**DETERMINANTS OF AQUACULTURE FISH SEED PRODUCTION AND DEVELOPMENT IN OGUN STATE, NIGERIA**

F.O.A. George[1]; O. J. Olaoye [2]; O. P. Akande[1]; and R. R. Oghobase[1]

[1]Department of Aquaculture and Fisheries Management, University of Agriculture, Abeokuta, Nigeria

[2]Agricultural Media Resources and Extension Centre, University of Agriculture, Abeokuta, Nigeria

## ABSTRACT

Aquaculture is the fastest growing food production system worldwide and is particularly important in bridging the gap between fish demand and supply in Nigeria. This study was carried out to determine factors affecting aquaculture fish seed production and management in Ogun State, Nigeria, an important coastal and fish producing state. Through structured questionnaire and personal interviews, data were collected from 58 hatcheries and analyzed using descriptive and inferential statistics. Major challenges identified by this study include lack of good quality brood stock, high mortalities during larval development, high costs of hatchery inputs and equipment, water quality maintenance and energy-related problems. It is recommended that government should offer low-interest loans for continuous training of fish hatchery operators, who should be mandated to train regularly to update their knowledge on new developments in the industry. These steps should result in enhanced fish seed production for viable and sustainable aquaculture development in Nigeria.

**Keywords:** Brood Stock; Fish Seed; Production; Sustainable Aquaculture; Ogun State; Nigeria

## INTRODUCTION

Fish farming is expanding rapidly throughout the world and has a high potential for the provision of valuable protein in less developed countries (Little & Edwards, 2003). Due to global population expansion, demand for high quality animal protein, especially from aquatic sources, is rising. Increasing the aquaculture production is clearly needed to meet this demand in the third millennium, especially as the capture fisheries resources are declining, due to over fishing, habitat destruction, and pollution (Dunham, Majumdar, Hallerman, Bartley, Mair, Hulata, Liu, Pongthana, Bakos, Penman, Gupa, Ratalishbweg & Hoestgen Schwark, 2001).

Aquaculture plays an important role in many developing economies.  In Nigeria, 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). Total fish production in Nigeria is estimated at about 30 percent of demand, thus scarce foreign exchange is devoted to the importation of large volumes of frozen fish (ThefishSite, 2009). According to Otubusin (1998), inadequate fish seed supply is a major constraint to aquaculture development in Nigeria. Although domestication of species and advances in induced breeding have enhanced the breeding of fish in captivity and extend the spawning season to a limited degree, it has

not yet allowed substantial seed production outside the normal spawning season for many species. At present, a large percentage of the total seed requirements for aquaculture are obtained from the wild, where supply is completely dictated by the natural breeding cycle of the target species. Domestication and extension of breeding seasons, for example in shrimp production, could have profound influences on productivity and markets. Other factors that cause unpredictability of seed supply include flooding and other natural or man-made disasters, including oil spills, disease outbreaks, and limited availability of feeds for broodstock and larvae (Mair, 2002).

The African catfish, *Clarias gariepinus*, is the commercial aquaculture species in Nigeria. A major problem identified as hindering the promotion and development of the aquaculture industry in Nigeria has been the scarcity of fish fingerlings. Desired quantity and quality have never been available. While the present total production and supply from all sources is less than 50 million fingerlings, the requirement in the short term is at least 500 million, annually. Until about 15 years ago, no less than 60% of all fish seed supply in Nigeria was from the wild (Bondad-Reantaso, 2007). Many fish farms have been abandoned in the country for lack of fish seed. Many technical problems arise in the production of seed either in the pond or hatchery system. Principal among these are: the lack of and poor management of broodstock, especially feeding and handling; and the poor record keeping of all activities regarding induced spawning, care of eggs, fry, feeding, and general management of fingerlings (Atanda, 2006).

Lack of fish fingerlings has been one of the major constraints for aquaculture development in Nigeria for the past 40 years (Aquaculture and Inland Fisheries Project (AIFP), 2005). Fish seeds are indispensable to the operations of fish farms. Thus, the federal government of Nigeria introduced the fish farm project under which pilot fish farms were established for potential fish farmers to replicate so as to produce more fish for the people. In addition, the Fish Seed Multiplication Project was designed to provide fish farmers with fingerlings with which to stock their ponds (Federal Department of Fisheries (FDF), 1995). However, these projects have, to date, been largely ineffective and could not supply adequate quantities of fish seed for neither the government projects, nor the private individuals (Barker, 1986).

Quality seed and fish feed are the essential components for the fish growth, In promoting seed supply, consideration should be given to the fact that the small localized hatcheries, whilst delivering seed locally, can be more responsive to changing trends in demand, more economically flexible, and have lower start up costs. They can thus play an important role in the sustainability and equity of seed supply and, in many cases, may be more appropriate media for seed distribution than the larger, centralized seed supply systems (Mair, 2002). The potential negative impacts of genetics related to broodstock management issues, such as inbreeding, genetic drift, introgressive hybridization, and unconscious selection, have been well established that many, if not the majority, of aquaculture stocks have been negatively impacted by poor genetic management (Mair, 2002).

Availability of fish seed of the candidate species in adequate quantity is one of the most important factors for a sustainable and profitable fish farming, which involves a number of management practices in the maintenance of quality broodfish in adequate number. In the tropics, most aquaculture species can be grown year round, subject to suitable availability of water

and demand for cultured fish is also largely year round, with seasonal troughs and peaks associated with the availability of fish from capture fisheries and cultural preferences. However, for the majority of species, spawning and seed supply is seasonal, thus multiple spawning species are often preferred for successful aquaculture (Mair, 2002).

**OBJECTIVES OF THE STUDY**

This study attempted to examine the factors affecting the production and management of fish seed in hatcheries and the resultant effect on aquaculture development in Ogun State, Nigeria. The specific objectives were to identify the constraints or limitations to fish seed production and management; examine the role of hatchery fish seed production on the development of aquaculture; and recommend measures that could be taken to ameliorate the scarcity of fish seed in Ogun State, Nigeria.

**MATERIALS AND METHODS**

The study area, Ogun State, Nigeria lies within $20^{o}45$'E and $3^{o}55$'E longitude and $7^{o}01$'N and $7^{o}8$'N latitude in the tropics. Ogun State is bounded in the west by Benin Republic, in the south by Lagos State and the Atlantic Ocean, in the east by Ondo State, and in the north by Oyo state. As shown in Figure 1 below, Ogun State covers a land area of 16,409.28 square kilometers and represents less than two percent of Nigeria's landmass. The natural vegetation ranges from fresh-water swamp with mangrove forest in the southwest and diverse forest communities to the woody Guinea savannah in the northwest. The rainy season starts around the middle of March and continues till late October, while the dry season starts in November and lasts until February, in most locations. Rainfall ranges between 900 and 1600mm, annually. The area is warm throughout the year with an average temperature ranging between 28 and $35^{0}$C. Humidity is between 85 and 95 percent (Oloruntoba & Adegbite, 2006).

Like most states in the southwest, Ogun State is highly urbanized, with a population of approximately 3.73 million people and growth rate of about 3 percent, annually, and has about twenty (20) local government areas (The National Population Commission (NPC), 2006). The state was divided into four agricultural extension zones by the Ogun State Agricultural Development Programme (OGADEP) based on agro-ecological features for effective dissemination of improved technologies (Figure 1).
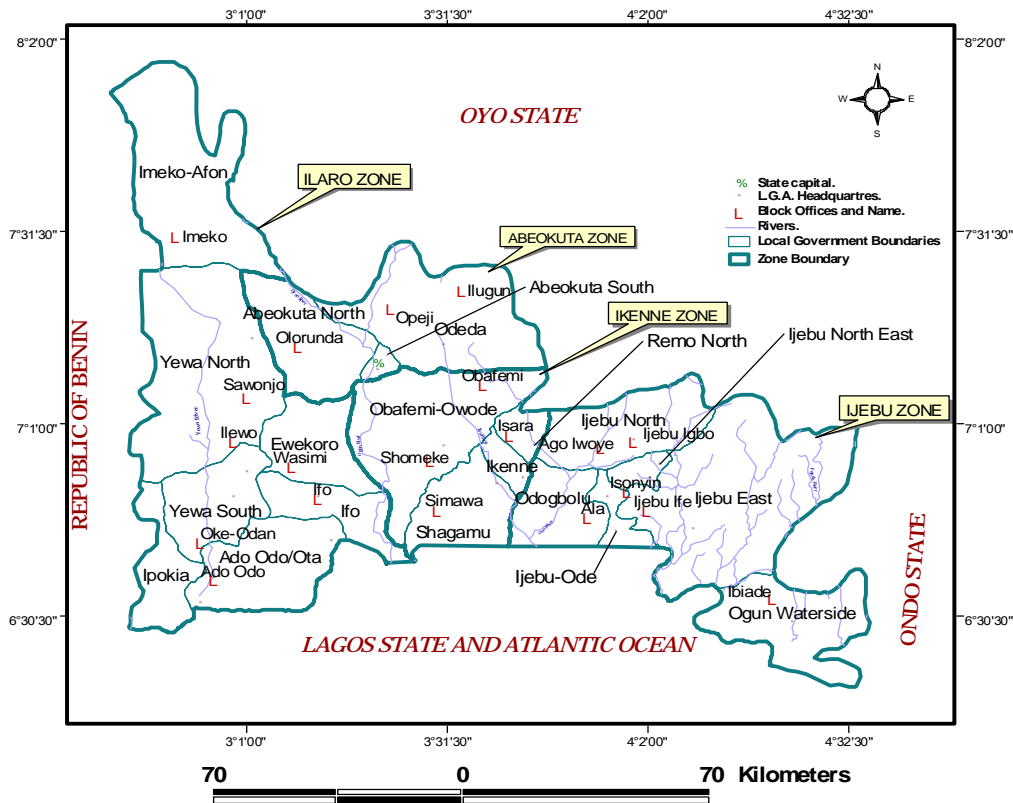
**Figure 1: Ogun State Agricultural Development Project (ADP) zones and blocks showing study location**

Ogun state has a total water surface area of 2,237,000 hectares and is well endowed with natural water bodies, such as springs, perennial flowing rivers, lakes, and brackish waters, estimated at 173.8 square kilometers (Ita & Sado, 1984). This study was carried out in the Ijebu-Ode, Ilaro, Ikenne, and Abeokuta Agricultural extension operational zones of the Ogun State Agriculture Development Programme (OGADEP). The registered names and location of fish hatcheries located in each zone was collected from OGADEP and unregistered hatcheries identified by registered fish farmers in the state.

The names of the hatcheries were arranged in alphabetical order and selected randomly, according to the sample size (50%) of the fish hatcheries in each zones. Table 1, below, describes the sample sizes and population of respondents from each zone.

**Table 1: Number of selected hatcheries in the four (4) operational zones of OGADEP**

| S/N | Name of the Agricultural Extension Operational Zones | Total number of fish hatchery | Sample size (50%) |
|---|---|---|---|
| 1 | Ijebu-Ode | 30 | 15 |
| 2 | Ilaro | 34 | 17 |
| 3 | Abeokuta | 33 | 17 |
| 4 | Ikenne | 17 | 9 |
| **Total** | | 114 | 58 |

**Source: Fisheries Unit, OGADEP (2007)**

Quantitative data were collected using a structured questionnaire and personal interviews on selected fish hatcheries. These instruments were subjected to content validity analysis by experts in both the Department of Aquaculture and Fisheries Management and the Department of Agricultural Extension and Rural Sociology of the University of Agriculture, Abeokuta (UNAAB). The reliability of this study was based on information supplied by hatchery operators in the selected hatcheries sampled. A reliability coefficient (r) of 0.85 obtained for the instrument was used for data collection. Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS), Version 12, for regression and sample statistics.

**RESULTS AND DISCUSSION**

**Socio-economic characteristics of fish hatchery farmers**

Fishing activities are the exclusive preservation of people in their active age (FAO, 1997; Oloruntoba & Fakoya, 2002). As presented below, results in Table 2 show that majority (58.62%) of the respondents fell within the active age group of 31-40 years, while 25.86% of the hatchery farmers fell within 21-30 years, 10.34% fell between 41 and 50 years, and 5.17% fell in less than 20 years. This implies that people in the active age are very much involved in fish hatchery enterprise, while the older people may not have enough capital and strength for fish farming. The literacy level is relatively high, as the majority of the farmers (80.66%) had one form of formal education or the other. This phenomenon would assist the respondents to gain access to aquacultural information and acquire skills needed for other income generating fisheries activities. Almost half (44.83%) of fish hatchery farmers had aquaculture experience of 6-9 years. This implies that the farmers had acquired necessary knowledge and skills needed in fish hatchery enterprises for sustainability. Less than half (34.48%) of the respondents got their brood-stock from open markets, followed by personal farm (29.30%). This implies that good and matured brood-stocks are not easy to come by in the study areas.

**Table 2: Socio-economic characteristics of fish hatchery Operators**

| Age interval (Yrs.) | Frequency | Percentage (%) |
|---|---|---|
| <than20 | 3 | 5.17 |
| 21-30 | 15 | 25.86 |
| 31-40 | 34 | 58.62 |
| 41-50 | 6 | 10.34 |
| 51-60 | - | - |
| 61 and above | - | - |
| **Educational Qualification** | | |
| Primary Education | 3 | 5.17 |
| Secondary Education | 12 | 20.69 |
| NCE/OND | 9 | 15.52 |
| Graduate | 28 | 48.28 |
| Non-Literate | 6 | 10.34 |
| **Years of Aquaculture Experience** | | |
| Less than 20 | 3 | 5.17 |
| 2-5 | 20 | 34.48 |
| 6-9 | 26 | 44.83 |
| 10 & above | 6 | 10.34 |
| **Source of Brood-stock** | | |
| Open Market | 20 | 34.48 |
| Reputable Fish Farm | 12 | 20.69 |
| Personal Farm | 17 | 29.30 |
| River Side | 9 | 15.52 |

**Source: Field Survey (2007)**

**Academic specialization of the respondents**

Table 3 shows the academic specialization of the respondents. Only one (1) of the respondents, which represents 4.8%, specialized in fisheries management; 4 (19.0%) specialized in banking & finance / accounting; 1 (4.8%) specialized in farm management, while 3, representing 14.3%, specialized in agriculture; and 2 respondents each, representing 9.5%, specialized in education and business administration, respectively. About 40 percent of respondents did not specify their areas of academic specialization. This implies that the area of academic specialization of the hatchery operator is a major constraint to fish seed production and development. As shown on Table 3 below, that only 4.8% of the respondents specialize in fish farming, but this does not affect the fish seed production and management because it has no significant correlation with monthly fish seed production. The reason may be due to the fact that most of the respondents (85.7%) attended one seminar or the other on fish farming/breeding.

**Table 3: Academic specialization of respondents**

| Code | Academic specialization | Number of Respondents | Percentage (%) |
|------|------------------------|----------------------|----------------|
| 1 | Fisheries management | 1 | 4.8 |
| 2 | Banking  & Finance / accounting | 4 | 19.0 |
| 3 | Farm management | 1 | 4.8 |
| 4 | Agriculture | 3 | 14.3 |
| 5 | Education | 2 | 9.5 |
| 6 | Business Admin | 2 | 9,5 |
| **Total** | | **13** | **61.9** |

**Source: Field Survey (2007)**

**Problems encountered by respondents during fish seed production.**

Table 4  shows the problems encountered by the respondents during fingerlings production, one of the respondents, representing 4.8%, encountered only low hatchability as a constraint. Three (14.3%) of the respondents also agreed with the problem of fry mortality as a constraint, which concur with Madu (1994), who observed that many hatcheries in Nigeria reported low survival of fish hatchlings. Two (9.5%) respondents mentioned the lack of brood stock, which conformed to Madu (1994), who reported that many hatchery operators in Nigeria complained of lack of brood stock of culturable fish species. 42.6% of the respondents complained of water quality management problems, or fry mortality as their major constraints. Also, Madu (1994) observed that fish seeds (hatchlings) are also susceptible to poor water quality, which can result high-level mortality of fry. Regular supply of water is a basic requirement for functional hatcheries; the water must be of adequate quantity and quality to sustain the high water demand of hatcheries. Also, Eleshin-Nla (2005) reported that good

**Table 4: Problems encountered by respondents during fish seed production**

| Code | Types of problem | Number of Respondents | Percentage (%) |
|------|------------------|-----------------------|----------------|
| 1 | Low hatchability | 1 | 4.8 |
| 2 | Fry mortality | 3 | 14.3 |
| 5 | Lack of broodstock | 2 | 9.5 |
| 10 | Fry mortality & water quality management | 9 | 42.6 |
| 11 | Lack of broodstock & water quality management | 6 | 28.6 |
| **Total** | | **21** | **100** |

**Source: Field survey (2007)**

water quality and the availability of it at all times ensures the survival rate, good growth, reproduction, and other metabolic activities of aquatic organisms, including fish. Good quality water produces healthier fish than pond with poor water quality (Boyd, 1982). The problem of electricity is also common to almost all of the respondents (76.19%). This is very crucial and critical to the production of fish seed and management, according to Madu (1994). Electricity is essential for water aeration, especially in high stocking densities of fry and fingerlings. The use of electricity for aeration also helps to minimize water wastage by a flow-through aeration system. According to Anyanwu, Fleuren & Alakija (2005), irregular supply of electricity, hence consumption of fuel (petrol/diesel) and high costs of fuel increases cost of production of Water Recirculating System (WRS). This may lead to an irregular supply of quality fingerlings.

**Correlation between quantity of seed produced, age and size of brood stock used for seed production**

In table 5  the correlations between the quantities of fish seed produced per month and age and size of brood stock used are shown. Correlation coefficients between the quantity of fish seed produced and broodstock size and age are .028 and -.111, respectively.

**Table 5: Correlation between quantity of fish seed produced and age and size of broodstock used for spawning**

|  |  | Quantity | Size | Age |
|---|---|---|---|---|
| **Quantity** | Pearson Correlation | 1.000 | .028 | -.111 |
|  | Sig. (2-tailed) | . | .906 | .631 |
|  | N | 21 | 21 | 21 |
| **Size** | Pearson Correlation | .028 | 1.000 | .576 |
|  | Sig. (2-tailed) | .906 | . | .006 |
|  | N | 21 | 21 | 21 |
| **Age** | Pearson Correlation | -.111 | .576 | 1.000 |
|  | Sig. (2-tailed) | .631 | .006 | . |
|  | N | 21 | 21 | 21 |

**\*\*Significant correlation (P < 0.01) (2-tailed)**

**Table 6: Monthly production of fish seed by respondents**

| Code | Quantity of fish seed | Number of Respondents | Percentage (%) |
|---|---|---|---|
| 1 | 1000 – 10,000 | 4 | 19.0 |
| 2 | 11,000 – 20,000 | 1 | 4.8 |
| 3 | 21,000 – 30,000 | 9 | 42.9 |
| 4 | 31,000 – 40,000 | 3 | 14.3 |
| 5 | 41,000 – 50,000 | 2 | 9.5 |
| 6 | 51,000 – 60,000 | 1 | 4.8 |
| 7 | 61,000 and above | 1 | 4.8 |
| **Total** |  |  | **100** |

**Source: Field Survey (2007)**

Table 6 describes monthly fish seed production of the respondents. Over 80% of respondents produced between 1,000 and 40,000 fish seed per month, while only about 5% produced over 60,000 hatchlings per month.

## CONCLUSION

The availability of high quality fish seed is a pre-requisite for a successful aquaculture fish production enterprise. Aquaculture is vigorously being developed in Nigeria today, particularly to bridge the gap between fish demand and supply. The sustainability (i.e. the continuous profitable production) of fish seed production and aquaculture development in Nigeria is dependent not only on production factors (capital, manpower) but also on social (relationships with other enterprises, government policies and regulations, meeting consumers' needs) and impacts on the environment. Broodstock quality (age and size) were found to affect fish seed production and quality. Broodstock is obtained either from the wild or from research centers where they are constantly being developed to meet the needs of the industry, thus the importance of technical know-how for a viable and sustainable industry cannot be over-emphasized. On the other hand, the quality of wild stocks is determined by prevailing environmental conditions and strategies employed in inland fisheries management. Many of the respondents complained that broodstock were not readily available, possibly because of the crisis of reduced fishing effort and lower fish production levels in Nigerian inland fisheries. Results in this study clearly demonstrate that there has to be a synergy between production, environmental and social factors before sustainability can be achieved in Nigerian aquaculture. Thus, for sustainable fish seed production and aquaculture development, impacts of the fish hatchery enterprise on society, environment and other stakeholders should be positive. According to Seaver (2011), seafood sustainability is determined majorly by the impacts of the seafood on its consumers. At the global level aquaculture production has been increasing steadily since 1990 in response to declining capture fisheries production. The trend is similar in Nigeria because of inland aquaculture's potential for food security, livelihood and development. It is estimated that Nigeria needs to produce at least 700,000 metric tonnes (Winrock International, 2010) of fish annually to eliminate its dependency on fish importation. According to Obiyai and Ekubo (2011), Government should encourage more involvement in the fish farming business, create an enabling financial environment to increase investment in fish breeding and hatching operations to reduce the incidence of fingerling shortage in supply which will be counterproductive to aquaculture development in Nigeria. It could be deduced from the present study that major constraints to the production of high quantity of fish seed are energy and water quality related problems arising from skills gap in the industry.

## RECOMMENDATIONS

The production of high quality fish seed requires improved breeding techniques and procedures, thus it is expedient that fish seed hatchery operators invest in regular training and capacity building programmes that will improve their skills. This may require that Government agencies and ministries organize regular and mandatory training workshops and seminars for hatchery operators. Hatchery operation is also a highly technical enterprise which Government needs to regulate and open only to highly skilled and qualified people. Hatchery equipment and inputs are expensive. To enhance fish seed production and aquaculture development in Ogun state and Nigeria, Government may need to subsidize the prices of imported hatchery equipment and inputs.

**REFERENCES**

Adikwu, A.I. (1999). Aquaculture in Nigeria: Prospects and Constraints. *Journal of Fisheries Technology*, Federal College of Fresh Water Fisheries Technology, New Bussa, Niger State, Nigeria.  I(1):16 – 25.

Aquaculture and Inland Fisheries Project (AIFP), (2005). Overview of Fisheries in Nigeria. Newsletter of the Aquaculture and Inland Fisheries Project of the National Special Task Force for Food Security in Nigeria, Technical Note No. 16, June.

Anyanwu, P. E., Fleuren, W.G., & Alakija, A. (2005). Water Recirculating System Aquaculture in Nigeria: Problems and Prospects of the Dutch Model. Fisheries Society of Nigeria (FISON) Conference Proceedings.

Atanda, A. N. (2006). Analysis of Freshwater Fish Seed Resources in Nigeria. Fisheries Society of Nigeria (FISON) Conference Proceedings.

Barker, H.C. (1986). Investment Opportunities in Fish Seed Technology. Fisheries Society of Nigeria (FISON) Conference Proceedings.

Bondad-Reantaso, M.G. (2007). Assessment of freshwater fish seed resources for sustainable aquaculture. *FAO Fisheries Technical Paper,* No. 501. Rome: FAO

Boyd, C. (1982). *Water Quality Management for Pond Fish Culture (Developments in Aquaculture and Fisheries Science).* Netherlands: Elsevier Science Publishing  Co.

Cowx, I.G. & Van Anrooy, R. (2010). Social, economic and ecological objectives of inland commercial and recreational fisheries and aquaculture. EIFAC Proceedings of the symposium on Interactions between social, economic and ecological objectives of inland commercial and recreational fisheries and aquaculture. Antalya, Turkey. *EIFAC Occasional Paper No.44. Rome: FAO.*

Dada, A.A. (2006). Some Hints on Outdoor Nursery Management Operation for *Heterobranchus bidorsalis* Fisheries Society of Nigeria (FISON) Conference Proceedings.

Dada, B.F. (2003). Contribution of Fisheries to Employment Generation, National Economy and food Security in Nigeria. A paper delivered at the 2003 Fisheries Society of Nigeria (FISON) Public Lecture.

Dunham, R. A., Majumdar, K., Hallerman, E., Bartley, D., Mair, G., Hulata, G. Liu, Z., Pongthana, N., Bakos, J., Penman, D., Gupa, M., Ratalishbweg, P., & Hoestgen Schwark, G. (2001). Review of the status of Aquaculture genetics. In: R.P. Subasinghe, P. Bueno, M. J. Philips, C. Hough, S.E. McGladding, and J.R. Arthur (Eds.). Aquaculture in the third Millennium. *Technical proceedings of the conference on aquaculture in the third Millennium*, Bangkok, Thailand. NAGA, Bangkok and FAO Rome. 20-25, Pp 137-166.

Edwards, P., Little, D.C., & Demaine, H. (2002). *Rural Aquaculture.* United Kingdom: CABI Publishing.

Eleshin-Nla, A.I. (2005). Models of Water Recirculation Aquaculture System. Fisheries Society of Nigeria (FISON) Conference Proceedings.

Fagade, S.O. (1992). Keynote Address to Production, Utilization, and Marketing in Fisheries. Status and Opportunities. FISON Conference Proceedings.

Food and Agriculture Organization of the United Nations, FAO (1997).  Report of the *Workshop* on Gender *Roles and Issues in Artisanal Fisheries* in West Africa, Lomé, Togo.  In: B.W. Horemans and A.M. Jallow (Eds.), *1997*.

Federal Department of Fisheries (FDF). (1995). Federal Department of Fisheries Statistics.

Horsfall, J.D. (2005). Tilapia as Staple Culturable Fish Species for the Nigeria Rural Fish Farmers: A Review of its potentiality. FISON Conference Proceedings.

Huy, H.P.V., MacNiven, A., Tu, N.V., Bhujel, R.C. & David, C.L. (2003). Tilapia Seed Production in Hoi Chi Minh City, Southern Vietnam. *Aquaculture Asia,* 3(4), 23-25.

Ita, E.O. & Sado, E.K. (1984). Inventory of Nigerian Inland waters and their fishery resources with special reference to ponds, lakes, reservoirs and major Rivers: surface area and potential yield estimates. Kainji Lake Research Institute Annual Report.

Little, D.C. & Edwards, P. (2003)*.* Integrated Livestock-fish Farming Systems, Inland Water Resources and Aquaculture*.* FAO.

Madu, C. T. (1994). Status of fish hatcheries and fish seed fingerlings production in Nigeria. *National Institute of Freshwater Fisheries Research (NIFFR) Annual Report.*

Mair, G. (2002). Supply of good quality fish seed for sustainable aquaculture. *Aquaculture Asia,* 7(2), 25.

Moody, F.O. & Folorunsho, J.K. (2006). Assessment of water quality in Kigera Fish Farm, New Bussa. *Fisheries Society of Nigeria (FISON) Conference Proceedings.*

Nalçaoğlu, H. & Sari, M. (2010). Sociological analysis of sustainable fisheries management of the Endemic Pearl mullet in the fishing villages of Lake Van, Turkey. Proceedings of the symposium on "Interactions between social, economic and ecological objectives of inland commercial and recreational fisheries and aquaculture", Antalya, Turkey. *EIFAC Occasional Paper No.44.* Rome: FAO.

National Informatics Centre (NIC). (2007). Fish seed production 2004 – 2005. *Fisheries at a glance in Tripura (2004–2005).* Retrieved from: http://www.tripura.nic.in/fisheries/FisheryataGlance.htm.

National Informatics Centre (NIC). (2007). Fish seed production 2004 – 05. Retrieved from: www.tipurainfo.com

National Population Commission (NPC). (2006). *NPC releases 2006 population figure.* Retrieved from: http://www.nigeriavillagesquare.com/articles/nvs/npc-releases-2006-population-figures-14.html.

Nwadukwe, F. (2006). Induced Breeding. Workshop on Fish Farming Organized by the Federal Department of Fisheries (FDF) and Fisheries Society of Nigeria (FISON).

Obiyai, K.K. & Ekubo, N.A. (2011). Development of Entrepreneurship Skills Training Module on Fish Breeding and Hatching Occupation. *Asian Journal of Agricultural Sciences,* 3(2), 111-114. Retrieved from: http://www.maxwellsci.com/print/ajas/v3-111-114.pdf.

Ogun State Agricultural Development Programme (OGADEP). (2006). Annual Fisheries Report.

Ogun State Agricultural Development Programme (OGADEP). (2007). Annual Fisheries Report.

Oguntade, O.R., Ayinla, O.A., Oresegun, A., Adeogun, O.A., Ogunbadejo, H.G.K., & Alhaji, T. (2005). Trends in Fish Culture in Urban and Peri-urban Areas of Lagos State, Fisheries Society of Nigeria (FISON) Conference Proceedings.

Oloruntoba, A. & Adegbite, D.A. (2006). Improving Agricultural Extension Services through University Outreach Initiatives: A Case of Farmers in Model Villages in Ogun State, Nigeria. *The Journal of Agricultural Education and Extension,* 12(4), 273-283.

Oloruntoba, A. & Fakoya, E.O. (2002). Constraints to the Increased Fishing Productivity of Women in Rural peri-urban setting of Lagos State, Nigeria. *Journal of Extension Systems*, 19(2), 60-71. Retrieved from: http://jesoline.org.

Otubusin, S.O. (1992). Aquaculture, Food Security and Environment. Invited Lecture Presented at the Formal Launching of the National Association of Fisheries Students (NAFIS). University of Agriculture, Abeokuta (UNAAB).

Otubusin, S. O. (1998). Sustainable Utilization of Nigeria's aquatic/wetland resources:  Fish cage, pen and enclosure systems options.  In S.O. Otubusin, et al., (Eds.).  Sustainable utilization of Aquatic/Wetlands Resources.  University of Agriculture, Abeokuta, UNAAB, Abeokuta, Nigeria. Pp. 69-74.

Pickering, A.D. & Stewart, A. (1984). Acclimation of the interrenal tissue of the brown trout, *Salmo trutta L.*, to chronic crowding stress. *Journal of Fish Biology,* 24, 731–740.

Pillay, T.V.R. & Dill, W.A. (1976). Advances in Aquaculture. FAO Technical Conference on Aquaculture. Kyoto.

Reddy, P.V.G.K. (1999). Genetic resources of Indian major carps. FAO Fisheries technical paper 387. Rome: FAO. 76p.

Seaver, B. (2011). Redefining seafood sustainability. www.seafoodsource.com/newsarticledetail.aspx?id=9298.

TheFishSite. (2009). Nigeria's dependence on Fish imports. http://www.thefishsite.com/fishnews/9156/nigerias-dependence-on-fish-imports.

Tsadu, S.M., Yisa, A., & Ogubude, O.S. (2006). Separation of hatchlings from egg shells and unhatched eggs of *Clarias gariepinus* using net hapa and survival from brood stocks of varying sizes. Fisheries Society of Nigeria (FISON) Conference Proceedings, 2006.

Winrock International. (2010). Project Fact sheet: Nigeria MARKETS. http://www.winrock.org/fact/facts.asp?CC=5582&bu=

## ABOUT THE AUTHORS

Dr. F. O. A. George: Senior Lecturer, Department of Aquaculture and Fisheries Management, University of Agriculture, Abeokuta (UNAAB).

Dr. O. J. Olaoye: Agricultural Media Resources and Extension Centre, University of Agriculture, Abeokuta, Nigeria.

Mr. O. P. Akande: Department of Aquaculture and Fisheries Management, University of Agriculture, Abeokuta (UNAAB).

Miss. R. R. Oghobase: Department of Aquaculture and Fisheries Management, University of Agriculture, Abeokuta (UNAAB).