International Journal of Engineering, Management and Humanities (IJEMH)
Volume 2, Issue 3, pp: 248-258 www.ijemh.com

Standardization of Fish farm in Nigeria. A case of Ogun State

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Date of Submission: 14-06-2021 Date of Acceptance: 29-06-2021

ABSTRACT

The growth of a country's population is usually accompanied by an increase in the demand for human basic necessities of life, such as food, water, and shelter as it is the case with the unrestricted increase in the demand for protein rich food items especially of animal origin (Ugwumba and Chukwuji, 2010). Never before have people consumed so much fish or depended so greatly on the sector for their well-being because it is cheaper than other protein sources (FAO, 2014).

Fish is like a staple food consumed by a larger population of the country. This has resulted in high demand for fish both for local consumption and for export purpose. Unfortunately, the level of production has not matched the level of consumption. There is the need therefore to meet this shortfall in supply.

The awareness of the potential of fish farm to contribute to the domestic fish production has continued to increase in Nigeria. This stems from the need to meet the much needed fish for domestic consumption and for export.

The increase in the population of the country has resulted in a huge increase in the demand for animal protein; which is higher in quality than plant protein. The average protein intake in Nigeria is about 19.38g/caput per day, which is below the Food and Agriculture Organization (FAO) benchmark of 70g caput/day. This nutritional requirement is crucial in Nigeria, where malnutrition and starvation are the major problems faced by most rural dwellers in the country. Fish has been recognized to contribute about 55% of the protein intake in Nigeria. Standardizing this sector of production will not only lead to a reduction in the amount spent on imports, but also lead to the development of Small and Medium scale Enterprises (SMEs) in Nigeria; which are capable of generating employment, improve income generation and hence improve the standard of living of the populace.

If standardization is being developed and practiced, fish farm can generate lasting benefits for global food security and economic growth (FAO, 2014). In Nigeria, the current demand for fish is about four times the level of local production. Fish farming is an integral part of agriculture, which was found to have the capacity to increase the country's GDP (Gross Domestic Product) and can solve the unemployment problem for our teeming youths if adequately managed (Emmanuel *et al*., 2014).

I. INTRODUCTION

Ogun state is bounded in the West by the Benin Republic, in the South by Lagos State and the Atlantic Ocean, in the East by Ondo State and in the North by Oyo and Osun State.

This write-up covered the whole four agricultural extension zones as classified by the Ogun State Agricultural Development Programme (OGADEP) based on ecological views for effective, adequate and complete improved technologies dissemination. The four zones are Ikenne, Ilaro, Ijebu-ode and Abeokuta zone located in southwestern Nigeria.

1. Facts of Fishery in Nigeria

Overall total production of fish from capture fisheries in Nigeria is about 800,000 metric tons(hereafter MTs)in 2010 from the data of FAO Fishery Statistic as shown in Table.1

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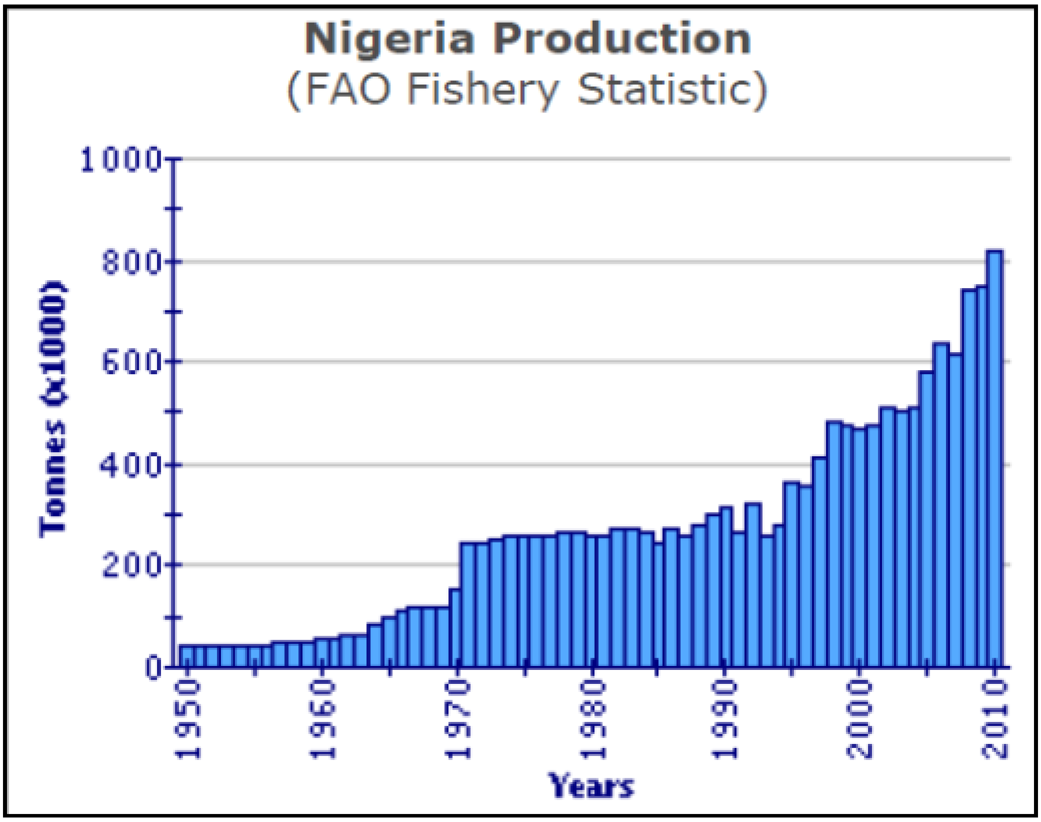

Table. 1.Total fish production in 1950 to 2010.

1.2 Fish Supply-demand Projection

Nigeria's demand for fish in 2010 was projected at 1.89 million MTs in Table 2. However, actual production was 800,000 MTs as shown in Fig. 1. The fish supply gap deficit was over 1 million MTs. Considering the population growth rate of Nigeria is 3 %, the fish supply gap deficit is expected to continuously increase. Current global average annual consumption is about 16.0kg/yr although it is 13.5 kg/yr in Table 2. If the Nigeria targets the amount, the total demand will be 20% more than the forecasted demand. The gap will be some 2 million MTs.

Year	Projected population (million)	Per capita fish consumption (kg)	Projected fish demand (t)	Projected domestic fish production (t)	Fish supply gap deficit (t)
2000	114.4	13.5	1,430,000	467,098	962,902
2001	117.6	13.5	1,470,000	480,164	989,836
2002	121.0	13.5	1,512,500	507,928	1,004,572
2003	124.4	13.5	1,555,000	522,627	1,032,373
2004	128.0	13.5	1,600,000	536,918	1,063,082
2005	131.5	13.5	1,643,750	552,433	1,091,317
2006	135.3	13.5	1,691,250	567,949	1,123,301
2007	139.1	13.5	1,738,750	583,872	1,154,878
2008	143.0	13.5	1,787,500	600,613	1,186,887
2009	147.1	13.5	1,838,750	617,353	1,221,397
2010	151.2	13.5	1,890,000	634,560	1,255,440
2011	155.5	13.5	1,943,750	652,606	1,292,143
2012	160.0	13.5	2,000,000	671,492	1,328,508
2013	164.4	13.5	2,055,000	689,958	1,365,042
2014	169.1	13.5	2,113,750	709,683	1,404,067
2015	174.0	13.5	2,175,000	730,248	1,444,752

Table 2. Fish supply-demand projection (2000-2015).

1.3 Market Issues

Traders and retailers do not use proper storage facilities, do not change the water sufficiently, and often leave the fish in the sun for long periods - all leading to product loss and lower quality, which translate to lower revenues. Traders indicate that limited financial constrains the ability to develop and invest in business operation or expansion. The fundamental infrastructure is far from being adequate and high-quality. The urban markets, where farmed fish is primarily sold, will continue to grow annually through population growth and high demand of fish protein.

1.4 Infrastructure

Most of the infrastructure of fisheries production, landing, and distribution, including food chains, refrigeration and cold storages merit close scrutiny.

II. FISH FARM SYSTEMS AND TECHNIQUES

There are different systems and techniques used for fish production. We have three major systems based on feeding methods; extensive, intensive and semi-intensive. In extensive system, the fish feeding is based on natural foods like phytoplanktons and zooplanktons. That is, no supplementary feeding is required. Intensive system is the one in which the fish are fed with an external food supply. Whereas, in semi-intensive, the fish are fed with supplementary feed in support of the natural food supply.

There various techniques used are as follows: Flow through systems, ponds, cages, tanks and recirculating systems:

- **A Flow-through System**, also known as a raceway, is an artificial channel used to culture aquatic organisms. Raceway systems are among the earliest methods used for inland aquaculture. A raceway usually consists of rectangular basins or canals constructed of concrete and equipped with an inlet and outlet. A continuous water flow-through is maintained to provide the required level of water quality, which allows animals to be cultured at higher densities within the raceway [Mirzoyan, *et al* 2010]. Freshwater species such as trout, catfish and tilapia are commonly cultured in raceways [Gupta MV and Acosta BO].
- **Fish Cage** refers to the rearing of aquatic species, within enclosures in natural waterways. The fish cages are placed in lakes, bayous, ponds, rivers or oceans to contain and protect fish until they can be harvested [Off-shore fish farming term; 2013]. The method is also called "offshore cultivation" when the cages are placed in the sea. Fish are stocked in cages, artificially fed, and harvested when they reach market size. Open systems are being implemented in a wide range of environments including freshwater rivers, brackish estuaries and coastal marine regions. Floating mesh cages are anchored to the seafloor and vary in size depending on the scale of operation and the species cultured.
- **Fish Tanks:** Fish farming can also be carried out in outdoor or indoor concrete or plastic tanks. Tanks can be inform of small aquaria (glass or plastic) or large fiber glasses. Production tanks varies in size and shape, however, round tanks between 5,000 to 10,000 liters are most commonly used [20]. Tanks need to be non-corrosive, therefore, plastic or fiberglass is recommended. Smooth round tanks with a conical shaped bottom are considered advantageous as this will assist with waste solids disposal during draining.
- **A Fish Pond** is a controlled pond, artificial lake, or reservoir that is stocked with fish and is used in aquaculture for fish farming, or is used for recreational fishing or for ornamental purposes. Most earthen ponds are used for culture of carps, tilapia, catfishes and sea bass.
- **A Recirculating Aquaculture System (RAS)** is essentially a closed system and involves fish tanks and filtration and water treatment systems. The fish are housed within tanks and the water is exchanged continuously to guarantee optimum growing conditions. Water is pumped into the tanks, through biological and mechanical filtration systems and then returned into the tanks. Not all water is 100% exchanged however as it is difficult to ensure that all waste products are converted or removed by the treatment process. Most culture systems recommend at least 5% to 10% water exchange rate per day depending on stocking and feeding rates. RAS occupy a very small area and allow the grower to stock fish at high densities and produce high yields per unit area. These systems are very intensive and therefore require a high level in management of stock, equipment and water quality. They provide a predictable and constant environment for growing fish. RAS can be expensive to purchase and operate. For this reason, it is usually only economically viable to farm high value species in these systems.

III. FISH SPECIES GROWN IN NIGERIA

Fish is very important in the diet of many Nigerians, high in nutritional value with complete array of amino acids, vitamins and minerals. In addition, fish products are relatively cheaper compare to beef, pork and other animal protein sources in the country. Fish contribute more than 60% of the world supply of protein, especially in the developing countries. The major species cultured in Nigeria include tilapias, catfish and carp. The production output and techniques of the major species cultured in Nigeria however, the African catfish species (*Clarias gariepinus* or *lazera*) are the most resistant and widely accepted and highly valued fish that are cultivated in Nigeria.

***Clarias* spp. (*C. lazera* or *gariepinus*) popularly known as Catfish**
· Its body has no scales
· Has omnivorous feeding habit
· It preys heavily on other species and even on its own fry and fingerlings.
· Usually it is not stocked alone but along with tilapia which provides food for it.
· It has relatively slow growth rate (when compared to with common Carp and
Heterotis spp)
· The flesh is very tasty and free from bones.

Other most common fish species that are grown in Nigeria earthen ponds include:

➢ ***Tilapia* spp. (*T. guineensis* and *O. niloticus*)**
· Its whole body is heavily covered with scales
· It has omnivorous feeding habit
· Very prolific. Hence it reproduces at a very rapid rate.
· Its flesh is very bony but the bones can be separated and removed especially when the fish is big.
· The flesh has a delicious taste.

➢ ***Cyprinus carpio* (Common Carp)**
· It has few large shiny scales
· It is sluggish and this makes it an easy prey for *Clarias* spp. Hence it is not advisable to stock it together with *Clarias* spp in the same pond.
· Does not grow well without supplementary feeding.
· It grows at a fast rate when fed well and can attain 2kg in 8-10months
· It has genetic potential to grow to a very large size (up to 10kg).

IV. FISH POND PREPARATION

Fig 1- A farm consisting of earthen, concrete and collapsible ponds

Before a pond can be stocked with new fish, the excessive wastes, which accumulate in the pond during the previous farming, must be removed and the soil and water conditioned or upon a newly constructed pond, the following preparations have to be taken into consideration: cleaning, liming, eradication of predators, fertilization, and aeration.

4.1 Cleaning

There are two methods of cleaning; the drying method and wet method. The drying method occurs where the ponds can be completely dried like a concrete pond. Whereas, the wet method takes place in ponds like earthen ponds in which the water in the pond cannot be completely dried.

4.2 Liming

Once the pond is cleaned, it is then filled with water and left overnight before flushing out to remove debris and elevate the pH. This process should be repeated until the pH of the water remains above 7, and only then the lime is applied. The types of lime to be used depend on the water pH. It is recommended that agricultural lime ($CaCO_3$) or dolomite [$CaMg(CO_3)_2$] should be used in a pond with water pH near neutral and the hydrated lime [$Ca(OH)_2$] should be used in a pond with water pH below 5. The amount of lime to be used should be carefully calculated to avoid inducing an excessively high water pH, which may increase ammonia toxicity and result in the mortality of the fish stocked. When the pond is properly limed and filled with water, the average water pH should be between 7.5-8.5 with daily fluctuation of less than 0.5.

4.3 Eradication of Predators

After liming, the pond should be filled with water to the maximum depth through a screen with fine mesh to prevent the predators and competitors from entering the pond. Some chemicals should be used to eradicate these animals in the pond before stocking. Fish can be killed by the application of tea seed powder at the rate of 20-30ppm. After the application of tea seed, the pond should be left for 3 days before the fry, fingerlings and post larvae can be stocked. Hypochlorite, either calcium or sodium salt, is currently used at 15-20% (60% active ingredient) to eliminate both vertebrates and invertebrates. The pond must be cleaned prior to the application of hypochlorite since hypochlorite may react with the organic matters and produces the toxic organochlorine compounds. Hypochlorite should be applied after the pond is filled to the maximum height and left for 3 days to allow the hatching of planktonic organisms. After the hypochlorite application, the pond should be aerated and the application of lime and fertilizer should be conducted on day 3, then stock the pond with fish on day 7. During the first month, water must not be added to the pond, unless the water quality is poor, to prevent the introduction of competitors and predators.

4.4 Fertilization

The pond must be fertilized with either organic or inorganic fertilizer to stimulate the plankton bloom in order to provide shade to the pond bottom and utilize the nitrogenous and phosphate wastes within the pond. The shade will also prevent the growth of harmful benthic algae. The sun dried chicken manure is the most common organic fertilizer to be used in amounts of 200-300kg/ha. The manure must be soaked in water for 24hours before it is spread over the surface of the water. Inorganic fertilizers, such as urea (46% N) and compound fertilizers like, ammonium phosphate (16:20:0) or those with N:P:K combination of (16:16:16) can be used at 20-30kg/ha. The fertilizer must be dissolved in water before it is spread over the water surface to avoid precipitation of the fertilizer onto the pond bottom, which will enrich the soil and accelerate the growth of benthic algae.

4.5 Aeration

0.5-1.0ha pond would require, four aerators installed at the corners of the pond, approximately 3-5m from the bottom of the dike and positioned at an angle that will encourage the maximum water flow within the pond. The type of aerator to be used depends on the depth of the water. One horsepower paddle wheel aerators should be used in ponds of less than 1.2m water depth and the 2 HP (horsepower) paddle wheel aerators should be used in ponds deeper than 1.2m. The aerators should be switched-on 24h before the post larvae are stocked to allow enough time to create the current and clean up the feeding area.

V. PRODUCTION MANAGEMENT

The purpose of fish farm management is to provide good fishing that will lead to increased yield. Pond owners must decide what they want from their pond and tailor their management to meet their goal(s). Fish business is generally prolific if proper handling and management precautions are adapted. The major management practices necessary for effective production are as follows; fish stocking density, feeding, water quality control, diseases control and record keeping.

5.1 Fish Stocking Density

Stocking marks the beginning of production cycle. Stocking density of any aquaculture pond has to be first and foremost considered in management principles. This is because if a pond exceeds its carrying capacity, fish stress is bound to occur which can eventually lead to fish mortalities. The process of stocking referred to here, starts with the collection of fingerlings from the hatchery, transporting them to the farm and, finally, putting them into the pond. Poor stocking procedures, are among the major causes of low survival in grow-out ponds.

They result in stress, diseases and reduced growth and eventually lead to mortality and financial losses. Also, quality fingerlings are another important factor to note while stocking. Poor quality stock will give poor production performance regardless of other factors. The most important practical criteria for assessing the quality of fingerlings are source, physical appearance and how they swim. A Pond's carrying capacity is influenced by the following: the size of fish in the pond (because this influences the feeding rate); the species of fish being raised because fish like *Clarias* spp become air breathers and do not need to rely on dissolved oxygen in the pond, therefore the carrying capacity is higher for *Clarias* spp compared to Tilapia; the amount and type of feed or fertilizer added to the pond and the water volume and quality.

5.2 Water quality

Water quality is the second aspect to consider in fish management. The failure or success of production lies on this key factor. Poor water quality at high level does not spare the life of the fish for a minute. Therefore, this has to be checked regularly as prescribed below. The basic water quality parameters that are important in maintaining fish health include: dissolved oxygen (>4.0mg/L), salinity (15-32ppm), temperature (26-30°C), pH (7.0- 8.5), nitrogen compounds [ammonia (< 0.15mg/L), nitrate and nitrite (< 4.5mg/L)], BOD [5day (50/30mg/L)], hydrogen sulphide (< 0.1mg/L) and pesticides.

These should all be checked at different times: Oxygen and temperature are measured at least twice daily to determine the influence of photosynthesis on concentrations. Salinity and pH are measured daily, and nitrate, ammonia and nitrite can be measured 2-3 times per week. Pesticides (those known to be used in watershed) should be tested periodically and at different rainfall levels to determine the effect of runoff on concentrations. Also check during periods of high rainfall increased water flow that influences water quality and may increase pesticides, sediment, and organic loading. Measure other parameters several times over a month period to know ranges. Know what pesticides are being used in the watershed and when, understand their toxicity, and test water periodically for those compounds.

5.3 Record Keeping

Keep thorough records from the onset of stocking to the harvesting period they are valuable in health management. Keep accurate records of numbers and sizes of fingerlings, time, type and quantity of the feed fed, periods of water changed, time of aeration, date of treatment and vaccination, etc. These records will help you evaluate the status of your fish populations and provide you with proper guide to next farming.

5.4 Fish Feed and Feeding

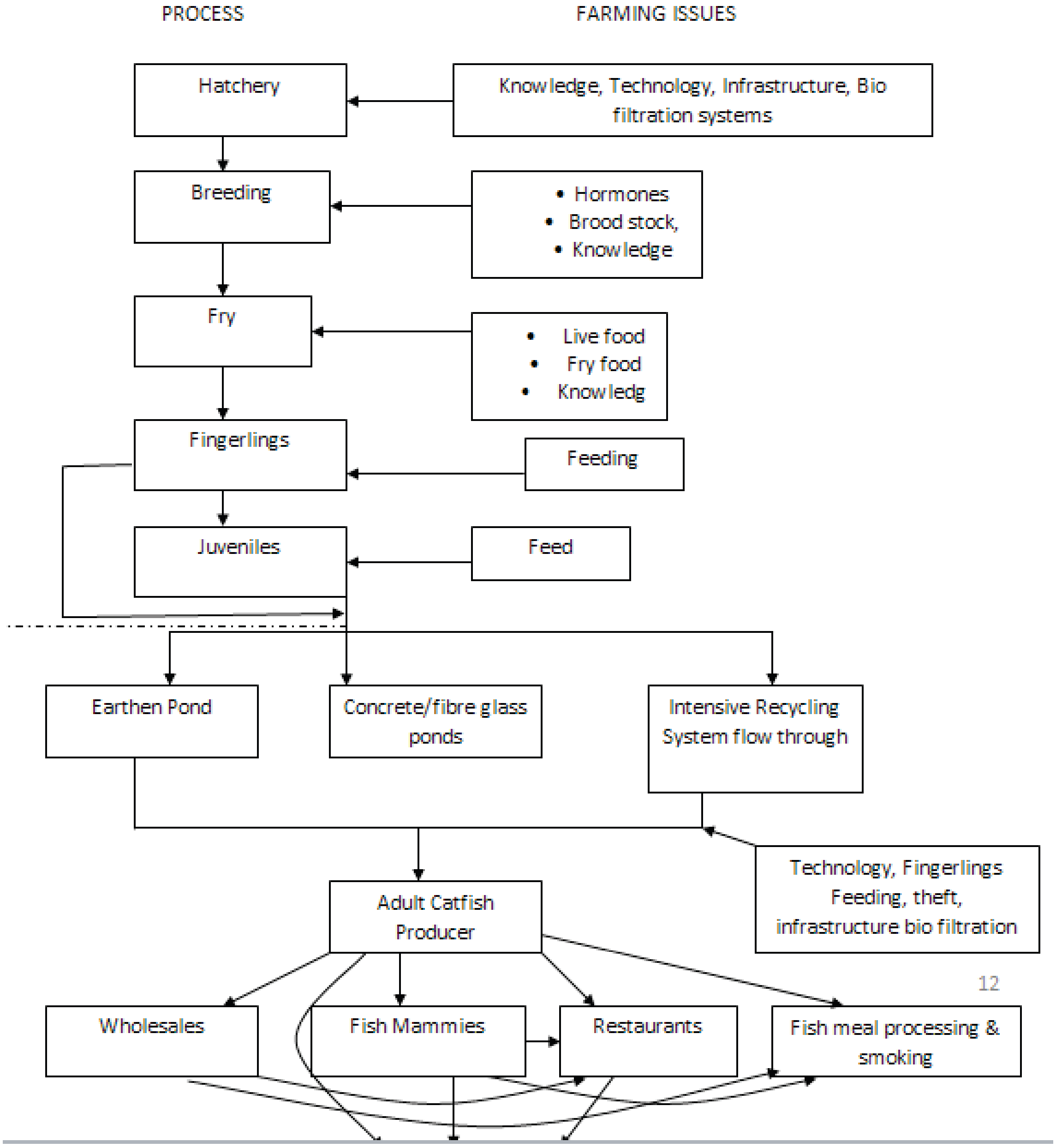

Figure 2: *Catfish concept to Consumption flow chart*

- **Fish feed** is a plant (phytoplankton) or animal (zooplankton) material intended for consumption by fish, kept in aquacultural systems. Fish feeds normally contain macronutrients, proteins, fats, fiber, trace elements and vitamins necessary to keep captive fish in good health. Depending on the type of the system in which the fish is being reared (intensive, semi-intensive and extensive system). The fish can be fed by natural and supplementary feeds or combination of both. Fish reared in intensive tank systems requires all nutrients in a complete pelleted diet since natural food is limited and fish cannot forage freely for natural foods. There are three (3) types of aqua-feeds produced worldwide: floating, slow-sinking and sinking to meet the nutritional requirement of fish species under culture and the culture system. The sizes are as follows: 0.5mm, 0.8mm, 1mm, 2mm, 3mm, 4.5mm, 6mm, and even 10mm (1cm) for larger fish. The sinking (hard) pellets usually sink to the bottom of the fish pond while the floating does not. The floating ability depends on the degree of fineness of the grounded food components and starch gelatinization power of the machine.

- **Feeding** is usually the largest operational cost of growing fish in aquaculture. The feed can represent greater than 50% of the variable costs in growing fish. Labour and feeding equipment are contributors to the total cost of feeding the aquaculture crop. Delivering the feed to fish at the right time, in the correct form, and in the right amount is necessary for optimal growth. The choice of feeding equipment depends on factors such as type and life stage of fish, type and size of feed, size of the operation, available labour, and the type of culture system. Therefore, a careful analysis of these factors is essential for successful and profitable fish culture. There are three groups of feeders and feeding methods—hand, automatic, and demand used to deliver formulated diets. The type of feeding system depends on the life stage of fish being cultured, size of operation, type of diet, available resources, and personal preferences. This is because larval and smaller fish require frequent feeding; they are often fed with automated feeders that can be set to feed throughout the day at regular intervals. Smaller aquaculture operations may have sufficient labour to feed all stocks by hand while in larger operations, hand feeding becomes a problem unless larger, automated equipment is used. Whatever method is used to facilitate feeding, the operator must periodically check for feeding effectiveness by sampling and weighting fish, calculating feed-conversion ratios, and adjusting the feeding rates.

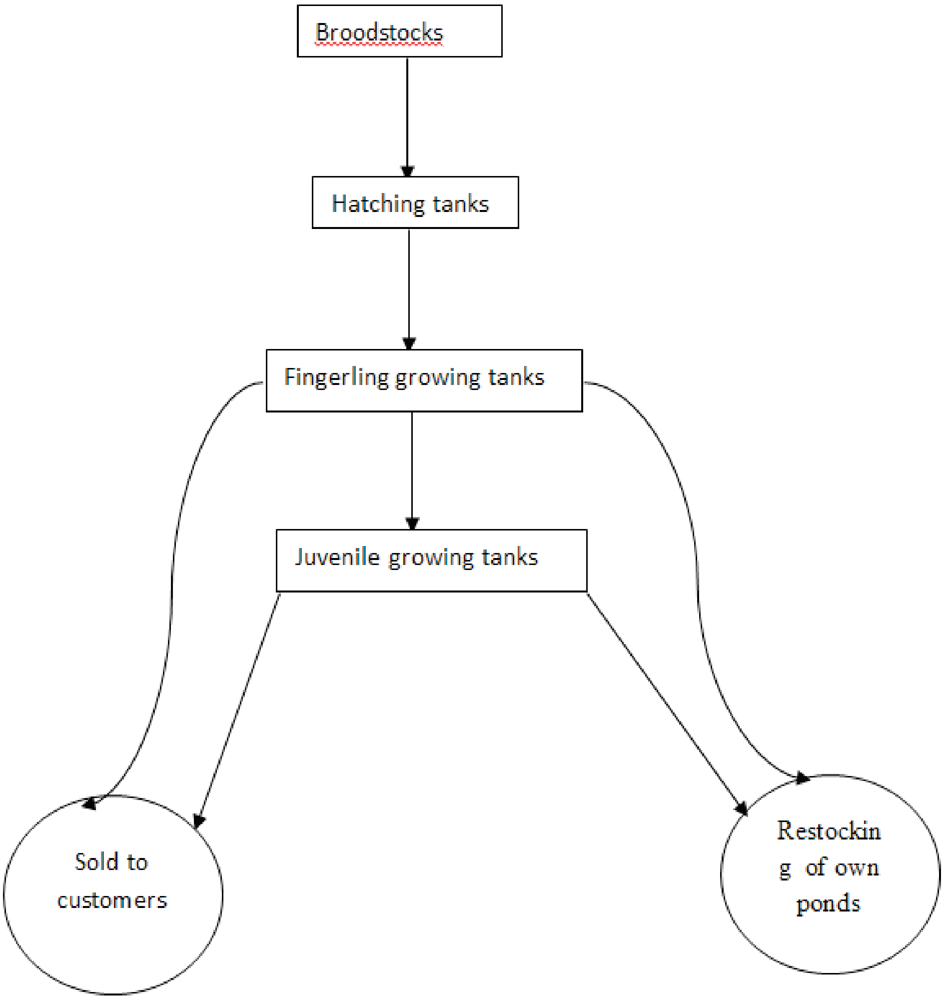

Figure 3: *Hatchery combined with grow out earthen ponds/ concrete*

5.5 Hand feeding

Manual or hand feeding can be used in all types of aquacultural systems - cage, net, pond, flow-through, and recalculating and is often the method of choice for small systems. Hand feeding can reduce capital expenditures for equipment, provided sufficient labour is available to perform the feeding duties. There are other advantages to hand feeding; the fish can be observed at each feeding for feeding behaviour to determine if they are actively eating all of the food presented to them. Floating pellets make observations easier. Fish can only be routinely fed to satiation by hand feeding. Observing the fish during feeding can also be critical in the early determination of disease or parasite problems.

5.6 Demand feeders

The cultured fish can be allowed to determine for themselves how much feed is made available when demand feeders are used. Demand feeders can be used to make food continuously available and allows for the fish to feed to satiation. Typically, fish fed with demand feeders consume amounts of feed similar to what they would eat. The demand feeders must, however, be readily accessible to the fish, and sufficient numbers of feeders must be strategically located around larger systems. Fish are trained to hit the trigger of a demand feeder when hungry and then become self-feeding. Some demand systems use a touch-sensitive trigger to activate some kind of mechanical delivery system. Other modifications of the demand feeder use an in-water feed tray that activates feed release as feed is eaten from the tray. Usually, all of the demand feeders are adjustable for food size and amount released per trigger activation. It takes classically about 7 to 10 days for rainbow trout to train and feeding to stabilize on demand feeders [30]. Demand feeders make feed available 24hours per day and result in less size variability in the harvested fish. Trout fed with demand feeders can have up to 10% better feed conversion than in hand-fed systems.

Other advantages from demand feeders are lower production costs from reduced labour requirements and increased feeding efficiency. Trout on demand feeders showed fewer disease problems and fewer problems with dissolved oxygen sags and ammonia spikes from heavy feedings.

5.7 Automatic feeders

An automatic feeder is basically a mechanism that delivers a prescribed amount of feed to the fish at desired time intervals. The major advantage of automatic feeders is the reduction in labour equipment necessitated by hand feeding, especially in larger operations.

Automated feeders have been adapted from other livestock operations to provide cost effective means to meet the array of needs for aquaculture. One key feature of automatic feeders is some kind of programmable device that allows the operator to vary the frequency and amount of feeding. This may be a combination of electrical and mechanical components that broadcast feed into the culture system. Some systems use electrical timers to determine the frequency, which are available from most aquaculture equipment suppliers. Ideally, the settings for frequency will allow enough flexibility to meet the needs of the fish. For smaller fish, the frequency may need to be several times per hour, and for larger fish the frequency could be hourly or longer. Automatic feeders use some kind of mechanical or pneumatic delivery system to present feed to the fish.

Problems and Prospects of Fish Farm in Nigeria

Nigeria as a nation is endowed with good natural resources which can enhance aquaculture development to a greater extent; however, the reverse is the case. Many researchers are wondering whether it is leadership problem or lack of skills required for the production or lack of awareness on the importance of aquaculture to national development. Of course, aquaculture benefits are numerous; it fulfills protein demand of the country, helps prevent food insecurity, creates jobs which settle the unemployment issue and it is prolific and profitable, generate income for individuals, serves as recreation centers for relaxation, can attract foreign exchange capable of increasing the country's GDP and so on.

Prominent among these are: poor management skills, inadequate supply of good quality seed, lack of capital, high cost of feed, faulty data collection, lack of environmental impact consideration and marketing of products. If the associated problems of production, especially the twin issue of feed production and fingerling supply are tackled, Nigeria will soon become a world exporter of catfish. According to Oota cited in, high cost of input, lack of credit facilities to fish farmers at low interest rate, lack of skilled manpower and lack of fish extension service are attributes contributing to underdevelopment of aquaculture in the country. The major problem hindering the promotion and development of the fish farm in Nigeria has been the scarcity of fish fingerlings and that the major factors militating against the production of high quantity of fish seed are energy and water quality related problems arising from skills gap in the industry.

Training needs of fish farmers

The training needs for fish farming indicating farmers needed training on feed formulation, fish breeding and hatchery management practices severely.

Fish diseases

High productivity in aquaculture production only transpire when fish are healthy and free from diseases. Fish disease management is aimed at preventing the onset of disease and measures to reduce losses from disease when it occurs. Let us see some common fish diseases, their causes and management control:

- ***Vibriosis*** is a bacterial disease causing significant losses of fish in marine fish farms. Vibriosis accounts for an estimated two-thirds of disease reported in grouper species. Vibriosis results in severe skin, muscle, fin, eye and internal organ damage of fish. Stressors that trigger vibriosis outbreaks include high water temperatures, high stocking densities, poor handling of fish, and an organically polluted culture environment. Antibacterial medication, reducing stocking densities, careful handling of fish, improving the culture environment through the use of clean pelleted feeds, stocking of fish in cooler season of the year and vaccination are important control measures.
- ***Streptococcosis*** is a disease of freshwater pond fish cultures, particularly *Streptococcus agalactiae* of tilapia (*Oreochromis spp.*). Clinical signs include cloudy eyes, exopthalmos and focal, ulcerative skin lesions along the caudal peduncle area. Control of streptococcosis relies on the administration of an antibiotic to which the isolate is sensitive together with control of any associated ectoparasites and appropriate risk reducing husbandry measures. Preventative measures are dependent on an effective vaccine against the pathogenic strains of *Streptococcus* present in the fish environment or to which the susceptible fish stocks are likely to encounter.
- Others diseases include Benediniasis, viral hemorrhagic septicemia, *Myxobolus cerebralis* (whirling disease), *Ichthyophthirius multifiliis*, *Epinephelus lanceolatus*, Viral Encephalopathy and Retinopathy (VER) Disease.

VI. CONCLUSION

Standards for development of aquaculture are not beyond the country's potentials. As can be deduced from the review on factors that hinder the development of aquaculture in the country, the problem is simply considered to be lack of management skills, support and the scarcity of the fingerlings. Nevertheless, proper aquaculture system design, good stocking and water quality management are essential to successful and quality fish production. Consequently, maintaining a good culture environment through use of proper management practices will reduce the risk of disease and increase production, fish quality, and marketability. Therefore, it is essential to implement and follow good aquaculture management practices to ensure quality and quantity yield. The agricultural sector is a key to unlocking the padlock of food insecurity, let alone its subsector, aquaculture. Statistics indicate that Nigeria spends 100billion Naira on fish importation annually. We cannot continue to rely on importation of every consumer goods, even the ones the country has both natural resources and man-power capacity to produce comfortably and successfully.

VII. RECOMMENDATIONS

- The sustainable management of both fisheries and aquacultures through science based formulation of national policies. In order to do so capacity building of human resources is most pressing. These should be the interdependency of hardware and software consolidation.
- To establish the fisheries high schools or training center to provide practical skills.
- To establish the college/graduate schools to provide the professional levels of education and skill training for advanced management, science, administration officers course. It should provide post-graduate degree.
- Building and equipment for the institutions/schools, and enforcement vessels and aircraft should be provided.
- Assistance in collaboration with the international organizations and the advanced governments to formulate the national policy to sustainability and climate change.
- To introduce the safe, healthy and accountable products for the domestic consumption and international trade. The introduction of guidelines for the sanitary and phyto-sanitary regulations for fitting the consumer standards in the Market nations is the key to sustainable international trade.

- The infrastructure is of the vital importance for the orderly developments for the industries. Such infrastructure may include among others the landing facility, storages, the paved transportation to carry the products for exports, water supply, sledges and electricity and the equipment and material for construction of the processing plants, freezers, refrigerator and packing mechanics.
- Cold chain distribution system - The transport, holding, and distribution of frozen fish in Nigeria is very primitive, usually not refrigerated, and temperature control even in cold storages and at sales points is quite inadequate if available at all. Distribution network within the country has to be examined and appropriate systems fitting to Nigeria should be structured.
- Water quality monitoring/management - A major problem facing Nigeria and its fisheries potential, both internal aquaculture, in particular, but perhaps also offshore, is very severe, geographically quite extensive pollution from oil production, oil spills, and oil transport.

Finally, fish business is viable in Nigeria from all indications but needs more efforts from the both public and government to increase its local production so as to bridge the gap between the fish demand and supply in the country.

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