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Abstract
This study was conducted to analyze the technical efficiency of participating and non participating fish production in FADAMA II areas of Kogi State, Nigeria. A three staged random sampling technique was used in the selection of 120 respondents (60 participating and 60 non-participating fish farmers). Data were collected with the aid of questionnaire and analyzed with Stochastic Frontier Production Function (SFPF) and efficiency ratio. The results showed that the coefficients of pond size (β=0.249), labour (β=-0.405), feed (β=0.116), fingerling (β=0.678), and vaccination (β=0.426) significantly influenced the output of participating fish farmers at 5%. Also, pond size, (β=-0.115), labour (β=-0.18), capital (β=0.28), feed (β=0.347), and fingerling (β=-0.45) influenced the output of non participating fish farmers at 5%. The inefficiency estimates indicated that age (β=0.41) and farming experience (β=0.22) decreased the technical efficiency of participating and non participating fish farmers respectively, while education (β=-0.102) increased the technical efficiency of non participating fish farmers at 5%. Pond size had efficiency ratio of less than unity (over-utilized resource) for both participating and non participating fish farmers, while fertilizer, feed, fingerling, and vaccination had efficiency ratio greater than unity (underutilized resources) for both participating and non participating fish farmers in the state. The study recommends that fish farmers should be enlightened through extension services for adequate allocation of farm resources to maximize output. Also, there should be provision of financial support through micro credit scheme to fish farmers in the area to increase the use of some production inputs and economies of scale.

Keywords: Fish, FADAMA, Participants, Non-participants, Resources, Kogi State, Nigeria.

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Introduction

Over the years, there has been a clarion call to improve the nutritional status of developing countries in the intake of animal protein such as fish product. Out of the 35grams of animal protein per day per person recommended by F.A.O., less than 7grams is consumed on the average in Nigeria (FAO, 2002). As a result of this, many Nigerians suffer from protein deficiency due to low protein intake with its effect on ill health and reduction in labour supply. Today, Nigeria is faced with the task of providing enough protein enriched food for its population due to the vital role it plays in health and general wellbeing of the economy.

Sequel to Fadama I, Fadama II project was conceived with a focus on community – driven development with maximum participation of the stakeholders at every stage of the project cycle. This approach is in line with African Development Fund (ADF) policies and development strategies for Nigeria which emphasized on poverty reduction, private sector leadership and client participation. The project activities according to Ajibefun and Aderinola (2004) were centered on Fadama User Groups (FUGs) and Fadama Community Associations. An FUG is composed of Fadama users with a common economic interest called Economic Interest Groups (EIGs). Fadama Community Associations (FCAs) are associates of FUGs that operate in a given area. Facilitators supported under the project helped in organizing the FCAs and funded them through an intensive process of group decision-making. Further use of large participating techniques results in Local Development Plans (LDPs). The LDPs were the basis for support under the project. In this manner, the project ensured that every activity funded by the project was conceived after informed discussion by the whole community, which resulted from consensus building and social inclusiveness (Ingawa et al., 2004). The Community Driven Development approach has become a major strategy used by both government and development assistance programmes.

Policy makers realize the need to transform the rural areas of Nigeria through the use of policy instruments that relate to agriculture either directly or otherwise with the aim to solving the above problems. Some of these policies involve a multidimensional approach including the technical components, the extension delivery system, and the support system basically comprising infrastructural transformation. This is the domain in which Fadama II dwells. The National Fadama Development Project was established to assist the benefiting states of the federation through the World Bank and African Development Bank supported Agricultural Development network to, among the other things finance the provision of shallow tube wells in Fadama areas for small scale irrigation, simplifying drilling technologies for shallow tube wells and wash bores, construct Fadama infrastructure, organize Fadama farmers for irrigation management, recover cost facilitate marketing and other services. Other objectives include the provision of post-harvest innovations, processing and packaging techniques.

A large percentage of the Kogi State populations are in the agricultural sector. However, poverty and extreme hunger are prevalent in the State. Akoh, et al. (2015) attributed this to inefficient use of available agricultural inputs for maximum production. According to Idachaba (2006), a real challenge to policy makers is to obtain reliable and consistent information since under circumstances of poor policy effect analysis; countries are compelled to formulate future policies without reliable result. It becomes necessary to undertake a study on the effect of Fadama II on resource use and technical efficiency of fish farmers in Kogi State in order to provide reliable and objective analysis to get empirical information for policy formulation. The objectives of this study were to determine the effect of the input used on output of participating and non-participating fish farmers, determine the effect of socio-economic characteristics of the farmers on their technical efficiency and determine the efficiency of resources used by fish farmers in the study area.

Materials and Methods

This study was carried out in Kogi State. It is situated in the middle belt geopolitical region of Nigeria and lies on latitude 6°30' to 8°50' North and longitude 5°50' and 8°50' East with a geological feature depicting young sedimentary rocks and alluvium along the river beds, which promote agricultural activities. It has a maximum temperature of 32°C and minimum of 22.8°C. The State was created on 27th August, 1991 from Kwara and Benue States. There are three main ethnic groups in the State namely Igala, Ebira and Yoruba. Other minority groups are Bassa Nge, Bassa, Komo, Kakanda, Oworo, Ogori Magongo and Eggan. Kogi State is made up of twenty one Local Government Areas, a total land mass of 29,833 square kilometers and a population of 3,314,043 (NPC, 2006).

The study employed a three staged sampling procedure in the selection of respondents. In the first stage, one FCA was purposely drawn from four (5) of the ten Local Government Areas (LGAs) that participated in Fadama II project. These are: Ibaji, Bassa, Lokoja, Kabba, and Idah. These LGAs were purposely selected sequel to their level of involvement in fish production. The population of Fadama II project consists of 9,215 participants, 672 FUGs, 35 FCAs and 160 service providers. A total of four (15) FCAs were selected. In stage two, two (2) FUGs were randomly selected from each of the FCAs to give a total of eight (30) FUGs. One FUG consists of a minimum of ten members. In stage three, three (2) respondents were selected from each of the FUG making a total of 60 participating fish farmers. Sixty (60) non-participant participants were drawn using the same format. In all, 120 respondents were selected for questionnaire administration.

Data collected were analyzed using of Stochastic Frontier Production Function (SFPF). Cobb-Douglas functional form was modeled as the Stochastic Frontier Production Function for the study. The Stochastic Frontier Cobb-Douglas functional form used was specified as:

\[
\ln Y = \ln \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 + \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \nu - \bar{v}
\]
Where:

$$Ln = \text{Natural Logarithm.}$$

$$Y = \text{Output (kg)}$$

$$X_n = \text{Vector of input expressed}$$

$$X_1 = \text{Pond Size (m}^2\text{)}$$

$$X_2 = \text{Labour used (Mondays)}$$

$$X_3 = \text{Capital invested (N)}$$

$$X_4 = \text{Fertilizer applied (kg)};$$

$$X_5 = \text{Feed used (kg)}$$

$$X_6 = \text{Fingerlings (Number)}$$

$$X_7 = \text{Vaccination (litres)}$$

$$\beta_0 = \text{Constant}$$

$$\beta_1 - \beta_7 = \text{Estimated coefficients}$$

$$V = \text{random error due to statistical noise, weather, diseases etc. which are outside the control of the farmers}$$

$$U_i = \text{Randomness (technical inefficiency) due to farmer’s socio economic characteristics such as age, sex, household size, educational status, farming experience, extension contact and marital status.}$$

The Stochastic Frontier Cobb-Douglas Production Function and technical inefficiency model were estimated jointly in a single stage maximum Likelihood Estimation procedure using the computer software Frontier version 4.1 (Coelli, 1996). The inefficiency model is given as:

$$U_i = D_0 + D_1Z + D_2Z + D_3Z + D_4Z + D_5Z + D_6Z + D_7Z.$$  

Where:

$$D_0 = \text{Constant}$$

$$D_1 - D_7 = \text{Estimated parameters}$$

$$Z_1 = \text{Age of farmers (years)}$$

$$Z_2 = \text{Sex of farmers (male or female)}$$

$$Z_3 = \text{Household size (number of persons)}$$

$$Z_4 = \text{Educational status (number of years spent in school)}$$

$$Z_5 = \text{Farming experience (years)}$$

$$Z_6 = \text{Extension contact (number of visits)}$$

$$Z_7 = \text{Marital status}$$

The coefficient of the production function and specific technical efficiency of the individual farmers were obtained through this estimation method. The specific technical efficiency of the farmers had value between 0 and 1. Efficiency ratio was used to determine the efficiency of resource use by farmers (objective 3). The estimated coefficients of the relevant independent variables were used to compute the Marginal Value Products (MVP). MVP is the total revenue multiplied by price. Efficiency ratio therefore is MVP/MFC

$$r = \frac{MVP}{MFC}$$

Where:

$$r = \text{Efficiency ratio}$$

$$MVP = \text{Marginal Value Product of a variable input}$$

$$MFC = \text{Marginal Factor Cost.}$$

The value of MVP was computed using the regression coefficient of each input and the price of the output as expressed below: - for Cobb – Douglas

$$MPP = \beta_iY, \text{ Therefore, } MVP = MPP \times Py$$

Where:

$$Py = \text{Price per unit output (Naira)}$$

$$\beta_i = \text{regression coefficient of input (Agboola, 2011)}$$

$$\text{MVPXi} = \text{Marginal Value Product of input Xi.}$$

The prevailing market price of inputs was used as the Marginal Factor Cost (MFC). Following Ibitoye et al. (2015), the values of the ratios are interpreted thus:

i. If $$r < 1$$, means that the resource in question was over-utilized-therefore, if the quantity of such input is increased, profit will increase.

ii. If $$r > 1$$, means that the resource was under-utilized. If the quantity of such input is decreased, profit will increase.

iii. If $$r = 1$$, it means that the resource was being efficiently utilized.

Optimum utilization of inputs requires that $$MVP = MFC$$. To ensure maximum profit and efficiency of resource use, a farmer must utilize resources at the level where Marginal Value Product is equal to Marginal Factor Cost, that is $$MVP = MFC.$$
Results and Discussion

Result of the maximum likelihood estimate and the diagnostic statistics of Cobb–Douglas Stochastic production function for participating and non participating fish farmers are presented in Table 1. The coefficient of pond size was 0.249 and -0.115, significant at 5% for participants and non participants respectively. This implied that pond size reduced technical inefficiency for participants. The result agree with Agboola (2011) who observed that a unit increase in pond size leads to a decrease in fish output. The coefficient of labour was – 0.405 and – 0.18, significant at 5% for participants and non participants respectively. The negative sign implied reduction in the technical inefficiency for fish farmers. This finding agrees with Shehu and Mshell (2007) who obtained a negative coefficient for labour among farmers in Adamawa State. Capital was -0.126 and -0.28 for participants and non participants respectively. This coefficient was not significant for participants while it was significant at 5% for non participants. This result implied that capital reduced technical inefficiency for fish farmers. The negative sign with respect to capital can be attributed to over utilization of capital resource. This agrees with Opalawa (2014) who attributed negative coefficient of capital to over utilization during the production process.

The coefficient of fertilizer was not statistically significant for both categories of fish farmers. On the other hand, the coefficient of feed was -0.116 and 0.347 for participants and non participants respectively. This input was significant at 5% for both categories of farmers except that while it was negative for participants, it was positive for non participants. The positive sign for project participants could be attributed to feed quality. The quality of feed given to fish by project participants was better than the ones sourced from the open market by non participants. The coefficient of fingerling was 0.678 and -0.45 for participants and non participants respectively. This variable input was significant at 5%. The signs implied that this input increased the technical inefficiency of project participants and reduced technical inefficiency of non participants. This could mean over dependence on the project for every production input by participants. The coefficient of vaccination was 0.426 and -0.63 for participants and non participants respectively. This production input was significant at 5% for participants and not significant at the level of measurement for non participants. The result showed that vaccination had a positive relationship with the output of participating fish farmers while non participant looked at it as something that was not serious.

The estimates of the inefficiency model of Cobb–Douglas Stochastic frontier production function for participating and non participating fish farmers are presented in Table 2. The signs of the coefficients are interpreted in the opposite direction. The coefficient of age was 0.41 for participants and 0.114 for non participants. This was significant at 5% for project participants. The positive sign implied that age decreased the technical efficiency of fish farmers. Participants viewed age as an important socio-economic variable that affect their technical efficiency. The coefficient of sex was 0.12 for participants and 0.06 for non participants. The positive sign of this variable and low level of statistical significance showed that the respondents did not see sex as an important determinant of their technical efficiency. The coefficient of educational status was 0.62 for participants while non participants was – 0.102. The coefficient for project participants was not significant and positive while the coefficient was significant at 5% and negative for non participants. The positive sign for the participants implied that this variable reduce the technical efficiency for the participants while the negative sign implied that it increases the technical efficiency for non participants. The coefficient of farming experience was 0.24 for participants and 0.22 for non participants. It was not significant for participants and significant at 5% for non participants. The positive sign implied that farming experience reduce the technical efficiency of fish farmers.

Efficiency of resource use for participating and non participating fish farmers are presented in Table 3. Table 3 shows the level of efficiency with which the various production inputs were used by fish farmers in the state. The result shows that pond size and capital were over utilized by the participating fish farmers while pond size and labour were over utilized by non participants. To improve profit from fish production, fish farmers in the state are expected to increase the quantity these production inputs. Fish farmers were over ambitious in the construction of their fish pond. Fish farming is a delicate business; hence, farmers should construct realistic ponds in order to make profit. Fertilizer/lime, feed, fingerling and vaccination were underutilized by both categories. This implies that, a decrease in the quantity of use of these inputs will increase the profit from fish production.

Conclusion and Recommendations

From the findings, it can be concluded that both participating and non participating fish farmers over utilized pond size, while fertilizer/lime, feed, fingerling and vaccination were underutilized. The technical inefficiency of fish farmers in the state was significantly reduced by labour. Based on the findings, the following recommendations are made: Provision of financial support through micro credit scheme to fish farmers in the area should be promoted to increase their level of production. This is due to the fact that overutilization of inputs such as pond by both categories and labour resource by the project participants were attributed to inadequate capital; and for maximum maximization of production resource by fish farmers, extension agents should endeavour to teach them how to maximize their usage.
References
### Table 1: Maximum Likelihood Estimate for Participating and non participating Fish Farmers

<table>
<thead>
<tr>
<th>Input</th>
<th>Participating</th>
<th>Non participating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>t-ratio</td>
</tr>
<tr>
<td>Pond size</td>
<td>0.249*</td>
<td>2.79</td>
</tr>
<tr>
<td>Labour</td>
<td>-0.405*</td>
<td>-8.25</td>
</tr>
<tr>
<td>Capital</td>
<td>0.126</td>
<td>0.87</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>0.203*</td>
<td>-0.370</td>
</tr>
<tr>
<td>Feed</td>
<td>-0.116*</td>
<td>-6.29</td>
</tr>
<tr>
<td>Fingerling</td>
<td>0.678*</td>
<td>3.87</td>
</tr>
<tr>
<td>Vaccination</td>
<td>0.426*</td>
<td>4.39</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.136</td>
<td>1.36</td>
</tr>
<tr>
<td>Gamma</td>
<td>0.664*</td>
<td>5.58</td>
</tr>
<tr>
<td>Sigma²</td>
<td>0.428*</td>
<td>3.41</td>
</tr>
<tr>
<td>Log likelihood function</td>
<td>69.31</td>
<td></td>
</tr>
<tr>
<td>RTS</td>
<td>-0.503</td>
<td></td>
</tr>
</tbody>
</table>

Source: Computed from Field Survey, 2013. *x* = significant at 5%.

### Table 2: Inefficiency estimates for participating and non participating fish farmers.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Participating</th>
<th>Non Participating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>t-ratio</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.81</td>
<td>-0.51</td>
</tr>
<tr>
<td>Age</td>
<td>0.41*</td>
<td>3.37</td>
</tr>
<tr>
<td>Sex</td>
<td>0.12</td>
<td>0.31</td>
</tr>
<tr>
<td>House hold size</td>
<td>-0.17</td>
<td>0.17</td>
</tr>
<tr>
<td>Educational Status</td>
<td>0.62</td>
<td>0.55</td>
</tr>
<tr>
<td>Farming Experience</td>
<td>0.24</td>
<td>1.76</td>
</tr>
<tr>
<td>Extension contact</td>
<td>-0.27</td>
<td>-0.70</td>
</tr>
<tr>
<td>Marital Status</td>
<td>0.17</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Source: Computed from Field Survey, 2013. *x* = significant at 5%.

### Table 3: Efficiency Ratio (MVP/MFC) for Fish Farmers

<table>
<thead>
<tr>
<th>Variables</th>
<th>Participating</th>
<th>Non Participating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pond size</td>
<td>0.98*</td>
<td>0.003*</td>
</tr>
<tr>
<td>Labour</td>
<td>2.1*</td>
<td>0.003*</td>
</tr>
<tr>
<td>Capital</td>
<td>0.9*</td>
<td>6.3*</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>496.3*</td>
<td>623.7*</td>
</tr>
<tr>
<td>Feed</td>
<td>3.8*</td>
<td>142.5*</td>
</tr>
<tr>
<td>Fingerling</td>
<td>103.1*</td>
<td>64.1*</td>
</tr>
<tr>
<td>Vaccination</td>
<td>64.7*</td>
<td>89.7*</td>
</tr>
</tbody>
</table>

Source: Computed from Field Survey, 2013. *x* = Over utilized, * = Underutilized