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Socio-Economic Determinants of Technical Efficiency in Rainfed Rice Production in Sokoto State, Nigeria

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ABSTRACT

The study examined socio economic determinants of technical efficiency in rainfed rice production system in Sokoto state, Nigeria. Using a multistage random sampling technique, 300 farmers were randomly selected from six purposively selected rainfed rice producing local government areas of Sokoto state. The data collected were analysed using descriptive statistics and stochastic frontier analysis (SFA). The maximum likelihood estimates on the determinants of technical efficiency shows that the coefficients of farming experience ($p<0.01$), off-farm income ($p<0.05$) and extension contact ($p<0.01$) significantly influenced technical efficiency of the rainfed rice farmers in the area. The mean technical efficiency in rainfed rice production system in the area was 73.2 percent suggesting that rice production fell 26.8 percent short of the maximum (frontier) possible output. The study recommends that farmers need to utilize their farming experience and endeavour to acquire more knowledge and skills in farming while the State Government should engage trained and qualified youths with NCE/Degree in agriculture to serve as extension agents and support them with transport facilities and commensurate remuneration for effective extension service delivery.

INTRODUCTION

Rice is a source of food, feed, employment and a source of raw materials for a variety of industries. About half of the world's population (more than 3 billion people) depends on rice for their staple food. Rice provides about 20% of direct human calorie intake worldwide, making it the most important food crop (FAO, 2012).

The failure of Nigeria's rice economy to match its domestic demand raises a number of questions both among the policy makers and researchers. A key reason to this concern is that of productivity and efficiency of the rice farmers in the use of resources. Average yield of upland and lowland rainfed rice in Nigeria is 1.8 tons//ha while that of the irrigation system is 3.0t ha^{-1} (Singh *et al*., 1997). This is low when compared with 3.0 t ha^{-1} from rainfed upland and lowland systems and 7.0 t ha^{-1} from irrigation system in places like Cote d' Ivoire and Senegal (WARDA, 2003). It therefore implies that rainfed rice farmers in Nigeria are not getting commensurate returns from the resources they commit to their enterprise. Sustainable national food security and economic development in Nigeria will continue to depend upon farmers' continued ability to sustain high yields in rainfed rice ecologies (Singh *et al.,* 1997). Considering the risk and uncertainty in which crop production takes place most especially in developing countries like Nigeria, farmers' resources need to be organized and used efficiently in such a way as to produce maximum output (Yahaya, 2013). The problem of inefficient use of resources in rice production has been the greatest obstacle to increased production (Udoh and Oluwatoyin, 2006).

It is in consideration of the inefficient use of resources that characterised rice production in Nigeria that this study stemmed to identify socio economic determinants of farmers' efficiencies in rainfed rice production in Sokoto State, Nigeria. This is with a view to advancing policy considerations for agricultural development in Nigeria

METHODOLOGY

Sokoto State is located between latitude 13^o 03' N and longitude 5^o 14' E with a land area of 28,232.37 Square kilometers. It is bordered in the north by Niger Republic, Zamfara State to the east and Kebbi State to the south and west (SOSG, 2015). In terms of vegetation, the State falls within the Sudan savannah zone. Rainfall starts late May and ends late September or early October with an annual mean rainfall ranging between 500mm – 700m. Over 80% of the inhabitants of Sokoto State practice one form of agriculture or the other. They produce such crops as millet, guinea corn, rice, cassava, potatoes, groundnuts and beans for subsistence and produce wheat, cotton, and vegetable for cash (SOSG, 2015).

The sampling frame was established by obtaining a list of all rainfed rice producing Local Governments Areas and the respective rainfed rice producing villages from the Ministry of Agriculture, Sokoto. The names of rainfed lowland rice producing farmers in the respective villages were obtained from the village heads and leaders of cooperative associations. This provided the bases for sampling. A 3-stage multi-stage random sampling technique was used to draw the sample. The first stage involved a purposive selection of six leading Local Government Areas noted for rainfed rice production in Sokoto state; these included Wurno, Goronyo, Rabah, Kware, Kebbe and Silame local government areas. The second stage involved a random selection of two rainfed rice producing villages in each of the selected Local Government Areas. The third stage was a random selection of 25 rainfed rice farmers from each of the sampled communities. A total of 300 rainfed rice farmers were sampled and interviewed. Primary data were collected using interview schedule administered by trained enumerators, while secondary data were sourced from text books, journals, CBN bulletins, past project works, and other relevant materials. Type of data collected included socio-economic characteristics such as age, farming experience, level of education, household size, etc, and production data such as farm size (ha), quantity and cost of utilized production inputs, output quantity, price, etc.

The tools of data analysis used were descriptive statistics and stochastic frontier analysis (SFA). The descriptive statistics used were frequency distribution and mean to describe data collected on socio-economics characteristics and level of resources utilization. The parametric Stochastic Frontier Analysis (SFA) (Aigner, 1977; Amaza & Maurice, 2005; Tijjani (2006); Ogundare, 2008), also referred to as the econometric frontier approach, which specifies the relationship between output and input levels and decomposes the error term into two components (the random error and the inefficiency component) was used to determine resource productivity and to capture the effects of socio-economic factors (inefficiency variables) on technical efficiency of the farmers. The specification of the models is given as follows:

Stochastic Frontier Analysis (SFA) model:

The functional form of the stochastic frontier was specified under the Cobb-Douglass specification model. The frontier model is defined as:

$$Ln(Y_i) = \alpha + \sum \beta_{ij} X_{ij} + V_i - U_i \ldots\ldots\ldots\ldots(1)$$

Where the subscript, ij refers to the j^{th} observation of the i^{th} farmer

Y_i = Output of the farmer (kg),
X_1 = Farm size (ha)
X_2 = Seeds (kg)
X_3 = Inorganic Fertilizer (kg)

X_4 =Labour (mandays)
X_5 = Agro-chemicals (liters)
X_6 = Variety (improved = 1, otherwise 0)
V_i = error term
U_i= Farmer specific characteristics related to production efficiency

It is assumed that technical inefficiency effects are independently distributed and assumed to be independent of V_i. V_is are assumed to be independently and identically distributed normal random errors, having zero means and unknown variance, q^2. U_{ij} is defined as:

$$|U_{ij}| = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \ldots\ldots\ldots(2)$$

Where: U_i= Technical inefficiency of the i^{th} farmer
Z_1 = Farming experience (years)
Z_2 =Level of Education (years)
Z_3 = Household size (No.)
Z_4 = Off-farm income (Dummy: Yes = 1, otherwise 0)
Z_5 = Contact with extension agent (Dummy: Yes = 1, otherwise 0)

The maximum likelihood estimates of the parameters in the Cobb-Douglass stochastic frontier production model defined by (1) given the specification of the technical inefficiency effects defined in (2) will be simultaneously obtained using a computer program (frontier 4.1).

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Rainfed Rice Farmers:

The result of the study on socio-economic characteristics is presented in Table 1. The result shows that rainfed lowland rice production in the study area was dominated by middle aged (31-40 years) and ageing males (41-50 years) with a family size of between 6 and 10 members. These are the economically active age brackets and people in this age brackets are usually self- motivated and innovative. The result shows that majority (59.67 percent) of the rainfed rice farmers had non-formal (Qur'anic) education and only 33 percent had formal education. Responses on farming experience shows that 41 percent of the rainfed rice farmers in the study area had been cultivating rice for a period of 16 - 25 years. This implied that rainfed rice farmers in the study area have been in farming profession for quite some period of time and are not novices in rainfed rice farming. The result further shows that 51.67 percent of the rainfed rice farmers were non-members of any cooperative society. This finding may be attributed to a minimal or absence of awareness campaign and/or sensitizations on the importance of cooperative societies to farmers in the study area. Result of the study also shows that majority (55.33 percent) of the farmers had no contact in whatever form with agricultural extension agents, however, 44.67% were at least contacted once.

Table 1: Distribution of the rainfed rice farmers by personal and socio-economic characteristics

Variable	Frequency	Percentage
Age (Years)		
20 – 30	30	10
31 - 40	89	29.67
41 - 50	91	30.33
51 - 60	52	17.33
61 Above	38	12.67
Household size		
1 – 5	58	19.30
6 – 10	154	51.40
Above 11	88	29.30
Education		
Non-formal	199	66.33
Formal	101	33.67
Farming Experience		
6 – 15	75	25.00
16 – 25	125	41.67
26 – 35	49	16.33
36 Above	51	17.00
Members of Coop-society		
Members	145	48.33
Non-members	155	51.67
Contact with Extension Agents	134	44.67
Contacted	166	55.33
Not contacted		

Determinants of Technical Efficiency

The study used multiple regression based on stochastic production frontier to determine technical efficiency, assuming a Cobb-Douglass functional form. Result of the inefficiency determinants and the associated diagnostic statistics are presented in Table 2. As confirmed by the diagnostic statistics, the result indicates the presence of production inefficiency among rainfed rice farmers in the study area. The Sigma Squared (0.175) is statistically different from zero ($p<0.01$). This indicates a good fit and the correctness of the specified distributional assumption of the composite error term. This simply implies that a one-sided random inefficiency component dominates the composite error term included in the model.

The result shows that all the coefficients of the inefficiency variables included in the model have the expected negative signs except the coefficient of household size. However, only the coefficients of farming experience ($p<0.01$), off-farm income ($p<0.05$) and extension contact ($p<0.01$) consistently and significantly influenced technical efficiencies of the rainfed rice farmers in the area.

Table 2: Maximum likelihood estimates of the Cobb-Douglass stochastic frontier model

Variable	ML estimate	T- value
Production Factors		
Intercept	0.158	4.963***
Farm Size (X_1)	0.841	3.105***
Seed (X_2)	0.172	1.391
Fertilizer (X_3)	0.413	2.407***
Labour (X_4)	0.328	2.132**
Agro-Chemical (X_5)	0.006	1.259
Variety (X_6)	0.036	1.961
Inefficiency factors		
Intercept	0.401	1.635
F/ Experience (Z_1)	-0.932	-2.519***
Education (Z_2)	-0.348	-0.722
Household Size (Z_3)	0.491	0.893
Off-farm Income (Z_4)	-0.588	-2.276**
Ext. Contact (Z_5)	-0.773	-2.914***
Diagnostic Statistics		
Sigma Squared	0.175	2.837***
Gamma	0.683	3.926***
Ln likelihood (X^2)	8.037	
Likelihood ratio test (LR)	22.749	
Mean technical efficiency	0.732	

*** = Significant at 1 percent, ** = Significant at 5 percent

Farming experience: Farming experience had a negative and significant ($p<0.01$) MLE of 0.932. This implies that as farmers in the study area advance in farming experience, inefficiency in resource use decreases and technical efficiency increases proportionately. A high level of farming experience is known to boost the farmer's technical knowledge more effectively; therefore, the farmer becomes more knowledgeable and skillful gradually which eventually leads to improved method of production and subsequent improvement on the TE of the farmer. Experience is a risk management factor and Ridler and Hishamunda (2001) confirmed that new farmers in agriculture are at a higher risk compared to experienced farmers. This conforms to the findings of Coelli and Battese (1996) who reported negative production elasticity between farming experience and technical inefficiency for farmers in Pakistan, thus suggesting that older farmers are relatively more efficient.

Off-farm income: off-farm income was found to significantly ($p<0.05$) and negatively influence the technical inefficiency of the rainfed rice farmers in the study area. This implies that as farmers diversify their income and earn more money from off-farm activities, inefficiency in resource use decreases and their technical efficiency increases. Off-farm income buttresses the farmers' farm income and affords them the opportunity to access enough production inputs which make them move closer to the frontier output. This finding is in line with earlier finding by Obamiro *et al.,* (2003) who opined that farm families with limited access to productive resources such as capital and inputs required for attaining physical efficiency will face low productivity.

Extension contact: Extension contact is negative and significant ($p<0.01$). This means that a unit increase in extension contact will subsequently increase the technical efficiency of the rainfed rice farmers by 0.77. The main concern of agricultural extension is to provide farmers the necessary education and technical information to enable them take effective farm management decisions that enhance their farm productivity (Ani, 2007). Along this line, Benor *et al.,* (1984) cited in Yilkat and Murtala (2009) reported that groundnut production has increased significantly in Gujarat, India as a result of extension services. The implication of this finding is that increased number of contacts with extension agents can considerably bridge the gap between efficient and inefficient rice farmers in the study area.

Farmers' specific technical efficiency

The distribution of farmers' specific technical efficiencies as shown in Table 3 indicates a wide variation of efficiency index across the rainfed rice farms which demonstrate a potential for efficiency improvement in the rainfed rice production system.

The distribution of rainfed rice farmers' specific technical efficiencies (Table 3) revealed a predicted technical efficiency of between 27.4 percent for the least efficient farmer and 98.1 percent for the most efficient farmer in the study area. The result further reveals that 35 percent of the rice farmers operated on a TE of 70-79 percent. Others were 29 percent and 15.33 percent who operated on a technical efficiency of 80-89 percent and 90-99 percent, respectively. On the overall, the result indicates that 79.33 percent of the rice farmers operated on a technical efficiencies of 70 percent and above. The mean TE in rainfed rice production system in the area was 73.2 percent suggesting that about 26.8 percent chances exist for increasing output without additional resources in the existing rice production system. In other words, rice production falls 26.8 percent short of the maximum (frontier) possible output.

The mean TE (0.732) operational in the rainfed rice ecology in the area is similar to that obtained by Udoh and Oluwatoyin (2006) but higher than that obtained by Igbekele (2006) who analyzed and linked the level of TE of Nigerian small scale farmers to specific farmers' socio economic and policy variables.The result demonstrates that for the average rainfed rice farmers in the study area to achieve the TE level of the most efficient farmer they would have to realize about 24.8 percent cost savings, while the least technically efficient farmer will realize about 70.6 percent cost saving if they are to attain the level of the most efficient farmer in the area.

Table 3: Distribution of rainfed rice farmers' specific technical efficiencies

Variable	Frequency	Percentage
< 0.3	11	3.67
0.30 – 39	18	6.00
0.40 – 0.49	12	4.00
0.50 – 0.59	7	2.33
0.60 – 0.69	14	4.67
0.70 – 0.79	105	35.00
0.80 – 0.89	87	29.00
0.90 – 0.99	46	15.33
Total	300	100
Minimum TE	0.274	
Maximum TE	0.981	
Mean TE	0.732	

Source: Computed from *frontier 4.1* output

CONCLUSION AND RECOMMENDATIONS

The result of the inefficiency factors shows that the farming experience, off-farm income and extension contact significantly influenced technical efficiencies of the rainfed rice farmers in Sokoto. The study shows that farmers were not maximally technically efficient in rainfed rice production in the study area, as such, rainfed rice production in the study area had not reached the frontier threshold. Therefore, within the context of efficiency of production, rainfed rice production can still be increased by adopting the technology of the most efficient farmers in the study area. Farmers need to exploit their farming experiences and should strive to acquire more knowledge and skills in their production activities. The finding also recommends that rainfed rice farmers under study could employ strategic income diversification to improve their technical efficiencies. The low level of agricultural extension activities in the area calls for a decisive policy option. It is not an overstatement to claim that without an effective agricultural extension delivery system, the goal to attain agricultural development and food security is a mirage. Agricultural extension is an essential ingredient for continued food supply and food security. It is hence recommended that there should be a strong and functional partnership between farmers, research organizations and extension institutions. This linkage will no doubt help to remove the challenges that research results do not reach farmers and that research results do not reflect farmers felt needs. Moreover, fresh and qualified youths (preferably NCE/Degree holders in agriculture) should be recruited and trained to serve as extension agents, while incentives such as transport facilities and commensurate remuneration be given to motivate them for greater effectiveness.

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