3), 1071; https://doi.org/10.3390/su14031071

Asuquo, L. E., Joe William, E. K. A., & EkpoKufre, O. (2022). A comparative study of the effect of potato fish feed and orange fish feed on growth of fishes. GASPRO International journal of eminent scholars. 8(1). 57-68

Audu and Yola (2020). Contemporary Issues in Fisheries and Aquaculture: A Review on Non – Conventional Feed Ingredients for Fish Feed in Nigeria. Bayero Journal of Pure and Applied Sciences,13(2), 22-28.

Azari, A. A., &Udoh, F. E. (2023). Economic viability of fish farming compared to crop cultivatio. *International Contemporary Journal of Science Education and Technology*, 2(2).

Beveridge, M. C., Thilsted, S. H., Phillips, M. J., Metian, M., Troell, M., & Hall, S. J. (2013). Meeting the food and nutrition needs of the poor: the role of fish and the opportunities and challenges emerging from the rise of aquaculture. Journal of fish biology, 83(4), 1067–1084. https://doi.org/10.1111/jfb.12187.

Chrispin C., Ananthan P.S., Ramasubramanian V., Sugunan V. V., Panikkar P. & Landge A. T. (2022). Rapid reservoir fisheries appraisal (r-RAPFISH): Indicator based framework for sustainable fish production in Indian reservoirs. Journal of Cleaner Production, 379, 134435. https://doi.org/10.1016/j.jclepro.2022.134435

Duarah J. P. & Mall M. (2020). Diversified fish farming for sustainable livelihood: A case-based study on small and marginal fish farmers in Cachar district of Assam, India. Aquaculture, 529, 735569. https://doi.org/10.1016/j.aquaculture.2020.735569

Etim, G. J &Afia, O. E. (2024). A study of locally produced potent feed for healthy fishes: emphasis on sources and cost effectiveness. International journal of modern health systems and medical Sciences 2(1). 58-68.

FAO. (2020). The State of World Fisheries and Aquaculture 2020: Sustainability in Action. Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization (FAO). (2023). "State of World Fisheries and Aquaculture." Rome, Italy: FAO.

Froehlich H. E., Gentry R. R. & Halpern B. S. (2018). Global change in marine aquaculture production potential under climate change. Nature Ecology & Evolution, 2(11), 1765-1770.

Irwin, B. J., Tomamichel, M., Frisher, M. E., Hall, R. J., Davis, A., Bliss, T., Rohani, P., Byers, J. E. (2024). Managing the threat of infectious disease in fisheries and aquaculture using

structured decision making. Frontiers in Ecology and the Environment, 12, https://doi.org/10.1002/fee.2695.

Kaminski A. M., Kruijssen F., Cole S. M., Beveridge C. M., Dawson C., Mohan C. V., Suri S. & Phillips M. J. (2020). A review of inclusive business models and their application in aquaculture development. Reviews in Aquaculture, 12 (3): 1881-1902. https://doi.org/10.1111/raq.12415

Musuka C. G. &Musonda F. F. (2012). Current and future prospects of commercial fish farming in Zambia. International Journal of the Bioflux Community, 5(1): 79-87.

Nguyen V. K., Pittock J. & Connell D. (2019). Dikes, rice, and fish: how rapid changes in land use and hydrology have transformed agriculture and subsistence living in the Mekong Delta. Reg Environ Change 19, 2069–2077 (2019). https://doi.org/10.1007/s10113-019-01548-x

Nikejah, O., PI, N., Udoh, F. E., &Olajide, K. (2021). Employability and vocational skills needed by university graduates for employment in Pig Production in Delta State. *Journal of Association of Vocational & Technical Educators of Nigeria (JAVTEN),* 21(1), 1-10.

Offiong, A. A., Udoh, F. E., &Akpan, A. A. (2024). Agricultural Education Fish Demonstration Farm and Acquisition of Psycho-Productive Skills in Fish Feeding and Disease Management by Undergraduate Students. *Universal Academic Journal of Education, Science and Technology*, 6(1), 47-59.

Olaganathan, R., &KarMun, A. T. (2017). Impact of Aquaculture on the Livelihoods and Food Security of Rural Communities. International Journal of Fisheries and Aquatic Studies, 5(2). Retrieved from https://commons.erau.edu/publication/838.

Pinstrup-Andersen, P., Rahmanian, M., Allahoury, A., …., Gitz, V. (2014). Sustainable fisheries and aquaculture for food security and nutrition. A Report by The High-Level Panel of Experts on Food Security and Nutrition.

Rosa da Silva J., Mauad J., Domingues C., Marques S. C. & Borges J. A. (2020). Understanding the intention of smallholder farmers to adopt fish production. Aquaculture Reports, 17, 100308.

Saad, A. I., &Udoh, F. E. (2023). Attitudes towards fish consumption and Farming: Reducing Reliance on Imported Fish. *Asia-Africa Journal of Academic Research and Review*, 3(2).

Ssepuuya G., Sebatta C., Sikahwa E., Fuuna P., Sengendo M., Mugisha J., Fiaboe K. K. &Nakimbugwe D. (2019). Perception and awareness of insects as an alternative protein source among fish farmers and fish feed traders. Journal of Insects as Food and Feed, 5(2): 107-116. https://doi.org/10.3920/JIFF2017.0056

Udoh, F. E., &Offiong, A. A. Concrete Pond Management Skills Required by out-of-School Youths for Sustainable Fish Farming in Akwa Ibom State. *Journal of Educational Realities-JERA*, 4(1), 106-116.

Udoh, F., Ekanem, S. F., &Offiong, A. A. (2019). School Farm Three-in-One Concrete Pond Construction Analysis: Implications for Integrating Theory and Practice for Students Acquisition of Sustainable Skill in Fish Farming. *International Journal of Innovative Research Development*, 8(5).

Udoh, F., Offiong, A. A., & Iwatt, E. B. (2022). Students Field Performance and Entrepreneurial Skill Acquisition Level for Self-Reliance in Fish Farming Technology. *Asia-Africa Journal of Agriculture*, 1, 12-28.

Valenti W. C., Kimpara J. M., Preto B. &Valenti P. M. (2018). Indicators of sustainability to assess aquaculture systems. Ecological Indicators, 88, 402-413.

Yusoff, F. M., Umi, W. A., Ramli, N. M. and Harun, R. (2024). Water quality management in aquaculture. Cambridge Prisms: Water, 2, e8, 1–22. https://doi.org/10.1017/wat.2024.6

Zreik, M. (2024). Synergizing trade and sustainability: advancing SDG 14 through international trade dynamics. Mar Dev 2, 13. https://doi.org/10.1007/s44312-024-00025-2