

Technology's Place in Nigerian Catfish Creation: A Review

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ABSTRACT

This article looks at Nigeria's catfish producing situation and how technology has changed over the years. Production is under significant strain due to growing demand brought on by population growth. Aquaculturists increased production in response to this pressure, but this demand-driven increase highlights the significant gaps as the industry struggles to deal with the lack of essential structures, such as markets, processing and preservation facilities, and insufficient structured funding. All facets of aquaculture have these gaps, and many of them may be filled with technology. Certain characteristics of aquaculture in underdeveloped countries make it more likely to expand slowly. In low-income areas, a large number of fishermen and aquaculturists are ensnared in economic structures that lead to relative poverty. Numerous explanations for the dynamics behind these outcomes have been proposed, with technology being widely acknowledged as a key factor. The production of catfish in Nigeria has been shown to be actively driven by rapid advancements in hatcheries, water quality, and molecular technology. The history, development, and future possibilities of aquaculture technology in Nigeria are the main topics of this essay. It does this by examining the technology currently used in catfish farming and the effects of their functions in maintaining a balance between fish supply and demand.

Key words: Nigerian aquaculture, technology, fish farming, and catfish production.

Instead of depending entirely on the natural supply from water bodies, a variety of methods of raising fish and other aquatic species are now required because to the population growth that always follows the rise in demand for inexpensive protein (Dauda et al., 2018). Aquaculture, as observed in other developed or developing nations of the globe, entered Nigeria in an attempt to conserve and replace the high demand on the country's waterways due to the fish supply (Grema et al., 2011). It has the ability to close the growing gap between Nigeria's fish supply and demand by maintaining aquatic creatures in a controlled environment (Dauda et al., 2013). With an annual demand of 2.1 million metric tons, Nigeria is the biggest fish eater in Africa and a major global consumer, according to Adewunmi et al. (2011). The promising potential of aquaculture, or more generally, aquatic flora and fauna, has become dubious due to the intricacy of the aquatic ecosystem. According to Adewunmi et al. (2011), fish farming, also known as catfish production, is the main fish species cultivated in Nigeria and is distinguished by strong disease resistance, high acceptability, and affordability. A significant fish species raised in many parts of the globe is the African catfish, often known as the Clariidae family, of which *Clarias gariepinus* is the most commonly raised (Dauda et al., 2018). Nigeria is the biggest producer, followed by Brazil, the Netherlands, and other nations (FAO, 2016). However, the success of African catfish farming, which made a significant contribution to the growth of aquaculture in the 1980s and 1990s, may be connected to the successful development of artificial propagation procedures in Nigeria (FAO, 2016). Ozigbo et al. (2014) state that poor management of Food and Agricultural

According to Nwachukwu and Onuegbu (2007), the best method to advance aquaculture in Nigeria is to introduce technology, among other things. With the correct technology, aquaculture's many facets may be developed and eventually made accessible to all fish farmers and aquaculturists (Joshua and Omidiji, 2002). In low-income areas, a large number of fishermen and aquaculturists are ensnared in economic systems that lead to relative poverty (Watanabe et al., 2001). Numerous explanations for the dynamics behind these outcomes have been proposed, with the agreement being that technology plays a significant influence (Pollnac, 1985). There is always space for improvement, even if the technology used have evolved according to local resources and socioeconomic circumstances. Artisanal fishing and aquaculture have benefited from the successful replication of innovations from other sectors (Walsh et al., 2002). This is particularly true in underdeveloped countries where improvisation is rather widespread. This essay will concentrate on the utilization of technology while acknowledging that small-scale fishermen and aquaculturists in third-world nations like Nigeria confront several challenges. In fisheries and aquaculture technologies, there are no universal solutions; instead, each community or unit should be examined separately to identify the technologies that are appropriate for its particular circumstances (Ben-Yami, 1984; Ben-Yami and Anderson, 1985). For instance, fisheries and aquaculture in certain regions of Nigeria are mostly managed by men using equipment and procedures designed by men for men, a practice that has persisted for many years. In terms of prejudice resulting from gender imbalance, this element will be mirrored in the kind of technology used. Additionally, this research is significant since 50% of the world's 15 million full-time artisanal fisherman and 15 million fish processors dwell in

developing nations (Compte et al., 1984; National Research Council, 1988). Fish caught and raised using traditional ways is the main source of protein for the families of these millions of people and the many others they feed (Poggie, 1980). Both commercial and subsistence fishing share a little financial income (Yagi et al., 2008). As a result, fishing productivity in the artisanal sector is inconsistent and poor; many fishermen only capture one or two tons of fish annually (Ward et al., 2002; McArthur and Sachs, 2002). Thus, the purpose of this research was to identify further technologies that would encourage active growth in the catfish sector as well as to analyze technologies that have already been created in developing catfish farming and the influence of their roles in balancing fish supply and demand.

Methodology

The Food and Agriculture Unit of the Pan African Research Group (FAT-PARG) conducted the conceptualization and research for this study from April to July of 2021. Online and offline research repositories such as Google Scholar, African Journals Online (AJOL), Agricultural Research Communication Center (ARCC), Federal University Gashua, and FAT-PARG libraries were used to find relevant material. In order to prepare this study, 115 of the most current and relevant items were analyzed from 209 online sources (research papers and websites) and 35 offline sources.

History of technology use in Nigerian aquaculture

Man has been interested in fish farming from the beginning of agriculture centuries ago as a means of producing food, earning money, and raising production levels as technology developed (Wuyep and Rampedi, 2018). Nigerian aquaculture was once conducted on a limited scale, but because of prompt technological advancements, it has developed into a commercialized system, as seen by intense fish farming today (Akinola et al., 2006). Nigerian aquaculture has used antiquated methods in recent decades, focusing on wetlands and coastal plains and interior waterways. However, since the cage culture technology was introduced, aquaculture growth has concentrated more on the coastal area. There are several prospects for large-scale aquaculture production in Africa, with Nigeria being one of the leading producers. Eighty percent of the output comes from small-scale farmers engaged in freshwater and brackish agriculture. This does not include macro algae and mariculture, which have not been thoroughly investigated because of the associated cost and technological constraints. Fish cultures were made easier by building clay ponds and tanks with dissolved salt concentrations below 0.5 parts per thousand. Fiber glass, PVC plastic, concrete, or treated wood are often used in the capital-intensive tank culture processes (Emmanuel et al., 2014).

Aqua-tech has increased fish sustainability in terms of preservation and shelf life, in addition to cultivation and management. For example, fresh fish may now be processed as desired without suffering a major loss of quality, unlike in the past (Davies et al., 2008). Fish used to be dried and preserved by smoking, but the antiquated, unregulated nature of traditional processing occasionally results in under or over drying and can make fish more susceptible to environmental contaminants like wind, dust, dirt, and flies (Bolaji, 2005). The growing interest in fish farming has harnessed and implemented the use of solar power, freezing, and salting for these objectives, even if this practice is still prevalent in Nigeria due to restricted access to electricity (Olorok, 1997). Nigerians are increasingly aware of the advantages of cutting-edge aquaculture technology. The heat produced by smoking or drying fish inhibits microbial activity and extends its shelf life by lowering the moisture content (Clucas and Ward, 1996; Oyeleye, 2003; Amoo et al., 2007). Many fish species have remarkable preservation "qualities" after being smoked, sun-dried, and even salted (Madu et al., 1984). Eves and Brow (1993) further shown that smoking and drying fish had two benefits: increased nutritional value and greater protein digestion.

Trends and prospects of technology in aquaculture

Applications of technology have always served as a link to a brighter future. Aquaculture technologies are no different. Aquaculture has seen rapid progress during the last several decades. From basic methods to sophisticated systems, a progression has been seen. Aquaculture today uses technology to boost output and growth to satisfy customer demand, which has been shown to influence the sector's economy by encouraging profitable operations (Lazard et al., 2010; FAO, 2010). Fish can now be infused with resistant strains and stress tolerance, which have prevented many diseases and increased the sustainability of aquaculture species in productivity, growth, food processing, and economy, thanks to the use of genetic tools and various reproductive techniques (Renault, 2009). There are many opportunities for technological advancement in aquaculture (Waite et al., 2014). Technological advancements in breeding techniques and production, reproductive control, strain and species selection, nutrition technology and feeds, vaccines, automated aeration, water exchange, and non-technological inventions like market certification standards and sophisticated supervisory structures have all contributed to the growth of the aquaculture industry over the past 50 years (Kumar and Engle, 2016; Joffre et al., 2017). According to recent research, investments in new goods, management techniques, and technologies result in substantial advantages for both producers and consumers (Kumar and Engle, 2016). Aquaculture production methods have improved (Asche et al., 2005). Technological developments have made it possible to use new management techniques, which has increased aquaculture productivity in terms of labor, output per unit of area, and water. As a result, manufacturing costs have decreased and market rivalry has increased (Barazi-Yeroulanos, 2010). This article discusses some of the technological developments and opportunities in aquaculture.

Aquaculture reproduction

Certain elements of the fish life cycle have been improved by advancements in fish reproduction. Juveniles may be produced in any season and selectively selected to increase growth and resistance to illness thanks to hatchery technology. Salmon breeding companies have emerged as a result of the technology of selective breeding, which uses genotyping and quantitative trait loci (QTL) to aid selection. This has resulted in the introduction of strains that are highly resistant to infectious pancreatic necrosis (IPN), a viral disease that previously devastated produce (Houston et al., 2010). Genetics and biotechnology are major factors in boosting the ecosystem's sustainability and production. Recent advancements in aquaculture technology have made it feasible to identify and conserve aquatic biodiversity. The transgenic shrimp, which was grown (Mialhe et al., 1995) and has been enhanced recently, is an example of how transgenic technology is a significant breakthrough that has been helpful in reproduction. Growth rates, market size, feed conversion, disease resistance, stress tolerance against harsh climatic conditions, and sterility problems may all be improved using transgenic technology. Genetic markers such as brief unique genetic codes have been established to help identify genes that are prominent indicators for growth, sex-determining variables, and illness susceptibility (Kocher et al.,

1998). Catfish, salmon, tilapia, and other farmed fish species are genetically upgraded and improved via the use of these markers. These cutting-edge methods have assisted farmers in overcoming the shortcomings of several conventional methods that decreased productivity estimates. Research organizations are working on several initiatives to study and better comprehend the genetic sequence of certain animals.

The Genetically Improved Farmed Tilapia (GIFT) program is a common example.

Feed technology

The price of aqua-feed proteins, particularly fishmeal, is one of the most difficult problems in aquaculture (Forster, 2008; Naylor et al., 2000). Despite the high protein content of fishmeal, its availability and cost are problematic, necessitating the search for alternatives and the addition of plant proteins. This is where technology comes into play since biotechnology makes it possible to provide a viable substitute for fish meal by improving manufacturing and processing methods through the use of plant protein (Mendoza et al., 2001). However, the presence of anti-nutritional elements makes using plant seeds and leaves as protein supplements problematic for finfish and mollusks (Papatryphon and Soares, 2001; Vielma et al., 2000). New dietary formulae have improved nutrition in aquaculture. Now that diets can be completely customized, major sectors like catfish, tilapia, shrimp, salmon, sea bream, sea bass, and trout are growing faster (FAO, 2010). In order to meet the unique requirements of manufacturing processes and end markets, several enterprises now have their own feed formulations. Depending on their goal economic size, a corporation may utilize one or more types of technology. For instance, a business may use techniques like sealed pellets and coated vacuums just to safeguard and boost the lipid content, which promotes a lot greater and more effective conversion of fishmeal to aquaculture products at a reduced production cost (Refstie and Asgard, 2009).

Disease management

Technology has significantly enhanced fish health. When compared to earlier decades, the illness conditions and mortality rates have decreased (Pulkkinen et al., 2010). Vaccines against bacterial, fungal, and viral illnesses have been created. Most of these vaccinations were based on adjuvants of mineral oil and dead or transformed cells to trigger immune responses. This is shown in the FAO (2010) study, which states that the overall fatality rate in Scotland's salmon sector decreased from 38% in 1997 to 12% in 2000, with a further dip occurring only recently due to advanced technical developments. Molecular techniques and technology have advanced in reducing treatment resistance to some illnesses, such as sea lice in Atlantic salmon, since the search for the ideal vaccine began a few decades ago (Alvarez-Pellitero, 2008; OIE, 2001). Recent studies have focused on developing vaccines against virus-related diseases using various cutting-edge technologies such as peptides, RNA, and DNA (Costello, 2009).

There are records of new illnesses that have impacted aquaculture because the variety of new pathogens has rendered the conventional methods of disease control ineffective. One of the best ways to address this problem is to use molecular techniques for pathogen screening, identification, and isolation. These methods not only help control diseases but also offer important insights into how diseases develop, as well as potential control, prevention, and treatment options like DNA vaccines. Numerous DNA or RNA-based probes show a lot of promise for quickly and easily identifying infections and their carriers. Advances in nucleic acid-based probes have benefited both wild and cultivated species in terms of disease control and prevention. Due to the unintentional transmission of virus-related diseases from brood stock to emerging progenies, these probes have been effective in selecting shrimp brood stock and stopping infection cycles. IHNV and type-A baculo virus in shrimp farming are two feasible accessible molecular studies (Durand et al., 1996); however, commercial probes for additional viral diseases, such as SEMBV, MBV, TSV, HPV, and YHV, are still being developed. Microbial probes have two main benefits over non-molecular methods: they are very sensitive and very selective (Walker & Subasinghe, 2000). They can readily identify microbial illnesses beforehand and provide more precise and quick pathogen identification due to their high sensitivity and specificity, respectively.

The widespread use of these molecular approaches has contributed to a decrease in reliance on preventive therapy and active antibiotic usage for disease management. Thus, their use contributed to improved illness management intervention and lower costs of control. In vitro tissue culture is available for many fish species, and biotechnological techniques are useful not only for pathogen screening but also for estimating a variety of health parameters, such as leucocytes, myeloperoxidase activity, phagocytic functions, hematocrits, and oxidative radicals (FAO and NACA, 2001; OIE, 2000; Groff and La Patra, 2000; Chi et al., 1999).

Overall system improvements

The majority of early aquaculture techniques relied on streams or fishponds. Floating cages on open bodies of water are not the only recent development (Fredheim and Langan, 2009). Nowadays, cage culture is common. High-density polyethylene pipes, or HDPE, were originally manufactured for gas production companies and are used in some of the well-known designs. The majority of popular aquaculture cage nets are made of knotless nylon in addition to specific HDPE moldings. However, more recent materials are also being used, such as Ultrahigh Molecular weight Poly-Ethylene (UHMwPE).

Technology advancements have made it possible to produce special service vessels like catamaran work boats and well boats. Additionally, fish pumps and counting and sorting arrangements have significantly decreased labor requirements, allowing for the efficient stocking of large sections (Forster, 2008). Computerized feed conveying systems with moving feed storage containers are evolving into full-service programs that provide personnel accommodations along with creative monitoring and communication strategies. Recirculatory aquaculture systems (RAS) give the possibility of aquaculture being carried out near market and with minimum environmental discharge. The natural predators of aquaculture stocks have been addressed by technology. Instead of using outdated, damaging methods like weapons to kill birds, better technical alternatives including scares and protective barriers are currently used (Muir, 2005; Quick and al., 2004). There have been claims throughout the years that hazardous medicinal materials are dumped into environmental waterways (Burridge et al., 2010). Better assessment and appropriate check in this ability have been prompted by improved research laboratory discovery methodologies (Peeler et al., 2007).

In the aquaculture industry, management positions have been simplified. At the industry and corporate level, the quality and suitability of information available to employees is crucial for efficient management implementation, and the Internet of Things (IoT) provides the powerful tools required for assistance. Using geographical characteristics for planning and regulatory purposes, as well as for collation and visualization, Geographic Information Systems (GIS) have established a framework for analyzing and presenting a wide variety of data (Ross et al., 2009). Additionally, ICT has been recognized as a crucial component in contemporary market chains. Key supermarkets use increasingly sophisticated market representations to support predictive requests targeted at particular goods that incorporate explicit short-range variables, such as campaigns on standby items with potential to increase or decrease consumption of perishable goods (Taylor and Fearn, 2009). The supply chain receives the information in the form of forward orders, which are typically placed less than 24 hours before delivery. As a result, producers require amazing scheduling and logistic information technology in order to react appropriately. For example, in the case of a large salmon company, technology is the only way to effectively select and mobilize the right processing plant and handle all the intermediate transport logistics, including determining which sites and cages should be harvested to provide the required product. The ICT systems also provide food and feed suggestion tools (Bostock, 2009). According to McGinnity et al. (2003), genetic introgression may potentially lead to a reduction in lifetime aptness and contribute to the decline of Atlantic salmon populations. On the other hand, it is anticipated that the number and frequency of escapes, broad features of the environment, and native stocks would influence concrete consequences. Genetic marker analysis is crucial for monitoring future changes as well as exploring populations where such occurrences have been previously found (Glover et al., 2009). Proposals for aquaculture to employ sterile triploid stock or, alternatively, create strains unable to reproduce in the wild have been sparked by certain circumstances (Wong and Van Eenennaam, 2008). The theory and technology behind such plans are commendable, even while their ecological effects are questionable.

Biotechnological tools

The only approach to apply and comprehend gene regulation and expression is via biotechnological research (Davies, 2005; Agresti et al., 2000; Alcivar-Warren, 2001). Similarly, transgenic alterations have produced several advantages when investigating biotechnological techniques for better cryopreservation of gametes and embryos.

Bioremediation

Bioremediation is a different strategy that shows promise. This makes it possible to utilize a variety of aquatic creatures and macroorganisms to break down hazardous waste to a level that is generally good for the environment (Rao and Sudha, 1996).

Various enhancement technologies related to aquaculture

Pen cages, aquapods, and sea-ranching technology—which produces juveniles in hatcheries but releases them to the sea to grow—are other new and improved aquaculture-related technologies. Over the last ten years, catfish farming has also been greatly aided by other new and modified production methods including biofloc and aquaponics. By teaching fish to eat algae and recycling fish waste to grow plants instead of releasing wastewater into the environment, these technologies aim to minimize the amount of fish feed used (Ogah et al., 2020a). These technologies are becoming more common recently, despite the fact that many farmers did not quickly embrace them owing to a lack of funding and technical expertise (Ogah et al., 2020b).

CONCLUSION

Nigerian fisheries and aquaculture have greatly benefited from the several technologies that have been presented. Balancing manufacturing with environmental care will get increasing attention as the globe shifts to more sustainable production methods. Because continuous intake of processed food is discouraged in certain medical circles, mass manufacturing also has some health concerns. There will probably be more discussion about using genetically modified organisms (GMOs) to improve food security, particularly in developing nations like Nigeria and regions affected by natural catastrophes, hunger, or conflict. Nigerians would have to determine how quickly the next wave of technical advancements can spread since there is a demand for these things in more sophisticated countries. Nigeria will be remembered in history as a quick adopter and a ready market for cutting-edge innovations, regardless of how the pendulum swings.

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