Journal of Agriculture and Environment Vol. 14 No. 1, 2018: 11-19
ISSN 1595-465X

ANALYSIS OF ALLOCATIVE EFFICIENCY IN RICE PRODUCTION UNDER THE NATIONAL PROGRAMME FOR FOOD SECURITY (NPFS) IN THE FEDERAL CAPITAL TERRITORY, NIGERIA: IMPLICATIONS FOR FUTURE INVESTMENT STRATEGIES

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ABSTRACT

This study analysed the allocative efficiency of rice production under the National Programme for Food Security (NPFS) in the Federal Capital Territory, Nigeria, with a view to guide future investment strategies. A multi-stage sampling technique was used to obtained data from 145 farmers with the aid of questionnaire. Data were analyzed using descriptive statistics and stochastic frontier production function. Majority (88%) of the respondents were males, and the average age of the respondents was 39.21 years. About 55% of them had one form of formal education or the other, while 63.5% of the respondents had access to credit of ₦74,508 on average. The diagnostic statistics; gamma (0.999) and sigma squared (2.492), were statistically significant at 1% probability level. Farmers operated below the maximum efficiency with a mean of (0.677) denoting an average farmer’s prospect of 32% improvement in utilization of resources. Education, access to credit facilities, membership of cooperatives and years of farming experience were observed to significantly influence the allocative efficiency of farmers. Government policy aimed at educating the farmers should be put in place to enhance their allocative efficiency. Input supply policy should be improved, while farmers should form cooperative societies to enable them access credit to improve rice production.

Keywords: Rice production; Allocative efficiency; National Programme for Food Security

INTRODUCTION

Rice has become one of Nigeria's leading food staples, but its consumption has outpaced production. As the most populous country in Africa south of the Sahara—one out of every five people in the region is a Nigerian (World Bank, 1992)—Nigeria has risen to become one of the leading importers of rice worldwide (Aboloma, 2016). In fact, by 2011, about half of the rice consumed in Nigeria was imported (Gyimah-Brempong *et al.*, (2016). The economic and cultural importance of rice as well as its crucial role in food security has turned rice to extremely “strategic product” along with wheat in many developing countries, including Nigeria, and as a result, reducing import dependence is now a major goal of Nigerian policy makers (Tijjani and Bakari, 2014). Moreover, given that a large amount of rice is now being consumed by low-income households in Nigeria, rice has become an important component of household food security (Ojeleye, 2015; Gyimah-Brempong *et al.*, 2016).

Nigeria has a potential land area for rice production. Suitable land area that could be cultivated is roughly 4.7 million hectares, but only 2.7 million hectares were devoted to rice (Diagne *et al*., 2011). However, the total paddy harvest in the country rose from under one million tons in 1970s to 4.2 million tons in 2010, yet, production has not keep pace with demand (Diagne *et al*., 2011). In fact, in 2014 alone, Nigeria spent over ₦365 billion on rice importations, which translate to about ₦1 billion per day (Central Bank of Nigeria CBN, 2015). This has become a source of serious concern by both citizens and government. CBN (2015) further reported that the Federal Government of Nigeria spent $2.41 billion on rice importation between January, 2012 and May, 2015.

While this dependence on rice imports is a major concern of Nigeria's government, numerous programmes set up to encourage domestic rice production and reduce import dependence were pursued to transform the Nigerian rice sector into a more productive one that can compete with foreign imports. One of such programmes is the National Programme for Food Security (NPFS) rice production sub-sector, whose broad objective is to attain food security and alleviate rural poverty in Nigeria (Federal Ministry of Agriculture and Water Resources/Food and Agriculture Organization, FMAWR/FAO, 2004). One of its specific objectives is to assist farmers in achieving their potential for increased output and productivity and, consequently increased incomes on a sustainable basis. Gyimah-Brempong *et al.* (2016), have noted that, policies that promote domestic rice production are likely to meet the demand for Nigerian rice in a way that benefits the poor. It can better their economy status and enhance the escape from economic trap occasioned by poor resource predicament of small scale farmers.

The intended goal for rice farmers to reach and sustain economic gains driven by high national rice demand is an indication that signals the need to measure their performance. In this regard, most of the published researches are skewed toward examining technical efficiencies alone (Kebede 2001; Villano, 2005; Tijani, 2006; Abedullah and Khalid, 2007; Wakili and Abu, 2015). By focusing only on technical efficiency, such works have ignored the gains in output that could be obtained in the short run by also improving the allocative efficiency. Allocative efficiency measures how an enterprise uses production inputs optimally in the right combination to maximize profits (Inoni, 2007). Thus, the allocatively efficient level of production is where the farm operates at the least-cost combination of inputs. Therefore, the aim of this paper is to evaluate the level of allocative efficiency for sampled rice farmers under NPFS programme in the Federal Capital Territory. The relationship between allocative efficiency and various socioeconomic characteristics of the rice farmers is also investigated vis-à-vis the economic efficiency of inputs.

MATERIALS AND METHODS

The study area is the Federal Capital Territory, commonly known as FCT, located in central Nigeria. FCT was created in 1976 from parts of Nasarawa, Niger and Kogi states. It is within in the Middle Belt region of the country. The Federal Capital Territory has a landmass of approximately 7,315 km^2, and it is situated within the Savannah region. The crops grown include rice, maize, garden egg, yams, maize and the livestock kept include goat, sheep and cattle by the native tribes which include Gbagyi (Gwari) as the major language, Bassa, Gwandara, Gade, Ganagana, Koro etc (Adejoh, 2014).

A multistage sampling technique was adopted for this study. The first stage involved purposive selection of villages that are participating in the NPFS rice production programme in the Federal Capital Territory (FCT), which include Pandagi site, Kawu site, Kilankwa site I, and Kilankwa site II. The second stage involved a 100% selection of all the farmers participating in the rice production scheme from each of the NPFS sites, giving a sample size of 145 respondents. Primary data were collected through personal interview with the rice farmers under the NPFS, using structured questionnaires, while descriptive statistics and stochastic frontier production function were used in the analysis of data obtained.

Analytical Technique

Stochastic Frontier Function

The stochastic frontier function is implicitly express as:

$$Y_i = f\left(X_{ij};\ ß\right) + V_i - U_i \quad (i = 1, 2, n) \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. \ (1)$$

Y_i is Output of the *ith* firm; X_{ij} is Vector of actual *jth* inputs used by the *ith* firm; *ß* is Vector of production coefficients to be estimated; V_i is Random variability in the production that cannot be influenced by the firm and U_i is deviation from maximum potential output attributable to technical inefficiency of *ith* farmer.

The above specification is expressed in terms of a production function, with the *Ui* interpreted as technical inefficiency effects, which cause the firm to operate below the stochastic production frontier. To specify a stochastic frontier cost function, the error term specification is simply altered from *(Vi - Ui)* to *(Vi + Ui).* This substitution would transform the production function defined by (1) into the cost function:

The stochastic frontier cost function is specified as:

$$LnC_a = f(P_a, Y_a : ß) + (V_i + U_i) \ \ldots\ldots\ldots\ldots\ldots\ldots \ \ldots\ldots\ldots\ldots (2)$$

Where: C_a is total cost of production of the *ith* firm, *f is* a notation for the functional form of the model, P_a is input prices, Y_a is Output of the *ith* firm, *ß* is Parameters to be estimated, V_i is Systematic component which represents random disturbance cost due to factors outside the scope of the firm, U_i is one sided disturbance term used to represent cost inefficiency and is independent of V_i.

The cost efficiency (*CE*) of an individual firm is defined in terms of the ratio of observed cost (C^b) to the corresponding minimum cost (C^{min}) under a given technology:

$$CE = exp(U) \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (3)$$

Where: *CE* = Cost efficiency, C^b = the observed cost and represents the actual total production cost; C^{min} = the minimum cost and represents the frontier total production cost.

In this study, the empirical model of the stochastic frontier cost function is specified as:

$$LnC_1 = \beta_0 + \beta_1 lnP_1 + \beta_2 lnP_2 + \ldots + \beta_6 lnP_6 + V_i + U_i \ldots\ldots\ldots\ldots\ldots..(4)$$

Where: C_1 is Total production cost (Naira), P_1 is Cost of fertilizer (Naira), P_2 is Cost of herbicides (Naira), P_3 is Cost of rice seed (Naira), P_4 is Cost of labour (Naira), P_5 is Cost of transport (Naira), P_6 is Cost of ploughing (Naira), Y_1 is output of rice (kg). The Vi are random variables which are assumed to be normally distributed $N(0, \sigma V^2)$, and independent of the U_i which are non-negative random variables, assumed to be half normally distributed $|N(0, \sigma U^2)|$ and account for the cost inefficiency in production.

The cost inefficiency model is specified as follows:

$$CE = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(5)$$

Where: *CE* is Cost inefficiency effect of *ith* farmer, Z_1 is Age of farmer (years), Z_2 is Years of formal education (years), Z_3 is Farming experience (years), Z_4 is Extension contact (1 contacted, 0 otherwise), Z_5 is Family size (total number of person in household) and δ is Parameter to be estimated.

The allocative efficiency of individual farmers is defined in terms of the ratio of the predicted minimum cost (C_i*) to observed cost (C_i) (Aboki *et al*., 2013 Tijjani and Bakari, 2014).

That is; $AE = Ci*/Ci = exp\,(Ui) \ldots\ldots\ldots\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ (6)$

Thus, allocative efficiency is an inverse function of cost efficiency and so, ranges between zero and one. The parameters of the stochastic frontier cost function and cost inefficiency were estimated using the computer program FRONTIER 4.1

RESULTS AND DISCUSSION

The distribution of the respondents' socio-economic characteristics is presented in Table 1. The distribution of the respondents by their gender indicates that 87.59% were male while 12.41% were female, implying that men were more engaged in rice production in the study area than women. The household size distribution however shows that about 41.38% had household size between 1-5 members, 50.34% had 6-10, and 8.28% had greater than 10 family members. The average household size was 6 members per household. This implies that the farmers in the study area have advantage of family labour for farm work, thereby reducing the cost of hired labour. However, large household size may increase household food consumption expenditure which can reduce the money that could be used for production purposes. Furthermore, respondents' distribution by their educational level is also shown in Table 1. About 46% of the respondents had no formal education, 31.72% had primary education and 17.93% had secondary education and 4.83% had tertiary education. Education is one of the key variables needed to foster productivity in any profession. Ogundari (2006) noted that education is needed to enhance productivity among farming households in Nigeria. It is likely that good education propels farmers to adopt innovations and technologies that are vital to enhancing productivity. The respondents' distribution by their farm size (also in Table 1) showed that 45.52% had 0.1-1.0ha, 32.41% had between 1.1-2.0ha, 13.10% had between 2.1-3.0ha, while 8.97% had farm lands greater than 3.0ha. The average farm size among the respondents is 1.63ha. This implies that rice farmers under NPFS in the study area are predominantly small-scale farmers. Maurice (2004) in his study on resource productivity in rice production among Fadama farmers in Adamawa State reported that the average farm size is 0.30 hectare. Small farm size is an impediment to agricultural mechanization because it impedes use of farm machines. On accessibility to credit which is expected to increase farmers' liquidity and consequently enhance their ability to purchase farm inputs and pay for hired labour, the results are equally as presented in Table 1, which shows the distribution of the respondents by the amount of credit received. The results revealed that 36.55% had no access to credit, while 47.58% had less than ₦100,000. Only 10.34% had access to ₦150,000 and above. The average credit accessed was observed to be ₦74,508, which is rather considered low.

Table 1: Socio-Economic variables of respondents

Socio-Economic Variables	Frequency	Percentage	Average (Mean)	Min/Maximum
Gender of Respondent				
Male	127	87.59		
Female	18	12.41		
Age (Years)				
21-40	78	53.79	39.21	20/68
>41	67	46.21		
Household Size				
1-5	60	41.38	6	1/14
6-10	73	50.34		
>10	12	8.28		
Level of Education				
No formal education	66	45.52		
Primary education	46	31.72		
Secondary education	26	17.93		
Tertiary education	7	4.83		
Farm Size				
0.1-1.0	66	45.52	1.63	0.4/4.5
1.1-2.0	47	32.41		
2.1-3.0	19	13.10		
> 3	13	8.97		
Membership of Cooperatives (summed years)				
Non-members	19	13.10		4/17
1-5	30	20.69		
6-10	94	64.83		
11-15	2	1.38		
Credit Access (₦)				
No credit	53	36.55		42,000/310,000
1-50,000	54	37.24		
50,001-100,000	15	10.34	74,508	
100,001-150,000	8	5.52		
> 150,000	15	10.34		
Total (n)	145	100		

Source: Field Survey.

Allocative Efficiency Analysis

The maximum likelihood estimates of the stochastic frontier cost function of rice farmers under NPFS is presented in Table 2. The sigma square (δ^2) (2.49) was significant at 1%. This indicates the goodness of fit and correctness of the specified assumption of the composite error term distribution. Furthermore, the value obtained for sigma square was significantly different from zero at 1%, indicating a good fit and the correctness of the specified distributional assumption. The gamma (γ) estimate was 0.99 and was significant at 1% level of probability, implying that 99% of variation in total cost of production was due to allocative inefficiency in the model. All the variables included in the model: land, seed, labour, fertilizer and chemicals were positive and significant at 1%. These results indicate that cost of rice production increases by the value of each coefficient as the quantity of each variable is increased by one percent. This finding disagrees with Inoni (2007) who found that apart from fertilizer, all other inputs were over-utilized. But agrees with Sani *et al.* (2010) who found that all inputs (fertilizer, labour and land) were underutilized. Hence, since the use of farm size, labour, seed, and agro-chemicals were underutilized, farmers could increase their utilization in order to improve their allocative efficiency.

Table 2: Maximum likelihood parameter estimates of stochastic cost frontier

Variable	Coefficient	Standard Error	t-ratio
Constant (β_0)	6.535*	0.0582	112.212
Land (β_1)	1.630*	0.030	54.317
Seed (β_2)	0.321*	0.014	23.408
Labour (β_3)	0.240*	0.041	5.879
Fertilizer (β_4)	0.061*	0.020	3.013
Chemical (β_5)	0.404*	0.013	30.786
Sigma (δ^2)	2.492*	0.788	3.162
Gamma (γ)	0.999*	0.0013	723.86

Source: Computer Analysis *P<0.01

Frequency Distribution of Allocative Efficiency of Rice Farmers under NPFS

Table 3 shows the distribution of farmers by their allocative efficiency. It was found that the minimum and maximum allocative efficiencies were 0.132 and 0.99 respectively, while mean allocative efficiency was estimated to be 0.67. Thus, opportunity still exists for increasing farmers' productivity through increasing efficiency in the use of existing resources. Furthermore, these results indicate that if the average farmer in the study area was to achieve allocative efficiency of his most efficient counterpart, then the average farmer could realize 33 percent cost savings, that is, [1-(0.67/0.99) x 100].

Table 3: Frequency distribution of allocative efficiency of rice production under the NPFS

Efficiency	Frequency	Percentage
0.10-0.19	2	1.38
0.20-0.29	5	3.45
0.30-0.39	6	4.14
0.40-0.49	12	8.28
0.50-0.59	19	13.10
0.60-0.69	19	13.10
0.70-0.79	33	22.76
0.80-0.89	25	17.24
0.90-0.99	24	16.55
Total	145	100.00
Minimum allocative efficiency = 0.132		Max allocative efficiency = 0.99
Mean allocative efficiency = 0.677		

Source: Computer Data Analysis

Also, the most allocative inefficient farmer needs cost saving of 87 percent [1-(0.132/0.99)]. Thus, there is an opportunity of increasing rice production by 33 percent by practising techniques and technologies used by the most allocative efficient farmers in the study area.

Determinants of Allocative Inefficiency in Rice Production under NPFS in the Study Area

Table 4 shows the estimates of the allocative inefficiency model for rice farmers. The results showed that age was negative and significant at 1% level of probability. This implies that increase in age would decrease allocative inefficiency. Age has a significant influence on the decision-making process of farmers with respect to risk aversion, adoption of improved agricultural technologies, and other production-related decisions. This will reduce technical inefficiency. The coefficient obtained for education was also negative and significant at 1% level of probability. The implication of this is that as level of education increases, allocative inefficiency would decrease. Managerial skill of farmers can be improved through educational attainment. Kalirajan and Shard (1985) noted that education sharpens managerial input and leads to a better assessment of the importance and complexities of good decisions in farming. The parameter estimate for membership of cooperative was negative and significant at 5% level of probability. This implies that increase in years of cooperative membership would reduce allocative inefficiency. Membership of cooperative participation may enhance a farmer’s accessibility to information on modern methods and techniques of farm operations. Access to credit was negative and significant at 1%. This implies that increase in the amount of credit received by farmers would reduce allocative inefficiency. Access to credit may reduce liquidity constraints and enhance a farmer’s accessibility to bulk purchase of agricultural inputs which in turn will decrease the cost of farm production. Farming experience was negative and significant at 5%. These results are consistent with the findings of Ogundari and Ojo (2007) who found that farmers’ experience and educational level significantly decreased allocative inefficiency in their study of economic efficiency of small-scale food crop farmers in Nigeria.

Table 4: Estimated determinants of allocative inefficiency

Variable	Coefficient	Standard Error	t-ratio
Constant	1.991**	0.909	2.189
Age	-0.117*	0.036	-3.202
Education	-3.888*	0.114	-3.388
Household size	-0.083**	0.048	-1.752
Farming experience	0.040**	0.020	1.943
Membership of cooperative	-0.134**	0.065	-2.066
Access to credit	-0.174*	0.059	-2.940
Extension contact	-0.012	0.010	-1.150

Source: Computer Data Analysis * P<0.01, ** P<0.05,

CONCLUSION

Farmers operated below the maximum cost efficiency with a mean of (0.677) implying that the allocative efficiency of an average farmer could be increased by 32% through better utilization of resources in the optimal proportions given their respective prices and the current technology. Education, access to credit facilities, membership of cooperatives and farming experience influenced the allocative efficiency of farmers. Government policy aimed at educating the farmers should be put in place to enhance their allocative efficiency. Input supply policy should be improved, while farmers should form cooperative societies to enable them access credit to boost production.

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