Journal of Sustainable Development in Africa (Volume 16, No.7, 2014)
*ISSN: 1520-5509*
*Clarion University of Pennsylvania, Clarion, Pennsylvania*

# RESPONSIVENESS OF RICE PRODUCTION TO THE USE OF INPUTS AMONG SMALLHOLDER UPLAND RICE FARMERS IN SOUTHWEST NIGERIA

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**ABSTRACT**

This study examined the responsiveness of upland rice production to inputs in southwestern Nigeria. Data was collected from 240 upland rice farmers in the States of Ekiti and Osun using a well structured questionnaire. Data obtained were analysed using descriptive statistics and stochastic frontier analysis. The results show that rice farming in the region was dominated by male farmers averaging 53 years cultivating a mean farm size of 1.1 ha. Frontier estimates revealed that labour, seedlings and herbicides significantly influenced rice output. The coefficients of the input elasticity values of fertilizer, herbicide, seed, farm size, and labourwere -0.137, 0.415, -0.066, 0.212, and 1.120 respectively.The mean technical efficiency level of 74% indicates that there is enough opportunities to increase rice output by expanding farm sizes and deepening labour use as the shortfall between the observed output and the frontier output was due to farm-specific technical inefficiency effects resulting from inputs utilization. There is thus the need to encourage rice farmers to use improved seedlings.

**Keywords:** Demand Gap, Imports, Yield, Upland Rice, Risk, Diversification, Policy Measures, Responsiveness

## INTRODUCTION

The importance of rice in the diet of Nigerians cannot be over emphasised as the consumption of the commodity has continued to outstrip domestic production. The causes of the growing importance of rice in Nigeria have been discussed exhaustively in the literature (Akanji, 1995; Akpokodje, Lancon and Erenstein, 2001; Ayanwale and Oluwasola, 2009; Daramola,2005;Iheke and Nwaru, 2008). To meet the nutritional need of the populace it has become necessary to import the commodity with substantial foreign exchange earnings to bridge the demand gap.For example from 1999, the value of rice imports rose steadily from US$259 million to US$655 million in 2001and US$756 million in 2002(CBN, 2006). The developmental challenge confronting Nigeria is thus how to produce the commodity locally to ensure food security, economically empower its teeming farming population, engage the increasing unemployed youths, create wealth and free the huge resources used in importing the commodity which could be invested in other sectors of the economy to enhance development.Consequently, Nigerian governments have put in place several policy measures and agricultural sector specific strategies to increase the domestic output of the commodity. Some of these measures include: the establishment of the Federal Government Rice Research Station (FRRS) at Badeggi in 1970 for the development and multiplication of improved varieties of rice seeds; the establishment of the National Accelerated Food Production Project (NAFPP) in 1972 to enhance prospects for achieving self-sufficiency in the production of five crops including rice, maize, sorghum, millet and wheat; the setting up of the National Crop Research Institute (NCRI) with the mandate of carrying out research on rice for improved productivity and an enhanced socio-economic benefits (Akpokodje*et al*. 2001; NCRI, 1988). Other programmes aimed at boosting the nation's food security goal including the production of rice were the Operation Feed the Nation (OFN) in 1976, the River Basin Development Authority (RDBA), Agricultural Development Projects (ADPs), the National Grain Production Programmes (NGPP)and the Structural Adjustment Programme (SAP). In addition, higher tariffs were imposed on imported rice (Bamidele, Abayomi and Esther, 2010) to increase the competitiveness of local rice farmers and encourage local production.

The coming on board of a new democratic government in 1999 further added impetus to the national drive to achieve self sufficiency in rice production and free the enormous resources used in importing the commodity for use in other priority areas in national development with the introduction of the Presidential Initiative on Rice in 1999 and the National Program for Food Security launched in 2001 (Bamidele *et al*, 2010). Although these policy measures contained import barriers to enhance local production, rice importation increased unabated with the tendency to discourage local farmers who lacked the economic or technical capacity to compete with the foreign imports. As Johnson, Takeshima and Gyiman-Brempong(2013) succinctly captured it, the resulting price incentives did not lead to any significant supply response, nor did the earlier public investments in the river basins, development and dissemination of high-yielding seed varieties and increased access to fertilizer improved yields. Some of the factors implicated in the failure of the farm production sector to respond positively to the policy incentives to increase rice production include improper production methods, scarcity and high cost of inputs, low mechanization, heavy reliance on labour, rudimentary post-harvest and processing methods, inefficient milling techniques and poor marketing standards particularly in terms of polishing and packaging (Daramola, 2005).By 2008, the Federal Government of Nigeria further provided a ₦10 billion (US$65.8 million) intervention fund as a policy strategy to increase local production of the commodity (Daily Independent, 2008).

In spite of these efforts to make Nigeria self-sufficient in rice production, the achievement of the policy objective has remained elusive.Currently, Nigeria consumes 5 million metric tonnes of rice annually (Businessday, 2014; Nigerian Current, 2014). While domestic output of the commodity is currently estimated to be 2.9 million metric tonnes, the deficit of 2.1 million metric tonnes is imported to augment domestic supplies at a cost of ₦360 billion (US$2.37 billion) (Businessday, 2014). The huge expenditure incurred on the commodity have been very unsatisfactory to policy makers given the fact that the country has enormous potentials to cultivate the product in nearly all agro-ecological zones.Currently, the area cultivated to rice has increased from 179,200 ha in 1965 to 630,000 ha in 1985; 1.07 million ha in 1995 and recently to 2.47 million ha (FAOSTAT, 2010; FMARD, 2001; NAERLS and NFRA,2009) while potential cultivable land to rice has been variously estimated by Imolehin and Wada (2000); Singh *et al.* (1997) and WARDA (1996) at between 4.6-4.9 million hectares. Yield is also low in Nigeria compared to other regions within the same ecological zone. For example, while the average yield for upland rice and lowland rain-fed rice in Nigeria is 1.8 tons/hectare (1.6 metric tonnes/ha) and that of irrigation systems is 3.0 tons/hectare (2.7 metric tonnes/ha), corresponding values for Cote D'Ivoire and Senegal in the same sub-region are 3.0 tons/hectare (2.7 metric tonnes/ha) and 7.0 tons/hectare (6.4 metric tonnes/ha) respectively (WARDA/NISER, 2001). There is therefore considerable potentials for Nigeria to increase rice output to meet policy goals through area expansion as well as achieve increase in yield. Consequently, there has been an intensification of policy in the Nigerian Agricultural Transformation Agenda (ATA) to make Nigeria self sufficient in rice production by encouraging the production, milling and packaging of the product locally with a view to eliminating its importation by 2015 ( Johnson *et al*. 2013).

To achieve this objective, government has introduced new import restriction macro-economic policies through tariff raise and investment strategies backed with institutional reforms to protect the local rice farmers and increase their competitiveness. Early in 2014, government further raised the special levy on imported rice from 40% in 2013 to 100% in addition to the statutory 10% import duty on rice (National Mirror, 2014). Consequently, importers pay 110% duty on rice imported into the country. In addition, government has embarked on institutional reforms of deregulating seed and fertilizer markets and setting up private sector marketing corporations to help coordinate the market and set grades and standards. Innovative financing mechanisms for supplying credit are also being pursued while physical investments are being made to establish staple crop processing zones (SCPZ) that are intended to encourage the clustering of food processing industries in proximity to raw materials and end markets (Johnson *et al*, 2013).

A major determinant of realizing these potentials as well as ensuring the success of the policy drive of government is the positive response of local output to various incentives especially, the enhancement of their access to and use of farm inputs.Rice output is expected to be influenced positively by farm size, labour, fertilizer used, agrochemical and quantity of seed planted. It is necessary to ascertain whether or not producers make rational choices in the selection and allocation of each of the considered or recommended inputs (Oyewo, Rauf, Ogundele and Balogun, 2009). Besides, knowledge of yield response to inputs used helps to identify inputs that has or lacks crop supporting technology (TSA, 2009). Hence, this study examined the responsiveness of upland rice output to the use of key inputs in the study area.

## METHODOLOGY

The study was carried out in Ekiti and Osun States of Nigeria. The States are located in the southwest geo-political zone. The zone lies between latitudes 4˚N and 9˚N of the Equator and longitudes 3˚E and 6˚E of the Greenwich Meridian. It is bounded to the North by Kwara and Kogi States; to the East by Edo and Delta States; to the South by the Atlantic Ocean and to the West by the Republic of Benin.The zone enjoys a humid tropical climate with a mean annual temperature of about $27^0$C. The mean annual rainfall ranges from 1200mm to 1450mm. The pattern of rainfall is characterized by the double maxima regime with one maximum in June/July and the other in September/October. There are two seasons in the area namely the wet and dry seasons. The wet season commences from March and ends in October while the dry season starts from November and ends in February.

The climatic diversity affects the vegetation of the area. In the southern part lies successive belts of tropical rain forest that breaks into more open woodland with hilly ranges while grass interspersed with trees and shrubs feature in the northern part of the area (Orimogunje, 2005). Major agricultural crops produced in the region include tree crops (cocoa, citrus, kolanut and oil palm) and food crops (yams, cassava, maize, rice) and vegetables. Rice cultivation is mainly carried out in the upland regions of Ekiti and Osun States. The hilly nature of the landscape makes the area susceptible to erosion under traditional shifting agriculture with dwindling fallow lengths (Ayanwale and Oluwasola, 2009).

A multi-stage sampling technique was used for this study. The first stage was the purposive selection of the major upland rice producing States (Ekiti and Osun) in southwestern Nigeria. The second stage involved the purposive selection of two Local Government Areas reputed for rice production in each of the selected States. Thus, Ekiti West and Irepodun/Ifelodun LGAs were selected in Ekiti State while Oriade and Obokun were selected in Osun State. At the third stage,a random selection of six communities in each Local Government Area was carried out. The fourth stage involved the random selection of ten rice farmers in each community. Thus, a total of two hundred and forty (240) respondents were thus sampled.

In this study, both Cobb-Douglas and translog stochastic frontier production functions (Seyoum, Battese and Fleming, 1998) were estimated and the estimated functions were statistically tested to select the function that better describes the data, using the generalized Likelihood ratio (LR) test. The results of the LR test show that the translog frontier models provide better representation of the data for the farmers. Since the null hypothesis of Cobb-Douglas being an adequate representation of the data was rejected at the 5% level. Hence, only the estimates from the translog models are presented in this study. In addition, descriptive statistics were employed to analyse socio-economic information on respondent farmers.

The translog stochastic frontier production functions that was estimated are defined by:

$$LnY = \beta_0 + \sum_{i=1}^{5} \beta_i LnX_i + \frac{1}{2} \sum_{i-1}^{5} \sum_{j-1}^{5} \beta_{ij} LnX_i LnX_j + V_i - U_i \qquad i, j = 1...5 \quad \text{------------(1)}$$

Where

$Y$ = quantity of paddy rice in kilogramme

$X_1$ = fertilizer used (Kg)

$X_2$ = pesticide ( litres)

$X_3$ = quantity of seed planted (Kg)

$X_4$ = farm size (hectares)

$X_5$ = labour utilized (man-days)

$V_i$ = random error that is assumed to be normally distributed with zero mean and constant variance ($\sigma^2_{vi}$)

$U_i$ = technical inefficiency effects which are independent of $V_i$ and have half normal distribution with mean zero and variance ($\sigma^2_{ui}$)

Following Battese and Coelli (1995) the mean of farm-specific technical inefficiency($u_i$) is defined as:

$$U_i = \sigma_o + \sigma_1 Z_1 + \sigma_2 Z_2 + \sigma_3 Z_3 + \sigma_4 Z_4 + \sigma_5 Z_5 \quad (2)$$

Where

$Z_1$ = age

$Z_2$ = educational level of farmer

$Z_3$ = household size

$Z_4$ = experience of farmer

$Z_5$ = rice variety used

The model defined by equations 27 and 28 was analysed using the maximum likelihood method to generate parameter estimates ($\beta_i$ and $\sigma_i$) and the variance parameters:

$$\sigma^2 = \sigma_u^2 + \sigma_v^2 \quad (3)$$

$$\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2) \quad (4)$$

The computer programme FRONTIER 4.1 developed by Coelli (1994) was used. The maximum likelihood estimates, sigma square ($\sigma^2$) and gamma ($\gamma$) were used to determine whether or not the model was fit and correct for the specified distribution assumption. The *a priori* expectations are that:

(i) rice output is influenced positively by fertilizer, pesticide, quantity of seed planted, farm size, and labour.

(ii) farm-specific technical inefficiency, $U_i$, is influenced positively by age of farmer and negatively by educational level, household size, rice farming experience, and rice variety planted (Umeh and Ataborh, 2006).

The elasticities of the mean output with respect to farm size, pesticide and labour were estimated at the arithmetic mean values of the different inputs, using the maximum likelihood estimates of the parameters in the model. Because inputs significantly explain variation in productivity in association with other inputs, (Herath, 1984), only those inputs with significant interactions were used in the computation of the elasticity. The signs of the elasticity measure depend on the signs of the estimated coefficients and the values of the cooperating inputs. These elasticities were obtained using the following expressions:

$$Elasticity\,(E) = \frac{LnY}{LnX_i} = \beta_i + \sum_{j=1}^{n} \beta_{ij} LnX_j, \text{ the cooperating inputs}:$$

i. $E = L_n \text{Y}/ L_n \text{(fertilizer)} = \beta_{14} \ln X_4$

ii. $E = L_n \text{Y}/ L_n \text{(herbicide)} = \beta_2 + \beta_{22} \ln X_2 + \beta_{25} \ln X_5$

iii. $E = L_n \text{Y}/ L_n \text{(seed)} = \beta_3 + \beta_{35} \ln X_5$

iv. $E = L_n \text{Y}/ L_n \text{(farm size)} = \beta_{14} \ln X_1$

v. $E = L_n \text{Y}/ L_n \text{(labour)} = \beta_5 + \beta_{25} \ln X_2 + \beta_{35} \ln X_3 + \beta_{55} \ln X_5$

## RESULTS AND DISCUSSIONS:

### The Socio-economic Characteristics of the Respondents

Majority of the sampled farmers (47.5%) fell within the age range of 51 - 60 years while another 20% aged more than 60 years. The mean age of the respondents was 53 years. Clearly, most of the farmers involved in upland rice culture in the southwestern zone of Nigeria had passed their middle ages where farmers are most physically active. Previous studies in the ecological zone further confirms this as Bamire, Oluwasola and Adesiyan (2007) found the mean age of rice farmers in Oriade area to be 58.1 years; while Ayanwale and Oluwasola (2009) found the average age of rice farmers in the area to be 51 years. The old age of rice farmers in the absence of farm mechanization will have serious impact on their ability, energy as well as the necessary drive to produce this commodity that requires high energy input. Consequently, the development of policy strategies that will encourage young men in rice cultivation is critical for the sustainable production of the commodity.

The educational level of the respondents is critical to the use of farm inputs necessary to increase rice output. It is also important in skill acquisition and technology transfer (Ogundele and Okoruwa, 2006). Only 20.4% of the 240 respondents had no formal education, 42.5% had primary education while 35% had secondary education. The remaining 2.1% had tertiary education. Although the level of education of the respondents was low, Umeh and Ataborh (2006) posits that asubstantial number of rice farm operators are sufficiently educated. As shown in Table 1, the farmers maintained large family sizes with a mean household size of about 12 while on the average, the farmers had been involved in upland rice cultivation for 26.6 years.Farm sizes were very small averaging 1.1 hectares which is substantially less than the national average farm sizes (NINCID,2006). However, this could be due to the fact that for the purpose of subsistence and farm diversification to mitigate income and output risks, farmers tend to operate several farm plots hence, these rice farms will not be the only farms operated by the farmers. This fact is buttressed by the fact that farmers had large family sizes which normally should have reflected on the rice farm sizes. More than half of the farmers (52.1%) planted local rice varieties while only 47.9% cultivated improved seedlings.

**Table 1: Socio-economic Characteristics of Respondents**

| Descriptive Variable | Frequency | Percentage | Mean | Standard Deviation |
|---|---|---|---|---|
| ***Age of respondents*** | | | | |
| ≤ 30 | 1 | 0.4 | | |
| 31 - 40 | 13 | 5.4 | | |
| 41 - 50 | 64 | 26.7 | 53.0 | 7.7 |
| 51 - 60 | 114 | 47.5 | | |
| > 60 | 48 | 20.0 | | |
| ***Education level of respondent*** | | | | |
| Did not go to school | 49 | 20.4 | | |
| Had primary education | 102 | 42.5 | | |
| Had secondary education | 84 | 35.0 | | |
| Tertiary education | 5 | 2.1 | | |
| ***Household size*** | | | | |
| 5 - 8 | 32 | 13.3 | | |
| 9 - 12 | 125 | 52.1 | 11.6 | 3.0 |
| 13 - 16 | 69 | 28.8 | | |
| > 16 | 14 | 5.8 | | |
| ***Farming experience*** | | | | |
| ≤ 10 | 6 | 2.5 | | |
| 11 - 20 | 32 | 13.3 | 26.6 | 8.7 |
| > 20 | 202 | 84.2 | | |
| ***Farm size*** | | | | |
| ≤ 1 | 188 | 78.3 | | |
| 1 - 2 | 39 | 16.3 | 1.1 | 0.9 |
| > 2 | 13 | 5.4 | | |
| ***Types of Seedlings used*** | | | | |
| Local varieties | 125 | 52.1 | | |
| Improved seedlings | 115 | 47.9 | | |

Field survey, 2011

**Estimates of Stochastic Production Frontier Model**

The maximum likelihood estimates for the translog stochastic frontier production model are as contained in Table 2. The coefficient of fertilizer was negative and not significant at any of the set levels (1%, 5%, and 10%). This implies that fertilizer was not a significant factor in upland rice production. This result was corroborated by the findings of Adeyemo and Akinola (2010), Adeoti (2001), Amaza (2000) and Ogundele (2003) hence, the suggestion that low demand elasticity for fertilizer could be attributed to the widely practised system of fallowing or poor access of farmers in terms of cost, timely availability and distance to fertilizer sale outlets. The coefficients of herbicides was also negative but significant at 1%. This is contrary to *a priori* expectations. This result suggests that the herbicide was inefficiently applied by a large proportion of farmers such that there was overuse by farmers who could not understand its application instructions as well as under utilization by farmers who could not afford the cost of purchasing the right quantity. This result is corroborated by Bamire *et al* (2007) who reported similar trends in upland rice farms in Oriade LGA of Osun State. Also contrary to *a priori* expectation was the coefficient of seed, which was negative but significant at 1% level. This could be attributed to loss of vitality as a result of some practices at farm level which affect homogeneity of paddy as well as the use of local varieties by majority of upland rice farmers. This lends credence to the conclusions of Ogundele and Okoruwa (2006), that the quality of seed is more important than the absolute quantity planted. Although the coefficient of farm size was positive, it was statistically insignificant. The coefficient of labour was positive and significant at 1%. Previous studies by Adeyemo and Akinola (2010), Adeoti (2001) and Ogundele and Okoruwa (2006) indicated existence of a positive and significant association between labour and crop output. However, Bamire *et al.* (2007) reported a negative relationship between labour and rice output in Osun State.

The coefficients of the second order terms are represented by $\beta_{11}, \beta_{12}$ ... $\beta_{55}$(Table 2). The coefficients of squares of the logarithms of fertilizer, and farm size and of interactions between fertilizer and farm size, fertilizer and labour, pesticide and farm size, pesticide and labour, and seed and labour were all positive. This implies that the variables did not exhibit decreasing returns to scale in the analysis of the translog production frontier. However, the coefficients of squares of pesticide, and labour; and of interactions between fertilizer and pesticide, fertilizer and seed, pesticide and seed, seed and farm size, and farm size and labour were negative. This implies that the variables had direct relationship with rice output.

The estimates for the diagnostic statistics, the sigma-square ( $\sigma^2$) and the gamma ($\gamma$) are also shown in Table 2. The sigma-square (0.013) was significant at 1% indicating that the model was fit and correct for the specified distribution assumptions of the composite error term implying the existence of inefficiencies in the use of inputs that affect the productivity of rice while gamma (0.740) was also significant at 1% suggesting the presence of one sided error component. The estimated $\gamma$ value means that 74% of the shortfall between the observed output and the frontier output was due to farm-specific technical inefficiency effects resulting from inputs utilization while the remaining was due to random effects that are beyond the control of the farmer.

**Table2:Maximum-Likelihood Estimates For Parameters Of The Translog Stochastic Frontier Production Function For Upland Rice Farmers In Southwestern Nigeria.**

| **Variable** | **Parameter** | **Coefficient** | **t-ratio** |
|---|---|---|---|
| Production function | $\beta_o$ | 1.688 | 3.235*** |
| Ln (fertilizer) | $\beta_1$ | -0.108 | -1.117 |
| Ln (herbicide) | $\beta_2$ | -0.786 | -4.309*** |
| Ln (seed) | $\beta_3$ | -0.302 | - 2.205*** |
| Ln (farm size) | $\beta_4$ | 0.212 | 1.575 |
| Ln (labour) | $\beta_5$ | 2.498 | 11.690*** |
| Ln (fertilizer)$^2$ | $\beta_{11}$ | 0.003 | 0.652 |
| Ln (fertilizer) x Ln (herbicide) | $\beta_{12}$ | -0.040 | -2.052 |
| Ln (fertilizer) x Ln (seed) | $\beta_{13}$ | -0.004 | -0.327 |
| Ln (fertilizer) x Ln (farm size) | $\beta_{14}$ | 0.025 | 1.777** |
| Ln (fertilizer) x Ln (labour) | $\beta_{15}$ | 0.036 | 1.134 |
| Ln (herbicide)$^2$ | $\beta_{22}$ | -0.098 | -3.048*** |
| Ln (herbicide) x Ln (seed) | $\beta_{23}$ | -0.039 | -1.201 |
| Ln (herbicide) x Ln (farm size) | $\beta_{24}$ | 0.004 | 0.071 |
| Ln (pesticide) x Ln (labour) | $\beta_{25}$ | 0.365 | 11.031*** |
| Ln (seed)$^2$ | $\beta_{33}$ | 0.008 | 1.574 |
| Ln (seed) x Ln (farm size) | $\beta_{34}$ | -0.027 | -1473 |
| Ln (seed) x Ln (labour) | $\beta_{35}$ | 0.065 | 1.922** |
| Ln (farm size)$^2$ | $\beta_{44}$ | 0.022 | 0.650 |
| Ln (farm size) x Ln (labour) | $\beta_{45}$ | -0.007 | -0.762 |
| Ln (labour)$^2$ | $\beta_{55}$ | -0.309 | -10.699*** |
| Diagnostic statistics | | | |
| Sigma square | σ 2 | 0.013 | 6.049*** |
| Gamma | Γ | 0.740 | 7.684*** |
| Log likelihood function | Λ | 259.127 | |
| LR test | | **12.129** | |

*** significant at 1%; ·** significant at 5%.

Source: field survey, 2011

### Responsiveness of rice output to inputs used

The responsiveness of rice output to inputs were determined through the calculations of elasticity values (Table 3). The table showed that three interaction and two squared terms are significantly different from zero at 5 percent level. The elasticities of the mean output with respect to the input, seed, land, fertilizer, herbicide and labour are estimated at the mean level of the different inputs. Only those variables with significant interactions were used. The sign of the elasticity measures depend on the signs of the estimated coefficients and the values of the cooperating inputs. The estimated elasticity of mean rice output with respect to fertilizer, herbicide, seed, land and labour were 0.001, 1.45, 0.13, 0.10 and 1.45 respectively.This suggests that the potential to use these inputs for productivity gains exists for the farmers. Summation of the partial elasticities gives return to scale of 3.14. The value of return to scale greater than one suggests that increasing return to scale prevails. A one percent increase in all inputs resulted in an increase of 3.14 percent in output level. Results also show that the elasticity of rice output with respect to fertilizer is estimated to be an increasing function of herbicide. It is also noted that the elasticity of output with respect to land is a decreasing function of land but an increasing function of labour while the elasticity of output with respect to fertilizer is an increasing function of labour. Similarly the elasticity of output with respect to herbicide is observed to be an increasing function of seed but the elasticity of output with respect to labour is observed to be increasing functions of land, fertilizer and labour.

The generalized likelihood ratio test statistic is significant for the rice farmers. This suggests the presence of the one – sided error-component, which implies that the effect of technical inefficiency is significant and a classical regression model of production function is an inadequate representation of the data. The variance ratio, defined as $\gamma = \sigma_u^2 / \left[\sigma_u^2 + \sigma_v^2\right]$ is estimated to be 74 percent. This means that about 74 percent of the discrepancies between observed output and the frontier output are due to technical inefficiency while 26 percent are due to uncontrollable factors related to production process.

**Table 3: Input Elasticity**

| Variable input | Elasticity |
|---|---|
| Fertilizer | 0.001456723 |
| Herbicide | 1.452527234 |
| Seed | 0.132303361 |
| Farm size | 0.101938267 |
| Labour | 1.4547311 |
| Estimate of return to scale | 3.142956683 |

Source: Field survey, 2011.

### CONCLUSION AND RECOMMENDATION

The study examined the responsiveness of upland rice production to inputs using data collected from 240 smallholder rice farmers in the upland regions of Ekiti and Osun States. Data obtained were analysed using descriptive and stochastic frontier techniques.

Results showed that upland rice production is done mainly by aging farmers with low level of education. Although they had large family sizes, their farm sizes were small averaging 1.1ha indicating that the household members were either in school or trades that did not add to the productivity of the farms or the farmers had other farm plots other than rice for income/food risk diversification.Although the use of improved rice seedlings was popular, majority of the farmers still used local rice seed varietieswith attendant effect on the viability of the seed as well as output.Furthermore, it was found that fertilizer use had no significant effect on rice output in the study area hence, most farmers did not use the input. Rather, the use of fallow to ameliorate soil fertility was popular.The increasing population and urbanization will adversely affect the effectiveness of this method and the sustainability of the soil productivity as fallow lengths decrease. The low level of education among the farmers was evident as there was misapplication of herbicides in the farms since the frontier estimates showed that a unit increase in the use of herbicide would decrease rice output by 0.42 units. There is thus a need for the education of the farmers through extension agents on the interpretation of the unit of measurement and application of various herbicides to ensure sustainable production of rice in the area. The input of seed also exhibited similar trends as it showed that a unit increase in the seeds used will decrease rice output by 0.07 units hence the need to encourage rice farmers to use improved seedlings. Labour significantly influenced rice output while farm size although statistically insignificant, positively influenced rice production.

Clearly, since the farm enterprises were operating at an increasing return to scale as indicated by the sum of the estimated elasticity coefficients, it is possible to increase the output of rice by expanding farm sizes and deepening labour use. In the face of increasing unemployment especially among the youths, encouraging able bodied and educated youths into the sector will enhance income and improve the self sufficiency in rice production goal of Nigeria. However responsiveness of rice to key inputs of fertilizer, herbicide and seedlings to rice output were negative. There is thus the need for the intensification of the implementation of policy of accessing these inputs to rice farmers at affordable costs and at appropriate periods. Enlightenment campaigns by extension agents for the appropriate use of these inputs especially by the largely illiterate farmers is also very crucial to achieve the policy goal.

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