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## EFFICIENCY ANALYSIS OF FADAMA FOOD CROP FARMERS IN SOUTHWEST, NIGERIA

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### ABSTRACT

*The technical efficiency estimates of beneficiaries and non-beneficiaries was less than one (or 100 percent) indicating that all the farmers were operating below the frontier. Technical efficiency indices of beneficiaries varied from a minimum of 78.4 percent to a maximum of 96.4 percent while that of non-beneficiaries lied between 41.2 percent and 89.2 percent. The difference in the mean technical efficiency levels of beneficiaries and non-beneficiaries was significant at the 5 percent level of probability. The estimated coefficients of all the parameters of production function are positive meaning that total farm value increases by the value of each of the coefficients as the quantity of each variable increases by a unit. The following variables: farm size, costs of labour, fertilizer, agro-chemicals and planting materials were significant ( $p < 0.05$ ) for the study area and beneficiaries. However, costs of fertilizer and agro-chemicals were not statistically significant ( $p < 0.05$ ) with respect to non-beneficiaries.*

**Keywords:** Efficiency, Fadama, Food Crop farmers and Southwest

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## INTRODUCTION

The increasing poverty situation, with more than 70 percent of rural households has led the Federal Government of Nigeria (FGN) to make food security and the eradication of poverty one of the central objectives of its economic policy (FAO, 2018). Past poverty reduction programmes have had a marginal impact on poverty, despite large budgetary allocations (Manyong et al., 2004). The government is particularly concerned about worsening rural poverty, rising unemployment rates among young people and the marginalization of women.

According to CBN (2018), over 60 percent of the country's population are small scale farmers who live in the rural areas and depend largely on agriculture for their livelihood. About 90 percent of the country's food is produced by these small-scale farmers who cultivate small plots of land and depend largely on seasonal rainfall, which is not evenly distributed throughout the year. In addition, the increasing rate of population growth at about 3.0 percent per annum, and the consequent pressures from other competing socio-economic demands for land overtime had drawn the already limited cultivable land from its traditional agricultural uses. This has led to a reduction in land-man ratio with small average size of land per capita and reduced farm yield, arising from the continuous cropping of the same plot on which little or no improvement technologies are used. This results into inadequate food production, increases poverty levels, and makes it impossible for farmers to meet other livelihood requirements, such as health and children's education (FAO, 2022).

Olayide and Vanden (1977) attributed the declining yield from food production to many factors such as the inappropriate use of improved technologies, inappropriate crop and land management practices, farmers' socio-economic factors, gender differentials in the accessibility to farm resources and in particular, the inefficient use of production resources. These have led to wastages, the inability to attain optimal production levels, low yield and low income, which invariably result in poverty and hunger. In an attempt to address these problems, The National Fadama Development Project was established to equip farmers with necessary resources as a way of promoting all-year-round food crop production. The resources provided included inorganic fertilizer, herbicides, improved seeds of rice and vegetables. However, studies have shown that resources may be available and not properly allocated or efficiently utilized. Though, the mid-term report on the Project beneficiaries in 2004 indicate some positive impacts in the use of resources provided by the fadama III project and the Community-Driven Development (CDD) approach employed, however, the analytical techniques used in the study were not reliable (PCU-NFDO, 2007). Also there had not been an in-depth study on the efficiency of use of productive resources, the net gain in income by the beneficiaries, and to what extent these compare with what is obtained by non-beneficiaries of the Project.

Hence, there is need to assess the socio-economic characteristics of the fadama III project beneficiaries, their current state of resource productivity, and to evaluate the impact on their income generating potentials and livelihoods. Pertinent research questions to be addressed include: What are the project resources/facilities available and accessible to beneficiaries of the fadama III project as compared to non-beneficiaries? What differences exist in the socio-economic characteristics of beneficiaries and non-beneficiaries? How do the costs incurred and returns from production of beneficiaries compare with those of non-beneficiaries? Are there differentials in the technical efficiency of resource use by beneficiaries and non-beneficiaries? How do the socio-economic characteristics of

respondents affect their technical efficiency levels of production? What are the constraints currently confronting the beneficiaries in their food production activities? These questions are important because, proffering solutions to them will assist the National Fadama Development Office in redesigning its programme more effectively to ensure all-year-round food production for poverty alleviation.

#### **1.4 Objectives of the study**

The main objective of the study was to compare the efficiency of resource use of beneficiaries and non-beneficiaries of Fadama III Project food crop production in Ila and Ifedayo Local Government Areas of Osun State.

The specific objectives are to:

- (i) determine the socio-economic characteristics of beneficiaries and non-beneficiaries of Fadama III Project food crop farmers in the study area;
- (ii) estimate the technical efficiency of the farmers; and
- (iii) determine the socio-economic factors influencing farmers' technical efficiency.

#### **1.5 Research hypotheses**

The hypotheses that were tested in the study, as stated in null form are:

- (i) There is no significant difference in the socio-economic characteristics of the farmers
- (ii) No significant difference exists in the technical efficiency of the farmers
- (iii) Socio-economic factors do not influence the farmers' technical efficiency

### **RESEARCH METHODOLOGY**

#### **Area of study**

The study was conducted in Southwest, Nigeria. This is because the geopolitical benefited from the Fadama III Project since its commencement in 2011, with a view to improving the beneficiaries' livelihoods (NFDO, 2011). The states to be sampled are Osun, Oyo and Ogun among the six states in the zone. Farming is well-embraced by the people of these states, particularly the rural/peri-urban households. They enjoy tropical climate type with bi-modal rainfall pattern supports the cultivation of both arable and tree crops at some periods of the year. This is complemented by Fadama users who engage in farming, even in the dry seasons, to ensure all-year-round food crop production. The states have Fadama III project sites with the availability of Fadama resources and project food crop farmers.

A multi-stage sampling technique was employed. Purposive sampling technique will be employed in selecting three states based on the prominence of Fadama project sites. Four Local Government Areas (LGAs) where the Fadama III Project are located were selected purposively based on the prominence of fadama III Project food crop farmers in the state. In each LGA, a list of all communities where the fadama III Project sites are located were obtained from the Local Fadama Development Officer (LFDO) from which five villages were randomly selected. In addition, a list of communities having Fadama food crop farmers (Rice and cassava farmers) but not under the Fadama III Project were obtained from the Agricultural Development Programme Officer (ADPO) in each LGA from which five farming communities (at least 25-30 km away from the Fadama III Project sites) were randomly selected. This was done to prevent possible spill-over effects of the

resources/facilities enjoyed by the Fadama III Project beneficiaries. Ten food crop farmers (rice and cassava) were selected randomly in each community to give a total of nine hundred (900) farmers, comprising equal numbers of beneficiaries and non-beneficiaries of the Fadama III food crop project.

### **Methods of data collection**

The study will employ primary data. Data were collected 900 rice and cassava farmers, using pre-tested structured questionnaire. The information sought include farmers' socio-economic characteristics such as age, gender, educational level, marital status, household size, farm labour force, farm size, membership of cooperative society, and farming experience. Information on input and output quantities and prices of the food crops as well as on the problems confronting farmers' food crop production operations were collected.

### **Data analysis**

Data were analyzed with descriptive statistics, budgetary technique and stochastic frontier production function. The difference of means test was employed to compare parameters of both beneficiaries and non-beneficiaries.

Descriptive statistics was used to describe the basic features of the study data. It involves the calculation of percentages and mean. Budgetary technique was used to analyze the costs and returns to farmers' production activities and to estimate the gross margins, while the stochastic frontier production function was used to estimate the technical efficiency (TE) of beneficiaries and non-beneficiaries, as well as determine the socio-economic factors influencing farmers' technical efficiency. The computer programme, FRONTIER 4.1 (Coelli, 1996) was used to analyse TE. The analytical techniques to be used and the formular for the difference of means test are specified below.

### **The stochastic frontier production function (SFPF)**

The stochastic frontier production model was independently specified by Bamire (2016). It comprises a production function of the basic regression type with a composite disturbance term equal to the sum of the two error components. The basic model used in literature to describe a frontier production function is specified as follows:

$$Y_i = f(X_i, \beta) + V_i - U_i \dots\dots\dots(1)$$

Where  $Y_i$  = value of farm output measured in naira ,  $X_i$  are explanatory variables and  $V$  and  $U$  are the error terms

It is further assumed that  $V$  and  $U$  are not correlated.

For this study, the translog variant of the model used is specified as:

$$\ln Y_i = \ln \beta_0 + \sum \beta_i \ln X_i + V_i - U_i \dots\dots\dots(2)$$

Where,

$\ln$  = the natural logarithm (i.e., logs to base e);

$Y_i$  = total quantity of food crop output in value (₦) of the i-th farm;

$X_1$  = farm size (ha) or total land planted to food crop (ha);  
 $X_2$  = labour (mandays);  
 $X_3$  = total quantity of fertilizer (kg);  
 $X_4$  = amount of other agro-chemical inputs (herbicides, pesticides etc) in naira;  
 $X_5$  = value of quantity of planting materials;  
 $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \dots, \beta_5$  = Vectors of unknown parameters to be estimated  
 $V_i$  = random error assumed to be independent of  $U_i$ , identical and normally distributed with zero mean and constant variance  $N(0, \sigma_v^2)$ . They represent random variations in output as a result of factors outside the control of farmers as well as the effects of measurement error in output variable.  
 $U_i$  = random variables that accounts for technical inefficiency effects which are assumed to be independent of  $V_i$  non-negative truncation at zero or half normal distribution with  $N(0, \sigma_u^2)$   
 $i = 1, 2, 3 \dots n$  farms

It has become a standard practice in efficiency analysis to include only the conventional inputs (i.e land, labour, fertilizer and other variable inputs) in the frontier production function. It is argued that non-conventional inputs such as education, credit, and land quality influence output indirectly by raising efficiency with which the conventional inputs especially land and labour are used. Therefore, the non-conventional inputs are used in the second stage analysis of factors influencing production efficiency.

For the investigation of relevant farm-specific and socio-economic factors influencing technical efficiency, a linear regression model will be used. The variables that are hypothesized to influence in this context are shown in equation (3).

The inefficiency model is defined by:

$$\mu_i = \delta_0 + \delta_1 Z_1 + \dots \delta_6 Z_6 \dots \dots \dots (3)$$

Where  $\mu_i$  = Resource use inefficiency effect of the  $i^{\text{th}}$  farm

$i$  =  $i$ -th farm in the sample

$Z_1$  = Age of the farmers (years);

$Z_2$  = Farmer's education (1 for farmers that had formal education and 0 otherwise);

$Z_3$  = Farming experience (years);

$Z_4$  = Access to credit (Yes =1; No = 0);

$Z_5$  = Access to extension services (Yes =1; No = 0);

$Z_6$  = Gender (1 for male, 0 otherwise);

Because the dependent variable in equation (3) is a measure of technical inefficiency, farm-specific variables with negative (positive) coefficient will have a positive (negative) effect on technical efficiency levels.

## RESULTS AND DISCUSSION

### Socio-economic determinants of technical efficiency of fadama food crop farmers

#### 4.2.1 Technical efficiency estimates

The distribution of technical efficiency (TE) indices derived from the analysis of the stochastic frontier production model are shown in Table 16. The TE of project beneficiaries ranged from 78.4 percent for the least technically efficient farmer to 96.4 percent for the most technically efficient farmer with a mean of 83.8 percent while that of non-beneficiaries

ranged from a minimum of 41.2 percent to a maximum of 89.2 percent, with a mean of 63.1 percent.

There was a significant difference between the mean TE of beneficiaries and non-beneficiaries at the 5 percent level of probability. In general, the mean TE of Fadama food crop farmers (73.46 percent for the whole sample, 83.8 for beneficiaries and 63.1 for non-beneficiaries show that farmers in the study area obtained about 74 percent of optimal output from the use of production input or resources. Project beneficiaries and non-beneficiaries also obtained about 84 percent and 63 percent optimal output from the use of resources available to them. In addition, all the mean TEs were less than one (or 100 percent), implying that all the farmers were operating below the frontier (i.e the optimal output level) and hence are not fully technically efficient. In other words, there is ample room for improvement in the efficiency of resource use of Fadama food crop farmers by 26 percent in the study area, 16 and 37 percent for beneficiaries and non-beneficiaries respectively. This calls for scaling up and out of the Fadama III Project site so that non-beneficiaries in other locations could benefit from the activities of the project to achieve the food sufficiency objective of the nation. It is also important to note that 85 percent of the beneficiaries had a TE level of above 90 percent and the remaining had between 71 and 90 percent. On the other hand, most (about 98 percent) of the non-beneficiaries had below 80 percent TE level, with a larger percentage (39.4 percent) having between 51 and 60 TE levels. None of them had above 90 percent TE level. All these show that fadama III project beneficiaries in Ila and Ifedayo Local Government Areas of Osun State were technically more efficient in their use of productive resources than the non-beneficiaries and this implies higher crop productivity and income generating potential.

**TABLE 1**

**Crop production efficiency distribution (percent) of Fadama food crop farmers**

| TE Levels     | Whole sample |            | Beneficiaries |            | Non-beneficiaries |            | t      |
|---------------|--------------|------------|---------------|------------|-------------------|------------|--------|
| (percent)     | Freq         | Percentage | Freq          | percentage | Freq              | percentage |        |
| 41-50         | 17           | 5.3        | -             | -          | 17                | 10.6       |        |
| 51-60         | 63           | 19.7       | -             | -          | 63                | 39.4       |        |
| 61-70         | 35           | 10.9       | -             | -          | 35                | 21.9       |        |
| 71-80         | 46           | 14.4       | 4             | 2.5        | 42                | 26.3       |        |
| 81-90         | 23           | 7.2        | 20            | 12.5       | 3                 | 1.9        |        |
| Above 90      | 136          | 42.5       | 136           | 85.0       | -                 | -          |        |
| Mean          | 73.5         |            | 83.8          |            | 63.1              |            | 2.914* |
| Std.deviation | 18.5         |            | 10.2          |            | 14.8              |            |        |
| Minimum       | 41.20        |            | 78.43         |            | 41.20             |            |        |
| Maximum       | 96.38        |            | 96.38         |            | 89.2              |            |        |

**Source:** Field survey, 2025

\*Significant at 5 percent level

**Determinants of technical efficiency among Fadama food crop farmers**

The stochastic frontier and inefficiency models were simultaneously estimated using FRONTIER 4.1. The maximum likelihood estimates of the stochastic frontier production function for Fadama food crop farmers are presented in the Table. The significance of the gamma ( $\gamma$ ) coefficients (0.859, 0.897 and 0.876) for the study area, beneficiaries and non-beneficiaries respectively at the 5 percent level suggests the presence of one sided error

component. This means that the effect of technical inefficiency is significant. The estimated  $\gamma$  coefficients means that about 86, 90 and 88 percent of the discrepancies between observed output and the frontier output of the study area, beneficiaries and non-beneficiaries are due to technical inefficiency. In other words, the shortfall in observed output from the frontier output is primarily due to factors, which are within the control of the farmers in the study area while the remaining was due to random effects. This confirms the presence of one sided error component in the models thus rendering the use of Ordinary Least Squares (OLS) estimating technique inadequate in representing the data. On the other hand, the sigma-squares ( $\sigma^2$ ) were significantly different from zero at the 5 percent level of probability, indicating a good fit and the correctness of the specified assumptions of the distribution of the composite error term. Rahman, 2003; Sharma, 1999 also observed the significance of  $\sigma^2$ . The log likelihood functions were estimated to be -289.813, -321.194 and -208.432 for study area, beneficiaries and non-beneficiaries respectively. Each of these values represents the value that maximizes the joint densities in the estimated model. Coefficients of all parameters of production function have the expected positive signs and are significant at ( $p < 0.05$ ) with respect to beneficiaries and non-beneficiaries except fertilizer and agro-chemicals that were not statistically significant as shown by non-beneficiaries' model. In specific terms, one unit increase in farm size, cost of labour, cost of fertilizer, cost of agro-chemicals and cost of planting materials will increase the beneficiaries' farm output in value by about 0.412, 0.301, 0.002, 0.261 and 0.107 respectively. On the other hand, one unit increase in farm size, cost of labour, cost of fertilizer, cost of agro-chemicals and cost of planting materials will increase non-beneficiaries' farm output by 0.284, 0.212, 0.067, 0.311 and 0.242 respectively. Statistical non-significance of fertilizer and agro-chemicals with respect to non-beneficiaries may be due to the fact that majority of them did not use fertilizer and agro-chemicals

The results of non-conventional inputs on the TE of Fadama food crop production are also shown in Table 2. Technical efficiency in Fadama food crop production in the study area and among project beneficiaries was positively and significantly influenced by education, farming experience, credit and extension contact at the 5 percent level of probability. For every unit increase in the level of education of beneficiaries, the level of technical efficiency of resource use increases by 0.02 units. This supports the findings of Feder et al. (1985) and Olawale, (2004) that education enhances farmers' receptiveness to improved farming techniques/ innovations which is capable of improving their productivity and livelihood. Also if farmers' experience in Fadama farming increases by one unit, beneficiaries' technical inefficiency level decreases by 0.3 units, implying that farmers gain experience overtime in the appropriate management of production resources on the farms. This agrees with Ajibefun et al. (2002) that farmers with more experience tend to be more technically efficient. In addition, for every unit increase in extension contact with project beneficiaries, technical efficiency level increases by 0.24 units, implying that access to extension service provides opportunities to the farmers to learn new research methods capable of improving their agronomic and management practices on the farms. This is evidenced from Adesina and Zinnah (1993) that effective extension services provide farmers with readily available information on efficient use of inputs that maximize output at least cost. The negative sign of credit implies that this factor contributes negatively and significantly to beneficiaries' technical inefficiency, i.e the higher the access to credit, the more technically efficient the farmer becomes. This is in line with the findings of Okike, *et al.* (2001) that accessibility to credit can contribute to farmers' resource use efficiency. Age and gender had no significant effect on the efficiency of resource use by beneficiaries even though their signs indicate a reduction in the level of TE. This suggests that these variables are not too important for consideration in technical efficiency of resource use among the

beneficiaries. On the other hand, non-beneficiaries' production was positively and significantly influenced by education and experience in Fadama farming while credit, age, gender and extension contact included in the model had no significant relationship with TE. However, the positive sign of extension may imply that non-beneficiaries are less likely to have contacts with extension agents and are less willing to adopt new farming practices and modern inputs.

**TABLE 2**

**Maximum-Likelihood estimates for parameters of the translog stochastic frontier production function for Fadama farmers**

| Variables                                             | Whole sample            | Beneficiaries           | Non-beneficiaries       |
|-------------------------------------------------------|-------------------------|-------------------------|-------------------------|
| <b>Production function</b>                            |                         |                         |                         |
| Constant                                              | 1.901<br>(3.312)*       | 2.063<br>(5.223)*       | 0.998<br>(1.925)        |
| Ln (Farm size)                                        | 0.229<br>(2.030)*       | 0.412<br>(3.271)*       | 0.284<br>(2.221)*       |
| Ln ( Labour)                                          | 0.181<br>(1.992)*       | 0.301<br>(2.432)*       | 0.212<br>(2.096)*       |
| Ln ( Fertilizer)                                      | (0.016)<br>(0.869)      | 0.002<br>(1.964)*       | 0.067<br>(1.089)        |
| Ln (Cost of agro-chemicals)                           | 0.284<br>(2.061)*       | 0.261<br>(3.985)*       | 0.311<br>(1.914)        |
| Ln (Cost of planting materials)                       | 0.352<br>(2.992)*       | 0.107<br>(3.116)*       | 0.242<br>(1.986)*       |
| <b>Inefficiency model</b>                             |                         |                         |                         |
| Constant                                              | 0.954<br>(5.521)*       | 0.831<br>(3.244)*       | 0.543<br>(0.785)        |
| Age                                                   | 0.827E-03<br>(0.927)    | 0.601E-02<br>(1.157)    | 0.309E-03<br>(1.521)    |
| Education                                             | -0.683E-01<br>(-1.997)* | -0.174E-01<br>(-2.119)* | -0.436E-02<br>(-2.186)* |
| Experience                                            | -0.724<br>(-1.982)*     | -0.324<br>(-2.473)*     | -0.141<br>(-2.948)*     |
| Credit                                                | -0.319E-02<br>(-2.861)* | -0.512E-02<br>(-3.365)* | 0.212E-01<br>(0.137)    |
| Extension                                             | -0.504<br>(-2.013)*     | -0.238<br>(-2.927)*     | 0.437<br>(0.761)        |
| Gender                                                | 0.085<br>(0.586)        | 0.037<br>(0.617)        | 0.053<br>(0.968)        |
| <b>Diagnosis statistics</b>                           |                         |                         |                         |
| Sigma-square ( $\sigma^2 = \sigma_v^2 + \sigma_u^2$ ) | 0.086<br>(2.008)*       | 0.092<br>(2.299)        | 0.089<br>(1.996)*       |
| Gamma ( $\gamma = \sigma_u^2 / \sigma^2$ )            | 0.859<br>(10.958)*      | 0.897<br>(16.532)*      | 0.876<br>(12.948)*      |
| Log of likelihood function ( $\lambda$ )              | -289.813                | - 321.194               | -208.432                |
| LR test                                               | 52.468                  | 63.853                  | 48.967                  |
| Mean of exp(-U)                                       | 0.833                   | 0.847                   | 0.826                   |

**Source:** Field survey, 2025

Figures in parentheses are the corresponding t-ratio values

\*significant at 5%

**Note :** A negative sign of the parameters in the inefficiency function means that the associated variable has a positive effect on technical efficiency, and vice versa.

### Elasticities and returns to scale of the parameters of SFP function

The return to scale (RTS) which is a measure of total resource productivity is presented in the Table . The return to scale estimates (1.062), (1.083) and (1.216) for the study area, beneficiaries and non-beneficiaries respectively indicate that Fadama food crop farmers were in stage one of production curve. Stage one is a region of increasing return to scale and is also an inefficient stage because increase in the use of input will lead to more proportionate increase in output. This shows that Fadama food crop farmers should make efforts to expand the present scope of production to actualise the potential in Fadama food crop production. That is, more of the variable inputs could be employed to achieve more output.

**TABLE 3**  
**Elasticities and returns to scale of the parameters of SFP function**

| Variables                  | Whole sample | Elasticities of Beneficiaries | Elasticities of non-beneficiaries |
|----------------------------|--------------|-------------------------------|-----------------------------------|
| Farm size                  | 0.229        | 0.412                         | 0.284                             |
| Labour                     | 0.181        | 0.301                         | 0.212                             |
| Quantity of fertilizer     | 0.016        | 0.002                         | 0.067                             |
| Cost of agro-chemicals     | 0.284        | 0.261                         | 0.311                             |
| Cost of planting materials | 0.352        | 0.107                         | 0.242                             |
| RTS                        | 1.062        | 1.083                         | 1.116                             |

**Source :** Field survey, 2025

## CONCLUSION AND RECOMMENDATIONS

### Conclusion

Based on the findings of the study, it can be concluded that beneficiaries of fadama III project were more literate, more physically active and energetic to meet the rigours of farming, more seasoned and experienced in fadama food crop farming, did not have the opportunities for for expanded land for farming and hence have good reasons to adopt land improvement technologies, had compact farmlands, cultivated larger farm size, had better access to productive resources, extension service and credit facilities. Beneficiaries were also more technically efficient in their use of resources and earned higher net income from fadama food crop production.

### Recommendations

Based on the conclusions of this study, the following recommendations are made in order to improve food crop production in the study area.

- (i) The federal government and developmental agencies/private organisation should make productive resources (such as improved seeds and fertilizers) available and accessible to farmers, particularly the non-beneficiaries of the fadama III project. Credit facilities as well as extension service should also be provided to the farmers.
- (ii) Farmers, particularly non-beneficiaries of the fadama III project should be sensitized on the appropriate use of productive resources, as well as on proper agronomic management practices. This could be accomplished through effective extension service of the States Agricultural development project (ADP).

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