www.jard.edu.pl http://dx.doi.org/10.17306/J.JARD.2022.01443

Journal of Agribusiness and Rural Development

pISSN 1899-5241
eISSN 1899-5772

1(63) 2022, 51–59
Accepted for print: 8.02.2022

ANALYSIS OF EFFICIENCY DIFFERENTIALS IN FADAMA III PROGRAMME AREAS IN KOGI STATE, CENTRAL NIGERIA

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Abstract. Introduction: The impact of the Fadama III programme on the efficiency levels of farmers in Kogi state, Nigeria was investigated. Materials and methods: Primary data were obtained with a questionnaire which was administered to 382 respondents selected through a stratified random sampling procedure. The Cobb-Douglas stochastic frontier production and cost functions were employed in the analyses. The resulting efficiency estimates for beneficiaries and non-beneficiaries were compared using the t-test. Major findings: Efficiency analyses indicate that the quantities of Seed, fertilizer and agrochemicals used were the drivers of technical efficiency among both categories of farmers, while costs of land, fertilizer and family labour were the drivers of allocative efficiency. Technical efficiency estimates for both categories of farmers were 0.79 and 0.71 respectively and respective allocative efficiency estimates were 1.22 and 1.44. Mean comparison of the technical efficiency levels indicated a t-estimate of 2.52 ($\alpha = 0.0124$) in favour of the beneficiaries while a t-estimate of –24.56 ($\alpha = 0.000$) indicated that beneficiaries were also more allocatively efficient. Conclusion: The beneficiaries, by acquiring skills and support from Fadama III, were more efficient than their non-benefiting counterparts. Continuous training will assist farmers to improve their efficiency and reduce the noticed deficits.

Keywords: Fadama III, farmers, beneficiaries, technical, allocative, efficiency

INTRODUCTION

Agriculture remains an indispensable sector in the world. More than 60% of the world's population relies on agriculture (Zavatta, 2014). As of 2019, about 27% of the world's population is engaged in agriculture (World Bank, 2021). In Nigeria, the sector accounts for 35% of total employment (World Bank, 2021) and contributes substantially to the economy in terms of GDP, and in the moderation of inflation (Akinyosoye, 2005). Such a sector that employs a huge component of the population, and produces the bulk of food supply, has become an intervention point in poverty reduction goals of governments.

The continuous poverty reduction efforts of Nigerian governments stem from predominant and elusive nature in the country. Generally, poverty continues to affect a huge portion of the Nigerian population. Official statistics indicate that 40% were poor as at 2020 (World Bank, 2020). However, the menace is more prevalent in the rural part of the country and hence, an agricultural phenomenon. Poverty and attendant hunger faced by farmers are caused primarily by inadequate production resources to support commercial agricultural production. Also, an increase in the human population aggravates existing pressure on productive resources and inadequate food supply (Akangbe et al., 2012). Another factor of food and income poverty is poor health (Onuche et al., 2014). Furthermore, rural financial supports are scarce and the rural finance policies implemented previously have impaired rather than assisted agricultural development in Nigeria (Simonyan and Omolehin, 2012). In addition, climate change has contributed

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immensely to increased desertification, unpredictable rainfall pattern and low farm yield. These scenarios and their negative impacts on agricultural production underscore the need for improved agricultural production through interventions. Many attempts by governments, International Development Agencies, local organizations and non-governmental organizations (NGOs) focusing mainly on rural livelihood improvement, in the past did not realize the desired affirmative impact and sustainability (Bature et al., 2013). Thus, although some levels of success were recorded, poverty remains entrenched in rural Nigerian.

Among the attempts to improve the agricultural economy, and establish sustainable development is the National Fadama Development Programme (NFDP). The NFDP is a tripartite funded intervention by the World Bank, the Federal Government of Nigeria and participating states, targeted at sustainable poverty reduction by improving the capacities of beneficiaries (Ike, 2012). The Fadama I, which was the first of 3 phases, was designed in the 1990s to promote simple low–cost improved irrigation technology under the Word Bank Financing (Folayan, 2013) to ensure sufficient food production (Akangbe et al., 2012). The NFDP is a World Bank 450 million-Dollar response to the prevalent widespread poverty in Nigeria. The NFDP is operational in all states of the federation and its first and second phases have assisted in increasing the income of rural people by 63 % (World Bank, n.d). The Fadama III, a follow up to the successful completion of the Fadama II project, covered crop production, animal husbandry, fisheries, agricultural market, commercialization and agribusiness, extension, research and support services. A major goal of the Fadama programme was improved production efficiency which was expected to manifest in the efficiency of the optimization of output and resource allocation. Such a goal, if met, could reduce poverty (Onuche and Oladipo, 2020; Gelaw, 2013).

Studies have been conducted on different aspects of the 3 stages of the programme across the country. The impacts of the Fadama programme and other agricultural interventions across the country have been documented. Folayan (2013) studied the effect of NFDP on the socioeconomics of Fadama participants in Ondo state. Raufu and Masuku (2013), Muhammad et al. (2011), Akangbe et al. (2012) investigated the impact of the Fadama II programme in other places. The impact of Fadama III has been studied (Ike, 2012; Bature et al., 2013; Ja'afar-Furo et al., 2013; Ogbonna and Nwaobiala, 2014; Osondu et al., 2015; Ominikari et al., 2017; Adereti and Fadare, 2017; Babatunde et al., 2017; Kwon-Ndung et al., 2018). Generally, these studies found that the interventions improved the welfare of the beneficiaries. Interventions in agricultural development in Kogi state, including Fadama programmes, have also received research attention. For instance, Yakubu et al. (2019) have documented the factors influencing participation of cassava farmers in Survival Farming Intervention Programme (SFIP). Also, Olaolu et al. (2013) have studied the effect of Fadama on participating rice farmers. Olaolu and Akinnagbe (2014) have also documented constraints and strategies to improving agricultural development under Fadama II. Akoh and Shaibu (2016) reported findings on the efficiency of fish farmers under Fadama II in Kogi state.

While information exists for factors of participation, the effect of livelihood and constraints on participation in the schemes in the state, information on the efficiency of production is limited to the aquaculture sector. Again, to the best of the knowledge of this investigation, studies have not been reported on the impact of Fadama III in Kogi state. Kogi state, located in central Nigeria, with a high percentage of population in crop agriculture, is one of the participating states. Poverty rate based on Purchasing Power Parity for the state as of 2010 was 72.5%. Of particular interest to an investigation in such a state as Kogi, is the impact of the programme on the efficiency of crop production. This is because crop production occupies a dominant segment of agriculture in the state. A study on the efficiency of production and resource allocation is imperative in order to bring to the fore whether or not available resources are being applied in the most economically rational manner. This is especially important since a major goal of the Fadama programme was to elicit improved efficiency in agricultural production. Efficiency in agricultural production might be investigated in two dimensions: technical efficiency and allocative efficiency. A technically more efficient farmer's output is closer to the production frontier (maximum output obtainable from resources combined) than a technically less efficient one. On the other hand, an allocative and more efficient farmer is better at minimizing resource wastage via input cost (Onuche and Oladipo, 2020).

We focused on a state level survey of efficiency in crop production in Fadama III areas in Kogi state in order to document specific findings that might be important in the review of the programme and future planning. A study with particular interest in a location is necessary to identify facts peculiar to the area, as intervention areas are likely to have peculiar socioeconomic and cultural that may research findings (Asrat and Simane, 2018). It was therefore important to study how technically and allocatively efficient Fadama III beneficiaries in Kogi state are, and whether or not they are better off than the non-beneficiaries in these regards. To this end, the following questions were considered pertinent: what is the level of technical and allocative efficiencies of Fadama III beneficiaries in Kogi state? And, do these efficiency levels differ from those of non-beneficiaries of the programme? To fill this knowledge gap, the technically and allocative efficiency levels of beneficiaries and non-beneficiaries were estimated and compared.

MATERIALS AND METHODS

Data and data sources

Primary data were obtained with the aid of a questionnaire administered to farmers who were selected through stratified random sampling. The sampling frame was obtained from the Kogi State Fadama Coordination Office. The study used the yard formula (Yamane, 1964) for the determination of the appropriate sample size. The total sample size of 228 was estimated for the beneficiaries. Furthermore, in order to investigate the impact of the programme, the within and without approach, which compares data from participants with non-participants was employed. Thus, the same number of respondents was selected for the non-beneficiaries. Care was taken to ensure that both sides were involved in the production of similar crops and under similar conditions. Only 191 matched copies of the questionnaire administered were valid for analysis.

Method of data analysis

Frequency distribution was employed to describe the socioeconomic characteristics of respondents, while the Cobb-Douglas stochastic frontier production and cost functions were used to estimate their technical and allocative efficiencies. Comparisons of efficiency estimates between beneficiaries and non-beneficiaries were undertaken using the t-test.

Technical efficiency

Following Onuche and Oladipo (2020), the model for technical efficiency was adapted as follows:

$$\ln Y = \ln\beta_0 + \beta_{1i}\ln X_{1i} + \beta_{2i}\ln X_{2i} + \beta_{3i}\ln X_{3i} + \\ + \beta_{4i}\ln X_{4i} + \beta_{5i}\ln X_{5i} + \beta_{6i}\ln X_{6i} + (v_i - u_i) \quad (2)$$

Where:

ln – natural logarithm, Y_j – output (kg), X_1 – farm size (ha), X_2 – seed (kg), X_3 – fertilizer (kg), X_4 – quantity of agrochemicals (litres), X_5 – hired labour (man-days), X_6 – family labour (man-days)

Allocative efficiency

Also, the allocative efficiency model was specified following Ani et al. (2013), as:

$$\mathrm{Ln}C = \beta_0(Y^*) + \beta_1(P_{1i}) + \beta_2\ln(P_{2i}) + \beta_3\ln(P_{3i}) + \\ + \beta_4\ln(P_{4i}) + \beta_5\ln(P_{5i}) + \beta_6\ln(P_{6i}) + \beta_7\ln(P_{7i}) \quad (3)$$

where:

C_1 – total cost of production in Naira
Y^* – value of output measured in Naira
P_{1i} – total output (kg/ha)
P_{2i} – cost of land
P_{3i} – cost of seed (₦/ha)
P_{4i} – cost of fertilizer (₦/ha)
P_{5i} – cost of agrochemicals (₦/ha)
P_{6i} – cost of hired labour (₦/ha)
P_{7i} – cost of family labour (₦/ha)
i – refers to individual farm
β_is – are structural parameters.

Test of mean difference

The comparison of the estimated efficiency levels for beneficiaries and non-beneficiaries were subjected to mean comparison using the t test. The t-statistic test is expressed as follows:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{SX_1^2}{NX_1} + \frac{SX_2^2}{NX_2}}}$$

where:

t – t-statistic
$\bar{X}_1$ – technical/allocative efficiency of beneficiaries of Fadama III
$\bar{X}_2$ – technical/allocative efficiency of non-beneficiaries of Fadama III

SX_1^2– standard deviation of technical/allocative efficiency of beneficiaries after Fadama III
SX_2^2– standard deviation of technical/allocative efficiency of non-beneficiaries of Fadama III
NX_1– sample size of beneficiaries
NX_2– sample size of non-beneficiaries

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Fadama III beneficiaries and non-beneficiaries

The Socioeconomic characteristics of beneficiaries and non-beneficiaries of the Fadama III programme in Kogi state (Table 1) shows similar composition of gender as well as male dominance. Folayan (2013) and Akangbe et al. (2012) reported male dominance among Fadama farmers in Ondo and Oyo State. Asrat and Simane (2018) and Guteta and Abegaz (2015) have alluded to the disadvantaged position of women in agricultural intervention owing to the enormity of their domestic chores and traditional deprivation due to the patriarchal nature of most African societies. The results further revealed that most of these farmers are married. Mohammad et al. (2011) and Bature et al. (2013) made similar findings elsewhere.

Furthermore, the beneficiaries of the Fadama III programme enjoyed more technical support in terms of extension visits than the non-beneficiaries.

Extension visits assist in increasing the likelihood of innovation adoption (Asrat and Simane, 2018) and helps to improve technical knowhow (Beshir et al., 2012), ultimately leading to improved efficiency. The farmers in both categories were within the same age range. The beneficiaries and non-beneficiaries were 43.1 and 42.4 years old, respectively. Bature et al. (2013) reported similar age groups among Fadama farmers. The age distribution indicates poor involvement of the youth in agricultural production, which have food production and economic consequences for the future. Furthermore, the household sizes of the majority of the beneficiaries (53.93%) and non-beneficiaries (61.8%) ranged from 6 to 10 for beneficiaries and non-beneficiaries, respectively, averaging 6 persons in both categories. Mohammad et al. (2011) reported a modal household size of 6–15 members among Fadama II farmers in Niger State. In developing countries where small-scale agricultural enterprises are largely labour-intensive, a large household size provides the much-needed labour for farming

Table 1. Socioeconomic characteristics of Fadama III beneficiaries and non-beneficiaries

Characteristic	Beneficiaries (n = 191)		Non-beneficiaries (n = 191)	
	frequency	percentage (%)	frequency	percentage (%)
Sex				
Male	102	53.4	106	55.5
Female	89	46.6	85	44.5
Marital status				
Married	177	92.7	162	84.8
Single	14	7.3	29	15.2
Extension visit				
Twice or more	121	63.3	54	28.3
At most once	70	36.7	137	71.7
Age (yrs)				
Less than 30	31	16.2	37	19.4
31–45	82	42.9	71	40.3
46–60	63	33.0	59	30.9
Above 60	15	7.9	18	9.4
Mean	43.1		42.4	
Household size (No)				
1–5	77	40.3	71	37.2
6–10	103	53.9	118	61.8
11–15	9	4.7	2	1.0
16–20	2	1.5	0	0.0
Mean	6		6	
Education				
Primary	69	36.1	56	29.3
Secondary	101	52.9	98	51.3
Post-secondary	21	11.0	37	19.4
Farming experience (yrs)				
1–6	71	37.2	71	37.2
7–12	72	37.7	101	52.9
13–18	33	17.3	17	8.9
19–24	15	7.8	2	1.0
Mean	9.2		8.0	

Source: own elaboration based on field survey, 2017.

activities. This helps reduce the need for hired labour in addition to the personal dedication to farm activities, which can improve production efficiency.

Similarly, the majority of both beneficiaries (52.9%) and non-beneficiaries (51.3%) had secondary education. However, in total, the level of education in the area is low. Mohammad et al. (2011) and Folayan (2013) reported similar findings among participants of agricultural interventions. Asrat et al. (2004) submitted that education is beneficial in understanding agricultural information and adoption innovations. Modal farming experience was 7–12 years for both beneficiaries (37.70%) and non-beneficiaries (52.88%). On average beneficiaries were more experienced (9.2 years) than non-beneficiaries (8.0 years). Aside from the level extension visits which were required to provide technical support for the beneficiaries, the findings on socioeconomic characteristics revealed similarities between the two categories.

Technical efficiency estimates of beneficiaries and non-beneficiaries

Table 2 presents the results of the maximum likelihood estimates for the technical efficiency of beneficiaries and non-beneficiaries of Fadama III programme in Kogi state. One of the cardinal goals of the Fadama III was increased efficiency, hence training and technical assistance provided were to assist farmers obtain maximum yield from the levels of input utilized. The diagnostic parameters were significant for both categories of famers, indicating the appropriateness of the model for the analysis (Table 2). The quantities of seed, fertilizer and agrochemicals used were the factors of importance in technical efficiency in the area among both beneficiaries and non-beneficiaries. Individual family labour had no influence on the technical efficiency of non-beneficiaries but it significantly influenced that of the beneficiaries.

This is an indicator that technical support provided for the beneficiaries in the course of the programme helped improve their efficiency in their use of labour and management which resulted in higher efficiency. Efficiency estimates showed that beneficiaries had an average technical efficiency of 0.79, while 0.73 levels were recorded for non-beneficiaries (Table 4). Akoh and Shaibu (2016) reported that Fadama II beneficiaries were more technically efficient in fish production than the non-beneficiaries. The general efficiency levels were high and fall within estimates found elsewhere. For instance, Olabisi (2012) presented a technical estimate of

Table 2. Maximum likelihood estimates for technical efficiency for beneficiaries and non-beneficiaries of Fadama III programme in Kogi state

Variable	Parameter	Beneficiaries (coefficient)	Non-beneficiaries (coefficient)
Constant	β_0	0.775*** (54.5)	8.82 (26.5)***
Farm size	β_1	0.03 (1.06)	0.051 (0.98)
Quantity of seed planted	β_2	0.050** (2.53)	0.062* (1.67)
Quantity of fertilizer	β_3	0.023*** (2.78)	0.04** (2.70)
Quantity of chemicals	β_4	0.834*** (25.50)	0.59*** (8.10)
Hired labour	β_5	–0.001 (–0.16)	–0.002 (–0.12)
Family labour	β_6	0.33*** (7.34)	0.17 (1.10)
Delta	δ	20.76*** (3.77)	21.80* (1.5)
Sigma square	S^2	6.4*** (3.78)	7.20 (2.65)
Gamma	Γ	0.99*** (461.7)	0.98 (92.3)
Log likelihood function = –90.5 LR test = 90.17			Log likelihood function = –61.7 LR test = 18.3
Mean		0.73	0.79

Source: own elaboration based on field survey, 2017.

70% for Fadama participant in Oyo state, while Ayanwale and Alimi (2004) found an estimate of over 90% for Fadama participants in southwestern Nigeria. Mean technical efficiency estimates for non-beneficiaries are in the same range as those estimated in non-interventionist based surveys in the same area. For instance, Onuche and Oladipo (2020) reported a mean technical efficiency estimate of 0.72 for aggregate crops in the area. Similarly, a technical efficiency estimate of 0.712 was reported by Onuche et al. (2020) for Bambara groundnut farmers in the study area. Thus, the higher level of technical efficiency of the beneficiaries can be attributed to the Fadama intervention in the area. The gap between the frontier and the estimates found for beneficiaries in this study is substantial (21%); hence the need for improvement in production techniques and resource allocation.

Allocative efficiency estimates of beneficiaries and non-beneficiaries

Table 3 indicates that the costs of land, fertilizer and the two types of labour were significant drivers of allocative efficiency among the two groups. Output for beneficiaries had a significant negative impact on allocative efficiency but not for the non-beneficiaries. Furthermore, output and family labour cost had the highest elasticities in the case of the beneficiaries. Over all, the elasticities of the variables for beneficiaries were higher than those of the non-beneficiaries. On average, the beneficiaries had a mean allocative efficiency estimate of 1.22 while the non-beneficiaries had 1.44 as the mean allocative efficiency, implying that beneficiaries were more allocatively efficient. The allocative efficiency estimate for beneficiaries is better than those found in non-interventionist based studies on the same area. Onuche and Oladipo (2020) found an allocative efficiency of 1.38 in a study in Kogi state. Similarly, Ani et al. (2013) reported an allocative efficiency estimate of 1.275 for groundnut farmers in Benue. Thus, the estimates found here imply that Fadama III had elicited significant improvement in resource allocation by farmers in Kogi state.

Comparisons of efficiency levels between of Beneficiaries and Non-beneficiaries of Fadama III

The technical efficiency estimates for beneficiaries ranged from 0.13 to 0.91 with an average of 0.79, while

Table 3. Maximum likelihood estimates for allocative efficiency for beneficiaries and non-beneficiaries of Fadama III programme in Kogi state

Variable	Parameter	Beneficiaries (coefficient)	Non-beneficiaries (coefficient)
Constant	β_0	1 079.0*** (1 116.1)	1.90*** (94.23)
Naira value of output	β_1	–203.3*** (–1 051.2)	0.005 (–0.40)
Cost of land	β_2	0.672*** (22.4)	0.77*** (42.48)
Cost of seed	β_3	–0.022 (0.81)	0.02 (1.49)
Cost of fertilizer	β_4	1.23*** (4.87)	0.008*** (5.70)
Quantity of chemicals	β_5	39.0** (2.21)	–0.002 (1.05)
Hired labour	β_6	0.15*** (4.15)	0.058*** (3.54)
Family labour	β_7	203.4*** (1036.3)	0.14*** (7.49)
Delta	δ	–3.80** (–2.30)	–4.70*** (1.15)
Sigma square	S^2	0.51*** (10.77)	0.57** (2.23)
Gamma	Γ	0.90*** (24.0)	0.99*** (73.7)
Log likelihood function = 46.7 LR test = 451.2			Log likelihood function = 913.0 LR test = 12.3
Mean	1.22	1.45	

Source: own elaboration based on field survey, 2017.

those of the non-beneficiaries ranged from 0.17 to 0.81 with a mean of 0.71 (Table 4).

Table 4. Technical and allocative efficiency estimates of beneficiaries and non-beneficiaries

Fadama III Status/ Statistics	Technical efficiency estimates	Allocative efficiency estimates
Beneficiary [Mean]	0.79	1.22
Minimum	0.13	1.14
Maximum	0.91	1.54
Coefficient of variation	0.22	0.063
Non-Beneficiary [Mean]	0.73	1.44
Minimum	0.17	1.37
Maximum	0.81	1.71
Coefficient of variation	0.19	0.046
t-test estimate	2.52 ($\alpha = 0.0124$)	–24.56 ($\alpha = 0.000$)

Source: own elaboration based on field survey, 2017.

Generally, coefficients of variation were low and their values indicate that the efficiency estimates were fairly uniform with both categories of farmers. The mean comparison of the technical efficiency levels of both categories indicates a t-estimate of 2.52 ($\alpha = 0.0124$) in favour of the beneficiaries. The t-estimate of –24.56 ($\alpha = 0.000$) also indicates that the beneficiaries performed better with respect to allocative efficiency.

CONCLUSION

In order to assess the impact of the Fadama III programme on the efficiency levels of benefiting farmers in Kogi state, this study compared their efficiency estimates with those of non-beneficiaries. The study revealed that due to the technical support and training they received, the beneficiaries of Fadama III were more efficient than their non-participating counterparts. However, the efficiency estimates leave substantial room for improvement. Improvements are needed to fill these substantial efficiency gaps. It is therefore recommended that beneficiaries be assisted with efficiency improving skills in the post-Fadama III era. Continuous training of farmers on up-to date skills will help impart the skills required to achieve improved efficiency.

This study has revealed the level of technical and allocative efficiency in Kogi state and indicated that although significant differences exist between the efficiency estimates of beneficiaries and non-beneficiaries, there exists the need for further improvements in order for the farmers to reach the economic efficiency frontier. This improvement has to be maintained in order to sustainably reduce poverty. It is therefore important to have a continuous documentation of the efficiency levels in the study area over time. Such investigations might also reveal the problems associated with the programme as regards enterprise efficiency, and reveal the sustainability status of the impact of the programme on production efficiency, as well as indicate areas for improvement.

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