



The Contribution of Aquaculture to Poverty Alleviation and Food Security Among
the Rural Poor in the Federal Capital Territory (FCT) Abuja

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Abstract

This study examined the impact of aquaculture on poverty alleviation and increased food security among the rural poor in the Federal Capital Territory (FCT) of Nigeria. The rapid rise of hunger and malnutrition around the world mostly affecting the very poor and the needy informed the decision to embark on this research. The world population is purported to reach 10.7 billion by 2050, with most of the growth occurring in developing nations and especially sub-Saharan Africa which is prone to hunger and deprivation. Despite all these developments, studies show that many traditional agricultural systems expected to meet the escalating global demand for food are failing. Over the years, agriculture has been intensified whilst attempting to provide humanity with food and is considered as a growth engine especially for developing countries. However, its non-traditional activities have contributed towards the largest environmental degradation pollution, deforestation, impacting development around the world. Challenges associated with meeting food demand calls for a carefully planned strategy to fashion out how the world's growing population will be fed with nutritionally balanced diet that will improve their general wellbeing, especially in regions with the highest number of malnourished populations that lack sufficient income to obtain food.

Aquaculture has been widely acclaimed as a means of farming through which poor communities in a developing country context could find the much-needed relief in providing for food production and economic emancipation. The aquaculture industry in Nigeria has experienced a rapid development in the last two decades, however, the sector faces many challenges such as lack of political will, availability of high-quality feed, high cost of materials, funding and weak institutions etc.

This study adopted the quantitative research method where 98 large, medium, and small-scale fish farmers were engaged in responding to questionnaires designed to address the set research aims and objectives and research questions designed for the study. Seven institutional heads in the study area were also interviewed using structured and semi structured interviews. Using SPSS and Nvivo, the data collected from the above-mentioned participants were analysed and that helped in providing responses to the set research aims and questions for the study.

From the analysis made, it became evidently clear that aquaculture in the FCT has the potential to grow in contributing effectively towards food security and poverty alleviation in the study area. Whilst it is beset with many challenges, the study found out that with right government policies, availability of essential inputs, availability of capital and the right government support, the sector will be able to reduce the high unemployment rate in the FCT and also help with food insecurity and poverty reduction.

The research has made a unique contribution towards academic discourse on the impact of aquaculture on food security and poverty alleviation in Sub-Saharan Africa and especially in the FCT, which has a limited amount of literature on the topic. Furthermore, it will provide the necessary resource for developing countries narratives, especially countries in West Africa.

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List of Abbreviation

ADP – Agricultural Development Programme
AADP – Abuja Agricultural Development Project
ACGSF - Agricultural Credit Guarantee Scheme Fund
AMAC – Abuja Municipal Area Council
AU – African Union
ATA - Agricultural Transformation Agenda
ATTC - Aquaculture Technology Transfer Centres
BBC – British Broadcasting Corporation
BMP – Best Management Practice
CBN – Central Bank of Nigeria
CFO – Chief Fisheries Officer
DEFRI - Directorate of Food, Roads and Rural Infrastructure
DFID – UK Department for International Development
EEZ - Exclusive Economic Zone
EU – European Union
FAO – Food and Agriculture Organisation
FCR – Food Conversion Ratio
FCT – Federal Capital Territory
FDF – Federal Department of Fisheries
FMARD – Federal Ministry of Agriculture and Rural Development
GDP – Growth Domestic Product
GESS - Growth Enhancement Support Scheme
GR - Green Revolution Programme
JICA - Japanese International Corporation for Africa
LGA – Local Government Areas
LIFDC - Low-Income Food-Deficit Countries
MFCTA - Ministry for Federal Capital Territory Agriculture
NACB - Nigerian Agricultural and Co-operative Bank

NAFPP - National Accelerated Food Production Programme
NALDA - National Agricultural Land Development Authority
NBS – Nigerian National Bureau of Statistics
NEPAD - New Partnership for Africa’s Development
NLSS - Nigerian Living Standards Survey
NGO – Non-governmental Organisation
OECD - Organisation for Economic Co-operation and Development
OFAR - On Farms Adaptive Research
OFN - Operation Feed the Nation
OSR - On Station Research
POU - Prevalence of Undernourishment
PPP - Public private partnership
RAS - Recirculating Aquaculture System
RBDA - River Basin Development Authority
R&D – Research and Development
SSA – sub-Saharan Africa
SPSS - Statistical Package for the Social Sciences
UN – United Nations
UNCLOS - United Nations Convention on the Law of the Sea
UNDP - United Nation Development Programme
USAID - United States Agency for International Development
WAAP - West African Aquacultural Production Programme
WAPPI – West African Aquacultural Production Programme Initiative
WB – World Bank
WHO – World Health Organisation

Definition of some Key Terms

Artisanal Fisheries – Traditional fisheries involving fishing households (as opposed to commercial companies), using relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, mainly for local consumption (FAO, 2015).

Capture Fisheries - The removal of aquatic organisms from natural or enhanced inland waters (fao.org), also called **wild fish**.

Fish Farming – Is the cultivation of fish in an enclosure such as tanks, ponds, lakes, dams, fibreglass, mostly for human consumption (Stickney, 2009).

Freshwater Fish – Fish species that inhabit freshwater environments such as rivers, lakes, tanks, streams, etc.

Industrial Fisheries – Large-scale, commercial fishing operations that involves substantial capital investment and take place in coastal or offshore fishing grounds, in which fishing is typically carried out by a crew and lasts from days to months at a time (Marine Fisheries, 2018).

Mariculture – Aquaculture in marine environments.

Fisheries or Fishery – The activity of catching fish and other living organisms from the wild aiming to be consumed as seafood.

Food insecurity – A person is food insecure when they lack regular access to enough safe and nutritious food for normal growth and development and an active and healthy life (fao.org).

Chapter 1: Introduction

1.1 Background

Aquaculture has been the fastest growing food technology in the world, its innovations had led to growth of various aquatic organisms, low production costs and an economically source of animal protein (Garlock *et al.*, 2020). Aquaculture attained a significant importance over the last three decades due to the dwindling stock of fish in the oceans and the increasing human population leading to a heightened demand for cultured fish (Steven *et al.*, 2018). The importance of the sector was recognised by Gephart *et al.* (2020) when they argued that aquaculture will remain critical in filling the demand for seafood. Its contribution towards poverty reduction and food security have been central to the world development agenda (Bene *et al.*, 2016). Despite the tremendous technological advancements and economic growth recorded around the world, the number of people living in poverty is still too high (Khumalo, 2013). An estimated 821 million people around the world still suffer from prevalence of undernourishment (PoU), of these almost 21 percent are in Africa, which represents more than 256 million people, confirming it as the continent with the highest number of PoU people living in the world (FAO, 2018b). In addition, almost 150 million children under the age five were affected by stunting, 50 million were wasting, and 40 million were overweight or obese due to high level of malnutrition in 2020 (Global Nutrition Report, 2020). Two billion people are affected by micronutrient deficiencies such as Vitamin A, Iron, Iodine, and Zinc. These deficiencies have increased significantly over the years (FAO, 2009; Lancet, 2014; WHO, 2018). Although the 2018 Global Nutrition Report index indicated that the proportion of stunted children globally has dropped from 32.6 percent in 2000 to 22.2 percent in 2017, this is a decline from 198.4 million to 150.8 million in numbers (WHO, 2018b). Nevertheless, the progress is simply not good enough, as malnutrition is still high.

The WHO (2018) noted that about 23.2 percent of the population in sub-Saharan Africa (SSA) experienced hunger and malnutrition between 2014-16. This meant that around one person out of every four or five in the region lacked access to enough amounts of safe nutritious food for normal growth and development to live and function properly (Cunningham, 2005; FAO, 2018b). The situation in Asia is also

not encouraging. It has been estimated that about 11.4 percent of its population is undernourished, and that is almost 515 million people lacking adequate access to food (FAO, 2018b). Furthermore, approximately 124 million people in 2017 were reported to be facing crisis level of significant food insecurity, an increase of 11 million (11 percent) people from 2016 (WHO, 2018). Another pressing challenge confronting the world is the impact of climate change threatening food security, the risk of new or intensified conflict and insecurity, famine, and drought. Furthermore, the impacts of Covid 19 and the war in Ukraine are pushing millions of people into hunger, especially in regions where the poorest and most vulnerable people live (Adeleke, 2020; FAO, 2022) combined with political instability and corruption, and volatility in agricultural yield/prices, among others (Thomas *et al.*, 2017). There is great risk that the progress made in food production over the years through improved agricultural seed varieties, increased fertilisation, and intensification to reduce hunger in particularly the developing world will stall or reverse, creating more anxiety (Richards *et al.*, 2014). On the other hand, the overexploitation of the environment has resulted in pollution, deforestation, degradation, which has impacted development around the world (Maurya *et al.*, 2020). Therefore, pressure put on the environment has caused degradation of natural resources (Foley *et al.*, 2005; Baloch *et al.*, 2020).

Over the years, agriculture has been responsible for providing humanity with food and considered a growth engine especially for developing nations. However, since the emergence of industrial agriculture, its activities have contributed towards the largest environmental degradation of natural resources by humans (Foley *et al.*, 2005; Kastner *et al.*, 2012). Although successful in increasing food production, its activities have led to increased use of land, demand for freshwater, loss of natural habitats, whilst contributing to energy consumption and greenhouse gas emissions (Barrett, 2010; Klein Goldewijk *et al.*, 2017). Furthermore, Klein Goldewijk *et al.* (2017) suggested that about 40 percent of land surface is presently cultivated for agricultural use. Springmann *et al.* (2018), opined that the environmental impacts of agriculture have caused about one-quarter of all greenhouse gas emissions, occupies almost 40 percent of land, and utilises about 70 percent of freshwater resources. The intensive application of fertilisers for food production in some regions has been responsible for surface and groundwater pollution, leading to a decline in marine life (Springmann *et al.*, 2018). Grassini *et al.* (2013) indicated

that crop yields have remained static in most crop production areas around the globe. It has also been reported that 24-39 percent of maize, rice, wheat, and soybean are no longer improving yields in most producing cropland areas across the globe (Ray *et al.*, 2013). Therefore, pressure put on existing farmland in areas that are unable to meet the current food demand will lead to increase in food prices, habitat and biodiversity loss (Bashir and Schilizzi, 2012).

On the other hand, research has shown that the current food production output is enough to meet the global demand for food (Tain *et al.*, 2016; Berners-Lee *et al.*, 2018). Yet, the alarming rates of food insecurity and hunger world-wide, brings to the fore that food production alone is not the solution to this continuous food crisis (Barret, 2010; Tian *et al.*, 2016). The term 'food insecurity' was defined by the FAO (1996) as "A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life." The causes of food insecurity may include non-availability of food, lack of access, improper utilisation, environmental stressors, inequalities, cultural, social and economic factors, and instability over a certain period of time (FAO, 2014; Campbell *et al.*, 2016).

Several supporting studies have revealed that food availability alone is not the contributing factor of not being able to feed the world's population (Kastner *et al.*, 2012; Godfray, 2014; Elum and Mjimba, 2016; Tian *et al.*, 2016). Hunger still exists because about 30 – 40 percent of food produced globally is wasted (Smith and Gregory, 2013; Gunders and Bloom, 2017). Smith and Gregory (2013) expressed that food wastage in developing countries can be attributed to lack of infrastructure and knowledge to keep food fresh, whilst wastage in developed countries is said to come from cheap food, and its being served in larger portions. From the above, it could be deduced that both pre-consumer and post-consumer losses have been major factors of food shortages throughout the world.

Amidst all these developments, Madre and Degust (2015) have argued that the world's protein dietary need will grow by almost 50 percent by 2030, and this growth has been necessitated by consumer demand, changes in dietary intake and increased income for urban dwellers. The importance of nutrition and a balanced diet, including vitamins and minerals cannot be overstated. These trends have led to similar dietary intake worldwide, leading more people to feed on fish

and meat products (Madre and Devuyst, 2015). Many renowned institutions such as the Food and Agriculture Organisation (FAO), World Bank, and Organisation for Economic Co-operation and Development (OECD) believe that aquaculture plays a key role in the provision of sustainable food resources (FAO, 2010; Subasinghe, 2014).

The FAO defines aquaculture as the “farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants” (FAO, 1997). From the above definition, it could be deduced that farming involves an intervention in the rearing methods to enhance the production process. For example, water management, stocking, feeding etc. Stickney (2009) defines aquaculture as “the rearing of aquatic organisms under controlled or semi-controlled conditions”. Parker (2002) noted that aquaculture consist of the development of biological and technological techniques such as application of genomics, genetics, selective breeding, improve quality of water, soil, and dissolved oxygen to enhance ecological sustainability in farming. The application of biotechnology has improved reproduction and early developmental feats in culture cycles, as well as expanding periods of fertilisation and fry availability (Thilsted *et al.*, 2016). Furthermore, artificial reproduction and sex reversal have been used to sustain production lines with regular supply of seeds, regulate sexual differentiation and maturity leading to increased production (Dutney *et al.*, 2017; Hoga *et al.*, 2018). These species exhibit sexual growth dimorphism with male growing faster than females, leading to more successful production (Chen *et al.*, 2018). Whereas in some cases, *Mugil cephalus*, European sea bass, *Dicentrarchus labrax*, and flat fish female have shown faster growth than the male (Dutney *et al.*, 2017). The most effective way to obtain monosex populations is through genetic manipulations, which has been exploited to offer significant and rapid economic gain in monosex culture practices (Budd *et al.*, 2015; Dutney *et al.*, 2017). The diagnosis of diseases and parasites and their management is also being practiced through advances in technology. Advances in technology has led to early detection of diseases and prevention, increased yield, larger income, and food security (Subasinghe, 2014; Akangbe *et al.*, 2015). Modern technology has led to continuous improvement throughout the value chain such as artificial spawning and juvenile production, enhanced production systems, disease management, genetically improve fish strains, improved feeds and feeding technique, and processing and distribution that has influenced production

efficiency (Ganesh *et al.*, 2018; Khan *et al.*, 2020). For example, China particularly diversified breeding technologies, and had 182 novel varieties of aquaculture species approved in 2017 as a result (Liu *et al.*, 2018). Both traditional and new breeding programs involve selective breeding, sex control, genome selection, hybridization, transgenesis, and many others. These techniques allow the progression in production of aquatic organisms even in environments that otherwise would not be suited for production (Satia, 2011).

1.2 Global Contribution of Fisheries and Aquaculture

In many countries the aquaculture business sector has developed into strategic player in agricultural food production since 1950s. At this time, both inland and marine aquaculture production amounted to less than 1 million tonnes (about 5 percent) of total fish production (Subasinghe *et al.*, 2009; FAO, 2014; Kumar and Engle, 2016). However, from 1980 to 2010, world cultivated fish increased by almost 12-fold at an average rise of 8 percent annually. The highest annual growth rates of 10.8 percent and 9.5 percent in the world were recorded in the 1980s and the 1990s, respectively (FAO, 2014; Kumar and Engle, 2016). Over the years, cultivation increased in many countries around the globe, with some countries (e.g., China, India, Bangladesh, Vietnam etc.) leading the way.

China continues to lead the world in aquaculture production, however, during the 1970s and 80s, the industry was characterised by low productivity and inefficiencies (Zou and Huang, 2015; Zhao and Shen, 2016). Studies showed that these periods were characterised by family-owned farms, grown in small-scale traditional systems that benefited families and the local communities (White *et al.*, 2004; Farquhar *et al.*, 2017). Although China still dominates in global aquaculture fish production, but recent evidence suggests that production declined from 59.9 percent in 1995 to 57.9 percent in 2018, respectively (FAO, 2020). Other top leading producers in 2018 were India (8.6 percent), Indonesia (6.6 percent), Vietnam (5.0 percent), Bangladesh (2.9 percent), whilst the Philippines, Egypt and Norway increased their global production output of fish as well (FAO, 2020). Currently, Asia accounts for 89 percent of global fish production. The total production of fish in this region grew from 82.61 percent in 1990 to 89 percent in

2018 (FAO, 2016; FAO, 2020). During the same period, Africa and the Americas increased their share size, however, Europe and Oceania declined slightly (FAO, 2020). This decline was attributed to more stringent regulatory measures on sustainable aquaculture production (environment, social, and economic), as well as pushback from interest groups and the public in Europe and Oceania (Bostock *et al.*, 2016; Varijashapanicker *et al.*, 2019). Amidst high production and low labour costs, fresh and frozen fish that meets consumers demand at a low cost were imported from Asia (Department of Agriculture, 2015; FAO, 2016).

Fish is an important source of dietary protein which up until recently came from capture fisheries. However, since the 1990s, marine fish landings have been in decline due to overfishing and depletion of fish stocks. Studies have suggested that over 90 percent of marine fish stocks throughout the world are fully or over exploited (World Bank, 2017; UNCTAD, 2018). In this respect, humans are unlikely to get any more produce from capture fisheries without negative consequences to the environment. In response to a growing concern for the impact of fishing in oceans and the need for sustainability, the FAO and some countries (e.g., Australia, New Zealand, Canada, Chile, USA) in the late 1950s and early 1960s created new approaches by which to avoid overfishing and collapse of fish stocks in the future. During the 1970s, most of these nations declared a 200 miles exclusive economic zones (EEZs) in their shorelines to achieve sustainable fisheries. Building on this, the United Nations Convention on the Law of the Sea (UNCLOS) in 1982 was implemented to support policy and fulfil laws relating to fish stocks. This gave coastal states the rights and duties to retain 90 percent of the ocean resources around their coastlines for their citizens. Also, countries could now limit catches within their zones (Boyd and McNevin, 2015).

Sustainability in the aquaculture industry has become a hot topic with intense debate by both industry and academia, this has led to many controversies which are still raging. For example, some argue that farmed aquatic organisms are highly dependent on natural ecosystems for inputs, leading to habitat destruction and degradation. Increasing food production is a major contributor to global warming, land usage, freshwater consumption, and overexploitation of capture fisheries (McGraw, 2017; Henriksson *et al.*, 2018; Boyd *et al.*, 2020). Boyd and McNevin (2015) have argued that even though aquacultures' input has increased over the years, its effect to the environment in comparison to other agricultural production

systems is negligible. For example, Fry *et al.* (2018) stated that the feed conversion ratios (FCRs) for the following farmed animals in 2018 were: cattle: 6.0–10.0, pigs: 2.7–5.0, chickens: 1.7–2.0, and farmed fish and shrimp: 1.0–2.4. Fry *et al.* (2018) suggested that aquatic animals are more efficient than larger terrestrial animals because they require less energy to move, stay upright, and regulate their body temperatures because most are ectothermic. Furthermore, Engle and D’Abramo (2018) claimed that improved management, governance, technological advances has enabled sustainable production practices in the aquaculture industry. Despite these gains, the aquaculture sector has been criticised for its negative environmental impact (e.g., water pollution due to the use of chemicals and pesticides), and social or economic conflicts (Alleway *et al.*, 2019; Boyd *et al.*, 2020). In addition, Naylor *et al.* (2021) alleged that many aquaculture systems still lack the motivation to meet sustainability standards, therefore, their contribution towards social economic or environmental performance varies across the board. This has been attributed to the fact that the target market usually does not reward producers through improved prices or access.

Nevertheless, aquaculture has several advantages over other forms of agriculture. It is the most diverse food production sector, culturing many aquatic species and represents the most sustainably efficient way in terms of the environments where farms are located. Presently, more than half of the world’s seafood for human consumption comes from farms (Froehlich *et al.*, 2018; FAO, 2020; Freitas *et al.*, 2020). It has also been argued that it has the capacity to be competitive in the provision of global fish food and compatible with evolving societal expectations (McGraw, 2017). Feed conversion ratio in production were consistently lower for aquaculture organisms compared with other terrestrial farmed animals (Table 1:1). Although there has been better efficiency over the years to produce better results with less feed across all the value chain.

Table 1:1 Comparison for feed conversion ratio for terrestrial animals to aquatic organisms (Brummett, 2013; Fry *et al.*, 2018)

	Edible feed conversion ratio (kg feed/kg edible weight), (Brummett, 2013)	Feed conversion ratio (kg feed/kg live animal weight), (Fry <i>et al.</i> , 2018)
Beef	31.7	6.0-10.0
Chicken	4.2	1.7-2.0
Pork	10.7	2.7-5.0
Finfish	2.3	
Fish and Shrimp		1.0-2.4

Fish is one of the most highly traded commodities in the world, representing about 10 percent of all agricultural products (Sumaila *et al.*, 2016). The sales revenue generated from exports of fishery products for developing countries in 2018 exceeded that of other agricultural products such as meat, tobacco, rice, and sugar combined (FAO, 2020). For example, in 2018 finfish was valued at US\$139.7 billion comprising of 47 million inland and 7.3 million marines cultured (FAO, 2020). The decline of capture fisheries has led to an increased global demand for seafood, aquaculture has stepped in to bridge the gap created. This increased demand for aquaculture was not only due to overfishing of wild fish around the world that reduced the fish stocks in the oceans to a critical level. It has been noted that pollution and destruction of natural habitat, and global warming contributed to reduced fish stocks. In addition, economic and political disturbances have led to a decrease in capture fisheries yields (Little *et al.*, 2016; Asiedu *et al.*, 2017a; Boyd *et al.*, 2020). The global rise in demand for food commodities has led to inflation and more costly food prices, putting the poorer section of society at an increasing disadvantage (FAO, 1981; Zilberman *et al.*, 2012; Tadasse *et al.*, 2016). The aquaculture industry has become a significant source of food for millions, especially in the diets of people in low and middle-income countries. Many of these people are poor, undernourished, and unable to afford alternative nutrient-rich foods such as fruit, eggs, and meat. Where there has been an increase in fish farming, the price of fish in the market has fallen leading to a rise in consumption (Belton *et al.*, 2018a).

To address the global fish shortage, while allowing the ocean to regenerate and replenish itself, aquaculture became the alternative solution to producing fish. However, aquaculture's growth rate was seen to slow down in the 2000s as

subsidies on agricultural inputs such as fertilisers, machineries, and cheap credit facilities intended to compensate farmers were removed. Despite these challenges facing the industry, in 2014, total global aquaculture production reached 101.1 million tonnes, valued at an estimated US\$165.8 billion. This was made up of 73.8 million tonnes of food fish and 27.3 million tonnes of aquatic algae (FAO, 2016). By 2018, production from aquatic animals and plants grew to 114.5 million tonnes (82.1 million for aquatic animals, 32.4 million for aquatic plants, and 26,000 for ornamentals), with an estimated first sale value of US\$263.6 billion combined (US\$250.1 billion, US\$13.3 billion, and US\$179,000 individually) (FAO, 2020). Farmed aquatic plants alone accounted for over a quarter of the total share of aquaculture production and are forecasted to rise due to demand. There has been a steady rise in the growth of aquaculture towards the global supplies of fish, molluscs, crustaceans, and aquatic plants since 1990 (Figure 1:1).

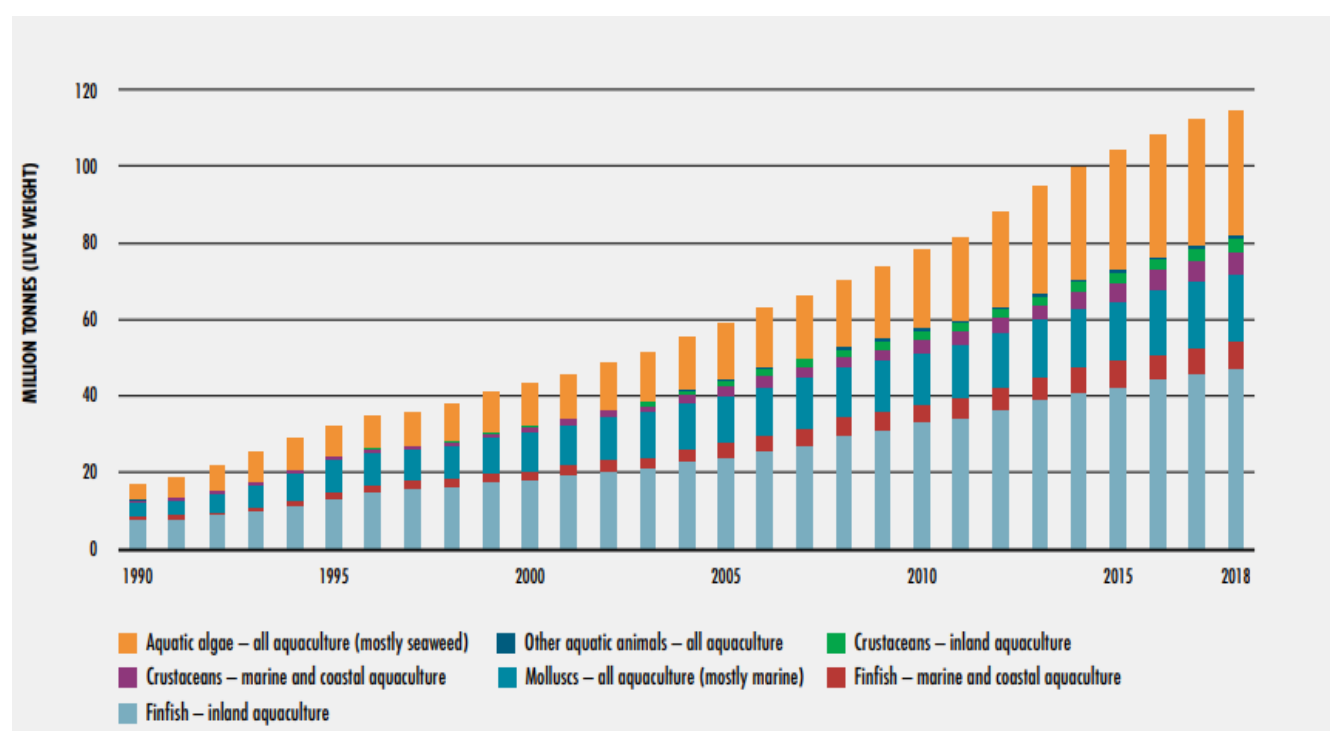


Figure 1:1 World aquaculture production of aquatic animals and algae, 1990 to 2018 (FAO, 2020)

Even with the growth of aquaculture, fish prices overall have risen rapidly due to the demand for and price of fishmeal, fish oil and feeds. Other factors that could

affect production are water (quality and quantity) and land area, bearing in mind also the added challenge associated with catching fish in the wild. In general, feed usually account for 50-70 percent of production costs (Aya, 2017; Rattanaphot *et al.*, 2018). Traditionally, fishmeal and fish oil are the major ingredients for fish feed, because they are the most nutritious and digestible, with high growth potential and balanced amino acid (Aya, 2017; Rattanaphot *et al.*, 2018; Egerton *et al.*, 2020). However, a limited supply of these ingredients are unable to meet the increasing demand of the feed industry and fish farmers (Tacon and Metian, 2009; Rana and Hasan, 2009; Thobaiti *et al.*, 2018). Kok *et al.* (2020) noted the price of fishmeal and fish oil increased globally from \$700 and \$600 per tonne in 2005 to about \$1,500 and \$1,700 per tonne in 2020 and continue to rise. Although the use of fishmeal and fish oil over the last 20 years has slightly declined, they remain important feed components for many carnivorous fishes and shellfish (Hua *et al.*, 2019). Freshwater aquaculture production in leading aquaculture producing countries (China, Thailand, India, Indonesia etc.) are heavily dependent on land and water resources. On the other hand, these resources are in short supply due to population growth, industrialisation, urbanisation, and land tenure structures (Rana and Hasan, 2009). These factors, have caused the price of fish to rise, driving fish out of the reach of mostly the poor who rely on it for their protein.

In 2020, the aquaculture sector employed over 20 million people, and presented livelihood opportunities and a source of income to fish farmers (FAO, 2022). Although the industry is at its infancy compared to other farming methods, the growth of the industry has expanded steadily (Figure 1:1). The FAO reported that global per capita fish consumption increased between 1990 and 2018 from 9.9 kg (67%) to 20.5 kg (88%), respectively (Figure 1:2), with estimates pointing towards further growth (FAO, 2020). Increasing interest from consumers habits has supported aquaculture growth and development. This increase does not include aquatic mammals, seaweeds, and other aquatic plants. The report also suggests that, both capture and aquaculture fishery production in 2018 alone was 179 million tonnes, of which about 156 million tonnes were directly consumed by people as food, and the remaining (22 million) tonnes was used mostly to produce fishmeal and fish oil (FAO, 2020).

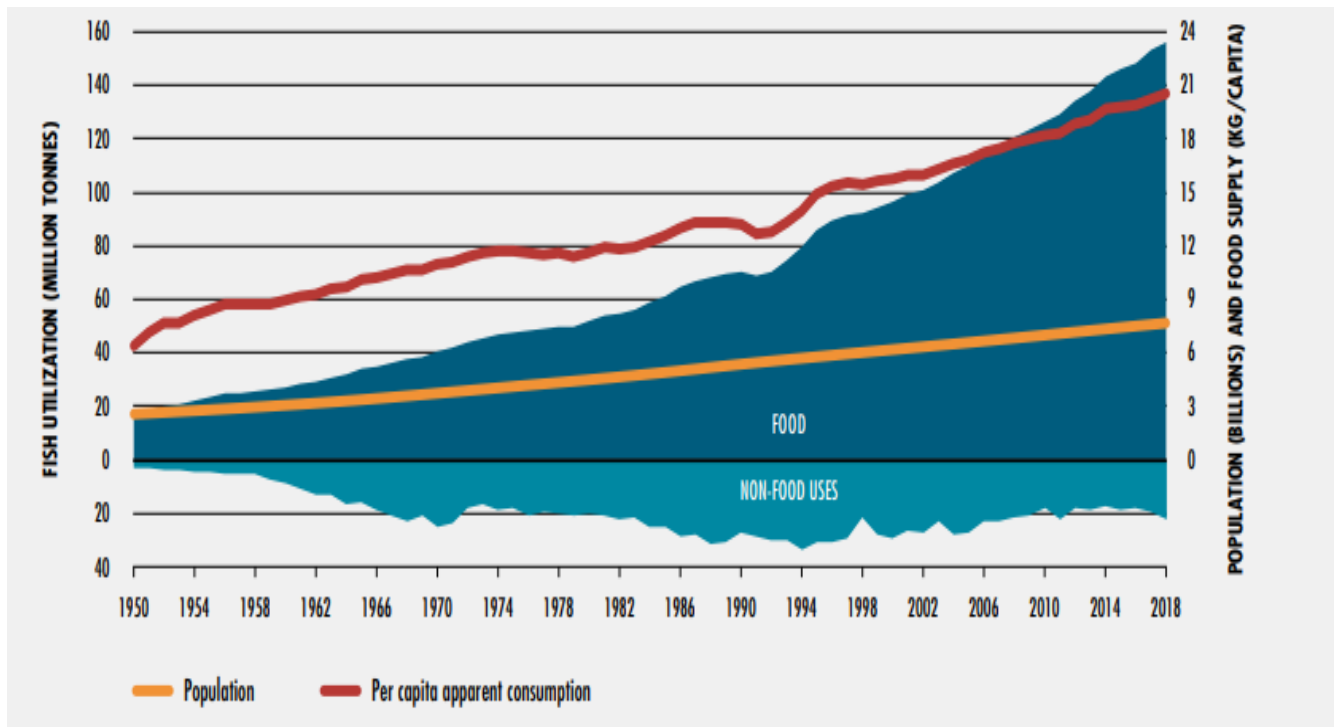


Figure 1:2 World fish utilisation and apparent consumption (FAO, 2020)

In spite of the growth attributed to the aquaculture food production sector, there is a diverse range of problems confronting farmers which has hindered aquaculture's swift development especially within impoverished areas. These issues include access to land, quality seed (fingerlings), expensive feed, water, power, availability of capital, and lack of infrastructure and investment, all of which are further exacerbated by corruption and conflicts in regions that are in dire need of aquaculture activities (Babatunde and Ewepu, 2015). Furthermore, studies have revealed that failure in aquaculture development in some parts of the world is due to weak or non-functional aquaculture governing institutions. De Silva and Soto, 2009; Elum and Mjimba, 2016; Burma, 2018 argue that a mere existence of institutions does not guarantee success, sometimes their presence could be where the problem lies. Institutions are either dysfunctional and in need of restructuring or are non-existence and need to be established. In this regard, institutions can be both a solution or challenge in some cases. Albeit the bottom line is that this sector has overtaken wild fisheries (Figure 1:1) as a global source for seafood supply.

1.2.1 Cultured Fish Species Around the World

There are diverse of species involved in aquaculture which includes both animals and plants. The FAO (2020) statistics suggest that approx. 600 species of aquatic organisms are recognised globally as culture species, including finfish, molluscs, crustaceans, frogs and reptiles, aquatic invertebrates, coral and aquatic plants. Aquatic organisms cultured consist mainly of finfish, molluscs, and crustaceans. A diversity of fish species are employed in the aquaculture sector, and the concentration of operation varies from extensive to relatively high for a great variety of culture organisms (Strom *et al.*, 2019).

The primary species cultured by farmers in Nigeria and the study area are African catfish (*Clarias gariepinus*), Nile tilapia (*Oreochromis niloticus*), and common carp (*Cyprinus carpio*), and pond aquaculture is the dominant production system in the region. More than 70 percent of farmers from the region practice a monoculture production system, with less than 30 percent engaging in polyculture (Adeleke *et al.*, 2020; Naylor *et al.*, 2021). Finfish is the most produced freshwater aquaculture taxa in the world. Therefore finfish, mainly consisting of fish farmed for human consumption will be the focus of this study.

1.3 Fisheries and Aquaculture in the Developing World

Fisheries and aquaculture are vital to millions of people living in the developing world, their production makes critical contributions for many poor households. Many families from these parts of the world rely on fish to feed their families, it is a cheap source of protein for many (Purcell and Pomeroy, 2015; Bene *et al.*, 2016; FAO, 2016). Per capita consumption of fish in developing nations increased considerably from 5.2kg in 1961 to 19.4kg in 2017, and from 4.0kg to 9.3kg in Low-Income Food-Deficit Countries (LIFDCs) in the same period (Belton and Thilsted, 2014; FAO, 2016; FAO, 2020). In 2018, the sale value of fisheries export in developing countries amounted to US\$88 billion, with net export revenues reaching US\$38 billion compared to US\$2.0 billion of revenues in 1990. This stable performance in the fisheries and aquaculture sector saw the industry surpass all

other major agricultural industries in the developing world (Bene *et al.*, 2016; FAO, 2016; Thilsted *et al.*, 2016; FAO, 2020).

Despite the integral role that fisheries and aquaculture plays in the development of national and local economies of developing nations, little seems to be done in Africa to develop the sector to compete favourably with other food manufacturing sectors or with those of commercially developed nations (Brummett *et al.*, 2008; Samy-Kamal, 2015). The varied challenges of fisheries and aquaculture in developing countries ranges from the over-exploitation of resources by over-fishing of high value fish for export to commercially developed economies to poor scientific and technical infrastructure. There is also the lack of effective management and planning, poor regulation, or neglect of farmers by law makers from the process of developmental planning (Adedeji and Okocha, 2011; Ramesh and House, 2013). Other issues include corruption, flood, and natural disasters (drought, water pollution) caused by adverse effects of weather. Furthermore, inadequate funding, lack of research facilities, access to land, unpredictable price of fish and increase in costs of inputs are crippling the growth of the industry (Ghose, 2014; Purcell and Pomeroy, 2015; Bene *et al.*, 2016). In spite of all the above-mentioned threats that have led to the dissipation or reduction in fisheries resources for the small-scale farmer in the developing world, there is strong evidence that if well managed, fisheries and aquaculture can play a part in supporting poverty reduction and make meaningful contribution to food security and nutrition in developing nations (Bene *et al.*, 2010b; Purcell and Pomeroy, 2015).

In the developing world, fisheries and aquaculture are predominantly inland culture, artisanal and marine industrial fisheries, by contrast to highly modern and mechanised fish production structure practiced in industrialised nations (Chilaka *et al.*, 2014). Fish production and consumption is mostly dominant in ten countries in the world (FAO, 2020). Eight of those countries are in Asia (China, India, Indonesia, Vietnam, Japan, Philippines, Thailand, and Korea) and two from Africa (Egypt and Nigeria). Jointly, they account for 55 percent of the world's impoverished and malnourished population and control over 50 percent of the global population. Nevertheless, they are responsible for 60 percent of global fish output, with China leading in total output (Belton and Thilsted, 2014; FAO, 2020).

Table 1:2 World capture fisheries and aquaculture production by region and selected major producers in 2020 (FAO, 2022)

Regions and selected countries	Total capture fisheries production	Total aquaculture production	Fish consumption per capita (kg/year)
Africa	2020 (1 000 tonnes, live weight equivalent)	2020 (1 000 tonnes, live weight equivalent)	
Egypt	419	1, 592	23.5
Nigeria	783	262	13.3
Americas			
Chile	1,773	1, 486	13.3
Peru	5, 626	144	25.0
Asia			
China	13, 226	49, 620	35.9
Indonesia	6, 925	5, 227	46.49
India	5,505	8,636	9.0
Vietnam	3, 422	4, 601	1.4
Europe			
Norway	2, 451	1, 490	19.5
Oceania			
New Zealand	363	119	24.5

1.3.1 Fisheries and Aquaculture Contribution in Africa

Aquaculture in Africa is not a new thing, its history could be traced back to at least 2500 BC in Egypt. During this period, tilapia was shown to be harvested out from an artificial pond, in a pictorial engraving of an ancient Egyptian tomb (Sneed, 1973; De Silva, 2012; Boyd and McNevin, 2015). In the 1920s, expatriates in Kenya saw the prospect of fish culture as a potential for food production and a way to reduce the overexploitation of wild capture fisheries. They invested and constructed the first fishpond in Kenya for the cultivation of tilapia, common carp and catfish, which subsequently spread to other parts of the continent (Munguti *et al.*, 2013).

Africa supplies 2.7 percent of global aquaculture input, valued at US\$2,776 million, and the fisheries and aquaculture sector combined was accountable for 40.4 percent of employment (Adeleke *et al.*, 2020; FAO, 2020). Aquaculture alone is responsible for 7.5 percent of the number of people employed, which represents 2.1 percent of the population of 15- to 64-year-olds in the continent (Munguti *et al.*, 2013; FAO, 2014). Notwithstanding, Africa had the highest growth rate (11.7 percent) of fish food production in 2000 to 2012, outperforming Latin America and Asia (Brown, 2012).

1.3.2 Aquaculture Production Systems

Aquaculture systems are normally categorised by the intensification of input applied into the production system (Huntingford *et al.*, 2012). There are three major production systems practiced all over the world namely, extensive, semi-intensive or intensive (Figure 1:3) (Edwards, 2015). Extensive systems use low stocking densities, with no supplemental feeding but rely on natural food like phytoplankton and zooplankton from the environment. This culture system requires less technological and human intervention. Semi-intensive production is higher and require more inputs compared to extensive systems, using more land and water. They utilise natural food and supplemental feeding, manipulated by human intervention. Intensive culture systems depend on very high stocking densities of culture organisms, and totally utilise artificial pelleted feed. These feeds are formulated using small wild fish or plants in relation to the species being

farmed (Tidwell, 2012; Edwards, 2015). This system is classified by intensification of seed, feed, labour, capital, and management, but using less land and water (Tacon and Metian, 2008; Bunting, 2013).

Aquaculture production globally are practiced in three types of water environment namely, freshwater, brackish water and marine (Figure 1:3) with great potential for culture of variety of organisms (Edwards, 2015; Ahmed *et al.*, 2018). Freshwater aquaculture is practiced in ponds, tanks, raceways, or lakes. The common freshwater inland aquaculture species are tilapia, catfish, salmonids, and carp. Brackish water aquaculture is carried out in lagoons, coastal ponds, and mangrove swamps (Troell *et al.*, 2014a). Buck *et al.* (2017) and Ahmed *et al.* (2018) stated that the most dominant group cultivated are crab, mussels, scallops, shrimps, and oysters. Marine culture is practiced inshore in cages and floating systems such as rafts and longlines anchored to the bottom and maintained on the surface by a floating framework. Mariculture practices includes culturing of finfish such as salmon, cod, seabass, snapper or seaweeds and shellfish.

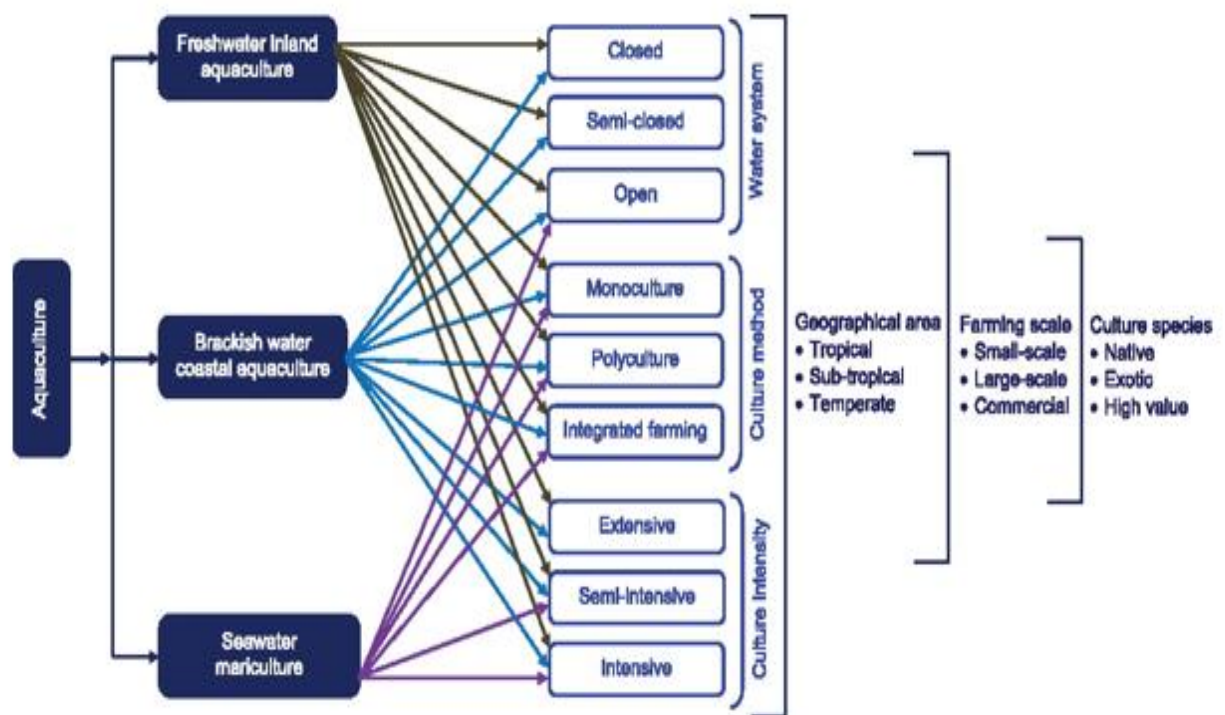


Figure 1:3 Types of aquaculture systems in different water environment (Ahmed *et al.*, 2018)

Buck *et al.* (2017) suggested that there are three water bodies that could be used for fish farming, namely: open, semi-closed and closed system. Open system refers to culturing of fish in natural water bodies such as oceans, rivers, bays, coastal lagoons, estuaries etc. Semi-closed systems are those in which water is exchanged between the farm and a natural waterway, referred to as flow-through. Flow-through systems include linear earthen and concrete raceways and tanks used to produce tilapia, salmon, trout, and catfish. Closed system is where the water is reconditioned and recirculated to the culture unit known as Recirculating Aquaculture Systems (RAS). Various combination of systems and methods are in everyday use to culture a wide range of aquatic organism.

The environment is a factor to be considered when selecting species for culture and production systems (Boyd and McNevin, 2015). Furthermore, a farm may decide to culture one (monoculture) or more species (polyculture). The latter is believed to be the more productive and preferred method and it is argued that raising a mixture of species will give a better utilisation of available food in the

environment (Stickney, 2009). However, management becomes more difficult when stocking fishes with specialised feeding habits or inadequate supply of fingerlings for culture. Evidence from Table 1:3 indicates that more culture of aquatic organisms is taking place in the freshwater environment, but the marine environment still plays a critical role in the supply of aquatic animal and plants.

Table 1:3 World aquaculture production output in million tonnes and growth (FAO, 2022)

	1990 – 2020	1990 – 2000	2000 – 2010	2010 – 2020	2015 – 2020
All aquaculture					
A. Starting annual output	17.3	17.3	43.0	77.9	104.0
B. Ending year's annual output	122.6	43.0	77.9	122.6	122.6
C. Accumulated increase in annual output	105.3	25.7	34.9	44.6	18.6
D. Overall increase	609%	149%	81%	57%	18%
E. Average annual growth rate	6.7%	9.5%	6.1%	4.6%	3.3%

There are a variety of culture systems that vary in design and stocking intensity that can be found in aquaculture (Boyd and McNevin; 2015 Soltan, 2016). For example, culture is conducted in ponds, tanks and raceways, cages and pens depending on the location and environment. Pond aquaculture, which is the most popular fish production system used in Nigeria and particularly the Federal capital territory (FCT) will be the focal point in this study. Ponds are constructed by removing earth (earthen ponds) to create dams or by building of concrete as an enclosure (concrete tanks) to culture fish. Earthen ponds are generally linked with extensive to semi-intensive production, whilst semi-intensive to intensive is usually carried out in concrete tanks. The latter system is more sophisticated, using technological enhancement to operate the system (Huntingford *et al.*, 2012; Boyd and McNevin, 2015).

Semi-intensive to intensive culture systems are popular in some Asian countries. With countries like China, Indonesia, India, Bangladesh, Vietnam, and the Philippines practicing both polyculture and monoculture to raise fishes in enclosures. Production in Asia is often integrated with other forms of agriculture (Lima *et al.*, 2018), for example rice could be grown together with fish. Aquaculture in Asia primarily consists of 'low-trophic' level organisms, which rely mostly on feed from the environment, making it relatively less expensive and more environmentally friendly compared to those that depend on high level protein feeds for their food or utilise more land for production (Dobbs *et al.*, 2013; EU, 2017).

In the Americas, Europe and Oceania, 99 percent of aquaculture production is via intensive aquaculture practices. The Americas are the second largest producer in volume terms, constituting about 3 percent of global fish production, followed by Europe and Oceania (EU, 2017). Aquaculture in these continents mainly consists of 'high-trophic' level species that necessitates the use of specific essential nutrients and feed additives (Sutili *et al.*, 2018; Hancz, 2020). It is therefore more expensive to practice aquaculture in these continents than in Asia. On the other hand, Africa's production methods are largely the extensive to semi-intensive systems. Aquaculture practices in SSA mostly consist of small-scale fish farming integrated into household agricultural systems (Edwards, 2015; EU, 2017). Africa and Oceania's global output compared to Asia, Americas and Europe are relatively lower (Table 1:4).

Table 1:4 World aquaculture production output in tonnes by continent and by main species group, 2020 (FAO, 2022)

	Africa	Americas	Asia	Europe	Oceania	World	Share in world total (%)
1. Finfish	2 236 531	2 420 696	50 029 487	2 673 669	100 711	57 461 094	46.9
2. Crustaceans	7 619	1 266 090	9 951 147	3 563	8 597	11 237 016	9.2
3. Molluscs	5 994	688 077	16 351 380	578 712	116 363	17 740 526	14.5
4. Other aquatic animals	60	370	1 052 346	6 671	2 844	1 062 291	0.9
(Aquatic animals subtotal)	(2 250 204)	(4 375 233)	(77 384 360)	(3 262 615)	(228 515)	(87 500 927)	(71.5)
5. Algae	104 091	25 315	34 916 316	21 792	10 065	35 077 579	28.6
Total aquaculture	2 354 295	4 400 548	112 300 676	3 284 407	238 580	122 578 506	100

1.4 Nigeria

1.4.1 Introduction to Nigeria

The Nigerian National Bureau of Statistics (NBS) reported that Nigeria's population as of September 2016 was estimated by the United Nations (UN) to be 188,116,669, with 48.1 percent living in the urban areas (Udo, 1970; NBS, 2017). It is the most populous country in Africa, and it is ranked seventh in the world (NBS, 2017). The country is divided into 36 states, with Abuja as the capital of the country. There are 774 local government areas (LGA), helping to support the federal system of governance in Nigeria (Figure 1:4) (Olaoye *et al.*, 2013; NOUN, 2015).



Figure 1:4 Nigeria's 36 states and the FCT (NOUN, 2015)

1.4.2 History of Aquaculture in Nigeria

The adaptation of aquaculture in other African countries as a farming technique is a recent phenomenon, and efforts were only really made to introduce and develop the sector in the 1940s and 1950s respectively (Brummett *et al.*, 2008). Fish farming was first introduced into Nigeria in the 1940s, when a basic pond was constructed to investigate the growth of various species in the country, at Onikan Lagos State. This was followed by the Buguma project in Rivers State (Fakoya *et al.*, 2005; Anetekhai and Agenuma, 2013). In 1951, a pilot fish farm of 20ha was constructed in Panyam, Plateau State. The project was initiated by the government of the Northern Nigeria. The main purpose of the Panyam fish farm was to improve the local dietary intake, increase revenue, encourage farmers to adapt other farming practices in order to survive, and create employment for the local population (Hecht, 2006; Olaoye *et al.*, 2013). The country was at the forefront in fish farming even before other African countries started practicing fish farming.

Nigeria has a large amount of farmland suitable for animal rearing and crop cultivation coupled with an appropriate climatic condition, not to talk of its vast array of surface water that could be employed to sustain its agricultural sector. Presently, the country has more than 300 different species of fish that could be cultured if all the available potential are harnessed (Francis and Davis, 2013; FMARD, 2014). They include both freshwater (catfish, tilapia, carp, prawns, snapper, croaker etc.) and marine species (sole, threadfin, barracuda, horse mackerel, cutlass fish, etc.) (Francis and Davis, 2013; FMARD, 2014). The contribution of fisheries in Nigeria comes from a combination of captured (wild) and cultured (farmed). According to an FAO statistic on fisheries and aquaculture production, output for 2020 in Nigeria for captured fisheries was 783,000 tonnes, whilst that of cultured was 262,000 tonnes respectively (FAO, 2022). The sector's contribution to the country's gross domestic product (GDP) in 2021 was \$881,54, a rise from \$871,41 in 2020 (NBS, 2022). This contribution is attributed to the rise of subsistence and small-scale aquaculture. Between 1961 to 2011, the sector recorded the highest growth rate of 10.3 percent compared to only 6 percent in crop production (Odetola and Etumnu, 2013). Even though aquaculture contributed less than 5% to the country's agricultural GDP (50%), the sector has

potential for expansion (Odetola and Etumnu, 2013). Walakira *et al.*, (2023) indicated that over 10 million Nigerians were employed in the primary and secondary operations in the aquaculture sector, with fish and other seafoods accounting for 37 percent of per capita protein intake in 2022. Therefore, bearing in mind the success attained by subsistence aquaculture over the years, if given the needed support, the sector could increase its production yield. This will be vital for the development of the nation in the areas of poverty alleviation, food security, infrastructural development, and a huge contribution to the GDP of the country.

Oyekhilomen and Zibah (2013) noted that fish farming in Nigeria was at its infancy, when compared to its prospective market value. The authors opined that the sector's main sources of fish food supply are artisanal fisheries, industrial trawlers, aquaculture, and frozen fish imported into the country. The sector is made up of three major sub-sectors; artisanal, industrial and aquaculture. For many years, the artisanal and industrial fisheries were the mainstay of fisheries production in Nigeria. But over the years, these benefits are severely threatened by ineffective fisheries management policies, illegal fishing, and insecurity. These have resulted in wild fish being over exploited economically and often well beyond biologically sustainable limits. Aquaculture is now the viable option to meet with the annual demands of fish supply in the country (Adeleke *et al.*, 2020; Okocha *et al.*, 2021). The role of aquaculture in attaining household and national poverty alleviation, contribution to the conservation of natural resources and food security in Nigeria cannot be overstated. Aquaculture activities provide vital nutrition and a source of business that offers a profitable means of livelihood. It promotes rural development and employment for both the local and urban dwellers alike.

The ready availability of market for fish in Nigeria cannot be overemphasised, analysts have valued Nigeria's fish market at \$1. 75bn (N292.25 bn) (Anudu, 2014), market for fish will always be assured. Research indicates that GDP growth originating from agriculture has many benefits for mostly the rural poor in deprived areas with no basic amenities (Mecozzi and Keatinge, 2015). Mecozzi and Keatinge, 2015 indicated that the sector is at least twice as effective in reducing poverty, hunger and malnutrition as growth generated through other sectors of the economy. This is because most of the raw materials used in production comes from that sector and it employs over 60 percent of the rural dwellers who are mostly poor, providing the much-needed income for their existence. Mecozzi and

Keatinge (2015) stressed the importance of not only seeking to eradicate hunger, but undernourishment as well, people's wellbeing should be the principal reason to consider a diet that is full of nutrients that will affect their health in a positive way, and henceforth, increase their quality of life.

1.4.3 Status of the Fisheries and Aquaculture Sector in Nigeria

Aquaculture practices and associated activities in Nigeria were introduced over seven decades ago. The first fish farm project constructed by the Federal Government of Nigeria in 1951 was to serve as a prototype to provide information for other aquaculture activities in the country (Fakoya *et al.*, 2009; Anetekhai and Agenuma, 2013). Although the first year of the farm harvest was insignificant (at about 800kg/ha), the then government of the western and eastern district saw it as a viable venture and decided to construct their respective fish farms (Edwards, 2015).

Within the last two decades, aquaculture has experienced a rapid expansion that has resulted in the passion for fish farming of individuals within the country. The boost in the industry has been enhanced by technological advancement and adoption, market opportunities and profitability, hunger, and poverty. Also, the decline in wild stocks and demand, population increase, and government support and awareness has helped in making aquaculture popular. All these have made fish farming move from a very low input subsistence level to semi-intensive with commercial innovation; a huge potential for investment (Olotu, 2014). However, aquaculture's development by the government of Nigeria has been so slow that it has not kept up with some of these technological advances, despite aquaculture being the source of livelihood for over three million people in the country (Adedeji and Okocha, 2011; Ramesh and House, 2013).

1.4.4 Aquaculture Development in the FCT

The FCT has great fisheries and aquaculture potential, the area is located at the geographical centre of Nigeria and has rich agricultural soil suitable for fish farming. Production of fish is primarily composed of small-medium scale rural activities and a few large-scale commercial aquaculture, but the majority of the participants tend to engage in aquaculture as a secondary or subsidiary activity to support their main income stream. The numbers of fishponds are growing, and the farmers are enthusiastic in making this venture a reality. Hence why this study will provide invaluable information for both the private and public sectors interested in aquaculture propagation. The FCT territory like others in the country has various challenges and constraints crippling the growth of the industry. Some of the problems that have restricted or limited the proliferation of the aquaculture sector are financial, ecological, technical, quality feed and seed, access to market, record keeping, processing and preservation facilities (Lewee and Khadijat, 2014; Phukan *et al.*, 2015).

1.4.5 Species Cultured

The most commonly cultured species of fish in the FCT by fish farmers are catfish and tilapia (Brummett *et al.*, 2008). But the predominant species farmed in the coastal parts of the country include African catfish (*Heterobranchus bidorsalis*), croaker (*Micropogonias undulatus*), sole (*Solea*) and snapper (*Lutjanus compechanus*), and these are consumed all over the country. The main cultured species are known to have good conversion rate, their cultivation lend themselves to efficient use of natural food resources and supplemental feed, as the species have been shown to exhibit a high survival rate under captivity (Olaoye *et al.*, 2013; Adewumi, 2015; Shaalan *et al.*, 2018). These species have also been identified as having a high growth rate, thereby reducing cost of production (Miller and Atanda, 2011; Adeyemi, 2014; Engle, 2019; El-Wahab *et al.*, 2020). From the study, it came to light that the two species (catfish and tilapia) are the most marketed and generally accepted by the public.

The FCT aquaculture sector has not taken off sufficiently to meet the gap between the supply and demand of fish, making fish unaffordable to the poor (Ramash and House, 2013). However, the region's aquaculture sector is rising rapidly and shows a significant promise to continue to accelerate. These trends can be attributed to the highly productive and profitable nature of the industry, high demand for fish product from the ever-growing population of the area, and employment opportunities. The area has access to inland waters (which include streams, reservoirs, and ponds) and indigenous species of fish that could be cultured. Furthermore, it has a wide variety of locally available feed ingredients such as maize, soya bean, sorghum, cassava, and rice that could be utilised to formulate cheap feed for the industry. The sector has the potential to provide additional employment opportunities (Kudi *et al.*, 2008; Rabo *et al.*, 2014; FMARD, 2016).

Over the years, the FCT administration, in its quest to make fish supply available to the public, has embarked on numerous projects, programmes and policies to boost fish production that include; establishment of 10 hectares of fish farm estates in Bwari Area Council - anticipated to provide livelihood to at least 2000 fish farmers, subsidised inputs (fingerlings, feed, fertiliser, nets, boats, etc.), provision of infrastructure (access roads, land, water, light, hatcheries, storage facilities, etc.) and laws on registrations and catch quotas. Even with these efforts, investigation shows that most of these projects have not come to fruition, with delays in start offs for some and others being abandoned (Ibeh, 2013; Agbo *et al.*, 2015).

1.4.6 Research Rationale

The primary purpose of this study was to identify the role of aquaculture in the development and empowerment of rural farmers in Nigeria, with the aim to improve their livelihood. The investigation explored the measures put in place by the government to support fish farmers and their well-being. Furthermore, it investigated the impact of these measures on farmers' income, and how it has improved and intensified the diversity of their protein dietary intake. Thus, it also determined how the natural resources, modern technologies and other inputs could be used effectively through responsible aquaculture practices. Aquaculture

is one of the most important aspects of Nigeria's agricultural sector because of its consumption demand of a population of nearly 190 million (NBS, 2017), and with the country's vast network of inland water space and land, could cultivate fish easily (Adewuyi *et al.*, 2010; Grema *et al.*, 2011). Yet, even with this potential, little progress has been achieved to make the country self-reliant.

1.4.7 Research Aims and Objectives

Aquaculture integration into other farming methods could play a major role in the fight against food insecurity and poverty reduction in Nigeria through the production of more freshwater species of fish. However, the concern for this industry is the limited supply of feeds, high cost related to purchasing fish feeds, lack of technical expertise, lack of fingerlings, and lack of finance for the poor Nigerian farmer. As a result, the FCT and its surrounding markets have seen the prices of fish soar, making it unaffordable for the average citizen. To combat the ever-increasing demand and shortage of fish for consumption, the Government relies heavily on imports; spending in the region of about \$700 million – (N252,350 million) annually according to the Minister of Agriculture and Rural Development, Mr Audu Ogbeh (Falaju Joke, 2016). Despite the neglect of the agriculture sector, it is still one of the most vital sectors in the Nigerian economy and contributes up to 40 percent of its GDP. The sector provides employment to about 70 percent of the people, and it is a major source of livelihood for the growing population, especially those in the rural areas (Izuchukwu *et al.*, 2016).

The overall aim of this study was to determine among other things, what contribution and impact if any, aquaculture has on rural farmers that have adopted the practice and how this can further be improved or augmented if the farmers are empowered. The research aims and questions of this thesis are investigated using the aquaculture sector in the FCT as described in section 1.4.7 and 1.4.8 below.

The following were the main aims and objectives that underpinned the investigation:

1. To determine the present status of aquaculture development in FCT, clearly identifying positive impacts derived so far and challenges faced.
2. To conduct an economic assessment of aquaculture on the local economy of the FCT, clearly showing its role in addressing rural poverty.
3. To identify socio-economic and policy factors that affect aquaculture development and its impact on the rural poor.
4. To develop resources to aid rural farmers to make more informed decisions.

1.4.8 Research Questions

To present a thorough research and broad-spectrum view on current contributions of aquaculture to poverty alleviation, food security and rural economy development, the following research questions formed the basis for the study:

1. What is the current state of aquaculture production in the FCT?
2. What are some of the challenges faced by fish farmers in the FCT?
3. What is the extent and growth pattern of Research and Development (R&D) investments by the Government in the FCT?
4. What role is the Nigerian Government playing to ensure sustainability of fish production for the future of the Nigerian public?
5. What incentives are available for the local fish farmer?
6. What is the economic implication of fish farming on the local environment?
7. What is being done to develop alternative feed ingredients?

1.5 Thesis Structure

The chapter 1 of this thesis is the literature review, it introduces the topic under consideration and critically explores the aquaculture industry. The chapter also lays out the aims and objectives, and research questions of this investigation. Chapter 2 provides the layout and methods within this study. Chapter 3 provides the summary of the FCT and Nigeria's overview of the aquaculture sector. Chapter 4 presents selected government officials' perspectives through interviews to determine impacts, challenges, and future of the aquaculture sector in the FCT.

Chapter 5 presents the results of fish farmers in the FCT, providing a more detailed assessment of the impact and challenges associated for the farmers who have adopted aquaculture as a source of livelihood. Finally, chapter 6 reflects on the overall findings of this thesis and the results implications, recommendations, limitations, and areas for further research.

Chapter 2: Design and Method

2.1 Introduction

Assessing the contribution of aquaculture to poverty alleviation and food security among the rural poor is difficult as these situations impact peoples' lives in various ways. The study was essential in the sense that it helped in the understanding of the impacts of aquaculture on poverty alleviation and food insecurity among the rural poor in the area. The method used to collect information from fish farmers was questionnaire surveys, and in order to gather information from government officials, interviews was the process. The study attempted to highlight the role of fish farmers, policy makers, Non-Governmental Organisations (NGOs), institutional organisations and government in influencing social and economic behaviour in the context of the research. This investigation also brought together useful information on how to generate ideas and innovations that will address poverty, food scarcity and malnutrition that is an ongoing scourge among the dwellers, focusing especially on the small-scale family farmers that do not enjoy all the benefits that their counterparts (commercial farmers) do. Larger farms on the other hand, have many advantages in terms of inputs, credits, political representation, or access for policy making (Purcell and Pomeroy, 2015; Bene *et al.*, 2016). The idea for this investigation is to empower people and inform rural communities by disseminating important information that will promote rural organisations. By so doing, give them a voice that will shape decisions and policies that affects their standard of lives through participating in cooperatives or associations to be better able to have enhanced access to face market constraints, finance and grants, subsidies or even employ new technologies on their farms that will affect their livelihoods. The study sought to place a priority on why the aquaculture industry should be properly implemented or developed to cater for the population within and around the FCT.

Poverty among rural folks in developing countries has been the cause of many problems in many countries and Nigeria is not an exception. Challenges like food insecurity, diseases, environmental degradation, and mass migration in rural areas continue to cause many issues in developing countries. Studies have shown that about three quarters of the world's poorest people live in the rural areas, this

calls for greater attention to be paid to rural communities (Bene *et al.*, 2010a; Satterthwaite *et al.*, 2010; Debrah, 2013). Recent discourses on poverty reduction and food security stress that support for agriculture connects economic growth and rural development. Agriculture is integral to maintaining rural communities by delivering multiple physical, socioeconomic, environmental and territorial benefits; its significance goes beyond poverty eradication and securing people's right to food (Prato and Longo, 2011). Poverty, food insecurity and undernourishment remain widespread, and deeply concentrated among the rural areas, where approximately 60 percent of Nigerians live. Agriculture accounts for 40 percent of the national production and provides 70 percent of total employment and hence the sector is and will continue to remain, for the unforeseeable future, the mainstay of the economy (Ramesh and House, 2013; Mecozzi and Keatinge, 2015). Only a prospering agricultural industry can provide the foundation for sustainable poverty reduction, food sufficiency and accelerated growth in other sectors.

2.1.1 Research Objectives

The main aims of the study were to determine the actual and potential contribution aquaculture plays among rural farmers and the institutions required to improve or empower these farmers to maximise the potential contribution of aquaculture development among the FCT fish farmers. There were four main objectives underpinning this study outlined in 1.4.7, and the overall objectives were to collect socio-economic data from farmers within the aquaculture farming systems in the study area. Furthermore, to identify the current contributions and institutions needed for different aquaculture systems to have the potential to reduce poverty, promote food security and rural economy development in different contexts, section 1.4.8 formed the basis for the study.

2.2 Research Methods

This section explains the research method used in this research in accordance with the research aims and objectives set in section 1.4.8. The choice for selecting the research tools is explained including data collection process. Table 2:1 gives an overview of how each of the research activities addresses the set aims and research questions of the study.

Table 2:1 Summary of research aims and objectives linked to research questions against research methods applied within this thesis.

Research Questions	Objectives/Research method
1. What is the current state of aquaculture production in the FCT?	Literature review, questionnaires with fish farmers and interviews with government and non-government officials
2. What are some of the challenges faced by fish farmers in the FCT?	Questionnaires with fish farmers, interviews with government and non-government officials, and observation
3. What is the extent and growth pattern of Research and Development (R&D) investments by the Government in the FCT?	Questionnaires with fish farmers, interviews with government and non-government officials, and observation
4. What role is the Nigerian Government playing to ensure sustainability of fish production for the future of the Nigerian public?	Interviews with government officials
5. What incentives are available for the local fish farmer?	Questionnaires with fish farmers, interviews with government and non-government officials, and observation
6. What is the economic implication of fish farming on the local environment?	Questionnaires with fish farmers, interviews with government and non-government officials, and observation
7. What is being done to develop alternative feed ingredients?	Questionnaires with fish farmers, interviews with government and non-government officials, and observation

2.2.1 Ethical Considerations

Ethical review and risk assessment were completed by the researcher to ensure that the needs of participants were taken into consideration, and that the work followed the ethical guidelines of Moulton College/University of Northampton, and the general British Educational Research procedures.

2.2.2 Autonomy and Informed Consent

Social research is underpinned by the principle of informed consent and the idea of seeking participants' desire and willingness to participate in advance prior to soliciting for their views on a subject is paramount to social research ethics (Hammersley and Traianou, 2012). Participants were made aware from the onset that they could opt out of the research at any point in time during the research if they felt uncomfortable or unable to continue. This information communicated in advance was to assure participants that they were free to participate and were not under any duress or undue influence (Nijhawan *et al.*, 2013).

A participation information sheet explaining the objectives of the study, the participant's involvement, how the data collected would be handled, requesting their participation in the process (Appendix 1) was given to the participants. Research participants were also given the necessary contact details of the researcher and who to contact if in doubt about its authenticity (Appendix 2). Consent forms (Appendix 3) were included and signed at the beginning of the interviews. All participants consented to their taking part in the process and no one objected to getting involved in the research.

2.2.3 Confidentiality and Anonymity

Participants from the onset were expressly informed about how their identity was to be protected. This was stated on the information sheet and was followed by initial discussion about it prior to the start of any interview or questionnaire administering. To ensure confidentiality and anonymity, all participants, their

locations, and names of organisations were always guaranteed and maintained and were only known to the researcher and the supervisory team. All personal data that will lead to the identification of participants were excluded from the transcript and subsequent reporting.

2.2.4 Data Protection

Gaining the trust of interview participants is paramount to producing credible research data. The information obtained from interviewee's was treated with utmost care and in line with the Data Protection Act of 1998. The main aim of handling such data was to keep it safe and secure, processed in a fair manner and for the purpose that it was collected, and not to keep it longer than required by law. Interviews were not recorded; however, all written record of responses were processed using NVIVO and SPSS, which was word protected and licensed via the University of Northampton. All other research written documents such as interview responses, consent forms etc were kept under lock and key to prevent any data relating to the project getting into a wrong hand.

2.2.5 Risks to Participants or Researcher

A thorough risk assessment was carried out in line with the university of Northampton's research policy and more importantly the country risk of Nigeria at the time. However, the researcher made it clear that the catchment area was safe and nowhere near the regions which were experiencing attacks at the time of data collection. There seemed to be no known significant risks such as physical, emotional, and financial risks that participants might have experienced, apart from the time that was spent in participating in the research and the resultant opportunity costs. All attempts were made by the researcher to prevent risks associated with breach of confidentiality, anonymity and data security as outlined above.

In minimising the risks to the researcher, all interviews were conducted at the participants place of work, and the researcher was accompanied by the research

team (driver, extension agent/s, chief fisheries officer/s). All interviews and questionnaires were conducted and administered during the daytime. These steps were taken to ensure that both the researcher and participants were safe and secured to contribute towards the research.

2.3 Sampling Strategy

At the onset of the study, contacts with personnel working at the Federal Department of Fisheries (FDF) and Abuja Agricultural Development Project (AADP) was made to inform respondents of the impending study and develop a contact list of fish farmers that were well established and agreed to participate in the study to allow smooth running of the fieldwork. The method for selection of participants was purposive or selective sampling, which will best answer the research objectives and questions set out in section 1.4.7 and 1.4.8, respectively.

The criteria for selection of a respondent for this study were based on the following.

1. They engaged in fish farming practice or are policy makers
2. They lived in the catchment area
3. They were willing to participate in the survey
4. Contacts were well established with participants before commencing of fieldwork by the research team

2.4 Data Collection

The researcher travelled to Nigeria on 3 February to 6 April 2016 and 31 May to 12 July 2017 to collect information from policy makers and fish farmers by physically examining general farm management practice employed on farms. The study employed a quantitative technique, which consisted of a combination (multiple) of two sets of data collected concurrently as the main primary data source. Though information was collected alongside each other, the findings remained independent. It is an efficient procedure that allows results collected from the investigation to be merged together during the interpretation phase of

the research to develop a better and all-inclusive response to strengthen the reliability and validity of the findings (Doyle *et al.*, 2016; Saunders *et al.*, 2016).

2.5 Interviews with Government Officials

The method used for data collection were structured and semi-structured interviews conducted with participants to address the research questions in section 1.4.8 of this thesis. Interviews were used in this study to explore complex issues in detail, and it ensures diversity and richness of personal experience and opinions (Cresswell, 2012; Silverman, 2013). Structured interviews are conducted using an interview schedule containing list of questions in a pre-defined order which is strictly followed (McGrath *et al.*, 2019). In this type of interview, the respondent has minimal control over the interview and the researcher is unable to collect information which are not covered in the interview schedule (Saunders *et al.*, 2019). Edwards and Holland (2004) noted that questions are asked in the same order and approach, with the view of obtaining comparable information from many participants. Whilst (Saunders *et al.*, 2019, p. 437) defines semi-structured interview as a "predetermined list of themes, and possibly some key questions related to these themes, to guide the conduct of each interview". This form of interview is flexible as questions are prepared in advance to guide the conversation, ensuring that core issues are covered during the interview (Holloway and Galvin, 2016; McGrath *et al.*, 2019). On the other hand, the difficulty associated with this type of data collection tool is that it is a challenge to obtain valuable information from respondents if appropriate questions are not asked (Corbin and Morse, 2003).

2.5.1 Interview Design

The research recruited two participants from the initial contact made in section 2.3 prior to traveling to Nigeria to gather data. This was made possible because the researcher knew those individuals and had worked in the same organisation in the past. The interviewer explained to the participants the nature of the investigation and how data collected will be disseminated. The remaining five

participants were selected through a snowball sampling strategy. Participants (first two) were asked if they knew other policy makers who may be relevant to the study and willing to take part in the study. Thus, this strategy further recruited the other five policy makers that were interviewed. All together seven government officials were interviewed. The justification for the sample size is the fact that the FCT is a small area. Furthermore, data saturation occurred after analysing the interviews from the participants. The observation came as the themes and patterns from the data set collected were drawing the same conclusion. So, there was no need to collect further data from other government officials as adequate sample size was reached (Guest *et al.*, 2020). Based on the six area councils of the FCT which constitute policy and decision making on fish farming, the researcher gained access to five senior executives of the area councils. In addition to these five, the remaining two that were interviewed as part of this research were from the FDF and AADP. Gaining access to policy makers in the catchment area is difficult, the initial network established was critical to recruiting, gaining trust, and obtaining data that would otherwise have been inaccessible through review of secondary documents (Ostrander, 1993; Liu, 2018). Therefore, the identification, and selection of respondents was 'Purposive Sampling' used by the researcher and the team to achieve the research questions set out in section 1.4.8.

The interview process was identified as the most suitable method to provide objectivity and in-depth understanding of the aquaculture sector in the FCT. This method took into consideration those who have specialised knowledge and experience in the topic under review and were able to provide accurate and varied information about aquaculture. Liu (2018) has indicated that elite participation in a research help in unearthing solid underlying evidence and insight. The interviewees have gained positions in their various institutions associated with aquaculture in the catchment area, and this aided in obtaining information that helped in identifying and analysing the economic impact of aquaculture in the FCT (Hochschild, 2009; Harvey, 2011; Waller, 2017). However, because of their expertise and their ability to use their positions especially in developing countries, they can be difficult to reach for research (Liu, 2018). The interview schedule comprised of 12 open-ended questions that focused on the status and drivers of aquaculture development, challenges to aquaculture growth, governance, and

policy effectiveness in managing the sustainable development of the aquaculture industry.

Participants were willing and available to express their opinions. So, staff working in governmental institutions such as AADP, FDF and Area Councils were consulted for their input. The nature of the interview guaranteed that the required data was obtained from each participant through a more tailored and flexible approach (Saunders *et al.*, 2009). Information was collected by conducting a face-to-face interview, through a more focused, open-ended structured and semi-structured questions in their various offices, at a convenient time for each respondent (Rowe *et al.*, 2016). The interviewer read out questions (Appendix 4) and manually recorded responses from the interviewee. The idea was to produce consistent and reliable data that will later be used to enhance the data collected from fish farmers during analysis. The interviews lasted between 50 minutes to 1 hour 15 minutes. It was vital that the procedure did not exceed one and a half hours, given consideration to the respondents' other commitments who might have had to free up time for the interview (Jacob and Furgerson, 2012). During the interview process, the author checked and clarified with respondents to make sure that any written text denotes the actual words of the participant.

In this case, all data was collected by the researcher in person, unlike the fish farmer administered questionnaires that were assisted by Chief Fisheries Officers (CFOs) and extension workers. This approach allowed the researcher to take total control of all the questions that were asked, and the recording of information from the process. The process was time consuming, because the researcher had to rely on the time and place chosen by participants. In addition, some interviews were cancelled only after the interviewer was at the venue due to some circumstances beyond the researcher's control. Often, interviews with top managers are confronted with much more far-reaching problems of access and interaction because they are professionals (Welch *et al.*, 2002; Liu, 2018). Negotiating direct contact to interview potential candidates have been confronted with many barriers from multiple gatekeepers. Research conducted by (Liu, 2018) shows that interviewers had turn up for an interview just to be informed that the respondent was in a meeting and had to wait or cancel a scheduled interview for another time, which can be time consuming. Generally, some researchers suggest that gaining and maintaining access to policy makers can be problematic due to the terms and

conditions (Smith, 2006; Lancaster, 2017; Liu, 2018). However, there have been occasions where researchers of other marginal groups were faced with obstacles than researchers of elite group (Smith, 2006). For example, Smith (2006) suggested that penetrating an immigrant community may exert a different kind of power that prevents researchers from gaining access to collect data. Nonetheless, the needed information was gathered from the right sources that were intended for this study.

These findings gathered through interviews with policy makers allowed the researcher to gain a deeper understanding of the impact of aquaculture on poverty and food availability because of their experience and knowledge in that field (Smith, 2006; Tomaz, 2016). The discussion focused more on what has been done to propagate fish farming among the locals, especially the category of people that are unemployed and food insecure. This strategy allowed for probing and prompting in greater depth on what the contribution of government and other institutions have been on the aquaculture sector development. This investigation shed more light on how aquaculture has influenced the livelihoods of the locals and allowed to explore more ways in which its implementation could be done in a sustainable way, taking into consideration, limited resource availability.

2.5.2 Coding Interview Data

Interview transcripts were re-read several times to look for natural units of meaning and entered into Nvivo 11 software for coding. Coding is a word or phrase that assigns related data using symbols or summaries to link data collected through interviews or observation to facilitate analysis (Saunders *et al.*, 2019, p. 206). Coding is only complete when the data set is thoroughly exhausted (Aspers and Corte, 2019). Codes and themes were developed, allocated and coded into major topics in-line with the research subject.

Each segment of data was coded to develop relevant codes that specifically addressed the research questions. This process enabled the author to classify, categorise and code data depending on various key words or concepts that were uttered, or identified through various conversational units of the interviewees’

responses. This notion was supported by Feng & Behar-Horenstein (2019) who posited that responses acquired through open-ended answers are used by researchers to “organise information and logically group the data into categories or themes, and to gain an innate understanding” (Feng and Behar-Horenstein, 2019). Participants were allocated identification (ID) codes to protect the identity of the speaker. Also, the consent form indicated that reports from the study will not include any information that could be linked to the respondents (Kaiser, 2009; Lippe *et al.*, 2019). Therefore, rich data collected from the comprehensive structured and semi-structured interviews conducted, based on a purposive sampling was then put through a rigorous process of coding.

All codes generated were reviewed, modified, and sorted into nodes and sub-nodes, so that related codes formed main themes/patterns reflective of the whole dataset, those not relevant were discarded or merged into other codes. This was done to check, categorise and assign values to key words or concepts that were expressed.

2.5.3 Data Analysis

There are many methods that could be employed to analyse qualitative data. For example, Smith and Firth (2011) indicated that there are three methods that could be used in classifying qualitative data. Firstly, methods used in describing and interpreting participants’ opinions and views such as thematic and content analysis. Secondly, methods that consider meanings in language such as conversational analysis and discourse. Finally, methods that help in coming up with theories such as constant comparative method employed in grounded theory. Sandelowski (2000) suggested that thematic analysis is the preferred method for general qualitative studies. Furthermore, it has been argued that thematic analysis is a strong mechanism in analysing data as it offers a systemic approach in a study. There are various ways of approaching thematic analysis (Javadi and Zarea, 2016). However, it could be argued that this variety causes confusion about the nature of thematic analysis, especially its distinction from a qualitative content analysis (Vajsmoradi *et al.*, 2013). Thematic analysis was the preferred method for analysing the data used in this research. Ayres (2008) described thematic

analysis as a “data reduction and analysis strategy by which data is segmented, categorised, summarised, and reconstructed in a way that captures the important concepts within a data set”.

Data derived from interview transcripts to facilitate data analysis was inductive (‘bottom up’) thematic analysis. This was carried out through a recursive process to identify, analyse and report themes within the data (Clarke and Braun, 2017). The importance of thematic framework is to produce rigorous and relevant analysis in terms of credibility of the research process (Clarke and Braun, 2017; Maguire and Delahunt, 2017). This approach was adopted because it helped in identifying, analysing, and interpreting key themes that formed the basis of responding appropriately to the research questions (Braun and Clarke, 2006; Vaismoradi *et al.*, 2013). It is also an organised way to handling data that leads to a clearer and well-structured final report (Clarke and Braun, 2017; Nowell *et al.*, 2017). Clark and Braun (2017) and Nowell *et al.* (2017) further argued that thematic analysis is a translator that enables qualitative and quantitative methods to interact with each other. However, its flexibility can lead to inconsistencies and incoherency when developing themes from a data set.

There are many approaches to thematic analysis, however, in this study, the six phases framework outlined by Braun and Clarke (2006) was used as a guide. Maguire and Delahunt (2017) have argued that this approach is the most influential, offering a clearer and usable framework for undertaking thematic analysis. The phases and processes utilised are outlined in (Table 2:2).

Table 2:2 Braun and Clarke thematic analysis phases (Maguire and Dalehunt, 2017)

Phases	Analytic Process
1. Becoming familiar with the data	Listening to, transcribing, and reading the data. Store data in well-organised files, keep records of all data field notes, transcripts, and reflexive journals.
2. Generating initial codes	Systematically coding key features of the data and collating relevant data for coding framework.
3. Searching for themes	Gathering all data and codes to establish potential themes
4. Reviewing themes	Establishing if themes work in relation to the extracted codes and checking if these themes are relevant to the data set.
5. Defining and naming of themes	Further refining each theme to produce an overall narrative for the data, separating themes, and subthemes. Generating clearer definitions and names for the themes.
6. Producing the report	Writing the report, selecting appropriate quotes for each of the relevant themes and integrating interview findings with questionnaire survey findings.

The six phases of framework described by Braun and Clarke (2006) used in this process are discussed below:

2.5.3.1 Data Familiarisation

In this research, familiarisation with the data started at the onset of the interview. All the interviews conducted, and notes taken were by the researcher. Potential ideas were written down and brought into the analysis. To understand the data, the researcher revisited the interview transcripts several times, looking for natural units of meaning. Transforming verbal research data into written data is a cornerstone of qualitative data analysis (Kowal and O'Connell, 2014). The author transcribed all the interviews conducted and in addition to re-reading of transcripts prior to coding, helped to develop more depth and breadth in understanding the data collected. Furthermore, reading through the transcripts offered the researcher the opportunity in noting potential themes and ideas.

2.5.3.2 Generating Initial Codes

Data management in this study was facilitated using NVivo 11 software. This software assisted in coding of the interview transcript. Saldana (2015) describe a code as “a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of the interview transcripts”. Coding helped in reducing the whole data set by labelling of statements under one or more concepts (Flick, 2014). The coding process in this research was achieved by assigning a word or phrase that addressed the research concept.

2.5.3.3 Searching for Themes

This section began with searching for themes/patterns within the data and merging codes into related categories. Expressions by individuals were examined and compared across all the interview scripts. In addition, links between codes were checked and similar codes were brought together to form categories. For example, questions number two, three, six, nine and ten were brought together to form a category known as Government support in the development of aquaculture (Appendix 4). Mind mapping was used to show relationships and organise codes into categories and potential themes and subthemes.

2.5.3.4 Reviewing Themes

Potential themes and subthemes identified for the study were thoroughly examined making sure that they were aligned with the coded data and accurately described the whole data set. Braun and Clarke (2006) have posited that, analysing potential themes involves two phases. First, it involves critically examining each theme to fit the coded data. Second, it ensures that the themes identified accurately describe the whole data set. Themes appropriateness with the data set played a significant role in ensuring that they are well linked to the

research questions, with the view of providing accurate answers to the investigation. The review yielded six potential themes and their subthemes.

2.5.3.5 Defining and Naming of Themes

After thoroughly going through the identified themes, each one was given a descriptive name, to indicate a clear definition which explained the meaning of each theme.

2.5.3.6 Producing the Report

A comprehensive report of the analysis of the study data linking the research objectives and the literature review was produced in the result section in chapter 3.

The study adopted the realist approach of reporting the motivations, experience and meaning of participants to reflect reality. This assumption was also supported by Braun and Clarke (2006) who suggested that “a theme captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set”. Themes identified, brought together components of the experience into a meaningful whole, which would have been irrelevant if viewed alone. The coding technique used for this study was inductive rather than a deductive approach. Data collected was specifically for the research, themes identified reflected the questions that participants were asked, it was data driven (Braun and Clarke, 2006b; Nowell *et al.*, 2017). Themes were strongly linked to the data and objective to participants experiences and not lead researcher’s own theoretical interest. An inductive approach according to (Saunders *et al.*, 2019, p. 51) is a process of collecting data to “explore a topic and develop a theoretical explanation as the data are collected and analysed”. This was achieved by asking all participants the same questions and probed inductively to respond to the subject in view (Ryder *et al.*, 2019).

Furthermore, this analysis was also examined at the semantic (explicit) level in contrast to the latent (interpretative) level. Semantic approach focuses on interviewees responses, the analyst is not looking for anything beyond what was said or recorded during the interviews (Braun and Clarke, 2006). Themes which were specific to the original research questions were included in the analysis based on their relevance rather than their frequency in the data corpus. Six overarching themes and their subthemes were identified that perceived to capture the common issues discussed in the data and pertinent to the aquaculture industry in the FCT (Table 2:3).

Table 2:3 Themes and Subthemes Identified During Analysis

Theme 1: Contribution of Aquaculture • Viable fish fingerlings • Subsidiary industries • Provision of infrastructures • Provides employment • Protein source • Control urban migration
Theme 2: Government Support • Transformation agenda • Training and workshop • Research and development (R&D) • Inputs • Finance • Create cooperative
Theme 3: Environmental Impact • Social impact • Economic impact
Theme 4: External Support • Technical support
Theme 5: Future of Fish Farming • Public investment • Alternative feed development
Theme 6: Challenges • Youth training • Technical knowledge • Security • Land • Finance • Feed • Basic infrastructure

The themes identified described important patterns about the data in relation to the research question as well as the overall objectives of the research. The investigation was aimed at identifying the actual and potential impacts of aquaculture development on poverty reduction and food security among the rural people, and also, to highlight institutions and their roles in promoting different aquaculture systems within different context (Hishamunda *et al.*, 2009; Stevenson and Irz, 2009).

2.5.4 Reflecting on the Research Process

Interviews as a research tool helps in gaining rich and qualitative information about participant's perspectives, experiences, and attitudes (Oltmann, 2016; McGrath *et al.*, 2019). This research has benefited immensely from the use of interviews as it enabled the researcher to receive quality information from respondents as well as develop a good working relationship with interviewees (Bell *et al.*, 2016).

The FCT as a capital city of the country is home to diverse population and getting through this community has been made possible through interviews and its ability to combine structured and semi-structured questions to obtain information. Using interviews also allowed the author to set agenda with regards to travel and interview dates, judging from the fact that the interviews were conducted face-to-face and the need for travel to different sections of the community.

However, it can be argued that getting willing and appropriate participants in research is always a herculean task and it is even more difficult in developing country setting, where every approach for research request is viewed with scepticism and apprehension (Amerson and Strang, 2015). Additionally, these countries have little or no resources and infrastructure to support research (Igoumenidis and Zyga, 2011; Bulled *et al.*, 2014; Amerson and Strang, 2015). The interview process in many cases generate great deal of material and this increased the amount of work to be done in coming out with a final product.

The experience has been an eye opener as it enabled the researcher to appreciate and understand the workings and operations of aquaculture in the FCT and the problems associated with its day-to-day activities. The interview conducted first offered the researcher an insight into the strides made by hard working members in the community in improving their livelihoods through fish farming.

2.6 Fish Farmers Questionnaires

Questionnaires have increasingly been used by researchers in business and management and diverse social sciences to gather quantitative data from targeted populations (Weir *et al.*, 2012; Rowley, 2014). In this study, data was collected through self-administered questionnaires to supplement information collected via interviews, and to gain specific information on fish farming in the study area. The main reason for the selection of self-administered questionnaire as an instrument for data collection was because of the potential to gain access to a larger sample (120) of fish farmers in the time that was allocated to collect information, considering their location, response rate, and financial availability to carry out the research. In addition, it enabled active participation of the researcher in data gathering to ensure that the questions were answered by the respondents that they were meant for. It also accounted for the time the field workers who assisted in data collection were going to spend during the process.

Davies and Hughes (2014) indicated that questionnaires provided a reliable and straightforward way of acquiring information of a total population from a selected sample. The process ensured that specific information from fish farmers was explored through their experiences and views as individuals in the aquaculture industry (Cohen *et al.*, 2017). So, in the case of obtaining information from the farmers, questionnaires were the more preferred method to interviews due to the large number of individuals involved and type of information that was going to be collected from participants.

2.6.1 Questionnaire Design

The questionnaire was developed following the basic principles of questionnaire design. These principles included: (i) keeping questions simple; (ii) defining the terms clearly; (iii) using simple wordings to avoid ambiguity; (iv) avoiding lengthy and complex questions; (v) avoiding multifaceted questions or negative words; (vi) avoid leading respondents to breach confidentiality; and (vii) avoid using double negative questions (McLafferty, 2003; Rowley, 2014).

The questionnaire (Appendix 5) was designed in collaboration with the researcher's supervisors to collect information on the economics and social aspects of fish farmers (see 1.4.7 and 1.4.8). The study was to identify the overall contribution of aquaculture to farmer's livelihoods when integrated with other farming methods or when practiced on its own. Data collected would highlight any potential areas that needed improvement and test the validity and feasibility of the questionnaire and distribution channels utilised.

The questionnaire had eight sections and contained 31 elements consisting of both open and close ended questions. The sections sought to obtain details relating to the respondent's farming operations and examined various actors and institutions linking aquaculture. The following were the eight sections explored:

- i) Background (history and farm characteristics)
- ii) Production (production and harvesting practices)
- iii) Income (sources of household income)
- iv) Challenges (constraints to development)
- v) Employment (staffing arrangements)
- vi) Markets (problems and prospects of marketing products)
- vii) Support and Information (support and information mechanism)
- viii) Food and Nutrition (impacts of fish farming on household and community).

2.6.2 Questionnaire Distribution

Questionnaires were distributed in two periods (section 2.4). In the first period, questionnaires were printed and reviewed by aquaculture experts in the study area before they were administered (Tusevljak *et al.*, 2013). Adequate measures taken to minimise data gathering errors were initial training of personnel in data gathering, and pre-testing and checking of questionnaire to assess any shortcomings on the field. Actual data gathering commenced in the second week, by distribution of questionnaires to farmers during visits to farms, houses, offices, or designated areas agreed upon. The interviewer via telephone interviewed farmers whom questionnaires could not be administered to on a face-to-face basis.

Their telephone numbers were obtained from the president of the Fish Farmers' Association database.

Using 'convenience' and 'purposive' sampling, 120 small-scale to medium scale fish farmers engaged in aquaculture activities were administered questionnaires. All the farmers (120) selected for this survey were registered with the various organisations within the study area (see 2.3). Those farmers had varying years of experience between them. This exercise was supported by the fisheries personnel and extension agents in the region that was investigated (Cohen *et al.*, 2017). These workers are inhabitants of the area, or they have good working rapport amongst the local farmers. In addition, they have a standard level of education to help explain the process to respondents during the survey. This schedule utilised 'closed' ended questions, where answers are predetermined, and 'open' ended questions that participants were free to respond to in their own words. The researcher read out the questions and explained to farmers when they needed clarification of questions they did not understand during the exercise. Questionnaires were filled out by the respondents in person, however, those who were unable to do so, were helped by the interview team. Opportunity was also given to participants who could not fill out the questionnaire immediately, to keep the questionnaire and fill it at a more convenient time. These were later collected at a time and place agreed by both parties. However, some of those questionnaires were never collected because farmers were not available when the team returned for collection. The interview team visited some farms up to three times to attempt collection of completed questionnaires with no success.

Out of the 120 questionnaires distributed, 98 were successfully collected from participants, a response rate of over 80 percent, which was considered appropriate for this study. A total of 56 fish farmers who were available and agreed to a visit, were visited on their farms to collect information. The visits to the farms were invaluable as it allowed the researcher and the team to ask questions about why things were done in a certain way, whilst physically observing the farming management practice that was carried out on the farm level. The process allowed the team to get involved in some activities such as feeding of fish, topping up of water to the ponds, practicing some of the techniques employed during harvesting and smoking of fish. This field technique enabled the researcher to obtain the required information from the respondents through probing and prompting in a

more personalised and flexible setting. All interactions between the parties and the author were mutual and thorough, as key information on farmers activities were discussed and learned.

On the other hand, 42 farmers were reached through group gatherings (workshop, seminar) organised by AADP or via telephone to collect information. As part of the research team, the workshop/seminar organisers allowed time during the programme for data gathering, there were 24 farmers present during the programme. The setting made it more difficult to explore each farmer's experience as a person during the group discussions. This might have led to farmers feeling reluctant to divulge negative information on their farm practices. Furthermore, there was a common theme identified from the responses received from the 24 farmers. However, the process was flexible, time saving and less expensive in comparison to farm visits (Etikan *et al.*, 2016).

Telephone interviews were also conducted by administering questionnaires to 18 farmers over the phone. Initially, this arrangement was not part of the plan, therefore, contacts were not made ahead of the authors trip to Nigeria. However, it became clear that some of the farmers could not be reached except by telephone interviews. The activity involved the researcher obtaining a list of farmers who were operational in the study area through the president of the Farmers' Association. The researcher, with the agreement of the president rang farmers and conducted the survey with farmers by reading out questions and recording their responses. Following on from this, some participants thought that this was a forum to obtain inputs and make requests. Nevertheless, information was gathered from those farmers that were willing to participate. It took about two to three hours each day for three weeks to complete the telephone interviewer-administered questionnaires. Still, the responses from those who participated were encouraging, as one could hear the enthusiasm from their voices about their experiences in fish farming. The ideal situation would have been to visit farms physically to gather the needed information, but issues such as distance, bad roads and farmer availability made it impossible for the team to visit all farms that were surveyed. The initial contact made by the interviewer through the agriculture organisations ensured that a good representation of sample farmers was guaranteed from the entire region that was surveyed. The interviewer with the help of the extension agents and other officers from the Ministry of Agriculture

and other NGOs worked as a team to explain to respondents the concept behind the study. The team took into consideration ethical guidelines; participants were made aware of their rights during the entire process.

2.6.3 Data Management

As a practice, the data that was acquired were thoroughly checked and corrected for any mistakes and inconsistencies at the point of collection. This allowed the interview team to make any necessary correction by clarifying with the respondents to make the process as efficient as possible. All data gathered were securely collected and kept by the researcher to reduce the loss of data, as this information is needed during the analysis stage (Bryman and Bell, 2015).

2.7 Methods to Address Questionnaire

Questionnaires were used to collect primary data from fish farmers in this research. They study a sample of fish farmers to produce representative findings that can be applied to the aquaculture sector in the FCT.

2.7.1 Coding Questionnaire Data

Data that were collected through questionnaire consisted of both close-ended and open-ended questions. Close-ended questions had predetermined responses and respondents were asked to choose from them. In this research, close-ended questions were used to ascertain basic information about respondents' participation in fish farming. For example, farmers were asked about species type, and culture type, etc. The responses to the close-ended questions were entered as 1, 2, 3 or Yes = 1 and No = 2 options, restricting the respondent to selecting only one or more answers from a pre-established list of response options (Table 2:4).

Table 2:4 Illustration of close-ended questions

S/No	Question	List of choices	Responses
5	What type of fish do you farm?	1=catfish, 2=tilapia, 3=catfish & tilapia	1, 2, 3

The open-ended questions allowed participants to describe and define their experience in fish farming. It encouraged interviewees to provide detailed developmental answers that helped in providing facts for the research (Arffman, 2016). For example, the question on the main challenges faced by farmers gave them the opportunity to detail the issues that they faced with regards to their operations. Some of the answers to this question were short and clear. However, due to the diverse nature of the responses received for others, the researcher used coding to group them into a single response (Table 2:5) (Popping, 2012). Singer & Couper (2017) argued that the adaptation of open-ended questions to some degree in questionnaires may result in more accurate and useful data, and in the extent of its representativeness and coverage they offer at a little additional cost, especially when dealing with complex data.

Table 2:5 Illustration of open-ended questions

S/No	Question	Responses received	Coding	Answers for each response
16	What are the main challenges experienced?	Fish feed, seed, selling, cost of rent, water supply, finance, disease, etc	Fish feed, fingerling, selling, environmental, and non-environmental	Yes=1 No=2

The questionnaire had 8 sections and contained 31 items, ranging from demographic, production, socio-economic, challenges, markets, and support and information. Demography sought to obtain participants details including number of years involved in fish farming, why they are involved in fish farming, type of culture system, types of fish species farmed, etc. The questions asked under this section were both closed and open-ended questions. The essence of these data

was to enable classification of respondents' views, whilst at the same time, establishing the relationship between the demography of participants and their connection toward fish farming. The second section ascertained participants opinions on the production methods used in raising fish. All questions in this section consisted of open-ended questions, and sought to determine number of ponds used, average cycle time for each species and number of harvests. The third section of the questionnaire centred on socio-economic factors such as income, employment, and food and nutrition of farmers. The questions asked under the socio-economic section sought to obtain farmers sources of income, number of employees, and impact of fish consumption on family's diet.

However, several factors or sources of errors could threaten validity of the study when using open-ended items, this may lead to associated challenges, which will result in threatening the validity of data collected (Arffman, 2016). Popping (2012) in support of this assertion argued that the identified challenges in open-ended questions such as ambiguous words and phrases, may jeopardise the overall data collected in research. For example, in this research, most of the interviewees were illiterate and needed the questionnaire to be translated into their local dialect. There could have been translation issues in conveying the questions on the questionnaire to the participants. To overcome this, the researcher being a native was always around to interpret the questionnaire into their mother tongue. It could also be argued that responses received will differ, as respondents may give answers that are not connected or lost in insignificant details. A case in point in this research was when respondents were asked to list the various challenges in connection with their operation, with a follow-up question on the key challenge out of the listed challenges. Some gave answers that they did not mention in the list of challenges.

2.7.2 Statistical Analysis

Data collected from the questionnaire was entered into the Statistical Package for Social Sciences (SPSS) version 26 windows software for analysis. Two types of analysis were made: descriptive analysis and inferential analysis. Descriptive statistics (utilising frequencies, percentages, range, standard deviation, mean and

median) were used to summarise data to provide a description of the basic feature of the sample (Marshall and Jonker, 2010). While inferential analysis using chi-square test for association was applied to test the significance of relationship or associations between two categorical variables (Marshall and Jonker, 2011).

Before conducting the chi-square test, the data was checked to make sure it meets the assumptions of the test.

The assumption of the chi-square test includes:

1. The two variables compared must be categorical – i.e., measured at an ordinal or nominal level.
2. The two variables must have two or more categorical, independent groups. For example, one of the chi-square tests was performed on reason for farming fish and how it relates to farmers income.
3. Independence of observations (no relationship between the subjects in each group).
4. Relatively large sample size (expected frequencies for each cell are at least 1 and expected frequencies should be at least 5 for 80% or more of the cells). In all the chi-square tests conducted, a p-value of less than 0.05 was considered statistically significant.

2.8 Demonstrating Rigour

Qualitative research is usually criticised as lacking rigour in its processes (Noble and Smith, 2015). This is because the concepts for demonstrating rigour in design by those of a qualitative background vary from the opinion required by those of quantitative studies. Maher *et al.* (2018) expresses that the tests and measures utilised to establish reliability, replication, and validity of quantitative studies are not appropriate to qualitative research. Quantitative researchers aim to design and apply numerical and statistical methods, focusing mainly on measurements and the adequacy of what is being measured, to establish validity and reliability of research findings. The process should be sufficiently detailed to facilitate interactions with other researchers and produce the same results when repeated under similar conditions (Merriam, 1998; Holloway and Gavin, 2016). This method is to determine whether the research truly measures that which it was intended to measure and provides a solution to the findings. The outcomes are usually

generalisable, predictable, and provides a causal explanation of the subject in scrutiny (Creswell and Creswell, 2017). Quantitative researchers are of the view that validity and reliability are core components of a research, lending itself to a process of discovery of a known reality (Markon *et al.*, 2011; Campbell, 2014). On the other hand, qualitative research is a field of inquiry that relies on a representative sample of individuals to offer a rich, detailed, and in-depth information of their views and experiences on a particular matter (Jackson *et al.*, 2007; Turner III, 2010). In this study, the selection of farmers was done by officers (extension agents) who have worked and developed a relationship with farmers over time (see 2.3). In addition to section 2.3, extension agents contacted farmers when they visited them on their farms or through telephone calls. Qualitative research uses a natural setting, multiple methods that are interactive and humanistic to understand human behaviour in a real-world setting (Austin and Sutton, 2014; Korstjens and Moser, 2017). The researcher does not manipulate or prefigure data of their interest, but only interpret their understanding of what the truth may be (Golafshani, 2003; Bashir *et al.*, 2008). The researcher becomes the main data collecting instrument and when used properly, the interview as a data collection method gives better insight into the subject of the study as it allows for a more personal and insightful access to data (Wilkinson and Birmingham, 2003). Therefore, the findings in qualitative research are not scientific or determined by formulae that is quantified as in quantitative investigation (Buchanan, 1992; Mays and Pope, 1995). Instead, the concepts of 'trustworthiness' and verification of data are used in qualitative research rather than validity and reliability (Lincoln and Guba, 1985; Darawsheh and Stanley, 2014; Holloway and Galvin, 2016). To ensure 'trustworthiness' of data, the principles affirmed by Lincoln and Guba (1985) are usually employed by qualitative researchers. The four terminologies used by Lincoln and Guba (1985) to describe trustworthiness in data are: credibility, transferability, dependability, and confirmability which are comparable to validity, external validity, reliability, and objectivity used in quantitative research. The strategies to ensure trustworthiness of data are summarised below:

Credibility in this research was achieved through prolonged engagement (50 to 75 minutes) with each participant, persistent observation, triangulation, negative case analysis and member checking (Lincoln and Guba, 1985; Merriam, 1998).

The researcher travelled to Nigeria to conduct the interviews with respondents. Member checking was carried out by clarifying with each respondent at the time of data gathering, to ensure a true representation of participants' comments during data collection. Apart from interviews with the senior executives, the researcher spent time interacting and observing other members of staff such as extension agents (6), supervisors (2), fisheries assistants (6) who worked alongside the executives in the department. During the interview, the researcher was in control of all the written record of responses and transcription from the interviews. All transcripts were revisited and checked to ensure that information obtained from respondents are accurately converted into textual data. These processes added to the credibility of the study.

The use of other teams not connected with the findings added credibility to this research (Lincoln and Guba, 1985). The study employed a comprehensive triangulation of multiple data sources in the form of interviews, questionnaires, and document scrutiny, as well as combining qualitative and quantitative methods of data collection to describe the aquaculture industry in Nigeria as emerged in this study (Cohen *et al.*, 2017; Denzin, 2017). The combining of methods in this research strengthened the outcome of the study, which would have not been possible utilising only quantitative method (Campbell, 2014). Member checking of the analysed data and interpretation were carried out throughout by constant scrutiny from the supervisory team and other research professionals within the field.

Transferability refers to the extent to which the findings in a study can be transferred or generalised to other contexts or situation beyond the scope of a study. This ensures that a detailed account of the research processes and context was clear and understandable for others to apply in a similar context (Merriam, 1998; Holloway and Galvin, 2016). Therefore, in this study, rich data collected through interviews was put through rigorous process of coding and thematic data analysis, as well as examination of both past and current study of a similar nature to ensure trustworthiness (Braun and Clarke, 2014; Creswell and Creswell, 2017).

Dependability refers to ensuring that a research study processes and results are comprehensive and could be repeated. This was achieved by giving a detailed account of the research setting, procedures, interview methods, data analysis and

all decisions taken by the researcher during the investigation (Merriam, 1998; Holloway and Galvin, 2016). This ensured that the research method and processes in this report were maintained.

Confirmability in this regard came through an audit trail of interpretations, which were in conformance with the data source. The investigation findings were a true representation of the participants' views and experiences and not the author's presumptions (Shenton, 2004; Holloway and Galvin, 2016). Other users can follow up how codes, themes and interpretation were generated through an examination of the study (Holloway and Galvin, 2016). Furthermore, the study utilised multiple data sources, including a combination of research methods to afford other readers the ability to establish whether the report presented reflected the participants' opinions.

Chapter 3: The FCT Case Study

3.1 Overview – Study Site

The study was conducted in 2016 and 2017 within the FCT, the capital of Nigeria. The FCT was created in 1976 replacing Lagos as the capital of Nigeria. The reason why it was selected for this study was because its indigenes are predominantly farmers and also, it has become home to all the tribes from other parts of the country, and as such, a true representation of Nigeria in one area. However, the bulk of farming is carried out in a subsistent way and cannot meet the food requirement of these growing cities. The study area is located in the centre of Nigeria, bordered by Kaduna State to the north, Kogi State to the south-west, Niger state to the west, and Nasarawa state to the east. The region is situated between the forest and savannah (grassland), with 60 percent of land allocated to agriculture and forestry (Manyong, 2005). It has an estimated land area of 222,000 million (ha) occupied by networks of water bodies, such as rivers, flood plains, manmade and natural lakes and reservoirs, which provide abundant prospects for fish farming (Lewee and Khadijat, 2014; Kudi *et al.*, 2008).

The territory is made up of six area councils namely Abaji, Abuja Municipal, Bwari, Gwagwalada, Kuje and Kwali Area Councils (Figure 3.1). Five of the six area councils were surveyed. Abaji was not included in this study due to the security reasons prevalent in the area at the time of data gathering.

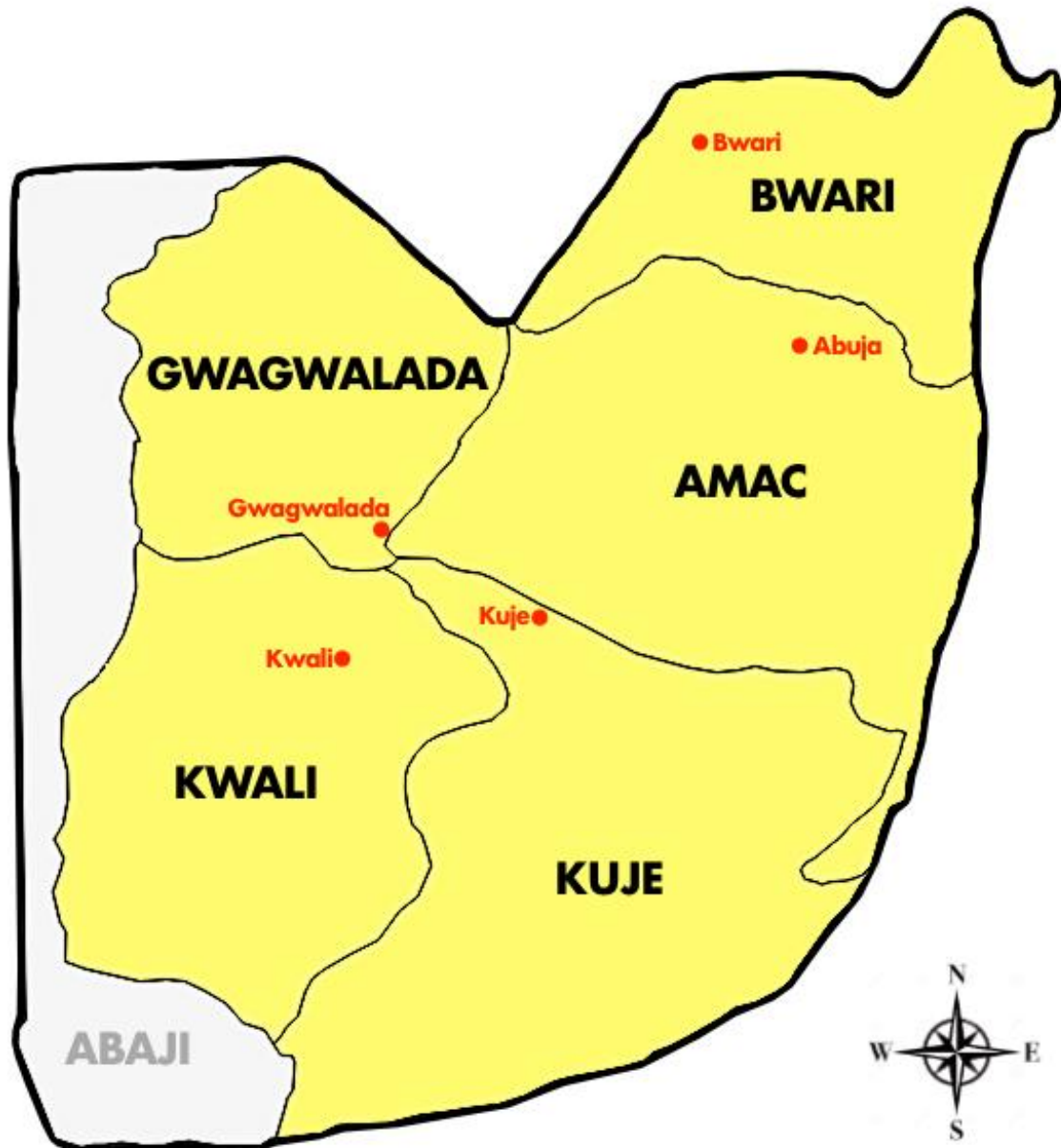


Figure 3:1 FCT, with the six area councils

The region exhibits three tropical climate weather conditions annually, which include a warm, humid rainy season and an extremely hot dry season. FCT's annual rainfall is about 1,631.7 mm, rich soil and its location within the Guinea-Savanna grassland, makes it agriculturally productive (Abubakar, 2014; Adeyeri *et al.*, 2015). The FCT experiences maximum temperature between 25°-30°C which persists throughout the year and permits all-year round production of cultured and wild fishes. All aspects of fish physiology such as food consumption, growth, breeding, and metabolism are directly influenced by their surrounding temperature (Ficke *et al.*, 2007). For example, studies have shown that in Nigeria,

catfish and tilapia requires rainfall in the average of 1,000 mm to 1,300 mm per annum and temperature ranging from 27°-30°C for growth and survival (Zidana *et al.*, 2015; Adeyemo *et al.*, 2018). Rainfall and temperature are the climatic factors that affect aquaculture production (Asiedu *et al.*, 2017a). Variations of these conditions could affect daily operations positively or negatively. Therefore, the ideal temperature and precipitation have influence on fish metabolism, growth rate, reproduction and exposure to diseases and toxins (Ezenwaji *et al.*, 2014).

Furthermore, labour is also readily available in the catchment area for this research. There are many youths who have left school and unemployed, who could be employed in the fish farming industry. For example, the youth unemployment rate in Nigeria stands at 80 percent, the economic implication of introducing young people into fish farming will help reduce the spiralling unemployment rate in that segment of the population and generate revenue for the country (CBN, 2014). There is a prevailing food fish deficit in the FCT, and future trends suggest that domestic fish demand will continue to increase particularly in FCT and its environs, due to rising population pressure and urbanisation (Ebukiba and Anthony, 2019).

The population of the FCT as at 2011 was estimated to be 2,193,613 (NBS, 2012), however, a recent survey indicated that the FCTs' population was over 3 million (Abubakar, 2014). Getting an accurate and up-to-date data was a challenge since the last population census was conducted in 2006. The FCT is growing at a fast rate, making it one of the ten most populous cities in Nigeria (Ogochukwu *et al.*, 2022). As a capital city of Nigeria, the FCT have high income earners, however, studies suggest that almost 40 percent of the population live below the national average poverty line (NBS, 2020), with the rural areas accounting for more of those in deprivation.

3.2 The FCT Aquaculture Sector

The aquaculture sector in the FCT is rising rapidly and shows a significant promise to continue to grow, with the public who have had some information on aquaculture believing that there is potential in investing in the industry. This trend can be attributed to the high productive and profitable nature of the industry, locally available feed ingredients, and the ranges of production systems in use

(FMARD, 2014; Ahmed *et al.*, 2018). There are also indigenous fast-growing fish species of aquaculture importance such as catfish, tilapia, etc. that dominate these water bodies and other cultivable fish species cultured in Nigeria which can thrive well in freshwater environment that could be put to aquaculture use in the area (Francis and Davis, 2013; FMARD, 2014). Furthermore, the government of Nigeria and the private sector are playing a facilitative role to provide a conducive environment for the aquaculture industry to succeed (Atanda & Fagbenro, 2017). Aquaculture is being promoted throughout the entire value chain. Nevertheless, the industry is still being confronted with challenges such as poor management skills, high cost of feed, inadequate supply of good quality seed, lack of capital, marketing of products and environmental consideration (Kaleem and Sabi, 2021; Onuche *et al.*, 2020), making fish farming non profitable for the many farmers who have adopted the practice.

3.3 Field Observation

The researcher and the research team visited 56 farms, to observe farmers while on farm. Physically visiting the farms enabled a better understanding and appreciation of the topic under review (Jimenez *et al.*, 2016). This allowed the researcher to engage in activities that included feeding of fish, feed formulation, stocking of fish, measuring water pH, checking water level, and topping it up, broodstock selection and hatchery management. This first-hand experience enabled the researcher to appreciate fish farming more and increased the motivation to learn more by getting involved in the industry. During this phase, the researcher recorded the physical, socioeconomic, and environmental conditions of the farms. In addition, the general livelihood situation of the farmer and the impacts of their activities to the surrounding communities was also explored. The researcher was involved in all the process to ensure consistency. This approach allowed the team to discuss, ask questions, and seek clarification on the best way fish farming is conducted.

The process enabled the researcher to ascertain information on individual farmers' management practices, which would not have been possible if not physically

present on the field. The following were some of the variables that were considered:

- i) Production systems
- ii) Technology employed
- iii) Input and output
- iv) Feeding regime
- v) Challenges
- vi) Staffing arrangements
- vii) Support and information
- viii) Available markets
- ix) Food and nutrition

3.4 Production Systems and Characteristics

Aquaculture production systems in the FCT were in the form of concrete tanks, earthen ponds, fibreglass, plastic containers, flow through and RAS systems, depending on the culture system being adopted. Production is carried out in freshwater environment, consisting of small to medium scale commercial farms that produces a variety of catfishes and tilapias in mainly monoculture systems, with a few practicing polycultures in enclosures for local and national consumption. This is consistent with freshwater aquaculture practices around the world (Naylor *et al.*, 2021). Farming in the study area is conducted based on feeding methods as indicated in section 1.3.3: extensive, semi-intensive and intensive (Emmanuel *et al.*, 2014). The diverse techniques used in the study are flow through systems, ponds, tanks and RAS systems.

3.4.1 Flow Through Systems

Fish farmers in the FCT build series of culture units (tanks) and fill it up with water to maintain suitable water exchange for fish production (Figure 3.2). They are designed in such a way that water enters from one end and exits at the other, enabling steady supply of oxygen from the incoming water and removal of waste

products from the outflow (Emmanuel *et al.*, 2014). Water is reaerated and waste removed as it exits one unit to the next one (Tucker and Hargreaves, 2008), allowing the reuse of some of the elements that would have otherwise been wasted. High quality flowing water is sourced from streams, springs, lakes, or wells, to ensure the required level of water for cultivation. The most common shape of tanks is circular and rectangular, with varying sizes (Sticky, 2009; Boyd and McNevin, 2015).



Figure 3:2 A flow-through concrete tank (Fakoya *et al.*, 2009)

3.4.2 Fish Pond

Ponds were the most common culture systems used in the FCT. Ponds are filled with fresh water in a controlled environment such as artificial lake, concrete tanks, reservoir or dams, or fibreglass to grow aquatic organisms for human consumption, recreational fishing, ornamental or production of algae for nutritional supplements (Stickney, 2009; Emmanuel *et al.*, 2014). The sizes of

ponds that existed varied from 100 to 1,000m². Most ponds (earthen and concrete) were built in connected series of 6 to 10 or more ponds or tanks with walls or dykes to reduce construction costs, concrete ponds were relatively smaller in sizes. This system recycles water to restore its quality by filtering and removing solid waste, ammonia, carbon dioxide to increase oxygenation. This method allows the reuse of some of the elements that would have otherwise been wasted. Most pond aquaculture is intensive, pellet fed and mainly monoculture. Ponds are mostly rectangular or square in shape, and their sizes and depth are dependent on the requirement of fish to be stocked and methods of harvest of the culturists.



Figure 3:3 An earthen fishpond (Fakoya *et al.*, 2009)

3.4.3 Fish Tanks

Tanks used in the study area were constructed of concrete, steel, or plastic for production of fish in indoors or outdoors environment. Tanks were in the form of large-deep cylindrical (silos), large fibreglass or small aquarium (Parker, 2002; Emmanuel *et al.*, 2014). Production tanks varied in sizes and shapes depending

on what was being cultured. Parker (2002) indicated that small tanks for spawning fish, maintaining fry and fingerlings are between 100 to 2,000 litres. Whilst Emmanuel *et al.* (2014) suggested that most used tanks measure between 5,000 to 10,000 litres. Emmanuel *et al.*, (2014) recommended that appropriate culture tank should be non-corrosive, smooth and round with a conical shaped bottom for easy discharge of waste product.

3.4.4 Recirculating Aquaculture System (RAS)

Recirculating Aquaculture Systems (RAS) are closed, tank-based and filtration and water treatment systems in which aquatic animals are raised in high density under a controlled environmental conditions (Emmanuel *et al.*, 2014; Turcios and Papenbrock, 2014). RAS are a technology for intensive aquaculture that reduces water and land use (Badiola *et al.*, 2018). The system enables 90-99 percent of water to be recycled through regular monitoring of parameters like nitrite, pH, oxygen and carbon dioxide content to guarantee optimum fish health and growth performance (Badiola *et al.*, 2012). High stocking density on the other hand allow the farmer to achieve maximum production from a minimal area. This system was predominantly used by commercial, larger farms in the FCT.

Intensive aquaculture has contributed significantly to resource depletion and climate condition in the study area. However, justification for the expansion of RAS systems instead of conventional aquaculture is that the system has less effect on the environment. Since water is recycled between the culture and water treatment unit, it enables aquatic production operation in relative isolation from the surrounding environment (van Rijn, 2013). Furthermore, the industry has developed acceptable practices from environmental, societal, and economic perspectives to minimise its negative impacts to the environment (Badiola *et al.*, 2018). In contrast, factors limiting RAS operation are high capital and operational costs, management, and difficulties in treating diseases. However, van Rijn (2013) stated that RAS systems are most effective in areas where land availability, operation costs and development of sustainable waste treatment methods are less of a constraint.

3.5 Opportunity and Constraints to Productivity and Sustainability

Nigeria, and most especially the study area has great potential to raise the volume and value of its aquacultural sector and expand its related business activities. For example, Akinsorotan *et al.* (2019) indicated that Nigeria has offshore aquaculture capabilities that is yet to be tapped within its coastal water bodies. In addition, Kaleem *et al.* (2021) stated that the progress in aquaculture development has been driven by nutrition improvement, generation of income, creation of employment. Aquaculture production can significantly increase using new technology and infrastructure. The impact would be enormous through raising rural incomes, boosting GDP growth, and creating business opportunities. However, several factors hinder aquaculture's smooth production performance. Unless actions are taken to improve domestic productions by resolving the factors hindering the development of the aquaculture industry, the country will always import fish amidst its abundant natural resources to meet most of its fish demand. The most important obstacles affecting aquaculture development is discussed below.

3.5.1 Land

The predominant freshwater culture of fish and other aquatic organisms are conducted in ponds and other land-based facilities. Land is the major production input for aquaculture. Land acquisition in Nigeria/FCT is mostly through communal tenure, where farmers use a portion of land in order to pay some dues. In some instance, farmers purchase their land from individual owners or government through certificate of ownership (Adedeji and Okocha, 2011; Kughur *et al.*, 2015). However, land resource is a major barrier to the development of an efficient and well capitalised aquacultural sector (Stickney, 2009; Boyd and McNevin, 2015). Land ownership or tenure is key to influencing farmers' investment in aquaculture production. High cost of land is a contributing factor to failure in operations especially amongst poor farmers (Adedeji and Okocha, 2011). Furthermore, competition for land resources between agricultural and non-agricultural users has led to fierce conflicts, due largely to increase in human and animal population

(Adisa, 2012). Adedeji and Okocha (2011) stressed that land suitable for agricultural uses are limited and under pressure with changing environmental and socioeconomic implications. It is becoming obvious that land appropriate for freshwater aquaculture is limited and under pressure from several human activities competing for the same resources (Springmann *et al.*, 2018). In recent times, there has been clashes between farmers and herdsmen battling for scarce land resources in Nigeria (Adeoye, 2017; Gever and Essien, 2019). These tensions have polarised communities particularly in rural areas leading to loss of properties and lives. Conflicts between farmers and herdsmen over land use has dreadful consequences to agricultural development. These issues have exacerbated poverty, food insecurity and the socioeconomic situation of mostly the rural populace, with dire consequences nationwide (Okoli and Atelhe, 2014). Another cause of conflict as cited by Bello (2013) is climate change, which is putting great pressure on natural resources. Adedeji and Okocha (2011) suggested that lack of land for culture is one of the constraints to operation in the aquaculture sector. Although aquaculture uses less land in comparison to other agricultural users, it still does have significant effects on land resources and cause environmental issues (Boyd and McNevin, 2015). Therefore, efforts must be intensified to integrate aquaculture in a way that minimises conflicts among land users and further environmental damage. This will create a more enabling environment for people to practice aquaculture.

3.5.2 Water

Good quality water is a basic requirement for optimum performance of cultured fish species and other aquatic organisms. Without access to adequate, constant supplies of good quality water, it would be impossible to produce fish (Adedeji and Okocha, 2011). High quality water is a major component in addition to good feed and feeding regime necessary for aquatic production (Davies and Ansa, 2010). Davies and Ansa (2010) stated that water supply is variable, i.e., it depends on the season, temperature, water source, stocking density, soil type, feeding rate and culture systems. Water is vital to increased food production and a source of employment and income for most people in the rural areas. Nigeria's water

resources are projected to be 250,000 million cubic metres, constituting of 190,000 million of surface water and the remainder is in the form of ground water (Kughur *et al.*, 2015). Nevertheless, fish farmers still compete for water with other users. Fish farmers in the FCT utilise water from rainfall, streams/rivers, well/borehole, tap water for their daily operations. However, some of the water available may not be suitable for fish farming due to pollution from industrial, agricultural and domestic discharge (Huntingford *et al.*, 2012). In some cases, prior treatment is essential to remove chemical, biological and physical hazards.

3.6 Policy and Governance of Aquaculture

The main drivers of aquaculture development in Nigeria have been socio-economic objectives such as generation of additional income, nutrition improvement and job creation (Adeleke *et al.*, 2020; Kaleem and Sabi, 2021). However, these objectives have not been met because of shortfalls in domestic production of fish food, leading to fish being cultivated to supplement the gap in demand to reduce fish imports. Aquaculture is one of the very important aspects of Nigeria's agricultural sector because of its consumption demand of a population of over 200 million and inland freshwater and land for fish culture potential (Adewumi, 2015; Pison, 2019). The aquaculture industry in Nigeria has experienced a rapid development from 1998 due to the private sector initiatives, resulting in peri-urban aquaculture expansion. The sector grew from 20,458 tons in 1998 to 291,233 tons in 2018 (Cai *et al.*, 2017; Adeleke *et al.*, 2020). In Africa, Nigeria is the second top producer of aquaculture, with the highest consumption demand in the region due to its population. However, the sector has been plagued by unstable policies, poorly implemented framework threatening the development of the industry. The country could learn from Egypt, the top producing country in Africa which has enjoyed a high priority and continuous intervention by the government to develop the sector, thereby, making it self-reliant (Soliman and Yacout, 2016; Adeleke *et al.*, 2020).

Until recently, the aquaculture sector in Nigeria was confronted with a lot of challenges (political, social, environmental, weak institutions). However, the aquaculture industry has evolved over the years since 1998, with the advent of

modern technology leading to a significant rise in production output across the country (Kughur *et al.*, 2015; Adeleke *et al.*, 2020; FAO, 2020). This growth in aquaculture in the country replicates what was witnessed in other developing countries such as Egypt, China and India, driven by high market demand (Miller and Atanda, 2011; Jamu *et al.*, 2012). The government has started to realise the importance of creating a conducive business environment by taking steps to develop and adopt aquaculture centred policies and strategies as a roadmap to improve the industry (Kughur *et al.*, 2015; Ayeloja *et al.*, 2017; Nzewi and Cordelia, 2018; Kaleem and Sabi, 2021). Some of these frameworks include policy reforms, ban on fish importation, provision of inputs (ropes, nets, engines, storage facilities, competitive markets, etc.), grants, subsidies, and tax breaks to farmers to enable maximum operation efficiency. Some of these policies and frameworks are discussed in section 3.6.1.

3.6.1 Agricultural Policies and Government Assisted Programme

Since attaining independence in 1960 from its colonel masters, the Nigerian government has tried to lift its citizens from poverty and make the nation food secured by introducing and launching various programmes and projects to shift the agricultural sector from mere subsistence level of farming to commercialisation (Tiri *et al.*, 2014; Kughur *et al.*, 2015). The Federal Government in collaboration with the States and Local Governments initiated several programmes and projects to support and assist farmers by providing an enabling environment for effective food production. Some of the agricultural development intervention programmes and projects introduced and launched from 1960 till date were National Accelerated Food Production Programme (NAFPP), Nigerian Agricultural and Co-operative Bank (NACB), Operation Feed the Nation (OFN), National Agricultural Land Development Authority (NALDA), River Basin Development Authority (RBDA), Agricultural Development Programmes (ADPs), Directorate of Food, Roads and Rural Infrastructure (DFRRI) and others (Maduagwu, 2000; Daneji, 2011; Kughur *et al.*, 2015). The main objectives of these policies were intended to:

1. To boost production of food for local consumption and export purposes

2. To maximise the nation's economic wellbeing
3. To make the country self sufficient
4. To provide infrastructures for and open the rural areas

However, provisional projects purposely focused on fisheries development can be said to have started in 1971, when the Nigerian Federal Government gathered scientific data, with the support of the FDF and enacted the "Sea Fisheries Decree" to control, licence and regulate coastal fisheries to ensure responsible practices. It was followed up by the "Sea Fisheries (Fishing) Regulations" in 1972, "Exclusive Economic Zone Decree" of 1978 and the "Inland Fisheries Decree" in 1992 as a code of conduct to direct the proper management of living marine resources (Vincent-Akpu, 2013), with no specific law governing the aquaculture industry at national level. On the contrary, most of these projects failed and subsequently led to most Nigerians living in poverty, food hunger and malnutrition because of lack of growth in the agricultural sector (Tiri *et al.*, 2014; Oguntegbe *et al.*, 2018; NBS, 2020). However, demand for food and population growth in the country shows an increasing trend. Metu *et al.* (2016) observed that domestic food production rose from 48.23% in 1990 to 114.93% in 2013, but still, could not meet the demand of a population increase of 98.08 million people in 1991 to 177.82 million people in 2014, making the country food insecure in terms of availability. This trend is supported by many other authors, who noted that the country's demand for food increased annually outpacing food production due to pressures from the growing population, climate variations, increase in prices of inputs, corruption, postharvest losses, among others have played a role in diminishing food supply and further production (Tiri *et al.*, 2014; Olowa and Olowa, 2016; Oguntegbe *et al.*, 2018; Kaleem and Sabi, 2021).

The abysmal performance of the agricultural sector led the Nigerian Government to introduce the Growth Enhancement Support Scheme (GESS) under the Agricultural Transformation Agenda (ATA) policy in 2011, in order to serve as a strategy to resolve the major issues associated with the agricultural sector (Akinwumi, 2011; Tiri *et al.*, 2014). After the introduction of GESS in 2011, the federal government in 2012 invested N30 billion as a support strategy to enhance the performance of small-scale farmers in the country, with a target of producing more food and reducing money spent on importation which was expected to run

for 4 years, until 2015 (Akinwumi, 2011; Tiri *et al.*, 2014). The success of the GESS was dependent on the active participation of targeted stakeholders (Figure 3.4) (Oredipe, 2015; Michael *et al.*, 2018). These stakeholders included: the government (local, states and federal level), fertiliser importers and distributors, seed companies and agro-dealers, banks, with farmers at the central point of this partnership. Contrary to the progress attained by the GESS programme to revolutionise the sector, the government did not keep up with its promise to repay the 50 percent balance of the subsidy to the participating inputs suppliers as promised in 2014, which left suppliers out of business (Babatunde and Ewepu, 2015). With this outcome, there was anxiety amongst stakeholders to the survival of the project, as targets set for the agenda were not achieved. For example, it was anticipated that 3.5 million jobs will be created by 2015, with the view of generating foreign exchange, and to reduce the hard-earned foreign exchange spent on food imports (FMARD, 2016).

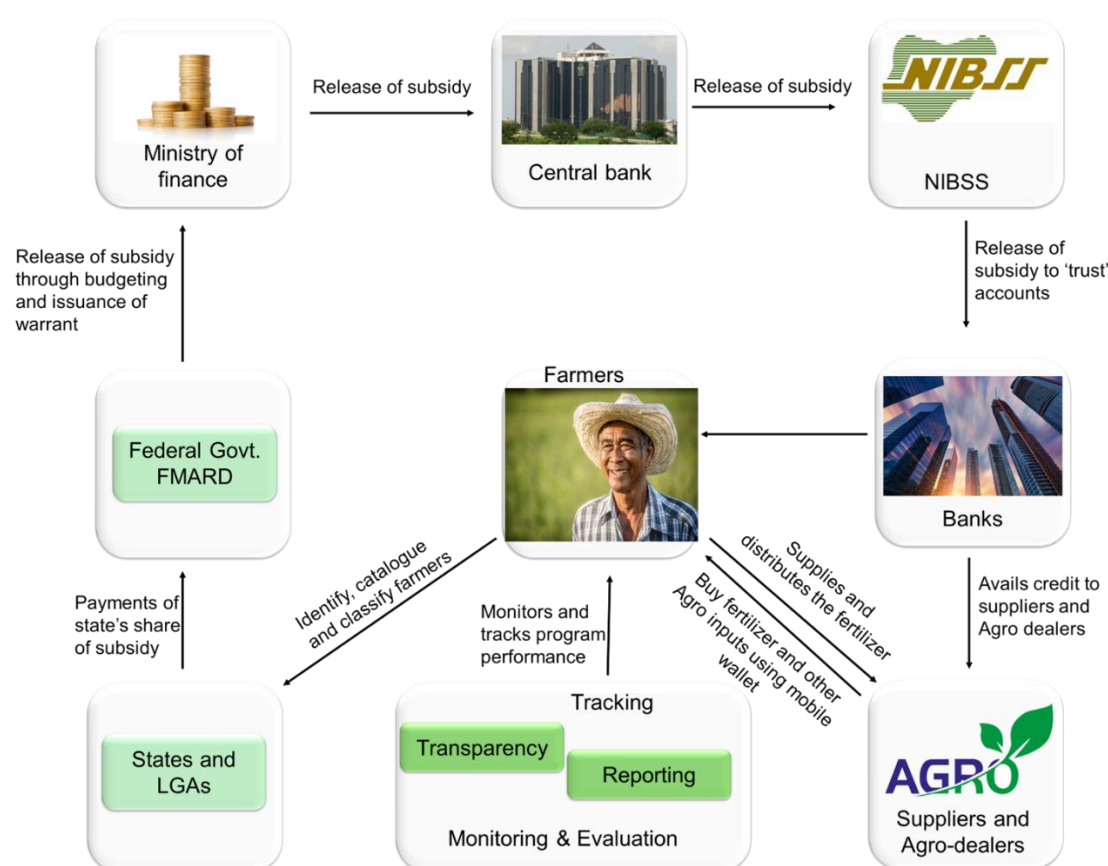


Figure 3:4 Stakeholders in the GESS (Oredipe, 2015)

Prior to the above-mentioned project, many other projects were initiated both on a local and international platform to drastically reduce hunger and poverty especially in the developing countries, of which so many humans suffer from throughout their lives. To mention a few, in 2005, some African Heads of states, delegates, experts and ambassadors; both in the private and public sectors attended a summit in Abuja the Federal Capital of Nigeria, captioned "*Fish for All Summit*" organised by the New Partnership for Africa's Development (NEPAD), with the support of the Worldfish Centre and FAO, the idea was to create a roadmap to eradicate poverty, achieve food security and malnutrition by increased focus on aquaculture promotion and development (NEPAD, 2005). This was followed in 2010 by the "*First Conference of African Ministers of Fisheries and Aquaculture*" in Banjul, The Gambia, led by the African Union (AU). The subject for the conference was "*African Fisheries and Aquaculture: Contributing towards Agricultural Development and Economic Growth*", which was related to the thirteenth AU gathering for Heads of State and Government summit held in Libya in 2009, with the theme as; "*Investing in Agriculture for Economic Growth and Food Security*" (NEPAD, 2010). In addition, in 2014, a joint conference of the AU Ministers of Agriculture, Development, Fisheries and Aquaculture was held in Addis Ababa, Ethiopia, to promote aquaculture as a vehicle for food security and starvation, poverty alleviation and for stimulation of economic growth for the poor (NEPAD, 2014). Besides the above-mentioned initiatives, there have been emphasis from various government agencies like Department for International Development (DfID), FAO, United Nations (UN) in support of these approaches.

Recently, in 2016, the government introduced a new policy called the Green Revolution Programme (GR) to consolidate on the successes and lessons learnt from the ATA. The GR strategy is intended to reintroduce the country to job creation, close the policy gaps, import substitution, economic diversification, and reposition the agricultural sector for greater investment, enhancing food security and poverty reduction (Ifeoma, 2019; Zakariyau, 2020). The recent policy is to identify constraints that hindered the country from meeting its domestic food requirements, and its inability to serve international markets to earn foreign exchange (FMARD, 2016; Hassan and Vandi, 2020; Zakariyau, 2020). Additionally, the policy will highlight ways to check population growth, improve

agricultural production, and curb importation of food (Hussain and Sulaimon, 2018; Hassan and Vandi, 2020).

To help solve the identified challenges, it has been suggested that the country will need to prioritise domestic food production, and offer incentives/subsidies (soft loans, inputs, extension officers) to farmers that will encourage them to produce enough food for home consumption, thereby, reducing the over dependence on foreign imports (FMARD, 2016; Michael *et al.*, 2018). Subsidies play a vital role in agricultural development the world over. In Nigeria, it constitutes a greater percentage of total budgetary allocations for farming (Adebayo *et al.*, 2016; Jayne *et al.*, 2018). In supporting the impact that subsidies have on farming, Seck (2016) indicated that it has largely been responsible for improving the efficiency and production capacity of farmers. Over the years, the federal government have spent substantial amount on the provision of subsidised agricultural inputs for farmers. For example, the government allocated over ₦27 billion input subsidies to support 1.5 million farmers in 2016/17 farming season. This created a huge financial burden on the government, and concerns were raised over its long-term maintenance, considering past policies that have been ineffective (Michael *et al.*, 2018; Nzewi and Cordelia, 2018; Jayne *et al.*, 2018). However, evidence suggest that agriculture contributes significantly to the GDP of the country. For example, the NBS in 2019 reported that the sector grew continuously from 1981 to 2019. The sector's contribution to the GDP observed between 2009 and 2019 were ₦11,625.44 billion and ₦31,904.14 billion, respectively (NBS, 2019; Dioha and Kumar, 2020). Also, the agriculture sector had risen by 3.17 percent in quarter one of 2019 from 2.46 percent in quarter four of 2018 (Figure 3.5) (NBS, 2019).

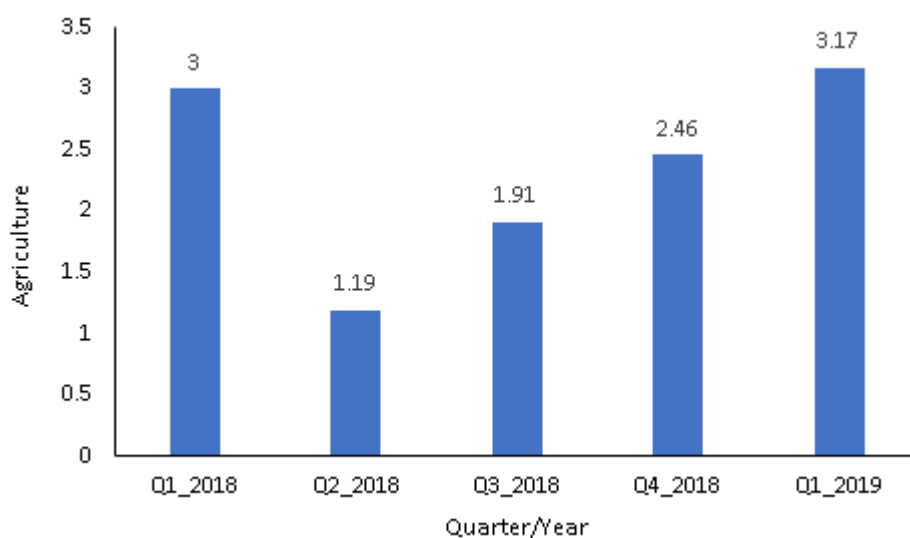


Figure 3:5 Agriculture Sector GDP in Nigeria 2018 – 2019 (NBS, 2019)

3.7 Case Study of Farms in the Region

Aquaculture production in the FCT is practiced in all the six Area councils (Abaji, Bwari, Gwagwalada, Kuje, Kwali, and Municipal), however due to security issues as of the time of data collection, Abaji area council was not included. The aquaculture sector in the FCT is made up of three types of farms, large and medium scale utilising the semi-intensive to intensive production systems, while the small-scale utilises extensive to semi-intensive production systems to culture fish. These farms are land-based systems, using freshwater to culture mostly catfish and tilapia in earthen ponds, concrete tanks, plastic containers, and fibre glasses (see 3.4). Pond aquaculture is the dominant production system in the FCT, accounting for all the farms in the region. Of the 98 farms that were surveyed, almost 98 percent who cultured fish were men, with less than 3 percent women engaging in fish cultivation. Women are mostly involved in processing and selling of the produce. Of the 98 farms that were surveyed, 56 were visited on the field to observe their daily farm operations. All the number of fish farms and farmers surveyed per region is illustrated in (Table 3:1), including the 24 farmers that data was gathered during workshop/seminar (see 2.6.2), and 18 of the farmers had their questionnaires administered through telephone calls (see 2.6.2). Farmers

whom data was gathered from workshop/seminar and telephone could not be reached on their farms due to bad road networks.

Table 3:1 Number of fish farms and farmers surveyed per region

Number of fish farms and farmers surveyed by region			
Region	Farms visited	Workshop/seminar	Telephone
Bwari	5		
Gwagwalada	12	24	
Kuje	16		
Kwali	9		
Municipal	14		18

The population of farms visited were grouped under Large, Medium, and Small-scale farms. One farm each was selected to represent each cohort. The researcher selected these three farms because they reflected all the characteristics of each cohort that they represented. The study revealed that each farm cohort (large, medium, and small-scale) had different way of operating. It came to light that they all had similarities as well (see farm A, B and C). The investigation looked at the level of input use and outputs (fingerling, feed, storage, harvest, market, etc) during production.

The analysis used data collected from a large-scale farm (farm A) in Gwagwalada Area council (Figure 3:1), located in the outskirts of the town, earmarked by the area council for farmlands for the locals. This farm had been in operation for over ten years as of the time of the survey, it belongs to a retired military officer, who was also a former Minister of the FCT, he had employed the use of a graduate of aquaculture to run the daily operations of the farm. The manager revealed that the interest for the owner of the farm to invest in fish farming was developed during the time the first pilot fish farm was constructed in Panyam, in the early 50s.

The farm utilised both earthen and concrete tanks to culture fish, operated an onsite hatchery for fingerling production, and formulated most of the feed for feeding their fishes. Daily activities included checking of water temperature, feeding, feed formulation, breeding and hatchery management and keeping

records. The farm had between two to six employees (full-time and part-time) combined during the time of data collection. The farmer stocked between 1000-1,500 fish in each pond (earthen) to raise fish from fingerling to marketable size (Figure 3:6), whilst hatchery (concrete) was used for breeding fish seed for the farm and sold some to nearby farms. The source of water was rainwater and borehole/well dug within the farm. The farm had a storage facility for all their equipment (feed, machineries, smoked fish), and a cold room to store fresh fish. Fish were grown in stages, so the farm harvested fish both partially and completely when they reached marketable size. Most of their customers were hoteliers, restaurants, retailers and a few wholesalers from the locality.



Figure 3:6 Pond with Catfish (Source: Researcher, 2017).

The second farm (farm B) is a medium scale operated venture in Kuje Area council (Figure 3:1). The farm has been in existence for exactly six years. This farm had similar resources as the above, but without an onsite hatchery facility. Daily operations of the farm were carried out by the farmer, with occasional help from families and part time employees when needed. The site was located around the

neighbourhood, with easy access by the locals. The farmer had acquired the land through family inheritance. Fish production was carried out in earthen ponds (Figure 3:7), culturing between 600-1000 fingerlings which were sort from other farms for production. The farmer utilised mainly rainwater, with occasional use of tap water, river and a small dugout well on the farm when there was the need. In addition, the farmer used a mixture (bought and formulate) of feed according to the fish raised. The farmer sold their produce to the public from the community, wholesalers, retailers. Fish was sometimes smoked, dried to preserve its shelf life in other to be sold when prices were right for the farmer. The farm had an onsite store to store up equipment for easy access during operation.



Figure 3:7 Earthen Pond for Fish Production (Source: Researcher, 2017).

On the other hand, the third farmer (farm C) was a woman (small-scale owned), who raised fish in a series of six concrete tanks in her backyard and had been farming for under three years (see figure 3:1). Daily activities for this farm were making sure the level and quality of water was sufficient, feeding of fish, ensuring that fishes were in good condition, and smoking of fish she had harvested from

her pond (Figure 3:8). Sources of water was rain and tap water. This farmer had help from their family members and employed neighbours on a part time basis to help with total harvesting of produce. The farmer stocked between 200-500 fingerlings bought from other farms for cultivation and feed also for feeding her fish. This farm had a small area for storing things (feed, nets, etc) within the home. The farmer sold fish to consumers around the neighbourhood, restaurants, hoteliers, and retailers.



Figure 3:8 A participant smoking fish on her farm (Researcher, 2017)

These farms were all registered under the various agricultural departments in their area councils. They had occasional visits from extension agents for support on farm activities, information on recent technology and practices, and they attended various trainings organised by the government, NGOs in their local area. These farms grew catfishes only, stocked between 2-3 fish/m², and harvested when the fish were between 1.5 to 2 kg average weight.

3.8 Challenges

These farmers indicated that the difficulties they faced were in sourcing raw materials and the initial investment in production equipment. Farmers stated that quality feed was expensive because there were no feed producers in the region. The other barrier was good catfish seed, as only a few farmers in the area had hatcheries, and the knowledge to operate them. The farmers who bought their fingerlings revealed that access to finance to obtain hatchery equipment was a hindrance to them breeding their own seed. Furthermore, obtaining land in the study area was a constraint to expansion for the small and medium scale farmers. Nevertheless, all the farmers acknowledged that fish farming is a profitable venture, and some of the help they had received from the agriculture department and various NGOs has helped them to continue farming.

3.9 Conclusion

This chapter is a summary of how fish farming is conducted in the study area. Through the case study of three farms, the investigation assessed the challenges and prospects of the aquaculture sector through available resources that have not been adequately exploited for production purposes to feed the ever-increasing population. It is evident that several factors explain the poor performance of the aquaculture sector in the FCT. Key challenges presented within this chapter suggest that lack of funding and access to credit facilities, poor infrastructure, lack of land, high cost of feed and inadequate supply of fingerlings and others were plaguing the development of the sector. Although there is improvement in policy formulation and efforts by the government to enhance production across the sector, still the small-scale fish farmers need to be empowered to the pathway of sustainable productivity. There exists a drive by many to meet the increasing demand for fish, to support and improve food nutritional security, as well as alleviating poverty through a total transformation of the current fish farming practices.

The size of the potential per capita consumption of the country makes this an opportunity that policy makers, local and foreign investors can target areas

impeding future growth and sustainability of the sector. The government and all stakeholders should make this a priority by creating an awareness of the possible potential contribution of aquaculture towards national development.

Chapter 4: Aquaculture from Federal Government, State and Local Level Perspective

4.1 Results

This section examines this study's results in view of the research questions, describing the words and opinions of the interviewees in connection to the themes derived during coding. Data analysis of policy makers interviews identified six predominant themes (Table 4:1). These themes are discussed, along with some participants quotations used as examples. Respondent coding (P01, P02, P03, P04, P05, P06, and P07) is used in this presentation of excerpts to shield the identity of the speaker. Themes selected in (Table 2:3) are relevant to answering the research questions in this study.

4.1.1 Demographics

Seven (7) participants from the fisheries department were interviewed (Figure 4.1). All the interviews were conducted face-to-face approach. The interviews conducted lasted between 50 – 75 minutes. All those who participated were currently working in the agricultural department of their various organisations and engaged with fish farmers both in the local and national level, disseminating information and knowledge on new aquaculture technologies that aid in the growth of the sector nationwide. Participants did not unanimously mention the subthemes indicated in Table 4:1; however certain subthemes were common amongst them.

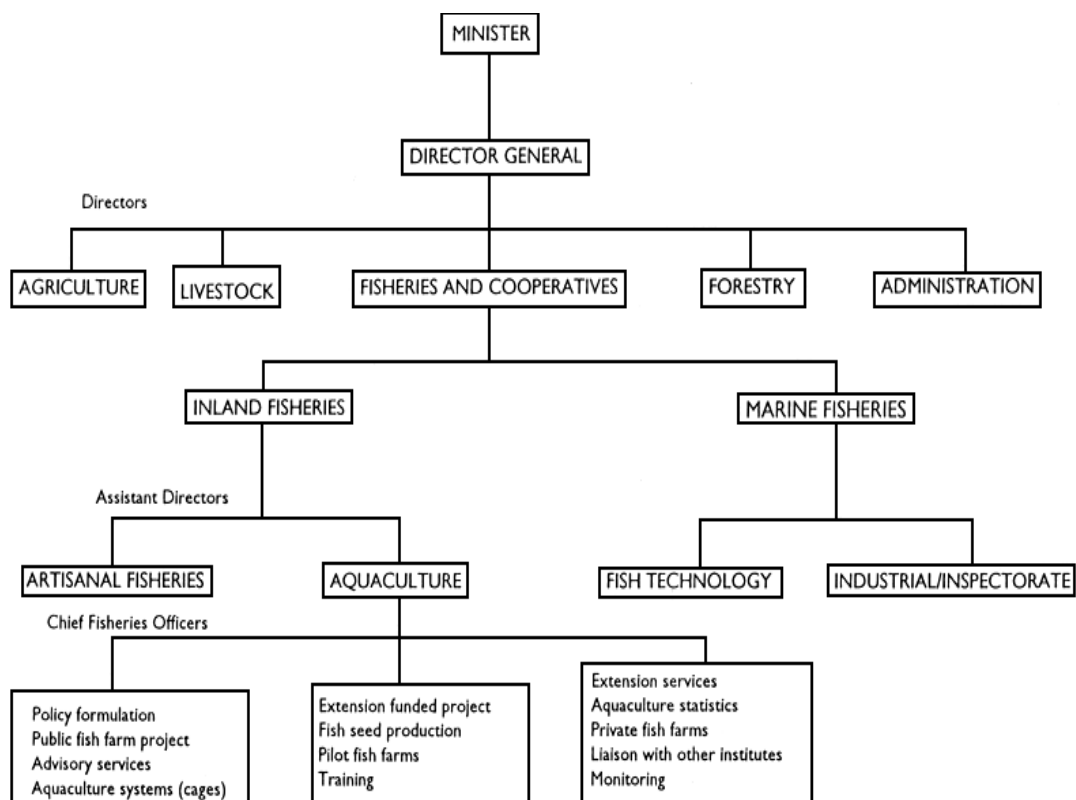


Figure 4:1 Organisational Chart of the Federal Department of Fisheries (2016)

Table 4:1 Themes and subthemes from analysis

Theme	Subtheme
4.1.2 Contribution of aquaculture	4.1.2.1 Viable fish fingerlings 4.1.2.2 Subsidiary industries 4.1.2.3 Provision of infrastructure 4.1.2.4 Provides employment 4.1.2.5 Protein source 4.1.2.6 Control urban migration
4.1.3 Government support	4.1.3.1 Transformation agenda 4.1.3.2 Training and workshop 4.1.3.3 Research and development (R&D) 4.1.3.4 Inputs 4.1.3.5 Finance 4.1.3.6 Create cooperative
4.1.4 Socio-economic impact	4.1.4.1 Social impact 4.1.4.2 Economic impact
4.1.5 External support	4.1.5.1 Technical support
4.1.6 Future of fish farming	4.1.6.1 Public investment 4.1.6.2 Alternative feed development
4.1.7 Challenges	4.1.7.1 Youth training 4.1.7.2 Technical knowledge 4.1.7.3 Security 4.1.7.4 Land 4.1.7.5 Finance 4.1.7.6 Feed 4.1.7.7 Basic infrastructure

4.1.2 Contribution of aquaculture

Contribution of aquaculture emerged as an overarching theme from data collected during the interview with participants. It revealed that aquaculture impacted positively to the development dynamics of the rural area in diverse ways. Six factors were identified which facilitated the contribution in development strategy for aquaculture propagation: viable fish fingerlings; subsidiary industries; provision of infrastructures; provides employment; protein source; and the control of urban migration. These factors are discussed in relation to how favourable conditions proliferate the growth of aquaculture in the FCT and its environment.

4.1.2.1 Viable fish fingerlings

Thematic analysis of participants conducted revealed that respondents felt that the lack of access to quality fish fingerlings (seed) has had an impact on the development of aquaculture production in the area. Participants indicated that quality fish seeds grew faster and were cheaper to purchase in comparison to other farming seedlings (cattle, goats, poultry), making fish produce more affordable to the public. However, their concerns were that high-quality fingerlings were not easy to come by, as almost 90 percent of farmers did not have the knowledge to produce fingerlings or could not afford a hatchery for production purposes. The study revealed that farmers had to travel far away to buy fingerlings, which was time consuming for their daily activities. Furthermore, respondents stated that the ideal situation would be for fish farmers to have the knowledge and resources to have their own hatchery. Although, the government, NGOs, and a few farmers were producing fingerlings that other fish farmers could purchase from to cultivate and believed that this was successful in acquiring the fingerlings for production. However, these sources could not provide enough fingerlings for the region, therefore farmers had to source from afar.

4.1.2.2 Subsidiary industries

Participants responses suggested that aquaculture is a vital sector due to the multiplier effects of fish farming to the creation of other industries significant to the economic performance of the rural areas in the FCT. Industries that have benefited from the activities of fish farming are fish feed manufacturing companies, housing, restaurants, hotels, motor parks, schools, and hospitals. These developments in the rural areas have offered the public with food and nutritional security, job creation, support of fisheries conservation, provides a better utilisation of marginal lands, and improved the local community and livelihoods for many.

4.1.2.3 Provision of infrastructure

Participants also noted that fish farming was responsible for the provision of infrastructure like roads, water, electricity, and markets for the rural areas. The availability of appropriate infrastructure and inputs are of economic importance to the fish farmers livelihoods in the study area. Although some of the infrastructure required for aquacultures expansion have been provided, however some respondents stated that still, the area lacked some basic infrastructure that support fish farming such as land for propagation, storage facilities, electricity, and modern technology.

4.1.2.4 Provides employment

Provision of employment through processing, distribution, transportation, and marketing were highlighted by a respondent as opportunities created by the aquaculture industry in the region. He noted that large scale development of the industry could lead to a better communication into rural areas, as this is needed for appropriate management of fish production and distribution in the FCT. The participants believed that a strong and efficient aquaculture industry will guarantee a good foundation for diversifying the FCT's economy and sustain the

strength of the area through generation of employment. However, there was a consensus that the failure of the sector will spell doom for the many that rely on it to survive.

4.1.2.5 Protein source

Participants identified fish as a major provider of direct and future potential supplier of affordable protein source in the region. Fish farmers in the region came from poor background, and some could not afford other sources of protein that came from meat or dairy products. Consumption of fish was high in the community, especially from individuals who had fish farms because of its many health benefits. Interviewees confirmed that fish played an important role in the diet of the rural community providing more than 40 percent of their daily protein intake. However, they expressed concern over the lack of attention placed on fish farming that support the rising demand linked to protein rich food for the rising population in the region.

4.1.2.6 Control of urban migration

Interviewees asserted that the enhancement of the aquaculture industry through provision of essential facilities for propagation has reduced and controlled urban migration from the rural areas. They acknowledged that youths who would have migrated to the cities in search of other jobs outside fish farming were engaged in fish farming in the community. The increase in fish farming activities have restricted the drift of rural people to urban areas. As a result, traditional aquaculture systems have seen an expansion which has led to the increase of productivity of rural land and water resources.

4.1.3 Government support

This category considered how fish farmers in the FCT received various support to enable their operation and remain in business. Six factors were identified which facilitated their development: transformation agenda; training and workshop; research and development; inputs; finance; creation of cooperative. These factors are discussed as follows.

4.1.3.1 Transformation agenda

Data gathered from the interviews had mixed responses to support received via the Government Transformation Agenda since it was launched in 2011. Nevertheless, all participants agreed that more tailored support to the aquaculture industry in terms of modern technology, better management practices, direct involvement of government etc. will benefit the industry. Find below two quotes with different reactions from interviewees.

"It has been effective; 2 hatchery and fingerling production centres have been established; 1 in Gwagwalada and 1 in Garki. National Aquaculture centre at Kuje, National Biotech Centre (with various ponds, processing facilities, feed mills, fingerling production) within Abuja Municipal Area Council (AMAC)" – (P03)

"That programme kick started, but never went far. Part of why it was not successful was because most of production is done in the Western world. It was a good programme, but never went round, and the government that established it is no longer there. It worked also because the former president was a patron. However, with a political will, the programme can still be sustained, because it was very beneficial" – (P04).

More than half of participants in this study were of the view that the government transformation agenda has had no significant impact in fish farmers' venture. This calls to question the role the government is playing to reduce poverty and make its citizens food secure.

4.1.3.2 Training and workshop

Findings from the interview indicated that fish farmers benefited from a variety of training and development initiatives through extension services, NGOs, and councils. Interviewed stakeholders revealed that training farmers had received included site selection, stocking of fish, feeding, checking water temperature, breeding techniques. They indicated that regular training in fish farming management was critical and valuable for fish farmers productivity. Respondents suggests that access to good quality training and information are imperative especially for new entrants in the sector. See quote below from an interviewee.

"At our level (area council), we do have quarterly briefing where we invite farmers, we sensitise them, we treat topic by topic with other group of livestock farmers, as well as encourage them. Also, we work in collaboration with NGO's that train participants on fish farming. They organise and teach them how to do fish farming and this people are from the grassroot level, people who are unemployed and we encourage the government to equip them to start their farms" – (P02).

Furthermore, participants described significant changes they had witnessed in fish farmers operational activities that had received training. Four respondents (n=4) asserted that they had trained fish farmers in their catchment area to provide farmers the opportunity to remain in fish farming.

4.1.3.3 Research and development (R&D)

Results from this study indicated that R&D has played a crucial role in impacting upon fish farmers' practices through a wide range of skills, knowledge, and expertise across the board. However, some of the participants expressed disappointment at the rate of growth in this area, connecting it with the level of insignificant production levels in the country to meet the high fish demand. The quotes below explains the opinion of interviewees in relation to R&D in the FCT:

"Government is not doing much in the area of R&D" – (P01).

"In terms of R&D, like I told you before now that we do what we call quarterly briefing to farmers which is like training farmers. Presenters do research before

presenting their papers. Sometimes we do have agriculture shows for both national and local level. We at the local government level take from our product and present gifts to people for first and second positions. Also, you students from universities and other colleges around, come for attachment and are taught fish farming production from hatchery production, stocking juveniles to table size level” – (P02).

Respondents were divided on support offered by the government in R&D, some felt that some areas were being addressed. On the other hand, there was a consensus that there was a need to upgrade the current standards in advancement in aquaculture to meet with international requirements. Research on fish feed formulation, assessment of quality fish fingerlings, and polyculture were identified as crucial areas for future research to strengthen the aquaculture sector in the FCT. Priority areas identified by respondents for research and investment were feed, breeding, climate change, land acquisition, storage facilities and stable markets for future growth.

4.1.3.4 Inputs for fish farming

In the area of providing input facilities for fish farmers, interviewees all echoed that farmers needed more support with resources that would enable their full engagement into fish farming operations. Support mentioned by respondents included accessible seedlings, public private partnership (PPP) with government through leasing of farmlands, storage houses, and cold rooms. The following quotes highlight this point:

“Public private partnership (PPP) with the government, where the government leases farms and facilities to farmers for aquaculture production” – (P03).

“The reality is that the council is supposed to provide e.g., store for storage, cold rooms etc, but none is operational by the government, only the private sector” – (P04).

Although respondents were of the view that aquaculture has received some attention from the government towards providing facilities to advance the industries production capabilities, there were still gaps in feed formulation, breeding techniques, modern technology to improve growth rates.

4.1.3.5 Finance

The study revealed that small-scale fish farmers were not able to access credit facilities from local financial institutions to cater for their various business needs for optimal production and expansion possibilities. Farmers were unable to obtain credit from financial institutions because they were poor and without any collateral. Therefore, could not purchase land, construct ponds, buy expensive high-yield machineries, to start fish farming which is highly capital intensive to start. However, findings from two respondents in the study area agreed that government had supported in various ways to assist fish farmers in their businesses, they believed that more efforts is needed to improve the industry. Two quotes below expressed by interviews:

"Provision of loan by the government to farmers" – (P01).

"Credit facility such as soft loans with low interest, grants in cash and aids, technical support, policies/legislation are put in place, subsidies, input supply e.g., feeds, fish fingerlings, broodstock, culture facilities – medications, hormones, nets, ph meters, and aerators etc" – (P03).

This study has highlighted that fish farming services and machineries require considerable amounts of finance to set up. Unsuitable financial policies have been a major cause of aquaculture's slow development across the country. Therefore, this calls for substantial investment from both the public and private sector to address critical financial constraints in the FCT's aquaculture sector.

4.1.3.6 Create cooperative

An interviewee emphasised the need for fish farmers to create a cooperative and operate as a formal organisation to obtain the required resources for operation. The role of cooperatives amongst fish farmers in relation to benefits obtained across the board cannot be overemphasised. Some of the benefits identified by participants includes sources of credit to rural farmers, provision of significant services like inputs, machineries, extension staff, markets for farm produce, etc. Quoting the interviewee:

"The majors in place – government is in support and that is why they say people especially farmers should register as cooperatives to come out with what they want to do. If a group is formed and they go to the government, they will be given the amount they demand" – (P06).

Furthermore, the participant noted that cooperative organisations in the country have enhanced agricultural development in multiple ways, for example: increased production, processing, marketing, and distribution services, delivering training and transfer of technology, and financing of farm products, deemed a pillar of strength for the aquaculture sector.

4.1.4 Socio-economic impact

The study identified two areas that fish farmers believe have impacted positively on the development of aquaculture in the community, they were social impact and economic impact.

4.1.4.1 Social impact

In relation to social impact, most interviewees (n=4) agreed that fish farming has greatly impacted their livelihoods and that of the community where they live. Interviewees highlighted how the government has helped to provide certain infrastructure to aid in the operational activities of farmers. Stakeholders expressed that fish farming is a vital sector in the FCT due to its multiple attributes which include provision of food and nutrition security, major source of protein, support for fisheries conservation, providing good utilisation for marginal lands. There was a consensus among respondents that aquaculture is a source of affordable fish for consumption especially among vulnerable groups who faces a major problem with malnutrition. The assertions below from two respondents lend support to the above views:

"So, to say, fish farming has improved protein intake of the local residents. With the level of poverty in the area, fish is cheaper protein source, it helps the local environment. At the same time, red meat is not good for some people, so they

eat fish, particularly, white fish. And the wild fish is not enough, so aquaculture bridge the gap” – (P02).

“Highly positive, when you count 100 houses you find a fish farmer, even amongst people without the knowledge of fish farming. The impact is highly felt” – (P04).

4.1.4.2 Economic impact

All interviewees indicated that aquaculture in the area has been responsible for the creation of employment and income for the locals. The study revealed that fish farming was a primary source of income for most farmers and others who incorporated fish farming into their other farming methods. There is high unemployment among the youths, which has come about as a result of increased migration from the rural areas and other states to the FCT. Fish farming if developed could help absorb the youths who otherwise would have been unemployed. The initial capital required to start fish farming is high, and this keeps many potential farmers away. The government provide the needed infrastructure and training to encourage the youth to embrace fish farming. Apart from the youths who migrate from the rural areas and other states to the FCT in search of non-existing jobs, there are many unemployed graduates in the study area who could also benefit from aquaculture if given the opportunity. The above sentiment is echoed by two interviewees as shown below:

“The impact is so much. Now there is limited employment, so many graduates are roaming about without jobs, so this is another source of employment. Many people are interested in fish farming in particular” – (P06).

“Income along value chain, employment (e.g., processing, filleting, smoking)” – (P07).

4.1.5 External support

Aquaculture in Nigeria has been supported by external agencies over the years. For example, the Japanese International Corporation for Africa (JICA), United Nation Development Programme (UNDP), United States Agency for International Development (USAID), and West African Aquacultural Production Programme (WAAP) were mentioned as the main sources of funding towards technical support

for fish farmers. These agencies provided training, grants, inputs, and modern technology. Recipients (CFOs, extension agents and farmers) were trained on various aspects of farm management practices (including pond preparation, species selection, stocking density, feed and feeding, disease control, harvesting, transfer and the application of modern technology).

4.1.5.1 Technical support

Five (n=5) of the interviewees expressed that the aquaculture sector has benefitted from external support over the years. Support for fish farmers from external sources has come in many ways from the above-mentioned agencies. Some respondents indicated that these supports have come in the form of training, technical assistant, machinery supply and other inputs to proliferate the fish farming industry in the country.

4.1.6 Future of fish farming

Participants were of the view that fish farming has a bright future and has the potential to grow and contribute effectively towards food security and poverty alleviation in the FCT. However, there were concerns expressed about the lack of investment and awareness of the value of the aquaculture industry.

4.1.6.1 Public investment

All participants agreed that the sector needed sustained investment to encourage more people into fish farming. However, there were disagreements amongst participants regarding where investment should go. Some were of the view that there was concentration of infrastructure in the capital city and that the rural areas should be taken care of to stem the flow of unemployed youth trooping to the capital in search of non-existing jobs. Others were of the view that the government was doing something, but more needed to be done to create the awareness and

spread support across all levels in the catchment area. The issue of catfish being the most farmed fish species came up in some of the responses received. For example, a participant noted that other species should be introduced to ensure variety of species cultured. The issue of land acquisition was another problem identified by one of the participants. Land is crucial to fish farming, without which nothing can be done. The following quotes from participants support the above assertions.

"My advice goes like this, in the country entirely, most of our farmers dwell on catfish farming. So, if the government agencies will introduce other fish species, this will improve the farming entirely. At the same time, there is the need for government to identify fish farmers in their locality and provide fish seedlings directly to the farmers. Fish farmers get fish seedlings from business people at more costs. More training needs to be encouraged, either formally or informally" – (P02).

- *"Create enabling policies*
- *Staff recruitment, capacity building of staff recruited (insufficient number in terms of quality and quantity)*
- *Fund research institutes*
- *Establish and sustenance of viable aquaculture technology transfer centres (ATTC)*
- *Adequate monitoring and evaluating of existing private and government farms*
- *Adequate certification and standardisation of farms to meet up with best management practices in order that the fish and fish products could be acceptable for consumption and exports*
- *Government should put in place standard hatcheries for development of broodstock, viable fingerlings in sufficient quantity*
- *Provide credits, grants, subsidies, loans etc"* – (P03).

"They should have done more, but because of land issues. We do not issue land to people, even the council has no land to do farming. Land brought so much confusion. People have misused the privileges that was given to the council, so it was taken away" – (P06).

4.1.6.2 Alternative feed development

Feed was identified as one of the major challenges faced by fish farmers, and this is because most quality feed is imported into the country, and very expensive for farmers. This often results in high cost of production and mostly leaving farmers with little or no return on their investments. Participants were unanimous in pointing out that there was the need for locally formulated feed using available ingredients in the community. The encouraging news is that participants indicated that efforts are being made in formulating feeds with local ingredients and hope that this will reduce the cost associated with feeding. The following quotes from respondents demonstrate these points:

"We encourage farmers, we provide them with the formula, and they can get all the materials from the local market (e.g., corn, soybeans, groundnut cake). Recently, our local technician has fabricated fish feed milling machine, including mixer and pelletiser. So, this gave us an opportunity to compound our own local feed. So, like I told you, we give them formula, e.g., we ask them to buy the quantity needed to arrive at a tonne or half a tonne as the case may be. Then we use this feed milling machine to grind them all together, passing through mixer to make sure is fully mixed before it will be subjected into pelleting machine. This method helps us to cut down buying finished feed at the rate of 50 percent. At the same time, there is a way we produce planktons for juveniles, when newly introduced into ponds" – (P02).

"Even though not sufficient, government and private farmers have fabricated feed production equipment and are already producing feeds using locally source materials, such as, guinea corn, rice bran, maize offal, blood meal, soya bean, groundnut cake, amongst other foodstuff" – (P03).

"Something will be done as fish farming is coming up. There are people who are going into fish feed production, we just have to encourage people. So, gradually, as fish farming is coming up, people are going into feed production" – (P06).

4.1.7 Challenges

Multiple challenges were identified in this study as impediments to the growth and sustainability of the aquaculture industry in the FCT in general. The most constraints highlighted included: youth training, technical knowledge, security, land acquisition, finance, feed, and basic infrastructure (roads, water, storage facility, market etc.). These factors highlighted are discussed in the following sections.

4.1.7.1 Youth training

An interviewee expressed the need to train up youths into fish farming. The respondent indicated that fish farmers were not able to employ professionals to advise them on best aquaculture management systems due to the high costs involved. Therefore, various NGO's have been involved in training unemployed youths with the view of empowering them to get into the aquaculture sector. This strategy has been working well for those youths who have embraced aquaculture. This has enabled many youths to come out of poverty and are food secured. Quote below according to the respondent:

"They cannot employ professionals to help, so they go around asking for advice from the professionals. Like I said, there was an NGO that came up with a programme to train youths into fish farming, that has been one of the best methods of alleviating poverty in the area" – (P02).

4.1.7.2 Technical knowledge

Lack of technical knowledge and expertise was highlighted as one of the concerns hindering the swift development of the sector. Three respondents (n=3) noted that the availability of qualified extension staff and professionals in the sector has resulted to low productivity in fish farming. Respondents all agreed that quality extension services and professionals play a significant role in supporting the development of the aquaculture sector in the FCT. The following as indicated in their quotes:

"Lack of expertise/technical knowledge" –(P01).

"A number of them are interested in the venture, but lack of technical knowhow, poverty and lack of awareness has hindered them from practicing fish farming" – (P02).

"Technical knowhow" – (P04).

4.1.7.3 Security

Security in the form of poaching and theft of fishes from the farm was identified as one of the constraints responsible for lack of adoption or low production of aquaculture in the catchment area. The interviewee posited that fish farmers have lost their livelihoods through lack of proper security to protect their property. Thus, security is a major problem that has affected the industry and deters potential investors from joining the sector.

4.1.7.4 Land

Interviewees (n=3) suggested that the competitive use of land in the FCT has created a shortage in land available for use in agriculture production. The respondents stressed that land resources in the study area is in short supply due to population growth, industrial development, urban migration, and the land tenure agreement. Therefore, making land very expensive for the poor farmer to

acquire. This constraint has been associated to the major setback in the performance of the industry as a viable economic potential for the population in that region. The following quote highlights this point:

"Land space for aquacultural practice cannot be gotten easily due to competitive usage of space especially in the urban areas, e.g., some farmers have lost their farms for people practicing recreational parks and housing, even though they are wet lands which should have been used for aquacultural practices" – (P03).

4.1.7.5 Finance

Inadequate finance was expressed by respondents (n=5) as a great concern amongst fish farmers or potential investors in the industry. Interviewees indicated that most of these farmers have no capital in the form of credits, loans, grants, or subsidies to facilitate their businesses, which has limited the growth of the sector in the region. Finance is vital in sustaining the aquaculture industry, which is relatively high to setup and maintain. They regarded finance as the greatest restricting factor affecting the intensification of the sector in the FCT, limiting farm size and operations, and consequently, the alleviation of poverty and hunger. Interviewees agreed that empowering fish farmers to acquire the required capital for their business will bring multiple benefits that includes improved livelihood, localised development, facilitate education, enhanced technical knowledge. Therefore, for these reasons, it is crucial to properly examine the aquaculture industry, to put in place substantial structures. Quote below from one participant:

"Well, like I told you, majority of these farmers are local people without capital, if they are to be empowered by the government or any NGO, of course it will boost fish farming in the country at large" – (P02).

4.1.7.6 Feed

Availability and access to high quality feed was expressed by respondents (n=3) as an impediment for the industry. These respondents were in consensus that feed was very expensive in the area, and sometimes scarce, so that farmers were having to travel faraway to acquire feed for operation. Further, interviewees

disclosed that lack of feed manufacturing industry in the area has created a shortage, and fish farmers have no choice, but to rely on expensive feed imported into the country. One interviewee indicated that due to the persistent challenge fish farmers were facing accessing feed in the locality, farmers stopped farming fish. On the contrary, respondents stated that there are raw materials in the study area that could cater for feed manufacturing industry and reduce the price of fish but was not utilised. For example, as expressed by two respondents:

"Lack of feeds (expensive), and they travel faraway to get feeds" –(P01).

"Feeds – a lot of famers have stopped fish farming because of cost of feeds" – (P05).

4.1.7.7 Basic infrastructure

Interviewees (n=2) highlighted absence of essential infrastructure such as roads and transportation, competitive markets, storage facilities and distribution, electricity, and water supply as a constrain to fish farming in the study area.

Respondents indicated that almost all the fish farms in the catchment area were situated in the rural areas and there were no good road networks for farmers to transport fish to the urban market where they could sell their product for better prices. Farmers liaise with their fellow fish farmers to harvest fish at the same time to share transport to the market, or process fresh fish by smoking, drying, salting, or fermenting on their farms, also done by buyers to extend the shelf life of the harvested fish and potentially allow part of the harvest to be sold later when prices for preserved fish may be higher. Farmers indicated that they incur at least 30 percent losses during transport to the market, as their commodities are transported by foot, bicycle, motorcycles, or motor vehicles, depending on the availability of transportation. Lack of competitive market and pricing for fish produce was identified as another impediment to the profitability associated with aquaculture. Participants stated that most of the marketing of fish was carried out by women, who purchase fish from fish farmers and sell to the public fresh or processed. The following quotes from a respondent:

"Competitive markets (sometimes low prices has forced farmers to sell at ridiculous prices, thereby, losing their investment)" – (P03).

"Market – even the two designated fish markets have been turned to general markets, and lack of uniform pricing" – (P03).

In relation to storage equipment and distribution of fish products, interviewees expressed concern that lack of proper storage facilities like cold rooms, refrigerators, and electricity was another bane of the industry's growth and development which affected the price and distribution of farm produce, thereby increasing spoilage of fish products. Fish farmers stated that when starting in the fish business would often lose 30-50 percentage of their harvest. Respondents indicated that for protein from fish to be available all through the year, farmers relied on processing to enable easier package, delivery, and marketing of their commodities. Furthermore, the study revealed that competition for water resources in the FCT was increasing the conflict between other users (crop and livestock farmers and herdsman) within the communities. In addition, climatic variations, and shocks such as intense rains and floods, and drought event causing immediate and future threat to productivity and retention of the aquaculture industry. Participants stated that they were concerned that climate change is causing water shortages or complete dryness in ponds during the dry seasons.

4.2 Discussion of Interview Results

The results presented in section 4.1 describe the key findings of the interviews conducted with policy makers to provide a clearer understanding of the factors and institutions that facilitate or prevent the development of aquaculture in the FCT. Responses collected in these interviews were used to compare between data collected during questionnaire survey to determine if the level of similarities were appropriate (Harris and Brown, 2010). This chapter explored a wide range of topics relevant to the aquaculture industry in the study area and provided rich contextual data on both the past and present issues hindering the growth of the sector, whilst debating on the potential of the industry if given the necessary attention. The discussion draws upon relevant literature to clarify and understand the key research findings in relation to the six identified themes in (Table 4:1).

4.2.1 Contribution of aquaculture

The study suggests that fish farming is serving the community in diverse ways, with a higher level of income for people who have adopted aquaculture activity. For example, Filipiski and Belton (2018) in their comparison of the full economic contributions of crop farms and fish farms in Myanmar, found that aquaculture produced higher overall incomes than agriculture, and generated a greater spill over into the economy. After recognising the benefits and potential of aquaculture, the government of Nigeria established programmes (Aquaculture and Inland Fishery Project (AIFP), Presidential Initiative on Aquaculture (PIA), etc) to create awareness of the importance of adopting aquaculture (Oluwemimo and Damilola, 2013). Key findings of the analysis indicated that small-scale aquaculture has improved food supply, employment, and income status of rural farmers in the FCT. Fish farming was recognised as having the potential to improve income of the very poor. These findings are synonymous with other developing countries in SSA and Asia, which reveals that fish farming even when practiced at a subsistence level, increases food production greatly (Thilsted *et al.*, 2016; Hasselberg *et al.*, 2020). Furthermore, research has shown that much of the food consumed in developing countries comes from small-scale farmers using low-cost cultivating technology appropriate to their resource base (Little, 2000; De and Pandey, 2014; Zmija *et al.*, 2020).

Other contributions highlighted by interviewees included viable fingerlings, subsidiary industries, provision of infrastructures, protein source, control of urban migration. In relation to viable fingerlings, participants expressed that due to the high demand and lack of sufficient fingerlings in the study area, farmers bought their fingerlings from neighbouring states for cultivation. The evidence that quality seed is key to aquaculture growth and development is also reaffirmed in a study conducted on giant gourami, a freshwater fish that plays a key role in the economy of Indonesia (Kristanto *et al.*, 2020). Kristanto *et al.* (2020) suggested that relying on old traditional techniques of spawning and breeding events had slowed the giant gourami reproduction prowess, which impacted on regular fingerling supply for production. This meant that fish farmers were not realising the full potential of their venture when they were using the old traditional method of reproduction. The role of modern breeding technique cannot be overemphasised. For

aquaculture to develop and meet its full potential, there is a need to improve its biological productivity through selective breeding technology (Gjedrem *et al.*, 2012). An increased usage of genetically improved species will enhance future production of farmed fish, shellfish, and seaweed. Therefore, participants expressed concerns over the availability of quality seed that yields good performance traits (efficient feed conversion, faster growth, high production) during culture.

Regarding subsidiary industries creation and provision of infrastructure, participants noted that aquaculture development has been responsible for the creation of other key industries such as fish processing and by-products sectors (fish oil, meal, skin, fins), and provision of vital infrastructure such as electricity, good roads, competitive markets which have boost the economy of rural areas. There is evidence that suggest that fish farming contributes directly and indirectly towards development (Kassam, 2013; Grealis *et al.*, 2017; Aung *et al.*, 2021). Increasing evidence suggest that people are indirectly earning a living through involvement in aquaculture related activities, including fish processing, distribution and marketing, boat building and engine repair (FAO, 2014; Monfort, 2015). In addition, the utilisation of land that would have been unsuitable for other agricultural purposes could be beneficial for recirculation systems thereby creating large potential for aquaculture production (Gjedrem *et al.*, 2012).

Furthermore, previous research indicates that access to basic infrastructure and services are essential to aquacultures prospects in Nigeria (Miller and Atanda, 2011; Adeoye *et al.*, 2012). Although participants expressed that due to aquaculture activities, some of these amenities were provided. However, respondents were of the view that the Government needed to do more to help them expand and stay in business for the foreseeable future. The farmers that were surveyed revealed that without adequate support, they were not able to meet the domestic demand of fish food supply and call on the government to give aquaculture the same attention given to other agricultural sectors. Although the government has enabled the establishment of a fish feed factory in Lagos, the distance between Lagos and the FCT is 718km, and with transport network problems, getting feeds to the area becomes expensive. The study area is also in need of fish feed factories. Similarly, a study conducted by some researchers in Kenya concluded that, small-scale fish farmers in that country encountered lack

of enabling government support which was a constraint for sustaining the fish farming sector in Kenya (Mbugua, 2008; Shitote *et al.*, 2012).

Fish as a vital source of cheaper protein cannot be overemphasised. The consumption of a variety of nutritious fish food has enriched the diets of many globally. Respondents in the catchment area acknowledged that poor fish farming households and the community at large benefited from diet rich protein available through aquaculture. The research findings indicated that fish directly benefitted the lower income section of the population than other sources of protein as it is the most accessible and cheapest source of protein available. These assumptions agree with findings expressed by Hasselberg *et al.* (2020) in a study conducted on fish consumption pattern in Ghana, and research findings by Belton *et al.* (2014) on the implication of food and nutrition security in Bangladesh.

4.2.2 Government support

Government support of any kind is necessary in the development and expansion of the aquaculture industry. Participants believed that if the FCT aquaculture sector is to reach its real potential and deliver expected socio-economic benefits, the government must place a greater attention and remove the obstacles to provide an enabling environment for investment. Although, the respondents commended efforts by the government for developing infrastructure such as hatcheries, fish markets, policies, and frameworks like the Transformation Agenda, On Station Research (OSR), On Farms Adaptive Research (OFAR), subsidies, and other support services to make aquaculture sustainable. However, respondents stated that most of these projects were abandoned after the government that initiated them left office. These supports the findings of a few authors (Anderson and Feder, 2004; Brummett *et al.*, 2008; Little *et al.*, 2012) who indicated that support directed towards building infrastructure, capacity building, training and extension services, and subsidy schemes provided to intensify aquaculture in SSA had failed to perform. A few authors (Beveridge *et al.*, 2010; Belton and Little, 2011; FAO, 2017) have pointed out that the failure of aquaculture development in Africa in comparison to Southeast Asia are as a result

of, different market conditions, development of infrastructure, government support, and entrepreneurial support towards delivery of products to market.

Furthermore, R&D has been essential in the increased use of modern technology for aquaculture. For example, Egypt is Africa's largest producer of farmed tilapia (Soliman and Yacout, 2016; Shaalan *et al.*, 2018). This rise in tilapia production has been attributed to significant expansion in the application of modern technologies such as production of male mono-sex fry, use of artificial feed and fertilisation, RAS, improved farm management practices (reduced stocking rates, improved water management, feeding, fertilisation). Furthermore, the prioritisation of the sector by the government, couple with a significant (99%) engagement by the private sector to satisfy the countries vision 2030 agenda (Dickson *et al.*, 2016; Soliman and Yacout, 2016; Shaalan *et al.*, 2018). The pressing question here is, why is the success in tilapia aquaculture in Egypt not occurring in other African countries as well, despite the enormous possibilities for aquaculture development on the continent (Hishamunda *et al.*, 2009).

In addition, this study pointed out that access to finance was a constraint to fish farming. The start-up capital required to finance a project is usually outside the reach of many small-scale fish farmers. The recurring purchases such as feed, fingerling, labour, transportation also presents a huge challenge. For example, majority of respondents indicated that the lack of sustainable funding inhibited fish farmers project expansion, thereby, threatening the promotion of food security in the FCT. Similar studies endorsed these findings that difficulty in obtaining financial support in West Bengal and Zimbabwe pushed small-scale farmers into borrowing money from informal sources with high interest consequences (Rahaman *et al.*, 2013; Shava and Gunhidzirai, 2017).

Likewise, credit plays a pivotal role in activating other factors of production and make under used capacities necessary for increased production (Izekor and Alufohai, 2010; Ndifon *et al.*, 2012; Odetola *et al.*, 2015). For instance, advances in agriculture in the Western world through innovations such as the agricultural treadmill and hybrid maize, the application of viable research and extension services, policy reforms, as well as direct capital investment in modern technologies have been responsible for transformation into conventional agriculture today. These applications have been critical for Europe and the USA in

feeding its citizenry (Roling, 2009), which would have been impossible without an established financial institution. However, this structure initiated in the western economies may not be applicable in developing world, so, calls for a more focus alternative to the developing regions.

4.2.3 Socio-economic impact

Fish production has impacted the local area positively in variety of ways according to interviewees. Respondents stated that the effect to the poor especially has been through the stimulation of the local economy, increased standard of living and nutrition intake, job creation and opportunities, higher farm productivity and income. These assumptions are evident in a few studies investigating the impacts of aquaculture on rural development and poverty, fish access and preferences among consumers, and human nutritional security and health (Irz *et al.*, 2007; Aiga *et al.*, 2009; El Mahdi *et al.*, 2015; Kassam and Dorward, 2017). Growing evidence suggest that aquaculture contributes directly as food for human consumption and as feed for livestock and fish production. In addition, people are directly employed on a full or part time basis in the value chain. Indirectly, it is also responsible for by-products, local marketing opportunities, increased purchasing power, reuse of pond sludge as fertiliser and water to irrigate the production of other food. Overall, aquaculture has the capability to reduce poverty while improving food security and nutritional well-being (Little *et al.*, 2012; Burns *et al.*, 2014; Filipski and Belton, 2018; Rashid *et al.*, 2019).

However, conditions differ in various parts of the FCT. For example, there is a reported high risk associated with small-scale aquaculture especially in rural dry land. Environmental shocks and pressures can also result to extension and retention in aquaculture (Tran *et al.*, 2013; FAO, 2016). There has been an increasing discourse regarding the complex role that aquaculture plays in household food security – be it negative or positive. However, the question is, who benefits? (Bene *et al.*, 2016). Understanding the assessment of food security calls for a multifaceted approach to fully measure the complex reality of insecurity within a community (Poppy *et al.*, 2014; Singh and Sharma, 2018).

4.2.4 External support

Over the past few decades, international donors have invested significant funds to promote aquaculture development in SSA. The active participation of donor agencies like USAID, JICA, FAO WorldFish, UK Government Department for International Development (DfID) has been beneficial in bringing advance aquaculture technology to expand the scope of small-scale aquaculture in the FCT with the view of alleviating poverty and enhancing food and nutritional security. However, interviewees expressed concerns in the anticipated impacts of donor project aquaculture production, monitoring, and sustainability in the area. They stated that projects initiated by international agencies were not performing as it should be. For example, they felt that the establishment of the Central Laboratory for Aquaculture Research (CLAR) in Egypt and the African Regional Aquaculture Centre (ARAC) in Nigeria, failed to produce positive or sustainable outcomes due to poor management (Olapade, 2020). This trend is replicated in other regions where donor support to promote small-scale aquaculture in rural development, livelihood enhancement, poverty reduction and food security has failed (Brummett *et al.*, 2008; Little *et al.*, 2012; Toufique and Belton, 2014). Common constraints identified by the authors as affecting aquaculture development in Africa include lack of quality feed and seed, limited access to investment, lack of competitive markets, limited technologies, and infrastructure, leading to marginal production or low retention rate of the industry.

4.2.5 Future of fish farming

Aquaculture development is experiencing growth in the region. Households, especially the poor, are benefiting from production and consumption of fish, income and wages, employment, generally boosting the rural economy of the study area. However, the study pointed out that the future of fish farming can only be guaranteed through market demand, public investment, regulations, training, and formulation of local feed to improve growth rates. Respondents argue that lack of investment and quality feed in the FCT has hampered their trade. These issues were considered as major constraints and needs a strong policy and

legislation which will promote investment as well as development of alternative feed industry in the country to attract growth in the sector.

The high costs of initial investment and inputs, as well as limited access to credit were an impediment to entry into the FCT aquaculture by investors. In addition, the quality feed imported into the country were very expensive for poor farmers. These results are consistent with other studies which emphasised that access to credit plays a vital role in developing a favourable condition for fish production (Olukunle, 2013; Okomoda, 2015; Satia, 2017). Similar difficulties of obtaining financial support from government was encountered by small-scale fish growers in West Bengal, where farmers were having to borrow money from informal sources (private money lenders, self-help groups) with high interest rates (Rahaman *et al.*, 2013). Although Satia (2017) stated that access to credit had improved in Nigeria since the creation of the 'Agricultural Credit Guarantee Scheme Fund' (ACGSF) in 1977 to cater for the agriculture industry. However, research shows that the fisheries and aquaculture sector is not given the same priority as that of other food production industries (Orok and Ayim, 2017; Oparinde *et al.*, 2017). Enough credit is needed to upscale aquaculture farming practices engaged by the fish farmers in the FCT, and Nigeria since huge capital is required to invest in the sector.

4.2.6 Challenges

Participants highlighted many barriers to aquaculture development in the FCT. Barriers to aquaculture development identified were youth training, technical knowledge, security, land shortage, access to finance, access to high quality feed, and basic infrastructure to drive the aquaculture industry in the region. Participants indicated that these barriers to sustainable aquaculture development have affected the industry's ability to meet the rising demand for fish food and the expected social and economic services of the community. These constraints associated with the aquaculture industry in the study area present significant challenges to retention and expansion of the sector, therefore, unable to attract new entrants (Adeoye *et al.*, 2012; Godfray, 2014; Oyase and Jemerigbe, 2016). Although respondents agreed that there was growth in the sector, still production

was low and not meeting the demand of the public. Nevertheless, it was observed that aquaculture has clearly demonstrated that it is an economically viable enterprise in Nigeria.

These barriers are synonymous with those identified in other developing countries and support current literature, which pinpoints failures in African aquaculture development because of the above-mentioned constraints. For example, Hall *et al.* (2011); Merino *et al.* (2012); Beveridge *et al.* (2013); and Molina *et al.* (2018) revealed the major constraints impeding aquaculture growth in Africa and Asia as: cost of resources and vital ecosystems services (feed, seed, space and capacity to disseminate and assimilate wastes), technical (selective breeding and genetics), social (access to market knowledge, conflict over resources, theft), economic (access to capital investment and profitability), environmental (destruction of ponds due to flooding, lack of water due to drought, high temperatures leading to fish die off or diseases) as well as suite governance issues (weak policy implementation, poor extension services). Boyd and Schmittou. (1999); Hossain *et al.* (2011); Godfray, (2014); Asiedu *et al.* (2017b), also suggest impact of climate change on future food production, negative effects of current food production methods on the environment, challenges from weeds, pests, diseases, and use of pesticides on ponds exploiting food sustainability and peoples' livelihoods. Absence of adequate infrastructure like roads, electricity, storage facilities, marketing and pricing, effective policies, efficient institutions, corruption among others was perceived by participants as negatively affecting the productivity of aquaculture.

4.2.7 Limitations of interviews of policy makers/government official

This is the first study in the FCT that explored the contribution of aquaculture to poverty alleviation and food security among the rural poor. Using qualitative structured and semi-structured interviews in this research enabled an in-depth exploration and understanding of the study under review in the region. Though seven participants were recruited from the policy makers during the interview process. The limitation here was the number of participants. However, after interviewing the seven participants, it became apparent that a saturation point

had been reached, as the responses from the said participants were similar in themes and views expressed. Thus, there was no need for further recruitment of government official. Conducting research in a culture where research is not common can be a challenge. Furthermore, getting to participants was not straightforward. There were times the researcher had to go through gatekeepers to get to the participants, and even when you get through to them with a date, there was no guarantee that the person will be available during the scheduled day and time. It therefore became time consuming to getting interviews.

Moreover, the coding and identification of themes within qualitative research is often completed by numerous authors to improve validity. However, given the nature of this study, the identification of codes and themes within the data was completed by one person with cross verifications from supervisors. To improve validity of data interpretation, extra time was taken to thoroughly identify recurrent themes in the data as well as appropriate quotations to support the presentation of results in order to minimise biases.

4.2.8 Conclusion

The aim of this chapter was to assess the contribution of aquaculture in the FCT through the analysis of policy makers perspectives. The objective was to identify the drivers, barriers, and future prospects of the sector. The review revealed that the FCT face major challenges in stimulating the development and expansion of fish production in the study area to cater for its growing population. The findings suggest that further promotion of the sector is necessary to increase local supplies of fish to boost the economy of the rural area, thereby, relieving pressure on wild fish resources. Although progress have been made over the years by the government to increase awareness and promote aquaculture. However, this study indicates that multiple constraints that still hinder the growth and sustainability of the industry include, limited access to credit, expensive feed and lack of quality seed, lack of input, land ownership, competitive markets, and environmental issues still persist.

To overcome these situations, more efforts is required from all stakeholders to enhance production to meet the national demand for fish supply. Furthermore,

the result suggested that the country should culture other species outside the two major (clarias and tilapia) ones already cultivated. This will help the sector to rise and adapt to meet changing and challenging conditions. Priority areas to improve the industry pinpointed were, more investment, awareness, research, private partnership, capacity building and training, support and empowerment for small-scale fish farmers who are the backbone of the sector.

Chapter 5: Aquaculture from the Farmers Perspective

5.1 Introduction

The findings in this chapter were obtained through a self-administered survey questionnaire among 98 fish farmers to quantify the key role aquaculture plays in the livelihoods of participants. The aim of this chapter was to investigate the following objectives:

1. To determine the present status of aquaculture development in FCT, clearly identifying positive impacts derived so far and challenges faced.
2. To conduct an economic assessment of aquaculture on the local economy of the FCT, clearly showing its role in addressing rural poverty.
3. To identify socio-economic and policy factors that affect aquaculture development and its impact on the rural poor.
4. To develop resources to aid rural farmers to make more informed decisions.

The researcher believes that the findings in this study will contribute to the current literature and provide a new and deeper understanding concerning the role of aquaculture in poverty alleviation and food security among the rural poor in the FCT. Quantitative data obtained during the survey was analysed using SPSS to enable statistical analysis. This enabled the author to establish the existence of associations or relationships between variables, make inferences from the population using mean, median, standard deviation, and range to arrive at a relevant result (Dellis *et al.*, 2014; Ali and Bhaskar, 2016). Therefore, as outlined in section 2.6, questionnaire was the most preferable method for collecting data about fish farmers in this chapter.

5.2 Questionnaire Result

5.2.1 Response rate

A total of 120 questionnaires were distributed, 98 were returned (81.7 % response rate). 56 responses were from fish farmers visited on their farms where they

completed questionnaires, 24 responses from workshop/seminar meetings organised by the AADP, and 18 fish farmers were contacted *via* telephone by the researcher. The sample size of 98 farmers was adequate to provide a deeper insight of the role of aquaculture in contributing to the livelihoods of small-scale fish farmers in the FCT.

5.2.2 Motivation and duration in fish farming

Most of the fish farmers (85%) venture into fish farming either as a means of livelihood (main source of income) or for business (alternative source of income). There was approximately even spread between farmers involved in fish farming for business or livelihood as shown in Figure 5:1. The remaining 15% went into fish farming out of a matter of interest (for leisure).

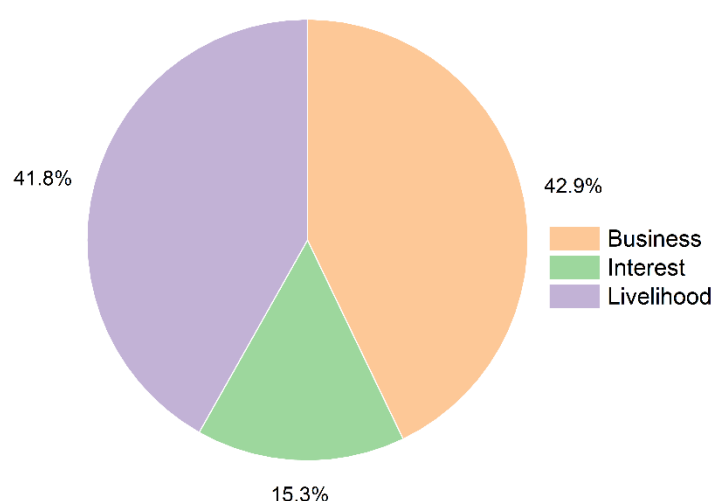


Figure 5:1 The motivation of engaging in fish farming spread across three major reasons which include for business, interest, and livelihood.

The distribution of years of being involved in fish farming span from 0.1 (about one month) to 29 years based on the survey, from which two, three, four, five and six years were the top five responses as shown in Figure 5:2, which accounted for 64% of the population studied, this implies that farmers were new in the industry (see 5.2.1). Those that have engaged in the fish farming for three years from the date of the survey had highest number which is 27% of the total response, which correlates to when government policy favoured fish farming.

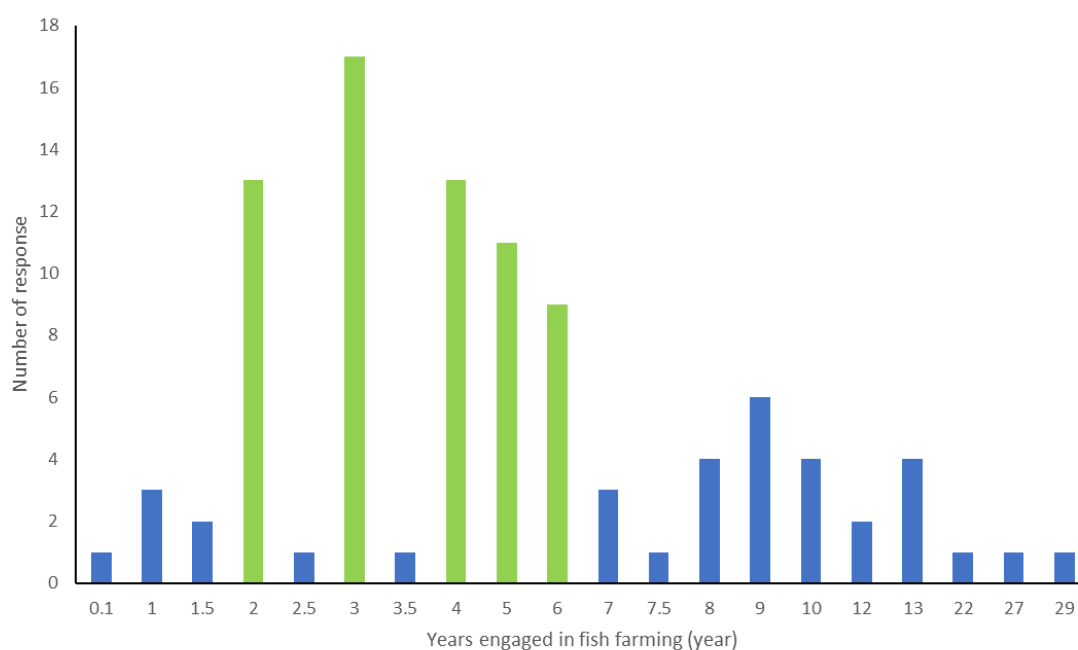


Figure 5:2 Distribution of years involved in fish farming among the farmers

5.2.3 Type of farming

The three types of fish farming considered were extensive, semi-intensive and intensive culture, from which 64 (65.3%) of the farmers were utilising the intensive culture system, 32 (32.7%) used semi-intensive method, while the remaining 2 (2%) exploited the extensive culture techniques, as presented in Table 5:1. The result of chi square test ($p < 0.05$; $p = 0.011$) indicates that there was a statistically significant association between the reason for fish farming and type of farming engaged. Farmers category determined the method used in raising fish.

Table 5:1 Type of farming method among the fish farmers

Reason for fish farming	Type of fish farming			Total
	Extensive culture	Semi-intensive culture	Intensive culture	
Business	0	11	31	42
Interest	2	5	8	15
Livelihood	0	16	25	41
Total	2	32	64	98

5.2.4 Species of fish farmed

The farmers primarily farm catfish or a mix of tilapia and catfish (Figure 5:3). It was observed that most farmers do not engage in farming only tilapia, but a large proportion prefer to farm either catfish or both catfish and tilapia. Catfish is the most preferred type of fish farmed across the three reasons for farming. Tilapia fish was not cultured amongst those that farmed fish for interest (Figure 5:4). The t-test revealed a p-value of 0.225 which implies rejecting the null hypothesis as such there was no statistically significant association between reason for fish farming and species type farmed. The choice of species to farm was totally independent of their reasons for engaging into fish farming (business, interest, livelihood).

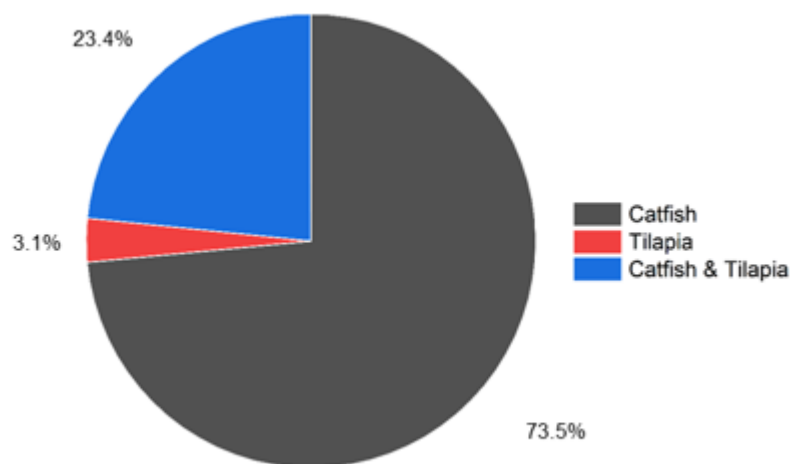


Figure 5:3 Distribution of type of fish farmed within the population studied.

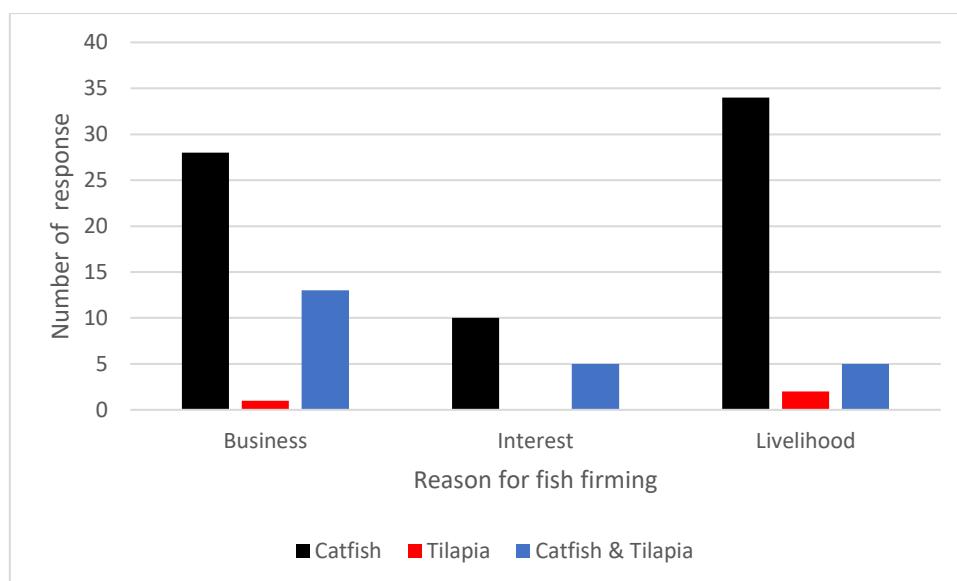


Figure 5:4 The type of fish considered for farming within the studied population.

5.2.5 Source of water for fish farming

Participants utilised different water sources available for production. Figure 5:5 shows that most farmers (31) utilised groundwater (well or borehole) for production, while 26 farmers indicated that their main source of water for production was from the river. While in (Figure 5:6), it was observed that some farmers were using two water sources to stock their ponds. Eighteen farmers noted that groundwater and mains have been their source for production, while 16 utilised river and groundwater.

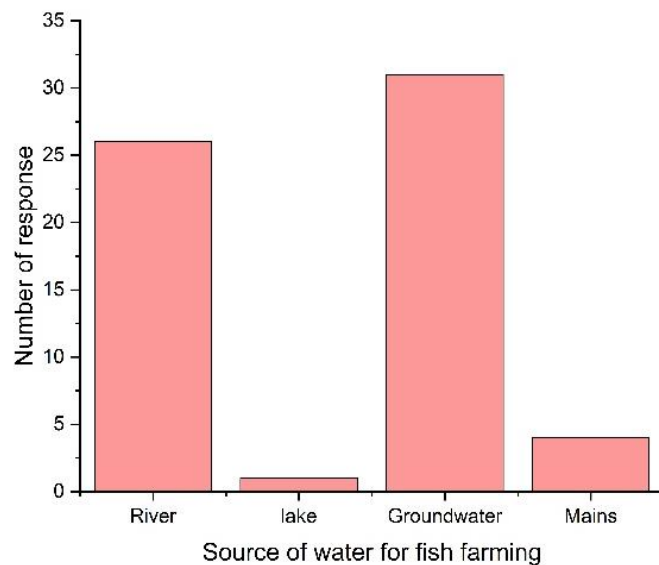


Figure 5:5 The basic source of water used for fish farming among the farmers.

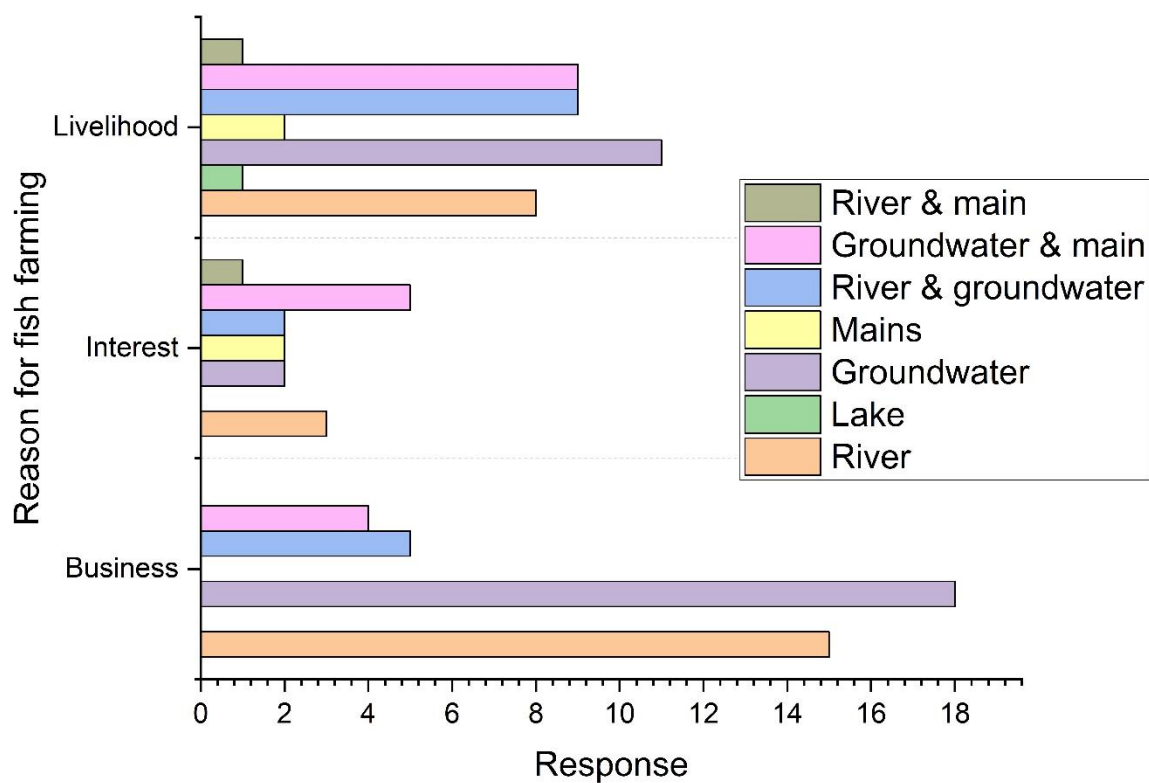


Figure 5:6 Sources of water used for fish farming as it relates to the reason for farming.

5.2.6 Land ownership for fish farming

Farmers preferred to use their personal land for fish farming with about 85% of farmers as shown in Figure 5:7. Since most of the farmer were indigene, they were using their ancestral lands while some of the non-indigene had bought the land for farming purpose. The percentage of farmers that uses government and rented land for fish farming were 10.2 and 5.1% of the population studied, respectively. Table 5:2 presents the type of land ownership as it relates to the motives of engaging in fish farming. Chi square test of ($p>0.05$; $p=0.703$) indicated that land ownership was not significantly associated with the reason for farming.

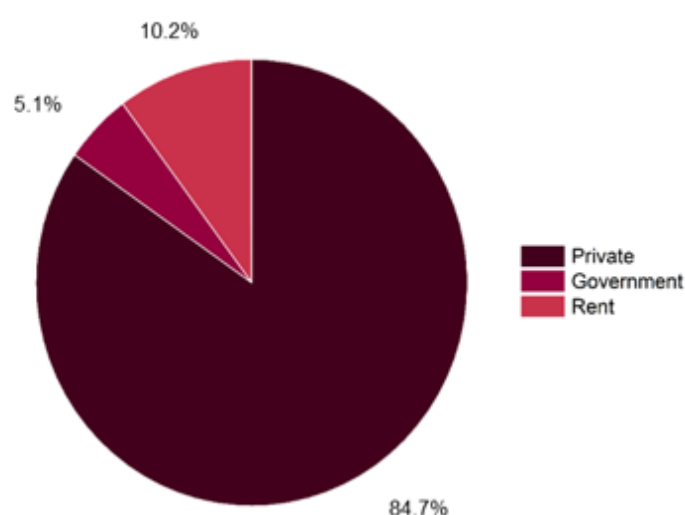


Figure 5:7 Land ownership employed for fish farming.

Table 5:2 Land ownership type for fish farmer

Reason for fish farming	Land ownership (%)		
	Private	Government	Rent
Business	88.0	5.0	7.0
Interest	73.0	7.0	20.0
Livelihood	85.0	5.0	10.0

5.2.7 Number of ponds used for fish farming

The number of ponds used by farmers ranges from 1-37 ponds of diverse sizes and shapes on their farms. Sixty-eight farmers owned between 2-6 ponds, of which majority were concrete ponds as presented in Table 5:3. The highest concentration of ponds was among those with 3 ponds for production. The mean number of ponds among the 98 participants that were surveyed was 5:6 ponds (SE =0.45; median = 4 ponds; SD= 4.48; range = 36 ponds).

Table 5:3 Number of ponds used during the fish farming

Number of ponds	Frequency	Percentage	Cumulative percentage
1	2	2.0	2.0
2	12	12.2	14.3
3	19	19.4	33.7
4	17	17.3	51.0
5	10	10.2	61.2
6	10	10.2	71.4
7	7	7.1	78.6
8	8	8.2	86.7
9	2	2.0	88.8
10	4	4.1	92.9
11	2	2.0	94.9
12	2	2.0	96.9
3	1	1.0	98.0
21	1	1.0	99.0
37	1	1.0	100.0
Total	98	100.0	

5.2.8 Average cycle time/number of harvest (catfish and tilapia)

The survey showed that the farmers had from two months to nine months of culture periods. Therefore, respondents harvested fish between one to six times per year depending on the culture system. The result revealed that most farmers had an average harvest of two and three times per year. This analysis will focus on these cohorts of farmers, as they represented almost 87 percent of the whole participants surveyed. The illustration of respondents that harvested catfish are presented in Table 5:4, and those that harvested tilapia. A mean for catfish farmers number of harvests times was 2.39 times, which means that the average period of harvest is about 5 months. (SE = 0.094; median = 2 times; SD = 0.92 times; range = 6 times) among respondents.

Table 5:4 Number of times for catfish and tilapia harvest per year

Reason for fish farming	Catfish harvest per year							Total
	0	1	2	3	4	5	6	
Business	1	2	24	10	3	1	1	42
Interest	0	0	8	6	0	1	0	15
Livelihood	3	0	23	14	1	0	0	41
Total	4	2	55	30	4	2	1	98
	Tilapia harvest per year							
	0	1	2	3	4	5	6	
Business	28	1	9	3	1	0	0	42
Interest	10	0	3	2	0	0	0	15
Livelihood	35	0	5	1	0	0	0	41
Total	73	1	17	6	1	0	0	98

5.2.9 Fish farming harvesting system (complete and partial)

Participants stated that they harvested their produce completely (all fish taken out) or partially (selected fish for sale) as shown in Figure 5:8 during their operation. Analysis of the test ($p > 0.05$; $p = 0.409$) showed no significant association between harvesting technique with reason for farming. Farmers decided and harvested their fish when they had reached table size.

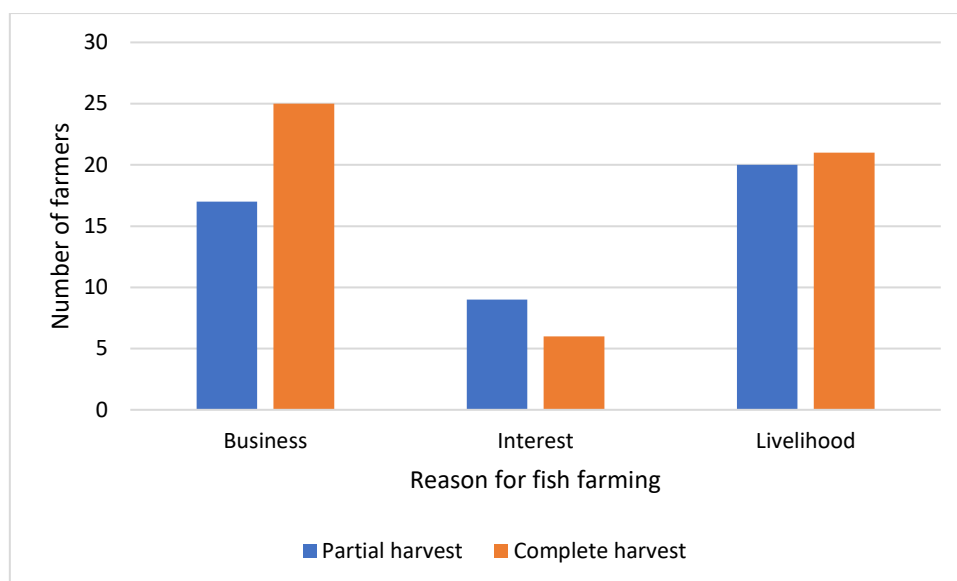


Figure 5:8 Nature of fish harvest among the fish farmers

5.2.10 Number of ponds harvested in past 12 months

Of the 98 participants who harvested their fish in the past 12 months, respondents had harvested fish from 1-17 ponds respectively, (Figure 5:9). Twenty-six farmers harvested from 2 ponds, while 20 harvested from 3 ponds. A mean of 3.96 ponds (SE = 0.23 ponds; median = 3 ponds; SD = 2.34 ponds; range = 17 ponds) were harvested across fish farmers in the 12 months before the study (5.2.2).

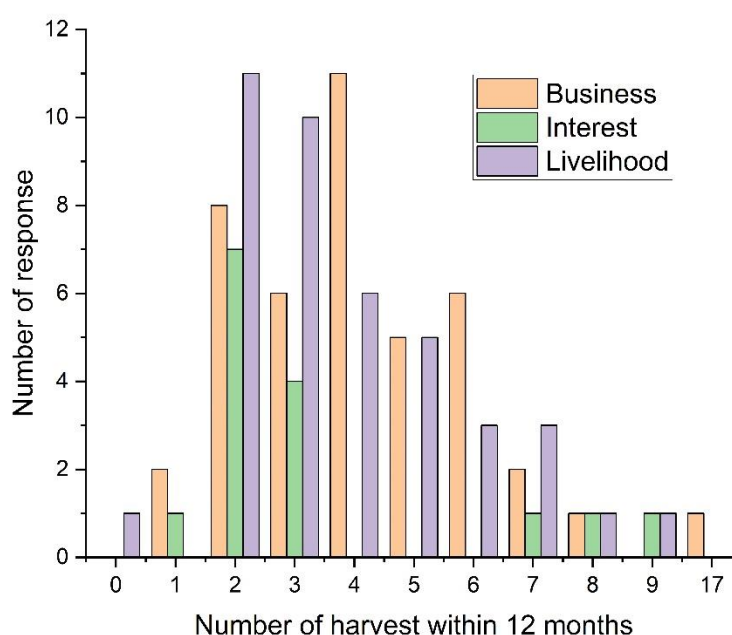


Figure 5:9 Relationship between reason for getting involved in fish farming and number of ponds harvested in the last 12 months

5.2.11 Relationship between fish farming and generated income

The analysis of fish farmers responses showed that most of farmers income was not in fish farming as presented in (Table 5:5). The chi square ($p < 0.05$; $p = 0.042$) revealed that the variables have a statistically significant association between reason for why farmers were in fish farming and income. However, the analysis indicated that farmers major source of income was not from aquaculture.

Table 5:5 Response from the studied population based on the question, if fish farming was their primary source of income.

Reason for engaging in fish farming	Is aquaculture the main source of income?	
	Yes	No
Business	8	34
Interest	7	8
Livelihood	17	24
Total	32	66

5.2.12 Main challenge being faced during fish farming

Respondents stated that they faced several issues that makes their operations immensely challenging. Some of the issues highlighted included lack of water, land, capital, and market. Due to the broad and diverse challenges highlighted by all respondents, the researcher decided to arrange them into five clusters for easy analysis. Therefore, the clusters were (i) Fish feed, (ii) Fingerling (fish seed), (iii) Selling, (iv) Environmental, such as climate variation related issues and (v) lack of infrastructure as presented in Table 5:6.

Table 5:6 Challenges faced by farmers during fish farming

Reason for fish farming	Main challenge faced during fish farming					
	I	II	III	IV	V	NA
Business	31	2	0	6	3	0
Interest	7	1	1	2	3	1
Livelihood	21	3	0	11	4	2
Total	59	6	1	19	10	3

I: Fish feed II: Fingerlings III: Selling IV: Environmental
V: Infrastructure NA: Not applicable

5.2.13 Workers employed in the last 12 months

The study revealed that respondents had hired between 0-6 workers either as full or part time basis during the year as seen in (Figure 5:10), which ascertain manpower engagement frequency. The distribution showed that the farmers that employed 1 or 2 workers in full and part time basis were the highest. A smaller proportion of respondent hired 5 and 6 people respectively in those 12 months. The mean for full time labour employed was 1.47 employees (SE = 0.12 staff; median = 1 staff; SD = 1.27 staff; range = 5 staff) among participants in 12 months. For part time workers, the mean was 2.10 staff (SE = 0.15 staff; median = 2 staff; SD = 1.52 staff; range = 6 staff) in the same period.

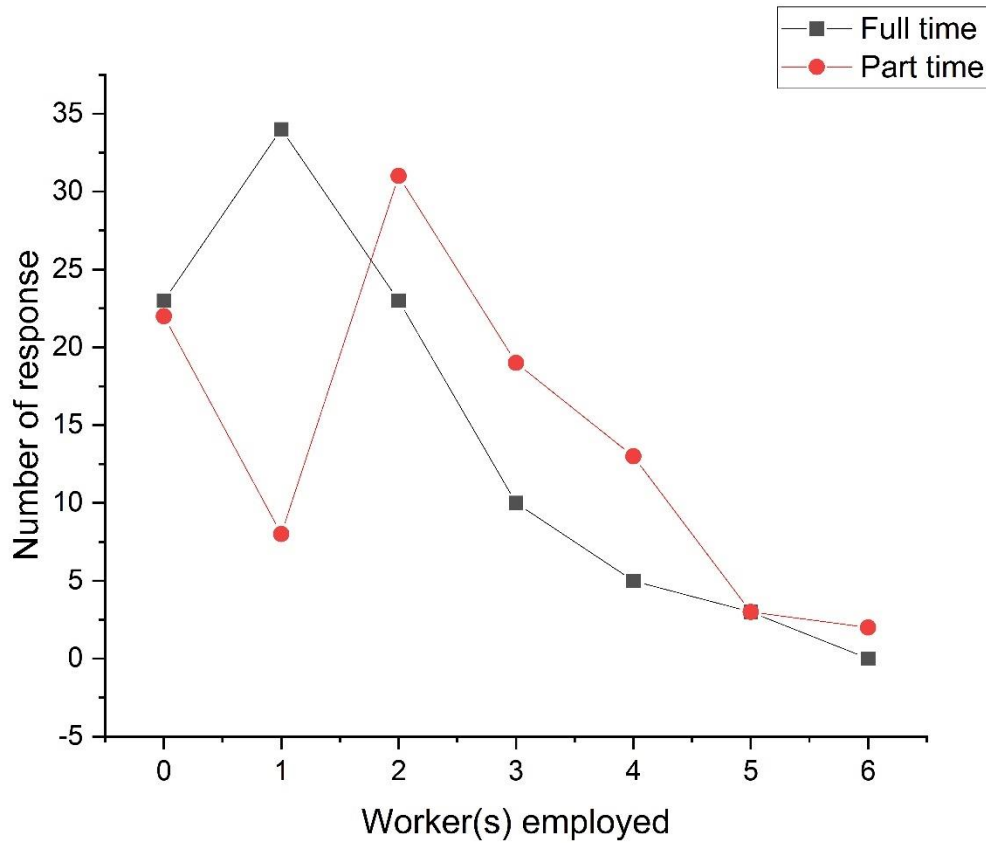


Figure 5:10 Full and part time workers employed within the last 12 months from the date of the survey.

5.2.14 Market availability for fish farmers

It was found that respondents sold their produce to a variety of customers, ranging from those who purchased their product to resell to others or for home consumption purposes (wholesalers, retailers, hotels, restaurants, consumers). Of the 98 fish farmers who sold fish, the most 38 sold directly to middlemen, followed by 11 selling to consumers. The overall pattern of sales is shown in (Figure 5:11).

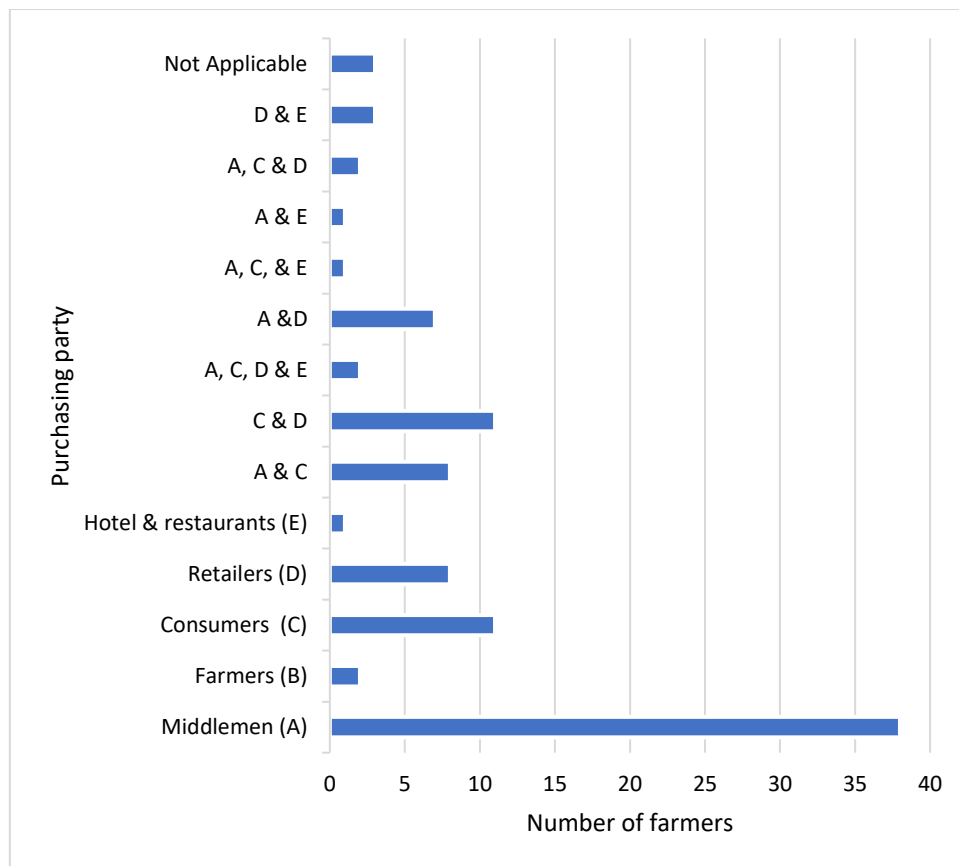


Figure 5:11 Market availability for the sale of fish produce

5.2.14.1 Value of farmers produce

Of the 98 respondents that sold fish, 53 indicated that they had no problem with pricing of their commodity, that is, the value buyers offered for the harvested fish and 45 asserted that their products were not accorded the appropriate value for money. Figure 5:12 shows the response from the population studied.

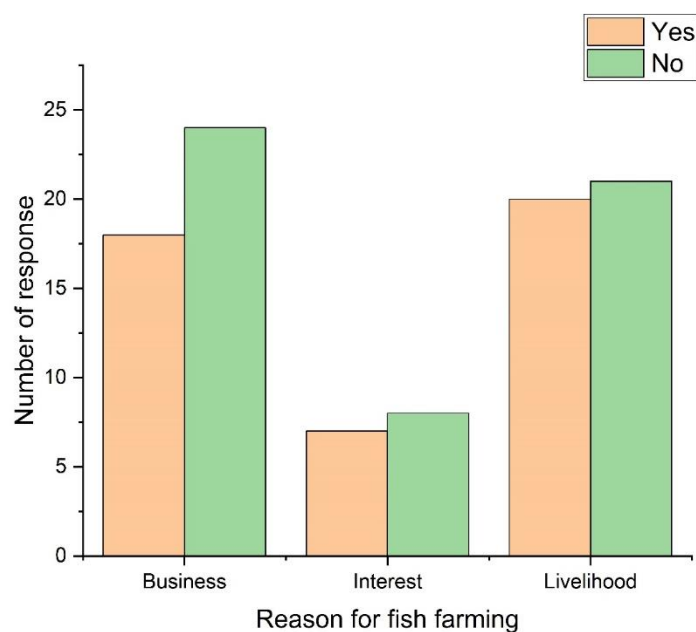


Figure 5:12 Distribution of data among the studied population based on the value farmers feel is accord to their farm produce, yes, for appropriate value and no for inappropriate value.

5.2.14.2 Delayed payment

The study shows that 78 farmers had no delayed payment in their business. However, 20 fish farmers revealed that their business has suffered from delayed payment of their produce as presented in (Table 5:7).

Table 5:7 Response from studied population based on their experience in terms of delayed payment of the purchase of their fish.

Reason for fish farming	Do you experience delayed payment	
	Yes	No
Business	10	32
Interest	2	13
Livelihood	8	33
Total	20	78

5.2.15 Obtaining support and information for the fish farmers

Fish farmers sources of support and information was varied in the study area. They indicated that beside the knowledge and skills they have acquired over the years in fish farming, they utilised other sources of support and information to remain and grow in their businesses. The sources of support and information mentioned were from; i) Government institution, ii) NGO's, iii) Books/journals, iv) Internet, v) Farmers, vi) Fish/feed sellers, and vii) Research institution/profession. Out of these seven sources, government institution obtained the highest score from 73 (74.5%), this was followed by NGO's that had 21 (21.4%). Farmers that obtained support and information from their fellow colleagues were 18 (18.4%), with fish/feed sellers coming fourth.

5.2.16 Availability of government support during start up

Of the 98 respondents, 46 indicated that they had received government support at the initial stage of their business operation. On the other hand, 52 farmers had not received any support as presented in Table 5:8. The support was in the form of training/technical knowledge, inputs, finance, and subsidies. The type of support received by the fish farmers were in acquiring extension staff to help in educating them on how to improve fish production using modern technologies, practical on farm assistance, giving invaluable information on farming operations.

Table 5:8 Government support during start-up of farm operation.

Reason for fish farming	Did you get government support during start up	
	Yes	No
Business	24	18
Interest	2	13
Livelihood	20	21
Total	46	52

5.2.17 Farmers future plans

Most of the respondents, 95 (97%) indicated that fish farming was an integral part of their livelihood and were going to expand their operation if provided a conducive environment as could be seen in Table 5:9. Fish farmers were of the view that some of the framework and institutions that enabled their continuous operation were lacking, and this has hampered their progress to remain in business or expand their venture.

Table 5:9 Fish farmers future plan of their farming operation.

Reason for fish farming	Possible future plan on the fish farming process		
	Expansion	Maintain status	Stop fish farming
Business	40	2	0
Interest	15	0	0
Livelihood	40	0	1
Total	95	2	1

5.2.18 Fish consumption in relation to family's diet and source of fish

Feedback from the 98 participants indicated that fish was a constant part of their diet. Respondents addressed this question in several ways because there was no restriction in responding to this question. For example, always, every day, once a week, regularly etc were some of the answers given by farmers. Therefore, the researcher decided to cluster them into three options (Always - daily, intermittent - 3-5 times in a week, and Occasionally - once in a while). Twenty-two (22.4%) participants indicated that their families eat fish always (almost daily), while 61 (62.2%) asserted that their families eat fish in an intermittent manner, with the remaining 15 (15.3%) expressing that their families consumed fish occasionally but would like to increase their fish intake if it were regularly available (Figure 5:13).

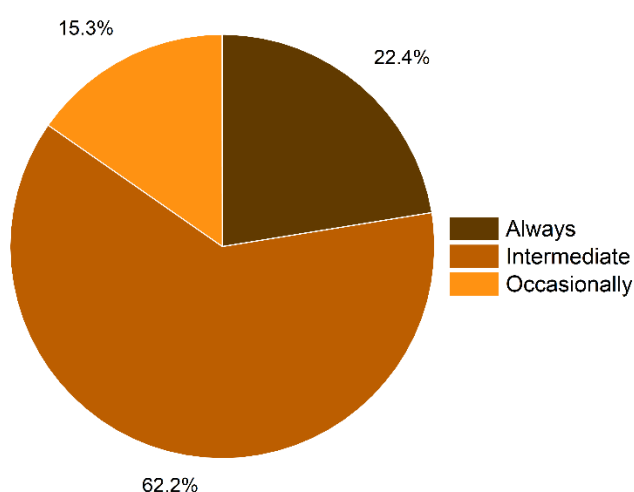


Figure 5:13 Frequency of fish consumption within the family

Of the 98 fish farmers surveyed, 58 (59.2%) agreed that fish provided their families a healthy balanced diet, while 36 (36.7%) asserted that it was their source of food protein as shown in (Figure 5:14).

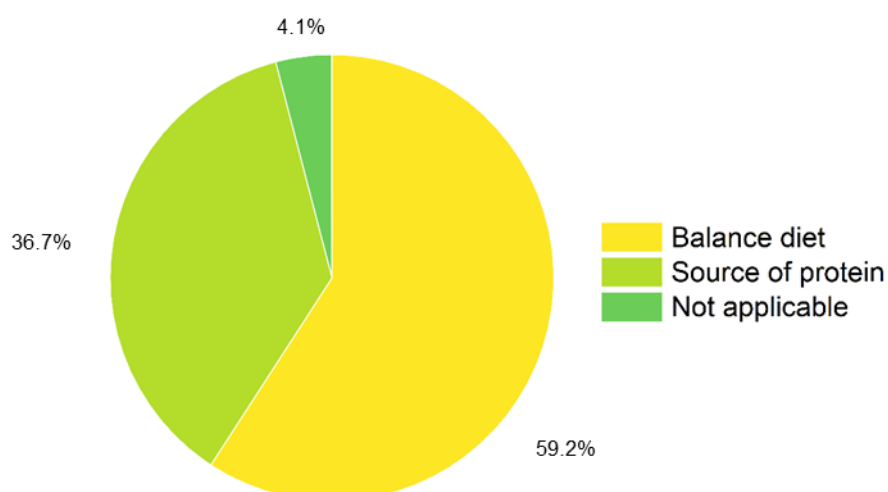


Figure 5:14 Impact of fish in family's diet

Almost 40 percent of farmers eat fish that they grew in their own farms, with nearly 60 percent getting fish from other sources for consumption. When asked, farmers stated that they never had enough from their own farms, or wanted other varieties that they did not grow themselves (Figure 5:15).

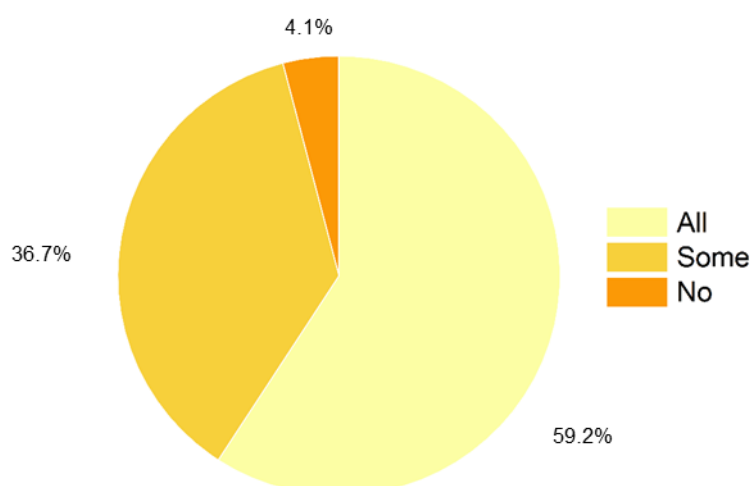


Figure 5:15 The source of fish consumed by family

These analyses were conducted to ascertain whether fish farming was making any difference in the livelihoods of the rural poor residing in the FCT, Abuja. These

findings are vital as they reveal where support is needed the most for further aquaculture development.

5.3 Discussions

The aim of this chapter was to examine and present a thorough view on the present development and contributions of aquaculture to poverty and food security in the FCT. The study in its quest to understand the constraints, motivations, and prospects of fish farming, surveyed 98 farmers currently involved in fish farming in the study area. Key findings of the analysis in 5.1 provided rich contextual evidence that supported and expanded upon existing knowledge on fish farming sustainability globally. The opinion that fish farming has the potential to impact on poverty and meet the expanding demand for food and nutritional security, informed the decision to undertake this investigation.

The quantitative method used in this chapter was useful in gaining access to a variety of fish farmers to ascertain information. This approach is being increasingly used in aquaculture research to explore the impact that it may have on the economic wellbeing of practitioners and the community that play host to it (Janssen *et al.*, 2017; Wuyep and Rampedi, 2018; Khondker *et al.*, 2018). These results have provided an understanding of the future of fish farming and highlighted the challenges and needs of the industry in the FCT, and Nigeria as a whole.

5.3.1 Summary and background of fish farmers

The investigation showed that 79 respondents (80.6 percent) managed their own farms, with 19 (19.4 percent) individuals employed as labourer/caretaker supplying labour for owners. In addition, the majority of farms hired both full-time and part-time workers alongside the main managers to help with farm operations. These findings clearly demonstrate the commitment of the participants to small-scale fish farming, and how important the activity is to farmers livelihood. Over 60 percent of farmers had half a year to six years of fish farming experience between them. This implies that most of the farmers were new in the industry and

may lack the experience, knowledge, and skills necessary for increased production levels (Aphunu and Nwabeze, 2012). Furthermore, the analysis revealed that 64 (65.3%) farmers were utilising the intensive culture system, 32 (32.7%) used semi-intensive method, while the remaining 2 (2%) exploited the extensive. These findings suggest that aquaculture has the potential to improve and generate higher income for the local economy if properly developed (Filipski and Belton, 2018). Intensification of aquaculture is categorised by heavy inputs in the form of high stocking density, nutritive pelleted feeds and fertilization, and the adoption of improved pond management practices, all resulting in high output (Carballo *et al.*, 2008; Edwards, 2015). However, the negative impact of this production method is labour intensive, requires high inputs of feed, and management (Little *et al.*, 2018; Oddsson, 2020). These results indicated that the aquaculture sector in the study area is moving from a low-input culture to more intensive and commercialised farming.

The various culture systems used to raise fish were earthen ponds, concrete tanks, fibreglass tank, plastic containers etc. (Iruo *et al.*, 2018). The culture type in the catchment area was single (monoculture) or multiple (polyculture) of fish species. The majority 74 (73.5%) of fish farmers were involved in the production of catfish (monoculture), with only 3 (3%) out of respondents farming tilapia. Of the 98 respondent that were included in this study, only 23 (23.4%) exploited the polyculture method. These findings revealed that majority of the fish farmers in the region were not utilising the polyculture technology which has the advantage of controlling prolific breeding, thus improving growth rate and production returns.

The method leads to a better yield by maximising all levels of the food chain compared with monoculture (Shoko *et al.*, 2016). Lutz (2007) is of the view that polyculture technology has greater potential to improve the utilisation of inputs and capacity. It is achieved by maximising the crop in the pond through the increased use of the wider range of available foods and pond depths. Culturing tilapia and catfish together goes the extra mile by seeking to capture synergies such as utilising waste products from one species to support production of the other(s) (Lutz, 2007) directly or indirectly. However, the author stated that determining and maintaining a proper balance of species requires finesse and forethought.

In addition to the above findings, the dominance of catfish culture in the study area is seen to be in line with findings by Oladejo (2010) and Adeyemo *et al.* (2018) that stated that catfish is widely accepted by Nigerians. Adewumi and Olaleye (2010) also indicated that catfish became the favoured species choice of farmers since the introduction of the hypophysation culture method in 1973. Nonetheless, when farmers were asked to comment on the reasons why they did not culture tilapia as they did catfish, farmers indicated that catfish were the most popular fish in the market, more resistance to stress, acceptable for a variety of food items and they had received more training and support for raising catfish. Farmers were of the view that deliberate effort to encourage tilapia farming has not been made, as of that enjoyed by catfish farming. These comments are consistent with Atanda and Fagbenro (2017) findings on the social and economic performance of tilapia farming in Nigeria. These results indicated that the study area (FCT) was not utilising the climatic condition, available water resources, and other potential ideal for tilapia farming. These challenges and constraints would need to be addressed and overcome for the FCT to fully exploit its potential in aquaculture in general, and tilapia farming in particular. Increasing public awareness and the political will for aquaculture development will present an excellent opportunity for the sector to grow.

Ninety nine percent (99%) of farms engaged in polysex culture techniques. When asked why they did not develop the monosex technology to enhance growth and maximise profit. Farmers stated that they lack the knowledge or skills to operate monosex system. This assertion demonstrated that farmers were not equipped enough to take advantage of the productivity gains in monosex culture (Dutney *et al.*, 2017; Molina *et al.*, 2018). Research has shown that species such as tilapia, salmon, seabass, seabream etc. have used sex reversal technology for production. This has resulted in increased productivity, leading to a cost-effective aquaculture resulting in significant progress in the industry (McAndrew and Napier, 2011; Gopakumar, 2015). Hence, genetic improvement has been a powerful and least expensive means of increasing the efficiency of aquaculture. Other reported genetic improvements technology includes gene transfer, selective breeding, chromosome manipulations, etc. (Ansah *et al.*, 2014).

Access to freshwater supply is one of the most important resources required for fish farming. Participants utilised different sources of water available for

production, with some farmers using two water sources to stock their ponds (figure 5.6) (Ahmed and Flaherty, 2013). Farmers acknowledged that water was checked regularly to replace water loss from seepage or evaporation, particularly during the dry seasons to maintain a depth of 1.0m (Lin *et al.*, 2001; Brummett *et al.*, 2008). Concerns about competition for water between other users was brought to the fore. Bello, 2013; Bello and Abdullahi, 2021 stated that until recently, farmers coexisted with herdsman, however, now they are witnessing growing conflict, which has resulted in damages caused by both herdsman and farmers, impacting people's livelihood. Bello and Abdullahi (2021) further indicated that cattle rustling, and banditry activities is a menace in the country at large. Rapid growth in aquaculture globally has increased stress on water usage, affecting the ability for human to produce food for the growing population (Troell *et al.*, 2014b). Shortages in freshwater availability resulting from human exploitation and climate change in many regions of the world pose a further threat to aquaculture production (Ahmed *et al.*, 2018). Still, Ahmed *et al.* (2018) argued that the direct consumption of freshwater by aquaculture in comparison to other terrestrial animals is minimal. The adaptability and relative resilience of the species raised in aquaculture have been touted as having the capacity to respond to increasing temperatures as well as other effects of climate change than other forms of agriculture. Therefore, it is often seen as a good alternative source of livelihoods and nutrition for many especially in the developing world.

Land is the most important aspect of production input in aquaculture. Successful aquaculture is dependent on the use of a suitable site (Phillip *et al.*, 2009; Miller and Atanda, 2011). However, the supply of land for fish farming practices is limited due to the explosive population growth in the study area. Farmers indicated that land for fish culture in the study environment was one of the issues they were having to deal with. The mode of land acquisition amongst the locals is mostly through traditional inheritance, and for others, it is by outright purchase or issuance of certificate of occupancy by the government. But land ownership amongst the indigenes of the FCT especially is becoming a big issue, with many farmers facing restrictions on ownership, mobility, future access, and security (Ugwumba and Chukwuji, 2010; Adewumi, 2015).

Land that was formally used for agriculture has been adapted for non-agricultural uses. This has resulted in fierce competition for land among users with the highest

bidders always coming from ventures other than agriculture that yields more profit than farming (Sroka *et al.*, 2018). For example, increasing urbanisation in the FCT has brought about extensive pattern of development, therefore, fertile agricultural lands have quickly disappeared to other uses for city expansion (Etim and Dukiya, 2013). In addition, Sroka *et al.* (2018) concur with the above when they argued that arable lands in most developing countries are disappearing fast. This assertion is in support with the UN prediction, that by 2050 the global population will reach 10.7 billion (UN, 2019b), and most of this growth will occur within the cities of developing nations, with an estimate of 68 percent of the world population living in urban areas (UN, 2019a). These situations have had an economic implication for the poor, being that most of them are farmers and cannot afford alternative farmlands, therefore, lack resources to becoming self-sufficient. Therefore, providing humans with food of nutritional value is becoming a serious problem (Phillip *et al.*, 2009; Miller and Atanda, 2011).

5.3.2 Production output characteristics

Different types and sizes of pond were utilised by respondents for rearing of fish. Fish were raised in concrete tanks, earthen ponds, plastic containers, fibreglass tank etc. (Iruo *et al.*, 2018). Concrete tanks were the most popular method for fish production in the study area. Respondents indicated that this method has the benefit of utilising less space, higher cost-effective feeding ratio (less wastage), great survival rates, higher stocking densities, as well as time for management of farm (Huntingford *et al.*, 2012; Boyd and McNevin, 2015). This method is predominantly practiced amongst government civil servants, unemployed, retirees and other professionals in urban or peri-urban settlements. These findings coincided with results obtained by Miller and Atanda (2011) and Olaoye *et al.* (2014) in their studies on increased productivity and profitability of aquaculture in urban and peri-urban areas. Fish farmers are seen to adopt the homestead fishpond method, fitted with recirculatory system for fish production which requires a minimum of space to conduct their activities (Sylvanus and Gao, 2007).

The findings in this study indicated that, fish farmers operating cycle were varied depending on the species farmed, type and how feeding was conducted, and the

level of intensification of technology. Most farmers adopted intensive technology which encourages higher production output (Huntingford *et al.*, 2012; Boyd and McNevin, 2015). This is in line with the study conducted by Dickson *et al.* (2016), who suggested that the adoption of modern technologies improves over-all fish farm performance which also results in additional environmental benefits through improved feeding efficiencies. Stocking density amongst farmers was 2-3 fish/m², with supplementary feeding and fertilization to increase production and maximise yield (El Naggar *et al.*, 2008). Stocking density has been identified as one of the most important parameters that influence fish growth and health (M'balaka *et al.*, 2012). M'balaka *et al.* (2012) emphasised that high stocking density can have an adverse effect on growth performance and survival rate through competition for food. Initial fertilization to pond stimulates the growth of microscopic plants that is the base of the food web, which results in increase production. This is consistent with the findings by El-Naggar *et al.* (2010) (referenced by Dickson *et al.*, 2016) who observed that pond fertilization is a technique for increasing pond production by providing high quality food at minimal cost.

Harvesting of fish was performed either completely (complete) or by selective (partial) procedure when fish had reached a mature size or market size (Lin *et al.*, 2001; Brummett, 2002). The survey revealed that participants (98) had harvested their products between 1 – 6 times (catfish farmers 1-6, tilapia farmers 1-4) annually. However, the most was among farmers who harvested their fish 2-3 times. From the 85 farmers who farmed catfish, 55 (65%) harvested their fish twice in a year, while 30 (35%) had harvested three times, stocking density among farmers was 2-3 fish/m². Less frequent harvesting allowed the growth of larger fish with the average weight of 2 to 2.5kg from two harvests a year, dropping to between 1.3 and 1.5kg when there were three harvests. This corroborates the study by Onyekuru *et al.* (2019) who observed a similar weight in their case study on catfish production.

Of the 23 respondents farming tilapia, 17 (74%) harvested fish twice, with only 6 (26%) harvesting three times in twelve months. All respondents who had farmed for over one year had harvested their fish at least once in a year. Harvest was highest amongst respondents with 2-6 number of ponds, these accounted for nearly 70 percent of fish produced. Planning and management are necessary in all spheres of life, and it becomes even more important in the aquaculture industry

where inadequate temperatures and unfavourable periods etc. can affect production (Tidwell, 2012; Costa *et al.*, 2017). To obtain better growth rate and greater control over production in every pond, farmers indicated that ponds were stocked at different phases to enable them to consistently offer their customers with fish product all year round. Production cycle ranged from 2 to 9 months among fish farmers depending on their production system and species farmed.

Those catfish farmers who harvested between 5 and 6 times were involved in hatchery and nurseries production. The hatchery included facilities such as water storage tanks, breeding tanks, incubators for hatching eggs etc. Hatched eggs (fry) were kept in the hatchery for 3-5 days before transferring into nursery tanks to grow into juvenile. Some farmers indicated that they sold their fish at the fingerling stage, whilst others allowed them to grow and become juveniles. Juveniles were kept for 4-6 weeks before they were sold to grow-out farmers who stock them to reach market size in ponds. The few tilapia farmers that the author interacted with indicated that they got their fingerlings from either government owned hatchery or few private farms. However, due to time constraint, the researcher could not visit those hatchery farms to ascertain the validity of the assertions made by the farmers.

Farmers had various sizes of ponds for juvenile and adult fish breeding. Main types of ponds utilised in the study area were concrete and earthen ponds (Quintero *et al.*, 2019), with few farmers using plastic containers or fiberglass at their backyard, due to lack of access to land for fish production. Ponds were rectangular or square in shape, and their sizes and depth were dependent on the requirement of fish to be stocked and methods of harvest (Huntingford *et al.*, 2012; Boyd and McNevin, 2015). The sizes of ponds that existed varied from 100 to 1,000m². Most ponds (earthen and concrete) were built in connected series of 6 to 10 or more ponds or tanks with walls or dykes to reduce construction costs, concrete ponds were relatively smaller in sizes.

Most farmers had ponds dedicated to treating diseased fish or keeping of fish (quarantine) brought from other farms before introducing to their stock, to check that they were free from any infections or parasites that could wipe out their existing stock. Participants stated that their experience in parasites and disease outbreak that wiped out all their stock in the past had played a key role in their

decision not to introduce new stock straight away when brought to the farm. This assertion coincides with several studies of infestation of parasites and diseases outbreaks in freshwater fishes and the negative impact on fish production, resulting in economic losses (Kent *et al.*, 2009; Menaga and Fitzsimmons, 2017). Infectious diseases and pathogens pose some of the greatest threats and causes damaging impacts on the livelihood of farmers in terms of losses in production, reduced income, employment, market access or share, investment and consumer confidence, food insecurity and failure or closure of the industry (Idowu *et al.*, 2017; Assefa and Abunna, 2018). Large scale of fish mortality often occurs due to a variety of environmental or biological factors and management practices in farmed fish. Factors influencing disease outbreaks include inappropriate stocking density, nutritional deficiency, low water quality and low temperatures etc. (Tavares-Dias and Martins, 2017). However, a healthy fish stock could be achieved by maintaining and keeping good health management practices between fish and their culture environment (Hossain *et al.*, 2011; Assefa and Abunna, 2018). It is imperative to investigate the causes of disease and prevent it before it occurs.

More than 90 percent of farms cultured nursery (fingerling) and adult (market size) fishes less than 10 percent had spawning (hatchery) facilities and brood stock for breeding purposes. Farmers indicated that, lack of access to training and experience in fish hatchery management and fingerling production has resulted to several factors such as shortage in seed supply, low or inconsistent quality, inadequate brood stock management practices, stress during nursing and transport, disease control, high cost of hatchery inputs and equipment etc. Respondents were of the view that they were not provided with useful tools in their business of fish seed production, and this has had a profound influence on their productivity and economic returns. The study highlighted the importance of quality fish seed in aquaculture propagation. Similar research(s) confirmed that quality fish seed are responsible for aquaculture expansion. For example, Bosma *et al.*, (2011) argued that the growth in hatcheries and nurseries in developing countries accounted for the development of intensive aquaculture. Furthermore, Rashid *et al.* (2009) indicated that induced breeding of carp has been successful through the establishment of hatchery production technologies. Additionally, MacNiven and Little (2001) suggested that poor quality seed was recognised as a

constraint on the growth of freshwater fish culture. Therefore, the importance of high-quality fish seed in aquaculture enterprise cannot be overemphasised.

5.3.3 Fish farmers income/economic characteristics of fish farmers

Farmers indicated that fish farming was a viable source of income in the rural area. Of the 98 farmers surveyed, 32 (33%) noted that aquaculture was their major source of income. Of those 32 fish farmers who stated that aquaculture was their major source of livelihood, 18 (56%) had earned between 60-100 percent of their income from producing fish. Aquaculture has been identified as an alternative means of livelihood, as it addresses poverty levels and under-nutrition in some of the poor communities located in developing regions (Kudi *et al.*, 2008; Gupta, 2010). Involving small-scale fish farming is part of a diversified livelihood strategy (Little *et al.*, 2016; Wuyep and Rampedi, 2018). Further, the role played by small-scale fish farming towards sustaining livelihoods has been well documented. For instance, the FAO reported that aquaculture sustained the livelihoods of more than 58.5 million people in 2020 as full or part-time workers. The study also found that at least 600 million people partially depended on the industry for their livelihoods (FAO, 2022). Further, increasing national demand for fish from the expanding population and inadequate supplies in Nigeria, has given a rise to the sectors development (Wuyep and Rampedi, 2018). Additionally, small-scale, and freshwater aquaculture have been recognised as imperative in contributing to the supply of healthy and affordable animal protein. Little *et al.* (2016) identified the major drivers of growth in aquaculture as growing middle level earners, consumption pattern and technological innovations. However, despite decades of research and development in the aquaculture industry, Africa has failed to reach its full potential. The sector has marginal production in SSA and unable to support the rising demand for protein rich food for its growing population (Edwards, 2015; Bene *et al.*, 2016). Nevertheless, given acknowledged nutritional benefits of fish and other aquatic products, the sector is sure to play an increasingly vital role in the supply of healthy diets and livelihoods for millions of people, while alleviating pressure on wild stocks.

5.3.4 Challenges and constraints

There are significant constraints in the aquaculture industry which make meeting rising demand for food fish, whilst meeting societal expectation and economic development challenging. Respondents faced a diverse range of issues that affected the sustainability of their business. Major challenges included infrastructure (water, land, input etc), lack of financial support, climate change, institutional policies, among others. These were arranged into five major clusters for easy analysis (Table 5:6).

5.3.4.1 Fish feed

The majority of respondents 59 (60%) expressed that lack of local quality feed or high cost of imported fish feed was the number one problem in their operation. Participants acknowledged that between 50-70 percent of their production costs was on feed. Farmers stated that there was no feed manufacturing industry in the area to serve the local fish farmers with affordable quality cheap feed. So, the industry is faced with irregular or shortage supplies of feed. Quality feed available in the study area is imported into the country or brought from other parts of the country. This makes feed very expensive, limiting farmers ability to intensify production and forcing some farmers out of fish farming venture, with significant economic implications. Studies have suggested that fish feed cost account for more than 60 percent of production cost in aquaculture (Aya, 2017). The lack of quality fish feed production has thwarted the success of fish production in the aquaculture industry (Ozigbo *et al.*, 2014; Aya, 2017; Rattanaphot *et al.*, 2018). Feeding farmed fish and other aquatic animals with products that are high in nutrients, and at the same time, economically and environmentally sustainable has become a major concern for the industry (Wong *et al.*, 2020). The drawback for freshwater aquaculture is the potential competition for fishmeal and fish oil as feed with other terrestrial farming (Rana and Hasan, 2009; Thobaiti *et al.*, 2018). Aquaculture production is totally dependent upon the provision and supply of high nutrient value inputs such as land, freshwater, feed etc. (Little *et al.*, 2016). The use of a great variety of ingredients such as wild fish stocks, fish oil and natural/cultivated invertebrate food organisms for feed production has been

criticised as having huge environmental consequences (Ytrestoyl *et al.*, 2015). This increasing use of commercial concentrated feeds and feed ingredients for production in intensive aquaculture systems has been associated with aquaculture's feeding regime, and this is suggested to pose a serious environmental and socio-economic problems (Wong *et al.*, 2020; Naylor *et al.*, 2021).

However, due to high concerns in marine resource used as a component base for feeds, aquafeed manufacturers are seeking for better sustainable ingredients derived from plants and insects for future aquafeed production (Brinker and Reiter, 2011; Belghit *et al.*, 2018). Reported main dietary fish meal and fish oil inclusion levels within aquafeed production have been decreasing gradually (Tacon and Metian, 2008; Bendiksen *et al.*, 2011). In addition, Bendiksen *et al.* (2011) indicated that, there has been reduced pressure on direct harvest of wild fish by replacing it completely with marine by-products (intestine, heads, bones, tail etc.). This helps in expanding the global supply of feed ingredients, which is desperately needed for aquaculture to grow and meet its potential. Aquaculture has benefited immensely from being recognised as a key component in improving environmental and economic efficiency, as well as food sufficiency (Stevens *et al.*, 2018; Mo *et al.*, 2018). The development of quality fish feed and its availability especially in Africa cannot be overemphasised, as research has shown that over 200 million people eat fish regularly (Ansah *et al.*, 2014; Tran *et al.*, 2019).

5.3.4.2 Fingerling

The availability of adequate hatchery for fish seed propagation is a significant factor in sustaining and realising a profitable fish farming venture (Gjedrem *et al.*, 2012; Kristanto *et al.*, 2020). However, this has not been the case in many regions of the country, as they lack functional fish hatcheries where fingerlings or juvenile fish can be purchased to stock ponds. So, the second most singularly pressing issue highlighted was the availability of quality fingerling (fish seed) for production. Participants stated that they farmed mostly catfish because they had difficulty accessing fingerling for tilapia and other fish species for their enterprise, and that their consumers preferred catfish to other species. Due to the above-

mentioned reasons, farmers restricted themselves to farming more of catfish than other species because of the demand for the product.

This finding is supported by Udo and Umanah (2017), who posited that catfish species are the most commonly cultivable fish in Nigeria. The success according to the authors is associated with new technological breakthrough in catfish seed production and unprecedented investment for that species. Suggesting that catfish has seen 90 percent investment tailored towards its development. The assertion by farmers that catfish was the most favoured species by their customers is anchored by the fact that catfish has a higher market value than that of tilapia, therefore, highly investable (Issa *et al.*, 2014). According to Iheke and Nwagbara (2014), catfish production is a profitable and viable business in Nigeria, and its development guarantees a steady and cheap fish supply in the country. Still, farmers face challenges of acquiring good quality fish seed (fingerling) for their venture. The major issues identified by respondents hampering aquaculture development included high costs of hatchery equipment, lack of good quality brood stock, high mortality rate of larval during development, poor water quality management and energy problems. The findings indicated that 29 farmers (29.6 percent) had issues in their mission to ascertain good quality seed for propagation. On the other hand, over 70 percent (69 farmers) participants were able to acquire seed either privately or government establishments to stock their ponds. As a matter of fact, the sector needs support to explore the potential of genetics and modern breeding technologies nationwide. This will help reduce the time; cost and risk involved in farmers travelling long distances to source for fish seed or collect from the wild.

5.3.4.3 Selling

Another constraint highlighted during this survey was problems associated with marketing of products according to fish farmers. Eighty-eight (90%) respondents acknowledged that there existed a strong demand for fish products, and the opportunity for increasing fish supply in the area, with only 10 (10%) indicating that they had issues with marketing of their fish. However, the problem they encountered was low pricing of their produce, lack of infrastructure (roads,

electricity, storage facilities, processing, packaging, and handling etc) to easily transport their products to urban markets. Inadequate infrastructure is identified as a major difficulty experienced when distributing and marketing of fish (Akintola and Fakoya, 2017; Adelaja *et al.*, 2018). By not being able to transport products easily due to the perishable nature of fish, farmers sold their fish at the farm gate or village markets, incurring huge financial losses. Farmers stated that given the short shelf life of fish, the longer they had the product, the greater it became susceptible to post-harvest losses, making their venture economically unsustainable and threatening to food security.

Furthermore, respondents indicated that they do not only sell at low prices but also on credit. The study showed that farmers preferred to receive their payments in cash rather than payment by credit. So, farmers would rather sell their produce in urban markets where they had no ties with their customers. However, this raises the cost of transporting of fish and thought of losses due to the nature of the product. The issues and challenges are forcing farmers to sell fish locally at lower prices that does not compare favourably with the urban markets. The study also observed that most farmers sold their produce individually without coordinating with other farmers. This is an indication that there is no networking in marketing of fish among farmers in the FCT. Lack of teamwork among farmers has made it impossible to gain the economies of scale of selling as a united front in prices and supply to the market. Studies have revealed that farmers need to form cooperatives and consult with other farmers to identify and explore available markets (Adewumi, 2015; Adeolu *et al.*, 2017). Other benefits for participating in cooperative is more access to credit which may lead to increased farm size, increased income which may influence farmer's interest in fish production (Jatto *et al.*, 2013).

Access to improved aquaculture input and output markets are vital for increased productivity. Well-functioning markets will transmit higher prices and allow changes in demand to be met by supply (Chaweza and Nagoli, 2018). For example, research carried out in Cameroon on improved fish production and marketing indicated that farmers were guaranteed cash for their products and a 100 percent sale in comparison to 50 percent or less when not sold through the 'collective-marketing scheme' initiation (Brummett, 2007). The collective marketing system ensured that a value chain was created that increased small-

scale fish farmers opportunities through selling and receiving of cash for their product. A reliable value chain, if scaled out to other farmers would in turn intensify food supply, increase farmers income, and accelerate national and local economy growth. Without an assured and adequate market, fish will not be available to consumers at the right time and in the right place, thus fish production will be made impossible. Fish production becomes effective to farmers only when their produce is bought at the right price by consumers.

5.3.4.4 Environmental factors

Significant environmental constraint affects the sustainability of aquaculture today, which makes meeting rising demands for fish food immensely challenging (Phukan *et al.*, 2015; D'Abramo and Slater, 2019). Studies have shown environmental conditions such as extreme rainfall and flooding, water pollution, increased fish diseases and parasites, excessive heat and drought that arises due to the hostile climatic conditions, among other factors were limiting the development of aquaculture (Weatherdon *et al.*, 2016; Boyd *et al.*, 2020). The consequences according to farmers has been damage to farmlands, loss of aquatic plants and animals, to loss and changes in water quality, introduction of predators or diseases. For example, Sofoluwe *et al.* (2011) revealed that climate change has directly affected the quantity and quality of food production in Nigeria and the same has been observed in other developing countries. The authors predicted that global food production could decline, especially in susceptible regions in developing nations, leading to severe hunger and starvation.

Climate change is anticipated to have an immediate and future threat to aquaculture production systems, and this could have serious implications to food security, including traditional forms of economic development (Belton and Thilsted, 2014; Thilsted *et al.*, 2016). In the study area, the main impact of climate change on tilapia and catfish farmers has been the lack of water due to drought, destruction of ponds as a result of heavy rainfall and flooding, occurrence of new diseases (lymphocystis and streptococcosis). The potential to understand and intervene in the multifaceted dynamics surrounding food security presents a crucial challenge in reducing food insecurity in a climate resistant and nutritional

sensitive manner, whilst achieving societal and environmentally sustainable goals (Poppy *et al.*, 2014; Belton and Thilsted, 2014; Thilsted *et al.*, 2016). Aquaculture has been identified to play a critical role in successfully addressing the challenges arising from food insecurity intensified by climate change, exacerbated by the predicted 2050 global population of 9.5 billion (D'Abramo and Slater, 2019). The understanding of aquaculture's response to climate change in relation to meeting the demand for fish food protein requires a broader strategy that determines its adaptation to the mitigating effects of climate change stressors at all levels. To maintain the present production level, or possibly exceed, the sector will have to employ several reactive and proactive management practices approaches like; water temperature, adjusting stocking time, change in production period, shift in production site, construction of embankments to avoid flood etc. (Asiedu *et al.*, 2017b; D'Abramo and Slater, 2019). Furthermore, stakeholders should support farmers in developing standards and codes that will ensure a responsible environmental and social aquaculture practice.

5.3.4.5 Infrastructure

Findings in this study revealed that fish farmers faced various challenges that could scupper the need to overcome the demand supply gap of the catchment area. Infrastructural problems came in the form of inadequate finance, insufficient land, lack of government support (extension staff, shortage of inputs, training), knowledge and technical know-how, government policy, poor infrastructure (road, power, processing, and storage facilities), inadequate information and theft of produce. Although lack of infrastructure constraint was ranked low among respondents, still 10 (10%) expressed that these issues presented a critical challenge to the expansion and retention of fish farm investment across the study area. Among the lack of infrastructure challenges recorded, finance, land, knowledge and technical know-how, and government policy were ranked amongst the highest. Some of them are discussed below.

Inadequate capital: Access to finance is key to aquaculture's development, without which, poor farmers cannot engage because of limited income (Adedeji and Okocha, 2011; Akinola, 2013). Starting a fish farm is highly capital intensive,

farmers require capital from their initial operation to acquire (land, pond construction, buildings, production equipment etc.) inputs, and repeated credit for recurrent expenditures such as feed, fingerling, labour, new equipment, or expansion. Sources of finance are a hinderance to agriculture in the country, economic growth can only be accomplished by putting in place well focused approaches to reduce poverty by empowering farmers through increased access to factors of production, mostly credit.

Land: Land is an important aspect of production input in aquaculture. Successful aquaculture is dependent on the use of a suitable site, however, the supply of land for fish farming practices is limited due to the explosive population growth in the study area. Therefore, providing humans with food of nutritional value is becoming a serious problem (Phillip *et al.*, 2009; Miller and atanda, 2011). These challenges have had an economic implication for participants, being that most of them are poor, and cannot afford alternative farmlands, therefore, lack resources to becoming self-sufficient (Ugwumba and Chukwuji, 2010; Adewumi, 2015).

Knowledge: The role of dissemination of adequate, quality, and existing and new information or knowledge is necessary to the improvement of the aquaculture sector. It is relevant to know that most of the population of the individuals engaged in aquaculture practices are illiterate or untrained, and this cohort of individuals rely solely on the old traditional methods of farming which contributes to low productivity. Therefore, it is pertinent that farmers are provided with up-to-date and comprehensive awareness on better tools and implementation strategies that is suitable to the indigenous environments of the farmer and their resource base capacity, that will enhance their productivity method to attain an all-year-round food sufficiency (Sokoya *et al.*, 2014; Zhang *et al.*, 2016). Rabo *et al.* (2014) suggested that aquaculture requires a multi-disciplinary skill to evaluate and develop an appropriate system. However, most of these farmers without the relevant awareness and education, are unable to make informed decisions on adoption of modern farming technologies that can improve their farming methods for the sustainability of their future.

Government Policy: Nigeria has regulations governing the aquaculture industry at national and local level. However, its implementation, monitoring, supervision, and enforcement over the years has been a huge challenge (Subasinghe *et al.*,

2021). Laws and regulations governing aquaculture are left to the discretion of the various state governments; hence, most of these farms failed to remain in business. Adewumi (2015) associated these failures to lack of government interest or commitment on specific targets, goals, objectives, and strategy that would foster growth and sustainability of the sector. These laws include changes in financial policies, registration and licencing or environmental issues. Government should play an active role by creating policies that will provide support and services such as grants for development, insurance, inputs supply, subsidies for adopters, special loans, and many more, geared towards aquaculture development. Adewumi (2015) stressed that it is necessary for a policy to survive even when its creators are out of office, so that it will promote stability and continuity, this will create a favourable environment for the industry to grow and flourish. Therefore, the need for a strong regulation and guidance by the national government for the support of the national aquaculture sector is required to develop and improve the domestic aquaculture supply.

5.3.5 Employment opportunities generated through fish farming

The study revealed that respondents had hired workers on a part time or full-time basis within the last 12 months before this investigation. More than 30 percent of farmers indicated that they had three people working on their farms in the past 12 months. This number included themselves and hired labour, while a smaller proportion had less or more than three working on the farm depending on the farm size. Thirty-five percent of respondents had one person working on full-time basis, with over 60 percent employing between 2-6 work force on a part-time basis, especially during harvest time. Fish farming in the FCT was mostly carried out by men, with only a few women involved in culturing. Although some women worked with their husbands as part of a family venture, only three women had their own farms out of the total of 98 farms. Most of the women have been involved in processing and marketing of the final product. The study showed that fish farming practices are providing the much needed formal and part time employment opportunities, thus contributing towards poverty alleviation and food security in the study area. A dynamic fish farming sector will reduce poverty in

the study area by providing work and livelihoods to the rural population, enhance food security and generate income through export of fish for farmers (Miller and Atanda, 2011; Olaoye *et al.*, 2013; Iruo *et al.*, 2018).

5.3.6 Market availability for fish farmers

Fish farmers in the study area sold their produce to a variety of customers, ranging from those who purchased their product to resell to others (wholesalers, retailers, hotels, restaurants) and those who bought fish for home consumption. Fish farmers sold their produce fresh, dried, smoked or in a frozen form. Participants indicated that at some time, especially during harvest, fish were dried, smoked, or frozen to preserve its shelf life, quality, and nutritional value. These assertions were supported by Adeyeye and Oyewole (2016) who stated that a variety of methods are utilised to preserve and process fish for consumption and easy storage purposes. Beside the methods mentioned above, the authors included frying, fermenting, and salting as one of the other various methods employed by farmers to prolong fish longevity. The study found that 70 to 80 percent of fish consumed in the country is smoked, mostly done on site or on the buyer's facility, making it one of the most widely used method. Research have shown that smoked fish enhances the taste of fish, increases usage in soups and sauces, minimises waste during bumper harvest time, easy to store, handle and transport (Adeyeye and Oyewole, 2016).

The study revealed that almost 40 percent (38 farmers) of farmers sold their produce to middlemen because they bought them in bulk and sold to the public, while 11 percent (11 farmers) sold directly to consumers who bought fish for home consumption. The remaining farmers, almost 50 percent sold their products to between two to five different types of customers as expressed in (Figure 5.11). Farmers indicated that they had customers ready to purchase their produce. However, participants expressed their concerns during marketing of fish as, low pricing, delayed payment, logistics and non-patronage of their products.

Out of the concerns highlighted by respondents, low pricing was ranked the highest in terms of severity. Forty five percent of fish farmers were unhappy about

how customers priced their products. The situation is in line with the findings expressed by Phukan *et al.* (2015) and Abdullah and Chowdhury (2016), who stated that low market pricing of fish is a key issue for fish farmers. The lack of stable market for small-scale farmers means that they are not able to achieve the desired profit for their goods. Abdullah and Chowdhury (2016) are also of the view that fish market is always fluctuating due to factors like, supply and demand, artificial control of markets by brokers, influence of intermediaries and other stakeholders. Another major hindrance militating against effective fish market is delayed payment from buyers. Twenty percent of fish farmers had experienced delayed payment in their business. Transporting was least amongst farmers' problems, with only three percent expressing concerns. Respondents suggested that this was because most of their produce were sold at the farmgate, and the public had easy access to farms to buy fish without hindrance due to the location of farms in the study area. Produce that were not sold immediately were smoked to preserve its shelf life to be sold in the future. Only about five percent of participants did not sell their produce, indicating that they were not given the expected price, thus refused to sell.

5.3.7 Obtaining support and information for fish farmers

Fish farmers' sources of support and information were varied in the study area. Some farmers utilised more than one source to grow and remain in business, this included government, NGO's (JICA, USAID, WAPPI etc.), books and journals, other farmers, feed, and fingerling sellers etc. Support and information according to farmers came either as training on new farming technologies, or as grants, and equipment (feed, fingerling, grants, water pumps etc.).

Feedback from nearly 75 percent of the respondents in the FCT expressed that their sources of support and information on farming operation were from the government (AADP, FDF, MFCT, etc.). It could be deduced from the above that the government is providing the enabling environment for aquaculture to flourish in the study area. Over the years the Government has supported fish farmers through the provision of subsidies, training and workshops, supply of inputs etc. to create awareness in fish farming (Tiri *et al.*, 2014). The government had

introduced and launched various programmes and projects to develop and improve the aquaculture sector from subsistence to commercial fish farms as production units, however, some of these projects failed. In 2011, the government of Nigeria came up with another framework known as the Agricultural Transformation Agenda (ATA) policy, to serve as a strategy to improve food production. Still, major issues associated with food scarcity were not resolved (Akinwumi, 2011). The current strategy is to address the appropriateness of Government interventions (FMARD, 2017). This approach was to identify key challenges prevalent in the sector and the constraints to the aquaculture industry development. These efforts have seen an upward trend in aquaculture, and this is expected to continue as Government directive review existing policies and formulate new approaches for sustainable aquaculture management and development in the country.

The next support and information sources expressed by 21 percent of farmers was from NGO's, with 18 percent networking with other fish farmers to gain the necessary skill set required for increased fish production. Studies have shown that experience plays a critical role in the success of fish farming and the maximising of losses (Aphunu and Nwabeze, 2012; Phukan *et al.*, 2015). While the remaining obtained support and information from fish feed and fingerling sellers, research institutions etc.

Of the 98 fish farmers who were involved in the study, farmers were asked if they had received support from government at the initial stage of operation, 46 (47%) stated that they had received government support in the beginning of their venture. Participants acknowledged that the support was in the form of subsidies and inputs (feed, fingerling, machinery, grants, guidance and advice, loans etc.), acquiring extension staff to help in educating them on how to improve fish production using modern technologies, practical on farm assistance, and giving invaluable information on farming practices. On the other hand, 52 (53%) indicated that they never got any assistance with starting up their venture. Farmers reiterated that the initial cost involved in starting up a fish farm had led to low adoption of fish farming in the study area. Similarly, Wandji *et al.* (2012) indicated that high initial investment cost is responsible for the low adoption levels in the aquaculture industry. This result is also linked to that obtained by Sheriff *et al.* (2008) which shows that cost involved from the beginning is a factor that has

hindered new entrants from especially the less wealthy households from patronage. Nevertheless, once established, fish farmers can engage in fish culture and generate a substantial financial benefit.

All the 98 participants agreed that fish farming was a source of income for them, with 95 (97%) expressing that they intend to continue their fish farming operation and possibly expand their venture. These farmers strongly agreed that fish farming is helping to create employment for the rural folks who have no other means of income. Representation of farmers came from all pool of life, from those in business to retirees, from those who farmed fish to supplement their income or as a major source of livelihood. These individuals included both the young and old, ceasing the opportunity to make a difference for themselves, their families, and the community at large.

5.3.8 Farmers perception of food and nutrition

Of the 98 participants, 22 (22.4%) indicated that their families eat fish always, while 61 (62.2%) asserted that their families eat fish intermittently, with the remaining 15 (15.3%) expressing that their families consumed fish occasionally but would like to increase their fish intake if it were regularly available. Fish food is the cheapest source of protein, a significant diet for most people in the developing countries (Kasozi *et al.*, 2018; Balami *et al.*, 2019). The impact of eating fish according to about 60 percent of farmers is that it provides their families with a healthy balanced diet, while 37 percent asserted that it was their source of food protein.

Almost 40 percent of farmers eat fish that they grew in their own farms, with nearly 60 percent getting fish from other sources for consumption. When asked, farmers stated that they never had enough from their own farms, or wanted other varieties they did not grow themselves. This result is vital as it reveals where support is needed for further aquaculture development. These analyses were conducted to ascertain whether fish farming was making any difference in the livelihoods of the poor residing in the FCT, for which the study was intended.

5.3.9 Limitations of questionnaire surveys

There were a few limitations experienced in gathering data through questionnaire in livelihood assessment, as participants felt that their personal data would be given to strangers. First, many participants collected the questionnaire but failed to return them, thus reducing the number of participants that was anticipated for the research. This was overcome by looking for more participants to make up for the numbers lost. Second, the researcher and the research team could not visit some farms due to logistical problems. However, this was overcome by administering questionnaires through telephone and workshop/seminar session. Third, a limitation of this study was that some participants had difficulties reading or interpreting the questions due to language barriers. This situation was overcome by translating the questions into their native language. Generally, the process was costly and time consuming.

5.3.10 Conclusion

This chapter analysed the data collected from the study area using SPSS to establish the relationships that exists between the population and variables identified for the research. The chapter established that poverty has been a major challenge to many countries in SSA, and Nigeria is no exception. Finding jobs for the unemployed has become a headache for many governments, and any occupation that offers prospect of providing solutions to this crisis is a welcome relief to both the government and the people concerned. Aquaculture in Nigeria has received a major boost as the government has now realised the important role that it can play in bringing relief to many citizens in the country. However, the enthusiasm with which farmers are embracing the sector is yet to be matched by government support as evident from the data collected. Apart from providing income to those that engage in it, it also provides essential nutrients that is missing in many diets in the study area.

The chapter highlighted that over 65 percent of fish farmers in the FCT were motivated by earning a livelihood and making earnings meet, however, the challenges faced such as land, capital, water etc. inhibits these farmers desire to

pursue fish farming on a larger scale to feed the growing demand for fish in the FCT. Furthermore, the study revealed that farmers were more inclined to farm catfish than tilapia and other species, there is therefore the need to introduce other high yielding species that will arouse the interest of the farmers.

Chapter 6.0: Discussion and Conclusion

6.1 Introduction

The main aim of this thesis was to present the key findings on the actual impacts of aquaculture on poverty alleviation and food security amongst the fish farmers in the FCT and the institutions required to maximise aquaculture's potential. The chapter begins with the summary of the aims and objectives of this investigation, followed by discussion, recommendations, limitations, and areas for further research.

The study thus examined measures put in place by the government to support farmers to increase their wellbeing and income. The study collected both quantitative and qualitative data at the same time, and data analysis occurred simultaneously, but independently (Creswell and Clark, 2017; Schoonenboom and Johnson, 2017). The design gave priority to the quantitative phase of the study. Data collected through interviews (qualitative) with policy makers was incorporated into quantitative data to augment the outcome of the study (Palinkas *et al.*, 2011; Wisdom and Creswell, 2013). The combination of data from the two sources provided an in-depth understanding of the perceptions and processes that shaped aquaculture's role in poverty reduction and food security, which would have been impossible without the two methods complementing each other.

This final chapter draws upon the key findings of the results in chapters 4 and 5 to present an integrated understanding on the study conducted in this thesis. The discussion confirms the statistical analyses findings on the impact of aquaculture on poverty and food security in Nigeria. The overall key findings are brought together in a discussion focused on the role aquaculture plays in poverty alleviation and food security among the rural poor by outlining each of the research questions in section 1.4.8. Finally, the chapter provides recommendations, limitations, and areas for further research.

6.2 Summary of the aims and objective

The main research questions are answered by achieving the aim of this study. The research aim is to examine the contribution of aquaculture to poverty alleviation and food security among the rural poor in the FCT. The results are summarised and classified with respect to the specific theme of each aim and objective as follows:

1. To determine the present status of aquaculture development in the FCT, clearly identifying positive impacts derived so far and challenges faced.
2. To conduct an economic assessment of aquaculture of the local economy of the FCT, clearly showing its role in addressing rural poverty.
3. To identify the socio economic and policy factors that affect aquaculture development and its impact on the rural poor.
4. To develop resources to aid rural farmers to make more informed decisions.

The research was achieved through the exploration of seven research questions linked to the aims and objectives as follows:

1. What is the current state of aquaculture production in the FCT?
2. What are some of the challenges faced by fish farmers in the FCT?
3. What is the extent and growth pattern of Research and Development (R&D) investments by the Government in the FCT?
4. What role is the Nigerian Government playing to ensure sustainability of fish production for the future of the Nigerian public?
5. What incentives are available for the local fish farmer?
6. What is the economic implication of fish farming on the local environment?
7. What is being done to develop alternative feed ingredients?

6.3 Addressing the research questions

This section answers the research questions which are framed from the research aims and objectives. The section presents the analysis of how the research questions are answered.

6.3.1 What is the current state of aquaculture production in the FCT?

This research question is mainly connected with research aims and objectives 1. The literature review, interviews conducted, questionnaires administered, and field visits were to critically investigate the current state of aquaculture production in the study area with the view of determining its viability in providing the much-needed relief for the identified issues of food insecurity and poverty in the study area. In chapter 1, the extant literature on aquaculture in the FCT was reviewed, and the evidence indicated that there has been expansion in the number of small-scale farmers taking up fish farming in the area. However, the data collected from fish farmers and analysed in section 5.3.4 showed a sector that face challenges such as lack of government support, high-cost fish feed, lack of funding for farmers and weak institutions etc. The potential for aquaculture in the FCT, was not in doubt, as the farmers that participated in the research overwhelmingly voiced their desire for sustained public investments and education for the sector to grow with the view of creating job opportunities and to help solve the food insecurity and poverty in the FCT. The result suggest that small-scale aquaculture has a higher potential to impact poverty and food security among rural folks, but they do not get the attention like their larger counterparts, for instance when things like policies and legislation are being considered. Therefore, large scale fish farming is more likely to have the resources needed to invest in larger operations and adopt modern technologies that result in increased fish production and employment generation. Though the primary motives for most small-scale farmers surveyed in this thesis was to make profit through integration of aquaculture into other livelihoods sources, their presence was more felt in the study area. Beveridge *et al.* (2010) indicated that even though aquaculture is one component of a diversified livelihood strategy for small-scale enterprises, most farmers dependent on it as a source of income.

Generally, Nigeria has all the potential to make its citizens self-sufficient in fish production and compete with world leading aquaculture nations (Akinsorotan *et al.*, 2019). Some of the potentials include employment creation, income generation, poverty alleviation, foreign exchange earnings, vast network of inland water space and land, and provision of raw materials for the animal feed industry. The current state of aquaculture production in the FCT looks promising though,

but evidence from the analysis made in chapters 4 and 5 suggest that there is a long way to go to be able to achieve self-sufficiency. However, whilst there are identified challenges, there is also overwhelming evidence to suggest that production of fish for consumption is improving and will continue to grow in the ensuing years.

6.3.2 What are some of the challenges faced by fish farmers in the FCT?

This research question is mainly connected with research aims and objectives 1. The literature review, interviews, conducted survey, and field visits have been used to identify and assess the barriers facing the growth of the aquaculture industry in the study area.

The understanding of aquaculture and its likely impact on rural development, poverty alleviation and food security has been a critical issue for researchers and government the world over. Whilst many studies (Ragasa *et al.*, 2022; FAO, 2023) have been conducted in the developed world context. There is still a long way to travel on understanding and evaluating the impact of fish farming to poverty alleviation when it comes to developing country context and especially SSA. The examined literature in chapter 1 of this study indicated that there are diverse ways that the sector can impact on rural development. There is a need to develop a better understanding about the challenges to aquaculture growth and the institutions required to manage the performance of the sector. Although this study revealed that the small-scale aquaculture farming sector has the highest impediments to growth and faces difficult challenges in realising its potential, the literature revealed in chapter 1 is inadequate to provide an in depth understanding of the present aquaculture sector in the FCT.

Research analysis of government officials' interviews presented in chapter 4 highlighted new and persistent challenges impending the future growth and development of the aquaculture industry in the FCT. For example, the chapter identified several barriers which included lack of training for the youths, lack of technical knowledge, security issues, land shortages, limited access to finance, lack of quality feed. Furthermore, chapter 4 highlighted low retention rates

associated with good training and information, lack of assistance with start-up cost leading to low adoption of fish farming enterprise in the study area. Overall, findings from chapters 4 and 5 revealed challenges that have led to the low performance of the industry in the FCT at large. Laws and policies governing aquaculture are said to be weak, and Adewumi (2015) identified one of the root causes for the impediment of aquaculture development to be lack of political will on the part of the federal government, causing the implementation, monitoring, supervision, and enforcement untenable. Adewumi (2015) suggested that government should play an active role by creating policies that will provide support and services geared towards aquaculture development.

These findings are synonymous with challenges identified by Walakira *et al.* (2023) that land availability and lack of incentives makes producing at scale difficult in developing countries. In addition, Walakira *et al.* (2023) stated that investments by government, aquaculture specific legislation aimed at boosting production would increase production and reduce reliance on imports and improve food security. This also goes to support the notion that aquaculture when properly instituted and managed provide a sustainable living to participants thereby eliminating the pressure on government with regards to job creation and food security (Ramesh and House, 2013; FMARD, 2016; Adeniyi and Dinbabo, 2020).

6.3.3 What is the extent and growth of Research and Development (R&D) investments by the Government in the FCT?

This research question is mainly connected with research aims and objectives 2. The literature review, interviews, conducted survey, and field visits have been used to identify and evaluate Government investments through (R&D) in the catchment area.

Research and Development is critical to the aquaculture industry. Results obtained from both chapters 4 and 5 agreed that fish farmers in the FCT needed to acquire various range of skills and knowledge to enable them to make better decisions and empowerment in their enterprise. These chapters revealed that the government at some point had offered support to fish farmers for some skills

acquisition. However, most of the participants indicated the assistance they had received did not have much impact in their daily operations, as they still needed to network to remain in operation. Participants highlighted areas they believed will benefit from R&D investment and crucial to make a difference in their experience as feed formulation, breeding techniques, climate change, land acquisition, storage facilities and stable markets for future growth. Despite the importance of R&D in scaling up the aquaculture industry in Nigeria, still there are common constraints identified in this study in relation to aquaculture development in the FCT.

These findings are in consonance with aquaculture development review conducted by the FAO on the Asia Pacific region (FAO, 2017), which identified commendable efforts being made in developing good aquaculture frameworks, though progress was not consistent across all countries and a lack of expertise and financial capacity often delayed execution. Still, aquaculture development in Asia is a success story. The study indicated that a number of policy-driven developments relating to the establishment of inter-governmental agencies, NGOs and networking that provide technical and financial assistance have been influential in the success attained in Asia (Dey *et al.*, 2008; FAO, 2017). Adeleke (2020) stated that focus in developing the aquaculture sector in Africa through increased financial and technical aids from donor agencies were diverted to combat emergent priorities. The analysis from majority of the participants presented in chapters 4 and 5 were of the view that, there is more to be done by the government to enhance the economic viability of aquaculture sector in the region.

6.3.4 What role is the Nigerian Government playing to ensure sustainability of fish production for the future of the Nigerian public?

This research question is mainly connected with research aims and objectives 3. The literature review and interviews conducted were to critically investigate the role the Nigerian Government is playing to guarantee a steady fish supply for the public.

The role of the government in ensuring the sustainability of aquaculture development cannot be overemphasised. Realising the importance of aquaculture and creating an enabling business environment by government through coordinating and adopting effective policies for the sector to thrive is necessary. However, findings presented in chapters 4 and 5 revealed weaknesses in the perceived effectiveness of national aquaculture governance structures. The study indicated that the federal government has not adopted aquaculture-centred policies and processes as a roadmap to guide development. For example, many stakeholders highlighted the lack of soft credits and incentives, access to affordable loans, and land ownership to increase and develop aquaculture production. In chapter 3.6.1, the study revealed that the Federal Government of Nigeria in 1960 rolled out many interventions to support and assist farmers by providing an enabling environment for effective food production. However, most of the initiated schemes in the country failed to perform. The investigation in chapter 3 also revealed that these schemes were not geared towards aquaculture. The only law that was enacted for the aquaculture industry by the Federal Government was in 1971, centred on federal activities. However, there was no specific law that catered for the states or local government levels (Vincent-Akpu, 2013). Participants analysis in this study revealed that there was a strong demand by all stakeholders for governance structures to be specifically tailored at both the national and local level. Good governance will provide an enabling environment to strengthen aquaculture development across the country.

6.3.5 What incentives are available for local fish farmer?

This research question is mainly linked with research aims and objectives 3 and 4. The literature review and survey conducted critically identified and assessed the resources that is available to encourage adoption of fish farming, while empowering farmers to make informed decisions.

Aquaculture products by nature (e.g., quality requirements, perishability, good access roads, storage houses, refrigeration, sale, hatcheries, transport for live fish, etc) are institutionally demanding to be economically profitable,

environmentally sound, technically feasible and socially acceptable. Institutional intervention is needed to provide the necessary incentives for aquaculture adoption among the rural dwellers who are mostly poor. However, evidence from chapter 4 indicated that most of the above-mentioned infrastructures were not provided by the government. Interviewees revealed that the ideal situation would be for the government to partner with public private partnership (PPP) who are able to provide facilities such as feed formulation, breeding techniques, modern technology to improve the sector. Likewise, the analysis in chapters 4 and 5 identified limited access to credit facilities as one of the major constraints that has hindered aquaculture's development in the FCT.

The findings as presented in chapter 5 of the study produced further evidence which suggest that the government can provide incentives in the form of extension officers to train farmers as well as other fish farming inputs that will help in the development of aquaculture in the study area. However, the priority of the state has been on other agricultural practices to the detriment of the fish farming sector. There is hope, as the study indicated in the findings that the government is now beginning to see the contribution of the sector to poverty alleviation and food security. Whilst participants as evidenced in the research findings in chapter 5 were optimistic about more support from the government going forward, they were circumspect of the fact that there were other pressing need in the general agricultural sector that needed attention and so their hope were measured and not high on the support that will be coming their way in the future. The findings in chapter 5 are in support of a study conducted by Mbugua (2008) and Shitote *et al.* (2012) on lack of government support encountered by small-scale fish farmers in Kenya.

However, there was ample evidence deduced from both the empirical analysis in chapter 1 and the research findings section in chapters 4 and 5 to suggest that, supporting the aquaculture sector with the needed financial incentives, tools and other facilities will go a long way in provision of food safety and poverty reduction in the rural areas of the country, as fish farming provides the empowerment needed to uplift rural folks, thereby, transcending to a better livelihood.

6.3.6 What is the economic implication of fish farming on the local environment?

This research question is mainly linked with research aims and objectives 3. The literature review, interviews conducted, administered questions, and field visits examined the financial impact of fish farming in the environment.

The understanding of aquaculture and its economic impact on the FCT area as well as the sector in general is of great importance in better appreciating its contribution and for a better planning purpose. An important element that emerged throughout the study was that aquaculture generated positive livelihood outcomes through improved food security and wellbeing as well as improved capabilities and reduced vulnerability within the studied environment. Chapter 5 provided a rich perspective about the benefits arising from aquaculture during capturing the day-to-day lived experiences of fish farmers within the study area through interaction and observations during the survey. Key findings presented within chapter 5 indicated that reduction of poverty, improved food security and wellbeing, and increased income were directly and indirectly generated from aquaculture. However, as indicated in chapter 1, the limited empirical evidence in Nigeria makes it difficult to provide an in-depth analysis and understand the current aquaculture sector in the country. There is the need for greater engagement of all key stakeholders and their perspectives to improve and better manage the sector (Soliman and Yacout, 2016; Satia, 2011; Adeleke *et al.*, 2020).

Though the research findings indicated that aquaculture in the study area was driven by multiplicity of factors and chiefly among them were provision of livelihood, meeting the increasing fish demand, improving food security and nutrition, reducing the excessive demand on wild fish resources. Whilst measures have been put in place to achieve the goal of food sustainability and to reduce pressure on government's bill on fish import, there are still many challenges that are faced by the aquaculture sector in the FCT and Nigeria in general. These challenges have contributed to the erratic trajectory of the aquaculture sector in the country during its journey from the early 1950s. A thorough examination of the chapter 5 unearthed several key constraints in relation to fish farmers operations. These constraints were environmental challenges that included lack of

water, flooding, disease outbreaks, droughts. In addition to these challenges are sociological challenges in the form of land acquisition, conflicts, theft, and lack of knowledge. Environmental and sociological issues are a great concern in the aquaculture industry. Neglecting or not adhering to good or improved management practices could lead to a devastating impact on farmed fish. The results analysis in chapter 5 stated that participants experienced parasites and disease outbreak that wiped out all their stock in the past, which led to their decision not to introduce new stock straight away when brought to the farm. This coincided with a study conducted by William and Kim (2015) that the emergence of medium and commercial scale aquaculture in Uganda led to an outbreak of diseases resulting in mass mortality of hatcheries and grow-out systems, causing significant economic losses to fish farmers (Referenced by Adeleke *et al.*, 2020). William and Kim (2015) stated that an assessment of some farms revealed that attention was not given to fish health management, farm management practices, inputs and products quality assurance, enforcement of aquaculture regulations and research, among others. Chapter 5 analysis revealed that to prevent economic losses, it is imperative for fish farmers to be well informed in practices that maintain and keep good health management practices within culture environments. These will guide researchers, policy makers and farmers to develop control or prevention strategies against potential threats to fish farming.

6.3.7 What is being done to develop alternative feed ingredients?

This research question is mainly linked with research aims and objectives 4. The literature review, interviews conducted, administered questions, and field visits identified and explored the assistance offered to farmers to develop fish using local ingredients.

The support from the state to farmers in the propagation of fish farming is paramount, as it provides an enabling environment that helps farmers in doing what they enjoy doing. Government support is extremely vital in an environment where there are many challenges as enumerated in chapters 4 and 5. For example, one of the major challenges highlighted by the study was lack of

affordable quality fish feed. The empirical evidence presented in chapter 4 suggested that government support in the form of soft loans, establishment of feed processing centres throughout the country will go a long way in helping ease some of the strain on farmers with regards to these constraints. The analysis in chapters 4 and 5 indicated that the local feed used in the area are mostly compounded from rice/maize bran, blood meal from abattoirs, soya bean, groundnut cake produced locally, with others using household waste for feeding of fish. However, the study discovered that the quality of feed produced locally is not tailored to specific fish species or size (e.g., juvenile, growth-out), therefore failed to achieve the intended goal. Quality feed used in the FCT is imported into the country with huge economic implication. Fish farmers indicated that between 50-70 percent of their production costs was on feed. The study revealed that the cost associated with acquiring quality feed has limited their ability to intensify production and profit margin, therefore forcing some farmers out of fish farming business. A lack of quality affordable feed was a major economic concern expressed among all farmers in chapter 5. Studies conducted by Udoh and Dickson (2017) indicated that despite various interventions including input subsidies, credit facilities, pricing policies and market liberalisation put in place to meet the demand for aquafeed and increase production in Nigeria, production is still very low and unable to meet the demand of the aquaculture sector.

Notwithstanding, chapters 3,4 and 5 in this study revealed that Nigeria has the resources to enable fish farmers full engagement into fish farming operations. In the area of feed manufacture, the country has available local ingredients such as corn/maize, rice, groundnut, soya bean, etc. that could be used for production. Furthermore, the call by the government and key stakeholders to find a lasting solution to food insecurity and poverty reduction in the FCT and the country, shows that efforts are been made to make the country food secure. Utilising all available tools will empower fish farmers, uplift rural folks, thereby, transcending into a better livelihood.

6.4 Recommendations

The scope and severity of poverty and food crisis in Nigeria is a clear indication that growth and development reforms are needed in the country. Findings revealed that the most vulnerable within communities (rural farmers) are experiencing extreme poverty and food insecurity, with adverse effect on their wellbeing. To transform the existing aquaculture practices into a modern sustainable productivity and positive development, the study suggested the following:

6.4.1 Government policies

A coherent policy for the aquaculture sector that can help to better manage production is lacking, Government should make policies that would support the development of the aquaculture sector in Nigeria. These policies should include access to vital facilities such as information, capital, skills, services and input and output markets to ensure that fish farmers are empowered to respond to the growing demand for fish in the local and urban markets.

From the evidence gathered during the research, and discussed in the literature review, it became clear that there was no coherent policy on aquaculture in general. It becomes even more confusing when it comes to small-scale fish farmers. Government policies over the years has concentrated on providing the enabling environment for the aquaculture sector, however, growth has stalled due to the implementation and enforcement of those policies as identified by the sector (Soliman and Yacout, 2016; Adeleke *et al.*, 2020). It is therefore imperative for the government to come up with adequate measures that will help steer the operations of small-scale fish farmers in the FCT. Providing the necessary policy guidelines on the direction of aquaculture will help in food insecurity in the study area as well as reducing the poverty and unemployment rate in the country. To further develop aquaculture in Nigeria, retain entrepreneurs, and to benefit from the enormous potential that it promises, the government needs to improve the regulatory environment so that fish farmers can work with confidence and expand their ventures.

Furthermore, government should create an enabling environment for supporting services both in the upstream and downstream side of the supply chain. This will ensure that all the needed supplies to help the growth of the sector is in place as well as ready market to reduce post-harvest losses. Without clear leadership from the government regarding the direction of aquaculture in the country, it is difficult to project aquaculture development as fast as some of the leading countries in the sector.

6.4.2 Training for stakeholders

Adequate investment by the government on training and raising of awareness especially among fish farmers and extension officers is relevant for the growth of the sector. The future of the aquaculture industry in Nigeria will be its ability to improve its current practices using modern aquaculture technologies, so that its potential to ensure food safety and poverty alleviation are enhanced for the benefit of all (Tiri *et al.*, 2014; Oguntegbe *et al.*, 2018; NBS, 2020). The data gathered in chapters 4 and 5 and the discourse made in the literature review suggested that there are limited training facilities available for fish farmers. Furthermore, there is information on what is available for farmers to have access to it. This has created gap in knowledge for farmers on best practices on their operations. This has impacted negatively on their activities.

Training in modern fish farming methods and the provision of modern technology will go a long way in increasing the efficiency with which the fish farmers operate in the country (Nzewi and Cordelia, 2018; Kaleem and Sabi, 2021). This could be done through consultation with international donor agencies and higher educational institutions for aquaculture both home and abroad. Cooperation with some of these agencies will help train fish farmers and help boost their confidence as well as their expertise in their operations. Extension officers in the states should be empowered to offer the needed support services to fish farmers.

6.4.3 Land acquisition reforms

Fish farmers rely on land for their survival, however, poorly regulated ownership and cost of purchase or rent of land is detrimental to the operation of small-scale farmers. The government should create policies that will reform the present land acquisition and tenure system, making sure that land earmarked for agricultural purposes is not used otherwise. Through the necessary reforms and the right legislature, farmers will be in a better position to acquire land with ease without going through many obstacles that are associated with the current way of obtaining land (Maduagwu, 2000; Kughur *et al.*, 2015). Evidence deduced from chapters 4 and 5 showed the availability of land for fish production was difficult to come by and the bureaucratic process involved in land acquisition hinders small-scale farmers from getting land for fish farming. The government should acquire designated lands for use by fish farmers and eliminate middlemen and landowners that create problems for fish farmers in getting the appropriate land for fish propagation.

6.4.4 Provision of incentives

Aquaculture's role is invaluable in food production and poverty alleviation. Therefore, the government should equip the sector with basic facilities (feed manufacturing industry, hatchery, markets, power, etc.) needed to encourage people to adopt fish farming. The low expertise and technology for fish feed and seed production creates reliance on imported materials, making distribution difficult and cost of inputs high, thereby, impacting on sustained growth for the industry.

Capital and sources of funding for fish farming in the study area were a major challenge for the sector, to overcome these, the government need to provide the needed funding to farmers through the provision of subsidies and grants. Furthermore, the government can guarantee loans from commercial banks, as the small-scale farmer finds it difficult to provide the necessary collaterals for the loans that they could obtain from these banks (Rahaman *et al.*, 2013; Shava and Gunhidzirai, 2017).

The government should help farmers to form a cooperative through which funding could be obtained, and also such an institution will act as a mouthpiece for the fragmented farmers by presenting a united front to negotiate for the appropriate incentives that will help promote the sector and help it grow (CBN, 2014). Providing the right incentives will attract unemployed youth into the sector, by so doing these will curb urban migration, transform both the rural and urban area, reduce importation of feed, create the needed employment that will cater for the youths especially. Although this approach would need a greater investment, albeit the return will be greater.

6.4.5 Infrastructure

Fish farmers need adequate infrastructure to enhance their productivity. Feed manufacturing industries should be a major priority of the state, or the Nigerian government should provide the enabling environment for private investors to go into it. This will ensure the availability of quality fish feed that was identified by the study as a major challenge faced by fish farmers in the study area, partly due to its importation and its expensive prices. Hatchery industries for the production of fingerlings should also be given the needed attention by situating them in various areas around the country. This will make accessibility easier for fish farmers. Construction of good roads, storage facilities, provision of readily available market, etc. will also enhance the production of fish and reduce poverty in the study area.

Evidence gathered in chapters 4 and 5 suggests that there is acute shortage of infrastructure that would facilitate fish farming in the FCT. This impedes the progress of fish farming in general in the FCT, and also act as a disincentive to small-scale farmers who may not have the requisite resources to fill the vacuum created by the lack of these infrastructure.

6.4.6 Research and development (R&D)

The link between research institutions and the aquaculture industry in the FCT is weak or non-existence. This affects the motivation for innovation, which in turn stagnates progress and productivity. Modern technological development in the country will boost fish production, supply high quality produce, and contribute to sustain increase in farmed fish. Research underpins effective and efficient fish farming, as it provides the needed platform for knowledge sharing in the industry.

The government should consider setting up research centres that will explore lesser-known species that will augment the few known species identified by the research in the study area. Providing funding for research centres will also enable the development of innovative way of fish farming in the FCT.

In summary, it will be necessary to improve institutional framework that creates structures that facilitate the flow of affordable aquaculture products to nutritionally vulnerable populations in the country. This could be achieved through government policies and participation of other agencies to invest massively in diverse modern aquaculture farming practices. Intervention should be geared towards improving fish farmer's access to credits, grants and subsidies, provision of quality feed and seed at affordable prices, train farmers on capacity building and provision of adequate infrastructure. These schemes must be incorporated into both the national and local planning strategy of promoting economic and business activities that are relevant for a meaningful and future transformation mechanism.

6.5 Thesis Limitations

There were many challenges faced during the course of this research, manifesting itself in the areas of data collection, translation and transcription of the data collected, lack of data on the study under consideration, budget constraint among others.

In the area of data collection in the FCT, the challenges faced included the time taken to translate and interpreting interview questions and questionnaire into the local dialect for some of the research participants to understand the research, as

well as transcribing the responses from the local dialect into English. The researcher was able to overcome this limitation as the researcher is fluent in the local dialect and also had recruited and trained the research team in helping with administering the questionnaires and translation and cross validation of the local dialect into English and vice-versa. In addition to this, the researcher worked in consultation of the Ministry of Fisheries in the Federal Capital in Abuja to improve accuracy and up-to-date knowledge on the aquaculture sector in the study area. The researcher would have preferred to interact with each participant on their farms, however, due to time constraint and bad road networks, this was not possible. However, this limitation was overcome by gathering responses via telephone and seminar forum.

Even though recent literature has explored aquaculture in the FCT and its environs (Kudi *et al.*, 2008; Olagunju *et al.*, 2022), it has come to light that not enough focus has been on the contribution of aquaculture towards food security and poverty alleviation in the study area. To overcome this, the researcher relied on secondary data sources from other parts of the country, international agencies such as FAO, UNDP, World Bank, etc. Although the thesis looked at the contribution of small-scale fish farmers towards food security and poverty alleviation in the FCT, the thesis did not consider other stakeholders in the community and their views on the subject being investigated. While the role of government institution was considered, other key stakeholders such as household consumers, fish mongers, supply chain networks would have been a valuable addition to the study.

6.6 Areas for Further Research

In reflection of the findings in chapters 4 and 5, important areas for further research will include:

Feed formulation using available local ingredients to reduce cost of importing feed.

Selection and breeding of aquatic species to be cultured: Further studies could concentrate on selection and breeding of indigenous species that will be suitable for cultivation in the study area to solve the problem of seed shortages.

Funding sources to support small-scale fish farmers: Research should be conducted on identifying viable sources of funding that will address the difficulties fish farmers face in obtaining finance to enter and remain in the aquaculture industry.

To extrapolate into different farming communities in the country, especially the hinterlands dotted across the country where farming mostly consists of subsistence food crop farming and how aquaculture could help during the seasons that they are not able to cultivate their crops, thus aquaculture helping alleviate the extreme poverty that they experience as a result of lack of other opportunities in those areas.

7.0: References

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8.0 Appendixes

Appendix 1: Research Participation Information Sheet

Study Title: The Contribution of Aquaculture to Poverty Alleviation/ Food Security among the Rural Poor in the Federal Capital Territory – (FCT) Abuja and its Environs.

My name is, an indigene of Karu FCT, I speak Gbagyi language. I have in the past worked with the Fisheries section of the Abuja Agricultural Development Project and have a great interest in what you do.

I would like to invite you to take part in a research study on the impact and benefits of aquaculture to the society. Before you decide, you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Ask questions if anything you read is not clear or would like more information. Take time to decide whether or not to take part.

Purpose of Study

This study is conducted to highlight the value of fish farming in the community; it is also a prerequisite for completing my research degree at the University of Northampton. The study will look at how fish farming will contribute to: Improved food supply, Employment, Income etc.

Why you have been invited

You have been chosen to participate because you engage in fish farming activities or are a stakeholder, and your input to this study is invaluable. The information you will provide will be relevant in undertaking this project.

Taking part in the research

Participating in this research is entirely voluntary; however, I believe that you can make an important contribution to the research. You are free to withdraw at any time, without giving a reason. To take part, the study will last for 20 – 30 minutes, which will involve filling of questionnaire.

Confidentiality and Anonymity

All information you provide during the course of this research will be kept confidential; although, members of the research team will have access to it. All data collection, storage and processing will comply with the principles of the Data Protection Act. Under no circumstances will identifiable responses be provided to any other third party. Data collected from the research will be stored anonymously on a computer based at the University of Northampton. Analysis of results may be available on academic journals, presentations at conferences or seminars.

Appendix 2: Participation Letter

My name is, a research student at the University of Northampton. I am conducting this study as part of my research degree in aquaculture, and would like you to participate as a respondent in this project. The title of the project is: "The Contribution of Aquaculture to Poverty Alleviation/ Food Security among the Rural Poor in the Federal Capital Territory – (FCT) Abuja and its Environs".

The focal point of this project is to investigate how aquaculture has impacted in the livelihoods of the locals and also explore ways in which its implementation could be done in a sustainable way. The study will seek to answer the following questions:

- What is the extent and growth pattern of R&D investments by the Government in the FCT and its environs?
- How do you recruit potential fish farmers?
- What role does your organisation play to ensure the sustainability of fish production for the future of the public?
- What incentives are available for the local fish farmers?
- What is the economic implication of fish farming on the local environment?
- What is being done to develop alternative feed ingredients?

To achieve the aim of this study, you have been selected as a director/manager in this organisation. The researcher believes that you will have valuable information at your expense that relates to the topic under consideration. The interview will be conducted at a time and place convenient for you, and should not last more than 30 – 45 minutes. This interview will employ collection of information that will be analysed later. The information you provide during this session will be kept strictly confidential, however, the results of this study may be published or presented at an academic or professional meeting.

Participation is voluntary and you are free to withdraw from this study at any time without having to give an explanation for your decision.

Please contact me on or if you have any questions about the study. Should you have a complaint about the conduct of the study, please contact my supervisor Dr on or

The success of this project depends hugely on your support and cooperation,
and I therefore hope that you will choose to take part in the survey.

Date

Appendix 3: Research Consent Form

The Contribution of Aquaculture to Poverty Alleviation/ Food Security among the Rural Poor in the Federal Capital Territory – (FCT) Abuja and its Environs.

I

Wish to participate in the above investigation.

Please read and complete this form carefully. If you are willing to participate in this study, ring the appropriate responses. If you do not understand anything and would like more information, please ask.

- I have had the research satisfactorily explained to me in verbal and/or written form by the researcher. **YES / NO**
- I understand that the research will involve filling of questionnaire. The meeting will take place at mutually agreed time and place, and will last for about 20 – 30 minutes. **YES / NO**
- I understand that I may withdraw from this study at any time without having to give an explanation for my decision. **YES / NO**
- I understand that all information that I provide will be treated in strict confidence. **YES / NO**
- I understand that the researcher may contact me if need be. **YES / NO**
- I understand that the results of the study may be published or presented at academic and professional meetings. **YES / NO**

I freely give my consent to participate in this research study and have been given a sheet for my own information.

Date

Appendix 4: Interview Questions

1. What is the role of aquaculture in the development of rural farmers?
2. What are the measures in place to support fish farmers to improve their well-being, income, improve and intensify the diversity of their protein dietary intake?
3. What is the extent and growth pattern of R&D investments by the Government of the FCT and its environs?
4. What is the impact of fish farming on the local environment?
5. Do you receive any support from external donors and agencies towards aquaculture development in the FCT?
6. How effective has the "Federal Government's Fisheries and Aquaculture Transformation Agenda" been for fish farmers in utilising sustainable natural resources in the FCT through established centres such as, hatchery/fingerling production, processing plants, technology transfer centres, fish feed mills etc.
7. What is the long-term potential of aquaculture in the FCT (a) with or (b) without the support of the "Federal Government's Fisheries and Aquaculture Transformation Agenda"?
8. What are some of the major constraints for fish farmers in the FCT?
9. How appropriate is government policies and institutional structures in terms of support for fish farmers?
10. Do you think the Federal Government is doing enough to encourage the public to invest in aquaculture?
11. If not, what do they need to do?
12. What is being done to develop alternative feed ingredients?

Appendix 5: FISH FARMER SURVEY – QUESTIONNAIRE

Name of Researcher: Blessing Katampe

Research Topic: The Contribution of Aquaculture to Poverty Alleviation/Food Security among the Poor in the Federal Capital Territory – (FCT), Abuja and its Environs.

Email Address: s0081040@students.moulton.ac.uk

Telephone Number:

Please take a few minutes of your time to fill in the following survey, and feel free to skip any question that you do not wish to answer.

Background

1. What is your link to aquaculture?

Owner/operator Labourer/caretaker Other (please specify)
.....

2. How long in years have you been involved in fish farming?

.....
.....

3. Why are you involved in fish farming?

.....
.....
.....
.....

4. What type of fish farming do you do?

Extensive culture Semi intensive culture Intensive culture

Other (please specify)

5. What type of fish do you farm? (please tick all that apply)

Catfish Tilapia Carp Other (please specify)
.....

6. What is your culture system? (please tick all that apply)

Monoculture Polyculture Monosex Polysex
.....

7. What is the source of water supply for your pond(s)? (please tick all that apply)

River..... Lake..... Ground water..... Other (please specify).....

8. Who owns the land that you farm fish on?

.....
.....
.....
.....

Production

9. How many ponds do you have?

.....
.....
.....
.....

10. What is the average cycle time for each species of fish that you farm?

Tilapia..... Catfish..... Carp..... Other (please specify).....

11. How often do you harvest your fish?

.....
.....
.....
.....

12. Please explain the system you use for harvesting?

.....
.....
.....
.....

13. How many ponds did you harvest from within the past 12 months?

.....
.....

.....
.....
Income

14. Is aquaculture your major source of income?

Yes

No

15. If not, what percentage of your household income came from aquaculture last year?

.....
.....

.....
.....

Challenges

16. What are the main challenges you have experienced during your operation?

.....
.....

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.....

17. Of those listed above, which was the main challenge to your operation?

.....
.....

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.....

18. Please explain why?

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.....

.....
.....

Employment

19. How many people have worked on your farm in the past 12 months?

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.....

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.....

20. Please describe the staffing arrangements regarding full and part time,
and family members employed on your farm?

.....
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.....
.....

Markets

21. Who do you sell your fish to and why?

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.....
.....

22. What problems have you faced when marketing your products?

.....
.....
.....
.....

Support and Information

23. Where do you get your information from?

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.....

24. Did you get any government support in starting up your farm?

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.....

25. What kind of support was it?

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.....

26. What are your future plans for fish farming?

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.....

27. Please explain your answer?

.....
.....
.....
.....

Food and Nutrition

28. How often do your family eat fish?

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.....
.....
.....

29. Please describe the impact fish has had in your family's diet?

.....
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.....
.....

30. Does the fish your family consume come from your farm?

Yes all

Yes some

31. Why?

.....
.....

.....
.....

Appendix 6: Interview 1

Interview with the Chief Fisheries Officer (CFO) Ministry of Federal Capital Territory Agriculture Unit

Date: 26/03/16

Q. 1. What is the role of aquaculture in the development of rural farmers?

13. Input and training

Q. 2. What are the measures in place to support fish farmers to improve their well-being, income, improve and intensify the diversity of their protein dietary intake?

A. Government institutions that have the mandate - Nigerian Institute for Oceanography and Marine Research (NIOMR), National Institute for Freshwater Fisheries Research (NIFFR), Universities, work with farmers to provide valuable information on health and diet.

Q. 3. What is the extent and growth pattern of R&D investments by the Government of the FCT and its environs?

A. Not much is done in that area

Q. 4. What is the impact of fish farming on the local environment?

A. Income along value chain, employment (e.g. processing, filleting, smoking)

Q. 5. Do you receive any support from external donors and agencies towards aquaculture development in the FCT?

A. No

Q. 6. How effective has the "Federal Government's Fisheries and Aquaculture Transformation Agenda" been for fish farmers in utilising sustainable natural resources in the FCT through established centres such as, hatchery/fingerling production, processing plants, technology transfer centres, fish feed mills etc.

A. While it lasted, nothing happened in the FCT. GES was a poorly implemented programme, would have been good if properly implemented.

Q. 7. What is the long-term potential of aquaculture in the FCT (a) with or (b) without the support of the “Federal Government’s Fisheries and Aquaculture Transformation Agenda”?

A. Huge potentials – from administration planning to have fish farm estate in all area councils. To enhance aquaculture in FCT, we have one in Bwari, and are planning to start one in Kwali soon, this will be earthen ponds instead of the use of concrete tanks in Bwari (this will be bigger than what we have in Bwari to promote commercial fish farming). We want to develop aquaculture centres with commercial important fish; we are presently working with New Bussa to create one in Maitama reservoir.

Q. 8. What are some of the major constraints for fish farmers in the FCT?

A. Land and expensive feed

Q. 9. How appropriate is government policies and institutional structures in terms of support for fish farmers?

A. It is appropriate, because policies and structures are put in place to ensure good business e.g. land allocation and input (fish feeds, nets, water pumps, smoking kiln, training – where professionals in the field are invited to train fish farmers); diversity of species – researching into – were tilapia and carp are chosen for this purpose in collaboration with University of Maiduguri to stock in commercial capacity.

Q. 10. Do you think the Federal Government is doing enough to encourage the public to invest in aquaculture?

A. Yes, they give investors a place in the estate to develop multipurpose centre for – canning of fish, smoking etc. for export purposes.

Q. 11. If not, what do they need to do?

A. The previous government did, however, implementation was poor. With the new government, emphasis on agriculture will encourage farmers

Q. 12. What is being done to develop alternative feed ingredients?

- A. Local ingredients are cheap and in abundance, however not good quality feeds are formulated, as they do not float. Imported and good quality feeds are expensive, so we are looking for investors in that sector.

Appendix 6: Interview 2

Interview with the Chief Fisheries Officer (CFO) Federal Ministry of Agriculture

Date: 16/03/16

Q. 1. What is the role of aquaculture in the development of rural farmers?

A. Provision of infrastructures such as; roads, water, electricity. When you establish fish farms in the rural areas, you have to provide access roads, markets, electricity, and water.

- To increase the income and livelihood of the people e.g. schools in Kainji, hospitals, foreign exchange.
- Subsidiary industries are also established e.g. fish feed manufacturing industry, housing, eateries and restaurants, hospitality industries; such as hotels, motels, motor parks, improve transportation.
- Provide nutrition for farmers and locals

Q. 2. What are the measures in place to support fish farmers to improve their well-being, income, improve and intensify the diversity of their protein dietary intake?

A. Credit facility such as; soft loans with low interest, grants in cash and aids, technical support, policies/legislation are put in place, subsidies, input supply e.g. feeds, fish fingerlings, broodstock, culture facilities – medications, hormones, nets, ph meters, and aerators etc.

- Public private partnership (PPP) with the government, where the government leases farms and facilities to farmers for aquaculture production.
- Technical knowhow – we teach farmers various technologies and ideas on how to run the value chain from production to processing, storage and preservation and utilisation through to marketing.

Q. 3. What is the extent and growth pattern of R&D investments by the Government of the FCT and its environs?

A. We have moved from basic research to adopting and adapting to various researches on farmers' farm. The various technologies that have been developed by the universities and research institutes have been further tested and brought down to the farmers' level using the Agricultural Development Project (ADP) and similar outfits as conduct or clearing houses. They further put these technologies to tests using various modalities like **On Station Research (OSR)**, **On Farms Adaptive Research (OFAR)**, **Small Plots Adaptive Techniques (SPAT)**, and mass adoption using various fora to discuss and moderate this technologies and techniques. This fora includes; 1. Monthly technology review meeting (MTRM), 2. Fortnightly training (FNT), 3. Farmers' day, 4. Agricultural shows such as world food day etc.

- The extension agents are attached to groups of farmers to take the messages to them and also get feedback to the system, with this, a cross fertilisation of ideas is ensured. Technical messages such as; species types and combinations, fish stocking rates, various types of culture facilities, dimensions and materials to be used, growth analysis and studies, fish feed formulation, ingredients and feeding. Daily management of the culture systems, application rates of the various inputs and the measurements of the physical, chemical and the biological statuses of the culture facilities and the water there in. Fish breeding, broodstock selection, fingerlings production.
- The government has setup institutions with mandates to carryout relevant researches e.g. Nigerian institute for Oceanography and Marine Research (NIOMR) in Lagos. African Regional Aquaculture Centre (ARAC), Port Harcourt, and National Institute for Freshwater Fisheries Research (NIFFR) Kainji.

Q. 4. What is the impact of fish farming on the local environment?

A.

- There is a lot of awareness because of the extension officers and government
- Development of rural areas with infrastructure (open up)
- Income of farmers improve
- Livelihood sustained

Q. 5. Do you receive any support from external donors and agencies towards aquaculture development in the FCT?

A. Yes, e.g. from **Japanese International Cooperation for Africa** (JIGA). They give out pumping machines, technical support.

Q. 6. How effective has the "Federal Government's Fisheries and Aquaculture Transformation Agenda" been for fish farmers in utilising sustainable natural resources in the FCT through established centres such as, hatchery/fingerling production, processing plants, technology transfer centres, fish feed mills etc.

A. It is been effective; 2 hatchery and fingerling production centres have been established; 1 in Gwagwalada and 1 in Garki. National Aquaculture centre at Kuje, National Biotech Centre (with various ponds, processing facilities, feed mills, fingerling production) within Abuja Municipal Area Council (AMAC).

Q. 7. What is the long-term potential of aquaculture in the FCT (a) with or (b) without the support of the "Federal Government's Fisheries and Aquaculture Transformation Agenda"?

A. Many people are already practicing and take it as business not just a developmental project but business at sustainable level. With support or not, they can be on their own.

Q. 8. What are some of the major constraints for fish farmers in the FCT?

A.

1. Land space for aquacultural practice cannot be gotten easily due to competitive usage of space especially in the urban areas, e.g. some farmers have lost their farms for people practicing recreational parks and housing, even though they are wet lands which should have been used for aquacultural practices.
2. Credits (loans, grants, subsidies)
3. Access roads/transportation
4. Competitive markets (sometimes low prices has forced farmers to sell at ridiculous prices, thereby, losing their investment)
5. Processing equipment – smoking kiln, electricity etc.
6. Preservation – electricity and infrastructure for storage
7. Market – even the two designated fish markets have been turn to general markets, and lack of uniform pricing

Q. 9. How appropriate is government policies and institutional structures in terms of support for fish farmers?

A. Inappropriate – one of the policies in the FCT is that you cannot farm fish in homes, such should be removed. Because fish farming when well practiced can even promote the greenness and sustain environment using the expelled water from tanks to support green environment.

- The policy that fish should not be farmed in urban area is cutting the people out
- Import duties on feeds and associated ingredients should be removed
- Not many demonstration centres for people to copy
- Extension and adaptive research institutions such as ADP's are not well funded for the technology to be accessed and disseminated to the end user

Q. 10. Do you think the Federal Government is doing enough to encourage the public to invest in aquaculture?

A. No – grants that were given to the farmers are stopped. Only 64 farmers in the country have been given N15 million each to establish and develop their farms under the programme of fish farm estate development programme instituted by the federal government since 2009 because of insufficient budgetary allocation to the fisheries and agriculture department of the Federal Ministry of Agriculture and Rural Development, whereas, over 5 thousand applications from suitable farmers were received by the government.

- Just about 100 fingerling production centres have been built by the federal government in the last 10 years. This cannot supply the fingerling needs of the farmers. Government has not employed enough technical officers to take the messages to the farmers. The few officers on board are not well equipped with good extension tools like; vehicles, lap tops, good office accommodation and all what it takes to give good work delivery.

Q. 11. If not, what do they need to do?

A.

They should

1. Create enabling policies
2. Staff recruitment, capacity building of staff recruited (insufficient number in terms of quality and quantity)
3. Fund research institutes
4. Establish and sustenance of viable aquaculture technology transfer centres (ATTC)
5. Adequate monitoring and evaluating of existing private and government farms
6. Adequate certification and standisation of farms to meet up with best management practices in order that the fish and fish products could be acceptable for consumption and exports
7. Government should put in place standard hatcheries for development of broodstock, viable fingerlings in sufficient quantity
8. Provide credits, grants, subsidies, loans etc.

Q. 12. What is being done to develop alternative feed ingredients?

A. Even though not sufficient, government and private farmers have fabricated feed production equipment and are already producing feeds using locally source materials; such as, guinea corn, rice bran, maize offal, blood meal, soya bean, groundnut cake, amongst other foodstuff.

Appendix 6: Interview 3

Interview with the Chief Fisheries Officer (CFO) Abuja Agricultural Development Project (AADP)

Date: 24/02/16

Q. 1. What is the role of aquaculture in the development of rural farmers?

A. Is in the aspect of trying to produce viable fish fingerlings that grow very fast. Also, we help them in fish farm establishment. We try also to produce locally formulated feeds that are less expensive than the imported ones.

Q. 2. What are the measures in place to support fish farmers to improve their well-being, income, improve and intensify the diversity of their protein dietary intake?

A. The government through the fisheries department connect fish farmers to fish markets. We also teach them how they can process their products – through smoking of fish, construct smoking kiln for the farmers so that they can have some of this fish for their diet, to improve their dietary intake.

Q. 3. What is the extent and growth pattern of R&D investments by the Government of the FCT and its environs?

A. In the ADP setup, we are linked up with research bodies (collaborate), were we get new innovation, which is passed across to farmers (we act as middlemen).

Q. 4. What is the impact of fish farming on the local environment?

A. We discover that people (new) are coming into fish farming, imbibing the technology, making fish more readily available for FCT inhabitants.

Q. 5. Do you receive any support from external donors and agencies towards aquaculture development in the FCT?

A. We receive support from United States agency for International Development (USAID), West African Aquacultural Production Programme (WAAP) etc.

Q. 6. How effective has the "Federal Government's Fisheries and Aquaculture Transformation Agenda" been for fish farmers in utilising sustainable natural resources in the FCT through established centres such as, hatchery/fingerling production, processing plants, technology transfer centres, fish feed mills etc.

A. Not very effective, as farmers still source for feeds and fish outside the FCT.

Q. 7. What is the long-term potential of aquaculture in the FCT (a) with or (b) without the support of the "Federal Government's Fisheries and Aquaculture Transformation Agenda"?

A. There is potential for growth because the market is increasing yearly, fish is brought from neighbouring states into the FCT

Q. 8. What are some of the major constraints for fish farmers in the FCT?

A. Feeds – a lot of famers have stopped fish farming because of cost of feeds

Q. 9. How appropriate is government policies and institutional structures in terms of support for fish farmers?

A. In the area of fisheries laws and regulations to protect the natural ecosystem to avoid over fishing. Government also links farmers with financial institutions for loan (act as collateral). Although they are not doing much in this area, more needs to be done

Q. 10. Do you think the Federal Government is doing enough to encourage the public to invest in aquaculture?

A. They are doing something – we have a fish farm estate in one of the area council (Bwari). Also, we have a fish market in Municipal. However, more needs to be done in this regard

Q. 11. If not, what do they need to do?

A. More needs to be done by establishing fish markets and estates in all area councils

Q. 12. What is being done to develop alternative feed ingredients?

- A. The ADP for example, is formulating its own diet and the ingredients are assembled locally. Farmers are encouraged into farming of some of the ingredients (maize, soya bean etc.).

Appendix 6: Interview 4

Interview with the Principal Livestock Superintendent (PLS) Kuje Area Council, Abuja.

Date: 13/06/2017

Q. 1. What is the role of aquaculture in the development of rural farmers?

Actually, aquaculture is an important part of agriculture in rural area, especially fish.

To me every family both rich and poor benefits.

People cannot all afford meat, but they can afford fish, it's very important in the life of rural people. Both farmers benefit from fish. farmers use the opportunity to catch fish to make soup, it is very very important.

So far so good, it is mostly the cheapest source of protein, easy to come by and readily affordable by the public in the rural area.

Q. 2. What are the measures in place to support fish farmers to improve their well-being, income, improve and intensify the diversity of their protein dietary intake?

The reality is that, the council is supposed to provide e.g. store for storage, cold rooms etc..., but none is operational by the government, only the private sector.

But as an area council, last year we sensitised farmers in the need to go into fish farming. We organise training and retraining, we encourage as well.

Sometimes we select them for Argungu fishing festival. They go to competition and win prices. Kuje area council participated in 2012.

Q. 3. What is the extent and growth pattern of R&D investments by the Government of the FCT and its environs?

We are supposed to go and collect data from farmers, but there are challenges. Mobilisation is not there to go and get information, get samples to take to lab. We do get some data but may not align with vision of government. No extension services operational, no money is released, everything is grounded because of democracy.

We have a fishery department in Area 11, FDF and also Fisheries society of Nigeria (FISON).

Stakeholders meet in order to brainstorm to boost fish production in Nigeria. President Goodluck Jonathan was the patron. We also try to discourage catch of fingerlings and also encourage production of fish in the country.

Q. 4. What is the impact of fish farming on the local environment?

Highly positive, when you count 100 houses you find a fish farmer, even amongst people without the knowledge of fish farming. The impact is highly felt.

Fish farming's key element is water, without water it is difficult. The government encourage fish production for those areas that do not have water by providing boreholes, safety tanks for water purposes for fish production. We have this here through Fadama 3 Agricultural Development Project (ADP).

Q. 5. Do you receive any support from external donors and agencies towards aquaculture development in the FCT?

Yes, the Fadama 3 programme has been a counterpart. The United Nation Development Programme (UNDP) contributes their percentage, the government does it's share, and the farmers have their own contribution. The Federal Government release funds to farmers through cooperatives and credit facilities, and inputs e.g. tractors etc...

Q. 6. How effective has the "Federal Government's Fisheries and Aquaculture Transformation Agenda" been for fish farmers in utilising sustainable natural resources in the FCT through established centres such as, hatchery/fingerling production, processing plants, technology transfer centres, fish feed mills etc.

That programme kick started, but never went far. Part of why it was not successful was because most of production is done in the Western world. It was a good programme, but never went round, and the government that established it is no longer there. It worked also because the former president was a patron. However, with a political will, the programme can still be sustained, because it was very beneficial.

Although, on periodic basis, we the extension officers are called for training and seminar workshops to acquire more information on technology, most time it comes late e.g. fish/poultry training and those into fish farming are invited to the council to enlighten them on new technology. Some of these workshops took place in Kaduna and Ilorin.

Q. 7. What is the long-term potential of aquaculture in the FCT (a) with or (b) without the support of the "Federal Government's Fisheries and Aquaculture Transformation Agenda"?

I think the future for fish farming in Kuje with or without government support is very very bright. Most of the farmers started without the government e.g. people need fertilisers, but they still are farming, the result will be expensive food since the price of such commodity was high.

Q. 8. What are some of the major constraints for fish farmers in the FCT?

Finance and technical knowhow. Some parts of the FCT are not prom to water supply. Water is crucial to fish production. A lot of commercial farmers present in Kuje area council are trained by the council who cover for lack of resources. There is no budget for projects that will benefit farmers. Furthermore, bad roads to transport fish to the market and inability to preserve goods.

Q. 9. How appropriate is government policies and institutional structures in terms of support for fish farmers?

The policies are there, but the problem is implementation. Difficulties in accessing funds because the farmers are rural and poor, makes it difficult for farmers to improve aquaculture.

Lack of appropriate policies and bureaucracies causes bottlenecks for beneficiaries. It is so sad, the people to ensure that these materials reach the beneficiaries are the ones who divert these materials. Farmers become victims because of the problem of corruption.

Q. 10. Do you think the Federal Government is doing enough to encourage the public to invest in aquaculture?

There are a lot of encouragement, but the rural people do not have access. All is done in the federal level, and also, the vision of the administrators in the local level (Chairmen) is not enough towards fish farming.

However, they mobilise farmers on local level to access some support. I think the reason they are trying is because of the hunger rampaging countries around. Now even the Youth corpsers are sent to farms just to encourage farming. There is sensitisation through loans for people to go back to farming, though not enough.

Q. 11. If not, what do they need to do?

To create awareness, encourage them to create cooperatives, so they can access funding at the state and federal level. To continue to sensitise people and make facilities like agricultural loans available for people to go back to farming.

Q. 12. What is being done to develop alternative feed ingredients?

In FCT, the production of feed for fish is by private companies or feed millers. Individual trained farmers are doing something in that regards, they have that idea e.g. my wife have poultry farm and she compounds her own feeds. I also discovered that even the illiterate are borrowing that skill to compound their feed. Some buy corn chaff in several bags and mix with concentrate and give to fish, some buy feed and mix corn chaff.

The feeds are expensive, so we encourage local farmers to use local feeds to feed fish. They use alternatives like; maggots, maize and rice chaff. The government need to encourage people who have technical skills to develop fish feed using local ingredients like cassava back, palm kernel chaff etc...

Appendix 6: Interview 5

Interview with the Divisional Head Veterinary Services, Gwagwalada Area Council, Abuja.

Date: 19/06/2017

Q. 1. What is the role of aquaculture in the development of rural farmers?

Well, you know, here in this part of the country there are a lot of natural fishing that is ongoing. Most of the fish farmers are not many, but those involved use it as a source of income. Because farmers get fish fingerlings at the rate of ₦50.00 and sale the table size for about ₦1,000.00, there is less expenses in farming fish compare to poultry farming. The most important thing is to have water, they rarely use drugs, so the outcome is much more than other farming method. This depends on the system you use e.g. earthen, concrete or plastic where they grow their fish. Most of their problem is management, most farmers venture into the venture without knowhow, they only seek assistance when they begin to have problems.

In addition, to the development of rural farmers, aquaculture serves as a simple farming activity that they can do to earn their daily bread, depending on how buoyant the farmer is. He can decide on hundreds or thousands of fish. a farmer can remain in his village and farm fish, then buyers will go and buy on the farm. So, this activity help us control urban migration and at the same time, control youth redundancy.

Q. 2. What are the measures in place to support fish farmers to improve their well-being, income, improve and intensify the diversity of their protein dietary intake?

At our level (area council), we do have quarterly briefing where we invite farmers, we sensitise them, we treat topic by topic with other group of livestock farmers, as well as encourage them. Also, we work in collaboration with NGO's that train participants on fish farming. They organise and teach them how to do fish farming and this people are from the grassroot level, people who are unemployed and we encourage the government to equip them to start their farms.

Q. 3. What is the extent and growth pattern of R&D investments by the Government of the FCT and its environs?

In terms of R&D, like I told you before now that we do what we call quarterly briefing to farmers which is like training farmers. Presenters do research before presenting their papers. Sometimes we do have agriculture shows for both national and local level. We at the local government level take from our product and present gifts to people for first and second positions. Also, you students from universities and other colleges around, come for attachment and are taught fish farming production from hatchery production, stocking juveniles to table size level.

Q. 4. What is the impact of fish farming on the local environment?

So, to say, fish farming has improved protein intake of the local residents. With the level of poverty in the area, fish is cheaper protein source, it helps the local environment. At the same time, red meat is not good for some people, so they eat fish, particularly, white fish. And the wild fish is not enough, so aquaculture bridge the gap. For particularly people at low level income, it is a good source of protein. The percentage of people on low income is more than those on high income. A house can buy ₦100.00 fish and prepare a meal for the whole family. Another advantage fish has over other sources of protein is how it is smoked, sun dried and kept for longer than other sources of protein.

Q. 5. Do you receive any support from external donors and agencies towards aquaculture development in the FCT?

The NGO's train farmers, but from my experience, there is not been any financial support from the NGO's.

Q. 6. How effective has the "Federal Government's Fisheries and Aquaculture Transformation Agenda" been for fish farmers in utilising sustainable natural resources in the FCT through established centres such as, hatchery/fingerling production, processing plants, technology transfer centres, fish feed mills etc.

Well, they are doing their best, it is by their efforts we source our broodstock. If you are into fish production, you need a parent stock, and this has to be best or full breed. In this part of the country we are into catfish production, and to get good seed you need at least a year, old parent to hatch and get the best seed without any problems. Because if you use under age parent, you will encounter problems of mass mortality or stunted growth. So, it is from these government agencies that we source parent stock. Some farmers are not into hatchery production, they buy their fingerlings or juveniles from the government agencies. Particularly, when we go to agricultural show programmes, these products are **being** exploited. Sometimes at local government level we buy the best product and give out to our farmers, so that the subsequent year, we can show case our product during agricultural shows.

Q. 7. What is the long-term potential of aquaculture in the FCT (a) with or (b) without the support of the "Federal Government's Fisheries and Aquaculture Transformation Agenda"?

What can I say, a number of people are leaving their jobs and getting on with the lucrative business in fish farming. Day in day out, we receive farmers that come for advice towards fish farming. So, with this scenario, I want to believe that fish farming is widening. Especially with the recent government policy that says everybody should go back to farming. So, even people in town do not wait until they get a farm, they use their backyard for fish farming through the use of plastic containers. Fish farming is not narrowing, people are getting awareness about fish farming. Like me as an example, I do buy fish in bulk for my family consumption, I prefer fish to meat.

Q. 8. What are some of the major constraints for fish farmers in the FCT?

Well, like I told you, majority of these farmers are local people without capital, if they are to be empowered by the government or any NGO, of course it will boost fish farming in the country at large. A number of them are interested in the venture, but lack of technical knowhow, poverty and lack of awareness has hindered them from practicing fish farming. They can not employ professionals to help, so they go around asking for advice from the professionals. Like I said, there was an NGO that came up with a programme to train youths into fish farming, that has been one of the best methods of alleviating poverty in the area.

Q. 9. How appropriate is government policies and institutional structures in terms of support for fish farmers?

Well, when you are talking about fish farming at the grassroot level and institutions, most of these farmers have never been to school. So, farmers in the local level do not know anything like this. However, if all this is put in place, there will be a bumper harvest. All their operation at the moment is semi intensive farming. I hope professionals will come in to improve this.

Q. 10. Do you think the Federal Government is doing enough to encourage the public to invest in aquaculture?

Well, particularly the present government are doing their best, but there is also room for them to do more.

Q. 11. If not, what do they need to do?

My advice goes like this, in the country entirely, most of our farmers **dwell** on catfish farming. So, if the government agencies will introduce other fish species, this will improve the farming entirely. At the same time, there is the need for government to identify fish farmers in their locality and provide fish seedlings directly to the farmers. Fish farmers get fish seedlings from business people at more costs. More training needs to be encouraged, either formally or informally.

Q. 12. What is being done to develop alternative feed ingredients?

We encourage farmers, we provide them with the formula and they can get all the materials from the local market (e.g. corn, soybeans, groundnut cake etc...). Recently, our local technician has fabricated fish feed milling machine; including mixer and pelletiser. So, this gave us an opportunity to compound our own local feed. So, like I told you, we give them formula, e.g. we ask them to buy the quantity needed to arrive at a tonne or half a tonne as the case may be. Then we use this feed milling machine to grind them all together, passing through mixer to make sure is fully mixed before it will be subjected into pelleting machine. This method helps us to cut down buying finished feed at the rate of 50 percent. At the same time, there is a way we produce planktons for juveniles in particular, when newly introduced into ponds.

Appendix 6: Interview 6

Interview with the Head of Section Fisheries Department, Municipal Area Council, Abuja.

Date: 19/06/2017

Q. 1. What is the role of aquaculture in the development of rural farmers?

You know eeh... fish is very important for human consumption. You know nowadays many people have run away from red meat and fish is recommended for people from middle age up – it is very important.

Q. 2. What are the measures in place to support fish farmers to improve their well-being, income, improve and intensify the diversity of their protein dietary intake?

The majors in place – government is in support and that is why they say people especially farmers should register as cooperatives to come out with what they want to do. If a group is formed and they go to the government, they will be given the amount they demand.

Q. 3. What is the extent and growth pattern of R&D investments by the Government of the FCT and its environs?

At our own level, we have not experienced that. The local government does not invest in R&D.

Q. 4. What is the impact of fish farming on the local environment?

The impact is so much. Now there is limited employment, so many graduates are roaming about without jobs, so this another source of employment. Many people are interested in fish farming in particular.

Q. 5. Do you receive any support from external donors and agencies towards aquaculture development in the FCT?

No, we have not.

Q. 6. How effective has the “Federal Government’s Fisheries and Aquaculture Transformation Agenda” been for fish farmers in utilising sustainable natural resources in the FCT through established centres such as, hatchery/fingerling production, processing plants, technology transfer centres, fish feed mills etc.

We are the grassroot, we don’t know, because we have not benefited from the Federal Government or Federal Department of Fisheries. They have not contacted us and we have no contact with them either.

Q. 7. What is the long-term potential of aquaculture in the FCT (a) with or (b) without the support of the “Federal Government’s Fisheries and Aquaculture Transformation Agenda”?

Long term potential – in agriculture, nothing is coming out like fisheries. People are willing, but the problem we have is land. Even us as a local government, it is difficult to acquire land, if not people are interested in fish farming.

Q. 8. What are some of the major constraints for fish farmers in the FCT?

Land, security and finance.

Q. 9. How appropriate is government policies and institutional structures in terms of support for fish farmers?

Government is interested because it wants people to go into farming so that unemployment will reduce. So, government is making everything possible for people to be able to go into fish farming.

Q. 10. Do you think the Federal Government is doing enough to encourage the public to invest in aquaculture?

They should have done more, but because of land issues. We do not issue land to people, even the council has no land to do farming. Land brought so much confusion. People have misused the privileges that was given to the council, so it was taken away.

Q. 11. If not, what do they need to do?

The problem is continuity of top-down rules and regulations, e.g. the last Minister of the FCT killed the Area councils. Lands that were allocated during the establishment of the councils were revoked by the then administration and people became stranded.

Q. 12. What is being done to develop alternative feed ingredients?

Something will be done as fish farming is coming up. There are people who are going into fish feed production, we just have to encourage people. So, gradually, as fish farming is coming up, people are going into feed production.

Appendix 6: Interview 7

Interview with the Divisional Head Veterinary Services, Kwali Area Council, Abuja.

Date: 20/06/2017

Q. 1. What is the role of aquaculture in the development of rural farmers?

- A. This serves as a protein source to the population (food).
- B. It serves as sources of income to peasant farmers.
- C. It provides employment to the rural area.

Q. 2. What are the measures in place to support fish farmers to improve their well-being, income, improve and intensify the diversity of their protein dietary intake?

- A. Accessibility of seedlings to farmers.
- B. Provision of loan by the government to farmers.
- C. Education on how to go about farming fish through extension services.

Q. 3. What is the extent and growth pattern of R&D investments by the Government of the FCT and its environs?

Government is not doing much in the area of R&D.

Q. 4. What is the impact of fish farming on the local environment?

- A. Source of protein.
- B. Source of income.
- C. Self-employment.

Q. 5. Do you receive any support from external donors and agencies towards aquaculture development in the FCT?

No.

Q. 6. How effective has the "Federal Government's Fisheries and Aquaculture Transformation Agenda" been for fish farmers in utilising sustainable natural resources in the FCT through established centres such as, hatchery/fingerling production, processing plants, technology transfer centres, fish feed mills etc.

Not effective.

Q. 7. What is the long-term potential of aquaculture in the FCT (a) with or (b) without the support of the "Federal Government's Fisheries and Aquaculture Transformation Agenda"?

With or without support, there is potential for fish farming.

Q. 8. What are some of the major constraints for fish farmers in the FCT?

A. Lack of funds.

B. Lack of feeds (expensive), and they travel faraway to get feeds.

C. Lack of expertise/technical knowledge

Q. 9. How appropriate is government policies and institutional structures in terms of support for fish farmers?

Lack of resources from government makes it difficult for training and retraining of fish farmers in the council.

Q. 10. Do you think the Federal Government is doing enough to encourage the public to invest in aquaculture?

No.

Q. 11. If not, what do they need to do?

A. Provide funds to Area councils.

B. Train farmers and staff.

Q. 12. What is being done to develop alternative feed ingredients?

Nothing is being done at the moment.

Appendix 7: Photographs from field work



Feeding of fish during farm visit



Fish ready for harvest during field trip



Smoking kilns on a farm during field visit



Fingerlings in a pond during field visit



An earthen pond stock with catfish