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Effects of Fadama III Additional Financing on Food Security and Sufficiency: Empirical evidence from Rice Farmers in Nigeria

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Abstract

The study was based on the evaluation of the effects of Fadama III Additional Financing on food security and self-sufficiency among rice farming households in Benue State, Nigeria. Data were collected from a total sample of 625 respondents, including 358 participants and 267 non-participants. Descriptive statistics, food insecurity indicators, and endogenous switching regression models were used to achieve the study's objectives. The findings revealed that the level of food insecurity among participating and non-participating households was particularly high, estimated to be 46% and 56% respectively. Food insecurity was reduced significantly by 31% at 1% probability level among the beneficiaries due to participation in Fadama III AF. Food insecurity would have been reduced by 28% among the non-participating households if they had benefited from the project. The study concluded that Fadama III AF was a programme tailored towards improving farm household welfare. Therefore, it is recommended that the project be sustained and possibly improved through more investments and timely dissemination of weather forecasts to enable farmers to plan rice planting efficiently. Also, government should increase its intervention concerning the price of inputs such as seeds, and land through more targeted policies.

Keywords: Fadama, Food security, Regression model, Rice, Nigeria

Research article
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INTRODUCTION

The National Fadama Development Project (NFDP) is a national rural and agricultural development project with broad activities that include off-wet season farming, post-harvest processing, and value chain conducts. This is conceived in order to meet the teeming demand of growing population of Nigerians and to support judicious used of endowed human and material resources in the country (Kuza et al., 2018). This is necessary so that farmers can grow crops on consistent schedule and create more reliable food supply. The National Fadama Development Project was executed in phases between 1992-2015, as Fadama I, II, III, and Fadama III AF. Fadama1 and Fadama11 principally focused on provisions of irrigation facilities to crop farmers and other swamp resources users such as vulnerable, fishermen and marginalized groups were inclusive as beneficiaries (Agbarevo and Okwoche, 2014).

Furthermore, Fadama III and Fadama III AF were anchored on the participatory approach and adopted a multidimensional intervention comprising increased agricultural productivity and productive asset creation, enhanced access to rural services, and increase community entrepreneurship as well as institutional capacity (IFPRI, 2019).

Oredipe (2018) asserted that farmers that participated in the Fadama III Additional Financing earned over ₦303 billion from the cultivation of rice, cassava, sorghum and tomato thereby contributing to the development of the country agricultural sector through employment provision, food availability, affordability and self sufficiency within the national economy in Nigeria. Adewumi (2018) reported that a total of 3.69 million metric tonnes of rice, 841,054 tonnes of cassava, 1,497,366 tonnes of tomatoes, and 184,978 tonnes of sorghum were the individual yield contributions of the crops thereby boosting the total productivity.

Rice, also known as *Oryza sativa* (Asian rice) or *Oryza glaberrima* (African rice) is a popular staple crop in Nigeria. It is one of the common consumed staple food in Nigeria, and with the rapid growth in Nigeria's population, which is estimated to exceed 200 million by 2019, there is an abundant market for rice in the country due to geometric growth in population, and ease accessibility by most of the citizenry (KPMG, 2019; PWC, 2018)[.
Nigeria produced about 5MT of rice whereas consumption stood at about 6.5MT thereby leaving a gap of 1.5MT that need to be bridge through importation. Importation because the production capacity is below the demand thereby creating a widening supply-demand gap (USDA, 2016; Shettima et al, 2019).

Nigeria is blessed with abundant fertile land suitable for rice production and other agricultural activities. The country possess about 84 million hectares but only about 40% are under cultivation due to constraints such as lack of equipment and machineries to break the barrier of subsistence farming, inadequate credit and financial support, and storage facilities. Furthermore, the incessant increase in the cost of production inputs such as fertilizer, seeds and crop protection products have aggravated the constraints faced by smallholder's farmers (Lyndon, 2019; PWC, 2018).

The Fadama development programme has been studied extensively in past and recent research such as those (Gushibet et al., 2019; Mustapha et al., 2018; Jirgi et al., 2019 and Solomon, 2020). These studies were insightful because they show that the project and the

Fadama III Additional Financing (AF) had a desirable influence on participant income. However, some of these studies limited the scope of their study to either Local Government Areas and failed to look at the food security gap filled by the programme.
Based on Adeyemi et al, (2020) and Folorunso, (2015), there are element of biased in the estimates of the impact of Fadama on food security. Though the studies make used of multiple regression models, it run into self selection bias and endogeneity bias which were not accounted for.

Related studies results are diverse on the impacts of Fadama projects on the performance of the farmers. For instance, Ishiaku et al., (2017) asserted that participants were more efficient than non-participants though both were operating based on the level of available resources and technical know-how. In the same manner, Balogun et al., (2011) affirmed that beneficiaries of Fadama II project were technically more efficient than the non-beneficiaries with significant opportunities to improve their existing production level. Based on the aforementioned, the research is underscored by the existing gap.

The study intends to examine the effects of Fadama AF III program on rice farmers food security and self sufficiency in Nigeria. The specific objectives are to

i. Evaluate the food security status of the rice farmers of Fadama III additional financing in the study area;
ii. Assess the effects of Fadama III additional financing on the food security status of rice farmers in the study area;

Research Hypotheses

i. Ho_2: Fadama III additional financing programme has no significant effect on the food security of program participant rice farmer in the study area.

Theoretical Review

The framework used in this study was based on the notion of utility maximization. Suppose that $u_j$and $u_k$denotes an individual's utility from two choices, which are respectively, represented by

$I_j$and I_kThe linear random utility is expressed as:

$U_j$and $U_K$denote the perceived utilities of participation and non-participation choices *j* and k;

$X_j$and $X_k$denote the vectors of explanatory variables which affect the decision to participate or not to participate;

$\beta_j$and $\beta_k$are vectors of the parameter to be estimated;

$\varepsilon_j$and $\varepsilon_k$represent the error terms, which are assumed to be Independently and Identically Distributed (IID).

In the case of participation, if a rice farmer chooses option *j*, it then follows that the perceived utility from option *j* is greater than that from the other option, say k as indicated in Equation (1)

$$U_{ij} = \beta_i X_i + \varepsilon_j and U_{ik} = \beta_k X_k + \varepsilon_k \quad (1)$$

Where,

$$U_{ij} = (\beta_j X_j + \varepsilon_j) > U_{ik} = (\beta_k X_i + \varepsilon_k), k \neq j \quad (2)$$

The probability that a rice farmer will choose to participate is expressed as:

$$P\left(Y = \frac{1}{X}\right) = P(U_{ij} > U_{ik}) \quad (3)$$

$$= P(B_j X_j + \varepsilon_j - B_k X_k + \varepsilon_k > 0/X).$$

$$= P(B_j X_i + B_k X_i + \varepsilon_j - \varepsilon_k > 0/X) \quad (4)$$

$$= P(B^* X_i + \varepsilon^* 0|\mathrm{X} >= F(B^* X_i) \quad (5)$$

Where,

$P$is the probability function;

$\varepsilon^* = \varepsilon_j - \varepsilon_k$ is a random error term;

$F(B^* X_i)$is the cumulative distribution function of ε^* estimated at $B^* X_i$;

$B^* = B_j - B_k$ is a vector of the net effect of the explanatory variables affecting farmers decisions to participate in the programme (Adeyanju, et al., 2020).

METHODOLOGY

This study was conducted in Benue State, North central Nigeria. The State is located between Longitudes 7º47′E and 10º E and Latitudes 6º25′N and 8º8′N and shares boundaries with five other states namely: Nasarawa State to the north, Taraba State to the east, Cross River State to the south, Enugu State to the Southwest and Kogi State to the west (NPC, 2020) estimated Benue S State at a projected population of 5,787,708 people in 2019.

The State possess friendly weather atmosphere with a steady rainfall between April to October and temperature ranging between 23^{o}C-32^{o}C. Majority of the inhabitants engaged in farming and predominantly in the cultivation of arable crops such as rice, yams, soy beans, cassava, sesame, guinea maize, and groundnuts.

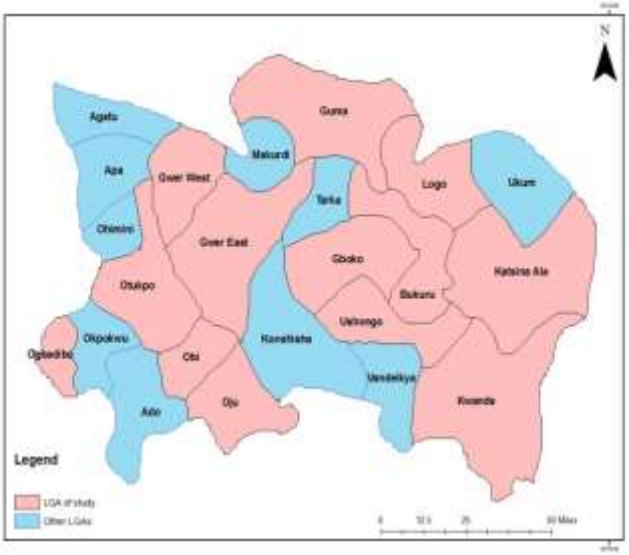

Figure 1. Map of Benue State, Nigeria showing Fadama III participating Local Government Areas

Yamane (1967) formula was used to determine the sample size for the participants and non-participants population:

$$n = \frac{N}{1+N(e^2)}. \quad (6)$$

Where *n* is the sample size, *N* is the population size, 1 is a constant and *e* is the level of significance (confidence interval of 95%). Since there are 3406 participants' rice farmers, then the sample was

$$n = \frac{3406}{1+3406\ (0.05^2)} = 357.96\ n\sim\ 358$$

Multi stage sampling was used in this study. The first stage was a purposive selection of the 13 (thirteen) participating Local Government Areas (LGAs) of Fadama III AF in the state that received inputs for one year. In the second stage purposive sampling was used to select farmers in the local government area who were rice farmers since the Fadama III AF programme targeted rice farmers in the Local government areas (non -participants). In the third stage, rice farmers who had taken part in the Fadama III AF programand the non-participants were selected through systematic random sampling. Since there was a list of rice farmers, this approach was preferred. The list of farmers (sampling frame) was accessed from the Benue State Agricultural and Development Authority (BNARDA), which comprised 3406 rice farmers from whom 358 participants were selected for the study, while another sampling frame, consisting of lists of (900) rice farmers from which 278 non-participants were also selected in the communities where the program was not conducted, was sought from the community leaders and BNARDA office to gather the non-participants but with socio-economic and biophysical characteristics comparable to the Fadama III AF project communities from the available baseline data, giving a total sample size of 625. The first farmer was chosen at random, while subsequent farmers were chosen in accordance with the formula given thus:

$$K\frac{N}{n} \quad (7)$$

Where k is the sampling interval, n is the sample size and N is the population size. An element was chosen from the list at random and every k^{th} element in the sampling frame selected.

Table 1. Sampling Procedure

LGAs	Sample Frame		Sample Size	
	Participants	Non- participants	Participants	Non- participants
Buruku	300	80	32	25
Gboko	565	150	59	46
Guma	550	80	58	25
Gwer- East	403	70	42	22
Gwer- West	110	50	12	15
Katsina-Ala	290	120	31	37
Kwande	230	55	24	6
Logo	150	100	16	17
Obi	155	60	16	31
Ogbadigbo	50	15	5	5
Oju	125	40	13	12
Otukpo	250	50	26	15
Ushongo	228	30	24	9
Total	**3406**	**900**	**358**	**267**

Source: Benue State Agricultural Rural Development Authority, BNARDA, 2019

This study does not measure the impact of Fadama III AF over time but rather effect at the time this study was done.The analysis of the food security of the rice farmers was done using the Household Food Insecurity Access Scale to accomplish objective (i). An endogenous switching regression model to achieve objectives ii, which involved looking at how the program affected the food security of the rice farmers. Last but not least, the z-test was employed to determine whether there is a significant difference between food securities of the participants and non- participants rice farmers.

To fulfil study objective (i), the average HFIAS score (Av HFIAS S), household food insecurity access prevalence, household food insecurity access-related conditions (HFIAC), and household food insecurity access-related domains (HFIAD) were taken into consideration (HFIAP).

$$HFIA\ Prevalence = \frac{(\ Number\ of\ households\ in\ HFIA\ category\ 1,2,3,or\ 4\ X100)}{Total\ number\ of\ households} \quad (8)$$

The ESR model was used to achieve objectives ii of the study. Under the assumption of endogenous switching between the selection and outcome models, the ESR model was estimated in three significant phases. In the first stage, the selection and outcomes' equations were estimated. The selection equation which was used to predict and explain the decision to take part in Fadama III AF was modeled as:

$$Y_{0i} = \alpha_{00} + X\alpha_0 + e_{0i} \\ = \alpha_{00} + \alpha_{01}x_{1i} + \alpha_{02}x_{2i} + \ldots + \alpha_{018}x_{0i} + e_{0i} \quad (9)$$

where:

Y_{1i} =Household food insecurity scale score under participation in Fadama III AF (Treatment group's outcome); F_{1i} =Household food insecurity scale score or poverty status under non-participation in Fadama III AF (Control group's outcome);

In other words, four expected outcome equations from equations can be expressed as:

$$E\left(Y_{1i}\left|D_i=1\right.\right) = \theta_1 + X_{1i}\alpha_1 + \sigma_{e_1u}\lambda_{1i} \quad (10)$$

$$E\left(Y_{0i}\left|D_i=1\right.\right) = \theta_1 + X_{0i}\alpha_1 + \sigma_{e_0u}\lambda_{1i} \quad (11)$$

$$E\left(Y_{0i}\left|D_i=0\right.\right) = \theta_0 + X_{0i}\alpha_0 + \sigma_{e_0u}\lambda_{0i} \quad (12)$$

$$E\left(Y_{1i}\left|D_i=0\right.\right) = \theta_0 + X_{1i}\alpha_0 + \sigma_{e_1u}\lambda_{0i} \quad (13)$$

where $E\left(Y_{1i}\left|D_i=1\right.\right)$ = Expected potential outcome of participating household under treatment; $E\left(Y_{0i}\left|D_i=1\right.\right)$ = Expected potential outcome of participating household under control; $E\left(Y_{1i}\left|D_i=0\right.\right)$ = Expected potential outcome of non-participating household under treatment; $E\left(Y_{0i}\left|D_i=0\right.\right)$ = Expected potential outcome of non-participating household under control; Finally, the impact parameters were estimated as:

$$\widehat{ATE} = E\left(Y_{1i}\left|D_i=1\right.\right) - E\left(Y_{0i}\left|D_i=0\right.\right) \quad (14)$$

$$\widehat{ATT} = E\left(Y_{1i}\left|D_i=1\right.\right) - E\left(Y_{0i}\left|D_i=1\right.\right) \quad (15)$$

$$\widehat{ATU} = E\left(Y_{1i}\left|D_i=0\right.\right) - E\left(Y_{0i}\left|D_i=0\right.\right) \quad (16)$$

where $\widehat{ATE}$ = average treatment effect; $\widehat{ATT}$ = average treatment effect on the treated; $\widehat{ATU}$ = average treatment effect on the untreated (control).

Hypotheses testing

Z – Statistic

The study's hypotheses were tested using the Z statistic.

$$z = \frac{Y_1 - Y_2}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}} \quad (17)$$

Where

Z = the value of the statistic

Y_1= mean of the annual rice production by the programme participants,

Y_2= mean of the annual rice production by the non-participants,

S_1^2 = variance of the annual rice production by the programme participants,

S_2^2= variance of the annual rice production by the non- participants,

n_1 = number of participants,

n_2= number of non-participants

Decision Rule
The z computed and z-tabulated was compared after the test. Accept the null hypothesis if the calculated z exceeds the tabulated z, and reject it otherwise.

RESULTS and DISCUSSION

Food security status of the participants and non-participants of Fadama III AF among rice farming households

The result of the analysis of household food insecurity access-related conditions (HFIAC) across participants and nonparticipants and according to their frequency-of-occurrence is presented in Table 2. A total of 58% of the households disagreed to be anxious and uncertain about food supply while the 6% and 41% indicated of being rarely and sometimes anxious and uncertain about it. No household reported being often anxious and uncertain about food supply. In general, the majority of households stated not using poor-quality food consumption and inadequate quantity of food as strategies to address the issue of food insecurity. For instance, in terms of poor-quality food consumption coping strategies, 54% claimed that they did not resort to non-preferred kinds of food, 54% affirmed that they did not use limited variety of food and 62% disagreed of employing non-preferred food.

Similarly, based on inadequate quantity of food coping strategies, 55% of households reported that they did not eat fewer meals in a day, 62% indicated that they did not experience total lack of food due to total lack of resources while 60% objected to going a whole day and night without eating anything due to lack of food. In terms of coping from food insecurity using poor-quality food consumption and inadequate quantity of food, only 3% of households reported of often using these methods. The majority of household who suffered from food insecurity affirmed that they sometimes used poor quality food consumption coping strategies (40% - 42%) and inadequate quantity of food coping strategies (3% - 39%). There were important differences between participating and non-participating in terms of HFIAC. There were more participating households (61%) than the non-participating ones (55%) that reported not being anxious and uncertain about food supply. The proportion of participating households that indicated not using poor-quality food consumption strategies ranged from 58 to 59% while that of the non-participating households ranged from 45 to 48%.

Also, 62% to 69% of participating households agreed that they did not use inadequate quantity of food coping strategies compared to 47% to 51% of non-participating households. A lower proportion of participating (34% - 35%) and non-participating (48% – 51%) households agreed that they sometimes used poor-quality food consumption coping strategies. Similarly, 3% to 32% of participant households stated that they sometimes used inadequate quantity of food coping strategies compared to 4% to 49% of participating households. These findings clearly showed that participating households had better food insecurity access-related conditions than the non-participating ones. Furthermore, it can be said that 39% and 53% of participating and non-participating households were anxious and uncertain about food supply, 41% and 53% used poor-quality food consumption coping strategies, and 35% and 50% used inadequate quantity of food coping strategies, respectively (Table 3).

Table 2. Household food insecurity access-related conditions at any time and at any frequency during the recall period by participation status in Fadama III AF

Household Food Insecurity Access-related Conditions	At any time (%)			At any frequency (%)								
	No			Rarely			Sometimes			Often		
	Part	Nonp	Total	Part	Nonp	Total	Part	Nonp	Total	Part	Nonp	Total
Anxiety and uncertainty about food supply	61	55	58	7	4	6	32	49	41	0	0	0
Poor quality food consumption coping strategies												
Non-preferred kinds of food	59	48	54	7	4	5	34	48	44	0	0	0
Limited variety of food	58	48	54	8	3	6	34	59	64	1	0	0
Non-preferred food	59	45	52	5	3	4	35	51	42	1	0	0
Inadequate quantity of food coping strategies												
Ate a smaller meal than they needed	62	47	55	6	4	5	32	49	41	0	1	0
Ate fewer meals in a day	63	65	62	30	45	38	3	4	3	4	1	2
Experienced total lack of food due to lack of resources	65	59	62	4	4	4	31	46	39	0	0	0
Went to sleep at night hungry due to lack of food	67	51	59	3	1	2	30	30	34	0	0	0
Going a whole day and night without eating anything due to lack of food	69	51	60	2	3	3	29	46	38	0	1	0

Source: Field Compilation (2022)

Rarely=Once or twice; Sometimes=Three to ten times; Often=More than ten times. Part=Participants; Non-P=Non-participants.

Table 3. Household food insecurity access-related domains by participation status in Fadama III AF

Food insecurity access-related domains	Participants	Nonparticipants	Total
Anxiety and uncertainty about food supply	39	53	46
Poor quality food consumption coping strategies	41	53	47
Inadequate quantity of food coping strategies	35	50	43

Source: Survey Data (2022)
Values in the tables are in percentages

According to Figure 2, the majority of both participating and non-participating households' food insecurity access scale scores were clustered at 0, but with the participating households having a higher frequency. Contrarily, non-participating households scored higher on the food insecurity access scale than participating households, which shows that the level of food insecurity was lower among participating households. Particularly, it was discovered that 54% of participating homes and 44% of non-participating households had food security (Table 4). In other words, food insecurity was more prevalent among non-participating households. Moreover, up to 52% of non-participating households were severely food insecure against 37% of participating households. In general, it can be said that food insecurity was very high among the sampled households with exactly up to half of them being food insecure. The results are consistent with earlier research, which showed that participants in Fadama III and Fadama III AF had better access to food than non-participants (Adetomiwa et al., 2020; Adeyemi et al., 2020; Folorunso, 2015; Ogunniyi et al., 2021).

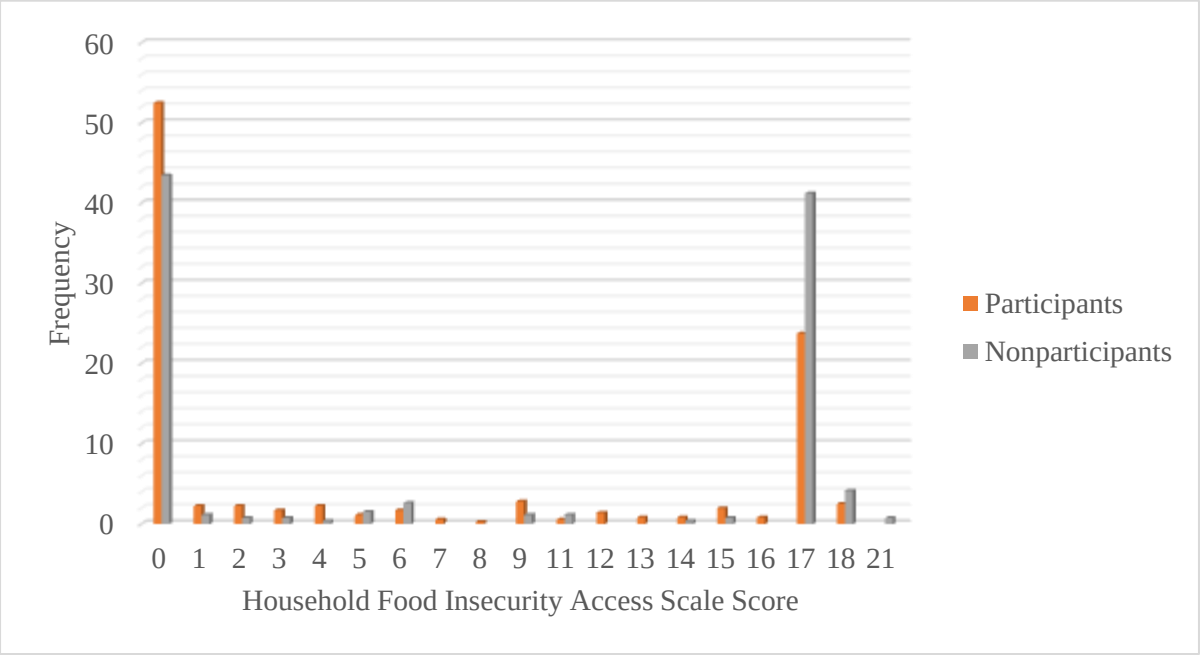

Figure 2. Frequency of household food insecurity access scale (HFIAS) score by participation status

Effects of Fadama III AF on food security and self sufficiency among rice farming households

The estimates of the endogenous switching regression model for food security are given in Table 5. All the independent variables included in the model, as a whole, significantly influenced not only the decision to participate in Fadama III AF but also the level of food security attained by the households (Wald =136.02, $p<0.01$). In other words, the model was insightful in explaining and predicting the decision to participate in Fadama III AF as well as the level of food security of the sampled households. The Chi-square test of independence between the decision to participate in Fadama III AF and the expected level of food security was significant, thereby justifying the assumption of endogenous switching and presence of sample selection bias in choosing whether or not to participate in Fadama III and the appropriateness of using the FIML estimator to estimate the model's parameters. But given the strong and negative correlation between the decision to participate in Fadama III AF and the level of food security among the participating households (Rho 1 = -0.373, $p<0.01$), it can be implied that the sample selection was negative; the negative sign indicates a positive bias, suggesting that farmers and that households with above than the average level of food insecurity access scale scores would be more likely to participate in Fadama III than their counterparts. This finding is consistent with earlier studies (Abdulai and Huffman, 2014; Abdulai and Binder, 2006; Barrett et al., 2012). Given the model, participation in Fadama III AF was significantly determined by marital status, household size, main occupation, farm size, rice earnings, farm assets, cooperative membership and number of years of cooperative membership.

Farm size appears to have differential impacts on participants and non- participants. Farm size on the other hand, has negative effect on the decision to participate representing diseconomies of scale (Blanc *et al*., 2016). This finding confirms with other result studies by (Bidzakin et al., 2019; Abdulla, 2015). Households with more rice earnings and farm assets, and households with more years of cooperative membership were more likely to participate in Fadama III AF than their counterparts. The findings are in line with okeke et al., (2019) in the study of effect of anchor borrower programme on rice farmers.

For both participating and non-participating households, households headed with farmers who had either secondary and tertiary education appeared to be more food insecure than those with either primary level of education. A result which is quite unexpected given the significance of education in terms of improving human capital and ultimately income level. Hence, the finding contradict the assertion of Folorunso, (2015) that concluded that education increased the probability to become food secure in Central States of Nigeria. Furthermore, the level of food insecurity increased with household size, which means that larger participating households will be less likely to be food secure than their counterparts. This finding is in agreement with Adeyemi et al., (2020) who found that household size had a negative and significant effect on food security in Benue State.

Similarly, earnings from other livelihood activities increased food security among both the participating and non-participating households, but its effect was smaller among the participating households. The finding is contrary to Gushibet et al., (2018), who found that farm income increased food security among the beneficiaries of Fadama III in Jos North Local Government Area of Plateau State.

Table 5. Full information maximum likelihood estimates of the switching regression model for food insecurity of participants and nonparticipants

	Participation (D = 1/0)			**Food security status for D = 1**			**Food security status for D = 0**		
Variables	**Coef.**	**SE**	***t*-value**	**Coef.**	**SE**	***t*-value**	**Coef.**	**SE**	***t*-value**
Constant	-4.722***	2.178	-2.168	-27.019***	10.524	-2.567	-19.76**	9.002	-2.195
Sex	0.144	0.141	1.027	-0.393	0.571	-0.689	-0.626	0.567	-1.104
Age	-0.018	0.05	-0.36	0.377**	0.191	1.969	1.412***	0.238	5.921
Squared age of rice farmer	0.0002	0.001	0.47	-0.003	0.002	-1.49	-0.014***	0.002	-5.751
Primary Education	0.107	0.257	0.415	-1.181	1.092	-1.082	-1.317	1.15	-1.146
Secondary Education	-0.093	0.231	-0.401	2.668***	0.871	3.063	3.449***	1.011	3.411
Tertiary Education	-0.077	0.226	-0.341	3.125***	0.918	3.405	3.566***	0.961	3.712
Marital status (Divorced, 0)	0.269	0.393	0.684	1.797*	1.728	1.04	-0.449	1.622	-0.277
Marital status (single)	-0.139	0.259	-0.537	-2.593**	1.226	-2.115	-1.237	1.16	-1.066
Mstatus widower	-0.438*	0.233	-1.879	1.264	1.092	1.158	3.05***	0.927	3.29
Household size	0.14***	0.037	3.76	0.279**	0.122	2.289	-0.107	0.183	-0.586
Main occupation	-0.198*	0.169	-1.171	2.976***	0.703	4.232	6.42***	0.674	9.53
Farm size	-0.751***	0.104	-7.226	0.32	0.546	0.586	2.28***	0.519	4.393
Total income excluding rice income	-0.179	0.134	-1.333	2.334***	0.664	3.514	3.072***	0.515	5.967
Log of rice income	0.328***	0.081	4.047	-1.882***	0.355	-5.295	-4.869***	0.387	-12.596
Non-farm asset owned	1E-05	1E-05	0.866	1E-04***	5E-05	2.514	1E-04*	6E-05	1.815
Square of non-farm asst owned	-6E-11	1E-10	-0.599	-6E-10*	4E-10	-1.778	-2E-09***	5E-10	-3.306
Farm asset owned	2E-05**	7E-06	2.232	5E-05**	3E-05	2.024	-8E-06	3E-05	-0.249
Square of farm asset owned	-2E-11	3E-11	-0.835	-1E-12	1E-10	-0.014	3E-10***	1E-10	2.705
Cooperative membership	1.947***	0.158	12.331						
Number of years in cooperative	0.183***	0.046	3.936						
Sigma 1	4.877***	0.195	25.016						
Sigma 2	4.218***	0.184	22.936						
Rho 1	-0.373***	0.107	-3.474						
Rho 2	-0.091	0.148	-0.612						
LR Chi2 test of indep.	9.98***								
LLF	-2071.84								
Observations	625								
Wald chi2	136.02***								
Prob > chi2	<0.001								

Source: Field Compilation (2022)

***<0.01, **<0.05 and *<0.1; SE=Standard Error.

The ATT estimate was about -2.8 and was statistically significant at 1% level of probability, which means that food insecurity access scale scores were reduced by 31%. In other words, food security increased by 31% among the participating households due to participation in Fadama III AF. Differently put, there was a positive and significant impact of participation in Fadama III AF on food security among the participating households. The result agrees with most previous studies such as (Gushibet et al., 2018; Mustapha et al., 2018; Solomon 2020).

Table 6. Estimates food insecurity access scale score, average treatment and heterogeneity effect estimates of participation in Fadama III AF

Outcome variables	Participation	Nonparticipation	Treatment effect	Change (%)
Participants in Fadama III AF	6.035 (0.307)***	8.803 (8.802)***	-2.767 (0.539)***	-31
Nonparticipants in Fadama III AF	6.187 (0.313)***	8.588 (0.435)***	-2.401 (0.536)***	-28
Both participants and nonparticipants	6.035 (0.307)***	8.588 (0.435)***	-2.553 (0.533)***	-30
Heterogeneity effects	BH_1 = -0.152	BH_2 = 0.215	TH = -0.367	

Source: Field Compilation (2022)

Values outside the brackets are average food insecurity access scale scores while those inside the brackets are standard deviations; ***<0.01, **<0.05 and *<0.1; BH=Biased Heterogeneity; TH=Treatment (Transitional) Heterogeneity; BH=Base Heterogeneity.

Similarly, the ATU estimate was about -2.4 and was statistically significant at 1% level of probability. The implication is that, if the nonparticipating households participated in the project, their food security level would have increased by 28%. In other words, there would have been a positive causal effect of participation in Fadama III AF on food security among the nonparticipating households had they participated in the project. On the other hand, the ATE estimate was about -2.6 and was statistically significant at 1% level of probability. Participation in Fadama III AF would have reduced food insecurity by 30% had the whole sampled households had participated in the project. According to transitional heterogeneity (TH) estimates, this measures whether the impact of participation in Fadama III AF was larger or smaller for households that participated or for households that did not. Had the non-participant households participated in the project, they would have experienced a better food security improvement than those that actually did participate.

Test of significance of the impact of Fadama III additional financing on food security status of participants

The null hypothesis that Fadama III has no impact on food security was statistically significant at 1% level of probability, which means that we can reject the null hypothesis in favour of the alternative. Therefore, it can be concluded that Fadama III has a negative and significant impact on food insecurity in the study area. In other words, that Fadama III has a positive and significant impact on food security in the study area.

Table 7. Impact of Fadama III additional financing on food insecurity

Hypothesis	Num. of participants	ATT	Std. Err.	z-value	*p*-value
Ho1	625	-2.77	0.54	-5.13***	<0.001

Source: Field Compilation (2022)
***<0.01.

CONCLUSION

The study explores the effects of Fadama III additional financing AF on the food securing and self sufficiency of rice farmers in Nigeria. The Fadama III additional financing, AF program has a considerable effects on the food security status of the rice farmers, contrary to the null hypothesis, which claims that there is no significant impact on Fadama III AF on food insecurity. Fadama III AF is food insecurity decreasing, that is, food insecurity declined in the State. Food security was positively influenced by household size, rice earnings, farm assets, and the number of years of cooperative membership. On the basis of the study's findings, the following recommendations are put forward:

i. Farmers should encouraged to form and join cooperative societies to enhance bulk purchase of input which will reduce input cost and ensure timely supply of same.
ii. Participation in Fadama III AF decreased food insecurity and poverty. Therefore, Fadama III is a program that can promote welfare and should be continued, potentially even improved, with additional funding and the elimination of gender bias by the inclusion of more women in the initiative.
iii. Rice farmers in the study area are severely hampered by climate fluctuation, making it impossible for them to plan their planting and other agricultural activities precisely. To give farmers more precise information for better planning and timely operation, meteorological station and other private agencies that disseminate weather forecasts should work to improve their service delivery to the farmers.

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