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RESEARCH PAPER

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# Economics of Smallholder Fish Farming to Poverty Alleviation in the Niger Delta Region of Nigeria

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## Abstract

The fisheries sector is important to the economy of the Niger Delta region of Nigeria, contributing to employment, income and food security in the region. Despite its contribution, however, poverty remains relatively high in the region. The study, thus, used farm and household level data gathered from 360 randomly selected smallholder fish producers to analyse the economics of smallholder fish farming as relates to poverty reduction in the Niger Delta area. Using enterprise budgeting, Foster-Greer-Thorbecke and Tobit regression models, we found that fish farming in the region is profitable and the depth of poverty on fish farming households is high. The effects of socioeconomic variables, farm size and assets on poverty were generally negative, indicating several interactions between poverty and the variables analysed. Fish production significantly reduced poverty in the region. This analysis provides a much-needed counterpoint to past policy commentaries on Niger Delta's fish production systems which have focused mainly on labels such as "small-scale" and "commercial" without expressing its relationship to poverty alleviation.

## Introduction

Fish production is very important not only as a source of animal protein to ensure food security but also to improve employment and income towards the elimination of poverty in developing countries (Okezie, Igwe, Nnabugwu, & Okezie, 2008). Flake and Nzeke (2007) stated that fish is the cheapest source of animal protein and represents a significant proportion of animal protein in the diet of most developing countries, including Nigeria. Globally, fish accounts for about 17 percent of animal protein intake and 6.7 percent of all protein consumed by humans (FAO, 2016).

There are two main sources of fish in Nigeria - domestic production and imports. The domestic component consists of artisanal fishing and fish farming, the latter of which involves rearing fish to a marketable size in an enclosed water body (Ogundari & Ojo, 2009; Olawumi, Dipeolu, & Bamiro, 2010). Fish farming mainly supplements the unpredictable production from capture (natural stock)/artisanal fisheries.

Though it has been practiced in Nigeria for over forty years, fish farming has not contributed notably to domestic production figures. The total fish demand for Nigeria, based on the 2014 population estimate of 180 million persons, was 3.32 million tonnes and the domestic fish production from aquaculture, artisanal fishing and industrial fisheries for 2014 was 1.123 million tonnes (Fishery Committee for the West Central Gulf of Guinea, 2016). In 2015, fisheries including

aquaculture, contributed 0.5 percent to the Gross Domestic Product (GDP) of Nigeria (Central Bank of Nigeria, 2015). There is the potential to increase domestic production as the country has more than 12 million hectares of inland waters suitable for fish farming development (Inoni, 2007).

Fish production in the Niger Delta is dominated by smallholder producers. Smallholder fish production is broadly characterized as a dynamic and evolving sub-sector that is employing labour-intensive harvesting, processing and distribution technologies to exploit marine and inland water resources (FAO, 2005; Bene, 2006; Bene, Macfadyen, & Allison, 2007). The activities of this sub-sector, conducted full-time, part-time or just seasonally, are often targeted at supplying fish and fisheries products to local and domestic markets, as well as for subsistence consumption (FAO, 2005; Bene, 2006; Bene *et al.,* 2007). Smallholder fish farmers amongst them are those who produce with stocking capacity of less than 2000 fingerlings (Federal Office of Statistics, 1999; Omitoyin, 2007). Generally, smallholder farmers constitute about 80 percent of the farming population in Nigeria (Awoke & Okorji, 2004).

Smallholder fish farming in Nigeria is practiced under four major systems: extensive, semi-intensive, integrated and intensive. The extensive system, according to Omitoyin (2007) and Nwike (2002), is characterized by low stocking density, low production with little or no nutritional inputs and low investment cost. In the semi-intensive culture system, fish is stocked at a higher stocking density than the extensive system and fed with supplementary feed to support the natural food supply (Ozigbo, Anyadike, Adegbite, & Kolawole, 2014). There is usually pond fertilization to increase the nutrient requirements in the semi-intensive culture system. Its production cost is usually moderate, and its yield is higher than the case in the extensive system - above 10,000kg/ha/year (Omitoyin, 2007). The integrated system is the culture of fish alongside other forms of agriculture. It is a farming system where resources are efficiently utilized and recycled to achieve higher production than would be obtained from a single production system (Otubusin, 1994). Devendra (1995) viewed integrated fish farming as a multiple land-use approach which combines fish farming with other agricultural (crops and animals) production systems. On the other hand, intensive fish culture system is one where fishes are stocked at a high density and fed exclusively on a nutritionally-balanced diet to meet their nutrient requirements (Ozigbo *et al.,* 2014). The cost of production is high, and the yield is also very high. It is worthy of note that the success of the various culture systems, especially the intensive culture system depends on many factors including the feed, the feeding system and the pond maintenance in place.

Feed and feeding systems are very important in the management of fish farming enterprises. In fact, the growth and performance of cultured fish are directly related to the amount of feed available in the pond, the quantity of feed fed and time of feeding (Bao-Tong, 1994). Omitoyin (2007) stated that fish should be fed properly with quality feed that meets the nutrient requirements of fish for each stage of their growth to achieve optimum growth. Complete feed supplies all the nutrients required by fish in the right proportion for optimum growth while supplemental feed does not contain the full complement of nutrients required for optimal fish growth (Ajimmy, 2007).

Pond maintenance is another important management practice in fish farming. There are many types of culture media through which fish can be raised or cultured. These include earthen pond, concrete tank, wooden and fibre tank, etc. In earthen pond, the walls are made of soil while the water control device can be of concrete, metal or wooden materials. Earthen pond is the most common type of fish production milieu in Nigeria (Adikwe, 1999). Fish ponds vary in size ranging from small (less than ½ hectare) to medium (0.5-1 hectare) and large (1 hectare and above) (Adinya & Ikpi, 2008). They are either dug by hand or with heavy equipment and vary in shape depending on the shape of the land where it is situated. Earthen ponds are easy to manage, and production is usually faster because of the addition of natural food to supplement the feed given to the fish (FAO, 2000). Fishes bred in earthen ponds are, however, prone to predators if not properly managed and this can reduce output rather drastically (Omitoyin, 2007). On the other hand, concrete ponds are usually built with cement, sand and gravel (FAO, 2000). It could be rectangular or circular in shape, with depth ranging from 1-1.2 metres. Concrete ponds are most common in urban and peri-urban cities where land is not available or not suitable for earthen pond construction (Omitoyin, 2007).

Fishing is one of the main economic activities in the Niger Delta region, with about 40 to 60 percent of the labour force engaged in it (Ekpo & Essien-Ibok, 2013). Fishing, as a major occupation of the region, provides an estimated 50 percent of the fish consumed in Nigeria (Bene & Neiland, 2004; Uyigue & Agho, 2007). Considering the persistent conflict in the region and damage to its environment due to crude oil spillage and considering also the rising unemployment rate (National Bureau of Statistics, 2016; National Bureau of Statistics, 2013; United Nations Environment Programme, 2011), fish farming provides a potential alternative means of self-employment in the region. The development of smallholder fish farms will help create employment opportunities, provide income, reduce poverty, address incessant conflicts and serve as an alternative to capture fishing that is no longer economically sustainable to inhabitants of the majority of the communities in the region due to oil spills.

Studies on Nigeria's fish production have focused

on various aspects such as: the socioeconomics of fishing (Anyanwu-Akeredolu, 2005; Nwosu & Onyeneke, 2013); description of the structure of the fishing sector (Tobor, 1990); financial analysis of commercial fishing (Fagbenro, 2005); the profitability of fish farming (Nwike, 2002; Adaka, Nlewadim, Ibekwe, & Ebonumah, 2006; Adewuyi, 2009; Allison-Oguru, 1987; Amaefula, Onyenweaku, & Asumugha, 2006; Amaefula, Onyenweaku, & Asumugha, 2009; Nwosu, Oguoma, Ohajianya, & Ibekwe, 2007; Nwosu, 2009); the role of fish as a safety net (Bada, 2005; Bene & Heck, 2005; Bene & Neiland, 2004); and its greater contribution to the nutrition of the population of the area (Fabiyi, 1985; Adeniji, 1987; Oyenuga, 1995; Kpadia, 2002; Ugwumba & Ugwumba, 2003; Ohajianya, Onyeagocha, & Ibekwe, 2006; FAO, 2007; Oguoma, Ohajianya, & Nwosu, 2010; Ugwumba & Chukwuji, 2010). While these studies have contributed to an understanding of the socio-dynamics of fishing in Nigeria, they have not adequately addressed the profitability of different management systems of fish farming and the poverty level of fish farmers in the Niger Delta region. Also, empirical evidence is scanty, isolated and devoid of in-depth analysis of the determinants of poverty among fish farmers in the Niger Delta in the context of their different drivers and degree of impact. This study analyzed the economics of smallholder fish farming systems and how it has alleviated poverty in the region. Specifically, it identified the different smallholder fish management systems in the area; determined the profitability of different smallholder fish management systems; and quantified the poverty profile of the smallholder fish farmers, in addition to ascertaining its determinants.

**Conceptual Framework**

**Poverty**

Individuals or communities are defined as poor, based on lack of income and inability to meet basic human needs for existence (Agboola & Amoo, 2008; Sidi, 2008; Osinubi, 2003; World Bank, 2002; Aromoloran, 1993). In other words, poverty means a condition of having little or no money or other endowment and not being able to get the necessities of life. Defining poverty indeed surpasses qualitative observational analysis of whether the people have access to essential facilities and needs. Oftentimes, some quantitative measures are adopted such as household expenditure (Grootaeri, 1994) and the poverty count index (Foster, Greer, & Thorbecke, 1984). The household expenditure measure focuses on the state of living of a household and attempts to differentiate who is poor from who is not poor by comparing household expenditure budget (Lipton, 1996). If an individual spends more than others, it is argued that such an individual is likely to be richer than the others. Alternatively, a minimum expenditure figure called expenditure budget line is used. Households whose expenditure fall below this normal figure are regarded as poor and those whose expenditure is above are regarded as rich (Ravallion, 1992). This approach allocates a higher poverty figure to rural people whose income on the average is far less than that of urban people.

Other measures of poverty have also been used. The poverty count index is a three-pronged measure that seeks to classify people into poverty levels using what is referred to as poverty-gap index (Lipton, 1996; Kingsbury, 1995; Chambers, 1995; Boltvinik, 1994). According to Ravillion and Sen (1994), it measures the degree of poverty as mean aggregate of people whose consumption is below the line defined as the first poverty layer. Poverty is very prevalent at this layer. Another measure, the square poverty-gap index is like the poverty gap index except it is based on a proportionate consumption short fall that is weighted to provide an aggregate measure (Ravillion & Sen, 1994). A third measure is the head count index defined as the proportion of the people living in households with mean consumption below the poverty line. This is the simplest and best-known poverty measure/index. The poverty head count is defined as the number of people in a population who are poor, and this is expressed as a percentage of the total number of individuals in the population (Faisal, Abdul, Naeem, & Asif, 2005; Ravallion & Bidani, 1994; Ravallion, 1998).

**Determinants of Poverty**

Multivariate analysis of the determinants of poverty among farming households in Africa has been carried out by many scholars. The results showed probable differences in factors that affect poverty amongst farming households. Poverty is typically determined at the household level. For example, Etuk, Angba and Angba (2015) found that the poverty incidence of fish vendor households was 0.569 and poverty gap was 0.48.

Poverty in farming households in Africa is driven by socioeconomic, asset, and institutional characteristics of the farmers. Previous researchers have found that accessibility/affordability of healthcare services, fish farming output and ownership of assets reduced poverty among farming households in sub-Saharan Africa (Nkpoyen, Bassey, & Uyang, 2014; Ndamu, 2016; Musuka & Musonda, 2013; Apata, Apata, Igbalajobi, & Awoniyi, 2010; Onyeiwu & Jialu, 2011; Etuk *et al.,* 2015). While there remains a debate as to whether poverty is a reflection of the socioeconomic status of farmers (Federal Office of Statistics, 1999; Edet, Nsikak-Abasi, & Esu, 2009; Igbalajobi, Fatuase and Ajibefun, 2013), several research studies have shown that socioeconomic characteristics, such as age, labour in farm operations,

household size, and farming experience, reduced poverty in fish farming households in Nigeria (Etim, 2007; Etim, Edet, & Okon, 2008; Etim, Edet, & Esu, 2009; Oladimeji, Abdulsalam, Damisa, & Omokore, 2013; Etim & Patrick, 2010).

On the other hand, empirical evidence has shown that poverty is negatively associated with income, gender, marital status and education (Osinubi, 2003; Etim, 2007; Etim, & Patrick, 2010; Faisal *et al.,* 2005; Oladimeji *et al.,* 2013). Research has also shown that membership of social organizations and pond size decreased poverty in rural households in Nigeria. The findings of Amaza, Olayemi, Adejobi, Bila and Iheanacho (2007), Umeh and Asogwa (2011), Asogwa, Umeh and Okwoche (2012) and Igbalajobi *et al.* (2013) indicated that membership of social organizations decreases the likelihood of being poor. Another factor is the size of a farmer's fish pond. Amao, Awoyemi, Omonona and Falusi (2009) found poverty to be negatively associated with pond size. This means that the larger the pond size, the less the likelihood of the owner being poor.

## Materials and Methods

### Description of the Study Area

The Niger Delta is located on the Atlantic coast of southern Nigeria where River Niger divides into numerous tributaries (Awosika, 1995). The area lies between latitudes $4^0$ 15'N and $6^0$ 30'N and between longitude $4^0$ 30'E and $8^0$ 30'E (Onojeghuo & Blackburn, 2011). The region spans over 70,000 square kilometres and has been described as the largest wetland in Africa. About 2,370 square kilometres of the Niger Delta area consists of rivers, creeks, and estuaries and stagnant swamps covering about 8,600 kilometres (Etiosa & Ogbeibu, 2007). The region cuts across the nine oil-producing States in southern Nigeria which include Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and Rivers States (Figure 1). Fishing, farming, and petty trading are the predominant economic activities of the region.

### Sampling Technique

Multi-stage purposive and random sampling techniques were used in drawing the sample for this study. The first stage involved purposive selection of five States - Akwa Ibom, Bayelsa, Delta, Imo and Rivers - of the nine States that make up the Niger Delta region. The second stage of the selection involved purposive selection of four Local Government Areas (LGAs) in each of the chosen States. The third stage involved a random selection of six villages in each of the chosen Local Government Areas, giving a total of 120 villages. The selected villages were known in the LGAs for the existence of fish farms. This was ascertained from a list obtained from extension agents of the Agricultural Development Programmes (ADPs) in the Niger Delta States showing villages with fish farming activities. Finally, three smallholder fish farmers were randomly selected from each of the 120 villages. The sample size of the study was therefore 360 smallholder fish farmers.

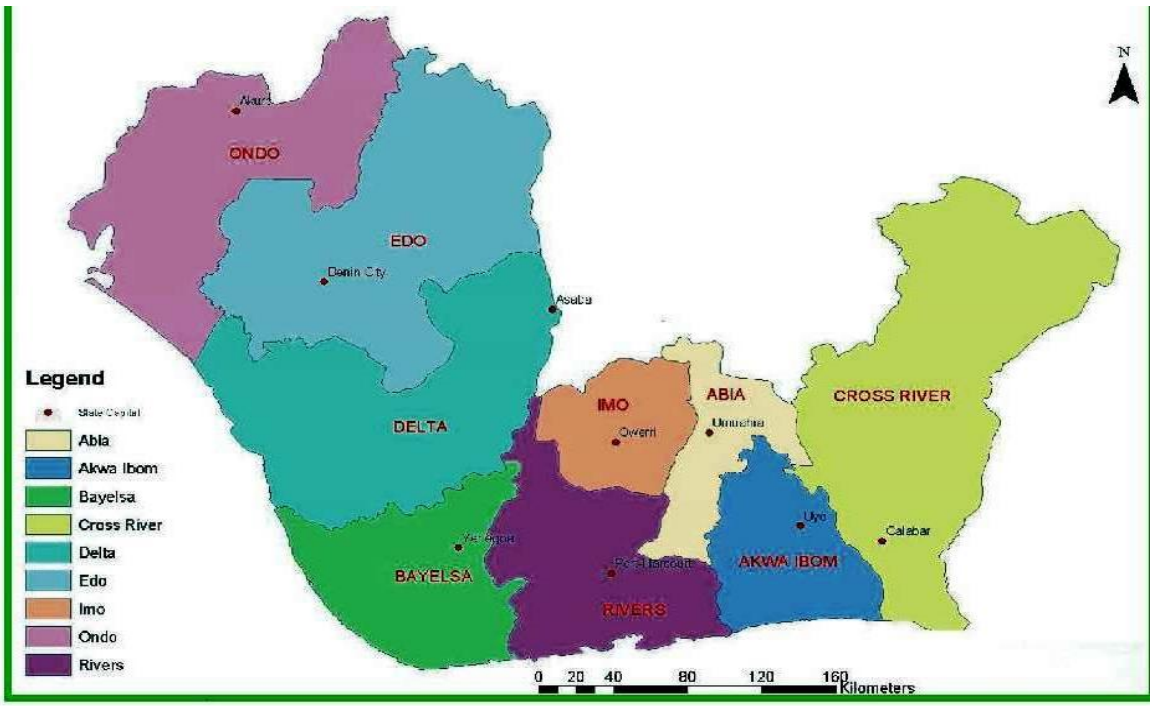


**Figure 1.** Niger Delta Map showing the States in the region Source: Federal Republic of Nigeria (2006).

**Data Collection**

Data for this study were collected at the farm and household levels with the aid of a structured questionnaire and lasted for a period of ten months, from February to November 2014. Data collected from the level of the farm include size and types of pond, as well as types of management systems of fish farming. Also collected at farm level were data on quantities and types of biological, chemical and physical inputs employed in production (fingerlings, fertilizers, feeds, labour used and capital employed), mortality rate, sources of fingerlings, and fish. Also, household level socioeconomic characteristics and assets data were collected. They include gender of the farmer, household size, household fish consumption, fish farming income, fish farming experience, educational level, house type, access to potable water, health facilities and occupation.

**Method of Data Analysis**

Data collected were analyzed with descriptive statistics, enterprise budgeting model, Foster-Greer-Thorbecke (FGT) index (Foster *et al.*, 1984) and Tobit regression model. In enterprise budgeting analysis, net returns of a farm business are total revenues less total costs. To achieve this, all the fixed and variable costs were aggregated and deducted from the total returns to derive the net returns. A mathematical expression of this procedure yields the equation designated as Equation 1 in the Appendix. The other important procedure related to net returns estimation involved the determination of depreciation value to capture the values of fixed input or costs of fixed capital. The standard simple calculations that make use of the straight-line method was applied in this case as specified in Equation 2 in the Appendix.

Foster *et al.* (1984) weighted poverty index was used to ascertain the poverty profile of the farmers. The reason for this choice is its decomposability among the subgroups. The FGT measure for the $i^{th}$ sub-group ($P\alpha i$) is specified in Equation 3 in the Appendix and entails the quantification of households with expenditure below the poverty line. Poverty line is the value of income or consumption expenditure necessary for a minimum standard of living. The standard of living of households in the study area was measured based on consumption expenditure. The focus was on consumption goods and non-food items. The consumption goods and non-food items include food, energy, medication/drugs, clothes and socials (burials and marriage ceremonies etc.). The households' expenditures were then summed up to get the total expenditures of the households. The total household expenditure was divided by the number of members of the household to get the per capita expenditure as used by World Bank (1996). This was further converted into adult equivalent, based on nutritional requirement, sex and age of the members of the households, using the nutrition-based adult equivalent scales provided by Federal Office of Statistics (2004). Multiplying the nutrition equivalent scales with the number of household members that fall in any of the age and sex categories, the monthly mean per adult equivalent household expenditure (MMPCHHE) for the sampled households were arrived at. By this method, the expenditure patterns of the farming households were investigated. The poverty line used for this study was two-third (2/3) of the Mean Monthly Per Capita Household Expenditure (MMPCHHE). Therefore, any household whose expenditure fell below the moderate poverty - line 2/3 of the MMPCHHE - was regarded as being poor, while those above 2/3 were regarded as non-poor.

Determinants of poverty in the study area were analysed using Tobit regression. Tobit model is used because the approach can avoid the use of Pearson correlations, which are inappropriate for censored variables and instead, using correlations estimated under the assumption of a censored multivariate normal distribution (Muthen, 1989). The model also uses all the information, including those on censoring, and provides consistent estimates (Fernando, 2011) in line with Tobin (1958). Equations 4 and 5 in the Appendix provide an indication of how this model is fitted. The dependent variable is poverty status. It is discrete when the households are not poor and continuous when they are poor. The explanatory variables specified as determinants of poverty among fish farmers in the area are: gender (dummy variable: 1 if male, 0 if female); age (years); marital status (dummy variable: 0 if single, 1 if married); household size (number of persons); educational level (number of years); pond size ($m^3$); value of assets (naira); value of fish production (naira); farming experience (years); labour employed (man-days); access to modern health care (dummy variable: access = 1, non-access = 0); distance to source of healthcare (km); type of construction materials used for roofing materials (dummy variable: modern roofing material (aluminium/zinc) = 1; non-modern roofing material (thatch/raffia) = 0); type of construction material used for walls (dummy variable: 1 if modern (cement), 0 if mud); residential status (dummy variable: 1 if landlord, 0 if otherwise); access to electricity (dummy variable: access = 1, non-access = 0); and membership of cooperative societies (dummy variable: 1 if member, 0 if otherwise)

## Results

**Socioeconomic Characteristics**

Table 1 shows that of the 360 fish farmers interviewed, 91.39% were males and 8.61% were

**Table 1.** Distribution of Smallholder Fish Farmers' Socioeconomic Characteristics

| Socioeconomic characteristic | Frequency | Percentage | Average |
|---|---|---|---|
| Gender | | | |
| Male | 329 | 91.39 | |
| Female | 31 | 8.61 | |
| Age (year) | | | |
| 21 – 30 | 14 | 3.89 | 43 years |
| 31 – 40 | 123 | 34.17 | |
| 41 – 50 | 159 | 44.17 | |
| 51 – 60 | 55 | 15.28 | |
| 61 - 70 | 9 | 2.50 | |
| Marital status | | | |
| Married | 312 | 86.94 | |
| Single | 31 | 8.61 | |
| Widowed | 11 | 0.031 | |
| Separated | 6 | 0.017 | |
| Household size (number of persons) | | | |
| 1 – 3 | 33 | 9.17 | |
| 4 – 6 | 114 | 31.67 | 7 persons |
| 7 – 9 | 191 | 53.06 | |
| 10 – 12 | 16 | 4.44 | |
| 13 - 15 | 7 | 1.94 | |
| Educational level | | | |
| No formal education | 19 | 5.28 | |
| Primary | 63 | 17.50 | |
| Secondary | 190 | 52.78 | |
| Tertiary | 88 | 24.44 | |
| Fish farming experience (years) | | | |
| 1 – 5 | 53 | 14.72 | 9 years |
| 6 – 10 | 199 | 55.28 | |
| 11 – 15 | 78 | 21.67 | |
| 16 – 20 | 30 | 8.33 | |

females. An examination of the characteristics showed that the fish farmers ranged from 21 years of age to 70 years, with an average age of 43 years. They had an average household size of 7 people, ranging from one person per household to 15 people per household. Most of the fish farmers had some years of formal education, with those with secondary education were the 52.78%, while those with primary and tertiary education accounted for 17.50% and 24.44%, respectively. Fish farmers with no formal schooling consisted only of 5.28%. The fish farmers had an average fish farming experience of 9 years, ranging from one year to 20 years.

**Management Systems and Practice of Fish Farming in the Niger Delta Region**

Table 2 indicated that majority (76.9%) of the fish farmers practised semi-intensive system while 23.0% practised an intensive system of fish farming. Earthen pond was most commonly used by the farmers, contributing 81.6% while 16.6% used concrete ponds. Less than 2% of the farmers used fibre and cage for fish farming in the area. Approximately 7.7% of the fish farmers owned pond whose sizes fell between 301$m^3$ to 900 $m^3$ while 0.8% owned ponds whose sizes ranged between 901$m^3$ to 1,200 $m^3$. Farmers whose ponds varied between 300$m^3$ to 600 $m^3$were over nine-tenth of the respondents. Regarding the number of fish ponds per farmer, 23.8% of the farmers had 1 to 3 ponds, 66.7% had 4 to 6 ponds and 19.1% had 7 to 9 ponds in their farms. Only 1.6% of the farmers had more than 9 ponds. The mean number of ponds owned by the farmers was 5. Greater proportion (82.5%) of the fish farmers obtained their fingerlings from hatcheries while 11.6% sourced fingerlings from streams/rivers and 5.8% sourced their fingerlings from other ponds. Monoculture was observed to be very common among the farmers as the majority (95.00%) raised their fish by this method while 5.00% reared by polyculture method. The majority (79.4%) of the fish farmers specialized in the production of catfish, 15% produced tilapia, and almost 5.8% produced both catfish and tilapia each farming season.

**Enterprise Budgets for 600$m^3$ of Semi- intensive and Intensive Fish Farming Systems**

Table 3 showed that the total production cost was ₦206,157.5 ($1,323.6) (prevailing exchange rate when data was collected: ₦155.75 to 1 USD, Source Central Bank of Nigeria, 2014). Nevertheless, the total variable costs and total fixed costs accounted for 74.4% and 25.6% of total cost of production while pond

**Table 2.** Management Systems and Practice of Fish Farming in Niger Delta Region

| Variable | Frequency | Percentage | Average |
|---|---|---|---|
| Intensive | 83 | 23.1 | |
| Semi-intensive | 177 | 76.9 | |
| Pond Type | | | |
| Earthen | 294 | 81.6 | |
| Concrete | 60 | 16.6 | |
| Fibre/Cage | 6 | 1.8 | |
| Pond Size($m^3$) | | | |
| 300 – 600 | 329 | 91.3 | |
| 601 – 900 | 27 | 7.7 | 600 $m^3$ |
| 901 – 1200 | 3 | 0.8 | |
| Number of Ponds | | | |
| 1 – 3 | 86 | 23.8 | |
| 4 – 6 | 240 | 66.9 | |
| 7 – 9 | 27 | 7.5 | 5 ponds |
| 10 – 12 | 6 | 1.6 | |
| Source of Fingerlings | | | |
| Hatchery | 297 | 82.5 | |
| Stream/River | 42 | 11.6 | |
| Other ponds | 21 | 5.8 | |
| Type of Culture | | | |
| Monoculture | 342 | 95.0 | |
| Polyculture | 18 | 5.0 | |
| Species | | | |
| Catfish (*Heterobranchus and Clarias Spp*) | 286 | 79.4 | |
| Tilapia (*Oreochromis niloticus*) | 53 | 14.7 | |
| Mixed Culture | 21 | 5.8 | |

construction (15.0%) constituted the main fixed cost component. On the other hand, the net returns were ₦ 233,842.5 ($1,501.4) indicating that the semi-intensive system is profitable in the area.

A similar observation was made regarding a 600$m^3$ intensive fish farming system as presented in Table 3. Percentages of the variable costs and fixed costs that constituted the total cost of production were 77.0% and 23.0% respectively, with pond construction constituting the major component of fixed costs. Total revenue for the intensive system was ₦888,000.0 ($5,650.1) while total cost was ₦308,460.9 ($1,980.5). The net return was ₦571,539.1 ($3,669.6) indicating that the intensive system was also profitable in the area.

**Poverty Profile of Fish Farmers**

Table 4 revealed that food had the highest percentage expenditure of 39.34% whereas the least expenditure was for socials at less than 10%. The mean monthly per capita household expenditure was ₦2,140.78 ($13.74) for which the moderate and core poverty lines of ₦1,427.19 ($9.16) and ₦713.59 ($4.58) were obtained respectively. Furthermore, 27.3% of the fish farmers were moderately poor, 43.8% were non-poor while 28.9% were core poor. This means that 56.2% of smallholder fish farmers interviewed were poor and it compares favourably with the national poverty level as at the time of the study.

**Determinants of Poverty among Smallholder Fish Farmers**

In estimating the determinants of poverty among smallholder fish farmers, a censored regression model made up of 17 regressors was used. Table 5 presents a summary of the Tobit regression for the determinants of poverty among smallholder fish farmers in the Niger Delta region of Nigeria. The results showed that sigma (ō) was 0.5023 with a t – value of 2.2708; thus, sigma was statistically significant ($P<0.05$). This indicated that the model had a good fit to the data. Also, nine out of the seventeen parameters estimated in the model were statistically significant. The intercept was 0.4146 and represented the poverty depth among fish farmers in the region.

The coefficient of the gender of smallholder fish farming households head was -0.0437. This implied that relative to the female-headed households, the level of poverty depth (0.4146) would decrease by 0.0437 for male-headed households, thus had a poverty depth of 0.3709 as against 0.4146 for female-headed households. This may be attributed to the involvement of male-headed households in different forms of off-fish farm activities. The coefficient of the marital status of smallholder fish farming household heads was 0.0825 (Table 5). This implies that the poverty status of smallholder fish farming households headed by married people would increase by 0.0825 to become 0.4971 while that of households headed by

**Table 3.** Enterprise Budget for 600m$^3$ of Semi-Intensive Fish Farm and Intensive Fish Farm

| Semi-Intensive | | | | |
|---|---|---|---|---|
| Item | Unit | Unit Price ₦ | Quantity | Value ₦ |
| Revenue | | | | |
| Fish | Kg | 550.0 | 800 | 440,000.0 |
| Total Returns (A) | | | | 440,000.0 |
| Variable Costs | | | | |
| Labour | Man-day | 1200 | 60 | 72,000.0 |
| Feed | 25kg/bag | 5000.0 | 5.6 | 28,000.0 |
| Fingerlings | No | 30.0 | 1000 | 30,000.0 |
| Medication | | | | 4,325.0 |
| Fertiliser/Chemicals | 50kg/bag | 3,000.0 | 20.0kg | 1,200.0 |
| Transport | | | | 5,800.0 |
| Electricity | | | | 4,590.0 |
| Other Costs | | | | 7,542.5 |
| Total Variable Cost (B) | | | | 153,457.5 |
| Gross Margin (A-B) | | | | 286,542.5 |
| Fixed Costs | | | | |
| Depreciation expenses | | | | 17,700.0 |
| Pond Construction | | | | 35,000.0 |
| Total Fixed Cost (C) | | | | 52,700.0 |
| Total Cost B+C) | | | | 206,157.5 |
| Net Returns | | | | 233,842.5 |
| Intensive | | | | |
| Item | Unit | Unit Cost ₦ | Quantity | Value ₦ |
| Receipts | | | | |
| Fish | Kg | 550.0 | 1,600 | 880,000.0 |
| Gross Returns (A) | | | | 880,000.0 |
| Variable Costs | | | | |
| Labour | Manday | 1500.0 | 61 | 91,500.0 |
| Feed | 25kg/bag | 5000.0 | 9 | 45,000.0 |
| Fingerlings | No | 30.0 | 2000 | 60,000.0 |
| Medications | | | | 6,830.0 |
| Fertiliser/Chemicals | 50kg/bag | 3000.0 | 32.5kg | 1,950.0 |
| Water | | | | 4500.0 |
| Electricity | | | | 6900.0 |
| Transport | | | | 7500.0 |
| Other Costs | | | | 13,531.0 |
| Total Variable Costs (B) | | | | 237,711.0 |
| Gross Margin (A – B) | | | | 642, 289.0 |
| Fixed Cost | | | | |
| Depreciation Expenses | | | | 20,749.9 |
| Pond Construction | | | | 50,000.0 |
| Total Fixed Costs (C) | | | | 70,749.9 |
| Total Cost(B+C) | | | | 308,460.9 |
| Net Returns | | | | 571,539.1 |

unmarried people would remain 0.4146. The explanation for this is that married households tend to have large household sizes, and this raises the dependency ratio. Household size had a coefficient of 0.1213, which implied that a unit increase in household size would raise the poverty depth by 0.1213. The coefficient of education was -0.0213. This implied that the poverty depth would decrease by 0.0213 for individuals in families whose heads had formal education to be 0.3933. Smallholder fish farming household heads without formal education had poverty depth of 0.4146. The regression coefficient for pond size was -0.2175. Farm income had a coefficient of -0.2634 meaning that for every naira increase in farm income, the level of poverty would reduce by 0.2634. The regression coefficient for farming experience of the smallholder fish farming household heads was 0.3030. The regression coefficient for labour employed in farm operations was 0.0797. The coefficient of type of construction material used for building roofs was -0.0586. The coefficient of type of construction material used in making the walls of buildings was -0.3104.

## Discussion

Fish farming in the Niger Delta region of Nigeria is dominated by men. The reason for this male

**Table 4.** Monthly Mean Per Capita Household Expenditure (MPCHHE)

| Consumption items | MPCHHE | Expenditure distribution (%) |
|---|---|---|
| Food | 4210.69 | 39.34 |
| Energy | 2910.56 | 27.19 |
| Medication/Drugs | 1592.80 | 14.88 |
| Clothing | 1009.78 | 9.43 |
| Socials | 980.09 | 9.16 |
| Total | 10,703.96 | 100.00 |
| Mean Monthly PCE | 2140.78 | |
| Moderate poverty line 2/3 of mean PCE | 1427.19 | |
| Core poverty line 1/3 | 713.59 | |
| Moderate poverty (%) | 27.3 | |
| Core poverty (%) | 28.9 | |
| Non-poor (%) | 43.8 | |

**Table 5.** Maximum Likelihood Estimates of Determinants of Poverty

| Variable | Coefficient | t – value |
|---|---|---|
| Gender ($X_1$) | -0.0437 | 12.7484*** |
| Age ($X_2$) | 0.5012 | 1.5047 |
| Marital Status ($X_3$) | 0.0825 | 1.9053* |
| Household Size ($X_4$) | 0.1213 | 1.9628* |
| Education ($X_5$) | -0.0213 | -2.4728** |
| Pond Size ($X_6$) | -0.2175 | -3.8701*** |
| Value of Asset ($X_7$) | -0.3309 | 1.6048 |
| Value of fish production ($X_8$) | -0.2634 | -2.1751** |
| Farming Experience ($X_9$) | 0.3033 | 2.8831*** |
| Labour Employed ($X_{10}$) | 0.0797 | 1.9021* |
| Access to Modern Health Care ($X_{11}$) | 0.2081 | 1.1063 |
| Distance to Source of Healthcare ($X_{12}$) | 0.5821 | 1.3345 |
| Type of construction material used for roof ($X_{13}$) | -0.0586 | -2.1387** |
| Type of construction material used for walls ($X_{14}$) | -0.3104 | -2.4118** |
| Residential Status ($X_{15}$) | 0.0806 | 1.3148 |
| Access to Electricity ($X_{16}$) | 0.0365 | 1.1027 |
| Membership to cooperative societies ($X_{17}$) | 0.5227 | 1.0169 |
| Constant | 0.4146 | 2.2793** |
| Sigma | 0.5023 | 2.2708** |

N/B: ***, ** and * denote significant at 1%, 5% and 10% respectively.

dominance could be connected to the rigorous nature of fish farming activities. This finding agrees with the works of Olasunkanmi, Omitoyin and Ipinmoroti (2010), Hundeyin-Agoro (2011), Okoye (2009), and Adeniyi, Omitoyin and Aderigbe (2010). These researchers observed that throughout the world, men are mostly engaged in fishing but those who served as intermediaries in the resulting trade are women. In terms of age, fish farmers in the area are generally in their productive age. This result agreed with the work of Agaga (2010) who reported that the average age of fish farmers was 44.6 years in Bayelsa State. Okoye (2009) also reported a mean age of fish farmers in Anambra State to be 49 years. Yunusa (1999) and Onyeneke (2017) observed that farmers within the age bracket of 31 to 50 years are usually more innovative, motivated and adaptive individuals. The implication of this is that most of these farmers are still in their active age, and therefore have the tendency to be more productive in fish farming in the study area. There is also a very small percentage of elderly persons in fish farming in the area. This may be attributed to the fact that at such advanced age, only few of such persons can adequately meet the physical rigors associated with fish farming activities.

There is a high percentage of married smallholder fish farmers in the study area and this is not unconnected to the fact that many ethnoreligious groups attach great importance to marriage as an indicator of social responsibility, trust, and achievement. Also, marriage provides social and economic security in the area (Ovwigho, 2011). The household size distribution showed that there were enough hands (family labour) engaged to carry out fish farming operations. This result agrees with Agbamu (2000), who said that the number of persons in a family paves the way for the use of family labour. The result agrees with the work of Okoye (2009) who reported a mean household size of nine persons in Anambra State.

It could be inferred from this study that

smallholder fish farmers in the area are educated. This result agrees with Ohen, Agom and Okon (2009) and Abda and Eglal (2010) in Khartoum North, Sudan. Regarding fish farming experience, smallholder fish farmers in the study area were adjudged to be moderately experienced in the business. This confirmed the findings of Okwu and Acheneje (2011) and Emokaro, Ekunwe and Achile (2011) who reported that less than 5 years of fish farming experience for a fishing community means inexperience and that the level of experience can also determine the level of knowledge on management practices. According to Omotosho and Fagbenro (2005), experience matters in the adoption of recommended packages of innovations and modern farm techniques.

Fish farming systems in the study area were mainly carried out in productive systems (semi-intensive and intensive). This finding agreed with Lawal (2002) who reported in her study that intensive and semi-intensive fish farming systems are characterized by heavy inputs in the form of protein pelleted feeds and fertilizer, high stocking density and improved pond management, all resulting in high yield per unit. However, semi-intensive fish farming was the predominant system practised in the region. This may be attributed to the fact that semi-intensive system requires less capital to start when compared to the intensive system which is high yielding and capital intensive. Regarding the type of facilities designed to serve as enclosures in rearing, earthen ponds were found to be used by majority of smallholder fish farmers in the area. The earthen ponds constitute the most common type of fish production ponds in Nigeria (Adikwe, 1999). The very common use of earthen pond by fish farmers in the Niger Delta could be since it is cheaper to construct and does not require much attention when established. Earthen ponds are easy to manage, and production is usually faster because of the addition of natural foods to supplement the feed given to the fish (FAO, 2000). Okwu and Acheneje (2011) have however criticized rearing fishes in earthen ponds due to the high incidence of predators such as frogs, snakes, lizards and even man. Olukunle (2004) supported the view that concrete ponds are relatively free from poaching and predation. The study found that fingerlings stocked by the farmers were mainly sourced from hatcheries and were thus more likely to be healthier and disease free. This agrees with Okwu and Acheneje (2011) who observed that fingerlings sourced from hatcheries have high growth rate and may be disease-free. Smallholder fish farmers in the Niger Delta Region predominantly practice monoculture (rearing only one type of fish). This could be attributed to ease of management associated with the method. This result is in line with that of Reddy (1999) who observed that fishes grow better when cultured individually under monoculture system and help the species to grow to its biggest size. Catfish was the common fish species reared by smallholder fish farmers in the Niger Delta. This may be due to its high preference/marketability, resistance to harsh environmental conditions and ability to survive even in running and stagnant water. Food and Agriculture Organization, FAO (2000) reported that catfish has market value that is two to three times more than that of tilapia.

The study showed that smallholder fish production in the Niger Delta is very profitable under the semi-intensive and intensive production systems. Awoyemi (2011), Adewuyi, Philip, Ayinde and Akerele (2010), Penda, Unaji, and Odoenmenem (2013), Omobepade, Adebayo, Amos and Adedokun (2015), Emokaro *et al*. (2011), Adeogun, Alimi and Adeyemo (2014), Esu, Asa and Iniedu (2009), Ohen, *et al.* (2009) also reported different levels of profit in fish farming in Nigeria. This study suggests that profit of smallholder fish farmers could be increased through more investment and total shift to intensive fish production. This production system yielded more profit than the semi-intensive. Output and profit are usually moderate in the semi-intensive system (Omitoyin, 2007) while in the intensive system of management, the output is high, and it is very viable (Carballo, van Eer, van Schie, & Hilbrands, 2008).

This study indicated that more than half of the surveyed fish farmers (27.3% were moderately poor while 28.9% were core poor) of the smallholder fish farming households in the Niger Delta were poor (Table 4). This is in line with Etuk *et al.* (2015) who found the poverty incidence of dry fish vendor households in Lower Cross River Basin, Nigeria to be 0.569 (56.9%). Poverty among fish farming households in the area is driven by different farm-specific and socioeconomic variables. There is a higher incidence of poverty in female-headed households than in male-headed households. Gender affects poverty and favours male farmers more than their female counterparts, probably because male farmers own production resources in the area, and are more involved in more livelihood activities than their female counterparts. Also, in the region, male-headed farm households are usually involved in other off-farm activities which provide additional income and hence enhancement of household welfare. Federal Office Statistics (1999), Osinubi (2003), Etim (2007), Etim and Patrick (2010), Oladimeji *et al.* (2013) found that the incidence of poverty in female-headed households was higher than in male-headed households across Nigeria. This result is vital as it reveals the importance of integrating/mainstreaming gender in future poverty related studies among smallholder farmers in the area.

Marital status and household size affect poverty. Smallholder fish farming households headed by married persons were poorer than those headed by unmarried persons. This may be attributable to the fact that married fish farm household heads had large

household sizes, which increased dependency and thus lowered welfare status than those farm households headed by unmarried people. Etim and Patrick (2010) and Oladimeji *et al.* (2013) found that the menace of poverty is low in households with unmarried heads. They explained that households with married heads tend to have larger household size, which raises the dependency ratio. Married smallholder fish farmers usually have larger household sizes, and this would imply large pool of fish farm labour and many mouths to feed. If labour in such households is not efficiently allocated and utilized, there would be inefficiency resulting from overutilization of labour and reduction in profit. Such households should be supported to increase their farm size and encouraged to participate in some off-farm employment to increase their income and alleviate their poverty. In general, the research indicates that as household size increases, the incidence of poverty increases too. The reason may be since increased household size implied more dependents who rarely contribute to household income. This was obvious because most dependents, particularly children, contribute less to family labour and income. The family, on the other hand, spends money in educating and training them in school and crafts respectively. This finding is consistent with the studies of Lipton (1983), World Bank (1991), FOS (1999) and Edet *et al.* (2009) where greater incidences of poverty were found to be associated with larger household size. Igbalajobi *et al.* (2013) summarized that household size increases the likelihood of being poor and this could be because increase in household size directly or indirectly reduces income per-head (per-capita income) as well as impair the standard of living of the households.

Poverty was also associated with educational level (Table 5). The extent of poverty increased most in households where the head has no formal education. This may be attributed to the fact that educated household heads have the tendency to adopt improved fish farming techniques better than the uneducated ones. This stands to raise the productivity and income of the educated heads with subsequent improvement of welfare amongst them. Education reduces poverty among smallholder fish farmers in the area. Education is a vital route to improved efficiency and increased yield which in turn reduces poverty. The result was synonymous with findings of Schubert (1994), FOS (1999), Etim and Patrick (2010) and Oladimeji *et al.* (2013) who observed that people with lower levels of education were more prone to poverty.

Pond size was negatively related to poverty. This result implied pond size significantly decreased poverty in the area. Amao *et al.* (2009) found poverty to be negatively associated with pond size. This means that the larger the pond size the less likelihood of being poor because farmers having larger pond size will tend to stock more fingerlings which would, in turn, increase their output, income and standard of living, while reducing poverty in such households. Value of fish production which was a proxy for output significantly reduced poverty in the Niger Delta Region of Nigeria (Table 5). An increase in fish farming output would increase farm income and lead to subsequent improvement in household welfare. Ndamu (2016) found that fish farming impacted positively on the life of fish farmers in Adamawa State, Nigeria and reduced poverty among them. Musuka and Musonda (2013) revealed that the adoption of smallholder aquaculture helped in poverty alleviation in Zambia.

This study found that poverty had a significant positive relationship with the household head's years of experience in fish farming. A year increase in fish farming experience of the household head would lead to a 0.3030-unit increase in poverty depth. This implies that the higher the farmer's experience in fish farming the more they are prone to poverty. This is contrary to *a priori* expectation and may be explained by the fact that most experienced fish farmers in the Niger Delta operate the artisanal and semi-intensive production systems which may not yield the income and profit required to bring them out of poverty (Etim *et al.,* 2009). The studies of Etim (2007), Etim and Patrick (2010), and Oladimeji *et al.* (2013) observed positive relationship between poverty and fish farming experience of fish farmers.

It was also observed that the quantum of labour put into fish farming operations by a household was positively associated with the household's depth of poverty. The figures indicated that a man-day rise in labour employed in fish farming operations would raise the poverty depth by 0.0797. This is explainable by the fact that increase in household labour usually leads to having more dependents and higher dependency ratio which tends to raise the poverty status of households. This could also be related to the fact that other economic activities provide more revenues (returns), than fish farming and fish farming is usually taken as the last option (or at least, worse than the average activity). So, fish farming is done when it is not possible to do the most rentable activities. In this sense, people that devote less time to fish farming and more to other activities are in general less poor. But of course, fish farming is always better than nothing. Etim (2007), Etim *et al*. (2008), Etim *et al*. (2009) and Oladimeji *et al.* (2013) found labour in farm operations to be positively associated with poverty.

Types of construction materials used for roof and wall had a relation with the level of poverty. Poverty depth reduced by 0.0586 for households using modern roofing material for their buildings and reduced by 0.3104 for households using modern cement materials. Using these materials is costly and can be used by those who can afford them (i.e. less poor households). Hence, modernity of dwelling units of smallholder fish farmers is a sign/indication of reduced incidence of

poverty. Inadequate access to modern shelter by households may cause them to be unable to exploit the economic benefits that are associated with this productive asset, thus making them vulnerable to a myriad of adversities which could lead to poverty (Khatun, 2015). The modernity of the dwelling unit (type of construction materials used for houses of smallholder fish farmers) could lead to lower incidence of poverty in the region. Smallholder farmers living in modern houses are more likely to afford better and larger concrete ponds used for intensive fish production, a production system that has proven to yield more profit than the semi-intensive system. Intensive production system requires that fish is reared in an entirely enclosed pond.

## Conclusion

This article applied enterprise budgeting, Foster-Greer-Thorbecke model and Tobit regression model to a large sample of fish-producing households to estimate the profit in smallholder fish production, in order to investigate poverty and its determinants among smallholder fish farmers in the Niger Delta region of Nigeria. The models performed well in determining profitability, estimating the poverty status of the farmers and in explaining it in terms of socioeconomic, farm-specific, asset variables as identified in similar studies in other parts of Nigeria and other countries. Building on previous works in the Niger Delta, the current study further explored the different fish production systems in the area to closely examine the level of profit between the different systems of production. This reflects the apparent differences in technology and organization, as well as capital investment between the production systems.

This analysis on different fish management systems and poverty reduction provides a much-needed counterpoint to past policy commentaries on Niger Delta's fish production systems which have focused mainly on labels such as "small-scale" and "commercial", without creating a clear link between the production systems and poverty alleviation. In the two management systems of smallholder fish farming in the region, intensive system is more profitable than the semi-intensive system. There is a need for more investment, enlightenment, and advocacy supporting smallholder fish farmers to fully adopt intensive fish management system. More than half of smallholder fish farming households in Nigeria's Niger Delta were poor. Poverty among fish farming households in the area is driven by different farm-specific and socioeconomic variables like gender, marital status, household size, education, pond size, fish output, farming experience, labour and type of construction materials of the dwelling units. Interestingly, the value of fish produced significantly reduced poverty in smallholder fish farming households in the Niger Delta. This result means that fish production alleviates poverty in the region.

This result of the significance fish output on poverty reduction is an interesting one to agribusiness managers and governments of the regions. Poverty alleviation and amnesty programmes of the governments should pay adequate attention to fish farming as it is shown from this study that it is an important way of reducing poverty in the region. Also, oil companies in the region should, as part of their corporate social responsibility, support smallholder fish farmers to increase their investment in fish production. Several elements of this study indicate that improved housing and government services can enhance smallholder fish producers' profit and alleviate their poverty. Equally of importance in alleviating poverty in this region is the provision of social services such as education and investment in housing and pond construction. Also, poverty alleviation programmes should target female fish farmers more and future research should disaggregate data and analysis by gender as this study shows that poverty is not gender neutral.

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## Appendix

Net returns is estimated using the following mathematical models:

$$\text{(i)} \qquad \pi = \sum_{i=1}^{m} P_1 Q_1 - \left(\sum_{i=1}^{n} P_j X_j + TFC\right) \qquad (1)$$

Where: $\pi$ = net returns,
$P_1$ = unit price of *ith* output,
$Q_1$ = quantity of *ith* output,
$P_j$ = unit price of *jth* input
$X_j$ = quantity of the *jth* variable input,
$\sum$ = summation,
n = number of inputs used in production;
m = number of enterprise, and
TFC = Total Fixed Cost.

(ii) Depreciation value was used to capture the values of fixed input or costs of fixed capital. This was obtained using straight line method as follows:

Annual Depreciation (AD)

$$AD = \frac{\text{cost of asset} - \text{salvage value}}{\text{Expected life span} \quad - \quad -} \qquad (2)$$

Where AD is expressed in Naira (₦)
The FGT measure for the ith (Pαi) is given

$$\text{as: } P_{\alpha_i} = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{Z - Y_i}{Z}\right]^{\alpha} \qquad (3)$$

For $\alpha = 0$ index $P_{ai}$ becomes $P_o = q/n$ = this stands for the head count or incidence of poverty.

$$q_i = P_i = X_i\,\beta + e_i \text{ if } P_i > P_i^* \qquad (4)$$

$$o = X_i\beta + e_i \text{ if } P_i \leq P_i^* \qquad (5)$$

Where qi is the dependent variable. It is discrete when the households are not poor and continuous when they are poor. *Pi* is the poverty depth intensity defined as (Z–Yi) and *Pαi* is the poverty depth when the poverty line (Z) equals the expenditure per adult equivalent, *Xi* is a vector of the explanatory variable, β is a vector of the unknown coefficient and *ei* is an independently distributed error.

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