Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.9, No.6, 2018
www.iiste.org

Determinants of Yield among Rice Farmers: Evidence from Fadama III AF Project Intervention in Sokoto State

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Abstract
The major focus of this paper was to examine the factors that contribute to rice yield among Fadama III AF beneficiaries in the three senatorial zones of Sokoto state. A sample of one hundred and twenty (120) rice farmers was surveyed across the three senatorial zones of the state to identify the determinants of yield and compare yield between senatorial zones. The study hypothesized that farm specific and socioeconomics are directly related to farm yield. Findings of the study could provide important insights on how to improve farm productivity among farmers in the study area. Results of the study revealed that farm size, experience, income and variability due to difference in farm location influence farm yield among Fadama III AF supported rice farmers in Sokoto state. Similarly, the high average yield obtained by the farmers could be as a result of Fadama III AF support in the area. The study concluded that farm specific factors could be tapped to improve yield.
Keywords: Determinants, yield, rice, Fadama III AF, intervention

1. Introduction

In Nigeria, despite the rapid growth of oil industry, agriculture still remained one of the most viable sectors of the economy. The agricultural sector contributed 33% to GDP in 2013 based on the rebased GDP figures (NBS 2014). About 80% of the domestic food in the country, especially from crops and forestry is produced by small scale farmers. The fishery and livestock products are supplemented by imports. Agriculture, in addition to providing raw materials to the manufacturing industries, also serves as a source of foreign exchange earnings as well as economic development. It provide employment for about 80% of the Nigeria's rural poor population (NBS 2014). Despite the economic importance of agriculture in Nigeria, agricultural practices are still carried out using low level technology. Inputs use is inefficient and average production per hectare is 1.4 tons, much lower than world average (4 tons/ha). One of the most important threats to agricultural growth and productivity in Nigeria; is low farm output due to inefficient resource use (Ajebefun, 2002; Aye & Mungatana 2010; Bosello et al., 2013; Hassan et al., 2012; Ogundele & Okoruwa 2006; Placid, 2000). Low farm yield was not only a source of concern for the farmers, but policy makers as well who recognized the problem as major threat to the Nigeria's food security and overall economic development (Ibekwe, 2010).

A rational farmer maximizes the use of inputs to produce output in a farm unit. Agricultural productivity is measured as the ratio of agricultural outputs to agricultural inputs. Crop yield is the measurement often used for a cereal, grain or legume and is normally measured in metric tons per hectare (or kilograms per hectare). Crop yield can also refer to the actual seed generation from the plant. For example, a grain of rice yielding three new grains of rice would have a crop yield of 1:3. Results from several empirical studies indicated that farm yield could be influenced by farm socioeconomic characteristics such as education, credit, age, land holding, house size, livestock keeping, extension services, income level and gender (Safa, 2005; Mpawenimana, 2005; Mabe et al., 2010; Parvin and Aktezuzzaman 2013; Ibekwe 2010; Jerry and Williams 2000). Therefore to raise the much needed agricultural output among farmers, it is important to explore the role of these socioeconomic factors in promoting farm yield. In Nigeria despite the contribution of some studies in providing information on the determinants of yield among farmers there is still dearth in literature. Analyses of previous studies were confined to specific locations usually within the same agro ecological zones mostly in southern Nigeria. This makes it difficult to generalize the findings to the whole country. The current study hopes to contribute in bridging the gaps in literature by conducting statewide analysis of the role of farm specific factors to raising rice yield among Fadama III AF beneficiaries in Sokoto state.

This study is different from other studies by being one of the few studies to conduct a statewide analysis of the influence of socioeconomic factors in determining farm yield among Fadama III AF beneficiaries in Sokoto state. Including a dummy for the senatorial zones to observe yield variability in the 3 senatorial zones of the state was another unique contribution of the study. Results of the study may be beneficial to improving rice yield in the study area. The main motivation for the study was the concern for decline in farm yield and the potential of the area as the epicenter for agriculture.

2. National Fadama III Additional Financing (AF) Project

Fadama III Project which started in year 2009 was aimed at increasing the income of rural farmers on sustainable

basis through accessibility to land and water resources. Although Fadama III project had ended since year 2013, Fadama III Additional Financing (AF) was introduced following the successes of the parent project in the 36 states of Nigeria. Fadama III AF was declared effective on the 30th May, 2014, with an implementation period spanning from 30th May, 2014 to 30th December, 2017.

The Fadama III AF Project supports the continued operation of the National Fadama Coordination Office (NFCO). Fadama III AF is consistent with Fadama III Project, no major changes are proposed to the Project Development Objectives, design or implementation arrangements of the original project. Fadama III AF focus in particular on selected value chain crops, namely cassava, rice, sorghum and horticultural crops. One of the key paradigm shifts in the implementation of Fadama III AF is the use of Business Plan in the disbursement of funds to the farmers across value chains. Fadama III AF which is Agribusiness oriented is adopting Business Plan as a disbursement instrument to ensure the profitability of each value chain crop chosen by project farmers. The target beneficiaries are youth, women and vulnerable groups. The Project Development Objectives (PDO) of the Fadama III AF is to increase the incomes of the users of land and water resources on a sustainable basis.

3. Objectives of the Study

The general objectives of this study was to assess the contribution of socio economic characteristics of the farmer in determining rice yield among Fadama III AF beneficiaries in Sokoto states Specifically, the study hopes to achieve the following objectives:

1) To estimate the relationship between yield and socioeconomic factors among rice farmers.
2) To determine the role of socioeconomic factors in contributing to yield.
3) To study the variability of rice yield across the three senatorial zones.

4. Methodology

4.1 Study Area

Sokoto state was created on the 3rd of February 1976. It was carved out of the then north western State. The capital city is Sokoto. Major Cities include, Balle, Illela, Wamakko, Gada, Sabon Birni, Goronyo and Tambuwal. The region's lifeline for growing crops is the floodplains of the Sokoto-Rima river system which are covered with rich alluvial soil. For the rest, the general dryness of the region allows for few crops, millet perhaps being the most abundant, complemented by rice, corn, other cereals and beans. Apart from tomatoes, few vegetables grow in the region. Agriculture is the predominant occupation of the people. Geographic Profile: Sokoto State is in the dry Sahel, surrounded by sandy savannah and isolated hills with an annual average temperature of 28.3 °C (82.9 °F). The State is mainly populated by Hausas and Fulani people. Most residents are Sunni Muslims. The state has 23 LGAs: Binji, Bodinga, Dange Shuni, Gada, Goronyo, Gudu, Gwadabawa, Illela, Isa, Kebbe, Kware, Rabah, Sabon Birni, Shagari, Silame, Sokoto North, Sokoto South, Tambuwal, Tangaza, Tureta, Wamako, Wurno,Yabo. The state is richly endowed with a lot of minerals resources.

4.2 Sampling and Data collection

Data was collected at district level using a structured questionnaire. The questionnaire was made up four parts. Part 1 covered questions on agricultural/environmental problems affecting the area. Part 2 considered crop production practices, production cost and crop yield, part 3 dealt with the economic characteristics of the respondents, the last section centered on the respondent's demographic variables. A list of farmers obtained from Fadama III AF beneficiaries serves as the sampling frame which was used to draw the sample for the study. The study population consisted of farmers who are beneficiaries of National Fadama III AF project in Sokoto state. The units of analysis were farmers who produced rice crop under the intervention of national fadama III AF project in the area. To enable the study include respondents with the desired characteristics, multi stage sampling was used. At the first stage two local government areas each from Sokoto central (Sokoto south, Kware) and Sokoto east (Gada, Rabah) senatorial zones and one local government area from Sokoto south (Tambuwal) were purposively selected. Selection of the local government areas was done purposely to include areas with large scale rice production. At the second stage in each local government area farmers were randomly selected. A total of 136 respondents were selected but only 100 useable surveys were realized

4.3 Model Specification

$$Y = b_0 + b_{1X1} + b_{2X2} + b_{3X3} + b_n x_n + u \quad (1)$$

Where β_i's are Parameters to be estimated, Y denote yield, X's are set of socio economic variables and U is the error term

4.4 Variables for the Study

Dependent variable: The dependent variable for the analysis in this study is the farm yield/ha of rice crop. It was obtained from the survey data as the product of farm harvest/ha for each respondent in the area.

Explanatory variables: Socio economic variables that were hypothesized to affect yield in rice farms were used as the explanatory variables in this study.
Socio economic variables: The study examined the effect of relevant socio economic variables on rice yield. The variables considered were age, gender, marital status, education, market distance, livestock, credit, marital status, education, experience, household size and farm size, extension and income. A dummy for the senatorial zone was also modeled to observe the impact of different zones in contributing to rice crop yield.

4.5 Data Analysis
Data on rice production clusters under Fadama III AF project intervention at local government level for 2017 dry season farming using a structured questionnaire was used for the study. Data for the study covered the three senatorial zones in the state. The local governments covered were Tambuwal representing (Sokoto South), Kware and Sokoto south for (Sokoto Central) and Rabah and Gada from (Sokoto East). The questionnaire was designed to collect data about agricultural activities of the farmers that cultivate rice under the Fadama III AF project support from 3 senatorial zones in Sokoto state. The questionnaires were used to collect farm level data from the selected farmers. It aimed at collecting information on relevant variables that explained variations in farm yield, crop production practices, soil type, and socioeconomic factors. The questionnaire was divided into 4 parts. Part I related to questions on agricultural/environmental problems affecting the area. Part 2 focused on rice production practices, part 3 dealt with the economic characteristics of the respondents, and finally part 4 centered on the respondents demographic variables.

4.6 Estimation Procedure
Stata and SPSS statistical packages were used to estimate the model for Sokoto state. Model estimation was done in stages. Firstly, multiple regression analysis was used to estimate the relationship between the dependent and the independent variables. At the second stage single factor ANOVA was conducted to compare means for the yield in the three zones and to determine if there was a significant difference between yields. ANOVA was used to test the following two hypotheses:

$$H_o: \mu_1 = \mu_2 = \mu_3 = \mu_4 \quad (2)$$

$$H_1: \mu_i \neq \mu_j \text{ for at least one i and one j} \quad (3)$$

where μ is a treatment mean. The F test was used to determine which hypothesis was accepted.

Lastly, Bonferroni corrected post hoc t test was used to reduce the chances of obtaining false-positive results (type I error). With an econometric model the impact the independent variables exerts on a dependent variable can be observed. Common problems however existed in the estimation of econometric variables such as the potential problems with estimation of the regression models. This might lead to the violation of the basic assumptions of classical linear regression models, these include multicollinearity, heteroscedasticity, outliers and measurement errors. To correct for these and ensure efficiency in the estimation, this study dealt with the problems which are typical to most cross sectional data as follows. White heteroscedasticity test was conducted which showed that the presence of heteroscedasticity does not exist in the dataset. The data was tested for normally using skewness and kurtosis normality test. Outliers were also identified and removed from the dataset. To improve the efficiency of estimators robust standard error estimation was used. Some variables such as access to extension, education, marital status, credit which do not improve the model and were not significant were excluded from the model.

5. Results and Discussion

5.1 Descriptive statistics
A summary of the basic statistic of the data set for the variables used in the study is presented in Table 1 below. The result showed that the mean for age was 40.89 years, gender 0.95, marital status 0.97, education 8.97 years, farm size 1.64 hectares, household size 11.38, experience 22.24 years, income ₦278,120 extension 3.36 contacts, credit ₦24,000 and 6.69 animals per household. The average yield of Fadama III AF supported farmers in the state was 4830kg/ha. On the basis of senatorial zone it was 9305kg/ha for Sokoto south, 3111kg/ha for Sokoto east and 4775kg/ ha for Sokoto central.

Table 6: Descriptive statistics for the variables used in the study

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Age (years)	100	40.89	11.021	17	70
Gender (dummy)	-	0.95	0.219	0	1
Marital status (dummy)	-	0.97	0.171	0	1
Education (years)	-	8.97	3.891	6	18
Farm size (ha)	-	1.649	1.531	1	15
Household size(No)	-	11.38	6.502	0	40
Experience (years)	-	22.24	11.285	2	50
Income (N)	-	278120	288654	30000	1500000
Extension contact (No)	-	3.36	2.037	0	10
Credit	-	24000	87038	0	500000
Livestock (No)	-	6.69	6.255	0	25
Yield/ha	-	4830	5655	500	40000
Senatorial zone					
Sokoto south(Yield/ha)	17	9305	9612	1200	40000
Sokoto east (Yield/ha)	43	3111	1981	800	8000
Sokoto central (Yield/ha)	40	4775	5202	500	26000

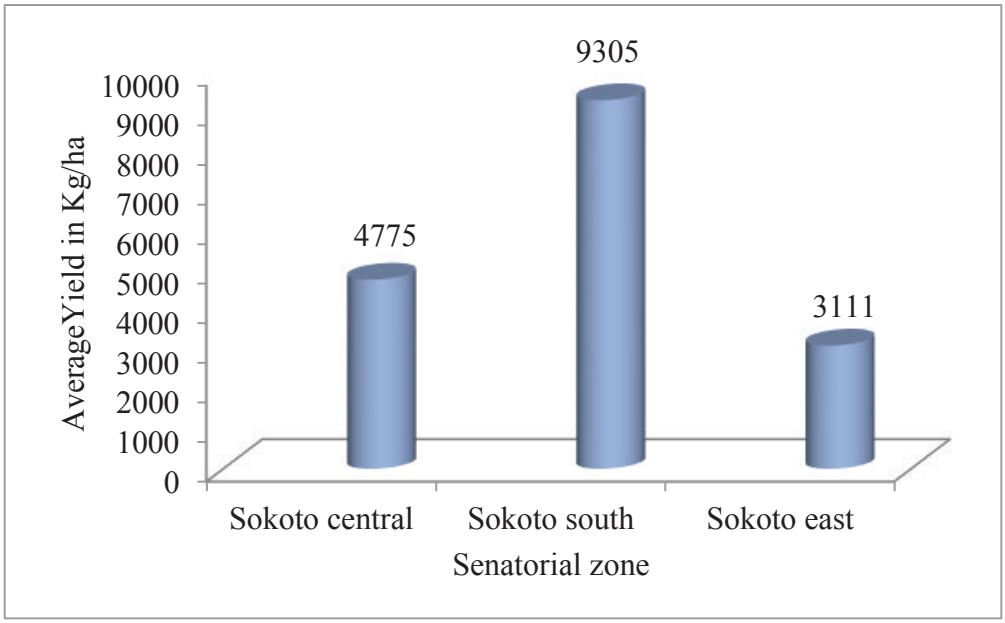

Figure 1: Average yield for the three senatorial zones

5.2 Result of the Regression for the Determinants of Rice Yield

Result of the regression for the determinants of farm yield is presented in Table 2. Findings of the study showed that the coefficient for farm size was negative and had a value of 52020. The coefficient was however, statistically significant at 1%. Similarly, the coefficients for gender and household size were negative but not statistically significant. The coefficient for experience was positive with a value of 117.26, the coefficient was significant at 5%. The variable for income was positive but not significant. In addition, the coefficients for the two senatorial zones included in the model were significant. The dummy coefficient for Sokoto south was positively related to yield with a value of 4101 while the coefficient for Sokoto east was negatively signed with a value of 2342.

Table 7: Regression results for the determinants of rice yield

Variable	Coefficient	Standard error	t value	P>|t|
Constant	1977.718	1351.716	1.46	0.147
Gender	−1961.117	1544.718	−1.27	0.207
Farm size	−52020.04***	10142.59	−5.13	0.000
Household size	−29.16223	73.12313	−0.40	0.691
Experience	117.26**	52.876	2.22	0.029
Income	0.00380*	0.00216	1.76	0.082
Senatorial zone				
2	−2342.705**	1002.926	-2.34	0.022
3	4101.021**	1879.913	2.18	0.032
Observations	100			
F	4.76			
R squared	32			

Note: p-value ***, significant at 1%; **significant at 5%; * significant at 10%; 2= Sokoto east
3=Sokoto south

The result of the ANOVA test shown in Table 3 below was statistically significant and the null hypothesis (H_o) was rejected. This implies that there were significant differences between at least two of the means of the three senatorial zones. But this does not tell you which means are different. To determine which means are significantly different, this study used the Bonferroni correction method to determine this. The Bonferroni correction is used to reduce the chances of obtaining false-positive results (type I errors) when multiple pair wise tests are performed on a single set of data. Bonferroni correction compared the means for Sokoto south with the mean for Sokoto central, then the mean for Sokoto central was compared with the mean for Sokoto east and then Sokoto south with Sokoto east. The result showed that the mean yield for Sokoto south does not differ significantly with the mean yield for Sokoto central. Similarly, the mean yield for Sokoto central does not differ significantly with mean yield for Sokoto east. But the mean yield for Sokoto south differs significantly with the mean yield for Sokoto east.

Table 3: Summary of ANOVA single factor

Groups	Count	Sum	Average	Variance
Sokoto central	40	191000	4775	27067564
Sokoto south	17	158200	9305.882	92390588
Sokoto east	43	133800	3111.627	3925814

Table 4: Result for t-test two sample assuming equal variances and post-hoc test

	Sokoto South Vs. Sok-Central	Sok-Central Vs. Sokoto East	Sokoto South Vs. East
Mean	9305 : 4775	4775: 3111	9305: 3111
Variance	92390588 27067568	27067564 3925814	92390588 3925814
Observations	17 / 40	40 / 40	17 / 43
Hypoth. mean diff.	0	0	0
t statistics	2.30	1.95	4.06
P(T<=t) two-tail	0.0249	0.0545	0.000
t Critical two-tail	2.00	1.989	2.00
Bonferroni correction	0.0167	0.0167	0.0167
	0.0249<0.0167 (False) Mean yield for Sokoto south not significantly different from mean yield of Sokoto central	0.0545<0.0167 (False) Mean yield for Sokoto central not significantly different from mean yield of Sokoto east	0.000<0.0167 (True) Mean yield for Sokoto south is significantly different from the mean yield of Sokoto east

6. Discussion

The study assessed the contribution of farm characteristics on the yield of rice farmers in Fadama III supported area across the three senatorial zones in Sokoto State. Findings of the study showed that farm size of the farmer; income and farming experience have a strong relationship with yield. Farm size had a negative relationship with yield. The result showed that when a farmer increased his farm size by one hectare there will be a corresponding decrease in the yield of rice crop by about 5202 kilograms the result was statistically significant at 1%. This finding showed that farmers that cultivate larger farms were not able to manage and utilize resources efficiently

especially because most of the farmers were using traditional methods and farm tools, hence low productivity. This finding is consistent to Adesoji & Farinde (2006). The variable for farm experience was positively related to yield and the result was significant at 5%. This finding indicated that farming experience is an important determinant of farm yield. Experience is necessary for raising yield because experienced farmers may apply their skill and knowledge in providing best farm practices and planning. Similar finding was made by Anigbogu *et al.,* 2015. Farmer income was another variable that showed positive and statistically significant relationship with yield. Little number of farmers with access to credit and the small amount they receive might be the reason for the low impact of the variable in the model.

This result suggested that income can positively contribute to yield. This could be explained by the fact that farmers with higher income have the ability to apply correct cultural and managerial practices, in addition, they would be able to buy and appropriately utilize inputs. This result supports the findings of (Anigbogu *et al.,* 2015; Garoma *et al.,* 2013; Di Falco *et al.,* 2011). House size and gender were other socio economic variables that could explain variation in yield which were included in the analysis. Results from the study showed that the coefficients for both house size and gender were negative but not significant. Women had ₦1961 less revenue than Men. Women could be associated with low revenue because they lacked control over resources, cultivated smaller farms and in addition were subjected to various kinds of discrimination which affected their ability to achieve higher farm income Al-Hassan (2012); Khai and Yabe (2011); Kuwornu *et al.,* (2013); Ogunniyi (2012) made the same observations and concluded that Men achieve higher revenue over Women due to their physical stamina, scale of operation and control of resources.

In order to observe if there was variation due to different locations the study modeled a dummy for senatorial zone as a proxy for ecological zones. Analysis of the study showed that yield varies according to zones. Farmers in Sokoto south senatorial zone have 4101 kg/ha higher yield than farmers from Sokoto central while farmers from Sokoto east had 2342kg/ha less yield than farmers from Sokoto central. This indicated that farmers from Sokoto south have higher yield, followed by Farmers from Sokoto central while farmers from Sokoto east had the least yield. The average yield of the farmers obtained in the study showed that generally farmers supported by Fadama III AF have significantly higher yield (4830kg/ha) than the farmers not supported by Fadama III AF who in most cases reported less than 2000 kg/ha. This underscores the impact of Fadama III AF intervention in the state. Fadama III AF provides support and assistance to farmers in terms of inputs, infrastructure and technical advisory services. This could be reason for the high yield of the farmers supported by Fadama III AF. This indicates that Fadama III AF project is making a positive impact by raising the productivity of the farmers hence the objectives of the Fadama project are being achieved in the state. This finding was consistent with the findings of (Illo *et. al.,* 2015; Lawal 2013; Olaolu *et. al.,* 2013; Ogwumba and Okechukwu 2014). These studies also assessed the impact of Fadama III in raising farm yield in other states of Nigeria.

7. Conclusion and Policy Implications

It is necessary to identify the role of socio economic characteristics on yield in Sokoto state in view of the importance of agriculture to the state. Few studies considered this kind of analysis. This study made significant contribution to literature by examining the impact of socioeconomic factors on yield of rice among farmers in Fadama III AF intervention areas in Sokoto state. One unique finding of the study was that farmers from Sokoto south senatorial zone were found to have more yield than farmers from Sokoto central and Sokoto east. Farmers in Sokoto south senatorial zone may be associated with higher yield due to their resource use efficiency, commitment and favorable climate and socioeconomic characteristics. The implication is that farmers from Sokoto central and east have more to benefit by exploring their socio economic factors. The main findings of this study was supported by the findings of previous studies (Ibekwe 2010; Williams and Jerry 2000; Mabe *et al.,* 2010; Mpawemina 2005; Parvin and Akteruzzaman 2013; Safa 2005). In their analyses they reported that farmer socioeconomic characteristics were important determinants of yield. Another notable finding of the study was that the average yield of the farmers supported by Fadama III AF program is by far greater than yield obtained by farmers not supported by Fadama III AF. This reflects the positive contribution of Fadama III towards improving agriculture in the state.

The study provided a sound empirical evidence of the impact of socio economic factors on farm yield among Fadama III AF supported rice farmers in Sokoto state. This study was distinguished from previous similar studies in the following ways. Firstly, the analysis of the current study was based on Fadama III AF supported rice farmers, results of the study could be used as a measure to assess the performance and impact of the program in the area. Secondly, the study introduces a dummy for senatorial zones this will make it possible to observe variation in yield of farmers from the three senatorial zones in the state. Government and other stakeholders should promote the use of socio economic factors to increase farm yield among farmers in the area. Some of the limitations of the current study were that only certain farm specific factors were considered and the analysis was based on one crop and do not cover the whole state. Future researches should include more factors that are

known to affect farm yield and ensure wider coverage in their analyses.

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