

**ECONOMICS OF FRESHWATER FISH FARMING AND LIVELIHOOD SUSTAINABILITY
AMONG FRESHWATER FISH FARMERS IN BAYELSA STATE, NIGERIA**

BY

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CERTIFICATION

This is to certify that this work “Economics of Freshwater Fish Farming and Livelihood Sustainability Among Freshwater Fish Farmers in Bayelsa State, Nigeria”, was carried out by Wasini Dobie Allen (Reg. No. 20104749138) in partial fulfillment of the requirements for the award of Master of Science (MSc.) Degree in Agricultural Economics.



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DEDICATION

To God Almighty and my Mum Mrs. Punumokumo Wasini.

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ABSTRACT

This study analyzed the economics of freshwater fish farming and livelihood sustainability among freshwater fish farmers in Bayelsa State. A multistage sampling technique was used to select fifteen fish farmers, from the list of registered freshwater fish farmers in each of the Local Government Areas selected. Structured questionnaire was used for data collection on the socio-economic characteristics of the fish farmers, their fish farming practices, costs and returns of fish farming as well as the factors that determined the output of the enterprise. Data on livelihood sustainability were also collected. Descriptive statistics, the net farm income model, indices and the multiple regression model were the analytical tools used. Findings from the study showed that 95% of the fish farmers were men. Most of them were married (91.66%), with a mean age of 54 years. The mean household size was 9 persons. Most of them are literates having spent an average of 12.8 years at formal school. All (100%) the fish farmers had other income sources. The mean years of experience was 6-10 years. Consumption and sale is the major reason the fish farmers went into fish farming. All of them (100%) practiced the semi-intensive level of management. The major nature of enclosure in the study area is concrete and earthen ponds. Majority (91.67%) of the fish farmers practiced the monoculture system of stocking. The catfish species was the major fish species cultured in Bayelsa State. Generally most of the fish farmers operated fairly large scale enterprises. The average net farm income of the fish farmers was positive (₦ 887,725.39). The multiple regression analysis indicated that cost of fingerlings, cost of feeding, size of fish farm and level of education were the factors that significantly affected the net return of the fish farmers at the 5% level of significance. Freshwater fish farming was found to be sustainable on the average, given the sustainability scores (environmental, social, institutional and economic) generated from the study. The major challenges faced by the fish farmers were high cost of fish feeds (100%), no good patronage from customers (100%), no good fish markets (100%) and the unavailability of training/research centers (100%). It was found that freshwater fish farming was a profitable business; there is therefore need for the creation of awareness and orientation about the profitability of the fishery enterprise and its overall importance in food security, livelihood sustainability and economic development.

Key Words: Fish farming, costs and returns, Fish farming practices, livelihood, sustainability, Bayelsa State.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The act of fish farming is growing; increasing by more than 10% per year and accounting for more than 54.6% of all fish consumed worldwide (FAO, 2014). While the world community has only recently viewed fish farming as a potential solution to the dilemma of depleted oceans, it is by no means a new practice. It most likely grew out of necessity, as foraging and hunting were not sufficient to provide a stable source of food to local communities.

Worldwide consumption of fish as food has undergone major changes, from an average per capita consumption of 9.9 kg in the 1960s to about 17 kg per person as of 2011 (Food and Agriculture Organization (FAO, 2011a) . With the decline in capture fisheries, fish farming which is a form of aquaculture i.e. the farming of aquatic organisms, including fish, crustaceans, molluscs and aquatic plants (Halwart, 2000), offers one way to supplement the production of wild capture fisheries.

It was not until after World War II that aquaculture gained much attention as a potentially large scale industry worldwide, with significant increase in production from about 3.9 percent in 1970 to 27.3 percent in 2000 (FAO, 2002) . In the 1960's, the act of fish farming became a significant commercial practice in Asia, where it had mainly been used as a small-scale means of local community food production for thousands of years (Kathryn *et al.*, 2004). In Africa, fish culture was first introduced over 50 years ago and presently, Nigeria is the leading producer followed by Madagascar and Zambia respectively. According to Coche, (1998) the activity is estimated to be 95% small scale, with fish ponds integrated into the paucity of agricultural activities. This is because currently, most fishery enhancement activities in Africa are generally private initiatives, either at the village level or at the farm level. In

Bayelsa State, the activity is still at a subsistence level involving mostly digging seasonal ponds in the well developed fresh water flood plains and swamps to retain fish at the recession of the flood water with little or no management, with subsequent low yields (Sikoki and Otobotekere, 1999, Aghoghovwia and Ohimain, 2015).

As an economic activity; awareness on the indispensability and sustainability of fish farming is also growing (FAO, 2005a). Through employment and income generation from fish farming, and subsequent higher purchasing power, fish farming households often improve their diets through increased food accessibility (Jacobi, 2013). Dey *et al.*, (2006) for example in Malawi found that the income of households owning fish ponds was 1.5 times higher than that of households without fish ponds. Hishamunda and Ridler in 2006 also showed in Zimbabwe that commercial tilapia farms were capable of providing jobs and incomes to the farmers in the region. Furthermore, it seems particularly successful to combine fish farming with other activities: Profits of fish farmers who combined fish farming with rice farming almost doubled (Kawarazuka and Bene, 2010; Aiga *et al.*, 2009).

Certain food products are bought more frequently because of a better income situation of the farmers through fish farming. Several recent studies highlight this trend: Household incomes from fish farming increase the consumption of staple foods (Jahan, *et al.*, 2010) and foods from animal sources (Dey *et al.*, 2006; Alderman, 1986), increasing the total energy intake of the fish farming households (Kawarazuka and Bene, 2010). Another reason for often observed increases in meat consumption could be that farmers, through incomes from fish farming, have more money to keep livestock on their farms for home consumption: Neiland *et al.*, (2000) for example show in a study in North-East Nigeria that increased income (from fishing) was used as input for farming resulting in the fishing households to have a higher farm-productivity.

Fish farming is generally been dominated by men while women and children predominate in pond management activities, fish processing, value-adding and post-production processes (Hino, 2011) as seen in Africa, where the activity is seen to be creating employment for underprivileged groups, e.g. women and young people (Hino, 2011; Jagger and Pender, 2001). Gender disparities not only affect the livelihoods of women themselves, but also livelihoods of the entire household and community, hence women are advised to engage actively in extension practices. (Jagger and Pender 2001; Weeratunge *et al.*, 2010)

However, with the increasing contributions of fish farming to livelihood sustenance, marine and fresh water catches declining, local consumers turning to farmed fishes for protein requirements; fish farming production still remains small and unable to meet the demands of consumers (Taiwo, 2011), even in the study area where enormous opportunities abound, (Partnership Initiatives in the Niger Delta, 2011).

Most fish farmers lack information on how to assess and determine the profitability of their farms; the fish farmers in Bayelsa State inclusive. Thus causing uncertainty and conservative behaviours amongst existing and potential fish farmers on investing in the enterprise. This means they have doubts on whether fish farming as a business venture is economically viable (Okechi, 2004). The prevailing marketing dynamics have not helped either as the farmers have been unable to assemble sufficient volume to attract serious and stable buyers, hence fish-farmers generally rely on a multitude of roving wholesalers and traders, who are opportunistic and purchase with little regard for quality or long-term partnership (Ekpebu *et al.*, 2009).

According to a report by the Food and Agriculture Organization (FAO) in 2005, even though there is often very little precise information about the real contribution of fish farming to livelihoods and economies in developing countries, and although many fish farmers are usually seen as poor and vulnerable, it is now widely acknowledged that, fish farming aside providing good sources of food

products to people, can generate significant profits and can make meaningful contributions to poverty alleviation and food security. According to Agboola (2011), pond fish culture in Nigeria is a viable enterprise. He stated that a well-built fish dam was a lifetime investment capable of fully paying back its fixed (investment) cost in 5 to 10 years at the maximum. He also compared the ability of fish farms to meet protein needs with that of leguminous crops in Nigeria and concluded that, in a well-managed fish farm, up to 3000 kg of fish could be harvested annually on a sustainable yield basis per hectare. This is six times more than cowpea and three times more than peanut for the same unit area. This is not suggesting that fish farms should replace crops, but at least, it shows that fish farming does not pay less than crops.

Fish farming generates income for the owner and is a viable business (World Bank, 2008). To add, it is an antidote to environmentally induced conflicts; and by extension a source of peace among rural dwellers especially in Bayelsa State. It is an unbreakable source/link to life sustenance for the Bayelsan (Ibaba and Olumati, 2009). This means that, with the prices of alternative meat protein sources soaring in Bayelsa State, the demand for fish products increasing especially in restaurants and markets (Kainga and Adeyemo, 2012), coupled with the dwindling nature of catches from capture fisheries as a result of oil exploration activities, and the wellbeing of various communities being compromised because their major livelihood source “capture fisheries” has become unsustainable and unreliable as a result of oil exploration activities (Ibaba and Olumati, 2009); it is high time fish farming received attention in the state.

1.2 Statement of Problem

According to Dan (2001), the World Resources for 2000-2001 indicates that 25% of the world’s fish stocks are over harvested and another 44% are at the edge of what can be maintained. Ecological theories attest to this fact, as they suggest that the world’s natural stocks of fish, though renewable, have

finite production limits, which cannot be exceeded even under the best management regimes (Okechi, 2004). In May 2003, an article also came out, where scientists showed that overfishing and utilization of destructive fishing practices leads to depletion of marine species, hence the disappearance of over 90% of large predatory fisheries in the global ocean (Myers and Worm, 2003).

Fisheries are a major food source for the world population. It represents the foci of the livelihood activities of most coastal communities. About 98% of the populations of these communities depend on fishing and fishery related activities for sustenance, asset and investment capital; and about 75% of their animal protein intake comes from fisheries (Alexandra, 2007). Capture fisheries is now a dwindling resource given a variety of factors (Partnership Initiatives in the Niger Delta, 2011). It has also become an unsustainable and unreliable livelihood source, especially in affluent regions like Bayelsa State, where the negative impacts of oil and industrial activities on the aquatic ecosystem have been a major contributor to the decline in capture fisheries (Ibaba and Olumati, 2009).

For the fact that the maximum sustainable fishing limit has been exceeded for most of our water bodies (FAO, 2000), fish production will now depend on artificial breeding, if fishes must be made available to humans (Tacon, 2001). This is a welcome development, as fish farming has proven to increase the production of fish above the level that can be produced naturally. The Food and Agriculture Organization (2005) attested to this fact, as it reports that, the overall decline in capture fisheries was being offset by continued increase in production of farmed fish, which topped 30 million metric tons, representing almost a three-fold increase in the past ten years (1988-1998).

However, fish farming, has not yet become the large-scale global food replacement for the numerous food-poor areas of the world, as many thought it would be (Kathryn *et al.*, 2004). In Bayelsa state, like in most parts of the country, it is still practiced by private individuals (Bayelsa State Ministry of Agriculture, 2012); hence its expansion has been a slow process. This is because majority of the private

sector fish farmers are resource poor, therefore they are small-scale operators. The small scale nature of the enterprise in turn, results in little or no returns and significantly lowers their standard of living (Sikoki and Otobotekere, 1999, Aghoghovwia and Ohimain, 2015). The inability of most fish farmers to have access to information on how to assess the profitability of their farms is also said to be partly hampering the development of fish farming worldwide. This in turn has led to potential farmers not opting into fish farming and even others becoming inactive. Furthermore, financing institutions are not keen to give loans to farmers whose enterprise profitability has not been feasibly appraised (Okechi, 2004).

Fish farming potentially provides high economic returns and social benefits. This means it can greatly benefit the poor through meeting their needs, including food security, poverty reduction, sustainable livelihoods, and community development, (FAO, 2000). However, with all the industry's explosive growth and potential benefits, fish farming can also carry risks. Much of the world's initial aquaculture development occurred during times when technical capacity, governance, policy, and oversight were weak. In some cases, this led to fledgling industries where inefficiencies and unguided development produced large-scale negative environmental, social, and economic impacts threatening the sustainability of the sector itself (USAID, 2013).

Too often, small-scale or family-operated fish farms have been edged out by large industrial-scale farms. The major economic contribution of these large facilities to a local community is often low-wage jobs, such as in processing plants. In many cases, most of the benefits from fish farming have gone to outside investors. Another concern is the potential loss of local low-cost food production in favour of high-value commodity exports. Fish farming has also been responsible for introducing exotic and invasive animals, plants, and diseases around the world, often inadvertently through development assistance. Ecosystems have been disrupted by these invasive species or diseases, leading to reduced productivity of natural

systems, loss of local livelihoods, and threats to local or even national economies (FAO, 2014, USAID, 2013). With intensive farming and the addition of more feeds and inputs, as required with high intensity culture, the potential for producing more effluents, disease, and pollution can rise considerably. As more species are cultured, genetic stocks are transported around the world, creating the risk of escape of cultured stocks into the wild (USAID, 2013).

This work therefore speaks to the need for the aquaculture sector to continue to play a responsible role in addressing the food and livelihood challenges of today and tomorrow. A key message is that there is need for reform in many segments of the fish farming, in order to promote more responsible development. This in turn requires an integrated view of fish farming, one that considers not only environmental, social and economic sustainability, but also institutional responsibility.

1.3 Objectives of the Study

The broad objective of this study was to analyze the economics of freshwater fish farming and livelihood sustainability among freshwater fish farmers in Bayelsa State, Nigeria.

The specific objectives were to;

- i. examine the socio-economic characteristics of the fish farmers in the study area,
- ii. identify and describe the types of fish farming practices/systems, the inputs employed in fish farming and the types of fishes produced,
- iii. determine the net returns of fish farming,
- iv. isolate and analyze the determinants of net returns,
- v. assess the livelihood sustenance strategies of the fish farmers, and
- vi. identify the production constraints to fish farming.

1.4 Hypotheses of the Study

The hypotheses tested were;

1. Net return generated by the fish farmers in Bayelsa State is not positively related to the cost of fertilizer, cost of fingerlings, cost of hired labour, family labour, cost of feeding, size of fish farm and production experience.
2. Net return generated by the fish farmers in Bayelsa State is not positively related to sex, age, household size, level of education, fish farming experience and size of fish farm of the fish farmers.

1.5 Justification for the Study

With the prevalent economic situation in Nigeria, there is a need to engage in a result oriented, highly sustainable and economically viable agricultural system, that can help meet the demands of the ever increasing Nigerian population. The information generated from this study will thus provide farmers with evidence and appropriate tools to determine the profitability of their fish farms. Potential fish farmers will find the information from this study useful as it will aid them in their enterprise selection and production decisions. It will also help lending institutions to better assess the viability of fish farming projects. Policy makers will use these findings too to plan effectively for sustainable fishery programmes since the findings will expose the inherent and peculiar characteristics of the fish farmers and the problems they face as well as the problems peculiar to Bayelsa State. Researchers who want to do further work on fish farming and livelihood studies, will find this work useful as a reference material. The findings will also give extension agents good background information about the fishing communities in Bayelsa State and a systematic approach in carrying out extension programmes. The general public will also benefit from this study as it would provide information on profitability or otherwise of fish farming in the study area. This study has indeed, added to existing knowledge on fish farming and livelihood sustainability in the study area.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Framework

2.1.1 The Concept of Fish Farming

Fish farming is the rearing of fish in ponds, cages and other enclosures in water (The Free Library, 2012). Globally, it is the most important source of animal protein. Locally farmed fish is also being preferred to imported fish, because of their low cost and because their size and freshness are attractive to consumers (Grosse, 2009).

People have long regarded the oceans as vast with inexhaustible sources of fish – a view reinforced by the copious catches of the past. Even when fish became harder to catch, many people continued to assume that more fish were available. In the past decade or two, this view of fisheries has been transformed. Fisheries statistics suggest that annual global fish catches have plateaued at roughly 90 million metric tons per year (FAO, 2002), or may even be declining. Fisheries depletion has created new impetus to expand seafood production through fish farming, often known as aquaculture (Rebecca and Rosamond, 2005), as it is highly unlikely that wild capture fisheries will be able to produce higher yields in the future.

During the 1970s, fish farming was a relatively insignificant industry, but today, it is as productive as the ocean fishing sector and even more. About 600 aquatic species are now raised in captivity, with different species being preferred for different regions. Experts predict that the importance of fish farming will increase even more in the future, because it has clear advantages over beef and pork production (World Ocean Review 2, 2013).

The global population is growing at a breathtaking pace. In 1950, the world had a total of 2.5 billion people, a figure that had burgeoned to 7 billion by 2012. According to the United Nations estimates, this number could exceed the 9 billion mark by mid-century. As populations increase, so too does the need for food. Fish is a widespread, affordable and healthy source of valuable protein. There is no question, therefore, that the global demand for fish will intensify in future (World Ocean Review 2, 2013).

When we consider that the amount of wild-captured fish has not increased in recent years, only one alternative remains: fish farming or aquaculture, must fill the gap. For many years the act of farming aquatic organisms has played a relatively minor role in global fish production, but its significance has increased dramatically over the past 20 years, spurred by the demand for food from Asia's fast-growing populations. Today, it makes a major contribution to human nutrition. Although it is difficult to estimate the number of people directly involved in fish farming production for lack of statistical information, especially on a global basis, it also serves as an alternative livelihood opportunity to many people all over the world. China's 350,000 people employed in its 22,000 village-operated fish farms and the Philippines' approximately 250,000 fish pond employees, give some indications as to the magnitude of this industry's labour force (in the form of cage operators, caretakers, construction workers, pump tenders, vehicle/machine operators, harvesting aides) or indirectly as employees in related or ancillary industries (as net manufacturers, boat-makers, fry gatherers, bamboo suppliers) (FAO, 2009).

Artificial fish production is now about three quarters of that from ocean fish and sea food caught in the wild. In 2011, this amounted to 78.9 million tonnes. No other food industry has shown such growth as this industry in recent decades. Between 1970 and 2008, annual production worldwide increased by an average of 8.4 per cent; much more than poultry farming and egg production, which have the second highest growth rates after it. This confirms the fact that, fish farming, is proving to increase the production of fish above the level that can be produced naturally (FAO, 2005a).

Fish farming is not equally important in all countries and all regions. For instance, central Europe in general prefers its fish to be caught in the wild. In China on the other hand, fish farming is widespread and has enjoyed a millennia long tradition, since carp were first domesticated. China is still the undisputed leader in farmed fish production in the world (World Ocean Review 2, 2013). Since 1970, it has recorded annual growth rates in production of an average of 10 per cent, although recently these have slowed to about 6 per cent. Today, 61 per cent of global production comes from China, with Asia as a whole supplying a massive 89 per cent. The proportion generated in the other world regions is therefore small. Europe and America produced approximately 2.5 million tonnes each in 2010, Africa a little below 1.3 million tonnes and Oceania less than 200,000 tonnes. Africa is still at an embryonic stage, and its potential is far from being exploited. However, developments in Africa are of paramount interest. Although production was barely 1.3 million tonnes in 2010, experts nonetheless expect to see fish farming become further established in Africa production (World Ocean Review 2, 2013).

In Nigeria, fish farming as a form of aquaculture is gaining increasing importance for employment creation and income generation, particularly in the socio-economically weaker communities of fishermen, which represents the poorest sections of the society in many developing countries (National Informatics Centre NIC, 2007). According to Afolabi and Fagbenro (1998), two major constraints to the establishment of fish culture enterprises in Nigeria are; Lack of initial capital input and the acquisition and ownership of land. Hence, it has become prohibitive and unaffordable especially in urban centers where competing and conflicting uses with pond fish culture exists. Imoudu (1999), in his own opinion said that, despite the high rental price of land, its availability in urban centers is limited to commercial, industrial, residential and recreational uses with little or no consideration for agricultural food production. According to Otubusin (1998), it is inadequate fish seed supply that is a major constraint to fish farming development in Nigeria. Others say, feed represents the most important component of commercial fish farming expenses being responsible for 60 -80% of total running cost. However,

findings from the Food and Agriculture Organization FAO, in (2004) , proves that in spite of the escalation in construction and operational costs, fish farming is still profitable and is a good source of livelihood.

2.1.2 The Nigerian Fisheries Sector and its Economy

The Nigerian fisheries sector is made up of capture fisheries and aquaculture. Capture fisheries encompasses both marine and inland fisheries. Nigerian marine sector has been on the downward slope for a number of years. Artisanal fishing within the inland waterways also show signs of decline, since the river systems are now over-exploited due to obnoxious capture fishing methods which include the use of undersized nets, chemicals, dynamites and destructions of nursery grounds (Partnership Initiatives in the Niger Delta, 2011). Nigeria's river system cannot therefore sustain any serious agri-business in capture fisheries to meet the burgeoning fish demand of the country's growing populace (Ovie and Raji, 2006).

Consequently, aquaculture has been rapidly expanding to meet the demand shortfall caused by decline in capture fisheries (FDF, 2005). It is significant to the nation's economy in terms of food security, income, employment, poverty alleviation, foreign exchange earnings and provision of raw materials (protein source) for animal feed industries. Nigeria has a huge appetite for fish. It is the commonest and cheapest source of protein for the teeming Nigeria's poor populace, estimated to be between 65-70% of the entire population, with current consumption standing at 1.2 million metric tons. Of the current annual demand of 1.5 million metric tons, the country only produces 511,000 metric tons, leaving an annual deficit of about a million metric tons, which the country imports annually to meet domestic consumption needs, (Ovie and Raji, 2006). It is estimated that over 10 million Nigerians are engaged in primary and secondary fisheries activities as fishers, fish farmers, fish processors, marketers, fishing boat builders, gear fabricators and menders, operators on board industrial fishing fleet, terminal/jetties operators, in-

and-outboard engines repairers and a host of other ancillary actors that derive their livelihoods from the fisheries (Ovie and Raji, 2006).. The craving or appetite for fish is on the increase in Nigeria given its implication for individual and national health. Fish contains Omega III fatty acids that are known to reduce cardiovascular diseases, hypertension and arteriosclerosis, thus becoming a preferred source of animal protein for those nearing 50 years of age and above. Omega III fatty acids are also known to enhance good brain cell development in developing foetus, (thus a vital diet for pregnant women) and intelligent Quotient (IQ) in developing children (FDF, 2005). From the foregoing, it is evident that fish and fisheries are crucial to the economy and health of the nation.

2.1.3 Status of Fish Farming in the Niger Delta

The Niger Deltans are primarily fishermen, who also engage in fish related activities like fish processing, fish transportation, gear manufacture and subsistence fish farming, hence they depend mostly on fish for their livelihoods and food (Akinrotimi *et al.*, 2007).

Niger Delta states contain many rivers, seas and creeks, which provide a strong pattern of marine and inland fish capture. However, given the seasonal nature of capture fisheries, combined with the negative impact of oil and other industrial activities on the aquatic ecosystem in the Delta, fishermen in the area have had to seek other employment, outside the fisheries sector to sustain their livelihood (Partnership Initiatives in the Niger Delta, 2011). The continuing depletion of fish stock in and around the Niger Delta and declining profitability in the stagnant capture fisheries sector makes it imperative to promote fish farming, especially in the coastal areas. The region has three ecological water systems, fresh water, brackish and marine waters. Each of these zones has its own indigenous cultivable fish species and suitable land topography. There is therefore a tremendous potential for fish farming in this area. If properly harnessed, the potentials of the Niger Delta can contribute immensely to production of fish in the region and Nigeria at large (Akinrotimi *et al.*, 2007).

2.1.4 Challenges to Fish Farming Development in Bayelsa State

Despite the advantage the State has to practice fish farming even on an extensive scale, there is no one single government fish farm in the State (Bayelsa State Ministry of Agriculture 2012). What is seen are a few privately owned farms barely surviving because of several limiting factors. Below are some of the major constraints to commercial fish farming in Bayelsa State and other Niger Delta States of Nigeria (Bayelsa State Ministry of Agriculture, 2012, Okwuokenye and Ikoye-Eweto, 2016).

- a. Lack of access to capital.
- b. Lack of effective legal framework for aquaculture
- c. Lack of assured access to land
- d. Difficulty in accessing farm inputs
- e. Lack of government support
- f. Insufficient capital for production activities
- g. Difficulty in getting loans for expansion
- h. Poor pricing of harvested fishes
- i. Poor power supply
- j. Theft from neighbourhood

Other setbacks also identified are; lack of inexpensive quality feed, insufficient supply of fingerlings, lack of trained workers and poaching.

2.1.5 General Considerations in the Choice of Fish Culture System

1. Access to Land: Land is an important and necessary resource in fish farming. This means that the farmer must have access to land, as in the case of pond culture or water bodies, such as dams or reservoirs (Hayward, 2013).

2. Demand for output from fish-farming: Every fish farmer must ensure that there is a demand for his output. Even for a small –scale farmer, family food-security is undoubtedly an important concern for him; however, this does not imply that he has no strong interest in meeting other basic needs. Such an interest means the fish-farmer will aim at surplus production to generate an income (Evans *et al.*, 2007).

3. Technology Availability: Because fish farming involves the application of certain methods and techniques in the breeding and rearing of fish, the selection of a particular culture system will necessarily depend on whether or not the technology for such is available in the country or project area and if so, its level of complexity and/or transferability to the fish farm (Hayward, 2013).

4. Culture Species: Huet and Timmermans, (1986), list's the following criteria for evaluating the suitability of specie for culture:

- a. It must withstand the climate of the region in which it will be raised.
- b. Its rate of growth must be sufficiently high.
- c. It must be able to reproduce successfully under culture conditions.
- d. It must accept and thrive on abundant and cheap artificial food.
- e. It must be acceptable to the consumer
- f. It should support a high population density in ponds.
- g. It must be disease-resistant

5. Availability of Inputs and Support Facilities: Corollary to the level of technology is the ready availability of the production inputs, mainly seed and feeds, and ancillary facilities and services like hatcheries, feed mills, processing plants, ice plants, and cold storages as well as the existence of adequate post-harvest handling and processing facilities to ensure high quality products (Evans *et.al.*, 2007).

6. Access to Capital and Investment Requirements : The major cost items in fish farming, as in any other type of agriculture, includes initial development and pre-operating costs and miscellaneous

expenses including harvesting and marketing costs. Where investment costs are high and land and labour are limited and costly, the trend will be intensification to achieve maximum yields per unit area. Where land, labour and fish are inexpensive and feed is unavailable or costly, the trend is for extensive culture utilizing larger pond area and natural food (Evans *et al.*, 2007).

7. Environmental Considerations: Fish farming has been associated with a range of issues including habitat degradation, contaminated water systems, increases in fish diseases, and the introduction of alien species. These adverse effects have to be addressed in order to develop sustainable, end-user level aquaculture systems, (Evans *et.al.*, 2007).

2.2 Overview of Fish Farming Methods and Practices

2.2.1 Fish Farming in Nigeria a Historical Perspective

The farming of aquatic organisms in a controlled environment was introduced to Nigeria in the early 1950s and fish production through aquaculture has risen steadily from a few hundred kilograms to over 45,000 metric tonnes (FAO, 2007). In Nigeria, the first trace of fish farming was practiced by some missionaries in the old Oyo State, where fish was raised to supplement the protein intake of pregnant women. Conventional fish farming in Nigeria, however, falls into two distinct periods; between 1950-1970 and 1970-1992. The first period popularized fish farming, while the second phase was on expansion and establishment of demonstration of fish farms in addition to bold attempts at reducing the major constraints for rapid fish farming development (Omitoyin, 2007).

Between 1951 and 1953, the Federal Government of Nigeria, under the auspices of the Federal Ministry of Trade and Industries, built the first pilot fish farm (about 20ha) in Panyam, Plateau state. It was intended that this farm would be operated as a quasi-commercial enterprise serving as a model and providing information for other farms to be built in other parts of the country (Satia, 1990). In 1954, due to disappointing results obtained from the culture of tilapia, common carp (*Cyprinus carpio*) was

introduced probably from Israel and Australia (Hundeyin-Agoro, 2011). The production recorded in the first year of Panyam fish farm was less than 800kg/ha, however, they had generated sufficient interest such that both the then western and eastern region governments built fish farms in their respective areas. In 1967, the Federal Government started additional pilot fish farms; the Ikoyi Fish Farm Project in Lagos and another in the East which was short lived due to the civil war (Hundeyin-Agoro, 2011).

Fish seed multiplication and training centers were also set up by the government between 1978-1980 in different parts of the country to facilitate fish production in Oyo (South West), Umuna Okigwe (South East), Panyam (North East) and Mañdo, Kaduna (North East) (Hundeyin-Agoro, 2011). Eleven River Basin Development Authorities (RDBA) were also established between 1977 and 1980 to accelerate fish farming development. The RDBAs were encouraged by the Federal Government to build commercial fish farms and to demonstrate the economic viability of fish farming (Omitoyin, 2007). The state of fish farming has experienced phenomenal growth worldwide from its origin in China. It has grown from what it used to be i.e. domestic affair to a colossal industry supplying 47.8 million tonnes of fish valued at approximately 70 billion dollars for human consumption globally (FAO, 2005a).

Prior to the 1990s, aquaculture development in Nigeria was driven by socio-economic objectives including, nutrition improvement of rural communities, generation of additional family income, creation of employment and diversification of income generating activities; and was promoted by international organizations and agencies and the government at Federal, State and Local Government levels. Today, fish farming is the fastest growing livestock production sector in Nigeria, with a growth of about 29% in 2006 alone, and with prospects of continued growth. This is because; demand for fish is on the increase in line with population growth, while catches from fisheries are on the decline, even globally, (Delgado *et al.*, 2008).

Fish farming in Nigeria today is responsible for about 9.7% (53,355 tonnes in 2005) of total annual fish supply of 705,000 metric tonnes which lags far behind the annual fish demand of 1,865,000 metric tonnes. This means most of the fish consumed by Nigerian citizens, is from natural water bodies. With declining catches from the wild, fish farming is now the only visible and sustainable fish production alternative that can ensure the satisfaction of our fish self-sufficiency quests (Hundeyin-Agoro, 2011).

2.2.2 Fish Farming Methods and Practices

Fish farming has a tradition of about 4000 years. However, during the period, and especially before the advent of printing, no records were available except the narratives handed down from one generation to another. Admittedly, China was the cradle of the beginning of fish farming, utilizing mainly the common carp (*Cyprinus carpio*) (Hinrichsen, 1998). It is said that, it began in China, possibly due to the desires of an emperor to have a constant supply of fish. It is also speculated that the techniques for keeping fish in ponds originated in China with fishermen who kept their surplus catch alive temporarily in baskets submerged in rivers or small bodies of water created by damming one side of a river bed. Another possibility is that fish farming developed from ancient practices for trapping fish, with the operations steadily improving from trapping-holding to trapping-holding-growing, and finally into complete husbandry practices e Philippines which have been practicing it for about 300 to 400 years (USAID, 2013, World Ocean Review 2 (WOR 2), 2013). Chinese who emigrated to other Southeast Asian countries probably carried the knowledge with them and inspired the local people to take up fish farming. Brackish water fish farming is thought to have originated in Indonesia with the culture of milkfish and grey mullet and must have spread to neighboring countries like the Philippines which have been practicing it for about 300 to 400 years (Hinrichsen, 1998).

The husbandry of fish is therefore not a new phenomenon. Ancient practices based on the modifications of natural bodies of water or wetlands to entrap young fish in enclosures until harvest, have just evolved

into more systematic and scientific methods and techniques (FAO, 2009). Based on this, Amos and Bolorunduro (2010), established the following criteria.

2.2.2.1 Purpose of Culture

A primary consideration in the choice of appropriate culture system would be the underlying goals/objectives of the proposed culture, which can include any or all or a combination of the following: Increased supply/production of fish for local/domestic consumption, employment/livelihood generation and improved income levels, greater foreign exchange revenues, and socio-economic development and the expansion of ancillary industries.

2.2.2.2 Level of Management Intensity

Fish farming with artificial feeding, is treated as an intensive operation. When artificial feed is not given, it is considered an extensive system. A balance between the two is considered semi-intensive system, a moderate level of input is involved and fish production is increased by the use of fertilizer and/or supplementary feeding. Space economy is a major factor considered in all the systems.

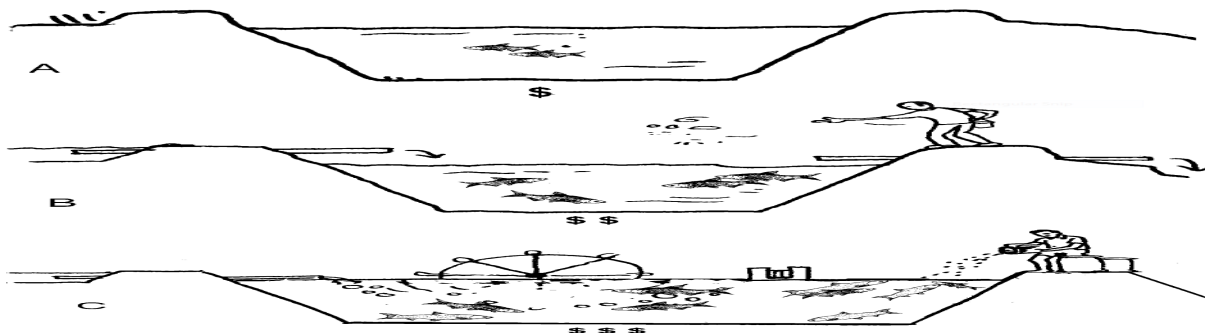


Fig. 2.1 Different levels of management intensity for fish farming
A: extensive, B: semi-intensive and C: intensive fish farming methods
Source: Carballo *et al.*, (2008).

2.2.2.3 Nature of Enclosure

Fish culture can be categorized into six culture systems based on the kind of enclosures (Abowei and Tawari, 2011); pond culture, cage and pen culture, raceway culture, raft culture, closed high-density culture, and ocean ranching.

1. Cage Culture: - Fishes cultured in this system are kept mostly in cages of metal mesh and left in the flowing water. Generally, floating-type of cages are used but submersible and rigid-walled cages are also used.

2. Raceway Culture: - Raceway farms are farms designed or constructed in a way to have regular and abundant flow of good quality and well-oxygenated water. The main sources of water are springs, streams, deep wells or reservoirs.

3. Raft Culture: In this system, the fishes are enclosed and reared in floating materials like raffia palms/bamboo in the water.

4. Closed High density: - In this method the fishes are raised in very high densities in artificial tanks and subjected to supplemental feeding and fertilization. An essential factor considered in this system is aeration of the water. This is usually done with a water purification system.

5. Ocean Ranching: Used mainly for rearing pacific salmon, wherein juvenile fish are hatched and reared, released to mature in the open ocean and caught when they are adults.

6. Pond Culture: Pond culture is probably the most prevalent in the world today. Under this system, the fishes are confined in earthen, concrete, or otherwise structured ponds whose waters are freshwater or brackish. This aspect of fish farming is comparable to land animal husbandry and is the most promising method for obtaining fry (Abowei and Tawari, 2011). Fish farming ponds range in size from a few dozen square metres to several hectares. Small ponds are normally used for spawning and baby fish production, while larger ponds are used for the grow-out period. Production ponds larger than 10 ha

become difficult to manage and are not very popular with most producers (Carballo *et al.*, 2008). Below are the different kind pond types.

(a) Excavated Ponds:

An excavated pond is dug out of the soil. The disadvantage of this type is that you need a pump to drain the pond.



Fig 2.2 A typical earthen pond.

Source: Kellen, (2005).

(b) Embankment ponds:

The dikes of an embankment pond are built above ground level. A disadvantage of this type of pond is that you may need a pump to fill the pond.



Fig. 2.3 A typical concrete pond.

Source: Kellen, (2005).

(c) Contour Ponds:

Soil from digging out the pond is used to build the low dikes of the pond. The ideal site has a slight slope (1-2%) so the water supply channel can be constructed slightly above and the discharge channel slightly below the pond water level. Since natural gravity is used to fill and drain the ponds, no pump is needed (Amos and Bolorunduro, 2000).

(d) Barrage Ponds

Barrage ponds are constructed by building a dike across a natural stream. The ponds are therefore like small conservation dams with the advantage that they are easy to construct. However, it is very difficult to control this system: it is difficult to keep wild fish out and a lot of feed added to the pond will be lost because of the current. A properly built barrage pond overflows only under unusual circumstances, (Taiwo, 2011).

2.2.2.4 Number of Species Stocked

Culture practices can be classified as monoculture, polyculture or integrated, (Taiwo, 2011). Monoculture is defined as a single specie culture; While polyculture, involves rearing several compatible fish species together. Most species can be cultured as single specie or reared with other species. The level and cost of production per unit area under these two types of culture systems can be significantly different. Polyculture systems usually have higher yields because feeds are properly utilized by the fishes; hence there is a less risk of project failure as compared to monoculture (Taiwo, 2011).

2.2.2.5 Scale of Production

Fish farming may range from homestead/ backyard ponds to large scale industrial enterprises. Amos and Bolorunduro, (2000), identified two types; Homestead/ backyard ponds and commercial fish ponds.

1. Homestead/ Backyard ponds

This is a fish pond mostly managed to augment family protein intake. Pond size varies according to space available.

2. Commercial fish ponds

Usually covers an area of less than half a hectare (for earthen ponds). These ponds demand more attention from the fish farmer. They are usually established for income generation.

2.2.2.6 Other Criteria for Classification

One can also classify fish farming, in terms of water salinity (freshwater, brackish water, or marine water), water movement (running water or standing water), water temperature (cold water, warm water), food habit (herbivorous, omnivorous, or carnivorous), and by its combination with agricultural techniques (rice plus fish farming, duck plus fish farming, chicken plus fish farming, or pig plus fish farming).

As shown, many criteria can be used to distinguish fish culture but, in practice, different forms of fish culture can occur together and overlap.

2.2.3 Factors that Influence the Output of Fish Farmers

Certain requirements of grow-out ponds must be satisfied; otherwise, they will have great influence on fish output and managerial operation. Below are the major factors that can influence output on a fish farm;

1. The Size of the Pond: The size of a pond is the major factor that determines what fish species to stock, the degree of management needed to maintain the fish, and how many fishes the farmer can remove in each production cycle. The best fishing ponds have a surface area of at least 1 acre. In such a pond, the fish have a larger space for activities and the decomposition of manure. The propagation of plankton can also be promoted (Virginia, Department of Game and Inland Fisheries, 2004). However, according to Dennis (2010), a series of ponds (200 to 300m²) are preferable to one large pond, in this

way, the timing of stocking and harvesting the different ponds can be staggered, allowing farmers to have a year round supply of fish.

2. The Depth of the Pond: Small, shallow ponds are more likely to have problems with aquatic vegetation, unbalanced fish populations, and low water levels caused by droughts. The average depth for a fishing pond should be between 6 and 8 feet, with maximum depth not greater than 10 to 12 feet. An average depth less than 6 feet increases the chances of aquatic vegetation problems, and depths greater than 12 feet are not necessary for good fish production (Virginia, Department of Game and Inland Fisheries, 2004).

3. Stocking of Fingerlings: The choice of fish to be stocked depends on the pond owner's goals and the resources available; however, the stocking of fingerlings is an important link in a chain of food fish culture, as fingerlings are the material basis of fish farming. The production of food fish culture demands that, fingerlings should be of a complete variety of species, in adequate quantities, in appropriate sizes and of no injury and diseases (FAO, 1985).

4. Pond Fertilization: Fertilization is usually necessary to provide phytoplankton with adequate nutrients for growth. Proper fertilization increases food availability throughout the food chain and indirectly increases the total amount of fish a pond can support. However, ponds should be limed first. By increasing pH and alkalinity alone, nutrient availability may be improved enough to sustain an adequate phytoplankton bloom. Fertilizing ponds will increase fish production by a factor of two or three. Infertile ponds will seldom produce more than 200 pounds of fish per acre. Well managed, fertile ponds will support 300-600 pounds of fish per acre (Michael and William, 2014).

5. Water Quality: Most fish kills, disease outbreaks, poor growth, poor feed conversion efficiency and similar management problems are directly related to poor water quality. Fishes cannot live without water; water supply must be adequate. The pond should be filled with fresh water at regular intervals so as to adjust water depth, control water quality and alleviate the serious surfacing of fish. The best thing

to do is to take the water from rivers, lakes, reservoirs and other large water bodies as a water source for fish ponds, because in natural water bodies, dissolved oxygen content, pH value, water quality and water temperature are more stable and suitable for fish to grow (FAO, 1985).

6. Feeds and Feeding the Fish: Feeding is the major measure for intensive pond fish culture and it is also the main daily work of the management for grow-out ponds. In high density polycultured ponds, each fish only gets a small amount of natural food. Therefore, the supplemental feeds and manures are essential to ensure the normal growth of fish and to obtain a high fish yield (FAO, 1985). The objective of feeding fish is to provide the nutritional requirements for good health, optimum growth, optimum yield and minimum waste within reasonable cost so as to optimize profits. Every farmer should be particular about the quality of feed fed to the fish because it is the feed that determines the:

- (i) Nutrient loading (and ultimately carrying capacity) in the pond, hence water quality within the culture system.
- (ii) Fish growth rate.
- (iii) Economic viability of the enterprise.
- (iv) Health status of the fish.

2.2.4 The Concept of Livelihood

In the most general terms, livelihoods can be described as people's means to secure the necessities of life. They are highly dynamic and shaped by a variety of different factors and forces that are themselves shifting constantly. The improvement of livelihoods of people in developing countries is the mission of many public and governmental institutions, and is successful when communities experience increased well-being and reduced vulnerability through higher incomes, improved food security and the more sustainable use of natural resources (DFID, 1999).

2.2.4.1 Contribution of Fish Farming to Livelihoods

Many fishing communities live in the world's poorest countries; they are often marginalized and landless, hence most often, fishing is often the livelihood of last resort and fishes often the only source of animal protein for the poor. This is why in many developing countries, fish grew in economic importance during the second half of the twentieth century and, by the end of the 1990s, the fisheries sector had become an important source of food, employment and foreign exchange, a situation that is likely to continue (WOR 2, 2013) .

The benefits of fish farming are varied between individuals, household members and the community at large (Kellen, 2005). The benefits are either direct or indirect (tangible or intangible) cutting through all aspects of people's lives (i.e. social, economic, psychological and nutritional) as shown below:

a. Food and Food Security

In many parts of the world, fish provides a high proportion of all animal protein (Bailey *et. al*, 1996). Fish produced in ponds has proved to be of high quality and is readily available when one needs it, thus ensuring food security.

b. Employment

Generally, almost all fish farming activities are small scaled, usually producing for subsistence use although surplus can be sold for cash (FAO, 2004); yet about 38 million people worldwide are employed in fisheries and aquaculture, 95% of them in developing countries (Kellen, 2005). Most individuals become fishers or fish farmers because they expect the activity to provide a means of livelihood for themselves and their families (FAO, 2000).

c. Financial Benefits

Fish farming is an ideal source of income and useful in various ways, especially for those that depend on agricultural activities for income. It can provide an important contribution to household cash income. A study in Tanzania found that between 65% and 90% of fish production is sold, compared to only 15% of

agricultural production in the same communities (Kellen, 2005). This cash income gives access to other benefits such as education, health services, clothing, other foodstuffs, etc. It also allows investment in other assets or enterprises such as land, livestock or fishing gear, which can further reduce vulnerability to poverty (Kellen, 2005).

d. Social and Cultural Benefits

Fish farming is rarely carried out alone and is often a very social activity, strengthening bonds between people and community cohesion. According to a brief by the Fisheries Management Science Programme (FMSP) in 2006, beyond the food, employment and financial benefits, there can be significant social and cultural outcomes attached to fishing especially fish farming. The income from community managed fish farms may go towards community projects and improving infrastructure and services for the community, or towards support for needy families.

e. Other Benefits

Integration of fish farming in crop and animal husbandry allows each element in the farm set up to benefit from each other thus reducing production costs of the farmer. This practice helps in the optimal utilization of available resources. On-farm and locally produced materials like green leaves, maize bran, have been used in fish farming as feeds, while cow dung and chicken manure have been used to fertilize ponds in Nigeria and other parts of the world. Therefore, it puts to use agricultural bi-products that would otherwise be of less importance. On the long term aspect, fish farming caters for fish species that are threatened with extinction in their natural habitats (Kellen, 2005).

2.2.5 The Concept of Sustainability

The original concept of sustainability as espoused by the World Commission on Environment and Development (1987) arose in response to an increasing awareness that economic development is having deleterious impacts on the environment, with subsequent negative impacts on human health, social wellbeing and the ability of future generations to meet their needs. Consequently, definitions of

sustainability have sought to capture the multifaceted nature of the concept primarily by encompassing economic, environment and social considerations (Sheriff, 2004).

In aquaculture, its potential impacts upon the environment and associated social systems has also called into question the sustainability of the industry, hence researchers and practitioners are now facing the challenge of defining and implementing sustainability in the industry. Emphasis is placed on policy development and the production of guidelines for sustainability, based on general definitions of what sustainable aquaculture might mean (Hennessy, *et al.*, 2013). The majority of the approaches and discussions may be divided into three principal categories: those that focus on the negative environmental impacts of aquaculture; those that place emphasis on the sustained economic viability of production systems based on the continued appropriation of input resources, and on the growth of the commercial aquaculture sector, and most recently a more holistic approach which addresses the integrated nature of the components which make up an aquaculture system, which is more closely allied to the multi-dimensions attributed to sustainability itself (Sheriff, 2004).

In a development context, the concept of “sustainable aquaculture” is often to be found associated with that of “sustainable livelihood”, as development agencies and national governments seek to conserve natural resources while simultaneously improving the livelihoods of fishers (Sheriff, 2004). Hence, in tropical coastal environments around the world, sustainable fish farming is now being promoted as a solution to alleviate pressure on capture fisheries by providing an alternative livelihood for coastal fishers engaged in destructive fishing practices

2.2.5.1 Sustainability in Fish Farming

One of the principal criticisms of the concept of sustainability, which hinders its ability to provide practical guidance for environmentally and socially aware development, is the lack of a clear definition over which consensus can be reached. As, its interpretation remains context specific, an attribute that

some authors find to be in its favour (Sneddon, 2000). As Sneddon (2000) notes, “context specificity forces the crucial questions; what exactly is being sustained, at what scale, by and for whom, and using what institutional mechanisms?.

Despite the ambiguity of the sustainability concept, if sustainable fish farming is a goal to be achieved, the goal must be defined, and thus requires some interpretation of what sustainability is (Hennessy, *et al.*, 2013). Costanza and Patten, 1995) points out that the basic idea of sustainability is relatively straight forward, requiring that something exists or survives. Furthermore, any definitions are essentially, no more than predictions of what one might hope will lead to sustainability, assessment must wait until the fact (Costanza and Patten , 1995). There is however, scope to learn from past and current activities, with the possibility of providing informed guidance and predictions for the future.

This study thus defines sustainability in freshwater fish farming as the cost-effective production of the aquatic organisms, which keeps a harmonic and continuous interaction with the ecosystems and the local communities. It must be productive and profitable, generating and distributing benefits, which may or not be monetary gains. It must use the natural resources in a rational way and must not degrade the ecosystems into which it is inserted. It must generate employment for the local community, increasing quality of life and respecting local culture (Valent *et al.*, 2011).

2.3 Theoretical Framework

2.3.1 Approaches to Assessing Sustainable Fish Farming

In comparison to agriculture, its terrestrial counterpart, both aquaculture as an industry and the associated interest in sustainable aquaculture are relatively recent developments and the growth of the industry has been coincidental with increased social awareness of the environmental consequences (Pillay, 1997). In the last decades, as both aquaculture and sustainability have grown in importance, the way in which the concept of sustainable aquaculture is interpreted has developed from relatively narrow

focus on the environmental interactions between aquaculture and the wider environment, to a more holistic approach to sustainability in which social issues are receiving progressively more attention. Interpretations of sustainable aquaculture can therefore be classified according to three principal approaches (Sheriff, 2004):

1. Environmental approach to sustainable aquaculture
2. Bio-economic approach to sustainable aquaculture
3. Holistic approach to sustainable aquaculture

1. Environmental Sustainability

Approaches to environmental sustainability emphasize environmental sustainability or more simply, the relationship between aquaculture activities and the natural environment. This approach does not seek economic growth but merely a sustained level of production and consumption within the limits of the ecological carrying capacity and the indefinite maintenance of global life support systems (Goodland 1995: Goodland and Daly, 1996).

2. Bio-economic Approach to Sustainable Aquaculture

Economic sustainability is concerned with the maintenance of a continued benefit to aquaculture producers and is inextricably linked with environmental sustainability when productivity is dependent upon the appropriation of environmental goods and services. The relationship between good farm management to reduce negative impacts on the environment and the subsequent economic benefits which can result is therefore a key topic in sustainable aquaculture. For Schimittou (1993), economic viability based on sound environment is the only valid objective of sustainable aquaculture system.

3. Holistic Approach to Sustainable Aquaculture

A holistic multi-dimensional approach seeks to incorporate the values encapsulated by the sustainable development paradigm within the concept of sustainable aquaculture. Several frameworks exist for assessing the sustainability of a system holistically. However, within the food and agricultural industry,

the most commonly used framework is the Sustainability Assessment of Food and Agriculture Systems Framework (SAFA) (SAFA, 2013). This framework proposes guidelines for assessing the impact of food and agriculture operations on the environment and people. The guiding vision of SAFA is that food and agriculture systems worldwide are characterized by four dimensions of sustainability:

- Good governance
- Environmental integrity
- Economic resilience and
- Social well-being

The SAFA approach offers a holistic framework that encompasses all aspects of sustainable cropping, livestock husbandry, fisheries, aquaculture and forestry production, postharvest, processing, distribution and marketing (SAFA, 2013). It builds mainly on existing sustainability schemes, creating opportunities for enterprises to use existing data and combining efforts with other tools and sustainability initiatives. SAFA allows a fair playing field for all by presenting a framework that is adaptable to all contexts and sizes of operations. In SAFA, what matters is performance, leaving space for the diversity of implementation means possible. It encourages continuous improvement and builds capacity for sustainability. It strives to establish an easy-to-use standardized system, which does not require external experts (SAFA, 2013).

It is apparent from the points raised above that only a holistic approach to sustainability can meet the aims of sustainable development as set out by the WCED. For this reason, the holistic approach to sustainable fish farming forms the basis for the assessment of livelihood sustainability among the freshwater fish farmers in Bayelsa State.

2.3.2 Profitability Measurement

Net Farm Income Assessment:

Net farm income is a measure of profitability and is determined based on information derived from a business or farm operation's income statement. The term "profitability" is the difference between the value of what is produced or service provided and the cost of producing that product or providing that service. Net farm income analysis was used to determine how profitable freshwater fish farming business is Bayelsa State. This analytical technique was used to estimate the profit or the net income which is the difference between the gross farm income and the total costs of production variables, (Agboola, 2011).

2.4 Empirical Framework

2.4.1 Socioeconomic Characteristics of Fish Farmers in Bayelsa State (Farm Household Characteristics)

According to Allison *et al.*, (1995), and a Niger Delta Human Development report (UNDP, 2006), the following salient socioeconomic characteristics of the farm households in the state, forms the background to farming practices in the State.

1. Household Size Characteristics: Generally, information on size distribution of farm households in the state is fragmented. However, evidence from observation and available literature indicates that farm households are generally made up of 2 to 25 persons. Normally made up the husband (or family head), his wife or wives and children. The large size of households in the area is informed by the need to provide farm labour from within the family, thus avoiding of labour from non-family sources.

2. Occupational Characteristics:

Owing to the seasonal nature of farming activities in the state, farmers engage in subsidiary or secondary occupations in to stay employed all year round and supplement farm incomes. Consequently, farming is not the only occupation farmers engage in. Secondary occupations farmers engage in are either primary

farm-related or secondary non-farm related. Among the farm related subsidiary occupations are forest resource exploitation and fishing. Fishing activities involves capture fisheries and fish farming. Products from these subsidiary activities are widely traded in both urban and rural markets in and outside the state. The non-farm activities usually center's on petty trading, dress making, etc.

3. Income Characteristics: Data on household income in the Bayelsa State is so fragmented and in some cases unreliable because of the attitudes of farmers in the area towards divulging information on their incomes for fear of tax assessment. In many cases, they do not keep records of their farm expenses and revenues too. However, their income ranges from ~~N~~6, 000.00 to ~~N~~40, 000. 00 per annum depending on the size and number of farm holdings operated. With respect to income from the non-farm sector, there is hardly any information available.

4. Age-sex-education composition: Farmers in Bayelsa State are of ages ranging from 18 to 55 years. However, persons between the ages of 25 and 50 years constitute the most of the active group of farmers in the area. It is instructive to know that, most youths are involved because of the absence of wage employment. Women are more involved in farming as compared to men, with most of them being poorly educated.

5. Households head structure: Census surveys carried out by UNDP for the Niger delta region of Nigeria in 2006, shows that there are more males (54%) than females (46%) in the Bayelsa State. Similarly, there are overwhelmingly more male (93%) heads of households than females (7%).

2.4.2 Net Returns on Fish Production

All around the world, several literatures on the economics of fish farming exists. In Saudi Arabia, Elhendy and Alzoom (2001) assessed the cost of tilapia farming in the central region of Saudi Arabia. Their study showed that the minimum average cost of production occurs for 201 tonnes of tilapia per year per farm; and profit is maximized for a production of 300 tonnes annually per farm. They opined

that irrespective of the fact all the fish farmers were operating at a less than minimum efficient scale, they still made profits.

In another research, Kassali *et al.*, (2011) analyzed the economics of inland fishing, aquaculture and fish marketing in Niamey and Tillabery areas of the Niger Republic. Their study showed that both aquaculture and inland fish production were profitable with a rate of return of 61% and 320% respectively.

Yesuf *et al.*, (2002) assessed the economics of fish farming in Ibadan Metropolis of Nigeria. They revealed that most farmers with secondary education and above operate at small-scale level with an average of three (3) ponds. Most of the fish farmers practiced polyculture fish farming, with *Clarias spp.* being the most raised species followed by the *Heteroclarias spp.* The gross margin analysis revealed that medium scale farmers derived the highest return of ₦1.55 for every one naira expended. This is followed by large-scale farmers at ₦1.52 for every one naira compared with only ₦1.34 for every one naira spent by small-scale farmers. Ajao, (2006), also in Oyo reported that fish farming was profitable and that 80% of the fish farmers in the state, operated less than two hectare farms

In Cross River State, Ele *et al.*, (2013) carried out a study on the economic analysis of fish farming in Calabar, Cross River State, Nigeria. Their results showed that majority of the farmers made a gross margin of ₦400, 000 – ₦3,500,000 per cycle. This shows that the business is profitable.

In Bayelsa State, Kainga and Adeyemo, (2012), in a study on an economic survey of homestead fish farming in selected communities of Bayelsa State, found that; total fixed cost and total operating cost spent on homestead fish farming by the farmers was estimated at ₦377, 150 and ₦ 332, 910 respectively; while net return was estimated at ₦ 117, 940 per cycle. According to them, farmers should

be encouraged to invest in fish farming as the enterprise was capable of making returns of ₦1.17 to every ₦1.00 invested in it.

2.4.3 Determinants of Net Returns in Fish Production

El-Naggar and Kareem (2008) examined the economics of fish farming in the Behera Governorate of Egypt. They reported that, high prices of fish feed; declining fish prices and lack of finance were the top ranking constraints facing fish farmers in that area. The findings also revealed that quantity of fish seeds is a notable and significant factor contributing to net returns.

According to Nwosu and Onyeneke (2013) years of experience plays a significant role in any farming enterprise. This was confirmed by Abbas, (2015). He asserted that high farming experience will result to increased training and indoctrination of the farmers and from which they would learn certain skills that would enable them increase their farm productivity and revenue.

Kudi and Atala (2008) examined the resources, cost and returns and other factors affecting fish production in Kaduna State, Nigeria. The study revealed that land, water, labour and capital were the main resources employed in fish production. The costs and returns analysis indicated that, variable cost constituted 97.63% of the total cost of fish production in the study area, while fixed cost constituted 2.37%. Amongst the variable inputs, fingerlings/juveniles (42.82%) and feed (34.70%) constituted the highest (77.52%). Total cost of production and total revenue realized per cycle was ₦571, 231.79 and ₦5, 853,625.64 respectively. Net income was ₦5, 282, 393.85, indicating that fish production was highly profitable.

2.4.4 Fish Farming as a Livelihood Activity

As an economic activity; awareness on the indispensability and sustainability of fish farming is also growing (FAO, 2005a). Through employment and income generation from fish farming, and subsequent higher purchasing power, fish farming households often improve their diets through increased food

accessibility (Nora, 2013). Dey *et al.*, (2006) for example in Malawi found that the income of households owning fish ponds was 1.5 times higher than that of households without fish ponds. Hishamunda and Ridler in 2006 also showed in Zimbabwe that commercial tilapia farms were capable of providing jobs and incomes to the farmers in the region. Furthermore, it seems particularly successful to combine fish farming with other activities: Profits of fish farmers who combined fish farming with rice farming almost doubled (Kawarazuka and Bene, 2010; Aiga *et al.*, 2009).

Certain food products are bought more frequently because of a better income situation of the farmers through fish farming. Several recent studies highlight this trend: Household incomes from fish farming increase the consumption of staple foods (Jahan, *et al.*, 2010) and foods from animal sources (Dey *et al.*, 2006; Alderman, 1986), increasing the total energy intake of the fish farming households (Kawarazuka and Bene, 2010). Another reason for often observed increases in meat consumption could be that farmers, through incomes from fish farming, have more money to keep livestock on their farms for home consumption: Neiland *et al.*, (2000) for example show in a study in North-East Nigeria that increased income (from fishing) was used as input for farming resulting in the fishing households to have a higher farm-productivity.

Fish farming is generally been dominated by men while women and children predominate in pond management activities, fish processing, value-adding and post-production processes (Hino, 2011) as seen in Kenya, where the activity is seen to be creating employment for underprivileged groups, e.g. women and young people (Hino, 2011; Jagger and Pender, 2001). Gender disparities not only affect the livelihoods of women themselves, but also livelihoods of the entire household and community, hence women are advised to engage actively in extension practices. (Jagger and Pender 2001; Weeratunge *et al.*, 2010).

2.4.5 Livelihood Strategies of Fish Farmers

Ahmed *et al.*, (2012) examined the participation of women in aquaculture in three coastal districts of Bangladesh. They reported that fish farmers generally engaged themselves in diverse portfolios of income generating activities like vegetable gardening, fish seed trading and off-farm activities during off-seasons and also because of the paucity of on-farm employment opportunities.

In another research Pravakar, *et al.*, (2013) assessed the present status of fish farming and livelihood of fish farmers in Shahrasti Upazila of Chandpur District, Bangladesh. Their study showed that only 20% of the fish farmers were engaged in fish farming as their main occupation. This implies that for most of them (80%); fish farming was seen as an additional source of income for their households.

Abbas, (2015) assessed the economics of fish farming and its contribution to household poverty alleviation in Akure South and Owo Local Government Areas of Ondo State, Nigeria. He revealed that 43.33% of the fish farmers saw fish farming as their major source of income. He concluded that most fish farming households adopted diversified sources of income to minimize shocks and vulnerabilities.

In Bayelsa State, Okwuokenye and Ikoyo-Eweto (2016) in a study on farmers participation in homestead fish production: implications for poverty alleviation in Bayelsa and Delta States, Nigeria, reported that most (76%) of the fish farmers interviewed indicated that, they engaged in other jobs in addition to the homestead fish farming activity. In precise terms, most (76%) of them had other jobs they do (especially civil service jobs) in addition to fish farming i.e. majority of them are part-time operators. Their results showed that the farmers participated in homestead fish farming business to help support their economic activities and to increase/to meet food security of their household. They hence, concluded that like in other findings, people took part in most agricultural production to help meet up with the food security of their households.

2.4.6 Constraints to Fish Farming

The DFID sustainable fisheries livelihoods program in a study conducted in Ghana 2001, reported that the constraints and vulnerability of fisheries communities are mainly due to resource depletion, increasing competition on open access resources, inequitable use of resources, natural disasters like storms, and over-reliance on one type of asset and lack of options. Others were lack of government support, remote locations and poor services, low literacy, scarcity of feeds, inadequate training, insufficient supply of fingerlings amongst other (DFID, 2001).

According to the FAO, the ability of fisher men and women to contribute to food security and poverty alleviation can be constrained due to stock depletion, lack of access to capital, limited alternative employment opportunities, and lack of appropriate technology. However, constraints in the form of governance and policy issues over access to and control over aquatic environments and the distribution of benefits accruing from these resources is probably the most important (FAO, 2006).

According to Adeogun (2007), The Bayelsa State Ministry of Agriculture (2012) and Okwuokenye and Ikoye-Eweto (2016) fish farming like any other agricultural enterprise is also constrained by a number of factors. They reported that the most commonly expressed problems facing fish farmers in the country is the lack of technical know-how. Other constraints also identified include; high cost of inputs, limited infrastructure such as lack of capital, changes in land use and policy among others.

2.5 Analytical Framework

2.5.1 Enterprise Budgeting

The enterprise budget has been the cornerstone of most production economic analysis as well as a necessary step, in most production economics research. Enterprise budgets provide a fairly simple and readily understandable measure of profitability of a specific production activity (enterprise). It estimates the gross returns, variable costs, and other requirements of the enterprise (Carole, 2005).

A budget is generally defined as a structured system for estimating values of the revenue generated and the costs incurred. Thus, the enterprise budget itemizes the types, quantities, and prices of products to be sold by the enterprise. All costs associated with that particular production activity are also itemized by types, quantities, and prices (Carole, 2005). The revenues are then compared with costs to determine whether there is adequate revenue to cover all costs; if yes, then the enterprise is profitable (Nandlal and Pickering, 2004). The most useful enterprise budgets are those that include sufficient detail to fully understand each specific line item. Column headings typically include the name of the item, its description, the unit of measure used, its cost for the unit specified, the quantity to be used of that unit for the time period specified, and the total cost or value for that particular item for the specified time period, production system, production technology selected, and level of production selected (Carole, 2005).

Basically, enterprise budgets can be organized and presented in several different formats, but they typically contain three sections:

- i. Income/receipts
- ii. Variable or operating expenses and
- iii. Fixed expenses.

i. Gross Receipts: This refers to gross returns or total sales from the farm. It is the income generated from the sale of farm produce e.g. fish, fingerlings etc. (Info.net –biovision , 2012). They are estimated by multiplying the total expected harvest weight (quantity) with the expected price per unit weight (kg).

ii. Variable Costs: This is also referred to as operating costs. These are costs that vary with production or expenses related directly to the quantity of fish produced for market (Douglas and Reginal, 2004). All production costs/expenses will include; cost of fingerlings, feeds, labour, interest on operating capital, etc. Total Variable costs (TVC) is the sum of all variable costs.

iii. Fixed Costs: These are costs that are incurred regardless of the level of production (operation) (Douglas and Reginal 2004). They include; depreciation, interest on investment capital and other costs not related to active production of the business. They are also referred to as ownership costs. Total fixed costs are the sum of all fixed costs.

2.5.2 Profitability Measures

1. Net Returns: The most important measure of profitability from the enterprise budget is the net returns (Okwu and Acheneje 2011). Net returns are calculated by subtracting total costs from total revenue. That is;

$$\text{Net returns} = \text{TR} - \text{TC} \quad \dots \text{eqn. (2.1)}$$

Where TR = Total Revenue

TC = Total cost.

Positive returns indicate that the enterprise is profitable even in the long term while negative returns indicate that the enterprise is not viable and should be abandoned if costs cannot be reduced.

2. Returns Above Variable Costs: An intermediate measure is to calculate income above variable costs, also referred to as gross margins. Income above variable costs provides a measure of whether the business can continue to operate in the short run. It is the difference between the gross returns and the total variable costs, if this figure is positive, it means that all variable expenditures are covered and the enterprise is profitable at least in the short run if they are negative, it is advisable to close the business if you cannot reduce on the variable costs, (Businessdictionary.com, 2010).

$$\text{GM} = \text{GFI} - \text{TVC} \quad \dots \text{eqn. (2.2)}$$

Where GM = Gross margin

GFI = Gross farm income

TVC = Total variable cost

2.5.3 Mechanics of the Budget

In addition to the basic calculations in the budget, there are other relationships that can be checked to ensure internal consistency of the budget. Uncertainty and risk can be accommodated in enterprise budgets with sensitivity or break-even analysis and risk analysis. Sensitivity analysis brackets a baseline enterprise budget with more and less favourable scenarios. It shows the stability of an outcome under a range of plausible assumptions about risky, uncontrollable factors such as prices and yields. Break-even analysis identifies the yield, price, or cost threshold at which enterprise revenues would just equal costs (including opportunity costs) (Manivong, 2014).

Another relationship that can be analyzed is feed conversion ratio (FCR); this is a commonly used measure of the efficiency of feed use. It is calculated by dividing the weight of the feed fed by the weight gain of the fish. Thus, for every pound of weight gain of fish, the FCR indicates how many pounds of feed were required to produce that weight of fish. Calculating the FCR from the budget values of quantity of feed fed and quantity of fish sold provides a check on the validity of these values (Carole, 2005).

2.5.4 Other Concepts Considered in an Enterprise Analyses

1. Depreciation

Depreciation must be calculated for all capital goods (goods with a useful life greater than a year). There are different ways to calculate annual depreciation, depending upon the use. For income tax purposes, the double declining balance method (also known as diminishing-balance or reducing-balance method) is frequently used because it allows for greater deductions in the early years. Its calculation is based on rapid decline in value during the early years.

An enterprise budget is developed for only one period of time, however, and represents a “typical” or “average” year. Depreciation methods that calculate different amounts of depreciation for different years

pose problems for enterprise budgets. Thus, for purposes of an enterprise budget, the straight line method to calculate annual depreciation is the best. Straight line depreciation results in the same amount of annual depreciation for each year. To calculate depreciation, the initial cost of the asset is needed. Its useful life in the business must be estimated. Finally, its resale value at the end of its useful life must be known. The initial cost is the purchase price. The useful life of equipment can be found by consulting with other fish farmers using that same type of equipment or from the farm's own records (Carole, 2005).

It is calculated as follows:

$$\text{Annual depreciation} = \frac{\text{cost price} - \text{salvage value}}{\text{Years of useful life}} \quad \dots \text{ eqn. (2.3)}$$

This calculation represents the difference between the initial purchase price and its resale value, divided by the number of years it is likely to be used in the business. In reality, there is little salvage value for most types of equipment on a fish farm (Carole, 2005). For practical purposes, therefore, the following equation can be used to calculate annual depreciation:

$$\text{Annual depreciation} = \frac{\text{cost price}}{\text{Years of useful life}} \quad \dots \text{ eqn. (2.4)}$$

With the straight line method, the amount calculated for annual depreciation is constant across the years that the piece of equipment will be used. This makes it a preferred method when preparing an enterprise budget.

2.5.5 The Indicator/Index Method to Sustainability Assessment

An indicator is defined as a single measure of a characteristic (e.g., water temperature), the units of which can be described by a particular metric (e.g., annual maximum temperature) (Nelitz *et al.*, 2013). The indicator approach to measurement uses a specific set or combination of indicators (proxy indicators) and measures by computing indices, averages or weighted averages for those selected

variables. The result of this integration of a wide variety of variables into a more comprehensive and realistic form is called an index. This approach can be applied at any scale (e.g., household, country) (O'Brien, 2004; Glwadys and Claudia, 2009).

According to Nelitz *et al.*, (2013), key considerations when identifying and selecting indicators include: appropriateness and relevance to dimension of interest; transparency (not too complicated, should be repeatable); feasibility (considering cost of data collection and time availability); and size and composition of each indicator (absolute versus relative values etc.). Since the framework's components are dynamic over time, it is important that all the indicators relate to the particular year chosen.

2.5.6 Regression Analysis

This is a statistical tool that measures the relationship between independent variables and a dependent variable. In this study, two regression analyses were carried out to determine the factors affecting the net return from fish farming. Therefore, two production functions were fitted to the available data to analyze the determinants of net returns. The production function, establishes the proportion of variation in the dependent variable that can be explained by the independent variables, (Agboola, 2011).

The implicit form of the production function to assess the relationship between the cost of fertilizer, cost of fingerlings, cost of hired labour, family labour, and cost of feeding, size of fish farm, production experience and net return was:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, \dots, X_7, U) \quad \dots \text{eqn. (2.5)}$$

Where Y= Naira value of matured table fish per production period (₦/production period)

X₁-X₇ are the explanatory variables and U= random error term

Four functional forms of the model (linear, semi-log, double log and exponential) were fitted to the production function in order to investigate which production function has the best fit. The lead equation

was chosen based on economic, statistical and econometric criteria such as, highest value of coefficient of multiple determination (R^2), highest number of significant variables and conformity to a priori expectations.

The explicit forms of the four functional equations are;

Linear:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + U \quad \dots \text{eqn. (2.6)}$$

Semi-log:

$$Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 + U \quad \dots \text{eqn. (2.7)}$$

Double log:

$$\log Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 + U \quad \dots \text{eqn. (2.8)}$$

Exponential function:

$$\log Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + U \quad \dots \text{eqn. (2.9)}$$

It was expected a priori that $b_1, b_2, \dots, b_7 < 0$. That is an inverse relationship exists between the dependent and independent variables.

The implicit form of the production function to assess the relationship between the sex, age, household size, level of education, fish farming experience, size of fish farm of the fish farmers and their net return was:

$$Y = f(X_1, X_2, X_3, X_4, X_5, \dots, X_6, U) \quad \dots \text{eqn. (2.10)}$$

Where Y = Naira value of matured table fish per production period ($\text{N}/\text{production period}$)

X_1, \dots, X_6 are the explanatory variables and U = random error term

Four functional forms of the model (linear, semi-log, double log and exponential) were fitted to the production function in order to investigate which production function has the best fit for the phenomena.

The lead equation was chosen based on economic, statistical and econometric criteria such as, highest

value of coefficient of multiple determination (R^2), highest number of significant variables and conformity to a priori expectations.

The explicit forms of the four functional equations are;

Linear:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + U \quad \dots \text{eqn.}(2.11)$$

Semi-log:

$$Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + U \quad \dots \text{eqn.}(2.12)$$

Double log:

$$\log Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + U \quad \dots \text{eqn.}(2.13)$$

Exponential function:

$$\log Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + U \quad \dots \text{eqn.}(2.14)$$

It was expected a priori that $b_1, b_2, \dots, b_6 < 0$.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The study was conducted in Bayelsa State, a state nicknamed as the "Glory of all lands". Bayelsa State is made up of eight Local Government Areas namely; Ogbia, Nembe, Brass, Southern Ijaw, Yenagoa, Kolokuma/Opokuma, Ekeremor and Sagbama Local Government Areas (Ebiegberi, 1999).

Bayelsa State constitutes and occupies a greater proportion of the Niger Delta region of Nigeria, a subtitle describing and identifying the state in its geographical aspects considering it maintains a southern shoreline along the coast of the Atlantic Ocean (Abi and Atei, 2007).

The state is located in the heart of the Niger Delta, in the South-South geographical zone of Nigeria. Geographically, it lies within latitude 04° 15" North and longitude 06° 45" East (Bayelsa State Government, 2008). It has a total Population of about 1,998,349. The four main languages spoken are Izon, Nembe, Epie-Atissa and Ogbia. Like the rest of Nigeria, English is the official language in Bayelsa State. Bayelsa State has a riverine and estuarine setting. A lot of her communities are almost (and in some cases) completely surrounded by water, hence making these communities inaccessible by road (USAID, 2008).

Its ecosystem is amongst one of the richest and most productive in the country. Beyond its scenic beauty and the imposing environmental splendour that characterizes the area, economic activities are highly centered on marketing and distribution trade, as their occupational mainstays are fishing, farming and trading (Sukulu, 2007). That is, the people of Bayelsa State are predominantly fisher men, even though they are still involved in other trades like gin distilling, saw-milling, canoe and boat weaving and white collar jobs in government ministries, parastatals as well as private establishments (Abi and Atei, 2007).

Bayelsa State has one of the largest crude oil and natural gas deposits in Nigeria. As a result, petroleum production is extensive in the State. However, the majority of Bayelsans live in poverty (USAID, 2008). They are mainly rural dwellers due to its peculiar terrain. They lack adequate transportation, health, education and other infrastructural facilities as a result of decades of neglect by the central governments, state governments, and petroleum prospecting companies. The state, as a result, has an almost non-existent commerce (USAID, 2008), although several changes and improvements are made daily in every nook and cranny of the state.

A personal interview by the researcher with the head of the fisheries department, Bayelsa State Ministry of Agriculture, in 2012 indicates that, although Bayelsa State is a traditional riverside fishing community in Nigeria, the development of culture fisheries is lagging behind capture fisheries. However, fulltime and part-time fishermen in practically all areas of the state have for long realized that the seasonal as well as perennial pools, swamps, lakes and lagoons in the state form a rich and surer source of fish than river fisheries especially during the dry season. This had over the years led to local and uncoordinated attempts to convert some of these floodplain ponds and swamps into what can be rightly described as extensively managed and largely unfed “culture ponds”, (Bayelsa State Ministry of Agriculture, 2012).

3.2 Sample Selection

A sampling frame consisting of all the 198 registered freshwater fish farmers in Bayelsa State was collected from the State Fisheries Department; Ministry of Agriculture, Bayelsa State. The multi-stage sampling technique was adopted for this study. The first stage, involved the use of the purposive sampling technique to select four Local Government Areas out of the eight Local Government Areas in the State, namely, Yenagoa, Southern Ijaw, Ogbia and Kolokuma-Opokuma. These Local Government Areas were purposively selected because the list of registered freshwater fish farmers indicates the predominance of the fish farmers in these areas. The second stage made use of the simple random

sampling technique to select fifteen fish farmers, from the list of fish farmers in each of the Local Government Areas selected, making a total of sixty (60) fish farmers.

3.3. Data Collection

To obtain sufficient information and data to accomplish the objectives of this study, data were collected from primary sources. The primary sources involved the use of structured questionnaire with both closed and open ended questions, which were administered by the researcher to the respondents. The information collected were on the socio-economic characteristics of the farmers, the types of fishes produced, cost and returns associated with freshwater fish farming, the types of inputs used, livelihood profiles of the farmers (for example, household assets, activities, and other socio-cultural and contextual information), and major sources of household income, etc. Data were also collected on cost of land, cost of construction of buildings and fish production facilities, cost of acquisition of equipment and machinery (capital investments), costs relating to operations like cost of taxes, depreciation, permits and licenses, cost of acquisition of financing and operational income like products and production quantities, etc. The data for this study lasted for eight months between April 2014 – December 2014.

3.4 Data Analyses

Objectives i, ii and vi were achieved using simple descriptive statistics such as mean, frequency distribution and percentages.

Objective iii was achieved using the Net farm income, to determine the cost and returns of freshwater fish farming in the study area. Net farm income gives an overall level of profitability of an enterprise by putting both fixed and variable costs into consideration and subtracting the costs from the total revenue.

The net farm model is stated as follows;

$$\text{NFI} = \text{TR} - \text{TC} \quad \dots \text{eqn. (3.1)}$$

$$\text{TC} = \text{TVC} + \text{TFC} \quad \dots \text{eqn. (3.2)}$$

Where TR = Total Revenue, TC = Total cost, TVC= Total variable cost and TFC= Total fixed cost

To achieve objectives v, a Sustainability Index (SI) was constructed to assess the livelihood sustenance strategies of the freshwater fish farmers. The indicators that were used were sourced from related literature. The index and method used by Dolli (2006) (i.e. the use of ‘qualitative to quantitative’ scoring tools), in his work “Sustainability of natural resource management in watershed development project” was adopted to construct indices for the four dimensions (Environmental, Institutional, Economic and Social) of sustainability considered in this study. Scores were assigned to every dimension of sustainability. The scores obtained by the respondents for each dimension, were then summed up to obtain that dimension score. The sustainability index for each dimension was then calculated as the ratio of actual score obtained by the respondent and maximum possible score. The formula is as follows;

$$\text{Sustainability Index (SI)} = \frac{\text{Actual score obtained by the respondent}}{\text{Maximum possible score}} \times 100 \dots \text{eqn. (3.3a)}$$

The overall sustainability index was computed by considering the scores obtained in social, technical and environmental sustainability. It was computed by the following formula:

$$\text{Overall Sustainability Index} = \frac{\text{Actual score of Institutional sustainability} + \text{Economic sustainability} + \text{Environmental sustainability} + \text{Social sustainability}}{\text{Maximum possible score}} \times 100 \dots \text{eqn. (3.3b)}$$

Measurement of Dimensions and Indicators of Sustainability

Table 3.1 Template for Measuring Institutional Sustainability

S/N	Sub-component	Unit	Scoring	Max
1.	Legislations on employee's welfare fully exist?	Score	0 . No Yes	1. 1
2.	Does the Local Government / State Government assist fish farmers?	Score	0 . No Yes	1. 1
3.	Existence of govt. funded research and dev. programmes and training on aquaculture development.	Score	0 . No Yes	1. 1
4.	Are there aid organizations working to assist fish farmers?	Score	0 . No Yes	1. 1
5.	Do fish farmers put forward their views to be captured and included in the development planning process of this state in any form?	Score	0 . No Yes	1. 1
6.	Existence of a national /state monitoring agencies to monitor antibiotics and other chemical residues	Score	0 . No Yes	1. 1

Table 3.2 Template for Measuring Economic Sustainability

S/N	Sub-component	Unit	Scoring	Max
1.	Net farm Income	Score	0. Negative 1. Positive	1
2.	Ratio Benefit to Cost	Score	0. Negative 1. $>0 < 2$ 2. ≥ 2	2
3.	Stability of Yield	Score	0. Not stable / Not sure 1. Averagely stable 2. Yes	2
4.	Do you reinvest your profits into business?	Score	0. No 1. Yes	1
5.	Have durables - sewing machine, Motor cycle/biclcle, keke NAPEP, car, refrigerator.	Score	0 none 1 one 2 some 3 some of them and others 4 all of them 5 all of them and more	5
6.	Savings in the form of- deposits in banks, loans, ornaments/ jewellery, self- help group savings, insurance of family members, cash in hand, liquid assets	Score	0. No 1. Yes	1
7.	Is it easy to assess to savings	Score	0 don't have 1 not easy 2 moderately easy 3 easy 4 very easy	4
8.	No. of income sources family have aside fish farming	Count		
9.	HH income security	Score	0 none, 1 fairly secure 2 secure , 3very secure	3
10.	Serious indebtedness of farmer/ family	Score	1. No 0. Yes	1

Table 3.3 Template for Measuring Environmental Sustainability

S/N	Sub-component	Unit	Scoring	Max
1.	Where do you dispose liquid waste from your fish farm	Score	4. Dug pits on farm 3.On farm land 2. Into gutters 1.Rivers/streams/borrow pits/canals	4
2.	Where do you dispose solid wastes from your farm?	Score	5. Government / private dirt collectors 4. Dug pits on farm 3.On farm land 2. Into gutters 1.Rivers/streams/borrow pits/canals	5
3.	No. of fish farms you have aside the one used for this project	Count		
4.	Reporting of escapees (number of escape events)	Score	0. No 1. Yes	1
5.	Own land	Score	0 No 1. Yes	1
6.	Source of brood stock	Score	1. Wild 2. Buy 3.Raise them	3

Table 3.4 Template for Measuring Social Sustainability

S/N	Sub-component	Unit	Scoring	Max
1.	Fishes cultured are they indigenous and locally important.	Score	0. No 1. Yes	1
2.	What % of employees is local?	Score	>70% (3) 30-70% (2) < 30% (1)	3
3.	Turnover of employees or time in the company?	Score	<1 year (0), 1-3 years (1), >3 years (2)	2
4.	Access to police station	Score	0 . No 1. Yes	1
5.	Access to market	Score	0 . No 1. Yes	1
6.	Assess to - TV, cable , radio, phone	Score	0 none 1 one 2 some 3 some of them and others 4 all of them 5 all of them and more	5
7.	Belong to a fish farming group	Score	0. No 1. Yes	1
8.	Belong to any other social group or HH member belong to a social group	Score	0. No 1. Yes	1
9.	Have any kind of trainings on fish farming?	Score	1. Yes No. 0	1

Decision rule: Any dimension whose index was ≤ 50 was considered not sustainable. An index of > 50

< 70 was considered averagely sustainable, while an index with a value of > 70 was seen as sustainable.

Regression Analysis

Two production functions were fitted to the available data to achieve objective iv.

The implicit form of the production function to assess the relationship between the cost of fertilizer, cost of fingerlings, cost of hired labour, family labour, cost of feeding, size of fish farm, production experience and net return was:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, \dots, X_7, U) \quad \dots \text{eqn. (3.4)}$$

Where Y = Net value of matured table fish per production period (₦/production period)

X₁ = Cost of fertilizer used per production (₦/production period)

X₂ = Cost of fingerlings used in a production period (₦/production period)

X₃ = Cost of hired labor used (₦/production period)

X₄ = Family labour used per production period in mandays

X₅ = Cost of feeding in a production period (₦/production period)

X₆ = Size of fish pond in cubic metre (m³)

X₇ = Production experience of respondents (years)

U = error term

The implicit form of the production function to assess the relationship between the sex, age, household size, level of education, fish farming experience, size of fish farm of the fish farmers and their net return was:

$$Y = f(X_1, X_2, X_3, X_4, X_5, \dots, X_6, U) \quad \dots \text{eqn. (3.5)}$$

Where Y = Net value of matured table fish per production period (N/production period)

X_1 = Sex (Dummy variable, 1 for male, 0 for female)

X_2 = Age (Years)

X_3 = Household size (number of persons)

X_4 = Level of education (years)

X_5 = Fish farming experience (years)

X_6 = Size of fish pond in cubic metre (cm^3)

U = error term

CHAPTER FOUR

RESULTS AND DISCUSSION

4. 1. Socio-Economic Characteristics of the Fish Farmers

4.1.1. Gender of Fish Farmers

Table 4.1 shows the distribution of the fish farmers according to gender.

Table 4.1: Percentage Distribution of Fish Farmers According to Gender

Gender	Frequency	Percentage
Male	57	95.00
Female	3	5.00
Total	60	100

Source: Survey data, 2014.

Sex plays a very important role in fish farming and agriculture, especially in terms of property acquisition. Majority (95%) of the fish farmers were males, while 5% were females. The dominance of males in freshwater fish farming in the State may be as a result of the fact that, the production process requires much time and energy which can mostly be met by the males. This result can be justified by the findings of Okwuokenye and Ikoyo-Eweto (2016) in their study on participation in homestead fish production: Implications for poverty alleviation in Bayelsa and Delta State, Nigeria. These findings can be further supported by the assertions of Ekong (2003), Fregene and Digun-Aweto (2008), Brummett *et al.*, (2010) and Hino (2011); that fish farming has generally been dominated by men while women and children dominate in pond management activities, fish processing, value-adding and post-production processes.

4.1.2. Age Distribution of Respondents

The percentage distribution of the fish farming respondents according to their age is shown in Table 4.2.

Table 4.2: Percentage Distribution of Fish Farmers According to Age

Age (Years)	Frequency	Percentage
31-40	7	11.67
41-50	15	25.00
51-60	25	41.66
61-70	9	15.00
71-80	1	1.67
81-90	3	5.00
Total	60	100
Mean	54 Years	

Source: Survey data, 2014.

The table shows that the mean age of the fish farmers is 54 years. The results implies that the fish farmers are not too young nor too old, hence, it can be said that most of them are in their productive age (31-60) thus economically active. This is in line with FAO (1998) and Yunusa (1999) whose studies reported similar results in different parts of the world. In support of this research findings, Fakoya and Daramola (2005) noted that respondents within this age bracket are innovative and motivated individuals who can cope with challenges that may emanate from farming activities. It could be said that, the result portends a great future for fish farming in the study area.

4.1.3. Marital Status

The percentage distribution of the fish farmers according to their marital status is shown in Table 4.3.

Table 4.3: Percentage Distribution of Fish Farmers According to Marital Status

Marital Status	Frequency	Percentage
Married	55	91.66
Single	2	3.33
Separated	1	1.67
Widow	1	1.67
Widower	1	1.67
Total	60	100

Source: Survey data, 2014.

The result implies that majority of the fish farmers (91.67%) are married while 3.33% of them are single. The remaining percentage of fish farmers were either separated or widowed. The result indicates that the fish farmers are people who are responsible in one way or another. The findings of Okwuokenye and Onemolease (2006) complied with this assertion. They stressed that agricultural activities (fish farming inclusive) are mostly carried out by married people and who also have family responsibilities. The proceeds from the fishing activities may be used to meet up the economic demands of their families, hence the dominance of married people. Reports of Arimi and Odebode (2014) also supports this assertion as they noted that proceeds from fishing activities are used for taking care of family economic needs.

4.1.4. Household size

The frequency distribution of the fish farmers by size of household is presented in table 4.4.

Table 4.4: Percentage Distribution of Fish Farmers According to Household Size

Household Size	Frequency	Percentage
1-8	39	65.00
9-16	13	21.67
17-24	6	10.00
25-32	2	3.33
Total	60	100
Mean	9 Persons	

Source: Survey data, 2014.

The table shows that the average household size was six (9) persons with majority (65%) of them having between 1-8 members. The result implies that the farmers have large household sizes and responsibilities to carter for. Hence, for a large household size, it will suggest a heavy burden being placed on the resources of the household which will invariably affect retained profit. . Large household size may however, serve as an important source of labour in assisting the fish farmers in carrying out some of the farming activities like stocking, bailing/drainning of water, pumping water into the pond, harvesting and sorting. The use of family labour will go a long way in lowering cost of production. The findings of Allison *et al.*, (2005) and UNDP (2006) supports this assertion. They acknowledged that the use of family labour will go a long way in lowering cost of farming activities and therefore increasing their income.

4.1.5. Level of Education/ Highest Educational Qualification

The distribution of the fish farmers according to their educational levels/ years spent in school is presented in Table 4.5.

Table 4.5: Percentage Distribution of Fish Farmers According to Level of Education

Level of Education/Highest Educational Qualification	Frequency	Percentage
None (0)	3	5.00
1-6	5	8.33
7-12	24	40.00
13-18	16	26.67
19-24	9	15.00
25-30	3	5.00
Total	60	100
Mean	12.8 Years	

Source: Survey data, 2014.

The results on Table 4.5 confirms that the farmers had spent an average of 12.8 years in school; implying that most of them have at least attended secondary school. A larger percentage (40%) of the fish farmers have at least spent 7-12 years in school, followed by 26.67% of them who have spent 13-18 years in school. This result indicates that, most of the fish farmers were literates. With most of them having post primary educational qualification, the fish farmers are bound to be successful, considering that a post primary education is considered an important contributing factor for increased productivity in agriculture (Chikezie, 2008).

4.1.6. Other Occupations of the Fish Farmers

Table 4.6 shows the distribution of the fish farmers according to their other occupations.

Table 4.6: Percentage Distribution of Fish Farmers According to their Other Occupations

Occupation	Frequency	Percentage
Artisan	10	16.66
Pensioner	16	26.67
Self employed	12	20.00
Salaried (Private/Govt.)	22	36.67
Total	60	100

Source: Survey data, 2014.

Fish farming is a seasonal activity as such the fish farmers in Bayelsa State engaged themselves in other income generating activities or had other sources of income in order to survive; as well as make ends meet. This is confirmed from the results given in Table 4.6. The findings of Ahmed *et al.*, (2012), Pravakar, *et al.*, (2013), Abbas, (2015) and Okwuokenye and Ikoyo-Eweto, (2016) complied with this assertion. They concluded that most fish farmers adopted diversified sources of income to minimize shocks and vulnerabilities.

4.1.7. Years of Experience

Table 4.7 presents information on the level of experience the fish farmers have in fish farming.

Table 4.7: Percentage Distribution of Fish Farmers According to Years of Experience

Years of Experience	Frequency	Percentage
1- 5	16	26.66
6-10	22	36.67
11-15	15	25.00
16-20	5	8.33
21-25	1	1.67
26-30	1	1.67
Total	60	100
Mean	9.3 Years	

Source: Survey data, 2014.

The level of experience the fish farmers have in fish farming was measured as the number of years they have been in the business. According to Nwosu and Onyeneke (2013), years of experience plays a significant role in any farming enterprise. They opined that there was a positive and significant relationship between years of experience in fish farming and farmers' farm revenue. This implies that farmers with longer experience of farming earned higher incomes than those with shorter experience, thus suggesting that higher farm experience will lead to higher farm revenue. The positive relationship between farming experience and farm revenue was also reported by Abbas, (2015). He asserted that high farming experience will result to increased training and indoctrination of the farmers from which they would learn certain skills that would enable them increase their farm productivity and revenue. The table shows that the fish farmers have been in the business for an average of 9.3 years. The result indicates that the fish farmers have not been in the business for a long time, hence it might be negatively affecting their revenue. However, the results imply that the creation of Bayelsa State, some twenty years ago must have opened up employment opportunities in the area of freshwater fish farming , most especially as artisanal fisheries is now on the decline.

4.2. Fish Farming Practices and Characteristics of Fish Farming in the Study Area.

4.2.1. Purpose of Culture

Table 4.8 shows the distribution of fish farmers according to purpose of culture.

Table 4.8: Percentage Distribution of Fish Farmers According to Purpose of Culture

Purpose of Culture	Frequency	Percentage
Consumption	0	0
Sale	0	0
Consumption and Sale	60	100
Total	60	100

Source: Survey data, 2014.

Findings on the purpose of culture indicated that all the fish farmers (100%) embarked on fish farming for both sale and consumption. This result is in line with the reports of Amos and Bolorunduro (2010), which stated that amongst the purposes of fish farming (whether small-scale, low-input, low-technology or large-scale, high-investment and high-technology), the cultivation of fish for food and as a source of livelihood was the most important function of fish farming.

4.2.2. Level of Management

The frequency distribution of fish farmers according to level of management is presented in Table 4.9.

Table 4.9: Percentage Distribution of Fish Farmers According to Level of Management

Level of Management	Frequency	Percentage
Intensive	0	0
Semi- intensive	60	100
Extensive	0	0
Total	60	100

Source: Survey data, 2014.

Table 4.9 shows that all (100%) the fish farmers in the study area practiced the semi-intensive system of management. According to Amos and Bolorunduro (2010), this result is attributed to the fact that, formulated fish feeds are very expensive, hence the fish farmers find it very difficult to solely feed the fishes with formulated feeds from their fingerling/juvenile age till they are ready for marketing; hence they supplement feeding with household wastes or other forms of feeds.

4.2.3. Nature of Enclosure

The frequency distribution of fish farmers according to nature of enclosure is presented in Table 4.10.

Table 4.10: Percentage Distribution of Fish Farmers According to Nature of Enclosure

Nature of Enclosure	Frequency	Percentage
Intensive	0	0
Semi- intensive	60	100
Extensive	0	0
Total	60	100

Source: Survey data, 2014.

The result on the distribution of fish farmers according to the nature of enclosure as shown in Table 4.10 indicates that the pond enclosure method is the most prevalent method used in the study area. This is confirmed by the fact that a 100% of the fish farmers used the pond enclosure method. This result is attributed to the fact that, when compared to other forms of enclosures, the farmers have a better control of the reared fishes in the pond method of enclosure than in other methods (Abbas, 2015).

4.2.4. Types of Ponds

Table 4.11 shows the distribution of fish farmers according to types of ponds.

Table 4.11: Percentage Distribution of Fish Farmers According to Types of Ponds

Types of Ponds	Frequency	Percentage
Earthen	37	61.67
Concrete	23	38.33
Total	60	100

Source: Survey data, 2014.

Majority (61.67%) of the fish farmers as seen in Table 4.11 use earthen ponds to raise their fishes, while the rest (38.33%) of them used concrete ponds. Most of them used earthen ponds, because of the inconveniences encountered in always changing the water in concrete ponds.

4.2.5. Number of Species Stocked

Table 4.12 demonstrates the frequency distribution of fish farmers according to the number of species stocked.

Table 4.12: Percentage Distribution of Fish Farmers According to Number of Species Stocked

Types of Ponds	Frequency	Percentage
Monoculture	55	91.67
Polyculture	5	8.33
Total	60	100

Source: Survey data, 2014.

Table 4.12 shows that 91.67% of the fish farmers practiced a monoculture fish farming system, while the rest (8.33%) raised more than one specie at a time. Monoculture practice may be taking the lead because, it has being observed that fishes grew better and attained their biggest size when cultured individually under monoculture system than when they are put in a polyculture system (Rundquist ,1984).

4.2.6. Types of Fishes Stocked

Table 4.13 presents the distribution of fish farmers according to types of fishes stocked.

Table 4.13: Percentage Distribution of Fish Farmers According to Types of Fishes Stocked

Types of Fishes Stocked	Frequency	Percentage
Clarias Species	46	76.67
Heterobranchus Species	9	15.00
Clarias and Heterobranchus spp	5	8.33
Total	60	100

Source: Survey data, 2014.

Majority (76.67%) of the fish farmers adopted the monoculture method in the production of the African Catfish (*Clarias gariepinus*). It can be seen from Table 4.13 that the rest of the fish farmers (15%) and (8.33%), cultured the *Heterobranchus* species and the *Clarias* and *Heterobranchus* species of the catfish species respectively. This implies that all of them (100%) raised the catfish fish species. This result is attributed to the fact that most of them practiced the monoculture system of management and because the cat fish is a hardy fish; it is generally accepted by the people, has a high market price as well as has greater demand preferences when compared to other types of fishes. It also grows very fast, have a high feed conversion ratio and a high survival rate under captivity (Kianga and Adeyemo, 2012; Abbas, (2015).

4.2.7. Scale of Production

The percentage distribution of fish farmers according to scale of production in presented in Table 4.14.

Table 4.14: Percentage Distribution of Fish Farmers According to Scale of Production

Scale of Production	Frequency	Percentage
Small Scale	20	33.33
Commercial	40	66.67
Total	60	100

Source: Survey data, 2014.

Table 4.14 indicates that, 33.33% of the fish farmers considered their enterprise as small scale, whereas 66.67% of them considered their enterprise as a commercial one. This result implies that the benefits of fish farming is yet to be fully appreciated in the study area.

4.3. Costs and Return Analysis of Fish Production in the Study Area

Estimate of costs and return analysis were made from fish farming using average cost (Fixed and Variable) and yield data generated by the fish farmers per cropping season as shown in Tables 4.15-4.18. The cost and return analysis in Table 4.18 showed that the variable costs accounted for the largest proportion (90.68%) of the total cost of fish farming in the study area (see also Table 4.17). The fixed cost of production consisted of the depreciated cost of land purchase/rent, water pump, generator, farm store house, nets, wheel barrows etc. and accounted for 9.32 % of the total cost (see Table 4.16). The result shows that a total cost (TC) of ₦458, 974.61 was incurred by a respondent per cropping season, while a total revenue (TR) of ₦1, 346,700 was realized. Net farm income (NFI) was ₦ 887,725.39. This indicates that fish farming in the study area is profitable. This result is consistent with the findings of Agboola (2011) who observed that fish farming is profitable.

Table 4.15: Estimated Fixed Costs (In Naira) for Fish Production Cycle

n=60

Items	Unit of Measure	Size of Unit	Qty	Cost Per Qty (₦)	Total Cost (₦)
A. (Fixed Costs)					
Baskets	Number	-	2	337.17	674.34
Wheel barrows	Number	-	2	6708.33	13,416.66
Drums	Litres	200	2	5,462.50	10,925.00
Land cost/ rental value	M ³	-	1	33,416.67	33,416.67
Construction of pond	Number	-	1	86,333.35	86,333.35
Nets	Number	-	2	1,500.00	3,000.00
Basins	Litres	40	4	457.50	1,830.00
Water pumping machine	Hp	1.5	1	17,841.67	17,841.67
Borehole	Number	-	1	35,000.00	35,000.00
Plumbing materials	N/A	-	-	4,666.67	4,666.67
Farm house / store	Number	-	1	27,833.33	27,833.33
Cutlass	Number	-	2	448.34	896.68
Weighing scale	Number	-	1	2000.00	2000.00
Maintenance	N/A	-	-	10,000.00	10000.00

Source: Survey data, 2014.

Table 4.16: Depreciation of Fixed Items (In Naira) for Fish Production Cycle

n=60

Items	Expected Useful Life (Years)	Annual Depre. (₦)	Depre. Value Per Cycle (₦)	% of Total Cost
B. Depreciated Costs				
Baskets	1	674.34	337.17	0.07
Wheel barrows	3	4,472.22	2,236.11	0.49
Drums	4	2,731.25	1,365.63	0.30
Land cost/ rental value	1	33,416.67	16,708.34	3.64
Construction of pond	30	2,877.78	1,438.89	0.31
Nets	2	1,500.00	750.00	0.16
Basins	3	610.00	305.00	0.07
Water pumping machine	2	8,920.84	4,460.42	0.97
Borehole	30	1,166.67	583.33	0.13
Plumbing materials	2	2,333.34	1,166.67	0.25
Farm house / store	5	5,566.67	2,783.33	0.61
Cutlass	3	298.89	149.45	0.03
Weighing scale	2	1000.00	500.00	0.11
Maintenance	-	-	10,000.00	2.18
Total	-	-	42,784.34	9.32

Source: Survey data, 2014.

Table 4.17: Estimated Variable Costs (In Naira) for Fish Production Cycle

Items	Unit	Qty	Cost /Unit /Qty (₦)	n=60	
				Total Cost (₦)	% of Total Cost
C. (Variable Costs)					
Juveniles/Fingerlings	N/A	2,265.88	6.92	15,679.92	3.42
Fuel	N/A	-	-	33,200.00	7.23
Transport and handling charges	N/A	-	-	23,400.00	5.10
Medications	N/A	-	-	11,700.00	2.55
Fertilizer (Organic/Inorganic)	N/A	-	-	3,000.00	0.65
Lime	N/A	-	-	1,541.67	0.34
Feed (Concentrated)	N/A	-	-	176,685.35	38.50
Feed (house hold waste/others)	N/A	-	-	51,883.35	11.30
Labour (Hired)	Monthly	-	12,283.33	73, 700.00	16.06
Labour (Family)	Monthly	-	3,116.67	18,700	4.07
Contingencies	N/A	-	-	6,700.00	1.46
Total Variable Costs				416,190.27	90.68

Source: Survey data, 2014.

Table 4.18: Estimated Enterprise Budget (In Naira) for Fish Production Cycle

Items	Unit	Qty	Cost/Qty/ Unit (₦)	Cost / Month (₦)	Amount Generated (₦)
D. (Revenue)					
Qty dead /unaccounted for	-	21.38	-	-	-
Quantity given away as gift	Kg	18.85	600.00	-	11,310.00
Quantity consumed	Kg	91.60	600.00	-	54,960.00
Quantity sold	Kg	2,134.05	600.00	-	1,280,430
Total Revenue					1,346,700
Total Revenue (Table D)					= ₦ 1,346,700
Total cost (Tables B+C)					= ₦ 458,974.61
Net Farm Income (D- (B+C))					= ₦ 887,725.39

*Average Pond Size (38.87 m³)
Source: Survey data, 2014.

4.4. Determinants of Net Returns

(a) Estimated Fish Production Function

Table 4.19 presents the results of the multiple regression analysis on relationship between the net return generated by the fish farmers and cost of fertilizer, cost of fingerlings, cost of hired labour, family labour, cost of feeding, size of fish farm and production experience.

Table 4.19. Multiple Regression Results Showing Determinants of Net Return

Explanatory Variables	Linear	Semi-log	Double Log	Exponential
Intercept	-51775 (-0.839)	-77372 (-1.7482)	2.4635 (0.6060)	12.2991 (19.81)
Cost of Fertilizer (X₁)	-3.09 (-0.889)	-2571.58 (-1.215)	-0.03 (-1.4395)	-2.15 (-0.61)
Cost of Fingerlings (X₂)	-1.74 (-3.68) **	-30339.43 (-2.92)**	-0.34 (-3.51)**	-1.61 (-3.40) **
Cost of Hired Labour (X₃)	-0.20 (-0.50)	-6190.87 (-0.20)	-0.07 (-0.24)	-2.30 (-0.57)
Family Labour in Mandays (X₄)	2178.08 (1.31)	58633.30 (1.73)	0.57 (1.84)	0.02 (1.46)
Cost of Feeding (X₅)	-0.31 (-4.93) **	-45660.98 (-3.31)**	-0.62 (-4.91)**	-3.82 (-6.61) **
Size of Fish Farm (X₆)	267673.46 (2.66) **	19231.95 (3.23) **	0.11 (2.01)**	0.74 (0.74)
Production Experience (X₇)	918.32 (0.93)	6455.39 (0.76)	0.09 (1.17)	0.01 (0.60)
R²	0.70	0.71	0.76	0.71
F	17.31	17.80	23.38	17.80
N	60	60	60	60

Source: Survey data, 2014.

Figures in parenthesis are the t-ratios

** Significant at 5%

On the basis of selection criteria, viz: a priori expectation in terms of sign and magnitude of the coefficients, the economic rationale, the significance of the coefficients and the overall performance of the model; the double-log functional form was eventually selected as the lead equation. The double-log

functional form had the highest R^2 value, the variables are significant at 5%, with appropriate signs on most of them. The result of the lead equation, shows that the coefficient of determination (R^2) is 0.76 which implies that, about 76% of the variations in the value of fish output is jointly explained by the included variables ($X_1 - X_7$) while the remaining 24% are exogenous to the system. The F- value of 23.38 indicates that the overall equation is statistically significant at 5%.

From the result, it is evident that two of the variables, cost of fingerlings (X_2) and cost of feeding (X_5) have a negative significant relationship with profit. The negativity indicated that the variables and revenue move in opposite directions i.e. the higher the cost of negatively signed variables, the lower the revenue. This agrees with the a priori expectation of the study.

In consonance with the a priori expectation, the regression coefficients of cost of fertilizer (X_1) and cost of hired labour (X_3) are also negative although not significant.

However, contrary to a priori expectation size of fish farm (X_6) was positive and significant while family labour (X_4), and production experience (X_7) were positive although not significant. The reason that could be adduced for the former is that, these variables have a direct relationship with total profit. This may imply that, increase in family labour, size of fish farm and production experience would influence the increased use of other inputs which would result to increased output and profit.

The coefficients of X_1 , X_2 , X_3 and X_5 were negative and significant, X_6 , was positive and significant; while the coefficient of X_4 , and X_7 were positive and insignificant. Therefore, hypothesis one which states that; total profit earned by the fish farmers in Bayelsa State is not positively related to cost of fertilizer, cost of fingerlings, cost of hired labour, family labour, cost of feeding, size of fish farm and production experience is hereby accepted with respect to the variables X_1 , X_2 , X_3 and X_5 with negative coefficients, and rejected with respect to the variable X_6 with positive coefficient.

(b) Estimated Socio-economic Determinants of Net Returns in Fish Production

Table 4.20 presents the results of the multiple regression analysis on relationship between the net return generated by the fish farmers in Bayelsa and sex, age, household size, level of education, fish farming experience size of fish farm.

Table 4.20: Multiple Regression Results of Relationship Between the Socio-economic Characteristics of Freshwater Fish farmers and Net Return

Explanatory Variables	Linear Function	Semi-log Function	Double-log Function	Exponential Function
Intercept	192518.1771 (3.23)**	526713.4545 (3.20)**	15.8543 (7.22)**	14.5970 (18.07)**
Sex (X₁)	13780.60 (0.46)	30676.39 (1.19)	0.19 (0.55)	0.09 (0.22)
Age (X₂)	-2720.10 (-3.08)**	-52018.01 (-1.09)	0.11 (0.18)	-0.02 (-1.60)
Household Size (X₃)	-1617.53 (-0.67)	-61806.36 (-3.38)**	-0.35 (-1.45)	0.01 (0.35)
Level of Education (X₄)	927.32 (0.68)	19719.83 (2.18)**	0.16 (1.32)	-0.01 (-0.02)
Fish Farming Experience (X₅)	-473.69 (-0.29)	6446.80 (0.61)	0.26 (1.81)	0.01 (0.53)
Size of Fish Farm (X₆)	502981.99 (4.18)**	26960.02 (4.91)**	0.35 (4.73)**	3.38 (2.07)**
R²	0.55	0.66	0.40	0.18
F	10.85	17.25	5.79	1.88
N	60	60	60	60

Source: Survey data, 2014.

Figures in parenthesis are the t-ratios

** Significant at 5%

On the basis of selection criteria, viz: a priori expectation in terms of sign and magnitude of the coefficients, the economic rationale, the significance of the coefficients and the overall performance of the model; the semi-log functional form was selected as the lead equation. The semi-log functional form had the highest R² value; most of the variables were significant at 5%, with appropriate signs on most of them.

The result shows that the coefficient of determination (R^2) is 0.66 which implies that, about 66% of the variations in the value of fish output is jointly explained by the included variables ($X_1 - X_6$) while the remaining 34% are exogenous to the system. The F- value of 17.25 indicates that the overall equation is statistically significant at 5%.

From the result, it is evident that size of fish farm (X_6) and level of education (X_4) were positive and significantly explain the variation in the value of fish. This implies that a unit increase in these inputs will lead to an increase in the value of output. Sex (X_1) and production experience (X_5) were also positive but not significant. While age (X_2) and household size (X_3) were negative and non significant.

The coefficients of X_1 , X_4 , X_5 , and X_6 were positive and significant, while the coefficient of X_2 and X_3 were negative and insignificant. Therefore, hypothesis one which states that; net return earned by the fish farmers in Bayelsa State is not positively related to the socio-economic characteristics of the fish farmers is hereby rejected with respect to the variables X_1 , X_4 , X_5 , and X_6 with positive coefficients, and accepted with respect to the variables X_2 and X_3 with negative coefficients.

4.5 Sustainability Assessment

Section 4.5 assesses sustainability in freshwater fish farming in Bayelsa State under institutional, economic, social and environmental sustainability.

4.5.1. Institutional Sustainability

Table 4.21 presents the institutional sustainability result of the fish farmers in the study area.

Table 4.21: Institutional Sustainability

n=60

	Sub-component	Unit	Scoring	Max.	Value	Remark
1.	Legislations on employee's welfare fully exist?	Score	0 . No 1. Yes	1	0.17	
2.	Does the Local Government / State Government assist fish farmers?	Score	0 . No 1. Yes	1	0.50	
3.	Existence of govt. funded research and dev. programmes and training on aquaculture development.	Score	0 . No 1. Yes	1	0	
4.	Are there aid organizations working to assist fish farmers?	Score	0 . No 1. Yes	1	0	
5.	Do fish farmers put forward their views to be captured and included in the development planning process of this state in any form?	Score	0 . No 1. Yes	1	0.17	
6.	Existence of a national /state monitoring agencies to monitor antibiotics and other chemical residues	Score	0 . No 1. Yes	1	0.33	
					19.5%	Not Sustainable

Source: Survey data, 2014.

Fish farming is not institutionally sustainable in Bayelsa State (19.5%). The results show that, fish farmers in the state receive little or no assistance from the government (0.5). There is really little or no check on the disposition and effect of antibiotics and other chemical residues from fish farming by any legal body (0.33) on the environment. There is also the non-existence of any research or aid organizations assisting the fish farmers in any way. The fish farmers too on their part do not have any platform to air their views (0.17). Legislations on employee's welfare too, do not fully exist among them (0.17). These results implies that a lot needs to be done to ensure that fish farming attains institutional sustainability in Bayelsa state.

4.5.2. Economic Sustainability

Table 4.22 presents the economic sustainability result of the fish farmers in the study area.

Table 4.22: Economic Sustainability

n=60

S/N	Sub-component	Unit	Scoring	Max	Value	Remark
1.	Net farm Income	Score	0. Negative 1. Positive	1	1	
2.	Ratio Benefit to Cost	Score	0. Negative 1. $>0 < 2$ 2. ≥ 2	2	2.00	
3.	Stability of Yield	Score	0. Not stable / Not sure 1. Averagely stable 2. Yes	2	1.50	
4.	Do you reinvest your profits into business?	Score	0. No 1. Yes	1	1.00	
5.	Have durables - sewing machine, bike, keke napep, car, refrigerator.	Score	0 none 1 one 2 some 3 some of them and others 4 all of them 5 all of them and more	5	2.53	
6.	Savings in the form of- deposits in banks, loans, ornaments/ jewellery, self- help group savings, insurance of family members, cash in hand, liquid assets	Score	0. No 1. Yes	1	1.00	
7.	Is it easy to assess to savings	Score	0 don't have 1 not easy 2 moderately easy 3 easy 4 very easy	4	2.92	
8.	No. of income sources family have aside fish farming	Count		12	3.37	
9.	HH income security	Score	0 none, 1 fairly secure 2 secure , 3 very secure	3	2.17	
10.	Serious indebtedness of farmer/ family	Score	1. No 0. Yes	1	1.00	
					58 %	Averagely Sustainable

Source: Survey data, 2014.

Based on the criteria used to assess economic sustainability amongst the fish farmers the economic sustainability index was 58 %. This result indicates that, fish farming in the study area is averagely

sustainable. The net farm income value is positive (N887, 725.39), the ratio of revenue to cost (2.9) also indicated economic viability. Yield is considered as averagely stable (1.5) among the fish farmers. All the farmers (1) reinvested into their business. They all had one form of durable goods or another (2.53), as well as savings which are easily assessable. They all had other fairly secured (2.17) income sources aside fish farming. None of the fish farmers or their family members was also in any kind of serious debt. This means that, fish farming as an economic venture can be considered sustainable.

4.5.3. Environmental Sustainability

Table 4.23 presents the environmental sustainability result of the fish farmers in the study area.

Table 4.23: Environmental Sustainability

n=60

S/N	Sub-component	Unit	Scoring	Max	Value	Remark
1.	Where do you dispose liquid waste from your fish farm	Score	4. Dug pits on farm 3. On farm land 2. Into gutters 1. Rivers/streams/borrow pits/canals	4	2.45	
2.	Where do you dispose solid wastes from your farm?	Score	5. Government / private dirt collectors 4. Dug pits on farm 3. On farm land 2. Into gutters 1. Rivers/streams/borrow pits/canals	5	2.98	
3.	No. of fish farms you have aside the one used for this project	Count		6	0.73	
4.	Reporting of escapees (number of escape events)	Score	0. No 1. Yes	1	0	
5.	Own land	Score	0 No 1. Yes	1	1.00	
6.	Source of brood stock	Score	1. Wild 2. Buy 3. Raise them	3	2.05	
					46.05%	Not Sustainable

Source: Survey data, 2014.

The environmental sustainability value for this study was 46.05%. This value shows that fish farming in Bayelsa state, is not environmentally sustainable. This score is attributed to the fact that, since there is almost a non-existent legal framework to check the disposal of waste from fish farmers as shown in the institutional sustainability table, wastes from fish farming activities (both liquid and solid), were disposed indiscriminately (2.45). There is also the problem of the risk of escaped farmed fishes; which

could result not only to disease transmission but also the introduction of possible invasive species into native environments, as non (0) of the fish farmers, aside attributing escapees to theft; ever consider escapees as a threat the environment. Most of them did not raise their brood stocks themselves (2.05). However, a major plus was that they all had access to their own plots of lands.

4.5.4 Social Sustainability

Table 4.24 presents the social sustainability result of the fish farmers in the study area.

Table 4.24: Social Sustainability

n=60

S/N	Sub-component	Unit	Scoring	Max	Value	Remark
1.	Fishes cultured are they indigenous and locally important.	Score	0. No 1. Yes	1	1.00	
2.	What % of employees is local?	Score	>70% (3) 30-70% (2) < 30% (1)	3	3.00	
3.	Turnover of employees or time in the company?	Score	<1 year (0), 1-3 years (1), >3 years (2)	2	1.60	
4.	Access to police station	Score	0 . No 1. Yes	1	1.00	
5.	Access to market	Score	0 . No 1. Yes	1	1.00	
6.	Assess to - TV, cable , radio, phone	Score	0 none 1 one 2 some 3 some of them and others 4 all of them 5 all of them and more	5	4.00	
7.	Belong to a fish farming group	Score	0. No 1. Yes	1	0.40	
8.	Belong to any other social group or Household member belong to a social group	Score	0. No 1. Yes	1	0.85	
9.	Have any kind of trainings on fish farming?	Score	1. Yes No. 0	1	1	
					87.35%	Sustainable

Source: Survey data, 2014.

With a social sustainability value of 87.35%, fish farming is considered highly sustainable, socially. The fishes cultured were indigenous and locally important (1), hence, there is a market for them. Even though, the turnover of employees in the business was between 1-3 years, more than 70% of the employees were indigenes. All the farmers had access to both a police station and market, as well as telecommunication assets. Although most of them are yet to appreciate the importance of social groups, a few of them or their family members belonged to one kind of social group or another. The result also indicates that all the fish farmers had one sort of training or the other on fish farming as well as are all willing to avail themselves for re-training if need be.

$$\begin{aligned}
 \text{Overall Sustainability Value:} &= \frac{(1.17 + 18.49 + 9.21 + 14.85)}{6 + 32 + 20 + 17} \times 100 \\
 &= \frac{43.72}{75} \times 100 \\
 &= 58.29\%
 \end{aligned}$$

The overall sustainability result of 58.29% indicates that fish farming in Bayelsa State was averagely sustainable. This score indicates that a lot still needs to be done, especially in the area of environmental sustainability and institutional sustainability. The result implies that the freshwater fish farmers embark on several strategies to ensure that their livelihood is sustained. Hence, there is livelihood sustenance among the freshwater fish farmers in Bayelsa State.

4.6. Problems and Constraints in Fish Farming

Table 4.25 presents the problems and constraints the fish farmers in the study area.

Table 4.25: Percentage Distribution of the Problems and Constraints in Fish Farming

Problems	Frequency	Percentage
High cost of feeds	60	100.00
No good patronage from customers	60	100.00
No good fish markets	60	100.00
No training/research centers	60	100.00
No support from government	50	83.33
Not enough space	35	58.33
Theft /poaching	33	55.00
Inadequate fingerlings/juveniles	31	51.67
Lack of good fish cooperative societies	28	46.67
Other problems (harassment from L.G.A officials, time, disease, hike in transport fares, lack of transport facilities)	6	10.00

*Multiple responses recorded

Source: Survey data, 2014.

Factors that constitute constraints to fish farming in the study area has been demonstrated also in Table 4.25. All (100%) the fish farmers considered, high cost of fish feeds, no good patronage from customers, no good fish markets and the unavailability of training/research centers, as major challenges to their enterprise. Most (83.33%) of them had no support from government; 58.33 % had the issue of inadequate space while 55% and 51.67% of the challenge of theft/poaching and inadequate fingerlings/juveniles respectively. The results also indicates that 46.67% of them were constrained by lack of good fish cooperative societies, while other problems formed 10%. These challenges as highlighted in section 2.1.7 constitutes the major constraints in fish farming, as well as the justification of this study.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study was designed to examine the economics of freshwater fish farming and livelihood sustainability among freshwater fish farmers in Bayelsa State, Nigeria. The study was specifically aimed at examining the socio-economic characteristics of the fish farmers in the study area; identifying the fish farming practices of the farmers; determining the costs and returns of the enterprise, as well as the factors that determine their output. The sustainability of their livelihood was also analyzed.

Data were collected with the aid of structured questionnaire, alongside with personal interviews from sixty randomly selected fish farmers from four Local Government Areas of the Bayelsa State. The data were analyzed using descriptive statistics, net farm income model, indices and multiple regression models. Results show that 95% of the fish farmers are men, with most of them being married (91.66%). The findings from the study indicates that 41.67% of them fall between the age range of 51-60 years. The mean household size was 9 persons. The result indicates that most of the fish farmers are literates. Fish farming is a seasonal activity as such all of them had other income sources. The mean years of experience was 6-10 years. Consumption and sale is the major reason why the fish farmers went into fish farming. All of them (100%) practiced the semi-intensive system of management. The most prevalent nature of enclosure in the study area was concrete and earthen ponds. Most (91.67%) of the fish farmers practiced the monoculture system of stocking, while the remaining 8.33% practiced polyculture. The catfish species is the major fish species cultured in Bayelsa State, some of the reasons being that it is generally accepted by the people, has a high market price as well as have greater demand preferences when compared to other types of fishes. Generally most of the fish farmers operated a fairly large scale of production.

The average net farm income of the fish farmers was positive ₦ 887,725.39. This means fish farming is a profitable business in Bayelsa State. Some of the factors that significantly affect the revenue of the fish farmers are: cost of fingerlings, cost of feeding, size of fish farm and level of education. Fish farming is also considered averagely sustainable, given the overall sustainability score of (58.29%) generated from the study.

5.2 Conclusion

From the foregoing, it can be deduced that the fish farmers are vibrant and energetic members of the labour force. It is also clear that, fish farming is a very profitable business to be engaged in. Apart from the fact that it is a profitable business; with the right sustainability mindset, it is a sustainable enterprise capable of contributing immensely to the livelihoods of the people engaged in it.

However, fish farming practices in Bayelsa State are generally poor and need sufficient input both from the fish farmers and the government to enhance its growth. Some of the factors that significantly affect the revenue of the fish farmers are, cost of fingerlings cost of feeding, size of fish farm and level of education. Some of the challenges faced by the fish farmers in the study area are; high cost of fish feeds, no good patronage from customers, no good fish markets and the unavailability of training/research centers. Net farm income will definitely increase, if these factors are taken into consideration, in formulating policies and programmes for the fish farmers.

5.3 Recommendations

Based on the findings of this study, the following were recommended;

1. Fish farming in the area is dominated by males; females should be encouraged to participate in fish farming, so as to augment the income of their households.
2. The results show that most of the fish farmers are not in any form of cooperative society. The fish farmers already in cooperatives should thus encourage each other, to form and manage functional

cooperative groups as well as pool their resources for individual development within the fish farming industry.

3. There is need for the creation of awareness and orientation about the profitability of the fishery enterprise and its overall importance in livelihood sustainability and economic development.
4. Fish farmers should get themselves trained and retrained continuously on the latest technologies of fish farming, especially on how to raise their fingerlings artificially by themselves.
5. Most of the fish farmers are unaware of the importance of the sustainability of their enterprise. The farmers should form groups as an avenue to sensitize them on the key areas of sustainability.
6. Government participation in fish farming in the area is highly needed. Government should assist the fish farmers as well as provide them with readily available, adequate and standard inputs at subsidized rate.

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Department of Agricultural Economics,
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Sir/Madam,

I am a postgraduate student of the above named university. I am undertaking a research work on the Economics of Freshwater Fish Farming and Livelihood Sustainability Amongst Freshwater Fish Farmers in Bayelsa State. The research work is undertaken, in partial fulfillment of the requirements for the award for a Master of Science (Msc.) Degree in Agricultural Resource and Environmental Economics. This study is purely an academic exercise and promises to be beneficial to the Aquaculture industry and particularly fish farmers in Nigeria. I therefore, crave your indulgence to answer the questions truthfully and without any reservations, as strict confidentiality in the treatment of information given by respondents is fully guaranteed.

Thanks for your anticipated co-operation.

Yours faithfully,

WASINI DOBIE ALLEN
(Researcher)

QUESTIONNAIRE

Date..... Questionnaire Number ()

A. Geographic Information (Location of fish farm) L.G.A/Town

1. Name of respondentRelationship of respondent to owner.....
2. Age (as of last birthday)years old
3. Sex: 1 - Male 2 – Female 4. Home Address of owner / operator.....
5. Level of Education? No formal education () Completed Primary school () unable to complete primary school () Completed Secondary school () unable to complete secondary school () NCE/OND () University () Others please specify.....
6. No. of years spent in school.... Years
7. What is your primary occupation?
8. What is your secondary occupation.....
9. No. of years engaged in fish farming.....10.Marital status.....11. HH size.....

B. Fish Farm Characteristics

1. Is this mainly a fish farm () 2. The fish farm is part of a bigger farm() 3. Name of farm/fish farm.....4. What year was the fish farm established?5. What is your objective for doing fish farming? 1- Own consumption 2- To sell 3-Own consumption and to sell 4- Others (Specify)
6. What type of fish do you culture 1- Tilapia sp 2- Clariais sp 3- Heterobranchus sp 4. Others specify
4. Why do you culture these specie(s)?..... 5. Where do you rear your fish? 1-Ponds {Earthen (), Concrete (), Both ()}, 2. Tanks 3- Others (Please specify).....
- 5.1 Why..... 6. Size of fish farm.....7. Number of ponds/enclosures

Pond No.	Area (size)	Status of ownership	Culture method (mono. Poly.)	Production method (Intensive etc.)	Depth	Source of water
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Focus pond - The particular pond where the last cropping is completed and where all relevant information for this study will be collected.

8. Focus pond no:8.1 Month stocked8.2 Month harvested.... 8.3 No. of harvests....

8.4 How many times do you stock and harvest per year?..... 9-How do you rate the level of your production? Small () Medium () high ()

C. Farm Investment

Item	Inventory (Area/No)	Year(s) Acquired	Cost	Repairs	Estimated life	% of use in focus pond
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Land lease / rental , Farm structures, Farm machinery and equipment (Nets, generator, water pumps, aerators, paddle wheels, feed mill, feed dispenser, rain boosts, hooks; twine, rope, buckets, baskets, basins), Fish transporters: Tricycle, Pick-up, Van, Motorized boat, Canoes, salaries, fuel and oil, transport cost of inputs , rentals, etc.

D. Other Production Costs (Non-cash)

Commodity	Qty	Unit of measure	Weight per unit (Kg.)	Total Qty(Kg.)	Value (P)
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E. Material Inputs (Where do you get your materials? Ministry/Extension, Agro-service centre , Farm service centre , cooperative society , Local Mrkt, Others pls specify.....)

Item	Qty	Unit	Weight/Vol.	Price	Solid / Granule Inputs		Liquid Inputs	
			Per Unit (Kg)	Per Unit (Liter) (P)	TotalQty/(Kg)	TotalValue(P)	TotalVol.	Total value (Liter) (P)

1.Seed

2. Feeds

3. Fertilizer

4.Others,

F. Labour Inputs

Activity(M/F)	Family	Hired	Total Food cost Cash/Non- Cash	No. of persons	No. of days	No. of hrs	Prevailing wage rate
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G. Production and Disposition (Average production and revenue, Pls indicate)

	2nd Time	1st Time	2nd Time	Other
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1. Area harvested

2. Production

2.1 Quantity

2.2 Local unit used

2.3 Weight per local unit (kg.)

2.4 Total production in kg

3. Disposition (in local unit)

3.1 Sold

3.1.1 Price per l.u. (P)

3.1.2 Price per kg (P)

3.2 Workers share

3.7 For home consumption

3.8 Given away

3.9 Others:.....

H. Buyer Information (Please Encircle code/s)

1) Where do you sell your product? 1. Fish Market 2.Regular market 3. Farm 4 By order 5. Others

2) Who sell your products after harvest? 1. Self 2.Spouse 3.Other family members 3.Fish dealer 4.

Others (Specify).....

3) In what form are they sold? 1.Live 2.Fresh 3.Frozen 4.Salted 5.Smoked 6.Others (Specify).....

I. Problems Encountered

High cost of feeds() No good patronage from customers() No good fish markets()

No training/research centers() No support from government() Not enough space()

Theft /poaching() Inadequate fingerlings/juveniles() Lack of good fish cooperative societies()

Other problems.....

J. Dimensions and Indicators of Sustainability

1.Institutional Sustainability

1. Legislations on employee's welfare fully exist? 0 . No 1. Yes

2.Does the Local Government / State Government assist fish farmers? 0 . No 1. Yes

3.Existence of govt. funded research and dev. programmes and training on aquaculture development
0 . No 1. Yes

4. Are there aid organizations working to assist fish farmers? 0 . No 1. Yes

5.Do fish farmers put forward their views to be captured and included in the development planning
process of this state in any form? 0 . No 1. Yes

6.Existence of a national /state monitoring agencies to monitor antibiotics and other chemical residues
Score 0 . No 1. Yes

2. Economic Sustainability

1.Stability of Yield 0.Not stable / Not sure 1.Averagely stable 2. Yes

2.Do you reinvest your profits into business? 0. No 1. Yes

3.Have durables - sewing machine, bike, keke napep, car, refrigerator. 0 none 1 one 2 some

3 some of them and others 4 all of them 5 all of them and more

4.Savings in the form of- deposits in banks, loans, ornaments/ jewellery, self- help group savings,
insurance of family members, cash in hand, liquid assets 0. No 1. Yes

5.Is it easy to assess to savings 0 don't have 1 not easy 2 moderately easy 3 easy 4 very easy

