DETERMINANTS OF ALLOCATIVE EFFICIENCY OF RAIN-FED RICE PRODUCTION IN TARABA STATE, NIGERIA

Tijjani A.
U.M Bakari
Department of Agricultural Economics and Extension
Modibbo Adama University of Technology, Yola, Nigeria

Abstract

This paper analyzed the determinants of allocative efficiency of rain-fed rice production in Taraba State, Nigeria. Structured questionnaire was used to collect data from 234 rain-fed rice farmers through multi-stage random sampling. Stochastic frontier cost function was employed to analyse the data. Majority (82%) of the respondents were males, 84% of them were in their active ages (21-50 years), 89% had one form of formal education or the other, 64% have farmed for more than five years and about 85% were small scale holders. The diagnostic statistics, gamma (0.84) and sigma squared (0.03), were statistically significant at 1% probability level. The result further revealed that cost of herbicide, seed and family labour were significant at 1% level, while cost of hired labour and ploughing were significant at 5% level. The mean allocative efficiency (AE) was 0.69.. The analysis also showed that education and farming experience were the major determinants of allocative efficiency among the respondents. Government should enhance farmers' education levels through the establishment of functional literacy classes to improve their allocative efficiency.

Keywords: Rice production, allocative efficiency, stochastic frontier, Taraba State, Nigeria

Introduction

Rice, a major commodity in the world trade, has become the second most important cereal in the world after wheat in terms of production (Akinbile, 2007). 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. In Nigeria, rice is one of the important food crops that has attained a staple food status and also become a major source of calories for the urban poor (Idiong, 2007). Furthermore, it has been emphasized that rice is not only a key source of food, but also a major employer of labour and source of income for the poor. In rice producing areas, the enterprise provides employment for more than 80% of the inhabitants in various activities along the production/distribution chain from cultivation to consumption (Ogundele and Okoruwa, 2006).

Nigeria has a potential land area for rice production. The land area that could be cultivated is roughly 4.7 million hectares, but only 2.7 million hectares were harvested to rice. Although, the paddy harvest rose from under one million tonnes in 1970s to 4.2 million tonnes in 2010, yet, production has not keep pace with demand (Diagne *et al*., 2011). The estimated annual consumption of rice is put at five million metric tonnes. Therefore, the country has to import the deficit. This inability of the Nigerian rice sector to match the domestic demand has led the country in expending billions of Naira on the importation of rice into the country. Nigeria imports on average 1.7 million tonnes of white rice annually, making the country as the world's second largest rice importer (Diagne *et al*., 2011).

The low output realized by rice farmers is an indication that signals the need to measure their performance. In this regard, most of the published researches in Taraba State were skewed toward examining technical efficiencies alone. This includes Ahmadu and Erhabor (2012) who examine the technical efficiency of rain fed rice farmers in Taraba State. 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. Therefore, the aim of this paper is to quantify the level of allocative efficiency for sampled rice farmers in Taraba State. The relationship between allocative efficiency and various socioeconomic characteristics of the rice farmers is also investigated.

Methodology

The Study Area

The study was conducted in Taraba State, Nigeria. Taraba State is located in the north eastern part of Nigeria. The state lies between latitude 6^0 30´ and 9^0 36´ North of the equator and longitude 9^0 10´ and 11^0 50´ East of the Greenwich meridian (Taraba State Ministry of Information, Youth, Sports and Culture [TSMIYSC], 1999).The state has a land area of 59, 400 km^2 with a population of 2,300,736 people (Federal Republic of Nigeria Official Gazette, 2009). The state shares a common boundary with Bauchi State in the north and Gombe State in the north east, Adamawa State in the east and Plateau State in the North West. The state is further bounded to the West by both Nasarawa and Benue states, while it shares an international boundary with the republic of Cameroun to the south and south east

(TSMIYSC, 1999). The state has a tropical climate marked by dry and rainy seasons. The rainy season starts in April and ends in October. The wettest months are August and September. The mean annual rainfall ranges from 800mm in the north to over 1800mm in the south. The dry season, on the other hand, starts in November and ends in April The mean daily temperature ranges between 14.8oC and 34.4^{o}C.The state is predominantly agrarian in nature, with about 80% of its inhabitants depending on subsistence agriculture practices mainly in food production. The climate, soil and hydrology of the study area provide good atmosphere for the cultivation of most staple food crops, grazing of animals, fresh water fishing and forestry.

Sampling Techniques

Data for this study was derived mainly from primary source. Secondary data was also used to complement the primary data. The data were collected with the use of well-structured questionnaire. Multi-stage random sampling technique was employed. Taraba State is divided into four ADP zones namely: Zone I, II, III and IV. Each zone is divided into blocks and each block is divided into cells. In the first stage, two zones (zone I and II) were purposively selected for their prominence in rice production in the state. The second stage was the purposive selection of four blocks noted for rain-fed rice production in zone I and II. These include: Mayo-lope, Lau, Bantaje and Mutum-Biyu. The third stage involved purposive selection of three cells known for rice production in each block as follows: three cells in Mayo-lope, these include: Donadda, Katibu and Mayolope; three cells in Lau, these include: Garin-dogo, Kabawa and Lau; three cells in Bantaje, these include: Gindin-dorowa, Bantaje, S/gida; and three cells in Mutum-Biyu, these include: Gassol, Tella and Mutum-Biyu. The fourth and final stage was the proportional random selection of farmers from the list compiled by trained enumerators in each of the cells. Hence, a total number of 234 farmers were sampled for the study.

Analytical Technique

Stochastic Frontier Cost Function

The stochastic frontier function is typically specified as:

$Y_i=f(X_{ij}; ß) + V_i-U_i$ (i = 1, 2, n)………………………………. (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 specifications have been expressed in terms of a production function, with the U_i 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 (V_i - U_i) to (V_i + U_i). This substitution would transform the production function defined by (1) into the cost function:

The stochastic frontier cost function is specified as:

$\text{Ln } C_a = f(P_a, Y_a{:}\beta) + (V_i+U_i)$……………… …………(2)

Where: C_a is total cost of production of the ith firm, P_a is input prices, Y_a is Output of the ith firm, β 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:

$CE = \exp(U)$ ……………………………………..…………… (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:

$\text{Log } C_1 = \beta_0 + \beta_1 \log P_1 + \beta_2 \log P_2 + \beta_3 \log P_3 + \beta_4 \log P_4 + \beta_5 \log P_5 + \beta_6 \log Y_1 + V_i + U_i$….(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), P4 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 V_i 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:

$CE_i = \delta_o + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5$ …………………………. (5)

Where: CE is Cost inefficiency effect of ith farmer, Z_1 is Age of farmer (years), Z_2 is Years of 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.

Ui provides information on level of the allocative efficiency of the ith farm. The allocative efficiency of individual farmers is defined in terms of the ratio of the predicted minimum cost (Ci*) to observed cost (Ci) (Aboki *et al.*, 2013).

That is AE = C_i^*/C_i = exp (U_i)………… ……………………….(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 (Coelli, 1996)

Results and discussion

Socio-Economic Characteristics of the Respondents

Table 1 shows the distribution of respondents based on their socio-economic characteristics. Majority (82%) of the respondents were males because they are the household heads and mostly involved in strenuous activities while their female counterpart handles food processing and marketing activities. Majority (84%) of them were aged between 21-50 years old, suggesting that they are predominantly youths and hence might be vibrant and economically productive. Also, majority (62%) are married with a mean family size of seven members. This could enhance the release of family labour, thus making more hands available for productive activities. Furthermore, majority (88%) had one form of education or the other, hence will possibly be innovative. Similarly, 64% of them had more than five years experience and 85% were small scale farmers cultivating less than five hectares of land. This may not encourage mechanization system of farming and thus, production may continue to be minimal in the area.

Allocative Efficiency Analysis

The estimates of the parameters of stochastic cost frontier model of rice farmers as contained in Table 2 were positive. This implies that the variables used in the regression analysis have direct relationship with total cost of rice production. The cost of production increases by the value of each coefficient as the quantity of each variable is increased by one percent. The coefficients for fertilizer and transportation were positive and not statistically significant. Meaning that, they affect total cost of production but not significantly. The insignificance of fertilizers could be attributed to their scarcity at the time they are needed most. Hence, farmers resort to using quantities that are far below the recommended doses. Thus, increasing the use of fertilizer will add to the total profit by minimizing it cost in an efficient manner. Ogundari (2008) in his analysis on resource productivity, allocative efficiency and determinants of technical efficiency of rain-fed rice farmers in Ondo State found that 64% of his respondents under-utilize fertilizer while 36% over-utilized it. In case of transportation, the reason for it insignificance could be attributed to the fact that farms are usually not far from the respondents' homes, so they spend relatively less on transportation.

The estimated coefficients for cost of herbicide, rice seed, family labour, hired labour and ploughing were positive and significant either at 1% or below. This implies that increase in any of them will lead to an increase in total production cost.

The results of inefficiency model showed in Table 2, reveals that age is positive though insignificant. This result is surprising, as age is expected to increase allocative efficiency. However, the reason could be attributed to the positive correlation that usually exists between age and household size. In the study area, it was found that aged farmers have many dependents; a phenomenon that may leads to diversion of funds from farming activities to addressing home necessities; hence, reducing cost efficiency. The table further shows that, the coefficient of family size was positive and significant at 5%. This finding corroborates with that of Latifat, *et al.* (2013) who reported, in their study of technical and allocative efficiency of palm oil processing in Benue state, that household size decreases allocative efficiency of their respondents.

Furthermore, the result shows that level of education and farming experience have negative signs as expected and significant at 1%. It implies that farmers with more years of education tend to be more efficient in resource allocation, probably due to their enhanced managerial ability. Also, farmers with high level of experience have tendency of mobilizing and using resources efficiently. This result is in agreement with those of Bakari (2010) and Rahman *et al*. (2012) who in their independent studies found a positive relationship between education and farming experience and the resource allocation of their respondents.

The coefficient of extension contact is negatively signed but insignificant. The insignificance of this variable is related to the fact that extension system is very weak in the study area. This may be attributed to high ratio of extension agents to farmers and also, to lukewarm attitude of some of the extension officers available.

The result of the diagnostic statistics shows that the variance parameters for the frontier cost function are statistically significant at one percent level. The estimate of the sigma squared (0.03) indicates that the distributional forms of error terms are well specified. The gamma estimate (0.84) shows the 84% of the variation among the respondents is due to differences in allocative efficiency. Thus, the results of the diagnostic statistics confirmed the relevance of stochastic frontier cost function, using the maximum likelihood estimates.

Allocative Efficiency indices of the Respondents

Allocative efficiency is the ability of a firm unit to choose optimal input levels for given factor (input) prices. The deciles frequency distribution of allocative efficiencies of the respondents is presented in Table 3. The table revealed that average measure of allocative efficiency of 0.69 was recorded in the area. This suggests that respondents were about 69% allocatively efficient while the remaining short fall can be attributed to their allocative inefficiencies. The minimum and maximum measures of allocative efficiencies were 0.51 and 0.90 respectively. This implies that the least allocatively efficient farmer was 51% efficient whereas, the most allocatively efficient farmer was 90% efficient. Thus, if the average rice farmers in the area were to achieve the level of allocative efficiency shown by the most efficient farmer, then they would realize a cost saving of 43.33%.

The table further shows that about 83% of the farmers had allocative efficiency from 0.61 and above, indicating that on the relative term most of the respondents were fairly efficient in allocating their cost structure in course of rice production. However, there is room for improvement of their allocative inefficiency.

Conclusion and Policy implication

Farmers operated below the maximum efficiency with a mean of (0.69) implying that the allocative efficiency of an average farmer could be increased by 31% through better utilization of resources in the optimal proportions given their respective prices and the current technology. Education 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 and farmers should form cooperative societies to enable them access credit to boost production.

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Table 1:Socio-economics characteristics of the respondents

Variable	Frequency	Percentage
Gender		
Male	192	82
Female	42	18
Family size(number)		
1 – 5	135	57.69
6 – 10	63	26.92
11 and above	36	15.39
Educational level		
Non (illiterate)	27	11.54
Qur'anic	54	23.08
Primary	75	32.05
Secondary	48	20,51
Tertiary	30	12.82
Farming experience (years)		
≤ 5	84	35.90
6 – 10	51	21.80
11 – 15	51	21.80
16 – 20	27	11.50
>20	21	9.0
Farm size (hectares)		
0.1 – 2.4	144	61.54
2.5 – 4.9	54	23.08
≥ 5.0	36	15.38
Source: Field survey,2013		

Table 2: Maximum Likelihood Estimate of parameters of Cobb-Douglas Stochastic Frontier Cost function for Rice farmers

Variable	**Parameter**	**Coefficient**	**Standard error**	**t.value**
Cost factor	β_0	1.600***	0.178	8.995
Cost of fertilizer	β_1	0.004	0.004	0.977
Cost of herbicide	β_2	0.211***	0.053	3.981
Cost of seed	β_3	0.630***	0.060	10.49
Cost of family labour	β_4	0.012***	0.004	2.774
Cost of hired labour	β_5	0.424**	0.004	1.828
Cost of ploughing	β_6	0.081**	0.033	2.429
Cost of transportation	β7	0.141	0.021	0.534
Inefficiency model				
Age	δ_1	0.0003	0.0826	0.003
Education	δ_2	-0.107***	0.036	-2.946
Farming experience	δ_3	-0.614***	0.107	-5.718
Extension contact	δ_4	-0.041	0.026	-1.596
Family size	δ_5	0.153**	0.705	2.173
Variance parameters				
Sigma squared	σ^2	0.03***	0.007	4.437
Gamma	γ	0.84***	0.113	7.389
Log likelihood function	LLF	90.97		

Source: Computer Print out.***, **, * indicate Significance 1, 5&10 percent probability levels.

Table 3: Frequency Distribution of Allocative Efficiency of rice farmers

Range of allocative efficiency	Frequency	Percentage
0.51 – 0.60	40	17.09
0.61 – 0.70	86	36.75
0.71 – 0.80	73	31.20
0.81 – 0.90	34	14.53
0.91 – 1.00	1	0.43
Total	234	100
Min. 0.51		
Max. 0.90		
Mean 0.69		

Source: Computer print out, 2014