# PROJECTION OF HOMESTEAD FISH OUTPUT IN ADAMAWA STATE, NIGERIA: MARKOVIAN APPROACH

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**Abstract:** The study was on projection of homestead fish output in Adamawa State, Nigeria: Markovian approach. The objectives of the study were to: describe the farm sizes of homestead fish farmers in Adamawa State and to project its future output at a long run. Data were collected using structured questionnaire administered to 150 fish farmers using snowball sampling techniques and were analysed using descriptive statistics and Markov chain processes. Majority of the farmers live in semi-urban area and rear catfish in ponds that are less than 40m$^3$ on a temporary land. Also, they were homestead ponds containing less than 4,000 fingerlings that they sale at harvest. The projection showed more than 2000kg of output per production. It is concluded that majority of the farmers have higher output on the long run. The study recommends that; youth and women should be engaged in fish farming as it promises higher output at the long run.

**Keywords:** Homestead, fish, output, projection

## Introduction

Aquaculture has been the fastest growing food-producing sector globally; its contribution to tropical Africa total fish production is still insignificant (Machena and Moehl, 2001). Nigeria is one of the largest importers of fish and fish products with average record of 560,000 metric tonnes annum. Nigeria must work to substitute imports with domestic production to create jobs, reduce, poverty in rural areas where 70% of population lives and ease the balance of payments. Nigerians are high fish consumers and their demand for fish is estimated at 1.55 million tones with domestic fish production stands at 511,000 metric tonnes and fish importation is about 560,000 metric tonnes which cost more than ₦30 billion per year (Amiengheme, 2003).

In recent decades, the gap between the potential and actual economic benefits from marine fisheries at global seen has widened dramatically, costing the world economy an estimated 50 billion US dollars per year. This ensures that the world's capture fishery resources make its full potential contribution to global economy calls for major steps such as establishing effective resource investment programmes and rebuild the resources themselves. Meanwhile, inland fisheries, although often undervalued, are a core component in the livelihoods of millions of people in both developing and developed countries. Some 61 million people are involved in the sector in which over half of them are women. Although 2008 recorded 10 million tonnes of fish, substantial declines in inland fishery resources have been caused by irresponsible practices, habitat degradation among others. On a more positive note, aquaculture policies in Southeast Asia–where fish is a fundamental part of people's diets–reveals that well-planned government interventions built on comparative advantages and fostering an enabling incentive environment can lead to economic growth, food security and better living standards (FAO, 2010).

An increase in human population over the years lead to high demand for fish and fish products and though the local production continuous to increase, but cannot meet up with the local demand which leads to increasing gap. Even as the year 2015 is fast approaching there is minimal indication of overcoming this challenging trend. Throughout Nigeria, the last few years witnessed a rapid expansion in aquaculture. Available data showed that fish production from aquaculture ranges from 15,840 tonnes in 1991 to 25,720 tonnes in the year 2000 and 86,350 tonnes in 2009 (FDF, 2010). Meanwhile, there exists evidence that substantial part of fish production from homestead farms, rural aquaculture and small scale fish farms scattered all over the country are not documented (Akinrotimi *et al.,* 2007). Anetekhai *et al.* (2004) observed that production varies from 0.5 tonnes per hactare in small scale to as much as 10 tonnes per hactare in large scale for earthen ponds and this largely depends on level of management intensity.

The occurrences of a future state in a Markov Processes depends on the immediate preceding state and only it, in such process, the past is irrelevant for predicting the future given the knowledge of the past (Taha, 2001). A recent application of Markov chains is in goestatistics of discrete variables conditional on observed data. Such an application is called "Markov chain geostatistics", similar with kriging geostatistics. The Markov chain goestatistics method is still in development. Markov chains is also used in predicting future state of events such as coding, trends, human resources planning, and profit planning market share and trend, sales planning (Madawaki *et al.,* 2002). It is also now of special interest in problems relating to agriculture, this has been demonstrated by (Dittoh, 1985), Atobatele (1986) as cited by Mshelia (1991). On this premise, the study is directed to describe the farm sizes of homestead fish farmers in Adamawa State and to project the future output on a long run.

## Materials and Methods

### *Study area*

The study was conducted in Adamawa State, Nigeria. Adamawa State lies between Latitude 7$^0$ and 11$^0$ North of the Equator and between Longitude 11$^0$ and 14$^0$ E of the GMT. The wet season commences in April and ends in late October, while the dry season starts in November and ends in April. The mean annual rainfall of the area is about 1000 mm (Adebayo, 1999). The study area falls within the Northern Guinea Savannah Zone of Nigeria with 21 administrative local government areas, land mass of 2,310.05 km$^2$ and a population of 3,178,950 which is projected to be 4,111,704 in the year 2016 at 2.9% yearly growth rate (NPC, 2006). The area is bounded by Taraba State to the south, Gombe State to the west, Borno State to the north and Cameroun Republic to the east, respectively.

The major activities in Adamawa State are agricultural activities such as inland artisanal fishing, livestock rearing and crop farming especially arable crop production, the major livestock reared are cattle, sheep, goats and birds, while the major crops cultivated are sorghum, maize, yam, beans, ground nut, rice, sugar cane, bambara nut, beniseed, sedges, sweet potato,

There are a lot of fishing activities in the study area as some rivers located within the study area (Kiri, Njuwa, Chuchill, Yinagu, Chachelek and Gerio) linked one of the major rivers in Nigeria (Benue), also two large commercial farm (Gessedaddo and Sebore) are located in the state, where fish are harvested on relatively large scale. The peak period of fishing from the natural water bodies is in August-October, while in April-May it drops to its minimum in which the dams (restricted fishing areas) are occasionally opened at such time for its fish capture. Common natural fish species around are Catfish and Tilapia. The wild fish are mostly harvested using fishing gear (nets and hooks).

***Source of data and sampling procedure***

Data for this study was derived mainly from primary source which was collected with the use of structured questionnaire. Snowball sampling technique, which was using the contacted respondents to identify subsequent respondents, was used to contact150 respondents for this analysis. The data was collected from across the state, but most of the data were collected from the urban and semi-urban areas of Mubi, Michika, Yola, Mayo-Belwa, Numan, Ganye and Guyuk.

***Analytical techniques***

The analytical tools that were used in this study were Descriptive Statistics and Markov Chain Processes.

***Transition probability of Markov chains***

The technique of Markov chain that was used to measure the input and output scale of fish in future was developed during the twentieth century and was used primarily in physical and chemical sciences. Its use in economics is rather in recent time. Markov chain processes are now of special interest in problems relating to planning in agriculture. This has been demonstrated by Dittoh (1985); Atobatele (1986); Mshelia (1991); Onu (2000); Okpachu (2006) and Baruwa *et al.* (2011). In decision-making process, we are often faced with making decision based on phenomena that have uncertainty associated with them. This uncertainty is caused by inherent variation that have eluded control or due to inconsistency of natural phenomena. Rather than treat variation qualitatively, we can incorporate it into the mathematical model and thus handle it quantitatively. This treatment generally can be accomplished if the natural phenomena exhibit some degree of regularity, so that a probability model can describe their variation. Markov chains have involved in the future depend only on the present state of the process and so are independent of events of the past (Hillier and Lieberman, 1995). Markov chain is a mathematical technique which combines the idea of probability with those of matrix algebra to predict the future states of events such as voting trend, production trend, sales planning, profit planning, market share and trends sales planning, etc. (Madawaki *et al.*, 2002).

In the simplest language, the theory of Markov chain assumes the existence of a physical system S which has a number of possible system $S_1, S_2, \ldots, S_n$ and at each instance of time can be in one of these states. Then the time after successive trails can be denoted by $t_0, t_1, t_2 \ldots t_n$ with $t_o$ representing the starting point in t, $t_1$, the time of conclusion of the first trial etc. For Markov chains, the probability of passing to some state, $S_1$, at a time depends only on the state that the system was at the preceding time and does not change, if its state was at earlier times is known. With a given set of states ($S_1, S_2, \ldots, S_n$), it is assumed possible to estimate the probability, $P_{ij}$, of moving from state $S_i$ to state $S_j$. Let the starting or initial probability be denoted by

$$P_i(0) = \text{prob}(S_i \text{ at } t_o)$$

The set of the starting probabilities can be arranged as row vector as:

$P(0) = P_1(0), P_2(o) \ldots P_n(0)$

P(0) is probability vector that gives the probability of the system being in state $S_1, S_2, \ldots, S_n$ respectively, at the start. As stated earlier, $P_{ij}$ denote the transition from state, *i* to state *j*. Then, by arranging the transition probabilities in a rectangular array, a matrix P is obtained by:

$$P = \begin{Bmatrix} P_{11} & P_{12} & P_{13}\ldots & P_{1n} \\ P_{21} & P_{22} & P_{23}\ldots & P_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ P_{n1} & P_{n2} & P_{n3} & P_{nn} \end{Bmatrix} \quad \text{-------------- (1)}$$

This matrix, P, is called the transition matrix. Since the $P_{ij}$'s are probabilities, it follows that the probabilities in each row sum to unity. This of course is not true for columns. It should be noted, that:

$$\Sigma P_{ij}[0] = 1$$

However, if the elements of P do not depend on time, the transition probabilities are stationary. Further, P is a stochastic matrix because:

i. P is square
ii. the elements of P are non-negative; and
iii. each row of P adds up to unity

Various types of projections can be obtained from the transition matrix and the vector of initial probabilities. Projection techniques based upon Markov processes depend solely on the assumption that the elements of individual matrix have stationary transition probabilities. An appreciation of how much projection can be achieved possibly by considering a basic element in questions such as "if the system starts at a state $S_1$ at a time and the pattern of behavior (Markov process) of individual units as given by matrix transitional P is expected to continue" what would be the state of affairs in $t_1, t_2, t_3, \ldots, t_k$ years? If one lets $P_j(k)$ be the probability of the system being in state j after k steps, $P_j$ (o) would mean that initially the system is state j. Thus: [P (o) = $P_1(o), P_2(o) \ldots, P_j(o)$] and is a probability vector that gives the probability of the system being in state $S_1, S_2, \ldots, S_j$

$$\Sigma P_j K = 1$$

The probability of the system being in state *j* after *i* step is given by;

$$P_j(1) = [P(o)]\, P_j \text{ for any } j$$

**Results and Discussion**

***Distribution of respondents by location of pond and pond size, number of fingerlings, fish species and type of stocking seed***

Patterns of land ownership by inheritance and purchase tend to promote security, management and motivation of farmers for efficient utilization of resources than land acquired through lease or hire (Rahman, 2003). Table 1 shows how land is accessed by the respondents. Majority (69%) used temporary or inherited land, while 31% purchased the land. This shows that land, especially around urban areas were quite expensive and/or of high monetary value, of which purchasing it for such fish farming may not be economical in the near future for the fish farmers. Security needs and continuous monitoring of operations determine location of pond by fish farmers to minimize lost and enhance better yield. Table 1 also shows the location of fish pond of the respondents with respect to their dwelling areas. It indicated that 79% of the respondents had their pond within their immediate dwellings (backyards) while, 21% had their pond outside their dwelling areas. The implication is that majority of the respondents have their ponds in their backyards for security purpose, proper supervision and monitoring.

The results in Table 1 showed that majority (70%) of respondents in the study area lived in urban areas or semi-urban areas, while 30% lived in rural areas. This is because in urban areas, fish farmers will have more access to information and production inputs easily, in addition to wider market outlet from the relatively highly populated urban areas than their rural dwelling counterparts. Likewise pond size was distributed among the respondents. It revealed that majority (68%) of the respondents had pond sizes of more than 20 $m^3$ and only 32% had pond size of 20 $m^3$ and below. It implied that relatively large sized ponds were used by most respondents to give better space and efficient management with the available resources (inputs) such as feeds, labour, water, pond, capital among others for optimum output and profit.

Number of fingerlings stocked reflects the resources available in production efficiency and effective production that will yield optimum profit. When fingerlings stocked are larger than the capacity of the pond, it will initiate cannibalism among the stocked fish, especially when some fish are stronger than others. Table 1 described the distribution of fingerlings stocked per production cycle in a given pond. Majority (77%) of the respondents stocked less than 4000 fingerlings while about 23% of them stocked 4000 fingerlings and above. This entails that majority of the respondents' stocked fingerlings that they could manage effectively within their available resources such as capital, water, drugs, and feeds among others to give them optimum profit.

**Table 1: Distribution of respondents by source of land, location of pond, pond size and number of fingerlings**

| Item | Frequency | Percentage |
|---|---|---|
| **Source of land** | | |
| Purchase | 46 | 30.7 |
| Rent | 21 | 14.0 |
| Inheritance | 47 | 31.3 |
| Gift | 36 | 24.0 |
| Total | 150 | 100.00 |
| **Pond location** | | |
| Within dwellings | 118 | 78.7 |
| Outside dwellings | 32 | 21.3 |
| Total | 150 | 100.00 |
| **Area of Pond Location** | | |
| Urban | 27 | 18.00 |
| Semi-Urban | 78 | 52.00 |
| Rural | 45 | 30.00 |
| Total | 150 | 100.00 |
| **Pond Size ($m^3$)** | | |
| ≤ 20 | 48 | 32.0 |
| 21 – 40 | 83 | 55.3 |
| > 40 | 19 | 12.7 |
| Total | 150 | 100.00 |
| Mean Pond size | 28.9 | |
| Average fish per ($m^2$) | 10-20 | |
| **Number of fingerlings** | | |
| ≤ 2000 | 51 | 34.0 |
| 2001 – 4000 | 64 | 42.7 |
| > 4000 | 35 | 23.3 |
| Total | 150 | 100.00 |
| Mean Number of Fingerlings | 3,533 | |

**Source:** Field Survey, 2013

***Transition probability matrix for projected output of fish in Adamawa State***

The output of fish in Adamawa state on a long run was predicted using the Markov chain model, which indicated the size of output of each fish farmers on long run equilibrium in Adamawa State. This was captured by predicting the number of fish farmers on different output states on the long run in the study area. In order to estimate the transition matrix and probability vector for the projected output scale of table sized fish, three years' outputs were considered; 2011 ($t_o$), 2012 ($t_{o+1}$) and 2013 ($t_{o+2}$). The first step was the classification of the outputs into three categories to form the states "$S_i$", obtained from total output of farmers on their table sized fish in kilogramme (kg) for 2011, 2012 and 2013. The estimate transition matrix and probability vector were tasted between $t_o$ (2011) and $t_{o+1}$ (2012); $t_{o+1}$ (2012) and $t_{o+2}$ (2013 and $t_o$ (2011) and $t_{o+2}$ (2013). Each of the three categories was designated in an output state "$S_i$", the states were created on the basis of the output in Kg as follows:

$S_1$ = less than or equal to 2,000 kg
$S_2$ = 2,001 – 4,000 kg, and
$S_3$ = above 4,000 kg

In the first presentation, Table 2, $t_o$ (2011) and $t_{o+1}$ (2012), we had the first category; ($S_1$ = ≤2,000 kg), the second category, ($S_2$ = 2,001 – 4000 kg) and the third category ($S_3$ = >4000 kg). $Q_{11}$ was number of farmers that obtained, less than or equal to 2,000 kg of table sized fish in 2011 production, and still remained with the same output in 2012 production. $Q_{12}$ was number of farmers that obtained less than or equal to 2,000 kg in 2011 production, but transited to output between 2,001 – 4000 kg in 2012 production. $Q_{13}$ was number of farmers that obtained less than or equal to 2000 kg in 2011 production, but transited to output>4000 kg in 2012 production. $Q_{21}$ was number of farmers that obtained output between 2,001– 4,000 kg in 2011 production, but fall back to output less than or equal to 2000 kg in 2012 production. $Q_{22}$ was number of farmers that obtained between 2,001 – 4,000 kg in 2011 production, and still obtained the same output in 2012 production. $Q_{23}$ was number of farmers that obtained output between 2,001 – 4,000 kg in 2011 production, but shifted to more than 4,000 kg in 2012 production. $Q_{31}$ was number of farmers that obtained output more than 4,000 kg in 2011 production, but fall back to output less than or equal to 2,000 kg in 2012 production. $Q_{32}$ was number of farmers that obtained output more than 4,000 kg in 2011 production, but obtained output between 2,001 – 4,000 kg in 2012 production. $Q_{33}$ was number of farmers that obtained output more than 4,000 kg in 2011 production, and still maintained the same output in 2012 production.

In the second presentation, Table 3, $t_{o+1}$ (2012) and $t_{o+2}$ (2013); we had the first category, ($S_1$ = ≤2,000 kg), second category, ($S_2$ = 2,001– 4000 kg) and the third category ($S_3$ = >4000 kg). $Q_{11}$ was number of farmers that obtained output less than or equal to 2,000 kg in 2012 production, and still remained within the same output level in 2013 production. $Q_{12}$ was number of farmers that obtained output less than or equal to 2,000 kg in 2012 production, but transited to output between 2,001 – 4000 kg in 2013 production. $Q_{13}$ was number of farmers that obtained output less than or equal to 2000 kg in 2012 production, but transited to the last category of output (>4000 kg) in 2013 production. $Q_{21}$ indicated number of farmers that obtained output between 2,001 – 4,000 kg in 2012 production, but fall back to less than or equal to 2000 kg in 2013 production. $Q_{22}$ was number of farmers that obtained output between 2,001 - 4,000 kg in 2012 production, and still obtained the same level of output in 2013 production. $Q_{23}$ was number of farmers that obtained output between 2,001 – 4,000 kg in 2012 production, but shifted to more than 4,000 kg in 2013 production. $Q_{31}$ was number of farmers that obtained output more than 4,000 kg in 2012 production, but fall to output less than or equal to 2,000 kg in 2013 production. $Q_{32}$ was number of farmers that obtained more than 4,000 kg in 2012 production, but obtained output between 2,001 – 4,000 kg in 2013 production. $Q_{33}$ was number of farmers that obtained output more than 4,000 kg in 2012 production, and still maintained the same level in 2013 production.

In the third presentation, Table 4, $t_o$ (2011) and $t_{o+2}$ (2013); had the first category ($S_1 = \leq 2{,}000$ kg), second category, ($S_2 =$ 2,001 – 4000 kg) and the third category ($S_3 = >4000$ kg). $Q_{11}$ was number of farmers that obtained output less than or equal to 2,000 kg in 2011 production, and still remained within the same output in 2013 production. $Q_{12}$ was number of farmers that obtained output less than or equal to 2,000 kg in 2011 production, but transited to output between 2,001 – 4000 kg in 2013 production. $Q_{13}$ was number of farmers that obtained output less than or equal to 2000 kg in 2011 production, but transited to the last category of output (>4000 kg) in 2013 production. $Q_{21}$was number of farmers that obtained output between 2,001 – 4,000 kg in 2011 production, but fall back to output less than or equal to 2000 kg in 2013 production. $Q_{22}$ was number of farmers that obtained output between 2,001 – 4,000 kg in 2011 production, and still obtained the same output in 2013 production. $Q_{23}$ was number of farmers that obtained output between 2,001 – 4,000 kg in 2011 production, but shifted to output more than 4,000 kg in 2013 production. $Q_{31}$ was number of farmers that obtained output more than 4,000 kg in 2011 production, but fall back to output less than or equal to 2,000 kg in 2013 production. $Q_{32}$ was number of farmers that obtained output more than 4,000kg in 2011 production, but obtained output between 2,001 – 4,000 kg in 2013 production. $Q_{33}$ was number of farmers that obtained output more than 4,000 kg in 2011 production, and still maintained the same output in 2013 production.

**Table 2: Result of the transition matrix of fish output 2011 and 2012 production**

| Class | | Year$t_{o+1}$ (2012) | | | |
|---|---|---|---|---|---|
| | | **$S_1$** | **$S_2$** | **$S_3$** | **Total** |
| Year $t_o$ (2011) | $S_1$ | 58 | 32 | 15 | **105** |
| | $S_2$ | 24 | 49 | 36 | **109** |
| | $S_3$ | 15 | 36 | 43 | **94** |
| | **Total** | **97** | **117** | **94** | **308** |

Source: Field survey, 2013
$S_1 = \leq 2000$ kg, $S_2 =$ 2001– 4000 kg, $S_3 = >4000$ kg
Result: $S_1 = 0.31$, $S_2 = 0.38$, $S_3 = 0.31$

This can be interpreted into percentages as 31, 38 and 31%, respectively.
Confirmation: 0.31 + 0.38 + 0.31 = 1

**Table 3: Result of the transition matrix of fish output 2012 and 2013 production**

| Class | | Year $t_{o+1}$ (2013) | | | |
|---|---|---|---|---|---|
| | | **$S_1$** | **$S_2$** | **$S_3$** | **Total** |
| Year $t_o$ (2012) | $S_1$ | 52 | 28 | 19 | **99** |
| | $S_2$ | 17 | 53 | 21 | **91** |
| | $S_3$ | 8 | 11 | 45 | **64** |
| | **Total** | **77** | **92** | **85** | **254** |

**Source:** Field survey, 2013
$S_1 = \leq 2000$ kg, $S_2 =$ 2001– 4000 kg, $S_3 = >4000$ kg
Result: $S_1 = 0.31$, $S_2 = 0.38$, $S_3 = 0.31$

This can be interpreted into percentages as 31, 38 and 31%, respectively.
Confirmation: 0.31 + 0.38 +0.31 = 1

**Table 4: Result of the transition matrix of fish output 2011 and 2013 production**

| Class | | Year $t_{o+2}$ (2013) | | | |
|---|---|---|---|---|---|
| | | **$S_1$** | **$S_2$** | **$S_3$** | **Total** |
| Year $t_o$ (2011) | $S_1$ | 58 | 32 | 18 | 108 |
| | $S_2$ | 11 | 49 | 22 | 82 |
| | $S_3$ | 13 | 36 | 43 | 82 |
| | **Total** | **82** | **107** | **83** | **272** |

**Source:** Field survey, 2013
$S_1 = \leq 2000$ kg, $S_2 =$ 2001– 4000 kg, $S_3 = >4000$ kg
Result: $S_1 = 0.27$, $S_2 = 0.40$, $S_3 = 0.33$

This can be interpreted into percentages as 27, 40 and 33%, respectively.
Confirmation: 0.27 + 0.40 +0.33 = 1

***Interpretation of the transition matrix for projected output scale of fish farming in Adamawa State***

From the result of the initial probability in Table 2 and Table 3 which estimates subsequent years $t_o$ and $t_{o+1}$; $t_{o+1}$ and $t_{o+2}$ (2011/2012 and 2012/2013), respectively were both having identical results. The results indicated that, in the long run, 31% of farmers will obtain output of ≤2,000 kg ($S_1$) of table sized fish, 38% of the farmers will obtain output of 2,001 – 4,000 kg ($S_2$) of table sized fish and 31% of the farmers will obtain>4,000 kg ($S_3$) of table sized fish from their production. However, Table 4 that estimate for the first and the third year (2011/2013 i.e. $t_o$ and $t_{o+2}$) had a little deviation from the previous estimates, which have 27% of the farmers will obtain output of≤ 2,000 kg ($S_1$) of table sized fish, 40% of the farmers will obtain 2,001 – 4,000 kg ($S_2$) of table sized fish, while 33%of the farmers will obtain> 4,000 kg ($S_3$) of table sized fish from their production.

This could be concluded that, in the long-run, more of the fish farmers will get a relatively high yield (output) on their fish production, output state “$S_2$” which is likely to give them optimum return. The teeming population makes farmers to increase their output to meet up with protein demand. Meanwhile, the demand for fish is increasing compared to other sources of protein because of the health and age challenge on the consumers, which wild fish capture and fish products importation cannot meet up with the increasing demand for fish in Adamawa State. This is in line with Tiamiyu, (2012) and FAO, (2014) that projected tremendous output from fish farming at the long run.

**Conclusion and Recommendation**

The study indicates that, on the long run, majority of fish farmers will get higher output of table sized fish; more than 2000 kg in single production cycle. In that view, it is recommended that youth and women are encouraged to participate in fish business as it promise higher output and market outlet should be provided to sell the increasing output.

**References**

Adebayo AA 1999. Climate II. In: *Adamawa State in Maps*. Adebayo AA & Tukur AL (eds) 1st edition paraclete publishers Yola, Nigeria, pp. 112.
Akinrotimi OA, Onunkwo DN, Cliffe PT, Anyanwu PE & Orokotan OO 2007. The Role of fish in nutrition and livelihoods of families in Niger Delta, Nigeria. *Int. J. Tropical Agric. and Food Systems,* 1(4): 344-351.
Amiengheme P 2003. The Importance of Fish in Human Nutrition, Workshop on fish farming organized by Federal Department of fisheries and fisheries society of Nigeria, pp. 1-4.

Anetekhai MA, Akin-Oriola GA, Adrinola OJ & Akinola SL 2004. Step ahead for aquaculture development in Sub-Saharan Africa – the case of Nigeria. *Aquaculture,* 239: 23–248.

Atobatele JT 1986. The Size, Structure and Changing Income Pattern under New Technology in Oyo State. Unpublished Ph.D Dissertation, Department of Agricultural Economics University of Ibadan-Nigeria

Baruwa OI, Masuku MB & Alimi T 2011. Economic Analysis of Plantain Production in Derived Savannah Zone of Osun State, Nigeria. *Asian Journal of Agricultural Sciences* 3(5): 401-407, 2011 ISSN: 2041-3890 © Maxwell Scientific Organization, 2011.

Dittoh JS 1985. Production Response in Peasant Agriculture-a Time Series and Cross-Sectional Analysis of Cotton Production in North-Eastern Ghana, Unpublished M.Phil. Dissertation, Department of Agricultural Economics University of Ibadan-Nigeria

FAO 2010. *The State of World Fisheries and Aquaculture 2010,* FAO Aquaculture Global and Regional Reviews.

Federal Department of Fisheries 2010. Fisheries Statistics of Nigeria. Federal Department of Fisheries, Abuja .

Hillier FS & Lieberman GJ 1995. *Introduction to Operational Research (6$^{th}$ed.*) McGraw-Hill Inc., New York, p. 628.

Machena C & Moehl J 2001. Sub-Saharan African aquaculture: Regional Summary. In R.P.

Madawaki MD, Biradawa K & Adeleye A 2002. Quantitative Business Technique. Compaq Publishers, Miaduguri-Nigeria.

Mshelia SI 1991. Economics of Cotton Production in Nigeria: A Case Study of Out Growers Under Afcott Yola. Unpublished M. Sc. Thesis, Department of Agricultural Economics University of Ibadan-Nigeria.

NPC 2006. National Population Commission Federal Republic of Nigeria Official Gazette 2007: 24(94).

Okpachu AS 2006. Efficiency Measurement of Soybean Marketing in Benue State, Nigeria. Unpublished M. Sc. Thesis Federal University of Technology Yola.

Onu JI 2000. An Analysis of the Structural and Performance of Cotton Marketing in Northern Nigeria, Unpublished Ph.D. Dissertation University of Ibadan.

Rahman S 2003. Profit Efficiency Among Bangladesh Rice Farmers, *Proceedings of the 25th International Conference of Agricultural Economics* (IAAE), Durban, South Africa, 16$^{th}$-22$^{nd}$ August *Food Policy*, 28(5-6): 487-503.

Taha HA 2001. Operation Research. New Delhi: Prentiece Hall of India.