

Article

Urban Fish Farming in Jos, Nigeria: Contributions towards Employment Opportunities, Income Generation, and Poverty Alleviation for Improved Livelihoods

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Abstract: In most urban areas of sub-Saharan Africa, the migration of people from rural to urban areas in search of better socio-economic conditions and improved livelihoods is contributing to increased unemployment levels, poverty and large scale urban deprivation. Given such poverty situations and the prevalence of people who survive on less than 2 USD per day, local populations in these areas are increasingly vulnerable to food insecurity as well as malnutrition. One way out of this poverty trap is practicing small scale agriculture both for subsistence and income-generating purposes. In this paper, the role of small scale fish farming as a livelihood strategy by urban farmers in the city of Jos has been investigated by means of a mixed-method research design. Thus, both quantitative and qualitative data were collected for analyses in order to understand the various dimensions of small scale fish farming amongst 50 respondents randomly selected in the city of Jos, Nigeria. The results have shown the spatial distribution of these farming practices, as well as the demographic attributes of these farmers. Small-scale fish farming is a viable source of food, generating local employment opportunities as well as much needed income in an environment of urban deprivation. Some of the income (above ₦20,000 or 55.56 USD) derived from this fish farming significantly alleviates poverty, as it exceeds the Nigerian national minimum wage of ₦18,000 (50.00 USD). Results also show that the lack of reliable water supplies and high production costs are some of the most constraining problems that militate against operational effectiveness and efficiency, along with poor marketing of their produce and lack of preservation facilities. The lack of access to credit facilities was also mentioned as one of the problems besetting this activity. From the perceptions of the respondents in this study, a number of negative environmental impacts associated with small scale fish farming have been highlighted. Given these results and the growth potential of this kind of farming in Jos, more integrated local development planning is recommended for addressing the infrastructural and resource needs of practicing farmers for achieving long term sustainability in small scale fish farming.

Keywords: urbanization in Sub-Saharan Africa; Jos in Nigeria; increased unemployment; food insecurity; small scale fish farming; source of food; employment; incomes; improved livelihoods

1. Introduction

The United Nations (UN) has predicted that by 2050, the population of the world will reach 9.6 billion. The greater part of this increase in population is projected to occur within the cities of most developing countries [1,2]. According to the Department of Economic and Social Affairs in the Population Division of the United Nations (DESA/PDUN) [3], it is estimated that by the same year, 66% of the world's population will be living in urban areas. In Africa and Asia, urbanisation trends

are growing more rapidly than in other regions, and they are forecasted to be 56% and 64% urban by 2050, respectively [3]. It is expected that the countries of sub-Saharan Africa will contribute a larger proportion to the population growth globally, since their urban population is increasing at a faster rate, with an annual growth rate of 3.6% [3].

However, in many African countries, poverty and food insecurity severely affect the urban poor compared to their rural counterparts. The urban poor depend mainly on the market, while rural dwellers have an option to exploit natural resources for income generation and to provide food for themselves [4,5]. In 2011, the Food and Agricultural Organization (FAO) [6] stated that 960 million people globally are malnourished, with most of them living in Asia and Africa [7]. Moreover, FAO [8] and other sources [9,10] have indicated that about one-third of the sub-Saharan African (SSA) population is malnourished, as they survive on less than 2 USD per day. Furthermore, poor urban dwellers in SSA countries spend approximately 60% to 80% of their monthly salary on buying food in the market, thus rendering them susceptible to food price instabilities [11–16]. Both FAO [8] and Ravallion et al. [17] have indicated that about 33% of urban dwellers in African countries are living in poverty. In fact, cities such as Kampala (Uganda) and Lilongwe (Malawi) have the highest urban poverty levels in Africa, with 60% and 80% respectively of their populations classified as being urban poor [18].

The Nigerian population is estimated to contribute 212 million people to the world's urban population between the years 2014 and 2050 [3]. In Nigeria, urban poverty and food insecurity are fast becoming major socio-economic problems in urban areas [19], and this is afflicting mostly poor urban dwellers, especially those with weak livelihood strategies [19,20]. Historically, food insecurity at various scales has increased in Nigeria as agriculture was gradually neglected in favor of comparatively more investments in the commercial oil sector [21]. It is therefore, not surprising that 79% of urban households in Nigeria are without food security [22]. According to the Global Hunger Index (GHI), Nigeria was ranked number 41 in 2000 amongst 119 countries in terms of the prevalence of malnutrition and rising food prices [23]. The GHI is an indication of the commonness of food insecurity in any country. It is also an indication of the extreme suffering to which millions of poor people are subjected to [23]. The provision of adequate food supplies at a reasonable cost represents a great challenge, especially in the light of ongoing decline in per capita food supply, while the proportion of undernourished people living in urban areas is increasing. In Central Nigeria, where the city of Jos is located, poverty levels have increased consistently, from 50.8% in 1985 to 67.0% in 2004 [12].

One way to address poverty levels and under-nutrition in some of the poor communities located in developing regions involves small-scale fish farming as part of a diversified livelihood strategy. As indicated by Kawarazuka and Béné [24], compared to other food sources, "fish offer advantages as they may be more affordable, more available and consumed for preference in various regions of the developing world". Available evidence shows that most research associated with fish farming in Nigeria has focused on private commercial fishing, as well as the role played by small-scale fish farming, towards sustaining livelihoods in rural areas. For instance, James and Tunde [25] have reported on the increase of peri-urban aquaculture in Nigeria, and have documented the national experience, along with critical processes and technological innovations responsible for sustained growth in this sector. Indeed, given increased national demand for fish in Nigeria and inadequate supplies, the role of technological innovations necessary for increased fish production is widely recognized [25–30]. When it comes to fishing communities, many Nigerian studies have concentrated on their role and activities in predominantly rural areas with largely subsistence economies and associated vulnerabilities [31–34]. The operations and activities of such fishing communities are not similar to those involved in fish farming as conceptualized in this paper. Fishing at community level simply means wild fishing from freshwater and marine ecosystems, without any systematic effort towards increased production and personal incomes. For instance, Adelekan and Fregene [33] have studied how the livelihoods of fishing communities living near coastal waters are susceptible and

impacted by flooding incidences, and the need for policy-driven interventions that can enhance their current and future adaptation strategies against adverse environmental and erratic climatic factors.

On the other hand, there is limited literature on the socio-economic contribution of small-scale fish farming and attendant fishing practices which are aquaculturally-based, thus aiming towards increased productivity and profitability in some of the urban areas in Nigeria. Such activities are undertaken by local farmers who are either operating alone on a non-formal basis, or formally, as members of local agricultural cooperatives. More research in this study area is highly warranted, as it would help to identify factors that are constraining increased farming productivity and personal incomes, as well as the kinds of policy interventions that are required to stimulate such farming so that urban poverty and food insecurity are reduced. In responding to this research gap, the role of small-scale fish farming as a livelihood strategy by urban farmers in the city of Jos has been investigated in this paper. Addressing this main aim was undertaken by means of formulating the following research objectives: (1) to characterize the spatial distribution of fish farm sites in the city of Jos; (2) to explain farmer's perceptions on the role of urban fish farming on their own social and economic conditions; (3) to explain existing fish farming practices and characteristics; (4) to summarize the employment patterns relevant to fish farming; (5) to describe perceptions on the most important problems confronting fish farmers, as well as attendant environmental impacts of this activity; and (6) in order to gauge the order of severity and intensity of these problems, some measure of ranking was calculated based on analyses of the feedback obtained from respondents. In giving a theoretical contextualization for urban fish farming in Africa, a brief literature study is provided, and thereafter, a description of the study area, research design, and methods is provided. Then, the results of the study are presented and discussed before conclusions and recommendations are given.

2. Literature Review

This literature review starts with a broad overview of urban agriculture before examining several aspects of fish production such as food security, income, and employment, with special reference to a few African countries, including Nigeria. Although urban agriculture can serve as a viable livelihood strategy to reduce food insecurity and poverty amongst urban residents [10,35–37], its socio-economic importance has been recognized by both governments and non-governmental organizations over the last few decades (International Development Research Centre (IDRC) [38]. Urban agriculture is comprised of "mostly crop and livestock rearing on private, leased, or rented land in urban areas, in backyards, on vacant public lands, and in semi-public areas" [39]. Such agriculture supplies food to households during periods of shortage and uncertainty [40–42], and is an income-generating activity amongst urban farmers, who, in selling their surplus products, are able to supplement their household income [16,43]. Urban farming also serves as a source of nutritious food which can improve the health status of city dwellers [44]. The socio-economic role that urban agriculture plays in urban settlements should not be under-estimated. In Nairobi (Kenya), it is estimated that more than 650 hectares of land is devoted to urban agricultural practices, and approximately 300,000 households depend on urban agriculture for their income, food, and employment [44].

Fish Production: Employment Levels, Food Security, and Incomes

Recent studies by the World Bank [45,46] have showed that 25.4 million people are employed in the fish farming sector in Africa. Relatively few (7.8 million people) are employed in the actual fishing process, whereas the large majority (17.6 million) are employed in the processing, marketing, distribution, and supply industries associated with fishing [46]. Most of those employed in the actual fishing process (7.4 million of the 7.8 million) are small-scale fish farmers, while only 0.4 million are large-scale farmers [46]. In Tanzania, 10,802 people are employed in the fish farming sector, while in Egypt, the number is 586,123 [46]. The estimated number of farmers employed in the fish farming sector in Uganda is about 1.2 million people [47]. In Benin-City, Nigeria, 214,202 people are employed in fish farming [46].

The practice of fish farming in urban areas has played a vital role in contributing to food supply, and the livelihood of urban dwellers [47,48]. According to the FAO [49], fish is known to be the best source of animal protein, is rich in amino acids, and low in cholesterol. Moreover, fish farming is a vital means for the supply of nutrients such as calcium, iron, iodine, and vitamins [50]. In fact, fish products account for 20% of the protein consumed in Africa, 30% in Asia, and 10% in Latin America and the Caribbean [51]. Fish farming is also regarded as an important source of food to more than 400 million Africans, and contributes essential micronutrients, proteins, and minerals to their meals [10,52–55]. Fish constitutes 40% of the animal protein consumed in Nigeria [56]. The Federal Department of Fisheries (FDF) [56] has noted that Nigeria produced just over 800,000 metric tons of fish. Yet 600,000 metric tons of fish must be imported annually to supply the large demand for protein in this country [57]. These statistics show that fish products in Nigeria have not been sufficient to satisfy domestic demand for animal protein, thus bearing testimony to the fact that fish production has not been given the attention it deserves by the government [58].

Aquacultural fish production serves as a means of generating revenue from production and related processing and marketing activities [50,59]. By 2002, developing nations earned more foreign exchange from exports of fish products than sugar, rice, and coffee combined [60]. For instance, fish production serves as a significant sector of Uganda's economy. The exports of fish from Uganda increased from 1664 tons in 1990 to about 24,965 tons in 2008. This generated revenue of about 124.4 million US Dollars, or 7.2% of Uganda's total exports [60]. Fish production also occupies an important position in the Nigerian agricultural sector; its contribution to the agricultural gross domestic product (GDP) was approximately 1.3% in 2010 [61,62].

3. Study Area and Methodology

Jos, the capital city of Plateau State in Nigeria, has a population of 736,016 people [63], and covers an area of 249.9 km². It lies at an altitude of around 1290 m above sea level [64]. The climate is influenced by height above sea level and spatial position across the seasonal migration belt of the Inter-Tropical Discontinuity (ITD). Jos falls within the wet and dry climatic type classified by Köppen [65] as a Tropical Rainy (AW) climate. Mean annual rainfall is 1260 mm, and peaks between July and August; meanwhile, the mean annual temperature is about 22 °C [66]. Jos owes its origin to the introduction of tin mining and the convergence of railway lines that connect with several cities, thus integrating this urban settlement with regional economic networks [67]. The urban area of Jos has undergone a remarkable transformation as a result of the local tin mining industry, which flourished for several decades. However, the decline and subsequent collapse of the tin industry in the 1960s led to the widespread acceptance and practice of urban farming as an alternative source of livelihood [67].

Amongst the various types of urban farming in Jos designed to cope with the negative socio-economic impacts from the collapsed tin mining industry and other economic problems, this research has focused specifically on the small scale urban fish farmers in this area. The fish farming species involved include African catfish such as *Clarias gariepinus* and *C. nigro-digitatus*, as well as the clariid catfish, known as *Heterobranchus bidorsalis*, all of which thrive in freshwater habitats [68–70]. Almost 81% of small scale fish farmers in Jos are growing and rearing the *Clarius gariepinus* species rather than other species such as *Clarias nigro-digitatus* and *Heterobranchus bidorsalis* produced by 19% of farmers. The Third National Fadama project (a World-Bank assisted project) in Jos is comprised of a total of 125 farmers, of which 40% were randomly selected to obtain a sample size of 50 respondents for the current research.

A mixed method approach was used to address our research aims and related objectives. Within this research design, quantitative and qualitative data are collected and analyzed within a single research study, thus providing deeper insights and new knowledge about the phenomena being investigated [71]. In the research reported in this paper, questionnaires with both close-ended and open-ended questions were used to collect both numerical or quantitative data, as well as qualitative data from the selected fish farmers. The questionnaire-administered interviews were undertaken from

October 2015 to February 2016. These interviews were conducted only after prior informed consent was obtained from the responding farmers.

Close-ended questions were mainly numerical and focused on the demographical attributes of respondents, employment patterns, and incomes. Furthermore, other numerical data on the various aspects of farming practices such as operational problems and environmental impacts were presented in a Likert scale to assess trends or degrees of severity and intensity. All data collected in this manner were then subsequently analyzed statistically to yield the percentage (%) of responses, thereby yielding the research results. Furthermore, quantitative data obtained by means of the Global Positioning System (GPS) was used to characterize the spatial distribution of fish farms in Jos. This quantitative exercise produced a map showing the position of fish farms in relation to arterial routes in the study area. On the other hand, qualitative data were collected from respondents by means of addressing open-ended questions during semi-structured interviews. In such interviews, different narratives from respondents were transcribed into the questionnaires to help understand the socio-economic contributions and ramifications of fish farming towards livelihoods, as well as their perceptions of problems besetting their operational successes. These qualitative data were then subjected to content analyses whereby the main ideas, salient points, and meanings were identified and summarized as part of the results in this paper.

4. Results and Discussion

4.1. Spatial Distribution of Fish Farms

As shown in Figure 1, fish farms are scattered across the study area located in Jos. However, the location of at least 18 of these (50) farms is situated close to main roads, and this spatial pattern may be related to the ease of transporting produce to nearby markets, thus affording farmers the opportunity to sell their produce directly to buyers. This spatial pattern also imply that members of the public passing along these routes can access these farms to buy fish without much hindrance. Furthermore, some of these fish farms, besides proximity to road networks, are located nearer to previous tin mining ponds, which are sometimes exploited for water supplies during the dry seasons.

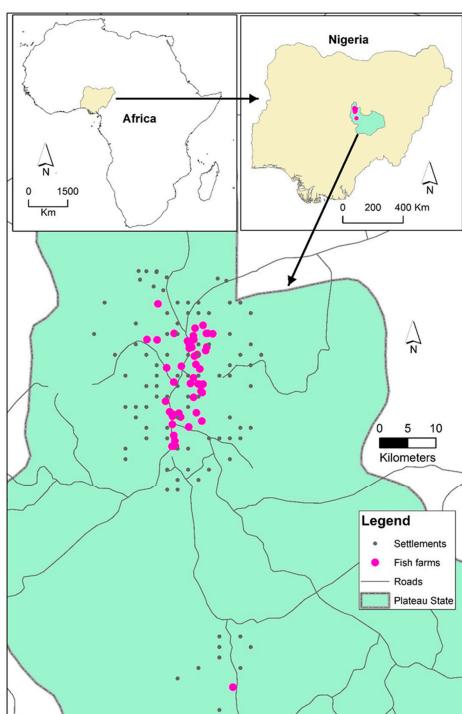


Figure 1. Spatial distribution of fish farms along main roads.

4.2. Socio-Economic Characteristics of Fish Farmers

Most (62%) of the respondents in Jos were male (Table 1). This is in line with results obtained by Ogunlade [72] in Osun State (Nigeria), where it was found that urban fish farming is predominantly a male-dominated activity. Forty percent (40%) of the respondents were in the 41–50 years age category, and 54% of them have acquired tertiary educational qualifications. This indicates that small-scale fish farmers in Jos are literate and have received basic education (Table 1). Sixty percent (60%) of the respondents had five years of fish farming experience, which may not be enough to gain the necessary skill set required for increased production levels. According to Aphunu et al. [73], experience played an important role in understanding fish farming in the Delta State (Nigeria). In an interview with one respondent on the 10 January 2016, the following points were made:

“If I had better knowledge of this fish farming business two years ago, I would not have lost my first stock of 4000 fingerlings”.

From this statement, it can be confirmed that personal experiences are very critical to successful fish farming and for minimizing losses. Fifty-two percent of respondents were part-time farmers. All respondents in the current study reported a monthly income of above ₦20,000 (55.60 USD), earned directly from fish farming (Table 1). Such an activity is not only affording these farmers a source of income, but also provides a source of protein to urban residents who buy the produce. Furthermore, the incomes were above the national minimum wage of ₦18,000 (50.00 USD) which was approved by the National Salary, Wages Commission (NSWC) [74], thus confirming the income-generation potential of small-scale fish farming, as mentioned in other studies [75].

Table 1. The socio-economic characteristics of urban fish farmers in Jos.

| Variables | Number of Respondents | Percentage of Responses |
|---|-----------------------|-------------------------|
| Gender of respondents | | |
| Male | 31 | 62% |
| Female | 19 | 38% |
| Age of farmers | | |
| ≤30 years | 6 | 12% |
| 31 to 40 years | 12 | 24% |
| 41 to 50 years | 20 | 40% |
| ≥51 years | 12 | 24% |
| Educational level of respondents | | |
| No formal education (and primary education) | 7 | 14% |
| Secondary education | 16 | 32% |
| Tertiary education | 27 | 54% |
| Experience of respondents | | |
| ≤5 years | 30 | 60% |
| 6 to 10 years | 15 | 30% |
| ≥11 years | 5 | 10% |
| Occupation of respondents | | |
| Full time | 24 | 48% |
| Part time | 26 | 52% |
| Income from fish farming activities (₦) | | |
| 20,000 (55.60 USD) and above | 50 | 100% |

4.3. Fish Farming Practices and Associated Characteristics

Sixty eight percent of respondents practiced fish production on family-owned land (Table 2). However, relatively few respondents use either their own land (28%) or rented land (4%). Apart from these trends, 82% of respondents also practice fish farming at other locations. Most (68%) of the respondents work on their farms for about seven days per week (Table 2), and 48% of them are occupied by this activity on a full time basis. These findings clearly demonstrate the commitment of the respondents to small-scale fish farming, and how important is this activity to their livelihoods. Those respondents with more than 500 fish per pond constituted 68% of the total, whereas those with

301 to 400 fish amounted to 8%. Regarding the number of fish ponds on individual farms, the majority (68%) of respondents had 6–10 ponds. Different types of ponds utilized by fish farmers are shown in Figures 2–4. Most (70%) of the respondents practiced fish production in concrete ponds (built vertically up from the ground with cement blocks), as shown in Figure 3. Furthermore, the average mass of fish sold by 90% of the respondents was 2 kg or less per buyer (Table 2). Large masses of fish were seldom (4–6%) sold to individual buyers.

Table 2. Fish farming practices and characteristics in Jos.

| Variables | Number of Respondents | Percentage of Responses |
|---|-----------------------|-------------------------|
| Land tenure | | |
| Family-owned land | 34 | 68% |
| Own land | 14 | 28% |
| Rented land | 2 | 4% |
| Location of fish farms | | |
| Practiced fish farming at home | 9 | 18% |
| Practiced fish farming at other locations | 41 | 82% |
| Number of days attending to fish farms | | |
| 5 to 6 days per week | 16 | 32% |
| 7 days per week | 34 | 68% |
| Number of fish ponds on the farm | | |
| 1 to 5 ponds | 14 | 28% |
| 6 to 10 ponds | 34 | 68% |
| ≥11 ponds | 2 | 4% |
| Number of fish per pond | | |
| ≤300 fish | 7 | 14% |
| 301 to 400 | 4 | 8% |
| 401 to 500 fish | 5 | 10% |
| >500 fish | 34 | 68% |
| Type of pond | | |
| Concrete pond | 35 | 70% |
| Concrete stone pond | 12 | 24% |
| Earthen pond | 3 | 6% |
| Marketed weight of fish | | |
| ≤2 kg | 45 | 90% |
| 2 to 3 kg | 2 | 4% |
| 4 to 5 kg | 3 | 6% |



Figure 2. Earthen ponds.

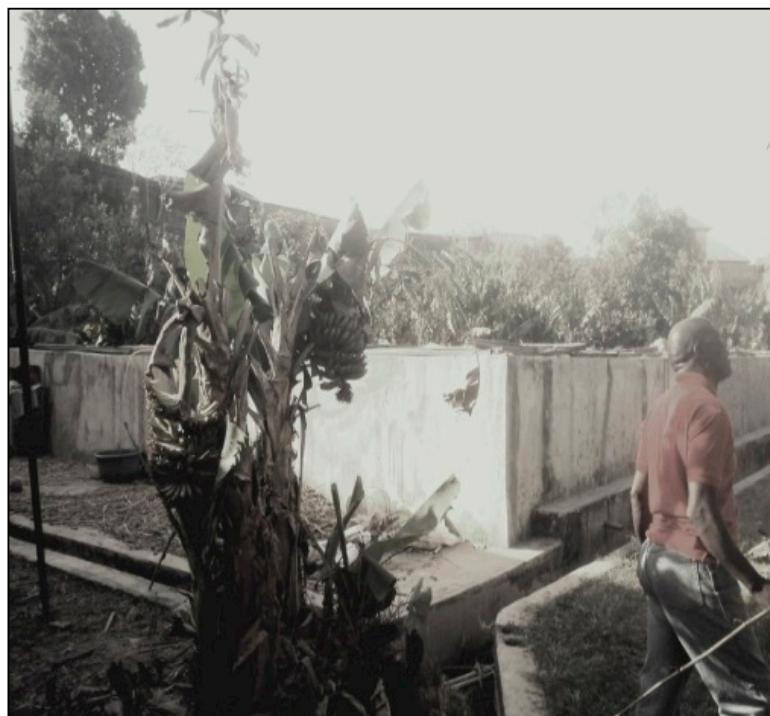


Figure 3. Concrete pond.

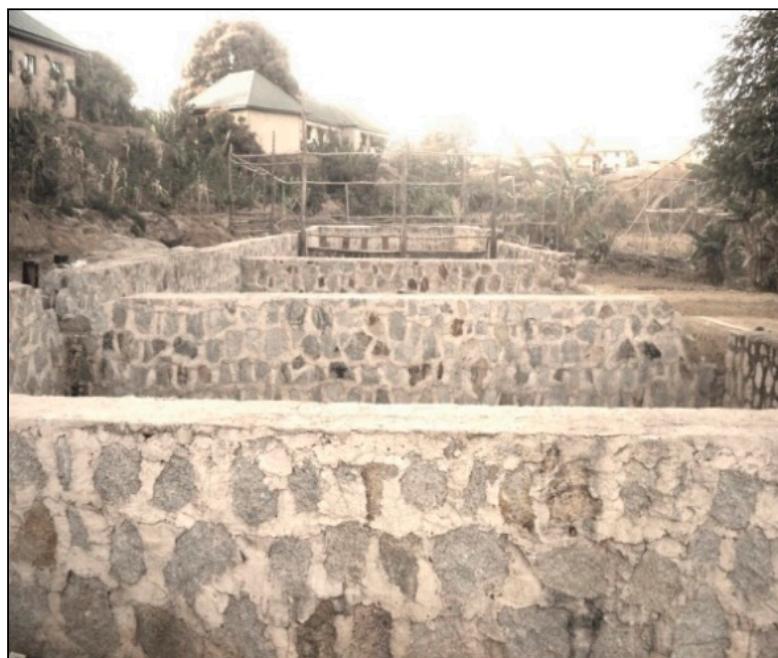


Figure 4. Concrete stone ponds.

4.4. Employment Opportunities Generated through Fish Farming

It was found that most (75%) of the respondents employed 3–4 workers, while a smaller proportion (25%) of them employed 1–2. While 43.8% of respondents had full-time workers, nearly 56% employed their work force on a part-time basis (Table 3). Seventy-five percent (75%) of the respondents pay over ₦15,001 (41.67 USD) in salaries to their employees per month (Table 3). Even though these salaries

are lower than the national approved minimum wage of ₦18,000 (50.00 USD) per month [74], in an environment of urban poverty, this is better than nothing.

Table 3. Employment generated through fish farming in Jos.

| | | |
|---|----------------------|-------|
| Number of Employees per Respondent | 1–2 Workers | 25.0% |
| | 3–4 workers | 75.0% |
| Type of employment | Part-time | 56.2% |
| | Full-time | 43.8% |
| Salaries of employees per month | ≤₦15,000 (41.67 USD) | 25.0% |
| | >₦15,001 (41.67 USD) | 75.0% |

4.5. Farmers Perceptions on the Socio-Economic Contributions of Urban Fish Farming

The different perceptions regarding the socio-economic contributions of urban fish farming towards the improvement of social and economic conditions in Jos are portrayed in Figure 5. All respondents strongly agreed that fish farming is serving as a source of income to them, while most (98%) mentioned that this activity is providing food for the urban population. In addition, 96% of respondents expressed strong views that fish serves as a good source of nutrition for people. Moreover, many of them (90%) strongly agreed that urban fish farming is contributing positively towards local economic growth in the Jos metropolis.

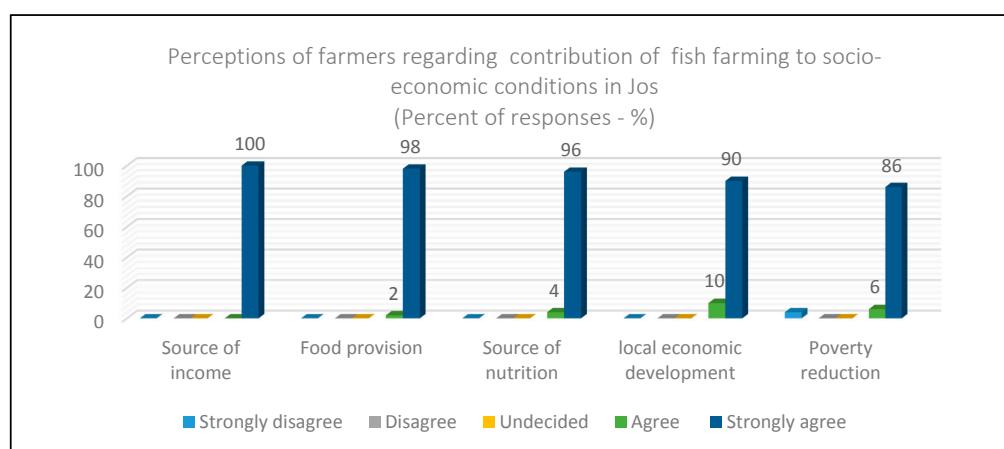


Figure 5. Farmers' perceptions concerning the contribution of urban fish farming in Jos towards improving economic and social conditions.

Finally, 86% of the respondents strongly asserted that fish production is helping to ameliorate poverty levels amongst the urban poor (Figure 5). This assertion is supported by some pertinent remarks made by one of the respondents during an interview held on 20 November 2015:

"Fish farming has really helped me and my family to survive the five months without salary. Although the income is not much, I was able to solve my family's financial needs from the profit I obtained".

Another positive testimony from a respondent (3 December 2015) that lends credence to the importance of urban fish farming as a source of livelihood, especially during difficult economic times, is summarized below:

"I have been working on this farm for the past two years and for four months I had no problems with my employer. I used the money I earned here to address my family needs."

My employer even provided me with a dwelling unit, as you can see; and at least I am surviving most of my challenges here”.

These findings support the results that have been mentioned in other research [10,75,76], that fish farming is a vital source of livelihood to many people in developing countries, as it provides local employment, a source of nutrition, and an income to urban farmers.

4.6. Perceptions of the Most Important Problems That Constrain Fish Farming

In Figure 6, the most important problems that constrain fish farming based on feedback from respondents in Jos are indicated. Most of the respondents (98%) expressed the view that there is a serious problem in terms of the availability of water for fish production (Figure 6). This problem was ranked number 1 in terms of its degree of intensity amongst respondents. Indeed, most streams and ponds around the study area dry up, notably during the January-April period, which is the dry season. Inevitably, as a mitigation step, farmers augment their ponds with tap water (chlorinated water) from regional water boards or suppliers. In the worst circumstances, water from the remaining tin mining ponds in the study area is used. Similar production constraints associated with poor water supplies have been mentioned in the Niger State [75]. Another major (98%) hindrance militating against effective fish farming in Jos is the high production costs, which were ranked number 2 in terms of severity. Farmers spend on average about ₦42,235 (117.32 USD) on feeds, ₦32,990 (91.64 USD) on fingerlings, and ₦22,449 (62.36 USD) on medication annually; meanwhile, ₦8,716 (24.21 USD) is consumed by miscellaneous expenses. During the interviews in this survey, one of the respondents had this to say on the 8 January 2016:

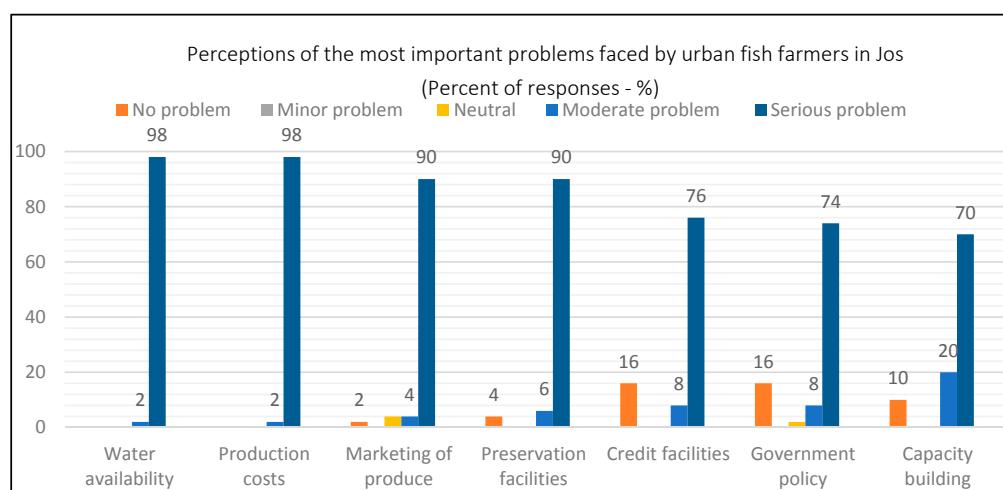


Figure 6. Perceptions of the most important problems faced by urban fish farmers in Jos.

“Animal fish feeds alone take 40% to 60% of the total cost of production. I realized (that) from the last stock I sold”.

In different studies [77,78], it has been confirmed that animal feed costs a lot of money. Also, almost all (90%) respondents expressed serious concerns around the lack of adequate preservation facilities (ranked number 3). This problem involves inadequate storage of their produce, which inevitably affects the shelf-life of their stock. In trying to circumvent this challenge, most fish farmers in the Jos study area use the traditional smoking method for preserving fish on their farms. As reported by Rahaman et al. [79] in a West Bengal study, without proper preservation methods, high perishability of stored fish becomes an important constraining problem towards increased productivity. Apart from the lack of preservation facilities, 76% of respondents experienced serious problems in accessing credit

facilities from local financial banks (Figure 6). This problem was ranked number 3 in terms of severity. In the absence of the required loans, small scale fish farmers are not able to cater for their various business needs for optimal production and even expansion possibilities. Similarly, small-scale fish farmers in West Bengal encountered the same difficulties in obtaining funds from government and financial institutions for the purpose of expanding their farming businesses [79].

Furthermore, most (74%) of the fish farmers in Jos who were included in this study lamented the lack of supportive government policies for enabling fish farming in the region, let alone subsidizing their production costs. However, the severity of this problem was less intense, as it was ranked number 4 based on the analyses of feedback from respondents. This situation is similar to the findings expressed by Mwangi as well as Shitote et al. [80,81], who stated that there are no supportive government policies for sustaining fish farming in Kenya. The lack of capacity building and training opportunities for small scale fish production was regarded as a very serious problem by 70% of respondents in Jos (Figure 6). This implies that these farmers are not adequately informed and enabled vis-a-vis the more recent, effective, and efficient modern methods for successful fish farming, thus disadvantaging them from reaching increased productivity levels. Nonetheless, this problem was the least severe, as it occupied the fifth rank in terms of the order of importance. Previous research findings in Kenya and Tanzania [82–84] also indicated that inadequate training programs, ineffective extension services, and inefficiency in disseminating technological knowledge to fish farmers are retarding the development of fish-related industries in these developing nations.

4.7. Farmers Perceptions of the Environmental Impacts of Fish Production

The results based on farmer's perceptions about the environmental impacts of fish production are summarized in Figure 7. According to the perceptions and viewpoints of all respondents in this study, fish production processes exert a negative impact on receiving water resources. Ninety percent (90%) of respondents blamed their fish farming practices for local environmental pollution, as waste waters are released into the environment without any mitigating controls.

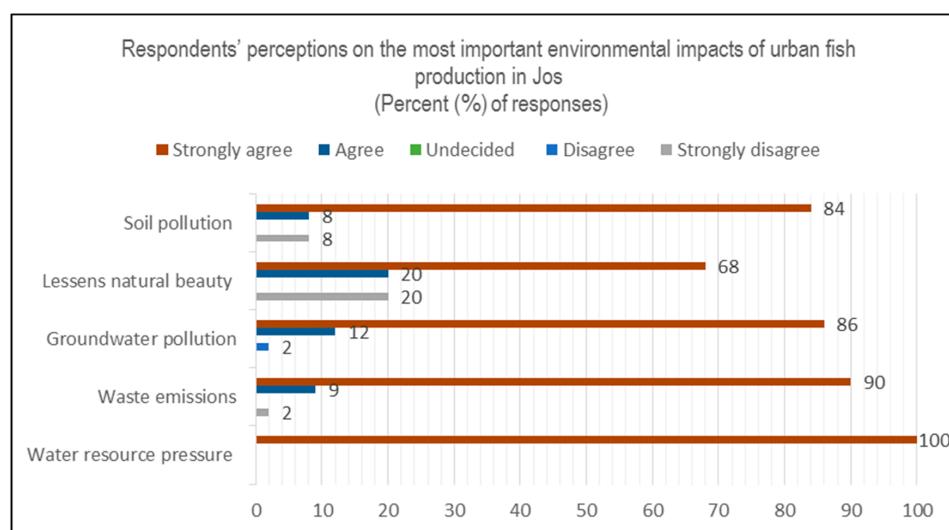


Figure 7. Respondents' perceptions on the most important environmental impacts of urban fish production in Jos.

Other negative environmental impacts of fish farming entailed pollution of groundwater (86%), soil (84%), and a decline in the aesthetic quality or natural beauty (68%) of the surrounding environment. In many countries, fish farming has been associated with such negative environmental impacts and

even undesirable nutrient enrichment, which may lead to accelerated eutrophication of receiving water bodies [85].

5. Conclusions and Recommendations

The main research aim of this paper was to examine the role of small-scale fish farming as a livelihood strategy amongst urban farmers in the city of Jos in Nigeria. Like other towns and cities in sub-Saharan Africa, Jos is experiencing accelerated migration of people from rural areas, growing unemployment levels, and, because of high poverty levels and lack of personal incomes, residents are particularly vulnerable to urban deprivation, including food insecurity. However, urban agriculture can make a positive contribution towards improving livelihood sources, thereby reducing the intensity of these vulnerabilities. Apart from characterizing the demographic profile of selected urban fish farmers in Jos, the results of this study have confirmed that small scale fish farming is an important livelihood strategy towards poverty alleviation and increased food security. Given the high number 7 of working days set aside by respondents (68%) for their farming activities, and the number 6–8 of fish ponds per individual farmer (68%), it is clear that this type of farming is playing an important role in improving local social and economic conditions and well-being amongst participants of the Third National Fadama project. These farming practices are providing much needed formal and part time employment opportunities, alternative sources of income, and food supply, thus contributing positively towards poverty alleviation.

Nevertheless, to transform the current small scale fish farming practices into a path of sustainable productivity and positive outcomes, there is an urgent need for government interventions that can empower and enable participants with resources and skills. Many respondents in this study have highlighted the high costs of production which are affecting their effectiveness and efficiency in a negative manner. To help circumvent these problems, these farmers need to be enabled through training interventions that emphasize business and financial planning skills, so that they can make informed decisions. Also, the need for extension services to these farmers cannot be over emphasized. Most crucially, given the lack of access to reliable supplies of clean or potable water, credit facilities, as well as adequate storage facilities, governments and other stakeholders should prioritize the improvement of local infrastructure, thus helping these farmers to avoid unnecessary food losses in their production value chain. To be successful, these interventions must be integrated into the local development planning to ensure that land is provided for small-scale fish farming, while also taking measures to address the negative environmental impacts of such activities through proper mitigation plans.

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References

1. United Nations (UN). *World Urbanization Prospects, the 2011 Revision: Highlights*; Department of Economic and Social Affairs, Population Division: New York, NY, USA, 2012.

2. United Nations (UN). *World Population Prospects: The 2012 Revision, Volume II, Demographic Profiles*; Department of Economic and Social Affairs, Population Division, Organization of the United Nations: New York, NY, USA, 2013.
3. Population Division of United Nations, Department of Economic and Social Affairs (DESA/PDUN). *World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352)*; United Nations: New York, NY, USA, 2014.
4. Garrett, J.L. Overview, in *Achieving Urban Food and Nutrition Security in the Developing World, Focus 3, Brief 1 of 10, A 2020 Vision for Food, Agriculture and the Environment*; IFPRI: Washington, DC, USA, 2000.
5. Frayne, B.; Pendleton, W. Urban food security in Southern Africa. In Proceedings of the African Food Security Urban Network (AFSUN) Regional Policy Conference, Ekurhuleni Municipality, South Africa, 10–12 June 2009.
6. Food and Agricultural Organization (FAO). Emergencies, from Prevention to Building Back Better. 2011. Available online: <http://www.fao.org/emergencies/home/news/emergency-news/emergencydetail/en/item/8894/icode/?uidf=1345> (accessed on 30 January 2017).
7. Standing Committee on Nutrition (SCN). Double burden of malnutrition: A common agenda. In Proceedings of the 33rd Annual Session, Geneva, Switzerland, 13–17 March 2006. Available online: <http://www.unsystem.org/scn/> (accessed on 30 January 2017).
8. Food and Agricultural Organization (FAO). Food security and trade: An overview. In *Trade and Food Security: Conceptualizing the Linkages of Expert Consultation*; Food and Agricultural Organization: Rome, Italy, 2002.
9. African Food Security Briefs (AFSB). Quarterly Bulletin, No 1; 2011. Available online: <http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Africa%20Food%20Security%20Brief%20,%20Issue%201.pdf> (accessed on 30 January 2017).
10. Food and Agricultural Organization (FAO). Growing greener cities in Africa. In *First Status Report on Urban and Peri-Urban Horticulture in Africa*; Food and Agriculture: Rome, Italy, 2012.
11. Urban Agriculture Magazine. 2000. Available online: <http://www.ruaf.org/sites/default/files/UA%20Magazine%20World%20Food%20Summit.pdf> (accessed on 29 March 2017).
12. National Bureau of Statistics (NBS). *Poverty Profile of Nigeria*; National Bureau of Statistics: Abuja, Nigeria, 2006.
13. Zezza, A.; Azzarri, C.; Davis, B.; Covarrubias, K.; Tasciotti, L.; Anriquez, G. The Impact of Rising Food Prices on the Poor. In Proceedings of the International Association of Agricultural Economists Conference, Beijing, China, 16–22 August 2009; pp. 7–8.
14. Dessus, S.; Herrera, S.; de Hoyos, R. The impact of food inflation on urban poverty and its monetary cost: Some back-of-the-envelope calculations. *Agric. Econ.* **2008**, *39*, 417–429. [[CrossRef](#)]
15. Oxfam, G.B. *Urban Poverty and Vulnerability in Kenya: Background Analysis*; Urban Programme Focused on Nairobi, Kenya; Oxfam: Oxford, UK, 2009.
16. Cohen, M.; Garrett, J. The food price crisis and urban food security. *J. Environ. Urban* **2010**, *22*, 467–482. [[CrossRef](#)]
17. Ravallion, M.; Chen, S.; Sangraula, P. *New Evidence on the Urbanization of Global Poverty*; Policy Research Working Paper 4199; World Bank: Washington, DC, USA, 2007.
18. United Nations Centre for Human Settlements Habitat (UNCHS). *State of the World's Cities Report*; UN-HABITAT: New York, NY, USA, 2001.
19. Ubokudom, E.O.; Nsikan, E.B.; Uwemedimo, E.O. Determinants of farm income among urban farmers in Niger Delta, Nigeria. *J. Agric. Environ. Res.* **2017**, *3*, 2065–2080.
20. Sunday, A.M.; Ogaboh, A.M.; Ekwuore, M.U.; Azalahu, A. Poverty, food insecurity and the rebranding question in Nigeria. *Can. Soc. Sci.* **2009**, *5*, 1–9.
21. Dada, E.A. Resource management and food insecurity in Nigeria. *J. Econ. Sustain. Dev.* **2011**, *2*, 23–43.
22. Orewa, S.I.; Iyangbe, C.O. The food insecurity profile among the rural and low-income urban dwellers in Nigeria. *Am.-Eurasian J. Sci. Res.* **2010**, *4*, 302–307.
23. Global Hunger Index (GHI). *The Challenge of Hunger: Ensuring Sustainable food Security under Land, Water and Energy Stresses*; IFPRI, Concern Worldwide, Welthungerhilfe and Green Scenery: Bonn, Germany; Washington, DC, USA; Dublin, Ireland, 2012.
24. Kawarazuka, N.; Béné, C. The potential role of small fish species in improving micronutrient deficiencies in developing countries: Building experience. *Publ. Health Nutr.* **2011**, *14*, 1927–1938. [[CrossRef](#)] [[PubMed](#)]

25. James, W.M.; Tunde, A. The rise of peri-urban aquaculture in Nigeria. *Int. J. Agric. Sustain.* **2011**, *91*, 274–281.
26. Ewuola, S.O.; Ajibefun, I.A. Selected media and socio-economic factors influencing innovation adoption by small-scale farmers: Empirical evidence from Ondo and Ekiti States, Nigeria. *Appl. Trop. Agric.* **2000**, *1*, 24–26.
27. Gomna, A.; Rana, K. Inter-household and intra-household patterns of fish and meat consumption in fishing communities in two states in Nigeria. *J. Nutr.* **2007**, *97*, 145–152. [CrossRef] [PubMed]
28. Olagunju, F.I.; Adesiyen, I.O.; Ezekiel, A.A. Economic viability of cat fish production in Oyo State, Nigeria. *J. Hum. Ecol.* **2007**, *21*, 121–124. [CrossRef]
29. Ofuoku, A.U.; Olele, N.F.; Emah, G.N. Determinants of adoption of improved fish production technologies among fish farmers in Delta State, Nigeria. *J. Agric. Educ. Ext.* **2008**, *14*, 297–306. [CrossRef]
30. Nozomi, K.; Christophe, B. Linking small-scale fisheries and aquaculture to household nutritional security: An overview. *Food Secur.* **2010**, *2*, 343–357. [CrossRef]
31. Victor, O.O.; Stella, B.W. Rural women’s livelihood strategies: A case study of fishery communities in the Niger Delta, Nigeria. *Gend. Technol. Dev.* **2009**, *13*, 225–243. [CrossRef]
32. Christophe, B.; Richard, M.F. Poverty in small-scale fisheries: Old issue, new analysis. *Prog. Dev. Stud.* **2011**, *11*, 119–144.
33. Adelekan, I.; Fregene, T. Vulnerability of artisanal fishing communities to flood risks in coastal southwest Nigeria. *Clim. Dev.* **2015**, *7*, 322–338. [CrossRef]
34. Ebhuoma, E.; Simatele, D. Defying the odds: Asset adaptation, climate variability and food security nexus in the Delta State of Nigeria. *Int. J. Disaster Risk Reduct.* **2017**, *21*, 231–242. [CrossRef]
35. Cofie, O.; Drechsel, P. Water for food in the cities: The growing paradigm of irrigated (peri)-urban agriculture and its struggle in sub-Saharan Africa. *Afr. Water J.* **2007**, *1*, 26–50.
36. Kwambisi, D.; Fraser, E.; Douglas, A. Urban agriculture and poverty reduction: Evaluating how food production in cities contributes to food security, employment and income in Malawi. *J. Int. Dev.* **2011**, *23*, 181–203. [CrossRef]
37. Hadebe, L.B.; Mpofu, J. Empowering women through improved food security in urban centres: A gender survey in Bulawayo: Urban agriculture. *Afr. Educ. Res. J.* **2013**, *1*, 18–32.
38. International Development Research Centre (IDRC). *Agriculture in Urban Planning: Generating Livelihoods and Food Security*; Earthscan: London, UK, 2007.
39. Jongwe, A. Synergies between urban agriculture and urban household food security in Gweru City, Zimbabwe. *J. Dev. Agric. Econ.* **2014**, *6*, 59–66.
40. Rogerson, C.R. Towards “pro-poor” urban development in South Africa: The case of urban agriculture. *Acta Acad. Suppl.* **2003**, *1*, 130–158.
41. Bush, R. Food riots: Poverty, power and protest. *J. Agric. Chang.* **2010**, *10*, 119–129. [CrossRef]
42. Zezza, A.; Taschetti, L. Urban agriculture, poverty and food security: Empirical evidence from a sample of developing countries. *Food Pol.* **2010**, *35*, 265–273. [CrossRef]
43. Mougeot, L. *Agropolis—The Social, Political and Environmental Dimension of Urban Agriculture*; International Development Research Centre: Ottawa, ON, USA, 2005; ISBN 1-84407-2320.
44. World Bank. *Urban Agriculture: Findings from Four City Case Studies*; No. 18; World Bank: Washington, DC, USA, 2013.
45. World Bank. *What Are the Facts about Rising Food Prices and Their Effect on the Region?* World Bank: Washington, DC, USA, 2012.
46. Food and Agricultural Organization (FAO). *The Value of African Fisheries*; Fisheries and Aquaculture Circular No. 1093; Food and Agricultural Organization: Rome, Italy, 2014.
47. Keizire, B. Sustainability Impact Assessment of Proposed WTO Negotiations: The Fisheries Sector. In *Country Case Study*; Ugandan Press: Kampala, Uganda, 2006.
48. International Fund for Agricultural Development (IFAD). *Fisheries Thematic Paper: Tool for Project Design Impact of Climate Change on Fisheries and Aquaculture in the Developing World and Opportunities for Adaptation*; International Fund for Agricultural Development: Rome, Italy, 2008.
49. Food and Agricultural Organization (FAO). *Putting Into Practice the Ecosystem Approach to Fisheries*; Food and Agricultural Organization: Rome, Italy, 2005.
50. Prein, M.; Ahmed, M. Integration of aquaculture into smallholder farming systems for improved food security and household nutrition. *Food Nutr. Bull.* **2000**, *21*, 466–471. [CrossRef]

51. Chuenpagdee, R.; Degnbol, P.; Bavinck, M.; Jentoft, S. Challenges and concerns in capture fisheries and aquaculture. In *Fish for Life*; Kooiman, J., Bavinck, M., Jentoft, S., Pullin, R., Eds.; Interactive Governance for Fisheries: Amsterdam, The Netherlands, 2005.
52. World Fish Centre. *Fish Supply and Food Security for Africa*; World Fish Centre: Penang, Malaysia, 2009.
53. Ssebisubi, M. *Analysis of Small-Scale Fisheries' Value Chains in Uganda*; Draft Report; Aquaculture Management Consultants Ltd.: Kampala, Uganda, 2011.
54. Food and Agricultural Organization (FAO). *Climate Change: Adaptation in Fisheries and Aquaculture Compilation of Initial Examples*; Fisheries and Aquaculture Circular No. 1088; Food and Agricultural Organization: Rome, Italy, 2014.
55. Adeolu, A.R.; Erie, O.G. The effect of trade and agriculture policies on fish trade and production in Nigeria. In Proceedings of the Fifteenth Biennial Conference of the International Institutes of Fisheries, Economics and Trade, Montpellier, France, 13–16 July 2010.
56. Federal Department of Fisheries (FDF). *Fisheries Statistics of Nigeria, Fourth Edition (1995–2007)*; Federal Department of Fisheries Government Press: Abuja, Nigeria, 2008.
57. Arene, C.J. Profile function analysis of small ruminant enterprise in Nsukka Local Government Area, Enugu State, Nigeria. *Econ. Aff.* **2002**, *47*, 209–214.
58. Béné, C. When fishery rhymes with poverty: A first step beyond the old paradigm on poverty in small-scale fisheries. *World Dev.* **2003**, *31*, 949–975. [[CrossRef](#)]
59. World Bank. *Turning the Tide: Saving Fish and Fishers: Building Sustainable and Equitable Fisheries Governance*; The World Bank: Washington, DC, USA, 2005; p. 20. Available online: http://www.seaweb.org/resources/documents/reports_turningtide.pdf (accessed on 6 October 2016).
60. Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). Agriculture for Food and Income Security. Agriculture Sector Development Strategy and Investment Plan: State of the Environment Report, Uganda National Environmental Management Authority (NEMA). 2008. Available online: <http://www.nemaug.org> (accessed on 13 October 2016).
61. Oyinbo, O.; Mohammed, M.O. Gender, water quality and catfish production for livelihood support: Evidence from catfish farmers in Lagos state, Nigeria. *Trakia J. Sci.* **2015**, *13*, 222–227. [[CrossRef](#)]
62. National Population Commission (NPC). *Federal Republic of Nigeria*; National Population Commission: Abuja, Nigeria, 2006.
63. Vivan, E.L.; Adesikuteb, Y.A.; Danjuma, A.K.; Adulrahaman, A.S. An analysis of inner city decay: A study of some selected slums in Jos metropolis. Plateau State, Nigeria. *Int. J. Sci. Tech. Res.* **2015**, *4*, 171–176.
64. Alfred, J. Assessment of Vehicular Emissions and Their Impact on Health in Jos, Plateau State. Unpublished Master's Thesis, Department of Geography, University of Jos, Jos, Nigeria, 2012.
65. Köppen, W. *Die Klimate der Erde. Grundriss der Klimatkunde*; Walter de Gruyter: Berlin, Germany, 1923.
66. Adzandeh, E.A.; Akintunde, J.A.; Akintunde, E.A. Analysis of urban growth agents in Jos metropolis, Nigeria. *Int. J. Remote Sens. GIS* **2015**, *4*, 41–50.
67. Omomoh, E.; Adeofun, C.O. An assessment of urban agricultural land-use changes using geospatial information systems: A case study of Jos-Bukuru. In Proceedings of the Farm Management Association of Nigeria Conference, Asaba, Nigeria, 18–20 October 2005.
68. Adewolu, M.A.; Akintola, S.L. Growth performance and survival of hybrid African catfish larvae (*Clarias gariepinus* × *Heterobranchus bidorsalis*) fed on different diets. *Zoologist* **2009**, *7*, 45–51. [[CrossRef](#)]
69. Akinyemi, A.A.; Adejola, A.Q.; Obasa, S.O.; Ezeri, G.N.O. Aflatoxins in smoked-dried fish sold in Abeokuta, Ogun State, Nigeria, Southwest, Nigeria. In Proceedings of the Environmental Management Conference, Federal University of Agriculture, Abeokuta, Nigeria, 12–15 September 2011; pp. 478–487.
70. Adewumi, A.A.; Olaleye, V.F. Catfish culture in Nigeria: Progress, prospects and problems. *Afr. J. Agric. Res.* **2011**, *69*, 1281–1285.
71. Williams, C. Research methods. *J. Bus. Econ. Res.* **2007**, *5*, 65–71. [[CrossRef](#)]
72. Ogunlade, I. Backyard fish farmers' information needs in Osun State, Nigeria. In Proceedings of the Africa Association of Agricultural Economists Conference, Accra, Ghana, 20–22 August 2007; pp. 165–169.
73. Aphunu, A.; Nwabeze, G.O. Fish farmers' perceptions of climate change impact on fish production in Delta State, Nigeria. *J. Agric. Ext.* **2012**, *16*, 1–13. [[CrossRef](#)]
74. National Salaries, Income and Wages Commission. Abuja, Nigeria. Available online: <http://www.nsiwc.gov.ng> (accessed on 13 October 2016).

75. Sanusi, S.M.; Danasabe, K.M. Problems and prospects of small-scale fish farming in Minna agricultural zone of Niger State, Nigeria, and its implications on increased fish food security. *Int. J. Agric. Res. Rev.* **2015**, *3*, 157–160.
76. Rena, K.J. *Global Overview of Production Trends. A Review of the World Aquaculture*; FAO Fishery Department: Rome, Italy, 2005.
77. Ugwuumba, C.O.A.; Nnabuife, E.L.C. Comparative study on the utilization of commercial feed and home-made feed in catfish production for sustainable aquaculture. *Multidiscipl. J. Res. Dev.* **2008**, *10*, 164–169.
78. Miller, W.J. Farm ponds for water, fish and livelihoods. In *Rural Infrastructure and Agro-Industries. Diversification*; Booklet No. 13; Food and Agriculture Organization of the United Nations: Rome, Italy, 2009.
79. Rahaman, S.M.; Bera, B.K.; Ananth, G.S. A study on problems and constraints in the production and marketing of fish in West Bengal. *J. Crop. Weed* **2013**, *9*, 110–113.
80. Mwangi, H.M. *Aquaculture in Kenya, Status Challenges and Opportunities*; Directorate of Aquaculture: Nairobi, Kenya, 2008.
81. Shitote, Z.; Wakhungu, J.; China, S. Challenges facing fish farming development in Western Kenya. *Greener J. Agric. Sci.* **2011**, *3*, 305–311. [[CrossRef](#)]
82. Ngugi, C.C.; Bowman, J.R.; Omolo, B.O. *A New Guide to Fish Farming in Kenya, Aquaculture*; CRSP: Nairobi, Kenya, 2007.
83. Wetengere, K. Socio-economic factors critical for adoption of fish farming technology: The case of selected villages in Eastern Tanzania. *Int. J. Fish Aquac.* **2009**, *1*, 28–39.
84. Scottish Fisheries Research Services (SFRS). *Scottish Fisheries Information Pamphlet No. 22*; The Scottish Government: Edinburgh, UK, 2003.
85. Farombi, E.O.; Adelowo, O.A.; Ajimoko, Y.R. Biomarkers of oxidative stress and heavy metal levels as indicators of environmental pollution in African cat fish (*Clarias gariepinus*) from Nigeria Ogun River. *Int. J. Environ. Res. Public Health* **2007**, *4*, 158–165. [[CrossRef](#)] [[PubMed](#)]



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