Improving Farmers' Efficiency in Rice Production In Nigeria: The Relevance of Agricultural Extension

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Abstract

This paper assesses the effects of extension services on farmers' efficiency and productivity in rice production in Kano State, Nigeria. Data for the study were collected from 126 rice farmers selected using multi stage sampling technique. Stochastic production frontier function was estimated to ascertain the effects of extension services on increasing efficiency and productivity in rice production. In addition to raising farmers' efficiency and increasing potential output, farmer access to extension services significantly (p<0.01) reduces production inefficiencies and yield losses. It is recommended that farmers' accessibility to agricultural extension should be enhanced. Also, provision of effective extension services to farmers should be highly considered in the current agricultural transformation programmes.

Key words: Rice, efficiency, Extension, Kano State.

Introduction

Nigeria is one of the largest rice markets in Africa, with an estimated population of 167 million people, growing at 3.2% annually and predicted to reach 221 million by 2020 (NPC, 2006). Nigeria's rice consumption has increased quite significantly over the last decade (6 – 7% per annum) and is now estimated at 6 million metric tonnes annually. In both urban and rural areas, rice has become a staple food of choice accounting for more than 20% of all meals consumed per week by a typical household. Nigeria's growing demand for rice is the effect of shifts in consumer preferences driven by urbanization and changes in employment patterns. Rice consumption in Nigeria is forecasted to reach 36 million tonnes by 2050 (FMARD, 2012).

Although, Nigeria is endowed with abundant natural resources suitable for rice production to domestically produce more than enough rice and even export surplus, yet the demand outstrips domestic supply. Nigeria's growing rice demand simultaneously presents a food security challenge and an economic opportunity for the country. Currently, a third (2 million mt) of Nigeria's rice demand is being met by importation, due to low adoption rate, low yield and inefficient production systems (FMARD, 2012). The average rice yield in the country is low and it ranges between 1000 and 2500kg/hectare (Amaza and Maurice, 2005; Ekeleme, *et. al*, 2008; Ayinde, *et al.,* 2009). On the other hand, Ekeleme, *et al.* (2008) found that if farmers have access to effective demand - responsive extension services and efficiently allocate resources about 7600kg/hectare could be realised, given the current state of rice production technology.

Accordingly, the Federal Government of Nigeria, as part of its Agricultural Transformation Agenda (ATA), has set a goal to achieve complete self sufficiency in rice production in the next 3 – 4 years. This implies achieving a significant increase in local production of rice to substitute about 2 million mt of rice currently being imported. To achieve this goal, agricultural extension services deserve a priority position in the current agricultural transformation agenda.

Evidently, extension services are expected to improve efficiency in all spheres of agricultural activities along the rice value chain activities. According to Daneji, *et al.*, (2010) a positive return to agricultural extension services arises because extension

system assists farmers to be better managers, adopt more modern farm inputs and prefer risky (high-return) production technologies.

Despite such common beliefs regarding the benefits of extension in farm activities, there is little empirical evidence on effects of extension services on farm-level efficiency in rice production to advocate public investment in Nigerian rice industry. Studies (Amaza and Maurice, 2005; Okoruwa and Ogundele, 2006; Ogundari and Ojo, 2007; Olarinde, *et al.*, 2008; Ayinde, *et al.*, 2009) on rice production efficiency in Nigeria focus on many determinants of efficiency without focusing on the role of extension activities in improving production efficiency.

In view of the perceived importance of extension services in raising farm productivity and efficiency in agriculture and existing knowledge gap, the study was aimed to assess effect of extension services on rice farmers' productivity and efficiency, that is, whether rice farmer's access to extension services is relevance to achieving self sufficiency in rice production through increased farm-level efficiency and significant reduction in yield losses.

Methodology

The study was carried out in Kano State, located in the Northern part of Nigeria between latitudes 13^0 N and 11^0 S and longitude 8^0 W and 10^0 E. The state has a land mass of about 20760 square km (NAERLS, 2010). Based on NPC (2006), the state has a projected population of 11,206,688 in 2012. The average annual rainfall is 700mm with the mean daily maximum and minimum temperatures of 35^0c and 19^0c, respectively. The major crops grown in the State include rice, maize, millet, cowpea, groundnut and vegetables (NAERLS, 2010).

A multi stage random sampling technique was used to obtain a sample of 126 rice farmers. In the first stage, the three major rice producing LGAs (i.e. Kura, Garun Malam and Bunkure LGAs) were purposively selected out of 44 LGAs in the State. Secondly, a major and accessible rice producing village was purposively chosen from each LGA. Thirdly, 11% of the given sample frames of rice farmers in each chosen village were randomly selected. The third stage involved a simple random selection of 77 rice farmers that had access to extension visits and 49 rice farmers that did not have contact with extension agent in the production season. Thus a total of 126 farmers were used for the study (Table 1).

Table 1. Proportion of rice farmers selected from villages' rice sample frames

LGAs	Villages chosen	Rice farmers' Sample frames		11% of the sample frame	
		With extension contact	Without extension contact	With extension contact	Without extension contact
Kura	Dan Hassan	217	109	24	12
Garun Malam	Garun Babba	311	105	34	12
Bunkure	Lautaye	168	224	19	25
Total	**3**	**696**	**438**	**77**	**49**

Source: Field survey, 2010

Data were collected based on the 2010 cropping season from the sampled farmers using a structured questionnaire and interview schedule. The information collected from the farmers includes rice production inputs and output, socio-economic, demographic and institutional characteristics of the farmers.

Analytical framework

Stochastic production frontier model also called 'composed error' model developed concurrently by Aigner *et al.*, (1977) and Meeusen and van den Broeck, (1977) was adopted. The stochastic production frontier model is generally defined as:

$$Y_i = f(X_i; \beta) + \varepsilon_i \dots\dots\dots\dots\dots\dots\dots\dots. (1)$$

where Y_i is output of the *i*th farms, X_i is a vector of inputs used by farm *i*, and ε_i is a

"composed" error term. The error term ε_i is equal to $v_i - u_i$. The term v_i is a two-sided

$(-\infty < v_i < \infty)$ normally distributed random error $(v \sim N[0, \sigma_v^2])$ that represents the

stochastic effects outside the farmers' control. The term u_i is a one-sided

$(u_i \geq 0)$ efficiency component that represents the technical inefficiency of farm. The

distribution of the term u_i can be half-normal, exponential, or gamma (Aigner *et al*. 1977;

Meeusen and van den Broeck, 1977) $[0, \sigma_u^2])$ is used in

this study. The two components $v_i \ and \ u_i$ are also assumed to be independent of each

other.

Technical efficiency (TE) of an individual firm is defined in terms of the ratio of the observed output to the corresponding frontier output, conditioned on the level of inputs used by the firm. Technical inefficiency is therefore defined as the amount by which the level of production for the firm is less than the frontier output. This is shown in equation (2)

$$TE_i = \frac{Y_i^*(observed\ output)}{Y_i(frontier\ output)} = \frac{f(X_i\beta)exp(V_i - U_i)}{f(X_i\beta)exp(V_i)} = exp(-U_i) \dots\dots. (2)$$

Empirical model

There are several functional forms for estimating the physical relationship between inputs and output but Cobb-Douglas functional form is preferable to other forms if there are three or more independent variables in the model (Hanley and Spash, 1993). Hence, Cobb-Douglas production function with four input independent variables was applied in this study. The four input independent variables were farm size in hectares, inorganic fertilizer in kg, human labour in man-hours, and quantity of seed in kg while the dependent variable output is rice in kg. The empirical Cobb-Douglas stochastic frontier model is specified as:

$$lnY_i = \beta_0 + \sum_{j=i}^{4} \beta_{ij}lnX_{ij} + v_i - u_i \ldots \ldots \ldots \ldots \ldots \quad (3)$$

In this study, the level of inefficiency in rice production is evaluated by the deviation from the frontier. Therefore, the effects of extension contact on efficiency are assessed by introducing farmer's access to extension visits as dummy variable in the 'inefficiency effects model' in addition to other variables representing farm and farmer characteristics to explain underlying causes of deviation from the frontier. The technical inefficiency effects u_i is defined by

$$u_i = \delta_0 + \sum_{j=i}^{6} \delta_{ij}z_{ij} \ldots \ldots \ldots \ldots \ldots \quad (4)$$

Where; Z_1 = is the age of the ith farmer, Z_2 = years of experience of the ith farmer in rice production, Z_3 = is a dummy variable, which has value one if ith farmer has access to extension agent and value zero for otherwise, Z_4 = years of schooling, Z_5= amount of credit in Naira used, Z_6 = years of membership in farmers' cooperative, δ_s = are unknown scalar parameters. These were included in the model to indicate their possible impact on the technical efficiencies of the farmers.
The computer program FRONTIER 4.1 (Coelli, 1996) was used to obtain the maximum likelihood estimates of the β_s and δ_s coefficients in equations (3) and (4), respectively.

Results and Discussion

Socio-economic characteristics of the sampled farmers

A summary of statistics of the variables used in the analysis is presented in Table 1. The mean and standard deviation of the values of the variables were computed for farmers that have extension contacts and those that have no extension contacts separately. The average farm sizes were 3.5 and 3.2 hectares for rice farmers with and without extension contacts respectively, implying that rice production was mainly done by small-scale farmers with average farm holding of less than 4 hectares. Mean rice yield of the farmers with extension contact was 2105.67kg/ha which are more than that of those rice farmers without extension contact with 1668.39kg/ha, implying a relative decrease of over 26%. Farmers with extension contact obtained higher yield by using more production inputs like fertilizers and seeds and less of human labour input. Similarly, the means of years of schooling and years of membership in farmers' cooperatives were 12 and 16

years respectively for farmers with extension contact may probably influence attendance to extension services.

Table 2. Descriptive Statistics of the Variables used in the analysis

Variables	Rice Farmers			
	With Extension Contact (n=77)		Without Extension Contact (n=49)	
	Mean	Std. Dev.	Mean	Std. Dev.
Yield (kg Ha^{-1})	2105.67	153.21	1668.39	174.68
Seed (kg Ha^{-1})	4.4	3.20	4.0	3.40
Fertilizer (kg Ha^{-1})	85.6	65.06	54.0	50.20
Labour (manhrs Ha^{-1})	398.0	72.13	531.0	53.11
Farm size (Ha)	3.5	1.55	3.2	1.82
Extension contact (dummy)	1	0	0	0
Age of the farmers	43.7	8.3	43.3	7.5
Years of rice production experience	18	4.5	19	6.7
Years of schooling	12	5.02	3	2.21
Amount of credit used (₦)	31,500	17,850	40,600	21,200
Years spent in cooperatives	16	2.6	8	5.4

Source: Field survey, 2010

The estimation of the Cobb–Douglas stochastic production function in Equation 3 concurrently with the technical inefficiency effects in Equation 4 generates the results shown in Table 3. The value of gamma (γ) = 0.771 is statistically significant at the 1% level, implying that over 77% of random variation in rice production is explained by inefficiency. The mean technical efficiency of the pooled sample was 58%. Thus, in a short run, there is a scope for increasing rice production by 42%, by adopting the technology and techniques used by the best farmers.

All the coefficients of the inputs in the production function are positive and statistically significant. The estimated coefficients for fertilizer and seed were significant at 5% level; while land and labour were significant at 1% and 10% levels respectively. The positive coefficients of these variables inputs indicate that increase in quantities of these inputs would result in increase rice output. The summation of the coefficients for all the inputs was 1.056 indicating that the production function assumed increasing returns to scale. Hence, an increase in all inputs by 1% increases rice yield by more than 1%, *ceteris paribus* (Table 2).

Table 3: Maximum likelihood estimates of Cobb-Douglas Stochastic Frontier Production Function (Dependent variable = Natural log of rice output in kg)

Variables	Parameters	Coefficient	T-value
Stochastic frontier			
Constant	β_0	0.431	3.742*
ln land (X_1)	β_1	0.361	2.718*
ln fertilizer (X_2)	β_2	0.216	2.124**
ln labour (X_3)	β_3	0.157	1.781
ln seed (X_4)	β_4	0.322	1.972**
Inefficiency model			
Constant	δ_0	0.237	0.103
Age of farmer (Z_1)	δ_1	0.467	1.348
Years of experience (Z_2)	δ_2	-0.555	-2.036
Extension contact (Z_3)	δ_3	-0.254	-2.824*
Years of schooling (Z_4)	δ_4	-0.201	-2.215**
Amount of credit used (Z_5)	δ_5	-0.166	-1.866
Years spent in cooperative (Z_6)	δ_6	-0.193	-1.930
Model diagnostics			
Sigma squared	σ^2	0.180	3.351*
Gamma	γ	0.771	6.345*
Log likelihood function		52.39	
Mean Technical efficiency	$\overline{TE}$	0.58	
Number of observations	N	126	

p≤0.05
Source: Field survey, 2010

The result of the inefficiency model in Table 3 shows that all the coefficients of the efficiency variables have negative signs except age of the farmer. As a rule, a negative sign on an estimated parameter implies that the associated variable increases technical efficiency or decreases technical inefficiency, and a positive sign reveals that the reverse is the case. Hence, the coefficients of years of rice production experience, extension contact, years of schooling, amount of credit used and years spent in farmers' cooperatives have negative and significant impact on the production efficiency of the rice farmers.

The coefficient of extension contact is negative and statistically significant at 1% level, implying that farmers' access to extension services increases rice production efficiency or reduces inefficiency significantly at 1% level. The result is similar to the findings reported by Obwona (2002) for Uganda and Ratna, *et al.*, (2007) for Nepal.

The technical efficiency distributions of rice farmers with and without extension contact are presented in Table 4. Among the farmers with extension contact, the technical efficiency ranged from 0.21 to 0.94 with a mean of 0.67. Similarly, technical efficiency among farmers without extension contact ranged from 0.20 to 0.91 with a mean of 0.49. This implies that there are scopes for increasing rice production by 33% and 51% among the farmers with and without extension contact respectively by adopting the technology and techniques used by the best rice farms. Only about 30% and 10% of farmers with and without extension contact respectively have exceeded technical efficiency of 69%.

Table 4: **Frequency distribution of technical efficiency estimates for educated and uneducated farmers**

	Rice Farmers	
	With Extension Contact	Without Extension Contact
Efficiency Score	%	%
0.10 – 0.29	5.2	14.3
0.30 – 0.49	18.2	44.9
0.50 – 0.69	46.8	30.6
0.70 – 0.89	22.1	6.1
≥ 0.90	7.7	4.1
Total	**100**	**100**
Maximum TE	0.94	0.91
Minimum TE	0.21	0.20
Mean TE	0.67	0.49
Std. Dev.	0.28	0.19

Source: Field survey, 2010

Table 5 shows the production losses due to technical inefficiency of rice farmers with and without extension contact and it was obtained by using equation 2. The result indicates that the production losses were 1037.13 and 1736.51kgHa^{-1} among the rice farmers with and without extension contact respectively. This shows that efficient inputs and output combinations are better achieved by more farmers with extension contact, which made them to minimize losses caused by inefficiency.

Table 5: Rice yield loss due to technical inefficiency

	Rice Farmers	
Variables	With Extension Contact	Without Extension Contact
Mean Technical efficiency (%)	67	49
Frontier yield (kg Ha^{-1})	3142.8	3404.9
Observed yield (kg Ha^{-1})	2105.67	1668.39
Yield loss (kg Ha^{-1})	1037.13	1736.51
Loss as % of observed yield	49.3	104.1

Source: Field survey, 2010

Conclusion and Policy Implications

Achieving the goal of complete self sufficiency in rice production through increased farmers' efficiency and productivity depends on the farmers' access to qualitative and effective demand - responsive extension services among other factors. As technically, rice farmers with extension contact are more efficient in minimizing losses and closer to the frontier yield. This justifies more considerations for investment in extension programmes in the current agricultural transformation agenda precisely in agricultural extension transformation agenda (AETA). This would enhance farmers' knowledge, skill and efficiency and accelerate complete substitution of rice imports in the country. Empirically, the results also show that there is ample room for improvement on the level of technical efficiency in rice production in the study area as 60% of rice growers had technical efficiency score below 70%.

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